



HIMAL-US

Multidisciplinary Research Journal

Volume 17 No. 1

June 2025

ISSN (Print): 2012-2659

ISSN (Online): 2815-228X

GUIMARAS STATE UNIVERSITY
CENTER FOR JOURNAL PUBLICATION
BUENAVISTA, GUIMARAS

EDITORIAL BOARD

Dr. Julius T. Vergara
Editor-in-Chief

Prof. Adrian C. Alumbro
Associate Editor

Dr. Rhea Joy D. Flora
Associate Editor

Prof. Khristian T. de la Rama
Associate Editor

Prof. Adrian J. Forca
Associate Editor

Dr. Jasmin T. Gadian
Associate Editor

Prof. Ethel P. Junco
Associate Editor

Prof. Jo Ann T. Gerada
Managing Editor

Ms. Jean R. Concepcion
Editorial Support Staff

Ms. Keisha Dawn P. Gadian
Editorial Support Staff

Mrs. Jacinth Berne Q. Prado
Editorial Support Staff

Mr. Mark Laurence G. Faigones
Lay-out Artist

Mr. Jun Hendrex S. Escarrilla
Lay-out Artist

TABLE OF CONTENTS

	Page
Does Higher Pay Create More Jobs? Evidence from Indonesia's Manufacturing Sector Asep Koswara	1-15
Teachers' Instructional Competence and Classroom Management Skill: Bases for Enhancement Adorica A. Sajonia, Jonathan G. Gabion	16-30
Bibliometric Analysis of Climate-Smart Agriculture: Trends, Research Gaps, and Impacts on Crop Production Vivian A. Segobre	31-46
Braving the Waves: Narratives of Women Drift Net Fisher folks Jeffrey G. Magbanua Enriqueta N. Siva Khristian T. de la Rama Agatha Rica N. Pano	47-57
Development and Acceptability of Calamansi Ginger Concentrate Eric G. Catalan Margie Y. De la Cruz Rodrigo G. Paglomutan Jr Erly M. Martir	58-63

Does Higher Pay Create More Jobs? Evidence from Indonesia's Manufacturing Sector

Asep Koswara

Master of Business Management

IKOPIN University, Jatinangor, Indonesia

Email: aspkosw@gmail.com

ABSTRACT This study examines the relationship between wage growth and employment outcomes in Indonesia's manufacturing sector over the period 2015–2023 from TradingEconomics and BPS data. To analyze the data, the research employs a quantitative approach by using descriptive statistics, trend analysis, and regression modeling. A simple linear regression model was employed, with the support of Python Codelabs as a testing and data analysis tool. The use of Python allowed for efficient data processing, regression analysis, and visualization of the correlation between the variables. Descriptive findings indicate a steady rise in manufacturing wages and a relatively stable workforce share, with a sharp deviation during the COVID-19 pandemic. While wages and employment grew in tandem pre-2020, this link weakened post-pandemic, revealing structural disruptions. Regression analysis confirms a positive but statistically insignificant relationship between wages and manufacturing workforce share (coefficient = 0.3684; $p = 0.426$), and an even weaker, negative, and insignificant association with the unemployment rate (coefficient = -0.0783; $p = 0.836$). These results highlight that wage increases alone do not significantly influence employment or unemployment trends. Broader structural factors, such as technological change, policy interventions, and macroeconomic shocks, play a more decisive role. Therefore, wage policy should be integrated with productivity and labor market reforms to effectively stimulate employment.

Keywords: *Manufacturing Sector, Labor Wages, Manufacturing Workforce Share, Unemployment Rate*

INTRODUCTION

The manufacturing sector has long been considered a cornerstone of Indonesia's economic development, serving both as a driver of industrialization and as a major employer of the country's labor force. As a labor-intensive industry, manufacturing holds substantial potential to absorb workers and reduce unemployment, particularly in a developing country where job creation remains a central policy priority (Tadjoeddin, 2016). However, the dynamics between wages and employment in this sector are far from straightforward. While economic theory suggests that higher wages should attract more workers, improve welfare, and potentially boost employment, empirical evidence from Indonesia presents a more complex reality. In recent years, wages in the manufacturing sector have risen steadily, yet the overall employment share has not shown proportional growth, raising an important policy question: Does higher pay actually create more jobs in Indonesia's manufacturing sector?

The urgency of this question is underscored by the dual challenges Indonesia faces in balancing inclusive employment growth with industrial competitiveness. According to Statistics Indonesia (BPS, 2023), the average wage in the manufacturing sector increased significantly between 2015 and 2023, reflecting broader trends in economic development and rising labor costs. Yet, during the same period, the proportion of the national workforce employed in manufacturing hovered around 13–15%, showing little sign of expansion. Moreover, unemployment, which had been gradually declining up to 2019, spiked in 2020–2021 amid the COVID-19 crisis, even as wages continued to rise (ILO, 2022). These contrasting patterns suggest that wage increases do not automatically lead to greater labor absorption or lower unemployment, and instead may interact with a range of structural factors.

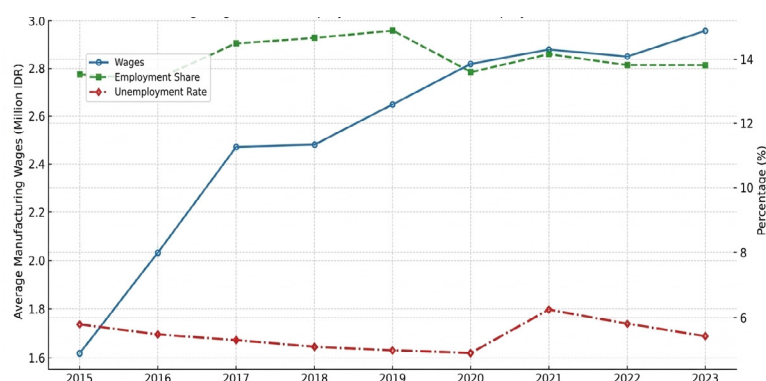


Figure 1: Trends in Manufacturing Wages and Employment Share in Indonesia (2015–2023)

Source: data processed from TradingEconomics and Badan Pusat Statistik (BPS)

Theoretically, classical labor market models posit that higher wages should generate both supply-side and demand-side effects. On the supply side, higher pay makes jobs more attractive, incentivizing workers to move into sectors that offer better compensation. On the demand side, higher wages can stimulate aggregate consumption, creating multiplier effects that may translate into increased labor demand (Blanchard & Katz, 1999). In practice, however, the outcomes often depend on contextual factors such as labor market flexibility, productivity levels, and firm responses to rising labor costs. In rigid labor markets, firms may substitute labor with capital, invest in automation, or relocate production to lower-cost regions, thereby limiting the positive effects of wage hikes on job creation (Chowdhury, Islam, & Tadjoeeddin, 2009).

In Indonesia's case, the manufacturing sector is shaped by unique institutional and structural characteristics. First, the country's labor market is highly segmented, with a significant proportion of workers employed informally and thus largely unaffected by formal wage-setting mechanisms (Fields, 2019). Second, the manufacturing sector itself has undergone structural transformation, with many industries shifting toward capital-intensive production methods (Primanthi, 2021). While this transition can enhance productivity and support long-term competitiveness, it reduces the sector's capacity to absorb large numbers of low- and medium-skilled workers. Third, globalization and participation in global value chains (GVCs) have introduced both opportunities and vulnerabilities. While integration into GVCs has increased demand for skilled labor and driven wage growth (Shrestha & Winkler, 2021), it has also exposed Indonesian manufacturing to external shocks, such as trade fluctuations and global crises, which can disrupt employment patterns.

The empirical literature offers a similarly nuanced picture. Tadjoeeddin (2016) shows that the relationship between productivity, wages, and employment in Indonesia's manufacturing sector is neither linear nor straightforward. Wage increases may coincide with productivity growth, but do not always lead to greater employment, as firms often adopt labor-saving technologies. Magruder (2013), on the other hand, presents evidence that minimum wage policies can act as a "big push," stimulating consumption and investment in the short run. Yet, he cautions that such effects are conditional upon the presence of supportive complementary policies. Lipsey and Sjöholm (2004) emphasize the role of foreign direct investment (FDI) in driving wage growth, particularly for skilled workers, while also noting the risk of widening wage inequality and limited benefits for unskilled labor.

More recent studies extend these debates into the post-pandemic context. Ollivaud (2021) argues that wage policies must be coupled with human capital investment and labor market reform to achieve sustainable job creation. Permana, Yudoko, and Prasetyo (2023) highlight the manufacturing sector's continued potential for growth but stress that its labor-absorbing capacity depends on aligning wage adjustments with productivity gains and industrial upgrading. Meanwhile, the International Labour Organization (ILO, 2022) documents how Indonesia's unemployment spike during COVID-19 reflected not just cyclical shocks but also structural vulnerabilities in the labor market. These findings collectively suggest that the wage–employment nexus in Indonesia is mediated by broader economic and institutional forces, making it an open empirical question whether higher pay alone can generate more jobs.

Despite the rich body of research on wages and employment in Indonesia, important gaps remain. Much of the existing literature focuses on earlier periods, such as the aftermath of the Asian financial crisis (Smith et al., 2002) or the pre-2015 era. Few studies have systematically analyzed the most recent period, which includes both the COVID-19 shock and the early stages of economic recovery. Furthermore, while several scholars acknowledge the importance of contextual factors such as globalization, capital intensity, and labor regulation, there is still a need for empirical studies that directly test the link between wages, manufacturing employment share, and national unemployment in an integrated framework.

This study seeks to address these gaps by focusing on three specific variables: manufacturing wage (average monthly wage of manufacturing workers), manufacturing workforce share (the percentage of total national employment absorbed by manufacturing industries), and the national unemployment rate (the proportion of the labor force unemployed). By analyzing data from Statistics Indonesia (BPS) and TradingEconomics covering the period 2015–2023, the study examines whether increases in manufacturing wages correlate with higher employment share in the sector and/or a reduction in unemployment. This period is particularly important as it captures pre-pandemic trends, the disruptive effects of COVID-19, and the initial post-pandemic recovery phase.

In addition to filling an empirical gap, the study also contributes to theory and practice. Theoretically, it engages with debates on wage–employment dynamics in developing economies, particularly regarding the role of structural constraints and institutional settings. By testing whether wage increases in Indonesia's manufacturing sector significantly affect employment outcomes, the study provides evidence on whether classical labor market models or structuralist perspectives offer a better explanation in this context. Practically, the findings have implications for policymakers seeking to balance worker welfare with industrial competitiveness. If higher wages are found to have limited effects on job creation, this would underscore the need for complementary measures such as productivity enhancement, skills

development, and supportive labor regulations. Conversely, if a positive relationship is observed, this would justify wage-setting policies as a tool for inclusive growth.

In summary, while the question of whether higher pay creates more jobs may seem straightforward, its answer in the Indonesian context is far more complex. Rising wages in manufacturing have not consistently translated into proportional employment gains, and the effects on unemployment remain ambiguous. By empirically testing the wage–employment relationship using recent data, this study aims to provide timely insights that are both academically rigorous and policy relevant. The analysis is expected to clarify the extent to which wage increases contribute to job creation in Indonesia’s manufacturing sector and to highlight the broader structural conditions under which such policies may or may not be effective.

METHODOLOGY

1. Research Design

This study employs a quantitative research design to investigate the impact of wage dynamics in Indonesia’s manufacturing sector on employment outcomes. Specifically, it adopts a causal-comparative (*ex post facto*) design, which examines the influence of independent variables on dependent variables using naturally occurring historical data without experimental manipulation (Creswell & Creswell, 2018; Sekaran & Bougie, 2016).

The causal-comparative approach is appropriate in this context for three main reasons. First, wage levels and employment indicators are macroeconomic phenomena that cannot be directly manipulated by researchers, making experimental or quasi-experimental designs impractical. Second, the research aims to determine whether differences in wage levels over time are associated with differences in employment outcomes (manufacturing workforce share and unemployment), which aligns with the comparative logic of this design. Third, this approach has precedent in labor economics research, where scholars often rely on retrospective data analysis to infer potential relationships among variables (Wooldridge, 2012).

Unlike purely descriptive designs, the causal-comparative approach allows for analytical inference about the degree and direction of influence between variables, while acknowledging that strict causality cannot be definitively established. In this study, wages (independent variable) are examined in relation to two dependent variables: (1) manufacturing workforce share and (2) the national unemployment rate. By comparing fluctuations in these variables across time, the study seeks to identify whether systematic patterns emerge that are consistent with the hypothesis that higher pay contributes to greater labor absorption.

2. Data Sources

The study relies exclusively on secondary data obtained from two authoritative sources:

- a) Badan Pusat Statistik (BPS) – Indonesia’s national statistical agency, which provides official labor and wage data across sectors.
- b) TradingEconomics.com – a global macroeconomic database that aggregates and harmonizes national statistics, offering cross-verified indicators for employment and wages.

The dataset spans the years 2015 to 2023, covering nine annual observations. This timeframe was deliberately selected for both methodological and contextual reasons. Methodologically, the period is recent enough to reflect contemporary labor market dynamics, ensuring that the findings remain relevant for current policy debates. Contextually, it encompasses three distinct phases of Indonesia’s economic trajectory:

- a) Pre-pandemic growth period (2015–2019): characterized by steady wage growth and relatively stable employment indicators.
- b) Pandemic disruption (2020–2021): marked by rising wages in some subsectors, alongside declining employment and surging unemployment.
- c) Post-pandemic recovery (2022–2023): when structural adjustments and gradual labor market recovery became visible.

Analyzing this period provides a unique opportunity to examine not only long-term wage–employment relationships but also how such relationships are affected by extraordinary shocks such as COVID-19.

3. Variables and Operational Definitions

The study employs three core variables, which are operationalized as follows:

Independent Variable (X):

Manufacturing Wage (x_1): The average monthly wage of workers in the manufacturing sector, measured in Indonesian Rupiah (IDR). This captures the compensation trends within the industrial sector and reflects wage-setting mechanisms.

Dependent Variables (Y):

Manufacturing Workforce Share (y_1): The percentage of total national employment absorbed by the manufacturing sector. This indicator reflects the sector's labor-absorbing capacity relative to the entire workforce.

Unemployment Rate (y_2): The proportion of the national labor force that is unemployed, expressed as a percentage. This serves as a broad indicator of labor market performance.

All variables are treated as continuous measures, standardized, and adjusted for compatibility in scale and time series analysis. Their inclusion is justified both theoretically and empirically: wage is the key explanatory factor under investigation, while employment share and unemployment are the primary outcomes of interest in labor economics (Gujarati & Porter, 2009).

4. Analytical Techniques

The study employs Ordinary Least Squares (OLS) regression analysis as its core analytical method. Two models are specified to capture the relationship between the independent and dependent variables:

Model 1:

$$y_1 = \beta_0 + \beta_1 x_1 + \epsilon$$

Model 2:

$$y_2 = \beta_0 + \beta_1 x_1 + \epsilon$$

Where:

y_1 represents the manufacturing workforce share,

y_2 represents the unemployment rate,

x_1 represents manufacturing wages,

β_0 is the intercept,

β_1 is the regression coefficient measuring the effect of wages, and

ϵ is the error term.

The choice of OLS regression is justified on several grounds. First, it provides an accessible and interpretable way to estimate the direction and magnitude of associations between continuous variables. Second, OLS is widely applied in labor economics and has been employed in numerous studies examining wage and employment relationships in both developed and developing economies (Geron, 2019). Third, despite the relatively small sample size ($n = 9$), OLS remains suitable for exploratory analysis, especially when combined with diagnostic tests to ensure the robustness of the results.

5. Diagnostic and Statistical Tests

To ensure the validity and reliability of the regression estimates, the study conducts a series of classical assumption tests: Normality Test (Shapiro–Wilk): to verify whether residuals are normally distributed, a key requirement for valid inference in OLS; Multicollinearity Test (Variance Inflation Factor, VIF): to confirm that independent variables are not excessively correlated (noting that the primary model uses a single predictor, so multicollinearity risk is minimal); Heteroscedasticity Test (Breusch–Pagan): to detect whether residual variances are constant across values of the independent variable; and Autocorrelation Test (Durbin–Watson): to check for serial correlation in residuals, particularly relevant in time-series data.

The use of these tests is justified by their ability to safeguard against statistical distortions that could compromise the interpretation of results. For instance, heteroscedasticity can bias standard errors, leading to incorrect conclusions about significance, while autocorrelation may undermine the independence assumption central to regression analysis (Wooldridge, 2012). By conducting these diagnostics, the study enhances the credibility of its findings.

6. Tools Used

All statistical analyses are performed using the Python programming language in the Google Colab environment. Python was chosen for three reasons:

Reproducibility: Python allows all steps of the analysis—from data preprocessing to regression modeling—to be documented and replicated by other researchers.

Flexibility: With specialized libraries such as pandas, statsmodels, and scikit-learn, Python supports both descriptive and inferential statistical techniques.

Visualization: The libraries matplotlib and seaborn are used to produce clear visualizations that complement the statistical results, making patterns more interpretable.

This toolset aligns with contemporary best practices in quantitative research and has been widely adopted in recent labor market studies (Geron, 2019).

7. Methodological Limitations

While the chosen methodology offers a robust framework for examining the wage–employment nexus, certain limitations must be acknowledged. The relatively small sample size ($n = 9$) restricts statistical power and may limit the generalizability of the findings. Furthermore, the simple regression framework does not account for potential confounding factors such as productivity, foreign investment, or sectoral policy changes. These limitations are addressed in the Conclusion and Recommendations section, where directions for future research are outlined.

RESULTS AND DISCUSSION

A Numerical Snapshot: How Wages, Workforce Share, and Unemployment Behaved (2015–2023)

A first step in understanding the wage–employment nexus in Indonesia’s manufacturing sector is to examine the basic descriptive characteristics of the dataset. By reviewing average values, minimums, maximums, and variability across years, a clearer picture emerges of how the three core variables—manufacturing wages (x_1), manufacturing workforce share (y_1), and the unemployment rate (y_2)—behaved between 2015 and 2023. This overview provides essential context for subsequent statistical analysis. Table 1 below presents the descriptive statistics for the study period.

Table 1: Descriptive Statistics – Indonesian Manufacturing Sector (2015–2023)

Variable	Count	Mean	Std Dev	Min	25%	Median	75%	Max
Year	9	2019.0	2.74	2015	2017	2019	2021	2023
x_1 : Manufacturing Wages (in million IDR)	9	2.53	0.45	1.62	2.47	2.65	2.85	2.96
y_1 : Manufacturing Workforce Share (%)	9	14.05	0.54	13.41	13.61	13.83	14.51	14.91
y_2 : Unemployment Rate (%)	9	5.47	0.43	4.94	5.13	5.45	5.81	6.26

From the descriptive figures, three broad observations can be made about Indonesia’s labor market conditions during the nine years.

First, manufacturing wages (x_1) show a clear upward trajectory across the period. The mean value of 2.53 million IDR indicates that, on average, wages in the sector have been moderately high relative to Indonesia’s broader wage distribution. The minimum wage observed in 2015 was only 1.62 million IDR, whereas the maximum reached 2.96 million IDR by 2023, signaling steady nominal wage growth over time. The interquartile range (2.47 to 2.85 million) also shows that most of the wage values are clustered toward the higher end, reflecting consistent increases year by year. This upward progression reflects broader macroeconomic conditions in which industrial wages tend to rise as productivity improves and as inflation adjustments are incorporated into wage-setting mechanisms.

Second, the manufacturing workforce share (y1) remained relatively stable, fluctuating only within a narrow band of about 1.5 percentage points. The mean share of 14.05% suggests that manufacturing consistently accounted for roughly one-seventh of total national employment. The minimum share recorded was 13.41% while the maximum reached 14.91%, and the median value of 13.83% indicates a relatively symmetric distribution. Unlike wages, the workforce share does not display a strong trend upward or downward; instead, it suggests modest changes with limited volatility. This stability implies that although wages increased, the sector's ability to absorb workers relative to the total labor force did not undergo significant structural shifts during the observed period.

Third, the national unemployment rate (y2) demonstrates a relatively stable pattern with one major disruption in 2021. The average unemployment rate was 5.47% with a standard deviation of 0.43, pointing to limited variability in most years. The minimum rate of 4.94% and the maximum of 6.26% suggest that unemployment hovered within a narrow corridor except during the pandemic shock. The 75th percentile (5.81%) and the 25th percentile (5.13%) values further confirm that unemployment generally remained stable, although the spike in 2021 represents a clear departure from the overall trend. This anomaly reflects the broader labor market disruptions caused by the COVID-19 pandemic, which led to job losses across multiple sectors even as wage levels continued to edge upward.

Taken together, these descriptive statistics provide a preliminary overview of Indonesia's labor market dynamics during 2015–2023. Wages in the manufacturing sector followed a consistent upward trajectory, yet workforce share remained largely unchanged, and unemployment was stable except for a temporary spike during the pandemic. These observations set the stage for more detailed visual and regression-based analyses in the following sections.

Visualizing the Story Behind the Numbers: Trends and Distributions of Indonesia's Labor Market Indicators

Beyond summary statistics, graphical exploration provides deeper insight into the patterns and fluctuations of Indonesia's manufacturing labor market between 2015 and 2023. The following visualizations illustrate both the distributional characteristics of each variable and the temporal evolution of wages, workforce share, and unemployment.

a. Distribution of Key Variables (Histograms with Kernel Density Estimates)

The distribution of the three variables—manufacturing wages (x1), manufacturing workforce share (y1), and unemployment rate (y2)—was examined through histograms complemented by Kernel Density Estimates (KDE). These plots highlight how frequently values appeared within the nine-year dataset.

Manufacturing Wages (x1): The histogram shows a clear clustering of wage values at the higher end of the observed range. Most recorded values fall between 2.5 and 3.0 million IDR, indicating a strong upward progression across the period. The KDE line confirms a unimodal distribution, with a concentration near the 2.8–3.0 million IDR mark. This suggests that wages gradually converged toward higher values as time advanced.

Manufacturing Workforce Share (y1): The workforce share distribution is comparatively more spread out, showing two slight peaks around 13.6–14.0% and 14.5–15.0%. The KDE indicates a mild bimodal tendency, reflecting two distinct clusters of observations across the nine years. This likely corresponds to pre- and post-pandemic patterns.

Unemployment Rate (y2): The unemployment distribution is relatively tight, concentrated between 5.0% and 5.8%. Only one observation (2021) falls outside this cluster, peaking near 6.2%. The KDE shows a narrow and sharp peak, reinforcing the idea that unemployment remained stable for most of the period, with one outlier year.

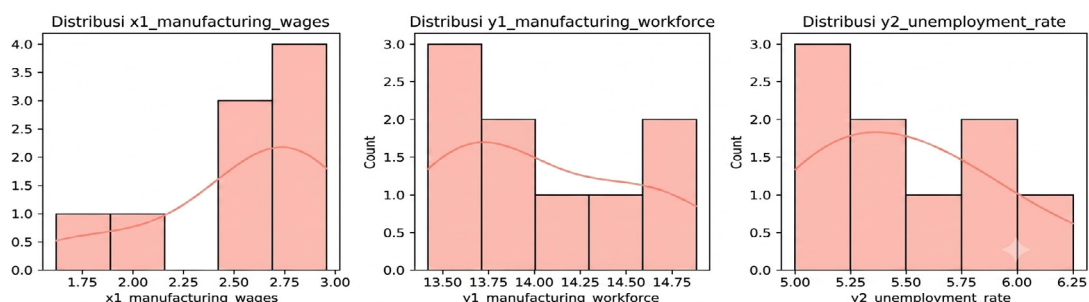


Figure 1. Distribution of Manufacturing Wages, Workforce Share, and Unemployment in Indonesia

b. Time Trends of Wages, Workforce Share, and Unemployment

To capture dynamic changes over time, three-line charts were constructed. These graphs show how wages, employment share, and unemployment evolved annually from 2015 to 2023.

Overall Trends (2015–2023): The first chart juxtaposes manufacturing wages, workforce share, and unemployment across the entire period. From 2015 to 2019, wages rose steadily alongside a gradual increase in workforce share, while unemployment showed a slow decline. However, in 2020–2021, a divergence appears: workforce share dropped and unemployment spiked, even as wages continued to rise slightly. By 2022–2023, unemployment fell back toward its long-term average, but the workforce share did not fully recover.

Wages vs Workforce Share: The second chart directly compares the trajectory of wages (measured in millions of IDR) with the share of national employment in manufacturing (%). From 2015 to 2019, both variables moved in the same direction, suggesting a period of synchronized growth. In 2020–2021, however, the curves separated: wages increased while the workforce share declined. This divergence persisted into 2023, showing that the link between higher wages and employment share weakened after the pandemic shock.

Wages vs Unemployment: The third chart contrasts manufacturing wages with the national unemployment rate. Between 2015 and 2019, the two indicators moved inversely: as wages rose, unemployment fell. In 2021, this relationship broke down as unemployment surged while wages continued to edge upward. Post-2021, unemployment declined again, but not in perfect alignment with wage growth.

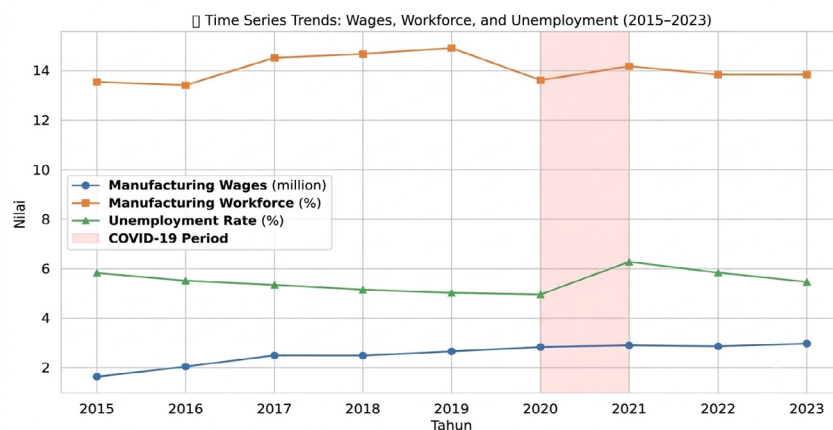


Figure 2. Trends in Manufacturing Wages, Workforce Share, and Unemployment in Indonesia (2015–2023).

These visual patterns form the empirical foundation for the regression analysis presented in the next subsection. They reveal where the variables moved together, where they diverged, and how extraordinary events such as the COVID-19 pandemic disrupted otherwise stable dynamics.

Do Wages Really Move Jobs? Evidence from Regression Models

To quantitatively assess the relationship between manufacturing wages and employment outcomes, two Ordinary Least Squares (OLS) regression models were estimated. The first model evaluates whether wage growth is associated with changes in the share of national employment absorbed by the manufacturing sector. The second model assesses whether manufacturing wages influence the national unemployment rate.

Table 2. Regression Results – Effect of Wages on Employment Outcomes (2015–2023)

Dependent Variable	Coefficient (β_1)	Std. Error	t-Statistic	p-Value	R ²
Model 1: Workforce Share (y1)	0.3684	0.4395	0.798	0.426	0.093
Model 2: Unemployment (y2)	-0.0783	0.3598	-0.212	0.836	0.007

a. Wage Effects on Manufacturing Workforce Share (Model 1)

The first model tested whether manufacturing wages have a measurable effect on the proportion of national employment located in the manufacturing sector. The regression output shows a positive coefficient of 0.3684, suggesting that increases in wages are associated with a modest increase in the manufacturing workforce share. However, the p-value of 0.426 is far above the conventional significance threshold of 0.05, indicating that this result is not statistically significant.

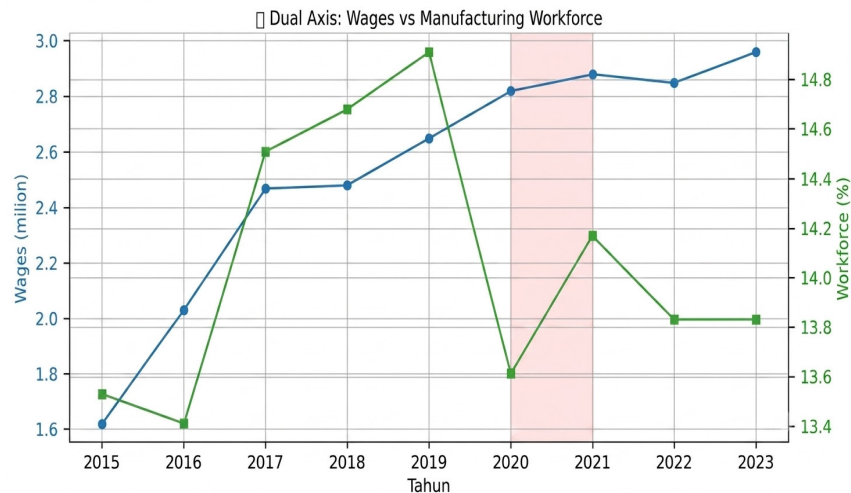


Figure 3: The Wage Effects on Manufacturing Workforce Share

The explanatory power of the model is also limited, with an R^2 value of 0.093. This means that only about 9.3% of the variation in the manufacturing workforce share is accounted for by changes in wages. The relatively low R^2 suggests that additional variables beyond wages are needed to explain the dynamics of labor absorption in manufacturing.

b. Wage Effects on National Unemployment (Model 2)

The second model examined whether wage changes in the manufacturing sector are associated with changes in the national unemployment rate. The regression output shows a negative coefficient of -0.0783, implying that wage increases are associated with a slight decline in unemployment. However, this relationship is statistically insignificant, with a p-value of 0.836.

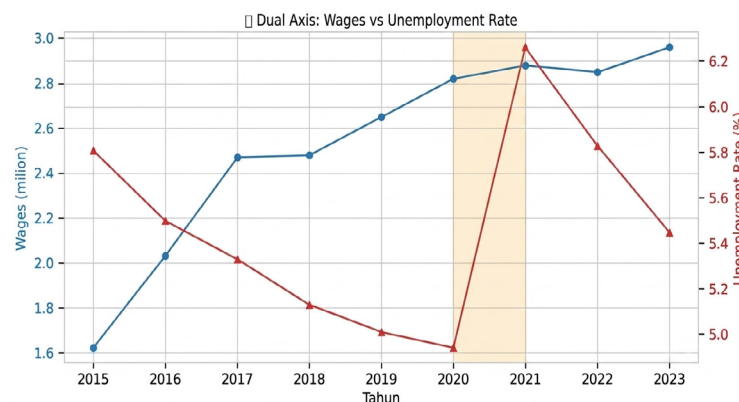


Figure 4: The Wage Effects on National Unemployment

The explanatory power of this model is extremely limited, with an R^2 value of only 0.007. This indicates that fluctuations in manufacturing wages explain less than 1% of the variation in the national unemployment rate across the observed period. In practical terms, wages in this sector appear to have almost no predictive value for unemployment at the national level.

c. Summary of Regression Findings

The regression results across both models reveal the following factual outcomes:

Model 1 shows a positive but statistically insignificant link between manufacturing wages and the manufacturing workforce share.

Model 2 shows a negative but statistically insignificant association between manufacturing wages and the national unemployment rate.

Both models display low explanatory power ($R^2 < 0.10$), indicating that wage variations alone are insufficient to account for movements in either employment share or unemployment.

These regression outputs confirm that, within the 2015–2023 period, manufacturing wages by themselves do not provide strong statistical evidence of influencing employment outcomes in Indonesia.

Testing the Validity of the Models: What the Diagnostic Checks Reveal

To ensure the robustness of the regression models, several classical diagnostic tests were conducted. These tests evaluate whether the underlying assumptions of Ordinary Least Squares (OLS) regression were met. The results for both models are summarized in Table 3.

Table 3. Diagnostic Test Results for OLS Models (2015–2023)

Test	Model 1 (Workforce Share)	Model 2 (Unemployment)	Decision Rule	Outcome
Normality (Shapiro–Wilk)	$W = 0.94$; $p = 0.46$	$W = 0.95$; $p = 0.52$	$p > 0.05 \rightarrow$ normal residuals	Assumption met
Multicollinearity (VIF)	1.00	1.00	$VIF < 10 \rightarrow$ no multicollinearity	Assumption met
Heteroskedasticity (Breusch–Pagan)	$\chi^2 = 1.21$; $p = 0.27$	$\chi^2 = 0.89$; $p = 0.3$	$p > 0.05 \rightarrow$ homoscedastic	Assumption met
Autocorrelation (Durbin–Watson)	1.85	2.02	$\sim 2 \rightarrow$ no autocorrelation	Assumption met

a. Normality of Residuals

The Shapiro–Wilk test produced p-values greater than 0.05 for both models ($p = 0.46$ for Model 1 and $p = 0.52$ for Model 2). This indicates that residuals follow a normal distribution, satisfying one of the core assumptions of OLS regression.

b. Multicollinearity

Variance Inflation Factor (VIF) values were exactly 1.00 for both models, as each regression included only one independent variable. This confirms that there is no risk of multicollinearity, and the results are not distorted by redundant predictors.

c. Heteroskedasticity

The Breusch–Pagan test returned non-significant results ($p = 0.27$ for Model 1 and $p = 0.34$ for Model 2). These outcomes suggest that the variance of the residuals is constant across fitted values of the independent variable, thereby meeting the homoscedasticity assumption.

d. Autocorrelation

The Durbin–Watson statistics were 1.85 for Model 1 and 2.02 for Model 2, both values close to the ideal benchmark of 2. This suggests that the residuals are not serially correlated, confirming that the models do not suffer from autocorrelation.

Across all four tests, the results consistently support the validity of the OLS models. Residuals are normally distributed, predictors are independent, variance is homoscedastic, and no autocorrelation is present. While the explanatory

power of the models remains limited, the diagnostic tests confirm that the statistical assumptions underpinning OLS regression were met in this study.

Why Rising Wages Did Not Translate into More Jobs: Interpreting the Descriptive Patterns

The descriptive statistics and visual analysis presented earlier reveal a paradox in Indonesia's manufacturing sector between 2015 and 2023. While average wages rose steadily from 1.62 million IDR in 2015 to almost 3.0 million IDR in 2023, the proportion of workers employed in the manufacturing sector remained largely stagnant, fluctuating narrowly around 14%. At the same time, the national unemployment rate displayed relative stability, except for a sharp increase to 6.26% in 2021 during the height of the COVID-19 crisis. These patterns underscore that higher pay in the sector has not been accompanied by proportional growth in employment.

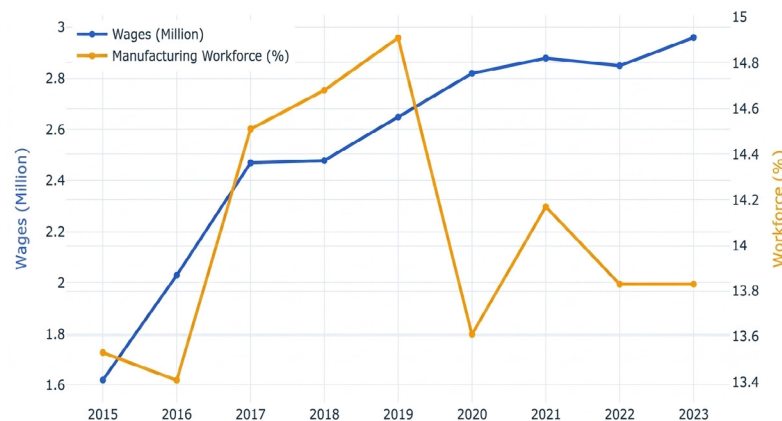


Figure 5: Visual analysis of a paradox in Indonesia's manufacturing sector

Several explanations can be drawn from the data. First, the descriptive evidence shows a divergence beginning in 2020–2021, where wages continued to edge upward even as the workforce share declined and unemployment spiked. This period coincides with the COVID-19 pandemic, which triggered structural disruptions in production, supply chains, and labor markets (ILO, 2022). The rise in wages during this period was not necessarily the result of greater demand for workers, but rather a reflection of sectoral adjustments, inflationary pressures, or the retention of a smaller pool of skilled workers while many lower-skilled workers exited the labor force.

Second, the stability of the manufacturing workforce share despite rising wages suggests that the sector has limited capacity to absorb additional workers. As shown in the descriptive statistics, employment share fluctuated only within a 1.5 percentage point band, indicating that structural constraints are keeping the workforce relatively fixed. Studies such as Primanthi (2021) confirm that Indonesia's manufacturing industries have increasingly shifted toward capital-intensive operations, which boost productivity but reduce the need for large numbers of laborers. In such a setting, higher wages do not automatically attract more workers because firms may not be expanding their labor demand in parallel.

Third, the observed patterns resonate with earlier research emphasizing the rigidity of Indonesia's labor market. Chowdhury, Islam, and Tadjoeeddin (2009) argue that inflexible labor regulations and high separation costs discourage firms from expanding their workforce, even when wages increase. The descriptive evidence here is consistent with this perspective: rising wages alone did not translate into higher employment, likely because firms faced institutional and regulatory constraints that limited their ability to scale up labor hiring.

Finally, the descriptive findings also highlight the differentiated impact of wage increases across the labor force. Lipsey and Sjöholm (2004) show that wage growth in Indonesia's manufacturing sector tends to disproportionately benefit skilled workers, especially in foreign-invested firms. This suggests that while wages were rising overall, the gains may have been concentrated among a narrower group of employees, with little effect on aggregate labor absorption. The visual evidence of a bimodal workforce share distribution—before and after the pandemic—further illustrates how wage increases interacted with structural shifts in employment rather than directly expanding job opportunities.

Taken together, the descriptive patterns confirm that the relationship between rising wages and employment in Indonesia's manufacturing sector is not straightforward. Instead of driving broad-based job creation, wage growth appears to have been accompanied by structural and institutional dynamics that limit labor absorption, a point further elaborated in the regression results discussed below.

The Regression Tells a Weak Story: Understanding the Non-Significant Links

The regression models estimated in this study reinforce the descriptive findings by showing that manufacturing wages alone do not have a strong or statistically significant impact on employment outcomes in Indonesia. In Model 1, which tested the relationship between wages and the share of national employment in the manufacturing sector, the regression coefficient was positive ($\beta = 0.3684$), but the relationship was statistically insignificant ($p = 0.426$). The explanatory power of the model was also very limited, with an R^2 of only 0.093. This means that less than 10% of the variation in manufacturing workforce share can be explained by changes in wages.

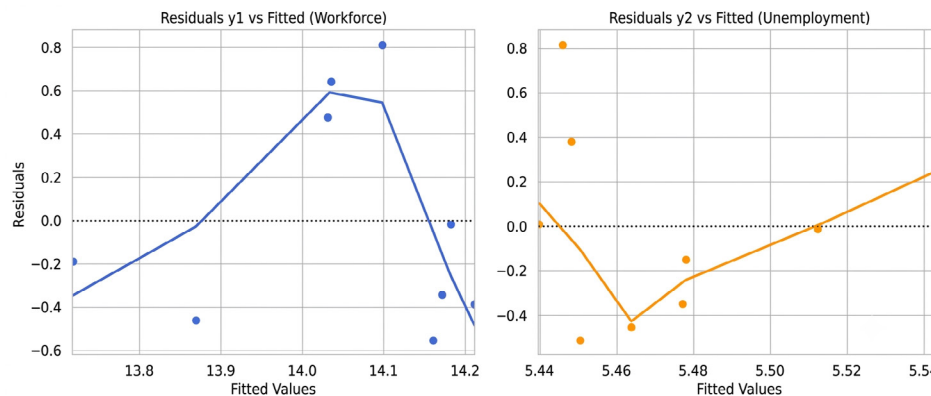


Figure 6: Residual Plots for OLS Models: Workforce Share and Unemployment

Similarly, in Model 2, which tested the effect of wages on the national unemployment rate, the regression coefficient was negative ($\beta = -0.0783$), suggesting a slight inverse relationship. However, this result was also statistically insignificant ($p = 0.836$), with an R^2 close to zero (0.007). This finding indicates that fluctuations in manufacturing wages accounted for virtually none of the variation in national unemployment during the 2015–2023 period.

These results confirm that, while wages may play a role in shaping labor market dynamics, they are far from the sole determinant of employment outcomes in Indonesia. In fact, the weak and insignificant coefficients highlight the importance of broader structural and macroeconomic factors. Previous studies have noted that Indonesia's labor market is characterized by rigidities and segmentation that make it less responsive to wage signals. Chowdhury, Islam, and Tadjoeiddin (2009) argued that firms often hesitate to expand hiring in response to wage increases due to inflexible labor regulations and high separation costs. The regression results in this study are consistent with that perspective: even though wages increased, the statistical evidence does not show a corresponding increase in workforce share.

The insignificance of the unemployment relationship also aligns with macroeconomic theory, which holds that unemployment is influenced by a wide range of factors, including GDP growth, investment cycles, and national fiscal or monetary policies. As Narjoko and Putra (2015) point out, globalization and industrial policies shape employment patterns in Indonesia in ways that extend beyond wage fluctuations. The findings here, therefore, support the argument that wages in a single sector—manufacturing—have limited explanatory power for aggregate unemployment trends.

Moreover, the lack of statistical significance resonates with Tadjoeiddin's (2016) claim that the wage–employment relationship in Indonesia is non-linear and structurally mediated. While descriptive evidence suggests wages and employment moved together in the pre-pandemic period, the regression shows that this association does not hold consistently once the full time span (2015–2023) is considered. The disruptive effects of COVID-19 created structural breaks that weakened any straightforward linear link.

Taken as a whole, the regression models “tell a weak story” in the sense that they do not provide strong evidence of a direct or causal relationship between wages and either manufacturing employment share or the national unemployment rate. This should not be interpreted as proof that wages are irrelevant; rather, it underscores the fact that wages operate alongside—and sometimes are overshadowed by—other determinants such as productivity growth, sectoral transformation, and external shocks.

Where This Study Stands Among Prior Research: Confirmations, Contradictions, and New Insights

The findings of this study both confirm and diverge from existing research on the wage–employment nexus in Indonesia's manufacturing sector, offering new insights into how recent dynamics—including the COVID-19 pandemic—have shaped the relationship.



Figure 7: Summary of the relationship of variables in questions

First, the results confirm earlier studies that highlight the weak and non-linear relationship between wages and employment in Indonesia. Tadjoeiddin (2016) argued that productivity, wages, and labor absorption in the manufacturing sector interact in complex ways rather than following a straightforward linear pattern. The insignificant coefficients in both regression models support this conclusion: while wages increased during 2015–2023, their statistical influence on manufacturing employment share and unemployment remained minimal. Similarly, Chowdhury, Islam, and Tadjoeiddin (2009) emphasized that rigid labor regulations and high separation costs discourage firms from expanding their workforce in response to wage increases. The regression findings here, showing limited responsiveness of employment indicators to wage fluctuations, are consistent with their observations.

Second, the findings stand in partial contradiction to research suggesting that wage increases can stimulate broader labor market improvements. Magruder (2013), for example, presented evidence that minimum wage policies in Indonesia can function as a “big push,” boosting domestic consumption and attracting investment. By contrast, this study’s results show that wage increases between 2015 and 2023 did not significantly reduce unemployment or expand the manufacturing workforce share. The divergence may be explained by contextual differences: Magruder’s study focused on the early 2000s, a period of strong growth and institutional reforms, whereas the current study covers a later period marked by global uncertainty and pandemic-related disruptions.

Third, the results provide nuance to the debate on wage inequality and the differentiated impact of wage growth. Lipsey and Sjöholm (2004) demonstrated that foreign direct investment (FDI) in Indonesia raised wages primarily for skilled workers, leaving many unskilled workers behind. The findings of this study resonate with that concern: the lack of significant aggregate employment effects suggests that wage gains may have been concentrated among a subset of workers, without expanding overall labor absorption. Similarly, Primanthi (2021) found that Indonesian manufacturing is increasingly capital-intensive, limiting opportunities for low-skilled employment. The descriptive evidence of a stagnant workforce share despite rising wages is consistent with this trend.

Fourth, the study aligns with more recent insights that stress the need for complementary policies. Ollivaud (2021) argued that wage policy in Indonesia must be integrated with investments in human capital and labor market reforms. Permana, Yudoko, and Prasetyo (2023) likewise emphasized that the manufacturing sector retains growth potential, but only if wage adjustments are matched by productivity improvements and structural upgrading. The non-significant regression results here provide empirical support for this policy perspective: wage increases alone appear insufficient to drive employment gains.

Finally, this study contributes a new dimension by incorporating the post-pandemic period into the analysis. Most prior studies examined data before 2015 or focused on earlier crises such as the Asian financial crisis of 1997–1998 (Smith et al., 2002). By extending the dataset to 2023, this research captures the unique structural break caused by COVID-19, when wages continued to rise even as the workforce share declined and unemployment spiked. This divergence highlights the vulnerability of wage-led employment strategies to external shocks, an insight that extends and qualifies earlier debates on the efficacy of wage policies in Indonesia.

In sum, this study situates itself within a broader literature that recognizes the complexity of wage–employment dynamics. It confirms the structuralist perspective that wages alone are insufficient drivers of employment, contradicts more optimistic accounts of wage-led growth, and adds new evidence from the pandemic era that underscores the fragility of wage–employment linkages in times of crisis.

Implications for Theory: A Stronger Case for Structuralist Perspectives in Indonesia's Labor Market

The findings of this study contribute to theoretical debates on the relationship between wages and employment, particularly in developing economies like Indonesia. Classical labor market models, rooted in neoclassical economics, predict that higher wages should simultaneously attract more labor supply and stimulate aggregate demand, thereby leading to job creation and lower unemployment (Blanchard & Katz, 1999). However, the empirical results from Indonesia's manufacturing sector between 2015 and 2023 suggest that this mechanism does not operate straightforwardly. The regression results showed no statistically significant association between wage increases and either manufacturing workforce share or national unemployment, thereby challenging the explanatory power of classical models in this context.

Instead, the evidence lends stronger support to structuralist perspectives on labor market dynamics. Structuralist approaches emphasize that employment outcomes are shaped not only by wage levels but also by institutional settings, industrial structures, and macroeconomic conditions (Fields, 2019). In Indonesia, several such structural factors appear to have mediated the wage–employment relationship. The increasing capital intensity of manufacturing (Primanthi, 2021), rigid labor regulations (Chowdhury, Islam, & Tadjoeeddin, 2009), and the unequal distribution of wage gains among skilled versus unskilled workers (Lipsey & Sjöholm, 2004) all contributed to weakening the direct influence of wage growth on employment expansion.

The results also demonstrate the importance of considering non-linear and context-dependent effects in wage–employment studies. Tadjoeeddin (2016) previously argued that the relationship between productivity, wages, and labor absorption in Indonesia is complex and mediated by broader industrial transformation. The findings here reinforce this argument by showing that while wages and employment moved together in the pre-2020 period, their relationship broke down during and after the COVID-19 pandemic. This disruption illustrates how external shocks can override expected wage–employment linkages, a point that classical models often overlook but structuralist perspectives explicitly address.

Furthermore, the insignificance of wages in predicting national unemployment suggests that aggregate labor market outcomes in Indonesia are multi-causal and sectorally fragmented. Narjoko and Putra (2015) highlight that globalization and industrial policies shape labor demand in ways that wage signals alone cannot explain. By showing that manufacturing wages had little predictive power for unemployment at the national level, this study strengthens the theoretical claim that employment generation in developing economies requires a multi-sectoral lens, not just sector-specific wage analysis.

By extending the analysis into the post-pandemic period, this study also introduces a new theoretical consideration: the vulnerability of wage-led employment strategies to macroeconomic shocks. During the COVID-19 crisis, wages continued to rise moderately while employment declined and unemployment surged. This finding illustrates that wage dynamics can decouple from employment outcomes under conditions of systemic disruption. Theoretically, this supports the structuralist emphasis on resilience and adaptability in labor markets, rather than reliance on linear wage–employment relationships.

The theoretical implication of this research is that structuralist frameworks provide a more accurate and comprehensive explanation of Indonesia's wage–employment nexus than classical models. The evidence suggests that labor market dynamics in Indonesia are shaped more by capital intensity, institutional rigidity, skill distribution, and global shocks than by wage levels per se. This study thus contributes to the ongoing theoretical debate by reinforcing the case for structuralist perspectives in analyzing employment generation in developing economies.

Implications for Practice: What Policymakers, Industries, and Workers Can Learn

While the regression results show that wage increases alone do not have a significant impact on employment creation, this does not mean that wages are irrelevant for Indonesia's labor market. Instead, the findings underscore the need for integrated policy approaches and coordinated responses from multiple stakeholders.

a. Implications for Policymakers

For government policymakers, the results suggest that relying solely on wage adjustments—such as raising minimum wages—will not suffice to generate employment growth. Although wages rose steadily between 2015 and 2023, the manufacturing workforce share remained stagnant, and unemployment displayed limited responsiveness. This highlights the importance of complementary policies that directly target productivity enhancement, industrial upgrading, and labor market flexibility.

Policies that link wage increases with skill development programs, vocational training, and technological adaptation are likely to be more effective in creating sustainable employment. Ollivaud (2021) emphasized that wage policy should be integrated with investments in human capital, and this study's results provide empirical support for that argument. By ensuring that wage growth is accompanied by improvements in worker productivity, the government can avoid scenarios where higher wages outpace employment growth.

b. Implications for Industries

For manufacturing firms and industry leaders, the evidence suggests that rising wages need not be perceived solely as a cost burden. Instead, they should be leveraged as part of broader strategies for efficiency and innovation. Firms that invest in upskilling their workforce, adopting advanced technologies, and shifting toward higher-value-added production are more likely to absorb wage increases without reducing employment.

At the same time, firms must recognize the risks of over-reliance on capital-intensive models that exclude low-skilled workers. Primanthi (2021) noted that Indonesia's manufacturing sector has increasingly favored automation and capital deepening, which limits job creation. The findings of this study reinforce that trajectory: unless industries deliberately pursue inclusive growth strategies, wage increases will not translate into broader employment benefits.

c. Implications for Workers

For workers, the results underline the importance of continuously improving skills and adaptability. Rising wages have primarily benefited skilled workers, particularly in foreign-invested firms (Lipsey & Sjöholm, 2004). This implies that workers who remain low-skilled may not fully enjoy the benefits of wage growth, and they may even face displacement in more capital-intensive industries.

Therefore, workers must actively engage in lifelong learning and reskilling to remain competitive. Government and industry programs aimed at providing affordable and accessible training opportunities will be essential in this regard. For labor unions, the findings also carry a strategic message: bargaining for wage increases must go hand in hand with advocating for investments in worker training and protection against automation-related job losses.

The broader practical lesson is that Indonesia's wage policy must be understood as part of a larger ecosystem involving industrial policy, education and training systems, and macroeconomic stability. Wage growth, when not supported by structural transformation, risks producing limited benefits in terms of job creation. Conversely, when linked to productivity, innovation, and inclusion, higher wages can contribute not only to better living standards but also to more resilient employment growth.

CONCLUSION

This study set out to examine whether rising wages in Indonesia's manufacturing sector between 2015 and 2023 translated into more jobs, either by expanding the sector's workforce share or by reducing national unemployment. The descriptive statistics revealed a consistent upward trend in wages but stagnant employment absorption and relatively stable unemployment, with a sharp pandemic-induced disruption in 2021. Regression analysis further showed that the relationship between wages and employment outcomes was statistically insignificant, with very low explanatory power in both models.

These findings carry two broad implications. Theoretically, the results strengthen structuralist perspectives that argue employment in developing economies cannot be explained by wage levels alone, but is instead shaped by institutional rigidities, industrial structures, and external shocks. Practically, the study highlights the limited effectiveness of wage increases as a standalone tool for job creation. Policymakers must complement wage adjustments with strategies to raise productivity, upgrade industrial capacity, and strengthen worker skills. Industries must balance efficiency gains from capital-intensive production with inclusive growth strategies, while workers must continue to invest in reskilling to remain competitive in a rapidly transforming labor market.

At the same time, this research is not without limitations. The study relied primarily on aggregate national-level data for manufacturing wages, workforce share, and unemployment. This approach provides a broad overview but may obscure sectoral differences, regional variations, or firm-level dynamics. Future research could address these limitations by incorporating disaggregated data, exploring causal mechanisms using more sophisticated econometric techniques, and examining how wage policies interact with investment patterns, technology adoption, and labor regulations.

In conclusion, while wages remain an important element of labor market dynamics, they are not sufficient on their own to drive employment growth in Indonesia. A more holistic approach—combining wage policy with structural reforms and productivity-enhancing strategies—is required to translate higher pay into more and better jobs.

REFERENCES

- Blanchard, O., & Katz, L. F. (1999). Wage dynamics: Reconciling theory and evidence. *American Economic Review*, 89(2), 69–74.
- Chowdhury, A., Islam, I., & Tadjoeeddin, M. Z. (2009). Indonesia's employment challenges: growth, structural change and labour market rigidity. *European Journal of East Asian Studies*, 8(1), 31-59.
DOI: <https://doi.org/10.1163/156805809X439886>
- Creswell, J. W., & Creswell, J. D. (2018). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches* (5th ed.). SAGE Publications.
- Fields, G. S. (2019). *Employment and development: A new view*. Oxford University Press.
- Geron, A. (2019). *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow* (2nd ed.). O'Reilly Media.
- Gujarati, D. N., & Porter, D. C. (2009). *Basic Econometrics* (5th ed.). McGraw-Hill Education.
- ILO. (2022). *Indonesia jobs outlook 2022: Navigating the pandemic recovery* International Labour Organization.
- Lipsey, R. E., & Sjöholm, F. (2004). Foreign direct investment, education, and wages in Indonesian manufacturing. *Journal of Development Economics*, 73(1), 415-422.
DOI: <https://doi.org/10.1016/j.jdevco.2002.12.004>
- Magruder, J. R. (2013). Can minimum wages cause a big push? Evidence from Indonesia. *Journal of Development Economics*, 100(1), 48-62. DOI: <https://doi.org/10.1016/j.jdevco.2012.07.003>
- Narjoko, D., & Putra, C. T. (2015). Industrialization, globalization, and the labor market regime in Indonesia. *Journal of the Asia Pacific Economy*, 20(1), 57-76. DOI: <https://doi.org/10.1080/13547860.2014.974321>
- Ollivaud, P. (2021). Investing in competencies and skills and reforming the labour market to create better jobs in Indonesia. *OECD Economic Department Working Papers*, (1670), 1-47.
- Permana, T. W., Yudoko, G., & Prasetyo, E. A. (2023). Forecasting the potential output and growth of the manufacturing industry: a case study of Indonesia's manufacturing sector. *Jurnal Ekonomi & Studi Pembangunan*, 24(2), 368-389. DOI: <https://doi.org/10.18196/jesp.v24i2.18716>
- Primanthi, M. R. (2021). *Characteristics of Indonesia's Large and Medium Scale Manufacturing Industries: An Exploratory Analysis* (Doctoral dissertation, The Australian National University (Australia)).
- Sekaran, U., & Bougie, R. (2016). *Research Methods for Business: A Skill Building Approach* (7th ed.). Wiley.
- Shrestha, R., & Winkler, D. (2021). The link between global value chain activity and local human capital: Evidence from Indonesia's manufacturing sector. *ERIA Discussion Paper Series*
- Smith, J. P., Thomas, D., Frankenberg, E., Beegle, K., & Teruel, G. (2002). Wages, employment, and economic shocks: Evidence from Indonesia. *Journal of Population Economics*, 15, 161-193.
LINK: <https://www.jstor.org/stable/20007804>
- Tadjoeeddin, M. Z. (2016). Productivity, wages, and employment: evidence from Indonesia's manufacturing sector. *Journal of the Asia Pacific Economy*, 21(4), 489-512. DOI: <https://doi.org/10.1080/13547860.2016.1153227>
- Wooldridge, J. M. (2012). *Introductory Econometrics: A Modern Approach* (5th ed.). South-Western Cengage Learning.

Teachers' Instructional Competence And Classroom Management Skill: Bases For Enhancement

ADORICA A. SAJONIA
JONATHAN G. GABION
Guimaras State University

ABSTRACT This study examined the instructional competence and classroom management skills of Senior High School (SHS) teachers in the Schools Division of Iloilo, Philippines, for School Year 2024–2025, aiming to inform enhancement efforts. Using a descriptive-correlational design with a quantitative approach, the study surveyed 300 SHS teachers through a validated and reliable questionnaire. It employed both descriptive and inferential statistics—such as frequency, percentage, mean, Mann-Whitney U test, Kruskal-Wallis H test, and Spearman's rho—to analyze the data. The results showed that SHS teachers in Iloilo demonstrated very high levels of instructional competence and classroom management skills. Instructional competence was most prominent in student engagement, while classroom management excelled in discipline and teacher-student relationships. The study found significant differences in instructional competence only when teachers were grouped by educational attainment. In contrast, classroom management skills varied significantly across educational attainment, subject group, and specialization. A strong positive correlation existed between instructional competence and classroom management skills. The study concludes that SHS teachers exhibit strong instructional and classroom management abilities, but recommend improvements in engaging disengaged learners and managing time effectively. Educational attainment plays a significant role in both competencies and classroom management, highlighting the need for advanced academic preparation. Based on these findings, a targeted professional development program is recommended, focusing on differentiated strategies for learner engagement, adaptive teaching, and time management, tailored to teachers' qualifications and subject specializations.

Keywords: *Strategies, Educational approaches, Learner engagement, Adaptive teaching, Philippines*

INTRODUCTION

The Philippine basic education curriculum has undergone a significant overhaul with the implementation of the K to 12 program. A key aspect of this program is the inclusion of competencies tailored to each student's level of comprehension, allowing them to focus on and master specific concepts, skills, and values. Moreover, the K to 12 program affords students ample time to fully grasp the lessons required for advancement to subsequent levels (Gamayaw and Binás, 2021).

In the realm of instruction, which encompasses teaching and learning, teachers play a pivotal role. Teachers play a central role in fostering student learning and achievement, with research highlighting the pivotal role of instructional approaches and interactions with students in building effective schools (Dela Fuente, 2021; Ranjan, 2020; Talikan, 2021).

Effective teaching demands more than just pedagogical content knowledge; it requires teaching competency—a combination of knowledge, skills, and attitude that enables educators to fulfill their responsibilities effectively. Teacher competence significantly influences student quality in academic achievement, social skills, emotional well-being, and moral development, emphasizing the need for holistic professional development programs (Mubarak, 2024).

However, success in the classroom goes beyond mere knowledge; it necessitates a genuine concern for students' development, coupled with competency across various domains to navigate the complex and dynamic educational landscape (Queroda, 2020; Dela Fuente, 2021). Effective classroom management reduces problem behaviors and increases student involvement, making it crucial for educational success (Yadav, 2022). It requires strong professional experience, knowledge, and effective teaching methods to create an effective learning environment for students (Özen and Yıldırım, 2020).

R.A. 10533, or the Enhanced Basic Education Act of 2013, introduced a 21st-century-aligned curriculum, emphasizing the need to shift from traditional teaching to a learner-centered approach. This transformation aims to equip students with vital skills like communication, critical thinking, and problem-solving to meet the evolving demands of education in the Philippines.

Teachers' competencies encompass various dimensions, including teaching effectiveness, professional recognition, scholarly abilities, and community services. The level of teaching competency exhibited by educators significantly influences student learning outcomes, underscoring the critical need for teachers to be aware of their

competencies and their impact on student learning. Therefore, understanding the instructional competence and classroom management skills of senior high school teachers in Iloilo is vital in enhancing teaching effectiveness and student outcomes. This study aimed to contribute to the development of targeted professional development programs that support teachers in delivering quality education.

The main objective of this study was to determine the instructional competence and classroom management skills among Senior High School teachers in the Schools Division of Iloilo, Philippines, for School Year 2024-2025 as a basis for enhancement. Specifically this study sought answers to the following questions: (1) what is the profile of the respondents in terms of educational attainment, position, subject group, length of service and specialization; (2) what is the level of teachers' instructional competence in terms of student engagement, content mastery and adaptability when taken as a whole and when classified according to educational attainment, position, subject group, length of service and specialization; (3) what is the level of teachers' classroom management skill in terms of classroom discipline, time management and teacher-student relationship when taken as a whole and when classified according to educational attainment, position, subject group, length of service and specialization; (4) are there significant differences in the level of teachers' instructional competence in terms of student engagement, content mastery and adaptability when classified according to educational attainment, position, subject group, length of service and specialization; (5) are there significant differences in the level of teachers' classroom management skill in terms of classroom discipline, time management, and teacher-student relationship when classified according to educational attainment, position, specialization, SHS track taught and length of service; (6) is there a significant relationship between teachers' instructional competence and classroom management skill; and (7) based on the findings of the study, what enhancement can be done.

METHODOLOGY

This study employed a quantitative descriptive–correlational design to examine the instructional competence and classroom management skills of Senior High School teachers in the Schools Division of Iloilo. The respondents consisted of 300 purposively selected teachers from five congressional districts, with 60 teachers per district, classified according to educational attainment, position, subject group, length of service, and specialization.

Data were gathered using a researcher-made questionnaire composed of three parts: (1) demographic profile, (2) a 30-item checklist on instructional competence (student engagement, content mastery, adaptability), and (3) a 30-item checklist on classroom management skills (classroom discipline, time management, teacher–student relationship). Responses were rated on a five-point Likert scale. The instrument underwent content validation by five expert jurors and pilot testing with 30 non-respondent teachers, yielding Cronbach's alpha coefficients of 0.970 for instructional competence and 0.744 for classroom management skills, indicating acceptable reliability.

Data collection followed the securing of permissions from the Graduate School, the Schools Division Superintendent, and School Heads. Questionnaires were personally administered and immediately retrieved to ensure completeness and confidentiality as well as adherence to the legal requirements set forth by the Data Privacy Act of 2012 (RA 10173).

Data were analyzed using descriptive statistics (frequency, percentage, mean) and inferential tests: Mann–Whitney U (differences by position), Kruskal–Wallis H (differences by educational attainment, subject group, length of service, specialization), and Spearman's rho (relationship between instructional competence and classroom management skills).

RESULTS AND DISCUSSIONS

Profile of the Respondents

The majority of Senior High School teachers held a Bachelor's Degree (61.3%, $f=184$), indicating that most have met the basic qualification requirements but have not pursued further graduate studies. However, a notable proportion of teachers have obtained a Master's Degree (33.3%, $f=100$), reflecting significant professional development. Only a small fraction has attained a Doctorate Degree (5.3%, $f=16$), suggesting limited representation of highly specialized academic credentials.

Regarding teaching positions, 89.7% ($f=269$) of the respondents held positions from Teacher I to III, while only 10.3% ($f=31$) were in Master Teacher I to III roles. This distribution suggests that the majority of the workforce occupies foundational or progressing stages in their careers, with a smaller percentage reaching advanced or leadership positions.

Subject-wise, the largest group of teachers specialized in HUMSS (38.7%, $f=116$), followed by STEM (23.0%, $f=69$), ABM (18.0%, $f=54$), and TVL (13.7%, $f=41$). PE (5.0%, $f=15$) and Arts & Design (1.7%, $f=5$) were less represented. This distribution may reflect both student demand and the availability of qualified teachers in these areas.

In terms of years of experience, 46.7% ($f=140$) of teachers had been teaching for 1 to 5 years, and 40% ($f=120$) had 6 to 10 years of experience. Only 13.3% ($f=40$) had been teaching for more than a decade. This indicates a predominantly young to mid-career workforce, possibly influenced by the recent full implementation of the K to 12 program, which increased Senior High School teaching positions. A similar trend was noted by Avenido and Buquia (2024), who found that younger teachers with shorter service durations were prevalent in the Department of Education, helping to nurture learners capable of driving national development.

Teacher specializations were diverse, with Math (19.3%, $f=58$), Science (19.0%, $f=57$), and English (18.7%, $f=56$) being the most common. Other areas of specialization included Social Science (15.7%, $f=47$), TLE (11.0%, $f=33$), Filipino (10.3%, $f=31$), and PE (6.0%, $f=18$). This distribution aligns with the multidisciplinary nature of Senior High School education, reflecting the need to cover various strands and specializations.

These findings are consistent with other studies. Marquez (2023) reported that in the Schools Division of Rizal, the majority of teachers (40%) were aged between 31 and 40 years, with 40% having 11–20 years of service. Similarly, Asis et al. (2022) found that most teachers in the District of Naic, Cavite, were within the 26–35 age range, held MA Academic Units, and were primarily positioned as Teacher I.

Table 1. Profile of the Respondents

Profile	f	%
Educational Attainment		
Bachelor's Degree	184	61.3
Master's Degree	100	33.3
Doctorate Degree	16	5.3
Position		
Teacher 1-3	269	89.7
Master Teacher 1-3	31	10.3
Subject Group		
HUMSS	116	38.7
ABM	54	18
STEM	69	23
TVL	41	13.7
PE	15	5.0
Arts & Design	5	1.7
Length of Service		
1 to 5 years	140	46.7
6 to 10 years	120	40.0
More than 10 years	40	13.3
Specialization		
English	56	18.7
Filipino	31	10.3
Science	57	19.0
Social Science	47	15.7
Math	58	19.3
TLE	33	11.0
PE	18	6.0
Total	300	100.0

Level of Teachers' Instructional Competence when Taken as a Whole

The instructional competence of Senior High School teachers in the Schools Division of Iloilo was exceptionally high, with an overall mean score of 4.61. This indicates that teachers effectively plan, implement, and assess instruction, promoting student learning and achievement. The findings align with similar studies, such as Tutica (2024), who found TLE Junior High School teachers in Roxas City to be "competent" and "outstanding" in instructional strategies, particularly in Home Economics. Asis et al. (2023) reported high instructional competence among public secondary school teachers in Naic, Cavite, with a recommendation for an enhancement program to address challenges. Avenido and Buquia (2024) observed similarly high competence among public elementary school teachers in teaching approaches and classroom management.

Instructional competence was evaluated across three domains: Student Engagement, Content Mastery, and Adaptability. Student Engagement recorded the highest mean score of 4.63, followed by Content Mastery at 4.62 and Adaptability at 4.59. Teachers demonstrated exceptional ability to motivate students ($M=4.74$), use real-world examples ($M=4.73$), and encourage collaboration ($M=4.72$). These findings reflect teachers' effectiveness in fostering learner autonomy and bridging theoretical knowledge with practical application. The ability to identify and assist disengaged or struggling learners was the lowest-rated aspect ($M=4.34$), though still very high.

In the domain of Content Mastery, teachers scored an overall mean of 4.62. They excelled in presenting lessons in an understandable manner ($M=4.78$), demonstrating comprehensive subject knowledge ($M=4.71$), and aligning assessments with learning objectives ($M=4.70$). Teachers also showed strong abilities in answering questions ($M=4.65$) and embedding higher-order thinking skills ($M=4.59$). The lowest score in this domain was for incorporating current developments into the curriculum ($M=4.47$), though it still reflected a very high level of competence.

Under Adaptability, teachers displayed the highest competence in selecting examples relevant to student experiences and real-world contexts ($M=4.68$), followed by adapting lessons with updated information ($M=4.61$) and aligning teaching methods with content standards ($M=4.61$). Teachers were proficient in adjusting teaching strategies based on learner abilities ($M=4.59$) and in incorporating varied assessment methods ($M=4.57$). The lowest-rated indicator in this domain was adjusting to novel or unexpected situations ($M=4.49$), suggesting room for further development in managing unforeseen instructional challenges.

These results underscore the high instructional competence of teachers in the Schools Division of Iloilo, aligning with findings from other studies that emphasize the correlation between teacher competence and student performance. However, areas such as incorporating current developments into the curriculum and adjusting to unexpected situations present opportunities for further professional growth and enhanced instructional adaptability.

Table 2. Level of Teachers' Instructional Competence when Taken as a Whole

Items	Mean	Description
Student Engagement		
Create an inclusive learning environment that encourages learners' participation	4.69	Very High
Utilize real-world examples to make the content relevant to learners.	4.73	Very High
Identify and attend to disengaged or struggling learners	4.34	Very High
Motivate learners to perform the task independently with self-confidence	4.74	Very High
Provide individual equal opportunities for acquiring the knowledge/skills	4.64	Very High
Ask clear and effective questions that stimulate learners to actively participate in the discussion	4.66	Very High
Challenge learners to think critically and, at the same time, be cost-effective, innovative, and appropriate for the objective of the lesson	4.6	Very High
Create activities that foster collaboration, communication, creativity, and critical thinking	4.59	Very High
Persuade learners to cooperate and collaborate while on task	4.72	Very High
Prepare learners by asking questions with an emphasis on thoughtful exploration	4.60	Very High
Content Mastery		
Demonstrate comprehensive knowledge of the subject matter	4.71	Very High
Answer learner questions accurately and thoroughly	4.65	Very High
Incorporate current developments in the fields into the curriculum	4.47	Very High
Assess learner understanding through formative and summative assessments aligned with the learning objective	4.70	Very High
Embed and encourage higher-order thinking skills along with teaching foundation skills	4.59	Very High
Demonstrate the successful use of the knowledge/skills in problem-solving through modeling	4.57	Very High
Demonstrate current professional knowledge to effectively design and plan instruction	4.58	Very High
Present the lesson in a manner that is understandable to the learners	4.78	Very High
Use different points of view and specific illustrations when appropriate	4.55	Very High
Deliver accurate and updated content using appropriate approaches and strategies	4.57	Very High
Adaptability		
Adjust teaching methods based on learner feedback	4.55	Very High
Flexible in teaching approach to cater to diverse learning styles	4.57	Very High
Adapt lessons to integrate new or updated information	4.61	Very High
Select examples relevant to learner experiences and make connections to a real-world context	4.68	Very High
Select teaching methods appropriate to the content standards	4.61	Very High

continuation of the table

Use a relevant teaching strategy to meet learning competencies	4.65	Very High
I am flexible and capable of adjusting to novel situations	4.49	Very High
Appropriate use of methods according to the learners' abilities	4.59	Very High
Use a variety of assessment methods to evaluate learner learning	4.57	Very High
Incorporate innovative and creative teaching approaches to engage students and foster deeper understanding	4.57	Very High
Overall Mean	4.59	Very High
Overall Mean	4.61	Very High

Scale of Means; 4.21 – 5.00 Very High; 3.41 – 4.20 High; 2.61 – 3.40 Moderate; 1.81 – 2.60 Low; 1.00 – 1.80 Very Low

Level of Teachers' Instructional Competence when grouped according to Variables

The instructional competence of Senior High School teachers in the Schools Division of Iloilo was very high, with teachers holding a Bachelor's degree demonstrating an overall mean of 4.59. This was characterized by strong performance in student engagement (M=4.62), content mastery (M=4.59), and adaptability (M=4.57). Teachers with a Master's degree showed similarly high competence, with an overall mean of 4.61 across all domains. Teachers with a Doctorate achieved the highest overall mean of 4.84, excelling particularly in content mastery (M=4.86) and student engagement (M=4.84). The consistent Very High level of competence across all educational attainment groups highlights that, regardless of their degree, teachers maintain excellent instructional practices.

These findings align with Canuto et al. (2024), who found no significant differences in teaching competencies based on educational attainment, suggesting that foundational teaching competencies remain strong across all educational levels.

Regarding teaching positions, both Teacher I-III (M=4.60) and Master Teacher I-III (M=4.63) groups exhibited very high competence across instructional domains. Master Teachers slightly outperformed Teacher I-III in all areas, supporting Villacorta and Arnado (2023), who noted that higher academic rank is positively correlated with higher instructional competence.

In terms of subject specialization, teachers across all groups showed very high competence, with ABM (M=4.68), TVL (M=4.69), PE (M=4.72), and Arts & Design (M=4.36) exhibiting strong instructional practices. However, variations suggest that specific fields like Arts & Design and STEM may benefit from further support to enhance instructional outcomes. This is consistent with Villacorta and Arnado (2023), who found that specialization plays a key role in determining instructional competence, with teachers in their field of expertise demonstrating higher competence levels.

Teachers with 1 to 5 years of service recorded the highest overall mean of 4.63, followed by those with 6 to 10 years (M=4.60) and those with more than 10 years (M=4.61). These results reflect the incremental development of competencies over time, aligning with the findings of Asirit et al. (2022), who emphasized the role of experience in refining instructional skills.

Specialization-wise, PE teachers scored the highest overall mean of 4.70, followed by TLE teachers (M=4.69). These results highlight the strong command of practical, skills-based subjects, where teachers excel in engaging students and adapting their teaching methods. Teachers in English, Filipino, Social Science, Math, and Science showed very high competence, with English teachers scoring M=4.62, and Science teachers posting the lowest score at M=4.56. These findings suggest that specialization in a teacher's assigned subject plays a crucial role in determining their competence, confirming the importance of aligning teacher assignments with their area of expertise to maintain high instructional standards.

Overall, the findings underscore the importance of matching teachers' instructional assignments to their specialization and educational background to optimize teaching effectiveness and ensure consistently high instructional competence.

Table 3. Level of Teachers' Instructional Competence when grouped according to Variables

Profile	Mean	Description
Educational Attainment		
Bachelor's Degree	4.59	Very High
Master's Degree	4.61	Very High
Doctorate Degree	4.84	Very High
Position		
Teacher 1-3	4.60	Very High
Master Teacher 1-3	4.68	Very High
Subject Group		
HUMSS	4.59	Very High
ABM	4.68	Very High
STEM	4.55	Very High
TVL	4.69	Very High
PE	4.72	Very High
Arts & Design	4.36	Very High
Length of Service		
1 to 5 years	4.63	Very High
6 to 10 years	4.60	Very High
More than 10 years	4.61	Very High
Specialization		
English	4.62	Very High
Filipino	4.60	Very High
Science	4.56	Very High
Social Science	4.60	Very High
Math	4.59	Very High
TLE	4.69	Very High
PE	4.70	Very High
Overall Mean	4.61	Very High

Level of Teachers' Classroom Management Skill When Taken as a Whole

The classroom management skills of Senior High School teachers in the Schools Division of Iloilo were assessed, revealing an overall mean of 4.62, indicating a very high level of proficiency across all areas evaluated: classroom discipline, time management, and teacher-student relationships. These findings reflect teachers' exceptional abilities in effectively managing classrooms and facilitating student learning.

In the area of classroom discipline, teachers demonstrated high proficiency with a mean score of 4.67. Notably, teachers excelled in enforcing classroom rules ($M=4.80$), addressing academic dishonesty fairly ($M=4.72$), setting clear expectations for behavior ($M=4.73$), and maintaining cleanliness and orderliness ($M=4.75$). These results align with Granada and Oco (2024), who found that teachers in the Talisayan District also demonstrated high competence in proactive behavior management and rule enforcement to maintain a positive learning environment. Zainuddin and Hardiansyah (2023) similarly emphasized the importance of enthusiasm and discipline in creating a warm, engaging classroom atmosphere, which was reflected in the present study.

Time management, another crucial aspect of classroom management, also received a very high rating ($M=4.51$). Teachers were effective in starting and ending classes on time ($M=4.39$), managing transitions between activities ($M=4.47$), and maintaining a regular schedule ($M=4.55$). These findings are consistent with Gumpal and Basmayor (2024), who observed that teachers demonstrated strong organizational skills, used group work strategically, and ensured efficient classroom management through effective time management strategies.

Teacher-student relationships also showed a very high level of competence ($M=4.67$). Teachers excelled in maintaining fair and unbiased treatment ($M=4.81$), being approachable for consultations ($M=4.72$), building a classroom community ($M=4.68$), and responding sensitively to the diverse needs of students ($M=4.70$). These results align with Nafisah et al. (2023), who emphasized the importance of effective teacher-student interaction, including appropriate

praise, addressing misbehavior, and actively involving students in the learning process. The strong teacher-student rapport indicated by these results reflects a nurturing classroom climate that promotes student engagement and learning.

The findings reinforce the critical role of effective classroom management in creating an optimal educational environment. As supported by the literature (Zainuddin & Hardiansyah, 2023; Granada et al., 2024; Nafisah et al., 2023; Gumpal & Basmayor, 2024), the teachers demonstrated skillful integration of discipline, efficient time use, and positive teacher-student relationships, all of which contribute to a productive learning environment.

Table 4. Level of Teachers' Classroom Management Skill When Taken as a Whole

Items	Mean	Description
Classroom Discipline		
Enforce classroom rules and policies	4.80	Very High
I am effective in the management of disruptive behavior	4.50	Very High
Create an environment that minimizes distractions	4.57	Very High
Address issues of academic dishonesty promptly and fairly	4.72	Very High
Develop classroom rules that foster respect, caring, and community in the classroom	4.76	Very High
Make clear expectations for behavior at the beginning of the school year	4.73	Very High
Involve parents and guardians in classroom discipline	4.46	Very High
Create a warm and welcoming room by proper positioning of chairs, displays, and equipment	4.70	Very High
Set boundaries and expectations at the beginning of the class	4.74	Very High
Manage cleanliness and orderliness inside and outside the classroom	4.75	Very High
Time Management		
Start and end class on time	4.39	Very High
Allocate time effectively for different classroom activities	4.47	Very High
Manage time well to cover all planned content	4.43	Very High
Provide time for learner questions and discussions	4.55	Very High
Observe an effective transition between different segments of the lesson	4.47	Very High
Keep the class in order by staying on time and on task	4.58	Very High
Have a regular daily schedule to help the learners prepare for the upcoming activities	4.55	Very High
Manage the transition of class discussions from one activity to another	4.55	Very High
Establish routine procedures to use time wisely in the class discussions and activities	4.60	Very High
Minimize time spent on discipline and a lot more time for discussions and activities	4.48	Very High
Teacher-student relationship		
I am approachable and available for student consultations	4.72	Very High
Build a sense of community within the classroom	4.68	Very High
Maintain fair and unbiased treatment of all learners	4.81	Very High
Gather information about the various learning styles of learners in the classroom	4.59	Very High
Provide learners with the ability to track their educational goals	4.56	Very High
Respond to learners' requests promptly and treat all students with respect	4.72	Very High
Exhibit sensitivity to gender and cultural differences, and learners with special needs	4.70	Very High
Respond appropriately in a non-threatening and proactive learning environment	4.63	Very High
Initiate pleasant conversation with and among the learners	4.70	Very High
Hold significant class meetings to help learners familiarize themselves with each other	4.61	Very High
	4.67	Very High
Overall Mean	4.62	Very High

Scale of Means; 4.21 – 5.00 Very High; 3.41 – 4.20 High; 2.61 – 3.40 Moderate; 1.81 – 2.60 Low; 1.00 – 1.80 Very Low

Level of Teachers' Classroom Management Skill when grouped according to Variables

The data indicate that Senior High School teachers consistently demonstrate a very high level of classroom management skills, with an overall mean score of 4.62. Teachers with a Doctorate reported the highest mean (4.82), suggesting that advanced academic preparation may contribute to more refined classroom management practices. However, the difference across educational attainment groups was small, with all groups scoring in the very high range, consistent with Bulilan (2022), who found that faculty performed well in classroom management regardless of academic

qualifications. This supports Yadav's (2022) view that effective classroom management is influenced more by teaching practices and organizational skills than by educational attainment alone.

In terms of position, Master Teachers ($M=4.68$) slightly outperformed Teacher I–III, likely reflecting their experience and leadership roles. This aligns with Malitic (2020), who observed greater classroom management expertise among senior teachers.

By subject, PE teachers received the highest rating ($M=4.81$), while Arts & Design teachers received the lowest ($M=4.42$), though still within the very high range. This difference may be attributed to variations in subject structure and classroom dynamics. These findings are consistent with Ahmed and Pierre (2024), who highlighted the role of teacher preparedness and emotional proficiency in effective classroom management.

Regarding years of service, teachers with 1–5 years of experience ($M=4.65$) demonstrated slightly higher ratings than those with 6–10 years of experience ($M=4.56$). This suggests that recent training and exposure to modern strategies may contribute to stronger classroom management early in a teacher's career, echoing Albayrak and Ateşkan (2022), who emphasized the importance of training for novice teachers. Cansing (2024) also found that newly hired teachers displayed strong instructional competence, which likely extends to their classroom management skills.

While teachers of varying experience levels all demonstrated very high levels of classroom management, novice teachers tended to excel in student discipline and teacher-student relationships, likely due to their fresh perspectives and focus on establishing authority. In contrast, mid-career teachers were more relaxed in their approach but still maintained high competency in classroom management.

Specializations such as PE ($M=4.80$) and TLE ($M=4.70$) demonstrated the highest levels of classroom management, possibly due to the interactive and activity-driven nature of these subjects, which require strong behavioral control and organization. These findings are in line with Pacuno and Sanchez (2020), who emphasized the role of effective classroom management in the instructional competence of teachers.

Overall, the results indicate that teachers across all specializations possess very high classroom management skills. Subjects that require more physical or interactive components, such as PE and TLE, appear to encourage stronger classroom management practices. These results suggest that teachers, regardless of their background or specialization, are well-equipped to foster effective learning environments.

Table 5. Level of Teachers, Classroom Management Skills When Grouped According to Variables

Profile	Mean	Description
Educational Attainment		
Bachelor's Degree	4.62	Very High
Master's Degree	4.58	Very High
Doctorate Degree	4.82	Very High
Position		
Teacher 1-3	4.61	Very High
Master Teacher 1-3	4.68	Very High
Subject Group		
HUMSS	4.59	Very High
ABM	4.67	Very High
STEM	4.54	Very High
TVL	4.69	Very High
PE	4.81	Very High
Arts & Design	4.42	Very High
Length of Service		
1 to 5 years	4.65	Very High
6 to 10 years	4.57	Very High
More than 10 years	4.64	Very High
Specialization		
English	4.66	Very High
Filipino	4.54	Very High

Continuation of the table		
Science	4.57	Very High
Social Science	4.61	Very High
Math	4.56	Very High
TLE	4.70	Very High
PE	4.80	Very High
Overall Mean	4.62	Very High

Differences in the Level of Teachers' Instructional Competence when grouped according to Variables

A significant difference in teachers' instructional competence was observed when grouped according to educational attainment ($H=10.948$; $p=.004$). This indicates that teachers' instructional competence varies based on their educational qualifications. These findings align with Bulilan (2022), who noted that higher educational attainment is associated with greater teaching competencies, suggesting that teachers' mastery of teaching skills and professional adaptability improve as they pursue advanced degrees.

However, these results contrast with Canuto et al. (2024), who found no significant difference in teaching competencies based on educational attainment. The discrepancy between the studies may be due to variations in sample populations or the contexts of the studies, indicating that the impact of educational attainment on teaching competence may differ depending on the setting or the specific teaching domains evaluated.

In contrast, no significant differences were found in instructional competence when teachers were grouped according to subject specialization ($H=9.437$; $p=.093$), length of service ($H=.857$; $p=.652$), or specialization ($H=3.226$; $p=.780$). These findings suggest that regardless of whether teachers handle HUMSS, ABM, STEM, TVL, PE, or Arts & Design, their level of instructional competence remains comparable. This reinforces the idea that effective instructional strategies are applicable across different subject areas and that teaching competence is more likely to be influenced by general pedagogical skills rather than content specialization.

These results are consistent with the findings of Canuto et al. (2024), who reported no significant differences in teaching competencies across 1 to 30 years of teaching experience. However, this contrasts with Villacorta and Arnado (2023) and Avenido and Buquia (2024), who argued that longer teaching experience correlates with higher instructional competence.

Overall, these findings suggest that teachers, regardless of their specialization in fields such as English, Filipino, Science, Social Science, Math, TLE, or PE, all demonstrated very high levels of instructional competence. This supports the notion that effective teaching transcends subject areas and is more influenced by universal teaching skills than by content-specific expertise.

Table 6. Differences in the Level of Teachers' Instructional Competence when grouped According to Educational Attainment, Subject Group, Length of Service, and Specialization

Variable	H-test	df	p-value	Remarks
Educational Attainment	10.948	2	.004	Significant
Subject Group	9.437	5	.093	Not Significant
Length of Service	.857	2	.652	Not Significant
Specialization	3.226	6	.780	Not Significant

Results indicate that there were no significant differences in the overall level of instructional competence of teachers when grouped according to their position (U-test value=3466.500; $p\text{-value}=0.124$). This indicates that regardless of whether a teacher holds a junior or senior position, the level of competence in areas such as student engagement, content mastery, adaptability, and overall instructional competence remains comparable.

These findings are consistent with Asis et al. (2024), who found that educational attainment does not significantly influence the instructional competence of teachers. This indicates that other factors—such as teaching experience, professional development, or teaching environment—may play a more significant role in shaping instructional competence than the teacher's position within the hierarchy.

Table 7. Differences in the Level of Teachers' Instructional Competence when grouped According to Position

Position	U test	p-value	Remarks
Teacher 1-3	3466.500	.124	Not Significant
MT 1-3			

p<0.05 level of significance

There were significant differences in the teachers' classroom management skills when grouped according to educational attainment ($H=7.102$; $p=.029$). Higher levels of education, such as having a master's degree or postgraduate units, are associated with more effective classroom management, particularly in maintaining discipline and fostering positive relationships with students. This finding is consistent with the research of Cabasag (2024), who emphasized the influence of educational attainment on lesson organization and the classroom's psychosocial environment. However, it contrasts with Gumpal and Basmayor's (2024) assertion that educational attainment does not significantly predict teaching performance, indicating that while it may not directly determine overall effectiveness, it does impact specific classroom management competencies.

Significant difference was also found when grouped according to subject group ($H=12.751$; $p=.026$). This indicates that the subject area a teacher handles may influence how they plan and manage classroom activities. It is possible that teachers in more structured or time-sensitive subjects, such as HUMMS, ABM, STEM, TVL, PE, and Arts & Design, have honed stronger time management practices due to the nature of the content and instructional demands.

However, no significant differences were found when grouped according to length of service ($H=2.368$; $p=.306$) and specialization ($H=11.821$; $p=.066$). His result aligns with the findings of Gumpal and Basmayor (2024), reinforcing the idea that experience alone is not a sufficient predictor of classroom management ability. Interestingly, this contrasts with Cabasag's (2024) findings, which identified significant relationships between years of service and classroom organization and environment.

Table 8. Differences in the Level of Teachers' Classroom Management Skills when grouped According to Educational Attainment, Subject Group, Length of Service, and Specialization

Variable	H-test	df	p-value	Remarks
Educational Attainment	7.102	2	.029	Significant
Subject Group	12.751	5	.026	Significant
Length of Service	2.368	2	.306	Not Significant
Specialization	11.821	6	.066	Not Significant

Similarly, no significant difference was found in the teachers' classroom management skills when grouped according to position ($U=3636.000$; $p=.243$). The level of classroom management skills of teachers does not vary whether a teacher holds the position of Teacher I–III or Master Teacher I. These findings are consistent with Gumpal et. al. (2024), who also found no significant predictive relationship between teaching position and classroom management skills. This indicates that the hierarchical rank or title held by a teacher does not necessarily correspond to better or more effective classroom management.

Table 9. Differences in the Level of Teachers' Classroom Management Skills when grouped According to Position

Position	U test	p-value	Remarks
Teacher 1-3	3636	0.243	Not Significant
MT 1-3			

p<0.05 level of significance

Relationship Between Teachers' Instructional Competence and Classroom Management Skill

There was a statistically significant positive relationship between teachers' instructional competence and classroom management skills, as indicated by a correlation coefficient of .790 ($p = .000$). The more competent teachers are in teaching, the more skillful they are in classroom management.

This finding is in line with Granada and Oro (2024), who emphasized that effective classroom management—particularly behavior reduction—supports uninterrupted teaching and promotes a harmonious learning environment. When teachers are competent in instruction, they are more capable of implementing strategies that minimize distractions and maintain classroom order. Furthermore, this strong correlation supports the findings of Villacorta and Arnado (2023), who identified a close link between teaching competencies and instructional skills.

Table 10. Relationship Between Teachers' Instructional Competence and Classroom Management Skill

Correlations		Instructional Competence	Classroom Management Skill	Remarks
Instructional Competence	Correlation	1.000		
	Coefficient		.790**	Significant
	p-value	.	.000	
	N	300	300	
Classroom Management Skills	Correlation	.790**		
	Coefficient		1.000	
	p-value	.000	.	
	N	300	300	

CONCLUSIONS

The findings affirm that all Senior High School teachers in the Schools Division of Iloilo possess a very high capacity to plan, implement, and assess instruction in ways that foster student learning and achievement. Teachers consistently apply sound pedagogical frameworks, align learning activities with curriculum standards, and employ assessment strategies that support the attainment of learning objectives. Such competence reflects both professional commitment and mastery of content, ensuring that instruction remains purposeful, engaging, and learner-centered.

Teachers also exhibit very high levels of ability, talent, and expertise in managing their classes to facilitate learning effectively. This indicates not only control over classroom dynamics but also the capacity to create a supportive environment that encourages active participation, fosters mutual respect, and addresses diverse learner needs. Their classroom leadership extends beyond discipline, encompassing the skillful orchestration of activities, resources, and interpersonal interactions that sustain productive learning climates.

Moreover, results show that educational attainment significantly influences instructional competence, with higher academic qualifications—particularly postgraduate degrees—contributing to greater pedagogical effectiveness and adaptability. Teachers with advanced education likely have deeper theoretical knowledge, exposure to current educational research, and broader professional training, enabling them to design more innovative, responsive, and differentiated learning experiences.

Classroom management skills are found to be partly shaped by teachers' educational background, teaching subject, and area of specialization. Variations were noted particularly in discipline and time management, indicating that subject-specific demands and training backgrounds can influence how teachers organize activities, enforce rules, and maximize instructional time. This implies that professional development programs may benefit from being tailored to the unique classroom management challenges of different subject areas.

A strong positive relationship exists between instructional competence and classroom management skills. Teachers who excel in lesson planning and delivery are also more adept at managing classroom behavior, time allocation, and teacher–student relationships. This reinforces the idea that instructional quality and classroom control are mutually reinforcing: well-prepared, engaging lessons reduce behavioral issues, while effective classroom management creates the conditions for successful instruction.

REFERENCES

- Adams, T., Koster, B., & Brok, P. (2020). Student teachers' classroom Management during the school internship. *European Journal of Teacher Education*, 45, 727 - 745. <https://doi.org/10.1080/02619768.2020.1860011>.
- Aindra, A., Wibawa, A., & Nurhadi, D. (2022). The teacher's competence and Performance: A systematic theoretical study. *International Journal of Education and Learning*, 4(1), 65-80. doi: <https://doi.org/10.31763/ijele.v4i1.397>
- Albayrak, D., & Ateşkan, A. (2022). Classroom management in higher education: A systematic literature review. *Journal of Further and Higher Education*, 46, 1006 - 1022. <https://doi.org/10.1080/0309877X.2022.2038099>
- Andhika, M., Suroto, S., Syahputra, R., & Pasaribu, L. (2024). Teachers' Skills in Classroom Management According to the Characteristics of Students in Elementary School. *Jurnal Ilmiah Teunuleh*. <https://doi.org/10.51612/teunuleh.v5i3.159>.

- Asirit, L.B.L., Hua, J.H., & Mendoza, L. (2022). A closer look at a neophyte Teachers' instructional competence: A phenomenological study. *International Research Journal of Science, Technology, Education, and Management*, 2(2), 11-25. <https://doi.org/10.5281/zenodo.6975604>
- Asis, J., Caballes, D., & Ortiz, O. (2023). Instructional competence of the public Secondary school teachers in the district of Naic: Basis for instructional enhancement program. *Polaris Global Journal of Scholarly Research and Trends*. <https://doi.org/10.58429/pgjsrt.v2n1a114>.
- Avenido, F., & Buquia, W. . (2024). Instructional Competence of Teachers in Relation to Learners' Academic Performance. *International Multidisciplinary Journal of Research for Innovation, Sustainability, and Excellence (IMJRIS)*, 1(5), 512-531. <https://risejournals.org/index.php/imjrise/article/view/446>
- Babadjanova, N. (2020). Effective Classroom Management Techniques For the Curriculum of the 21st Century. *Science Education*, 1, 281-285.
- Blömeke, S., Kaiser, G., König, J., & Jentsch, A. (2020). Profiles of mathematics Teachers' competence and their relation to instructional quality. *ZDM*, 52, 329-342. <https://doi.org/10.1007/s11858-020-01128-y>.
- Bragg, L., Walsh, C., & Heyeres, M. (2021). Successful design and delivery of Online professional development for teachers: A systematic review of the literature. *Comput. Educ.*, 166, 104158. <https://doi.org/10.1016/j.compedu.2021.104158>.
- Bulilan, Ramil. (2022). Educational Attainment and Teaching Competencies of University Faculty. Cam, S., & Koç, G. (2024). Professional Development Program to Develop Teacher Educators' Technological Pedagogical Content Knowledge. *Sage Open*. <https://doi.org/10.1177/21582440241242841>.
- Cansing, P.A. (2024). Instructional Competence of Newly Hired Teachers: Basis For Pedagogical Upskilling Plan. *EPRA International Journal of Environmental Economics, Commerce and Educational Management Journal* Volume: 11 | Issue | DOI: 10.36713/epra0414 |
- Canuto, P. P., Choycawen, M., & Pagdawan, R. (2024). The influence of teaching Competencies on teachers' performance and students' academic achievement in primary science education. *Problems of Education in the 21st Century*, 82(1), 29– 47. <https://doi.org/10.33225/pec/24.82.29>
- Cahyanti, A., Purwoko, B., Khamidi, A., Hariyati, N., & Roesminingsih, E. (2024). Fostering Student Motivation Through Teacher Competence. *EDUKASIA: Jurnal Pendidikan dan Pembelajaran*. <https://doi.org/10.62775/edukasia.v5i1.846>.
- Cipriano, J. (2024). Teachers' Empowerment in their Instructional Competence Basis of a Training Plan. *International Journal of Research and Innovation in Social Science*. <https://doi.org/10.47772/ijriss.2024.8120030>.
- Dumaguig, M. and Yango, A. (2023). Teachers' Pedagogical Competence, Classroom Management Skills and Students' Academic Achievement Among Selected Public City Schools Division in the Province of Laguna. *Technium Social Sciences Journal*. 44. 573-591. [10.47577/tssj.v44i1.8923](https://doi.org/10.47577/tssj.v44i1.8923).
- Fernández, R., Ruiz-Cabezas, A., Domínguez, M. C. M., Subía-Álava, A. B., & Salazar, J. L. D. (2024). Teachers' teaching and professional competences assessment. *Evaluation and Program Planning*, 103, 102396. <https://doi.org/10.1016/j.evalprogplan.2023.102396>
- Grande, H.R. (2024). Mathematics Teachers' Instructional Competence, Learner Related Factors in Relation to the Academic Performance in Mathematics 6. *International Research Journal of Modernization in Engineering Technology and Science*. Volume:06/Issue:04/. DOI: <https://www.doi.org/10.56726/IRJMETSS2027>
- Granada, G. D., & Oco, R. M. (2024). Classroom management and teaching Competencies of elementary teachers. *International Journal of Multiple Research Approaches*, 7(3), 1276-1283.
- Gumaod, J., Portugues, S., & Christy, D. (2022). Level of Competence among Mapeh Teachers in the Division of Surigao Del Norte, Dinagat Islands, and Camarines Sur. *International Journal of Science and Management Studies (IJSMS)*. <https://doi.org/10.51386/25815946/ijsms-v5i4p134>.

- Harlacher, J., & Marx, T. (2022). Classroom Management for Special Education Providers. New Considerations and Best Practices for Training Special Education Teachers. <https://doi.org/10.4018/978-1-7998-9494-0.ch005>.
- Heap, T., Thompson, R., & Fein, A. (2020). Designing teacher professional Development programs to support a rapid shift to digital. *Educational Technology Research and Development*, 69, 35 - 38. <https://doi.org/10.1007/s11423-020-09863-5>.
- Islami, R., Anantanukulwong, R., & Faikhamta, C. (2022). Trends of Teacher Professional Development Strategies: A Systematic Review. *Shanlax International Journal of Education*. <https://doi.org/10.34293/education.v10i2.4628>.
- Latpate, R., Kshirsagar, J., Gupta, V., & Chandra, G. (2021). Simple Random Sampling. *Advanced Sampling Methods*. https://doi.org/10.1007/978-981-16-0622-9_2.
- Malitic, L.M. (2020). The Instructional Competence and Leadership of Senior High School Master Teachers and the Schools' Performance in the Division Of Laguna. *International Journal of Advanced Research (IJAR)*. Vol. 8 (05), 767-779. DOI URL: <http://dx.doi.org/10.21474/IJAR01/10985>
- Marder, J., Thiel, F., & Göllner, R. (2023). Classroom management and students' Mathematics achievement: The role of students' disruptive behavior and teacher classroom management. *Learning and Instruction*. <https://doi.org/10.1016/j.learninstruc.2023.101746>.
- Marquez, J.F. (2023). Instructional Competencies of Teachers Transition From Distance Learning to In-Person Classes. *EPRA International Journal of Research and Development (IJRD)*. Volume: 8 | Issue: 3. <https://doi.org/10.36713/epra2016>
- Maryani, I., Irsalinda, N., Jaya, P., Sukma, H., & Raman, A. (2025). Understanding student engagement: an examination of the moderation effect of professional teachers' competence. *Journal of Education and Learning (EduLearn)*. <https://doi.org/10.11591/edulearn.v19i1.21455>.
- Moriera, M., Arcas, B., Sánchez, T., García, R., Melero, M., Cunha, N., Viana, M., & Almeida, M. (2022). Teachers' pedagogical competences in higher education: A systematic literature review. *Journal of University Teaching and Learning Practice*. <https://doi.org/10.53761/1.20.01.07>.
- Moser, C. (2022). Quota Sampling. *The SAGE Encyclopedia of Research Design*. <https://doi.org/10.4135/9780857020123.n459>.
- Mubarok, M. (2024). Relationship of Teacher Competency to the Quality of Students. *Abjadia: International Journal of Education*. <https://doi.org/10.18860/abj.v9i2.27845>.
- Muna, F., Nurhuda, A., Maghfuroh, A., & Lathif, N. (2024). Conceptions of Classroom Management in Education. *Jurnal BELAINDIKA (Pembelajaran dan Inovasi Pendidikan)*. <https://doi.org/10.52005/belaindika.v6i1.140>.
- Nafisah, A., Marmoah, S., and Riyadi (2024). Teacher Classroom Management Skills: Case Study of the Activator School Programme in Indonesia. *International Journal of Learning, Teaching and Educational Research* Vol. 22, No. 12, pp. 389-407, December 2023 <https://doi.org/10.26803/ijlter.22.12.19>
- Nguyen, D., Ng, D., Luo, W., & Mansor, S. (2020). Exploring the relationships Between instructional leadership and teacher competences: Singapore primary school teachers' perceptions. *International Journal of Leadership in Education*, 25, 919 - 940. <https://doi.org/10.1080/13603124.2020.1731765>.
- Nopas and Kerdsonboon (2024). Fostering Global Competence in Teachers Education: Curriculum Integration and Professional Development. *Higher Education Studies*; Vol. 14, No. 2
- Obispo, R.T., Magulod, Jr., G.C. and Tindowen, D.C. (2021). Teachers' Classroom Management Styles and Student-Teacher Connectedness and Anxiety. *International Journal of Learning, Teaching and Educational Research* Vol. 20, No. 5, pp. 123-141, May 2021 <https://doi.org/10.26803/ijlter.20.5.7>

- Ogar, A. (2020). Teachers' Classroom Management Skills and Students' Academic Performance In Business Studies In Etung Local Government Area Of Cross River State (February 11, 2020). Available at SSRN: <https://ssrn.com/abstract=3962588> or <http://dx.doi.org/10.2139/ssrn.3962588>
- Oriarte, R., Molines, E., Taracina, I.V., Zamora, D., Pañoso, J., Olea, M.M and Olea, W. T. (2023). Instructional Competencies of Mathematics Teachers and Their Performance in the Execution of Tasks. *International Journal of Business, Law, and Education*, 4(1), 15 - 24. <https://doi.org/10.56442/ijble.v4i1.102>
- Özen, H., & Yıldırım, R. (2020). Teacher Perspectives on Classroom Management. *International Journal of Contemporary Educational Research*. <https://doi.org/10.33200/ijcer.645818>.
- Pacuno, N., & Sánchez, A. (2020). Teacher Instructional Competence and Learners' Performance in Social Studies: Basis for Enhancement Program. *JPAIR Multidisciplinary Research*. <https://doi.org/10.7719/jpair.v42i1.807>.
- Paramita, P., Anderson, A., & Sharma, U. (2020). Effective Teacher Professional Learning on Classroom Behaviour Management: A Review of Literature. *Australian Journal of Teacher Education*. <https://doi.org/10.14221/ajte.2020v45n1.5>.
- Parto, L., & Yango, A. (2023). Teaching Competence and Adversity Quotient of Teachers in Alternative Learning System (ALS) and Students' Learning Engagement in The City Schools Division Offices in the Province of Laguna. *Technium Social Sciences Journal*. <https://doi.org/10.47577/tssj.v44i1.8935>.
- Pellerone, M., Rapisarda, V., Trischitta, M. C. A., Vitale, E., & Ramaci, T. (2020). Burnout and Self-Perceived Instructional Competence: An Exploratory Study of a Group of Italian Female Elementary School Teachers. *International Journal of Environmental Research and Public Health*, 17(4), 1356. <https://doi.org/10.3390/ijerph17041356>
- Priya, S. (2024). Impact of Teacher Professional Development on Student Learning at Secondary Level. *International Journal For Multidisciplinary Research*. <https://doi.org/10.36948/ijfmr.2024.v06i02.15219>.
- Ren, S., & Chen, Z. (2023). [Qualities of Excellent Clinical Teachers: An Empirical Study Based on Frontline Clinical Teachers. *Journal of Sichuan University. Medical science edition*, 54 3, 517-521. <https://doi.org/10.12182/20230560305>.
- Sansaluna-Maulana, S. A. (2021). The Teaching Practices of Senior High School English Teachers in Maguindanao, Philippines. *Randwick International of Education and Linguistics Science Journal*, 2(3), 358-363.
- Shrestha, M., & Acharya, B. (2023). Teachers' Professional Development Training For Their Professionalism. *Journal of Mathematics Education*. <https://doi.org/10.3126/jme.v5i1.60854>.
- Song, H., & Zhou, M. (2020). STEM Teachers' Preparation, Teaching Beliefs, and Perceived Teaching Competence: a Multigroup Structural Equation Approach. *Journal of Science Education and Technology*, 30, 394 - 407. <https://doi.org/10.1007/s10956-020-09881-1>.
- Szucs, L. E., Andrzejewski, J. D., Robin, L., Telljohann, S., Pitt Barnes, S., & Hunt, P. (2021). The Health Education Teacher Instructional Competency Framework: A Conceptual Guide for Quality Instruction in School Health. *The Journal of School Health*, 91(10), 774–787. <https://doi.org/10.1111/josh.13076>
- Thi, T. and Nguyen, H. (2021). The Effects of Classroom Management Styles on Students' Motivation and Academic Achievement in Learning English. *International Journal of Learning, Teaching and Educational Research* Vol. 20, No. 1, pp. 223-239, January 2021 <https://doi.org/10.26803/ijlter.20.1.12>
- Toshtemirovich, R. (2024). The Importance of Developing Students' Academic Competence in the Process of Modern Higher Education. *Current Research Journal of Pedagogics*. <https://doi.org/10.37547/pedagogicsrjp-05-04-09>.
- Tutica, H. (2024). Teaching competence and instructional strategies of TLE Junior High School teachers. Pantao (*International Journal of the Humanities and Social Sciences*). <https://doi.org/10.69651/pijhss020103>.
- Utilova, A., Khamzina, S., Shavaliyeva, Z., & Shakenova, T. (2024). Classroom Management Strategies in a Modern School. *3i intellect idea innovation* - https://doi.org/10.52269/22266070_2024_2_230.

- Waluyo, Hanan & Amalia, Nur. (2024). The Impact Of Teachers' Classroom Management Skills On Learning. *Didaktika Tauhidi: Jurnal Pendidikan Guru Sekolah Dasar*. 11. 47-60. 10.30997/dt.v11i1.12699
- Wilkins, N., Verlenden, J., Szucs, L., & Johns, M. (2022). Classroom Management And Facilitation Approaches That Promote School Connectedness.. *The Journal of School Health*. <https://doi.org/10.1111/josh.13279>.
- Yadav, D. (2022). Effective Classroom Management Skill: An Essential Skill For Teachers. *BSSS Journal of Education*. <https://doi.org/10.51767/je1107>.
- Yang, X., & Kaiser, G. (2022). The impact of mathematics teachers' professional Competence in instructional quality and students' mathematics learning outcomes. *Current Opinion in Behavioral Sciences*, 48. <https://doi.org/10.1016/j.cobeha.2022.101225>.
- You, H., Park, S., Hong, M., & Warren, A. (2024). Unveiling effectiveness: A Meta-analysis of professional development programs in science education. *Journal of Research in Science Teaching*. <https://doi.org/10.1002/tea.21985>.
- Zainuddin, Z. & Hardiansyah, F. (2023). Teacher Classroom Management Skills And Its Implementation in Primary School Learning. *Mimbar Sekolah Dasar*. 10. 92-105. 10.53400/mimbar-sd.v10i1.48865.
- Zhang, X. and An, I.L. (2024). Teachers' instructional competence, commitment, and satisfaction: Basis for professional development program. *International Journal of Research Studies in Education*, Volume 13 Number 4, 187-198w

Bibliometric Analysis of Climate-Smart Agriculture: Trends, Research Gaps, and Impacts on Crop Production

Vivian A. Segobre

West Visayas State University, College of Agriculture and Forestry
Lambunao, Iloilo, Philippines

ABSTRACT Climate-Smart Agriculture (CSA) plays a critical role in combating climate change, ensuring food security, and promoting sustainable crop production. This study conducts a bibliometric analysis of CSA research from 2015 to 2024, leveraging data from the Scopus database. The analysis pursues three main objectives: (1) examining research trends by tracking publication growth, subject areas, and document types; (2) identifying gaps in research by evaluating the distribution across countries, institutions, and funding sources; and (3) proposing directions for future research. Using a Boolean search string (“climate-smart agriculture” OR “CSA” OR “climate resilient agriculture” OR “sustainable agriculture”) AND (“bibliometric analysis” OR “scientometric analysis” OR “systematic mapping” OR “literature review” OR “science mapping”) AND (“crop production” OR “crop yield” OR “agricultural productivity” OR “farming systems”), data were retrieved from titles, abstracts, and keywords. After screening, 111 documents were retained for analysis, with bibliometric graphs and outputs generated directly from Scopus to ensure precision. Results show a consistent growth in CSA research, with a notable surge in 2024. Environmental Science (24.4%) and Agricultural and Biological Sciences (20.9%) emerged as the dominant fields, while the study also highlighted CSA's interdisciplinary nature, with contributions from Social Sciences, Computer Science, and Energy. India, the United States, and China led in research output, supported by robust institutional and funding networks. However, significant gaps remain in Africa and Latin America, with a scarcity of studies focused on socio-economic aspects and policy development. To propel CSA towards greater impact, it is crucial to foster collaborations, expand regional participation, and diversify funding sources, thereby advancing sustainable crop productivity and climate resilience globally.

Keywords: *Advanced agriculture, Crop products, Impact, Resiliency, Sustainability*

INTRODUCTION

Agriculture plays a crucial role in ensuring food security, economic development, and rural livelihoods worldwide. However, the sector faces increasing challenges due to climate change, which exacerbates extreme weather events, disrupts food systems, and threatens crop productivity (FAO, 2013). Rising global temperatures, unpredictable rainfall patterns, prolonged droughts, and more frequent pest and disease outbreaks have intensified the need for sustainable agricultural practices that enhance resilience and mitigate adverse environmental impacts. In response, Climate-Smart Agriculture (CSA) has emerged as an innovative approach that integrates strategies to increase agricultural productivity, enhance adaptation to climate change, and reduce greenhouse gas emissions (Lipper et al., 2014). The adoption of CSA involves various techniques, including improved soil and water management, agroforestry, conservation agriculture, climate-resilient crop varieties, and precision agriculture technologies (Rosenstock et al., 2019). These practices contribute to enhancing food security while ensuring environmental sustainability. However, despite the growing body of literature on CSA, there remains a need for a systematic evaluation of its research landscape to understand dominant themes, assess knowledge gaps, and analyze its impact on crop production.

Bibliometric analysis provides a structured and data-driven approach to examining research trends by assessing publication patterns, identifying influential authors and institutions, and mapping scientific collaborations (Donthu et al., 2021). Recognizing influential authors is not merely for academic ranking; it is important because their contributions often shape the direction of research, establish thematic priorities, and foster international collaborations. Understanding these leading voices helps highlight where innovations emerge and where future research may be directed. At the same time, bibliometric analysis is most valuable in uncovering research gaps, areas where evidence is limited or underexplored. This is critical for guiding future studies and maximizing the practical contributions of CSA to sustainable agriculture. Specifically, this research will examine how CSA research has progressed over time, determine key contributors in the field, explore dominant research themes related to crop production, analyze global research collaborations, and, most importantly, highlight gaps that need to be addressed to strengthen CSA's role in agricultural sustainability.

The principles of CSA align with several United Nations Sustainable Development Goals (SDGs). CSA plays a crucial role in achieving SDG 2 (Zero Hunger) by promoting sustainable agricultural practices that improve food security and crop resilience in changing climatic conditions (FAO, 2013). It also directly supports SDG 13 (Climate Action) by advocating climate adaptation and mitigation strategies that reduce the vulnerability of farming communities to climate-related threats (Vermeulen et al., 2012). Additionally, CSA aligns with SDG 15 (Life on Land) by encouraging

sustainable land management, soil conservation, and biodiversity-friendly agricultural practices (Lal, 2016). By examining the scientific landscape of CSA through bibliometric analysis, this study aims to support the global agenda for sustainable agriculture and climate resilience by identifying research gaps and areas requiring further innovation and investment.

Accordingly, this study seeks to conduct a bibliometric analysis of climate-smart agriculture (CSA) research with the following specific objectives: (1) to analyze research trends in CSA by examining patterns in publication growth, subject areas, and document types; (2) to identify research gaps by assessing the distribution of studies across countries, institutions, and funding sources, highlighting underrepresented regions and themes; and (3) to outline future research directions based on the trends and gaps revealed in the analysis. By addressing these objectives, this study will contribute to a deeper understanding of CSA research, providing valuable insights for scientists, policymakers, agricultural practitioners, and funding agencies. Ultimately, it will serve as a strategic tool for enhancing the adoption of CSA practices, improving crop productivity, and fostering climate-resilient agricultural systems globally.

METHODOLOGY

This study employed a bibliometric analysis to examine research trends, thematic areas, and scientific impacts of Climate-Smart Agriculture (CSA) in relation to crop production. Bibliometric analysis, as a quantitative approach, enables the systematic evaluation of research by assessing publication growth, citation performance, collaboration patterns, and keyword distribution, thereby providing insights into the development and direction of scientific inquiry within a particular domain.

The data were collected from the Scopus database, which was selected because of its wide coverage of peer-reviewed journals and high reliability as a bibliographic source. To retrieve relevant publications, a Boolean search string was constructed with the aid of ChatGPT and refined according to the study objectives. The final search string used was: ("climate-smart agriculture" OR "CSA" OR "climate resilient agriculture" OR "sustainable agriculture") AND ("bibliometric analysis" OR "scientometric analysis" OR "systematic mapping" OR "literature review" OR "science mapping") AND ("crop production" OR "crop yield" OR "agricultural productivity" OR "farming systems"). This search was applied to article titles, abstracts, and keywords, covering the publication period from 2015 to 2024, to capture recent advancements and contemporary perspectives in CSA research.

The initial search generated a total of 111 documents. Each record was carefully screened to ensure accuracy and relevance. Duplicate entries were checked using document titles, DOIs, and EIDs (unique Scopus identifiers). The screening confirmed that there were no duplications, and therefore all 111 documents were retained for analysis. No restrictions were placed on document type and language, ensuring broad inclusivity of relevant studies. However, the search was limited to the years 2015–2024 to capture recent research trends and developments.” The bibliographic information of these documents, including authors, titles, abstracts, keywords, source titles, publication year, and citation counts, was exported from Scopus in CSV format to facilitate analysis.

For the data analysis, only the bibliometric graphs and outputs generated directly from Scopus were used. These visualizations were examined to identify publication trends, influential authors and institutions, research collaboration patterns, thematic foci, and emerging knowledge gaps in the field of CSA and crop production. The interpretation of Scopus-generated outputs allowed for the extraction of insights regarding the growth of CSA-related research, its global distribution, and its contribution to enhancing crop resilience and sustainability. Since this study exclusively relied on secondary data from published literature indexed in Scopus, ethical approval was not required.

RESULTS AND DISSCUSION

Documents by Year

The results show a clear upward trajectory in the annual publications related to Climate-Smart Agriculture (CSA) from 2015 to 2024 (Figure 1), underscoring a significant rise in research activity within this field. From 2015 to 2019, the number of publications remained relatively low, with fluctuations below 10 documents per year. In 2020, there were 8 publications, followed by a slight dip to around 4 publications in 2021. However, a steady increase is seen from 2022 to 2023, indicating a growing recognition and emphasis on CSA research.

The most notable shift comes in 2024, when publications surged to over 50 documents. This sharp increase not only highlights a considerable rise in research output but also emphasizes the growing urgency and critical importance of CSA in tackling the dual challenges of climate change and food security. This trend suggests a shift in the academic and global focus, potentially fueled by increased funding, international collaborations, and an expanding recognition of the pressing need for climate-resilient agricultural practices.

The surge in CSA-related publications signals a heightened global awareness of the interconnectedness between agriculture, climate change, and food security. As more research emerges, it implies that the agricultural sector is increasingly being recognized as a key player in climate change mitigation and adaptation strategies. This increasing body of research could catalyze policy development and guide the implementation of more sustainable and adaptive farming practices worldwide. Furthermore, the rising research activity may encourage greater investment from both public and private sectors in climate-smart innovations, potentially leading to more rapid technological advancements in the field.

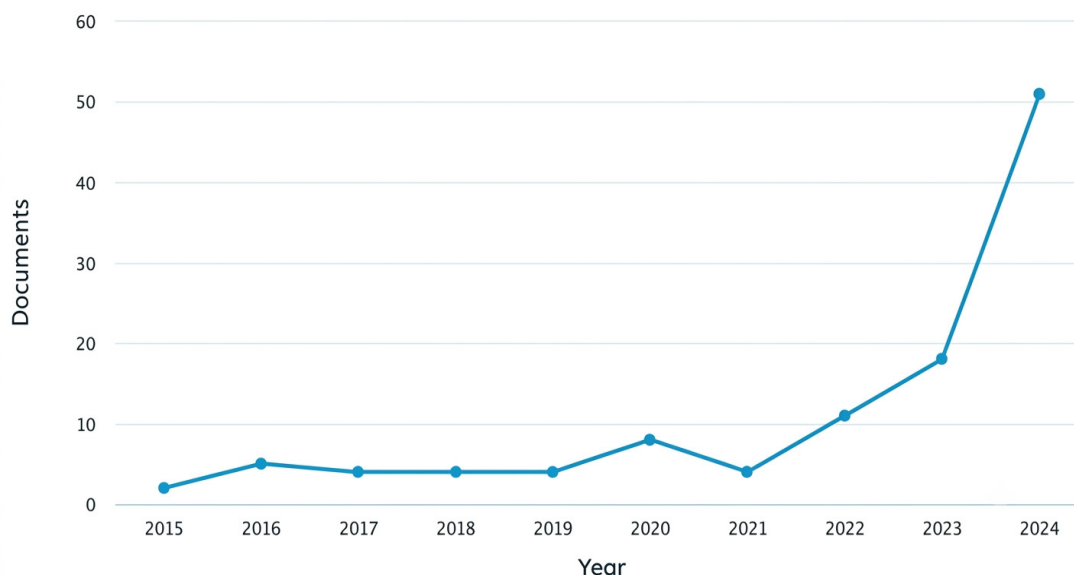


Figure 1. Annual trend of document publications (2015–2024).

Documents per Year by Source

The figure illustrates the trends in document publication by source over time from 2016 to 2024, highlighting the varying publication patterns across different sources (Figure 2). "Microbiological Research" remained constant, publishing one document per year throughout the entire period. "Agronomy for Sustainable Development" showed a slight increase from one document in 2016 to two documents in 2020, maintaining a steady output thereafter. "Sustainability Switzerland" exhibited a more dynamic trend, increasing from one document in 2018 to three documents by 2021, remaining stable until 2022, then decreasing to two documents in 2023, and finally peaking at four documents in 2024. "Frontiers in Sustainable Food Systems" started publishing in 2022 with one document and gradually increased to two documents in 2024, while "Water Switzerland" also started publishing in 2022 with one document and gradually increased to two documents by 2024.

The varying trends across these sources suggest different levels of focus and activity in CSA-related research within each publication outlet. Publications like "Microbiological Research" and "Agronomy for Sustainable Development" have shown a more consistent and stable output, indicating sustained but relatively less dynamic research activity in these journals. In contrast, journals like "Sustainability Switzerland," "Frontiers in Sustainable Food Systems," and "Water Switzerland" have exhibited more fluctuation, potentially reflecting shifts in the relevance of specific CSA topics over time, or changing editorial focuses in response to emerging global issues.

The fluctuations in publication trends across these journals imply diverse research priorities within the field of CSA. Journals like "Sustainability Switzerland" and "Water Switzerland," which have seen more pronounced variations in publication frequency, may be responding to urgent global challenges such as water scarcity, sustainability in agriculture, and the integration of ecological systems with agricultural practices. The steady output from "Microbiological Research" may suggest ongoing, foundational research into the microbiological aspects of CSA, providing crucial insights for climate-resilient agriculture. The trends also point to the evolving role of CSA research in addressing climate change, with some sources reflecting a greater alignment with contemporary environmental concerns, while others maintain a steady focus on long-term sustainable practices.

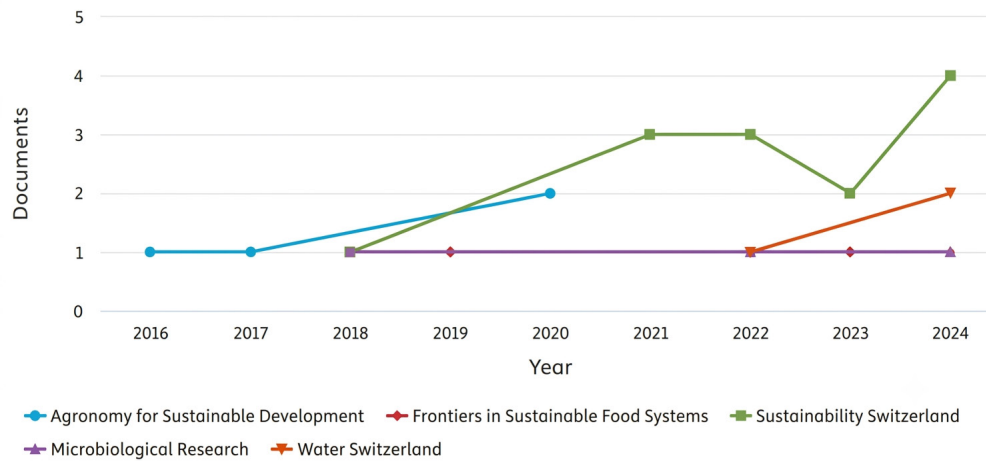


Figure 2. Trends in document publication by source over time.

Documents by Author

The figure presents the number of research documents authored by the top contributors in climate-smart agriculture (Figure 3). Cortner, O., El Bilali, H., Garrett, R.D., Gil, J.D.B., Indrasti, R., Kumar, A., and Wezel, A. lead with 2 documents each, indicating a strong research focus and influence in the field. Their consistent contributions underscore their pivotal roles in shaping the discourse on climate-smart agriculture.

Following these leading authors, A. Diuana, F. Abawiera Wongnaa, C., and Abbasi, E. have contributed with 1 document each. This distribution suggests a concentration of research output among a few key authors, while others have made fewer contributions. It may imply that a select group of researchers is driving the most impactful studies in the field, potentially influencing policy and practice.

The data highlights the contributions of individual researchers to the body of knowledge on climate-smart agriculture. The varying levels of contribution reflect different research interests, expertise, and engagement within the field. However, the concentrated contributions may also suggest a need for increased collaboration and diversity of voices to broaden the scope of research. It may be valuable for emerging researchers to engage with this core group of contributors to foster innovation and explore unexplored areas within climate-smart agriculture. Expanding the pool of active contributors could further enhance the depth and breadth of solutions to address climate change challenges in agricultural practices.

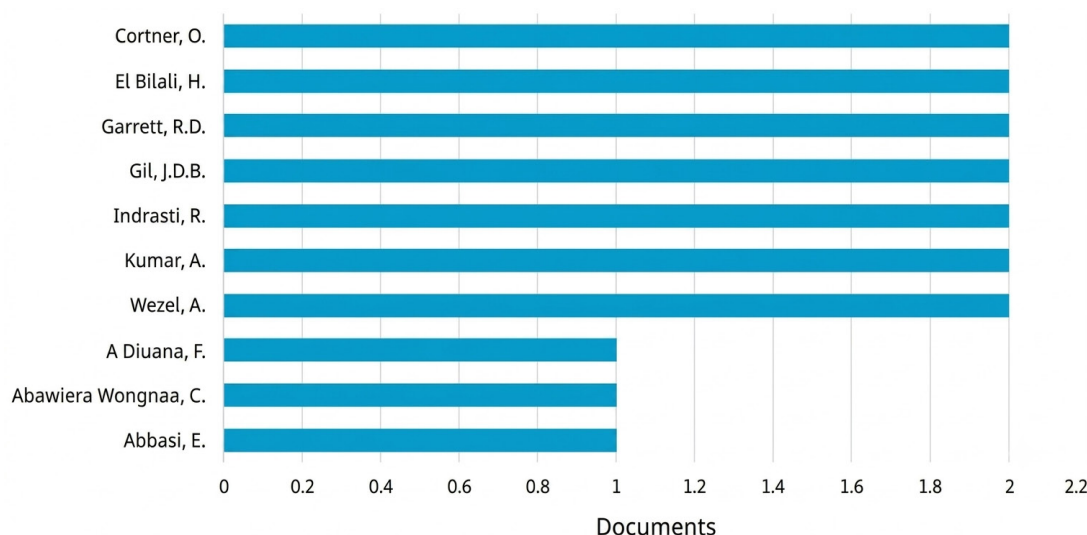


Figure 3. Leading authors in climate-smart agriculture research.

Documents by Affiliation

The figure illustrates the number of research documents produced by various academic and research institutions focusing on climate-smart agriculture (Figure 4). Banaras Hindu University leads with the highest number of contributions, indicating a strong institutional commitment to advancing agricultural sustainability and climate

adaptation research. This suggests that Banaras Hindu University is not only a leader in the field but also plays a central role in shaping the direction of future agricultural practices, potentially influencing both policy and practice at a global scale.

Following Banaras Hindu University, the Chinese Academy of Agricultural Sciences, Università degli studi di Bari Aldo Moro, IPB University, INRAE, and Badan Riset dan Inovasi Nasional have a comparable number of publications. The presence of these institutions reflects a diverse geographical distribution and widespread interest in developing sustainable agricultural strategies. This broad participation implies that climate-smart agriculture is a global priority, with research collaboration across continents contributing to a shared understanding of local and regional challenges.

Other institutions, such as the Ministry of Education of the People's Republic of China, Food and Agriculture Organization of the United Nations, Wageningen University & Research, and Cornell University, also contribute significantly to the body of knowledge on climate-smart agriculture. The data emphasizes the importance of global research efforts in addressing agricultural sustainability challenges and highlights the key roles played by various institutions in advancing scientific knowledge in this domain. This widespread engagement implies that collaborative research efforts will be crucial in developing scalable and adaptable solutions to the pressing challenges posed by climate change to global food systems. These efforts could also lead to more informed policy recommendations and innovations that foster resilience in agricultural systems worldwide.

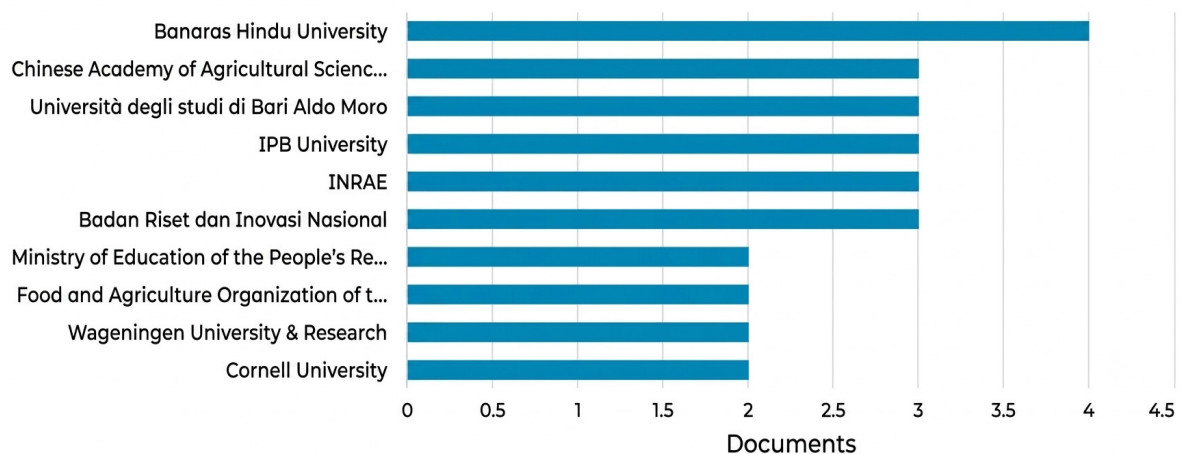


Figure 4. Institutional Contribution to Climate - Smart Agricultural Research

Documents by Country or Territory

The figure presents the number of research documents published on climate-smart agriculture by country, highlighting the leading contributors in this field (Figure 5). India ranks first with the highest number of publications, exceeding 20 documents, indicating its strong research focus on sustainable agricultural practices. The United States follows with 16 documents, reflecting its active engagement in addressing climate-related agricultural challenges. China ranks third with 14 documents. Italy and the United Kingdom contribute around 9 documents each, demonstrating Europe's growing involvement in sustainability research. Indonesia has 8 documents. Brazil and France contribute around 7 and 6 documents, respectively, showing significant interest in climate-smart farming solutions. South Africa and Australia each contribute a smaller number of publications, suggesting emerging but relatively limited research efforts in these countries.

The data underscores a global interest in climate-smart agriculture, with India, the United States, and China leading the research output, likely due to their large agricultural sectors and vulnerability to climate change. The varying contributions from other countries suggest potential research gaps, particularly in smaller or developing economies, which may lack the infrastructure or resources to conduct large-scale agricultural studies. These gaps highlight the need for targeted investments in agricultural research capacity in underrepresented regions to help mitigate the challenges posed by climate change. Additionally, the disparities in research output could limit the development of context-specific solutions for sustainable farming in these regions.

The findings imply that global collaboration is essential to address these gaps. International partnerships could help share knowledge, resources, and innovations that could benefit regions with less research activity. The implications

for policy-makers include the need for fostering greater cooperation between countries and institutions, improving funding mechanisms, and promoting capacity-building initiatives that focus on underserved regions. This would not only enhance global research efforts but also drive more inclusive and sustainable agricultural practices, ultimately contributing to global food security and climate resilience.

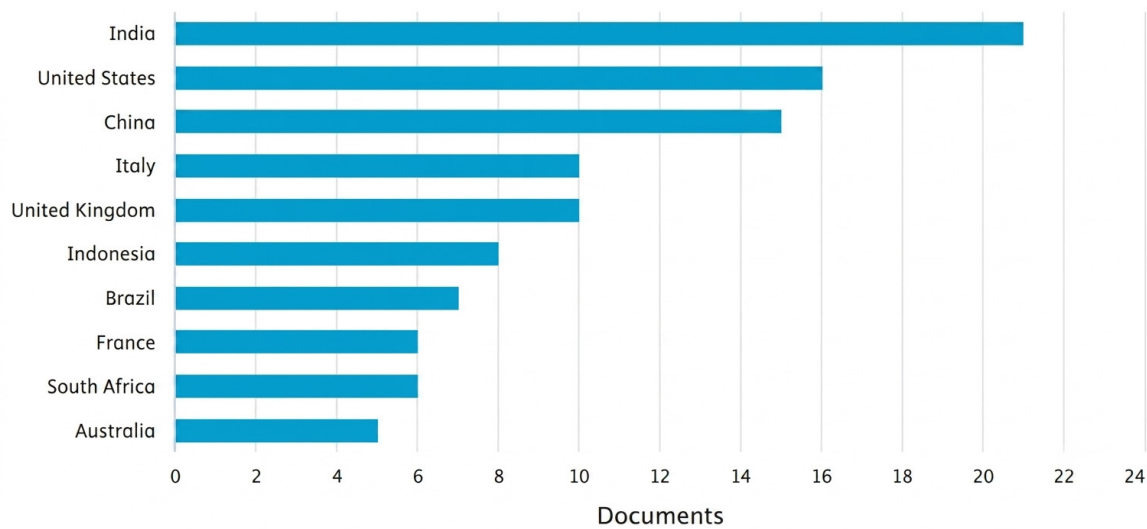


Figure 5. Global contributions to climate-smart agriculture research by country.

Documents by Type

The results show that research publications on climate-smart agriculture are predominantly focused on literature reviews (56.8%) and original empirical articles (32.4%), with a smaller proportion of conference papers (8.1%) and book chapters (2.7%). This distribution suggests that the field is primarily concerned with synthesizing existing knowledge and generating new empirical findings, which are crucial for guiding policymakers and practitioners in the effective implementation of climate-smart agricultural practices. However, the lower proportion of conference papers and book chapters indicates a gap in real-time discussions and in-depth, comprehensive explorations of the topic. The substantial presence of review articles and empirical studies reflects the growing demand for detailed knowledge and innovations in the field. Implications of these findings include the need for more dynamic academic exchanges through conferences to encourage real-time dialogue, as well as an emphasis on book chapters to provide comprehensive, interdisciplinary discussions.

While empirical research remains essential for advancing practical solutions, the lack of more diverse document types may suggest areas for future development, particularly in fostering broader engagement and providing comprehensive resources for both the academic community and field practitioners. Overall, these findings highlight the importance of a balanced approach to climate-smart agriculture research, one that integrates both in-depth knowledge synthesis and ongoing, real-time research discussions.

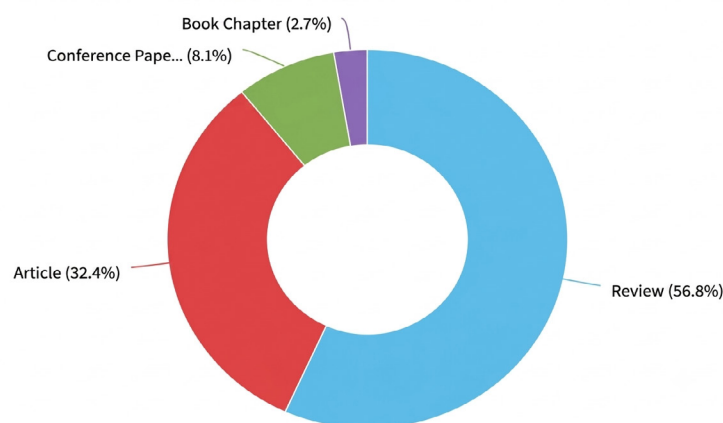


Figure 6. Distribution of climate-smart agriculture research by document type.

Documents by Subject Area

The figure illustrates the distribution of Climate-Smart Agriculture (CSA) research by subject area, showing the multidisciplinary character of the field (Figure 7). Environmental Science accounts for the largest share at 24.4%, underscoring the strong emphasis on environmental dimensions of CSA, particularly climate change mitigation, adaptation, and resource management. Agricultural and Biological Sciences follow closely at 20.9%, reflecting the central role of core agricultural research in advancing CSA practices. Social Sciences contribute 11.5%, highlighting the importance of addressing farmer behavior, adoption, and policy frameworks. Computer Science, at 9.0%, points to the growing use of digital tools, modeling, and precision agriculture in CSA, while Energy (7.3%) indicates links to renewable energy and sustainable resource use.

Other subject areas contribute smaller shares but add to the diversity of CSA research. Biochemistry, Genetics, and Molecular Biology account for 4.3%, supporting advances in crop improvement and resilience. Engineering contributes 3.8%, reflecting technological innovations, while Immunology and Microbiology (3.4%) and Medicine (2.6%) emphasize health and biosecurity aspects. Earth and Planetary Sciences (2.1%) show a minimal but relevant connection to climate and ecosystem studies. The "Other" category, at 10.7%, further reinforces the interdisciplinary reach of CSA.

The distribution implies that while CSA research is firmly rooted in environmental and agricultural sciences, there is growing recognition of the need to integrate social, technological, and energy perspectives. However, the relatively smaller share of socio-economic, policy, and health-related studies suggests a gap that must be addressed to ensure CSA strategies are not only scientifically sound but also socially inclusive, technologically adaptive, and relevant to the broader challenges of climate resilience (Figure 7).

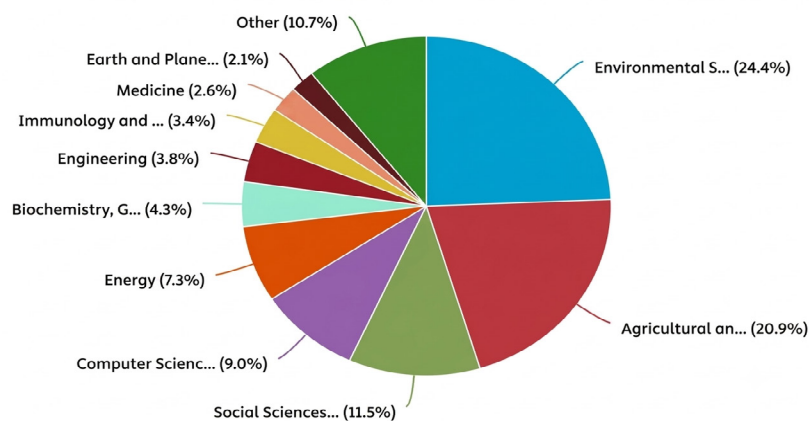


Figure 7. Distribution of climate-smart agriculture research by subject area

Documents by Funding Sponsor

The figure presents the distribution of research documents based on their funding sponsors (Figure 8), highlighting key organizations contributing to climate-smart agriculture studies. The National Natural Science Foundation of China is the leading funding source, supporting the highest number of research documents, indicating China's strong commitment to advancing research in sustainable agriculture and climate adaptation strategies. The National Key Research and Development Program of China follows closely.

Other significant contributors include the Consortium of International Agricultural Research Centers, the European Commission, and the Horizon 2020 Framework Programme, reflecting international and European investment in climate-smart agricultural initiatives. The National Institute of Food and Agriculture, the National Science Foundation, and the U.S. Department of Agriculture also contribute substantially, demonstrating the United States' engagement in this field.

The Bill and Melinda Gates Foundation and the Council of Scientific and Industrial Research have a relatively lower number of documents compared to the leading funding sponsors. The dominance of Chinese and international funding agencies highlights the global focus on climate-smart agricultural research. However, the varying contributions from different sponsors suggest potential funding gaps and the need for increased investment in specific areas or regions.

that may require greater international collaboration. Strengthening global funding networks can enhance research efforts, particularly in regions most vulnerable to climate change impacts on agriculture, informing future research directions.

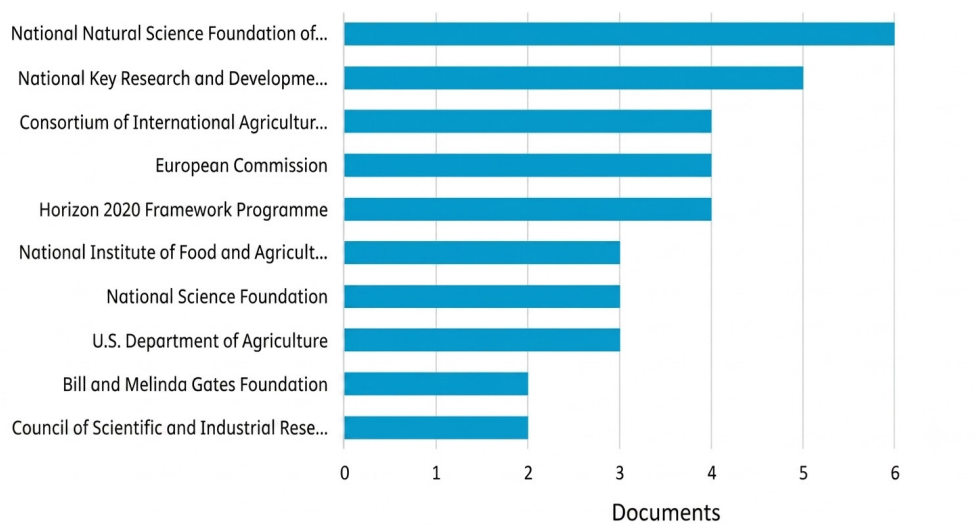


Figure 8. Major funding sponsors supporting climate-smart agriculture research.

CONCLUSIONS

The study reveals a consistent growth in climate-smart agriculture (CSA) research since 2015, reaching its peak in 2024, with a significant concentration of publications in journals like Sustainability (Switzerland). The research landscape is predominantly shaped by journal articles and agronomic/environmental studies. However, the distribution of research outputs is uneven, with Asia and Europe leading the charge, while Africa and Latin America remain notably underrepresented. Additionally, funding and authorship are concentrated within a small group of institutions, scholars, and sponsors, further exacerbating the imbalance. These trends underscore the need for a more inclusive and diverse approach to CSA research, highlighting the importance of engaging underrepresented regions and promoting interdisciplinary collaboration. To enhance the relevance and impact of CSA research, it is crucial to increase funding opportunities, encourage cross-disciplinary studies, foster global collaborations, and actively involve researchers from underserved regions. By doing so, CSA research can become more equitable, practical, and globally relevant, ensuring that advancements in the field address the needs of all communities and are grounded in real-world applications.

REFERENCES

- Abawiera Wongnaa C.; Amoah Seyram A.; Babu S. (2024). A systematic review of climate change impacts, adaptation strategies, and policy development in West Africa. *Regional Sustainability*, 5(2). <https://doi.org/10.1016/j.regsus.2024.100137>
- Abegunde V.O.; Obi A. (2022). The Role and Perspective of Climate Smart Agriculture in Africa: A Scientific Review. *Sustainability (Switzerland)*, 14(4). <https://doi.org/10.3390/su14042317>
- Adamides G. (2020). A review of climate-smart agriculture applications in Cyprus. *Atmosphere*, 11(9). <https://doi.org/10.3390/ATMOS11090898>
- Adnan A.; Hastuti C.O.I.; Hadiarto A.; Lestari I.P.; Haryati Y.; Indrasti R.; Cahyaningrum H.; Qomariyah N.; Permana D.; Nurmalinda; Ariningsih E.; Jayanegara A.; Wijaya A. (2024). Evolving Paradigms in Sorghum Research: A Bibliometric and Content Analysis of Global Trends and Future Directions. *International Journal of Design and Nature and Ecodynamics*, 19(3), 887-898. <https://doi.org/10.18280/ij dne.190318>
- Ahmadzai H.; Tutundjian S.; Elouafi I. (2021). Policies for sustainable agriculture and livelihood in marginal lands: A review. *Sustainability (Switzerland)*, 13(16). <https://doi.org/10.3390/su13168692>
- Aliloo J.; Abbasi E.; Karamidehkordi E.; Ghanbari Parmehr E.; Canavari M. (2024). Dos and Don'ts of using drone technology in the crop fields. *Technology in Society*, 76. <https://doi.org/10.1016/j.techsoc.2024.102456>

- Amri M.E.; Khayi S.; Triqui Z.E.A.; Amri M.; Mentag R. (2023). *Orobanche crenata*: A Bibliometric Analysis of a Noxious Parasitic Plant. *Plant Disease*, 107(11), 3332-3343.
<https://doi.org/10.1094/PDIS-10-22-2478-SR>
- Arenas-Calle L.N.; Whitfield S.; Challinor A.J. (2019). A Climate Smartness Index (CSI) Based on Greenhouse Gas Intensity and Water Productivity: Application to Irrigated Rice. *Frontiers in Sustainable Food Systems*, 3.
<https://doi.org/10.3389/fsufs.2019.00105>
- Armenta-Medina D.; Ramirez-Delreal T.A.; Villanueva-Vásquez D.; Mejia-Aguirre C. (2020). Trends on advanced information and communication technologies for improving agricultural productivity: A bibliometric analysis. *Agronomy*, 10(12). <https://doi.org/10.3390/agronomy10121989>
- Balusamy S.R.; Joshi A.S.; Perumalsamy H.; Mijakovic I.; Singh P. (2023). Advancing sustainable agriculture: a critical review of smart and eco-friendly nanomaterial applications. *Journal of Nanobiotechnology*, 21(1).
<https://doi.org/10.1186/s12951-023-02135-3>
- Baraj B.; Mishra M.; Sudarsan D.; Silva R.M.D.; Santos C.A.G. (2024). Climate change and resilience, adaptation, and sustainability of agriculture in India: A bibliometric review. *Heliyon*, 10(8).
<https://doi.org/10.1016/j.heliyon.2024.e29586>
- Barathi S.; Sabapathi N.; Kandasamy S.; Lee J. (2024). Present status of insecticide impacts and eco-friendly approaches for remediation review. *Environmental Research*, 240. <https://doi.org/10.1016/j.envres.2023.117432>
- Boubekri K.; Soumare A.; Mardad I.; Lyamlouli K.; Ouhdouch Y.; Hafidi M.; Kouisni L. (2022). Multifunctional role of Actinobacteria in agricultural production sustainability: A review. *Microbiological Research*, 261. <https://doi.org/10.1016/j.micres.2022.127059>
- Bouchet A.-S.; Laperche A.; Bissuel-Belaygue C.; Snowdon R.; Nesi N.; Stahl A. (2016). Nitrogen use efficiency in rapeseed. A review. *Agronomy for Sustainable Development*, 36(2).
<https://doi.org/10.1007/s13593-016-0371-0>
- Brooker R.W.; Karley A.J.; Newton A.C.; Pakeman R.J.; Schöb C. (2016). Facilitation and sustainable agriculture: A mechanistic approach to reconciling crop production and conservation. *Functional Ecology*, 30(1), 98-107.
<https://doi.org/10.1111/1365-2435.12496>
- Bulgari R.; Cocetta G.; Trivellini A.; Vernieri P.; Ferrante A. (2015). Biostimulants and crop responses: A review. *Biological Agriculture and Horticulture*, 31(1), 1-17. <https://doi.org/10.1080/01448765.2014.964649>
- Calia C.; Pulvento C.; Sellami M.H.; Tedone L.; Ruta C.; De Mastro G. (2024). A Bibliometric Analysis of Chickpea Agronomic Practices in the World During 45 Years of Scientific Research. *Legume Science*, 6(1).
<https://doi.org/10.1002/leg3.219>
- Chaudhuri S.; Roy M.; Suresh M. (2024). Can Cap-and-Trade Be a Regulatory Option to Address Groundwater Depletion and Irrigation Crises in India? Reflections, Issues & Options. *Environmental Management*, 73(1), 177-198. <https://doi.org/10.1007/s00267-023-01908-8>
- Chen J.; Zhao J.; Du H.; Xu M.; Lei Y.; Chen W.; Xu L.; Chao J. (2024). Earthworms' role in the management and regulation of croplands: Comparative research on field and laboratory studies revealed by bibliometric analysis. *Ecological Indicators*, 163. <https://doi.org/10.1016/j.ecolind.2024.112077>
- Crovella T.; Paiano A.; Falciglia P.P.; Lagioia G.; Ingrao C. (2024). Wastewater recovery for sustainable agricultural systems in the circular economy – A systematic literature review of Life Cycle Assessments. *Science of the Total Environment*, 912. <https://doi.org/10.1016/j.scitotenv.2023.169310>
- Dahal B.; Ghosh Bag A. (2023). Effect of Integrated Nutrient Management on Different Parameters of Lentil: A Review. *Communications in Soil Science and Plant Analysis*, 54(8), 1015-1023.
<https://doi.org/10.1080/00103624.2022.2137188>

- Díaz-Siefer P.; Fontúrbel F.E.; Berasaluce M.; Huenchuleo C.; Lal R.; Mondaca P.; Celis-Diez J.L. (2024). The market–society–policy nexus in sustainable agriculture. *Environment, Development and Sustainability*, 26(12), 29981-30000. <https://doi.org/10.1007/s10668-022-02691-y>
- Dirwai T.L.; Taguta C.; Senzanje A.; Nhamo L.; Cofie O.; Lankford B.; Nyambe H.N.; Mabhaudhi T. (2024). Status of agricultural water management practices in Africa: a review for the prioritisation and operationalisation of the African Union’s irrigation development and agricultural water management (AU-IDAWM) strategy. *Environmental Research Letters*, 19(10). <https://doi.org/10.1088/1748-9326/ad76bf>
- Donthu, N., Kumar, S., Mukherjee, D., Pandey, N., & Lim, W. M. (2021). How to conduct a bibliometric analysis: An overview and guidelines. *Journal of Business Research*, 133, 285-296. <https://doi.org/10.1016/j.jbusres.2021.04.070>
- Du C.; Wu Y.; Ma L.; Lei D.; Yuan Y.; Ren X.; Wang Q.; Jian J.; Du X. (2024). Bibliometric Analysis of Research on the Effects of Conservation Management on Soil Water Content Using CiteSpace. *Water (Switzerland)*, 16(23). <https://doi.org/10.3390/w16233415>
- El Bilali H.; Ben Hassen T. (2024). Regional Agriculture and Food Systems Amid the COVID-19 Pandemic: The Case of the Near East and North Africa Region. *Foods*, 13(2). <https://doi.org/10.3390/foods13020297>
- El Bilali H.; Dambo L.; Nanema J.; Tietiambou S.R.F.; Dan Guimbo I.; Nanema R.K. (2023). Impacts of the COVID-19 Pandemic on Agri-Food Systems in West Africa. *Sustainability (Switzerland)*, 15(13). <https://doi.org/10.3390/su151310643>
- El-Deriny M.M.; Ibrahim D.S.S.; Farag N.S. (2024). Rhizobacteria as a Potential Bioagent against Root-Galling Disease in Vegetable Crops. *Microbial Biostimulants: Biorational Pesticides for Management of Plant Pathogens*, 149-176. <https://www.scopus.com/inward/record.uri?eid=2-s2.0-85211312180&partnerID=40&m-d5=6b25e09c9eab979e37d366f03aa66bec>
- Eliseu E.E.; Lima T.M.; Gaspar P.D. (2024). Sustainable Development Strategies and Good Agricultural Practices for Enhancing Agricultural Productivity: Insights and Applicability in Developing Contexts—The Case of Angola. *Sustainability (Switzerland)*, 16(22). <https://doi.org/10.3390/su16229878>
- El-Khalifa Z.S.; Zahran H.F.; Ayoub A.; Alkhuly M.G. (2024). Egyptian Ecosystem’s Impacts on Climate Change: A Case Study of Some Agricultural Indicators; [Impactos Del Ecosistema Egipcio En El Cambio Climático: Un Estudio De Caso De Algunos Indicadores Agrícolas]; [Impactos Do Ecosystema Egípcio Nas Mudanças Climáticas: Um Estudo De Caso De Alguns Indicadores Agrícolas]. *Revista de Gestao Social e Ambiental*, 18(8). <https://doi.org/10.24857/rgsa.v18n8-051>
- Fahlevi M.; Asetya D.R.; Matroji F.J.; Dahlan S.P.; Dandi M.; Asyrof R.A. (2024). What Happens When IoT Meets Big Data? Revolutionizing Urban Agriculture for Future Cities. 11th International Conference on ICT for Smart Society: Integrating Data and Artificial Intelligence for a Resilient and Sustainable Future Living, ICISS 2024 - Proceedings. <https://doi.org/10.1109/ICISS62896.2024.10751358>
- Fatima F.; Ahmad M.M.; Verma S.R.; Pathak N. (2022). Relevance of phosphate-solubilizing microbes in sustainable crop production: a review. *International Journal of Environmental Science and Technology*, 19(9), 9283-9296. <https://doi.org/10.1007/s13762-021-03425-9>
- Fiorini A.C.O.; Angelkorte G.; Bakman T.; Baptista L.B.; Cruz T.; A Diuana F.; Morais T.N.; Rathmann R.; da Silva F.T.F.; Tagomori I.; Zanon-Zotin M.; Lucena A.F.P.; Szklo A.; Schaeffer R.; Portugal-Pereira J. (2024). How climate change is impacting the Brazilian agricultural sector: evidence from a systematic literature review. *Environmental Research Letters*, 19(8). <https://doi.org/10.1088/1748-9326/ad5f42>
- Food and Agriculture Organization (FAO). (2013). *Climate-Smart Agriculture: Sourcebook*. FAO.
- Francis D.V.; Abdalla A.K.; Mahakham W.; Sarmah A.K.; Ahmed Z.F.R. (2024). Interaction of plants and metal nanoparticles: Exploring its molecular mechanisms for sustainable agriculture and crop improvement. *Environment International*, 190. <https://doi.org/10.1016/j.envint.2024.108859>

- Fuhrmann-Aoyagi M.B.; Miura K.; Watanabe K. (2024). Sustainability in Japan's Agriculture: An Analysis of Current Approaches. *Sustainability (Switzerland)*, 16(2). <https://doi.org/10.3390/su16020596>
- Galvis-Ortega L.D.; Claro-Prado D.E.; Swaminathan J.; Rico-Bautista D. (2024). Drones in sustainable agricultural systems: A literature review. *Proceedings of the LACCEI international Multi-conference for Engineering, Education, and Technology*. <https://doi.org/10.18687/LACCEI2024.1.1.1970>
- Gamage A.; Gangahagedara R.; Subasinghe S.; Gamage J.; Guruge C.; Senaratne S.; Randika T.; Rathnayake C.; Hameed Z.; Madhujith T.; Merah O. (2024). Advancing sustainability: The impact of emerging technologies in agriculture. *Current Plant Biology*, 40. <https://doi.org/10.1016/j.cpb.2024.100420>
- Garrett R.D.; Niles M.T.; Gil J.D.B.; Gaudin A.; Chaplin-Kramer R.; Assmann A.; Assmann T.S.; Brewer K.; de Faccio Carvalho P.C.; Cortner O.; Dynes R.; Garbach K.; Kebreab E.; Mueller N.; Peterson C.; Reis J.C.; Snow V.; Valentim J. (2017). Social and ecological analysis of commercial integrated crop livestock systems: Current knowledge and remaining uncertainty. *Agricultural Systems*, 155, 136-146. <https://doi.org/10.1016/j.agsy.2017.05.003>
- Garrett R.D.; Ryschawy J.; Bell L.W.; Cortner O.; Ferreira J.; Garik A.V.N.; Gil J.D.B.; Klerkx L.; Moraine M.; Peterson C.A.; Dos Reis J.C.; Valentim J.F. (2020). Drivers of decoupling and recoupling of crop and livestock systems at farm and territorial scales. *Ecology and Society*, 25(1). <https://doi.org/10.5751/ES-11412-250124>
- Gherekhloo J.; Oveisi M.; Zand E.; De Prado R. (2016). A review of herbicide resistance in Iran. *Weed Science*, 64(4), 551-561. <https://doi.org/10.1614/WS-D-15-00139.1>
- Ghosh T.K.; Singh A.K.; Mitra S.; Karmakar S. (2024). Gathering insights into the global scenario of floating-bed agriculture through a systematic literature review for its promotion in the Indian context. *Progress in Disaster Science*, 24. <https://doi.org/10.1016/j.pdisas.2024.100367>
- Glavanits J.; Szabó T. (2024). FinTech Solutions Supporting Sustainable Agriculture - Lessons from Africa: FinTech Solutions Supporting Sustainable Agriculture. *ACM International Conference Proceeding Series*, 97-103. <https://doi.org/10.1145/3670243.3672435>
- Grigorieva E.; Livenets A.; Stelmakh E. (2023). Adaptation of Agriculture to Climate Change: A Scoping Review. *Climate*, 11(10). <https://doi.org/10.3390/cli11100202>
- Gupta J.; Kumari M.; Mishra A.; Swati; Akram M.; Thakur I.S. (2022). Agro-forestry waste management- A review. *Chemosphere*, 287. <https://doi.org/10.1016/j.chemosphere.2021.132321>
- Haby M.M.; Chapman E.; Clark R.; Galvão L.A.C. (2016). Agriculture, food, and nutrition interventions that facilitate sustainable food production and impact health: An overview of systematic reviews. *Revista Panamericana de Salud Publica/Pan American Journal of Public Health*, 40(1), 48-56. <https://www.scopus.com/inward/record.uri?eid=2-s2.0-84992700411&partnerID=40&md5=874a12e4e894ee710c7b98105fed05f0>
- Handayani N.U.; Ulkhaq M.M.; Sari D.P.; Mahachandra M.; Salsabila S.S. (2024). Building Food Resilience Against Floods: A Systematic Review of Absorptive, Adaptive and Transformational Strategies. *Journal of Ecohumanism*, 3(8), 2674-2686. <https://doi.org/10.62754/joe.v3i8.5760>
- Haque A.; Islam N.; Samrat N.H.; Dey S.; Ray B. (2021). Smart farming through responsible leadership in Bangladesh: Possibilities, opportunities, and beyond. *Sustainability (Switzerland)*, 13(8). <https://doi.org/10.3390/su13084511>
- Hibatullah F.H.; Sofyan E.T.; Nurbaity A.; Simarmata T. (2024). Revealing the Crucial Role and Prospect of Nano-biofertilizers for Improving Soil Health and Advancing Sustainable Crop Productivity; [Die entscheidende Rolle und die Potenziale von Nanobiodüngern für die Verbesserung der Bodengesundheit und die Steigerung der nachhaltigen Pflanzenproduktivität]. *Bodenkultur*, 75(1), 21-31. <https://doi.org/10.2478/boku-2024-0003>
- Hogan C.; Kinsella J.; Beecher M.; O'Brien B. (2023). The impact of work organisation on the work life of people on pasture-based dairy farms. *Animal*, 17(1). <https://doi.org/10.1016/j.animal.2022.100686>

- Jabed M.A.; Azmi Murad M.A. (2024). Crop yield prediction in agriculture: A comprehensive review of machine learning and deep learning approaches, with insights for future research and sustainability. *Heliyon*, 10(24). <https://doi.org/10.1016/j.heliyon.2024.e40836>
- Jiang J.; Cui S.; Lv L.; Jiang J.; Zhu Z. (2024). Bibliometric Analysis of Pesticide Residues in Soil-Vegetable System on CiteSpace. *BIO Web of Conferences*, 142. <https://doi.org/10.1051/bioconf/202414201007>
- Kasozi N.; Iwe G.D.; Walakira J.; Langi S. (2024). Integration of probiotics in aquaponic systems: an emerging alternative approach. *Aquaculture International*, 32(2), 2131-2150. <https://doi.org/10.1007/s10499-023-01261-x>
- Kazancoglu Y.; Lafci C.; Kumar A.; Luthra S.; Garza-Reyes J.A.; Berberoglu Y. (2024). The role of agri-food 4.0 in climate-smart farming for controlling climate change-related risks: A business perspective analysis. *Business Strategy and the Environment*, 33(4), 2788-2802. <https://doi.org/10.1002/bse.3629>
- Keller C.; Joshi S.; Joshi T.; Goldmann E.; Riar A. (2024). Challenges for crop diversification in cotton-based farming systems in India: a comprehensive gap analysis between practices and policies. *Frontiers in Agronomy*, 6. <https://doi.org/10.3389/fagro.2024.1370878>
- Khan A.; Tan D.K.Y.; Afridi M.Z.; Luo H.; Tung S.A.; Ajab M.; Fahad S. (2017). Nitrogen fertility and abiotic stress management in cotton crop: a review. *Environmental Science and Pollution Research*, 24(17), 14551-14566. <https://doi.org/10.1007/s11356-017-8920-x>
- Kharel M.; Dahal B.M.; Raut N. (2022). Good agriculture practices for safe food and sustainable agriculture in Nepal: A review. *Journal of Agriculture and Food Research*, 10. <https://doi.org/10.1016/j.jafr.2022.100447>
- Kindangen J.G.; Kairupan A.N.; Joseph G.H.; Rawung J.B.M.; Indrasti R. (2023). Sustainable agricultural development through an agribusiness approach and provision of location-specific technology in North Sulawesi. *E3S Web of Conferences*, 444A. <https://doi.org/10.1051/e3sconf/202344401003>
- Kiruba N J.M.; Saeid A. (2022). An Insight into Microbial Inoculants for Bioconversion of Waste Biomass into Sustainable “Bio-Organic” Fertilizers: A Bibliometric Analysis and Systematic Literature Review. *International Journal of Molecular Sciences*, 23(21). <https://doi.org/10.3390/ijms232113049>
- Kombat R.; Sarfatti P.; Fatunbi O.A. (2021). A review of climate-smart agriculture technology adoption by farming households in sub-Saharan Africa. *Sustainability (Switzerland)*, 13(21). <https://doi.org/10.3390/su132112130>
- Kostina-Bednarz M.; Płonka J.; Barchanska H. (2023). Allelopathy as a source of bioherbicides: challenges and prospects for sustainable agriculture. *Reviews in Environmental Science and Biotechnology*, 22(2), 471-504. <https://doi.org/10.1007/s11157-023-09656-1>
- Kumar A.; Naroju S.P.; Kumari N.; Arsey S.; Kumar D.; Gubre D.F.; Roychowdhury A.; Tyagi S.; Saini P. (2024). The role of drought response genes and plant growth-promoting bacteria on plant growth promotion under sustainable agriculture: A review. *Microbiological Research*, 286. <https://doi.org/10.1016/j.micres.2024.127827>
- Kumar A.; Verma J.P. (2018). Does plant—Microbe interaction confer stress tolerance in plants: A review. *Microbiological Research*, 207, 41-52. <https://doi.org/10.1016/j.micres.2017.11.004>
- Kumar V.; Raghuvanshi N.; Kumar A.; Rithesh L.; Rai A.; Pandey A.K. (2023). Deciphering phytomicrobiomes for sustainable crop production: Recent findings and future perspectives. *Plant Stress*, 10. <https://doi.org/10.1016/j.stress.2023.100285>
- Kusharki M.B.; Muhammad-Bello B.L. (2024). AIoT-Enabled Precision Agriculture for Sustainable Crop Disease Management: Advancing SDGs Through Graph Attention Neural Networks. *Lecture Notes on Data Engineering and Communications Technologies*, 192, 143-160. https://doi.org/10.1007/978-3-031-53433-1_8
- Lakhia I.A.; Yan H.; Zhang C.; Wang G.; He B.; Hao B.; Han Y.; Wang B.; Bao R.; Syed T.N.; Chaudhary J.N.; Rakibuzzaman M. (2024). A Review of Precision Irrigation Water-Saving Technology under Changing Climate for Enhancing Water Use Efficiency, Crop Yield, and Environmental Footprints. *Agriculture (Switzerland)*, 14(7). <https://doi.org/10.3390/agriculture14071141>

- Lakshmi V.; Corbett J. (2023). Using AI to Improve Sustainable Agricultural Practices: A Literature Review and Research Agenda. *Communications of the Association for Information Systems*, 53, 96-137. <https://doi.org/10.17705/1CAIS.05305>
- Lal, R. (2016). Soil health and carbon management. *Food and Energy Security*, 5(4), 212-222. <https://doi.org/10.1002/fes3.96>
- Lapidus D.; Franzen K.; Milliken C.; Ovington T.; Frankel-Reed J. (2024). Informing climate-smart agriculture in low-resource settings for practitioners: A review and analysis of interactive tools. *Gates Open Research*, 8. <https://doi.org/10.12688/gatesopenres.15299.1>
- Letourneau D.K.; Ando A.W.; Jedlicka J.A.; Narwani A.; Barbier E. (2015). Simple-but-sound methods for estimating the value of changes in biodiversity for biological pest control in agriculture. *Ecological Economics*, 120, 215-225. <https://doi.org/10.1016/j.ecolecon.2015.10.015>
- Li H.; Wang L.; Li J.; Gao M.; Zhang J.; Zhang J.; Qiu J.; Deng J.; Li C.; Froking S. (2017). The development of China-DNDC and review of its applications for sustaining Chinese agriculture. *Ecological Modelling*, 348, 1-13. <https://doi.org/10.1016/j.ecolmodel.2017.01.003>
- Lipper, L., Thornton, P., Campbell, B. M., Baedeker, T., Braimoh, A., Bwalya, M., ... & Torquebiau, E. F. (2014). Climate-smart agriculture for food security. *Nature Climate Change*, 4(12), 1068-1072. <https://doi.org/10.1038/nclimate2437>
- Liu Z.; Ju X.; Zheng L.; Yu F. (2023). The Bright Future of Biochar in Sustainable Agriculture: A Bibliometric Analysis. *Journal of Soil Science and Plant Nutrition*, 23(4), 5036-5047. <https://doi.org/10.1007/s42729-023-01547-2>
- Majoro F.; Wali U.G.; Munyaneza O.; Naramabuye F.-X. (2023). Sustainability Analysis of Soil Erosion Control in Rwanda: Case Study of the Sebeya Watershed. *Sustainability (Switzerland)*, 15(3). <https://doi.org/10.3390/su15031969>
- Martinez-Baron D.; Orjuela G.; Renzoni G.; Loboguerrero Rodríguez A.M.; Prager S.D. (2018). Small-scale farmers in a 1.5°C future: The importance of local social dynamics as an enabling factor for implementation and scaling of climate-smart agriculture. *Current Opinion in Environmental Sustainability*, 31, 112-119. <https://doi.org/10.1016/j.cosust.2018.02.013>
- Martinho V.J.P.D.; Cunha C.A.D.S.; Pato M.L.; Costa P.J.L.; Sánchez-Carreira M.C.; Georgantzis N.; Rodrigues R.N.; Coronado F. (2022). Machine Learning and Food Security: Insights for Agricultural Spatial Planning in the Context of Agriculture 4.0. *Applied Sciences (Switzerland)*, 12(22). <https://doi.org/10.3390/app122211828>
- Menefee D.; Saleh A.; Gallego O. (2024). Estimating soil carbon change using the web-based Nutrient Tracking Tool (NTT) with APEX. *Journal of Soil and Water Conservation*, 79(4), 180-190. <https://doi.org/10.2489/jswc.2024.00042>
- Mishra N.; Ghosh A.; Biswas G. (2023). Perspectives of crop improvement techniques and green chemistry towards sustainable agriculture. *Role of Green Chemistry in Ecosystem Restoration to Achieve Environmental Sustainability*, 343-351. <https://doi.org/10.1016/B978-0-443-15291-7.00025-0>
- Mucharam I.; Rustiadi E.; Fauzi A.; Harianto (2019). Development of sustainable agricultural indicators at provincial levels in Indonesia: A Case study of rice. *IOP Conference Series: Earth and Environmental Science*, 399(1). <https://doi.org/10.1088/1755-1315/399/1/012054>
- Okolie C.C.; Danso-Abbeam G.; Groupson-Paul O.; Ogundeji A.A. (2023). Climate-Smart Agriculture Amidst Climate Change to Enhance Agricultural Production: A Bibliometric Analysis. *Land*, 12(1). <https://doi.org/10.3390/land12010050>
- Palmitessa O.D.; Signore A.; Santamaria P. (2024). Advancements and future perspectives in nutrient film technique hydroponic system: a comprehensive review and bibliometric analysis. *Frontiers in Plant Science*, 15. <https://doi.org/10.3389/fpls.2024.1504792>

- Panda A.K.; Mishra R.; Dutta J.; Wani Z.A.; Pant S.; Siddiqui S.; Alamri S.A.; Alrumman S.A.; Alkahtani M.A.; Bisht S.S. (2022). Impact of Vermicomposting on Greenhouse Gas Emission: A Short Review. *Sustainability (Switzerland)*, 14(18). <https://doi.org/10.3390/su14181130>
- Patil A.S.; Mailapalli D.R.; Singh P.K. (2024). Drone Technology Reshaping Agriculture: A Meta-Review and Bibliometric Analysis on Fertilizer and Pesticide Deployment. *Journal of Biosystems Engineering*, 49(4), 382-398. <https://doi.org/10.1007/s42853-024-00240-1>
- Quintarelli V.; Ben Hassine M.; Radicetti E.; Stazi S.R.; Bratti A.; Allevato E.; Mancinelli R.; Jamal A.; Ahsan M.; Mirzaei M.; Borgatti D. (2024). Advances in Nanotechnology for Sustainable Agriculture: A Review of Climate Change Mitigation. *Sustainability (Switzerland)*, 16(21). <https://doi.org/10.3390/su16219280>
- Raisa D.M.; Sirajuddin S.N.; Syamsu J.A.; Arsyad M. (2024). Sustainable Agricultural Optimization: A Review of Integrated Farming System, Resilience, and Technology. *AIP Conference Proceedings*, 3098(1). <https://doi.org/10.1063/5.0223880>
- Rosa-Schleich J.; Loos J.; Mußhoff O.; Tscharnkte T. (2019). Ecological-economic trade-offs of Diversified Farming Systems – A review. *Ecological Economics*, 160, 251-263. <https://doi.org/10.1016/j.ecolecon.2019.03.002>
- Rosenstock, T. S., Lamanna, C., Chesterman, S., Bell, P., Arslan, A., & Richards, M. (2019). The scientific basis of climate-smart agriculture: A systematic review protocol. *F1000Research*, 8, 1745. <https://doi.org/10.12688/f1000research.20286.2>
- Sapkota T.B.; Khanam F.; Mathivanan G.P.; Vetter S.; Hussain S.G.; Pilat A.-L.; Shahrin S.; Hossain M.K.; Sarker N.R.; Krupnik T.J. (2021). Quantifying opportunities for greenhouse gas emissions mitigation using big data from smallholder crop and livestock farmers across Bangladesh. *Science of the Total Environment*, 786. <https://doi.org/10.1016/j.scitotenv.2021.147344>
- Scherer L.; Verburg P.H. (2017). Mapping and linking supply- and demand-side measures in climate-smart agriculture. A review. *Agronomy for Sustainable Development*, 37(6). <https://doi.org/10.1007/s13593-017-0475-1>
- Segnon A.C.; Zougmore R.B.; Green R.; Ali Z.; Carr T.W.; Houessionon P.; M'boob S.; Scheelbeek P.F.D. (2022). Climate change adaptation options to inform planning of agriculture and food systems in The Gambia: A systematic approach for stocktaking. *Frontiers in Sustainable Food Systems*, 6. <https://doi.org/10.3389/fsufs.2022.834867>
- Shahab H.; Iqbal M.; Sohaib A.; Ullah Khan F.; Waqas M. (2024). IoT-based agriculture management techniques for sustainable farming: A comprehensive review. *Computers and Electronics in Agriculture*, 220. <https://doi.org/10.1016/j.compag.2024.108851>
- Sharma R.; Kamble S.S.; Gunasekaran A.; Kumar V.; Kumar A. (2020). A systematic literature review on machine learning applications for sustainable agriculture supply chain performance. *Computers and Operations Research*, 119. <https://doi.org/10.1016/j.cor.2020.104926>
- Shin S.; Aziz D.; El-sayed M.E.A.; Hazman M.; Almas L.; McFarland M.; El Din A.S.; Burian S.J. (2022). Systems Thinking for Planning Sustainable Desert Agriculture Systems with Saline Groundwater Irrigation: A Review. *Water (Switzerland)*, 14(20). <https://doi.org/10.3390/w14203343>
- Singh S.K.; Patra A.; Chand R.; Jatav H.S.; Luo Y.; Rajput V.D.; Sehar S.; Attar S.K.; Khan M.A.; Jatav S.S.; Minkina T.; Adil M.F. (2022). Surface Seeding of Wheat: A Sustainable Way towards Climate Resilience Agriculture. *Sustainability (Switzerland)*, 14(12). <https://doi.org/10.3390/su14127460>
- Singh S.N.; Bisaria J.; Sinha B.; Patasaraiya M.K.; Sreerag P.P. (2024). Developing a composite weighted indicator-based index for monitoring and evaluating climate-smart agriculture in India. *Mitigation and Adaptation Strategies for Global Change*, 29(2). <https://doi.org/10.1007/s11027-024-10109-5>
- Singh V.K.; Singh A.K.; Singh P.P.; Kumar A. (2018). Interaction of plant growth-promoting bacteria with tomato under abiotic stress: A review. *Agriculture, Ecosystems and Environment*, 267, 129-140. <https://doi.org/10.1016/j.agee.2018.08.020>

- Sithole A.; Olorunfemi O.D. (2024). Sustainable Agricultural Practices in Sub-Saharan Africa: A Review of Adoption Trends, Impacts, and Challenges Among Smallholder Farmers. *Sustainability* (Switzerland), 16(22). <https://doi.org/10.3390/su16229766>
- Solano Porras R.C.; Artola A.; Barrena R.; Ghoreishi G.; Ballardo Matos C.; Sánchez A. (2023). Breaking New Ground: Exploring the Promising Role of Solid-State Fermentation in Harnessing Natural Biostimulants for Sustainable Agriculture. *Processes*, 11(8). <https://doi.org/10.3390/pr11082300>
- Soylu E.; Kızıldeniz T. (2024). Innovative approach of biodegradable mulches in sustainable agriculture for crop production and environmental conservation. *BIO Web of Conferences*, 85. <https://doi.org/10.1051/bioconf/20248501060>
- Sulewski P.; Kłoczko-Gajewska A.; Sroka W. (2018). Relations between agri-environmental, economic, and social dimensions of farms' sustainability. *Sustainability* (Switzerland), 10(12). <https://doi.org/10.3390/su10124629>
- Sun W.; Shahrajabian M.H. (2023). The Application of Arbuscular Mycorrhizal Fungi as Microbial Biostimulant, Sustainable Approaches in Modern Agriculture. *Plants*, 12(17). <https://doi.org/10.3390/plants12173101>
- Swastika D.K.S.; Priyanti A.; Hasibuan A.M.; Sahara D.; Arya N.N.; Malik A.; Ilham N.; Sayekti A.L.; Triastono J.; Asnawi R.; Sugandi D.; Hayati N.Q. Atman A. (2024). Pursuing circular economics through the integrated crop-livestock systems: An integrative review on practices, strategies, and challenges post Green Revolution in Indonesia. *Journal of Agriculture and Food Research*, 18. <https://doi.org/10.1016/j.jafr.2024.101269>
- Tao F.; Palosuo T.; Valkama E.; Mäkipää R. (2019). Cropland soils in China have a large potential for carbon sequestration based on a literature survey. *Soil and Tillage Research*, 186, 70-78. <https://doi.org/10.1016/j.still.2018.10.009>
- Thompson B.; Leduc G.; Manevska-Tasevska G.; Toma L.; Hansson H. (2024). Farmers' adoption of ecological practices: A systematic literature map. *Journal of Agricultural Economics*, 75(1), 84-107. <https://doi.org/10.1111/1477-9552.12545>
- Unati S.; Mpumelelo N.; Wonder N.; Michael A.A.; Mudau F.N. (2016). Challenges militating against the sustainable economic development potential of African aromatic, beverage, and medicinal herbs: A South African perspective. *Indian Journal of Pharmaceutical Education and Research*, 50(1), 80-89. <https://doi.org/10.5530/ijper.50.1.11>
- Vermeulen, S. J., Campbell, B. M., & Ingram, J. S. (2012). Climate change and food systems. *Annual Review of Environment and Resources*, 37, 195-222. <https://doi.org/10.1146/annurev-environ-020411-130608>
- Vikas; Ranjan R. (2024). Agroecological approaches to sustainable development. *Frontiers in Sustainable Food Systems*, 8. <https://doi.org/10.3389/fsufs.2024.1405409>
- Wang C.; Zang H.; Liu J.; Shi X.; Li S.; Chen F.; Chu Q. (2020). Optimum nitrogen rate to maintain sustainable potato production and improve nitrogen use efficiency at a regional scale in China. A meta-analysis. *Agronomy for Sustainable Development*, 40(5). <https://doi.org/10.1007/s13593-020-00640-5>
- Wang L.; Wu W.; Xiao J.; Huang Q. (2020). The Effects of Spatial Layout of Drip Irrigation Belts on Growth and Water Use Efficiency of Golden Pear; [不同滴灌带布置方式对黄金梨生长及水分利用效率的影响]. *Journal of Irrigation and Drainage*, 39(5), 10-17. <https://doi.org/10.13522/j.cnki.gggs.2019305>
- Wang R.; Yang X.; Chen X.; Zhang X.; Chi Y.; Zhang D.; Chu S.; Zhou P. (2024). A critical review of hydrogen application in agriculture: Recent advances and perspectives. *Critical Reviews in Environmental Science and Technology*, 54(3), 222-238. <https://doi.org/10.1080/10643389.2023.2232253>
- Westbrook A.S.; Wilcox N.R.K.; Stup R.S.; Xu S.; Djuric N.; Coffey R.E.; Özaslan C.; Xia R.H.; Urmaza S.; Sher M.A.; DiTommaso A. (2024). What we still don't know about weed diversity: A scoping review. *Weed Research*, 64(6), 418-433. <https://doi.org/10.1111/wre.12662>

- Wezel A.; David C. (2020). Policies for agroecology in France: Implementation and impact in practice, research, and education. *Landbauforschung*, 70(2), 66-76. <https://doi.org/10.3220/LBF1608660604000>
- Wezel A.; Herren B.G.; Kerr R.B.; Barrios E.; Gonçalves A.L.R.; Sinclair F. (2020). Agroecological principles and elements and their implications for transitioning to sustainable food systems. A review. *Agronomy for Sustainable Development*, 40(6), <https://doi.org/10.1007/s13593-020-00646-z>
- Wu Y.; Meng S.; Liu C.; Gao W.; Liang X.-Z. (2023). A bibliometric analysis of research on the climate impact on agriculture. *Frontiers in Sustainable Food Systems*, 7. <https://doi.org/10.3389/fsufs.2023.1191305>
- Wynn P.C.; Kongmanila D.; Bani S.; Pasefika-Seuao F. (2024). The role of animal products in balancing food baskets for Laos and the Pacific islands of Samoa and Vanuatu to minimise caloric and hidden hunger: a review. *Animal Production Science*, 64(13). <https://doi.org/10.1071/AN24042>
- Xing J.; Cao X.; Zhang M.; Wei X.; Zhang J.; Wan X. (2023). Plant nitrogen availability and crosstalk with phytohormone signaling and their biotechnology breeding application in crops. *Plant Biotechnology Journal*, 21(7), 1320-1342. <https://doi.org/10.1111/pbi.13971>
- Zondo W.N.S.; Ndoro J.T.; Mlambo V. (2024). The Adoption and Impact of Climate-Smart Water Management Technologies in Smallholder Farming Systems of Sub-Saharan Africa: A Systematic Literature Review. *Water (Switzerland)*, 16(19). <https://doi.org/10.3390/w16192787>

Braving the Waves: Narratives of the Women Drift Net Fisher Folks

Jeffrey G. Magbanua

Enriqueta N. Siva

Khristian T. de la Rama

Agatha Rica N. Pano

Guimaras State University

ABSTRACT This study examines the experiences of women engaged in pamukot or drift net fishing in Buenavista, Guimaras, Philippines, where women's contributions to small-scale fisheries are often undervalued. Guided by the Gender Dynamics in Fisheries Participation Framework, the study explored their fishing activities, roles, motivations, and challenges. Five women with at least 15 years of experience were purposively selected as informants, and data were gathered through in-depth interviews, focus group discussions, and document analysis using interpretative phenomenological analysis. Results revealed that women play crucial roles in fishing and household livelihoods, ranging from assisting their husbands, preparing and repairing nets, and marketing products, to managing conflicts and providing emotional support. Their motivations stem from economic necessity, family cooperation, and a sense of enjoyment. However, they face challenges such as inclement weather, equipment loss, occupational health risks, and balancing childcare with fishing duties. The study highlights the need for gender-sensitive programs, safety training, livelihood support, and disaster preparedness to strengthen women's participation and promote sustainable fisheries development.

Keywords: *fishing, gender development, life experiences, resiliency, vulnerability, women*

INTRODUCTION

Women fisherfolk's participation in small-scale fisheries reflects a complex interplay of social, economic, cultural, and environmental factors that shape their roles in coastal communities. Although fisheries are often seen as a male-dominated livelihood, women contribute substantially to fishing activities, household subsistence, post-harvest processes, marketing, and managing family resources. Despite these contributions, women's work in fisheries has historically been underestimated or rendered less visible in formal accounts of the fishing industry. Understanding their participation is therefore important for developing fisheries programs and management strategies that recognize gender roles, promote equitable participation, and support the sustainability of coastal livelihoods.

Women's involvement in fisheries takes different forms depending on local livelihood practices and prevailing gender norms. In many fishing communities, women participate in less visible or informal activities, including fish processing, marketing, bait collection, and other tasks that complement the fishing activities traditionally associated with men (Fabinyi & Barclay, 2021; Siar, 2003). These contributions matter not only to household survival but also to the broader economic and social functioning of coastal communities. Eder (2005) showed that differences within Philippine fishing communities shape access to and use of coastal resources, while Launio et al. (2010) emphasized the importance of understanding fisherfolk perceptions in managing marine resources. These perspectives suggest examining fishing livelihoods beyond the harvesting of marine resources and accounting for the different contributions of household and community members.

Women's roles are particularly significant because fishing households often depend on the combined labor of family members to maintain income and food security. Their participation may extend from preparing fishing materials and assisting in fishing operations to processing, selling, and managing the catch. These activities show that women are not merely supplementary participants in fisheries but active contributors to livelihood sustainability. The diversity of fishing livelihoods also illustrates how households adapt their activities according to available resources and socioeconomic conditions (Fabinyi & Barclay, 2021). Recognizing these contributions is essential to understanding how gender influences access to livelihood opportunities, responsibilities, and decision-making within fishing households.

Women can likewise contribute important knowledge and perspectives to fisheries and coastal resource management. Local ecological knowledge developed through prolonged interaction with marine environments can strengthen community participation and inform resource-management initiatives. O'Donnell et al. (2010), for example, demonstrated the relevance of fishers' knowledge in understanding conservation concerns, while Samonte et al. (2016) examined the relationship between marine protected areas and fisher livelihoods in the Philippines. Community-based approaches to marine resource management likewise emphasize the importance of considering the people whose livelihoods depend directly on coastal resources (Christie et al., 2002). Within this context, acknowledging women's

experiences can broaden the understanding of how fishing communities interact with, depend on, and respond to changes in marine resources.

Despite their contributions, women in fishing communities may face constraints tied to gender expectations, economic vulnerability, resource competition, and limited recognition within formal fisheries structures. Segi (2014) illustrated the complexities of resource competition affecting small-scale fishing communities in the Philippines, while Fabinyi and Barclay (2021) emphasized the social diversity that characterizes fishing livelihoods. These conditions indicate that women fisherfolk's experiences cannot be understood solely in terms of economic participation; their responsibilities within the household and community must also be considered. Programs intended to support fishing communities should therefore recognize women's different experiences, needs, and contributions alongside those of men.

The policy environment also provides an important context for understanding women's participation in fisheries. The Philippine Fisheries Code of 1998 (Republic Act No. 8550) provides mechanisms intended to protect traditional fisherfolk and promote equitable access to fishery resources. However, women's effective participation requires more than general recognition of fishing households. Their actual experiences, responsibilities, vulnerabilities, and contributions must be documented so that programs and interventions can respond to conditions encountered at the community level. Gender-responsive approaches to fisheries development are therefore important in ensuring that women's participation is recognized not only in household livelihood activities but also in community development and resource-management initiatives.

In Buenavista, Guimaras, pamukot, or drift net fishing, represents one of the livelihood activities in which women participate alongside their husbands and other members of fishing households. Their participation may encompass activities before, during, and after fishing, yet these contributions are not always sufficiently documented. Moreover, women engaged in drift net fishing simultaneously manage livelihood and household responsibilities while facing the uncertainties of fishing at sea. Documenting their narratives can therefore provide a more contextualized understanding of their participation, motivations, responsibilities, and difficulties and can generate evidence useful for designing gender-responsive programs for fishing communities.

Against this background, the present qualitative study explored the experiences of women engaged in pamukot or drift net fishing in the coastal areas of Buenavista, Guimaras, Philippines. Specifically, it sought to establish the different fishing activities in which women participate and the roles they perform in drift net fishing; ascertain their motivations for participating in the fishing industry as well as the challenges and issues they encounter; and generate baseline information that may guide the development of appropriate programs and training initiatives of the Guimaras State University Gender and Development program. Through these objectives, the study provides a gender-sensitive account of women's participation in small-scale fisheries and highlights their contributions, experiences, and needs within coastal fishing households and communities.

METHODOLOGY

Informants

The informants of the study were 5 purposively selected women drift net fisher folks from the coastal barangay of the Municipality of Buenavista, Province of Guimaras. The participants were qualified based on the following criteria: a) women who are currently engaged in "pamukot" or drift net fishing as a main source of income, and b) have at least 15 years of experience in drift net fishing.

Research Instrument

This study utilized the interview schedule validated by the panel of experts from the field of the fishing industry, gender and development, education, and qualitative research. Furthermore, the trustworthiness of this qualitative research was established based on Connelly LM (2016). The interview schedule has two parts. Part 1 gathered the personal data of the informants. Part 2 collected the statements, feedback, and testimonies of the informants on their experiences in relation to the drift net fishing.

Data Collection Procedures

The study was conducted upon the approval of the University Research and Development Committee. The researcher coordinated and obtained necessary permissions from local government units and fisher folks' organizations of the identified coastal barangays in Buenavista, Guimaras.

Moreover, the informants were identified based on the qualifying criteria set. After obtaining the required permission from the informants, the researcher scheduled and conducted the in-depth interview. Moreover, the researchers conducted a follow-up interview through direct and phone calls to collect sufficient data and clarify specific details that were not captured in the previous interview. Furthermore, a focus-group discussion was conducted after the initial analysis of the interview. The researchers prepared the transcripts of the interview and the focus-group discussion (FGD) for data analysis.

The digital audio and video recorders were used with the approval of the informants. An audio recorder was utilized to ensure that nothing would be omitted or altered during the conduct of the interview. Also, a digital video recorder was utilized to visually determine informants' hand and facial gestures that can be used to supplement the findings of this study. Additionally, pertinent documents and other evidence for verification were gathered with the approval of the informants.

All data were collected in compliance with the strict health protocols implemented by the Guimaras local government unit. Moreover, the data collected were used for the sole purpose of this research and were handled with strict adherence to data privacy and confidentiality.

Data Analysis Procedures

This qualitative study utilized an interpretative phenomenological analysis. The recorded in-depth interview of the informants and the focus-group discussion were transcribed into the actual language used. The researcher compiled, proofread, and thoroughly analyzed each of these transcribed responses. To make sense of these collected data, initial categories of the information about the experiences of the identified women drift net fisher folks were formed. From the formed codes, categories, and subcategories were identified. The researchers formed descriptions of these categories and subcategories based on the data gathered. A coding book was formulated containing the categories and their corresponding description.

To establish inter-rater reliability, the rater's table containing the experiences of the informants was developed and rated by two experts, including the researcher. The raters established a strong inter-rater agreement with a Kappa value of 0.832. After the inter-rater agreement was substantially established, the researcher rated and classified the entire set of experiences as stated by the informants. The formulated classifications of the experiences of the women drift net fisher folks were defined and described based on the data gathered.

Furthermore, the researcher verified the results of the in-depth and FGD through the analysis of the gathered documents, artifacts, pictures, and videos collected. The initial results were determined and were subjected to the informant's validation. Upon the informant's validation of their revealed experiences, the findings were finalized.

RESULTS AND DISCUSSION

Generally, the experiences of the women engaged in "*pamukot*" or drift net fishing can be categorized in terms of their (a) reason of engagement, (b) fishing activities participated, (c) roles performed, (d) challenges encountered, (e) strategies employed to overcome the challenges, (f) advantages and disadvantages of women engaged in drift net fishing, (g) source of motivation and strength, and (h) necessary values to survive in drift net fishing.

Reasons for Engagement in "Pamukot" or Drift Net Fishing

The informants emphasized that they were only involved in "*pamukot*" or drift net fishing after their marriage. The results revealed that women engaged in "*pamukot*" or drift net fishing because of three (3) main reasons: (a) "*pamukot*" as their main source of income, (b) to assist their husband, and (c) sense of enjoyment.

"Pamukot" as the Main Source of Income

The informants stated that "*pamukot*" is their family's main source of income. This sustained their daily needs, which include the education expenses of their children, food, payment for electric and water bills, medical expenses, and other financial obligations. This is evident in the statements of the informants.

As Donna (2023, p. 1) stated "*Kami ni banahon, gapamukot gid na kami kay amo ma lang na palangitan-an namon mo halin pa sang una.*" (Translation: My husband and I engaged in drift net fishing because that is our only source of income ever since.) Roxanne (2023, p. 6) added "*Sa pagstart ko yah, syempre una-una wala ka pangitan-*

an.” (Translation: I started drift net fishing because you don’t have a source of income.) This was further supported by Patricia (2023, p. 3), “*Amo lang na ang ginasaligan namon ang pamukot. Amo na sya ang amon pangabuy-an sa pang adlaw-adlaw nga tanan. Diri kami gakuha sang mga allowance sang kabataan, foods namon, kag pangbayad sa amon kuryente, tubig, bulong nmon, kag iban pa nmon nga kinahanglanon.*” (Translation: We rely on drift net fishing. It is the means in our daily living. It is the source of our children’s allowance, food, payment for our electric and water bills, and other needs.)

The recurring reliance on drift net fishing as the main source of income underscores the deep connection between the practice and the survival of these families. It reveals that, for many, “pamukot” is not just a means of making a living but is woven into their daily routines as the only dependable option. The lack of alternative livelihood opportunities is evident, and this dependency highlights the importance of exploring sustainable practices, financial literacy, and support systems to ensure their long-term well-being.

Assisting their Husband

Another reason for the women’s engagement in “pamukot” or drift net fishing is to assist their husbands. Primarily, all informants indicated that they started “pamukot” or drift net fishing to assist their husbands. Some stated that their husband are doing it alone or with assistance from their neighbors. Consequently, the vigorous tasks involved in “pamukot” or drift net fishing influenced their decision to assist their husband.

As Carah (2023, p. 2) specified “*Nag-upod ako pamukot kay wala sya upod. Alang alang nga paupdon ko duwa ko ka bata nga gaeskwela.*” (Translation: I joined my husband in drift net fishing because he is alone. Our children cannot assist him because they are studying.) Furthermore, the informants emphasized that assisting their husbands ensures that the entire income belongs to their family. As Maria (2023, p. 8) specified “*Kung mangita ka pa sa iban nga tawo ya, may porsyento pa na sila ya. Kung kamo ya nga mag asawa, ang inyo income buo gid.*” (Translation: If you will look for someone for assistance, then they will receive some percentage of the income. However, assisting my husband will provide us with the entire income.)

The decision to assist their husbands is deeply rooted in practicality and financial strategy. By working together, families maximize their income, which is crucial for their survival. This also underscores the value of unity within the family structure, as the collaboration strengthens their ability to meet daily needs without external interference. The implications suggest that fostering a sense of cooperation and mutual support in family businesses or livelihoods is essential for both emotional and economic stability.

Sense of Enjoyment

Some informants expressed a profound sense of enjoyment in being on the sea. Donna (2023, p. 6) indicated, “*Enjoy man ako sa lawod. (... joyfully laughing) Namian man ako nga daan sa lawod kag nami man kung managat ka ah.*” (Translated: I enjoy being on the sea. I like the sea and fishing.) In addition, Maria (2023, p. 6) stated, “*Namian ako magpalawod kag managat kapin pa gid may kuha ka nga banagan kag mga isda nag dalagku.*” (Translation: I like to go fishing, especially when you can catch lobster and huge fish.) These responses illustrate that fishing is not merely an economic activity but also a source of intrinsic joy and cultural attachment. The sea becomes a space of recreation, fulfillment, and personal satisfaction beyond livelihood concerns.

The sense of enjoyment highlights the emotional and cultural value of the sea for coastal communities. This implies that sustainable fisheries management and marine conservation should not only consider the economic benefits of fishing but also its role in promoting well-being, identity, and social cohesion. Recognizing the sea as both a livelihood resource and a source of happiness can strengthen advocacy for marine protection programs, as community members are more likely to support initiatives that safeguard something they deeply value and enjoy.

Fishing Activities Participated in by the Informants

Initially, the informants engaged in “pamukot” or drift net fishing. However, this was later extended to other related fishing activities. These include (a) *Paglibod* or ambulant fish vending, (b) *Panglukos* or squid fishing, (c) *Pamunit* or angling or bait fishing, (d) *Labay* or longline fishing, (e) *Panginhas* or shoreline shell seeking, and (f) *Panulo* or night fishing.

The participation of women in *pag-ilibod* or ambulant fish vending was also evident. Roxanne (2023, p.7) stated, “*Nagalibod ako isda. Ginabaligya ko ang amon isda diri sa amon barangay kag sa tupad nga mga barangay.*”

Bali ginadul-ong ko gid na house-to-house.” (Translation: I am selling our caught fish in our barangay and other neighboring barangays. I am selling it from one house to another.)

Donna (2023, p. 15) shared, *“Gapamukot kami sang akan bana. Gapanglukos kami. Kag gapamunit man kami kung wala kami gapamukot.”* (Translation: My husband and I do drift net fishing, we do squid fishing, and angling or bait fishing if we are not doing drift net fishing.)

Patricia (2023, p.11) stated, *“Gapanglabay kami na. Gapanalom na sya abi, gaupod man ako na sang una. Pero subong bawal na ang panalom mo. Panglabay ya ginapulawan gid na nmon asta mag-aga.”* (Translation: We do longline fishing. Previously, I accompanied my husband when he went spear-hunting. However, spear-hunting is now prohibited. We are doing longline fishing for the whole night until dawn.)

On the other hand, Maria (2023, p. 9) specified, *“Kung hunas, nagapanginhas kami sa baybay kung adlaw kag gapanulo kung gab-i.”* (Translation: If the tide is low, we are doing shoreline shell seeking during the day and night fishing at night.)

These testimonies reflect the diversity of fishing practices among coastal families, where both men and women take on complementary roles to sustain their livelihood. The shift from one method to another also demonstrates adaptability in response to seasonal changes, resource availability, and fishing regulations.

The diversification of fishing practices implies that coastal households adopt multiple livelihood strategies to maximize resource use, reduce risk, and ensure food and income security. The involvement of women in paglibod further underscores the gendered dimension of fisheries, where women contribute significantly to post-harvest activities and household income. These findings suggest that fisheries management and livelihood programs should not be designed with a one-size-fits-all approach. Instead, they should recognize the variety of practices and the roles of both men and women. Supporting diversified and sustainable practices—while enforcing regulations such as the prohibition of destructive methods—can strengthen household resilience, promote gender inclusion, and align with long-term conservation goals.

Roles Performed by Women in relation to “Pamukot” or Drift Net Fishing

When the informants were asked about their roles as women in “Pamukot” or Drift Net Fishing, it was established that they (a) assist in performing tasks directly associated with drift net fishing, (b) negotiation and communication with other fisher folks, (c) product preparation, (d) product marketing, (e) repair of damage fish net, (f) processing of legal documents, and (g) purchase of materials and equipment.

Assist in Performing Tasks Directly Associated with “Pamukot” or Drift Net Fishing

Women performed various tasks directly connected to *pamukot* or drift net fishing. These include *paglimpyo*, *pagsinsay*, *pamuna*, *pag-ariya*, and *pagbatak*. The accounts of the informants highlight the significant contribution of women in both preparatory and actual fishing activities.

Roxanne (2023, p. 9) shared, *“Gabulig ako ya kay banahon sa pagpanglimpyo sang pukot kag pagsinsay sang pukot.”* (Translation: I am helping my husband with cleaning and arranging the fish net into the boat.) *Paglimpyo* refers to the process of cleaning the fish net by removing caught trash, twigs, stones, rotten fish, crustaceans, and other objects. She further explained, *“Magsiling ka naman ya limpyohan ang pukot, ginakuha mo ang mga higko, bato, stick, drift woods, dunot nga isda, dawat, kasag kag iban pa nga basura.”* (Translated: Cleaning involves removing trash, stones, sticks, driftwood, rotten fish and crustaceans, and other garbage.)

On the other hand, *pagsinsay* was described as the procedure of properly arranging the fish net into the boat in preparation for the next *pamukot*. As Roxanne (2023, p. 9) described, *“Ang pagsinsay sang pukot, ikalaging or i-arrange mo sya sa pumpboat before ka mag-ariya.”* (Translation: *Pagsinsay* is arranging the fish net into the boat in preparation for the next drift net fishing.)

Moreover, women also engaged in *pamuna* or repairing minor damages in fishing nets. Carah (2023, p. 10) stated, *“Kung may mga guba sa amon pukot, mga buho tungod sa mga bato, kahoy kag iban pa, ginapuna ko lang. Ang pagpuna, bali ginatahi ko lang ang mga buho para makayo ang amon pukot.”* (Translation: I am stitching damages in our fish net like holes caused by stones, tree parts and other objects to fix our fish net.)

Additionally, women assisted in pag-ariya or putting the drift net into the sea and pagbatak or retrieving the nets from the sea. Maria (2023, p. 8) explained, *"Gabulig man ako sa pag-ariya ukon paghulog bala sang pukot sa dagat. Pagkatapos, balikan na namon kag batakon para makuha na namon ang amon hulik."* (Translated: I am helping in dropping the drift net into the sea. Then, we will return to pull the drift net back into the boat to gather the fish and crustaceans caught.)

Aside from these tasks, women also played a support role during fishing expeditions. Patricia (2023, p. 16) emphasized her responsibility in navigation, *"Kung galarga kami palawod, ako na ang gatan-aw sang alagyan sang amon baroto. Ginhambalan ko ang akon bana kung may mga mabunguan kami nga basura ukon pukot sang iban."* (Translation: When we go to the sea, I watch the pathway of our boat. I inform my husband if there are obstacles such as trash or the nets of other fisherfolk.)

These testimonies clearly demonstrate that women's work extends beyond household duties into direct involvement in physically demanding fishing tasks, contributing significantly to the overall productivity of the household's livelihood.

The active participation of women in Pamukot underscores their critical yet often undervalued role in small-scale fisheries. Their engagement in both pre-harvest (e.g., net cleaning, arranging, repairing) and harvest-related activities (e.g., dropping and pulling nets, navigation support) reveals that fishing is a collaborative household enterprise rather than an exclusively male domain. This implies that fisheries development programs and policies should adopt a gender-sensitive approach that acknowledges women's direct contributions, provides them with adequate training and support, and ensures their representation in decision-making. Recognizing women's labor not only affirms their role in sustaining household economies but also strengthens inclusive and sustainable fisheries governance.

Negotiation and Communication with Other Fisher Folks

It was further determined that women played an important role in negotiations and communication with other fisherfolk. Informants shared that disagreements and disputes occasionally arose among fisherfolk, particularly during fishing activities. In such situations, husbands often remained silent, while women took the lead in negotiating and communicating with others. Their assertiveness and calm approach ensured that conflicts were resolved without escalation

Patricia (2023, pp. 14–15) recalled, *"Kung kis-a indi gid mag intindihanay kami sa iban nga gapanagat. Gasingitanay pa na kung kis-a. Gahipos nalang na dayon ang akon bana kag ako na gaistorya sa iban nga gapanagat."* (Translation: There were times that we had disagreements with other fisherfolks. A few times, drift net fisherfolk were shouting at each other. My husband remained silent, and I was the one who talked to the other fisherfolk.)

Similarly, Maria (2023, p. 11) explained, *"Ako na lang ang gaistorya sa iban nga gapanagat kung may mga isyu para indi na magdaku ang gamo."* (Translation: I am taking the lead in communicating with other fisherfolk if there are issues to avoid escalation of the issues.)

These accounts highlight women's active role as mediators, negotiators, and peacekeepers in community fishing practices. Their involvement extended beyond household and physical fishing tasks into the social and relational aspects of sustaining harmonious community ties.

Women serve as crucial agents of social cohesion within fishing communities, often acting as the unseen anchors that hold the social and familial fabric together. Their assertiveness in negotiations not only prevents conflicts from escalating but also fosters cooperation and mutual respect among fisherfolk. This highlights the importance of integrating women's conflict resolution and leadership roles into fisheries governance and community-based resource management programs. By formally recognizing and strengthening these roles, local organizations and policymakers can promote more inclusive, peaceful, and resilient fishing communities where women's voices are valued in decision-making and dispute resolution.

Source of Strength and Hope

It was also revealed that women provide strength and hope to their husbands, encouraging them to remain resilient and strong in the face of challenges. They served as constant reminders to persevere and live meaningfully despite hardships. Donna (2023, pp. 8–9) shared, *"Kung kis-a gahambal ang akon banahon nga natak-an na ako sang pangabuhi ta ma. Ginahambalan ko sya, anhon ta kay amo na nadangtan ta, alangan man ta mawithdraw sa*

pangabuhi. Wala na na ya. Sulong lang gihapon.” (Translated: Sometimes my husband says that he is sick of our living conditions. And I tell him, we are already in this situation, so we cannot just withdraw from life. Let us just move forward.) Similarly, Roxanne (2023, p. 11) emphasized, *“Bisan mabudlay ang pangabuhi, padayon lang. Kung ano man nga problema, sulong lang ah. Kaya ni!”* (Translated: Just continue despite the difficulty in life. Regardless of the problems, just move forward. We got this!)

These accounts highlight the crucial role of women as emotional anchors within the family. Their words of encouragement not only uplift their husbands but also cultivate an atmosphere of perseverance and shared responsibility. This demonstrates that resilience is not only an individual trait but also a relational strength that emerges from spousal support. The implication is that women’s capacity to inspire endurance within their families contributes to household stability and strengthens coping mechanisms against economic or social hardships. Consequently, empowering women and acknowledging their role in sustaining family resilience is vital in community development and policy-making initiatives.

Production, Preparation, and Marketing

Women also play a significant role in the preparation and marketing of their caught sea products. Their participation ensures not only the quality of the products but also the efficiency of the marketing process. The preparation tasks involve (a) keeping the products in cold temperatures by storing them in boxes with ice, (b) sorting the products in terms of types and sizes, and (c) weighing the products for selling. As Maria (2023, pp. 7–8) elaborated, *“Ginabutang ko na dayon ang amon isda sa styrobox nga may ice. Pagkatapos, isorting depende sa klase sang isda kag kadalagkuon. Dayon ikilohon na kag ibaligya.”* (Translated: I immediately place our fish in a styrobox with ice. Then, I sort them by type and size, weigh them, and sell them.)

In terms of marketing, the informants have innovated their approaches. Previously, they worked as ambulant vendors. Recently, however, they adopted two efficient and effective strategies. First, they placed their products in a strategic position beside the road, which reduced selling difficulties and encouraged cash transactions. Carah and Patricia shared, *“Nabutang lang namon ang amon isda sa kilid sang karsada. Mas tawhay sya kag Cash basis ang baydanay. Wala na utang.”* (FGD, 2023, pp. 13–14) (Translated: We are placing our products beside the road. It is efficient and transactions are on a cash basis. No debts.)

The second strategy involved utilizing social media platforms and online payment systems. By posting their products online, women were able to expand their markets beyond their immediate community, even reaching overseas Filipino workers who ordered remotely and paid through online channels. Roxanne (2023, p. 17) explained, *“Bisan sa akon isda subong, ginaFacebook ko na sya para dasig mabaligya. Kung gina-social media ko na sya, wala utang. Cash na sya.”* (Translated: To sell our fish quickly, I am posting it on Facebook. It is paid in cash.) Similarly, Maria (2023, p. 14) added, *“Mas nami nga ga-social media kaya bisan abroad pa na ya makabakal gid. Gaorder lang sila nga idul-ong sa ila balay, baydan lang nila dayon G-Cash.”* (Translated: Social media is good because even those staying in other countries can place the order and make the payment through GCash.)

These findings imply that women not only contribute to household income but also drive local economic innovation. Their ability to adapt to modern technologies, such as social media and digital payments, reflects resilience and entrepreneurial capacity in the face of changing market dynamics. This shift demonstrates that women are not passive participants but are central agents in sustaining and modernizing traditional fishing livelihoods. Moreover, their practices suggest that digital literacy and access to technology are vital tools for rural women in enhancing economic opportunities. At the community level, such innovations may serve as models for other households, contributing to collective resilience, food security, and sustainable livelihood strategies.

Preparation of the Needed Materials

Some informants were actively preparing the necessary materials used during drift net fishing. These include, but are not limited to, rope, fuel or gasoline, drinking water, a flashlight, and a cell phone. Donna (2023, p. 6) stated, *“Ginaprepay namon ang mga kalat, gasoline, tubig, flashlight kag cellphone.”* (Translated: We are preparing the ropes, gasoline, drinking water, flashlight, and cellphone.) Similarly, Maria (2023, p. 10) emphasized the importance of communication devices, saying, *“Importanti gid ang pagdala sang cellphone kay in case bala may matabo sa lawod like aberya, pwede ka ya ka-contact sa higad kag pwede ka kapasugat.”* (Translated: You must bring your cellphone. If anything happens at sea, like a boat malfunction, you can contact someone for help.)

These accounts imply that careful preparation reflects not only the informants' sense of responsibility but also their ability to mitigate risks inherent in fishing activities. Ensuring the availability of necessities and safety tools, such as a cellphone for communication, highlights the value of precautionary measures in securing both livelihood and life. This indicates that women play an indispensable role in enhancing operational efficiency and safety during fishing expeditions. At a broader level, it underscores the importance of promoting safety awareness, access to communication technologies, and preparedness training among small-scale fishing communities, which can significantly reduce vulnerability to accidents and emergencies at sea.

Challenges Encountered by the Women Drift Net Fisher Folks

The challenges that the informants experienced can be classified into: (a) personal issues and constraints, (b) natural-caused issues and problems, and (c) Mechanical and Technical issues and problems

Personal Issues and Constraints

Lacking Swimming Skills

Considering that the informants have at least 15 years of experience in drift net fishing, it is surprising that the majority of them admitted they do not know how to swim. The remaining participants emphasized that they only have basic or beginner-level swimming skills. When asked how they could survive during disasters, given their low-level swimming ability, they stated that staying on the boat would keep them safe. Carah, Patricia, and Maria stressed that they do not know how to swim and would never let go of their boat if something unfortunate happened at sea.

This finding implies that despite their long engagement in fishing, safety practices are largely dependent on their reliance on the boat rather than on personal survival skills. This underscores a critical vulnerability among small-scale fisherfolk, as their lack of swimming competence increases the risks of mortality during accidents, strong waves, or boat malfunctions. It also reveals a gap in safety education and preparedness within fishing communities. At a broader level, this situation highlights the importance of integrating swimming lessons, life-saving techniques, and access to safety equipment (such as life vests) into community-based fisheries programs. Strengthening these capacities would not only protect the lives of fishers but also enhance the resilience and sustainability of their livelihoods in the face of maritime hazards.

Physically Demanding Tasks

"*Pamukot*" or drift net fishing involves several physically demanding tasks. All informants specified that "*pagbatak*"—the process of retrieving the fishing nets from the sea into the boat by hand—was extremely difficult. Patricia (2023, p. 14) explained, "*tama ka bug-at magbatak sang pukot kapin pa gid kung madamo sang ruruk.*" (Translated: Retrieving the drift net from the water into the boat is extremely heavy, especially if it caught "*ruruk*"). The difficult process of "*pagbatak*" often resulted in physical strain, causing "*lap-ok*" or blisters and calluses on the hands, as well as shoulder pain and fatigue. "*Ruruk*" refers to tree branches, bamboo, and similar debris carried by the current that often gets tangled in the net, making the task even more strenuous. Moreover, continual and prolonged exposure to the heat of the sun caused skin burns, irritation, and dehydration. Roxanne (2023, p. 15) stated, "*Tungod pirmi ka lang nabulad sa initan, nagakasunog man ang imo panit kag nagagaras.*" (Translated: Because you are always exposed under the sun, your skin gets burned and irritated.)

These findings imply that drift net fishing, while a vital livelihood, exposes fisherfolk to significant occupational health risks. The physical strain of retrieving nets not only causes short-term injuries such as blisters and sunburn but also has long-term implications, including chronic musculoskeletal problems and heightened vulnerability to heat-related illnesses. This highlights the need for improved occupational health awareness, provision of protective gear (such as gloves, hats, and hydration supplies), and the development of appropriate fishing technologies or mechanical aids to reduce manual strain. On a broader scale, it underscores the importance of integrating occupational safety into fisheries management programs, ensuring that the sustainability of livelihoods is aligned with the well-being of the fisherfolk who depend on them.

Time Management.

One of the main challenges specified by the informants was time management. Typically, they begin drift net fishing between 2:30 and 3:00 in the morning and return around 9:30 a.m. Upon arriving, they immediately prepare their catch for marketing by sorting, icing, weighing, and delivering the products to customers. As a result, this routine often disrupts their eating schedule and leads to irregular meal patterns. Maria (2023, p. 13) explained, "*Una gid nga problema,*

ang time management. Ang pamukot namon gabugtaw kami mga tag 2:30 asta 3 sang morning. Pagkaabot sina isorting pa na sya nmon, butangan ice, kilohon ko naman kag ilibod sa akon customer. Tapos adlaw ka na makakaon, pag abot mo pa sa balay mga 9:30 amo pa na pagpamahaw mo.” (Translated: Our first problem is time management. We wake up around 2:30 to 3:00 in the morning for drift net fishing. When we return, we still need to sort, ice, weigh, and deliver the fish. By the time we get home, it is already 9:30, and only then can we eat breakfast.)

This finding implies that the demanding and irregular schedule of drift net fishing not only strains the physical endurance of fisherfolk but also affects their health and overall well-being. Skipping or delaying meals may lead to nutritional deficiencies, fatigue, and long-term health complications that can weaken their capacity to sustain their livelihood. Moreover, it reflects how the dual roles of production (fishing) and post-harvest processing intensify women’s workload, leaving little room for rest or self-care. At a broader level, this situation highlights the need for livelihood support programs that consider the health and nutritional needs of fisherfolk, such as community-based feeding initiatives, health education, or time-saving technologies in fish processing. Addressing these challenges can improve not only productivity but also the quality of life among small-scale fishing households.

Losing Children’s Supervision

As mothers, the informants faced several challenges in supervising their children. Since drift net fishing requires them to wake up very early and often sacrifice sleep, their children were usually left under the care of relatives or left on their own. Donna (2023, p. 4) shared, *“sobra pa lang isa ka tuig asta magdinalagko sila, ginabaya-bayaan na namon kay uganang para makakita kami nga duwa sang kwarta.”* (Translated: When my children were still very young until they grew up, we often left them under the care of their grandmother so we could earn money.)

Most informants also revealed that the highest educational level attained by their children was high school. They explained that many of their children decided to start families at a young age instead of pursuing further studies. Among all the participants, only Roxanne was able to send her children to college. She expressed her gratitude by saying, *“Ang akon bata maGraduate na gid yah sa College, tungod sa pagtinguha para sa allowance, mga project, sa iban pa nga galastusan. Kag blessed gid ako kay maggraduate na ang akon bata.”* (Translated: My eldest child will graduate from college because of the efforts to provide for allowances, projects, and other expenses. I am blessed that my child will graduate.) (Roxanne, 2023, p. 11).

The demanding nature of drift net fishing, coupled with limited income, often forces parents—particularly mothers—to prioritize immediate survival over long-term educational investments. The lack of consistent parental supervision may contribute to early family formation among children, perpetuating cycles of poverty within fishing households. Roxanne’s case illustrates that with sufficient perseverance and resources, breaking this cycle is possible, but such opportunities remain rare. At a broader level, these accounts underscore the importance of accessible educational support programs, scholarships for fisherfolk children, and livelihood interventions that reduce the economic pressures on families. Strengthening these areas can help ensure that children in fishing communities achieve higher education, thereby enhancing the prospects for intergenerational mobility and community development.

Natural-caused Issues and Problems

Inclement Weather

The storm surge, heavy rains, and strong winds that generate huge waves and strong water currents were among the extremely difficult challenges faced by the informants. All of them testified that they have personally encountered storm surges, strong winds, and rough waves while engaged in drift net fishing. Maria (2023, p. 15) described her experience, stating, *“Gaulan gid ya kag grabe ang hangin, kag kung kis-a gaZero-zero visibility ang dagat.”* (Translation: The rain was heavy, the wind was strong, and sometimes, the sea had zero visibility.)

In addition, the informants shared their experiences of unfortunate sea accidents that instilled fear in them. Some of the common incidents identified were capsizing, locally referred to as *“nagkulob”*, and flooding, or *“nagkapan”*. Several informants also revealed that they had drifted away due to strong currents after losing control over the direction of their motorboats. Carah (2023, pp. 4–5) recalled, *“Pag-upod ko panagat sa akon bana, gulpi lang nabaskog ang ulan. Nagkulob gid ang amon motorboat. Maayo lang kay nakaguwa kami kag narescue sang iban nga mananagat. Gakulurog gid ako sang kulba.”* (Translation: I accompanied my husband in drift net fishing. Suddenly, our motorboat was capsized. Fortunately, we were able to swim out of the motorboat and were rescued by other fisherfolk nearby. I was trembling in fear.)

These accounts reveal the high vulnerability of small-scale fisherfolk to unpredictable and severe weather conditions. The risks they face not only endanger their lives but also threaten their livelihood, as accidents can result in loss of equipment, damaged boats, and reduced fishing productivity. Such experiences emphasize the urgent need for stronger safety measures, early warning systems, and community-based disaster preparedness programs. Moreover, the testimonies highlight the importance of providing fisherfolk with access to more resilient fishing vessels, proper training on maritime safety, and support systems during emergencies. Without such interventions, fisherfolk remain highly exposed to the adverse impacts of climate change and extreme weather events, further perpetuating cycles of poverty and livelihood insecurity.

Mechanical and Technical issues and problems

In some cases, the informants reported losing or sustaining damage to their fishing materials and equipment due to inclement weather or debris, such as tree parts, bamboo, and other materials carried by the strong currents. These floating objects often became entangled in their nets, making them difficult, if not impossible, to retrieve. Carah (2023, p. 17) explained, *“Kung mga dalagku nga kahoy kag mga kawayan nga masab-it sa pukot (ruruk), maguba gid na kag indi mo na makuha ang imo pukot kay kabug-at kag ginabaruron nila ang imo pukot. So bilin mo na gid na ang imo pukot sa dagat.”* (Translation: If large trees or bamboo get entangled in the net, it will surely be damaged, and you cannot retrieve it because it is too heavy and pulls the net down. So you are left with no choice but to abandon the net at sea.)

The loss and damage of fishing gear have significant economic and ecological implications. For small-scale fisherfolk, the cost of replacing nets and other equipment is a heavy financial burden, reducing their already limited income and threatening household food security. Abandoned or lost fishing nets, meanwhile, can lead to “ghost fishing,” where marine organisms continue to be trapped and killed, thereby contributing to resource depletion and ecological imbalance. This situation highlights the need for support mechanisms such as insurance for fishing equipment, access to affordable and durable gear, and training in net maintenance and recovery. Additionally, policy interventions on marine debris management and community-driven coastal clean-up initiatives could help minimize the risks of equipment loss and safeguard both the livelihood of fisherfolk and the sustainability of marine ecosystems.

CONCLUSION

The experiences of women drift net fisherfolk in Buenavista, Guimaras, reveal their critical yet often underrecognized role in sustaining household livelihoods and community fisheries. Their participation extends from direct fishing tasks to post-harvest processing, marketing, conflict mediation, and emotional support for their families. Despite these contributions, they continue to face formidable challenges, including exposure to occupational hazards, loss of equipment, vulnerability to inclement weather, and constraints in balancing fishing with childcare and household responsibilities. These narratives highlight the resilience and adaptability of women fisherfolk, while also exposing gaps in safety, livelihood security, and institutional support. Ultimately, the study underscores the necessity of integrating women’s voices and experiences into fisheries governance to foster inclusive, equitable, and sustainable coastal development.

REFERENCES

- Christie, P., White, A., & Deguit, E. (2002). Starting point or solution? Community-based marine protected areas In the Philippines. *Journal of Environmental Management*, 66(4), 441-454. <https://doi.org/10.1006/jema.2002.0595>
- Cleland, D., Dray, A., Perez, P., Cruz-Trinidad, A., & Geronimo, R. C. (2010). Simulating the dynamics of subsistence fishing communities. *Simulation & Gaming*, 43(1), 102-117. <https://doi.org/10.1177/1046878110380890>
- Connelly, L. M. (2016). Trustworthiness in qualitative research. *Medsurg nursing*, 25(6), 435.
- Eder, J. F. (2005). Coastal resource management and social differences in Philippine fishing communities. *Human Ecology*, 33(2), 147-169. <https://doi.org/10.1007/s10745-005-2430-z>
- Enworo, O.C. (2023), “Application of Guba and Lincoln’s parallel criteria to assess trustworthiness of qualitative research on indigenous social protection systems”, *Qualitative Research Journal*, Vol. 23 No. 4, pp. 372- 384. <https://doi.org/10.1108/QRJ-08-2022-0116>

- Fabinyi, M. and Barclay, K. (2021). Fishing livelihoods and social diversity. *Asia-Pacific Fishing Livelihoods*, 45-63. https://doi.org/10.1007/978-3-030-79591-7_3
- Launio, C. C., Morooka, Y., Aizaki, H., & Iiguni, Y. (2010). Perceptions of small-scale fishermen on the Value of marine resources and protected areas: case of Claveria, northern Philippines. *International Journal of Sustainable Development & World Ecology*, 17(5), 401-409. <https://doi.org/10.1080/13504509.2010.500023>
- Marriott, S. E., Cox, C., Amolo, R. C., Apistar, D., Mancao, R., & Mutsert, K. D. (2021). Implications of Community-based management of marine reserves in the Philippines for reef fish communities and biodiversity. *Frontiers in Marine Science*, 8. <https://doi.org/10.3389/fmars.2021.731675>
- McHugh ML. Interrater reliability: the kappa statistic. *Biochem Med (Zagreb)*. 2012;22(3):276-82. PMID: 23092060; PMCID: PMC3900052. Retrieved: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3900052/>
- Nowell, L.S., et.al. (2017), "Thematic Analysis: Striving to Meet the Trustworthiness Criteria", *International Journal of Qualitative Methods*, Vol. 16: 1 – 13. <https://journals.sagepub.com/doi/pdf/10.1177/1609406917733847>
- O'Donnell, K., Pajaro, M., & Vincent, A. C. J. (2010). How does the accuracy of Fisher's knowledge affect the seahorse Conservation status?. *Animal Conservation*, 13(6), 526-533. <https://doi.org/10.1111/j.1469-1795.2010.00377.x>
- Onsay, E. A., Baltar, K. C., Medroso, K. P. L., & Pesino, I. R. C. (2022). Economic behavior of fisherfolk that Govern their decisions to practice accounting: evidence from probit models. *Journal of Mathematics Instruction, Social Research and Opinion*, 1(3), 163-174. <https://doi.org/10.58421/misro.v1i3.42>
- Samonte, G. P. B., Ramenzoni, V. C., Dacles, T. U., & Fortenbacher, D. (2016). The effect of marine protected Areas of fishers' income in the Philippines. *Journal of Ocean and Coastal Economics*, 3(1). <https://doi.org/10.15351/2373-8456.1032>
- Segi, S. (2014). "Losing at sea, winning on land": a case study of Philippine small-scale and industrial fisher resource competition. *Society & Natural Resources*, 27(12), 1227-1241. <https://doi.org/10.1080/08941920.2014.948237>
- Siar, S. V. (2003). Knowledge, gender, and resources in small-scale fishing: the case of Honda Bay, Palawan, Philippines. *Environmental Management*, 31(5), 569-580. <https://doi.org/10.1007/s00267-002-2872-7>
- Wong, S. (2016). Can climate finance contribute to gender equity in developing countries?. *Journal of International Development*, 28(3), 428-444. <https://doi.org/10.1002/jid.3212>
- (2021). Sustainable marine conservation, baselines, and systematic monitoring—a few lessons from coastal resource management in the Philippines. *Philippine Journal of Systematic Biology*, 14(2). <https://doi.org/10.26757/pjsb2020b14008>

DEVELOPMENT AND ACCEPTABILITY OF CALAMANSI-GINGER CONCENTRATE

Eric G. Catalan

Margie Y. De la Cruz

Rodrigo G. Paglomutan Jr.

Erly M. Martir

Guimaras State University

ABSTRACT This study developed a calamansi-ginger concentrate and determined its acceptability in terms of taste, aroma, aftertaste, color, and general acceptability. This study used a Completely Randomized Design (CRD) with four treatments: 5%, 10%, and 15% ginger extract per kilogram of calamansi juice, and a control with no ginger extract. The treatments were replicated three times. Fifty respondents evaluated the developed formulations using a 9-point hedonic scale. Data were analyzed using mean and one-way analysis of variance (ANOVA), with a multiple range test used to determine differences among treatment means. Results showed significant differences among treatments in terms of taste, aftertaste, and general acceptability, while no significant differences were observed for aroma and color. The formulation containing 15% ginger extract obtained the highest mean ratings for taste (9.00), aftertaste (8.67), and general acceptability (9.00). In comparison, the 5% ginger formulation obtained the lowest ratings for taste (7.00) and general acceptability (7.00). The findings indicate that ginger extract concentration influenced the sensory acceptability of the calamansi-ginger concentrate, particularly taste, aftertaste, and overall acceptance. Among the formulations evaluated, the 15% ginger extract treatment demonstrated the highest sensory acceptability and may therefore serve as the preferred formulation for further product development and evaluation.

Keywords: *calamansi, concentrate, ginger extract, product development, sensory acceptability*

INTRODUCTION

Growing interest in food products made from natural, locally available ingredients has created opportunities to develop value-added beverages that combine sensory appeal with the benefits of plant-based raw materials. Fruits, herbs, and spices are increasingly incorporated into beverages because they contribute distinctive flavors, aromas, and naturally occurring bioactive compounds. Among locally available ingredients with potential for beverage development are calamansi (*Citrus microcarpa*) and ginger (*Zingiber officinale*), both widely used in food preparation and traditional beverages. Combining these ingredients into a concentrated beverage may offer an alternative way to use locally available agricultural products while meeting consumer preferences for flavorful, plant-based drinks.

Calamansi is a citrus fruit commonly cultivated and consumed in the Philippines. Its distinctive acidic taste and citrus aroma make it suitable for juices, concentrates, syrups, flavoring agents, and other processed food products. Beyond its culinary importance, calamansi contains sugars, organic acids, volatile compounds, and phenolic acids that contribute to its physicochemical and sensory characteristics. Cheong et al. (2012) characterized calamansi from the Philippines, Malaysia, and Vietnam and identified numerous volatile compounds and phenolic acids in the peel. Their investigation also showed geographical variation in calamansi composition, with Philippine calamansi peel showing comparatively high levels of total phenolic acids. These characteristics indicate calamansi's potential as a raw material for value-added food and beverage products.

The composition of calamansi juice also supports its potential use in beverage processing. Cheong et al. (2012) identified approximately 60 volatile compounds in calamansi juice and documented differences in its sugars, organic acids, phenolic acids, and other physicochemical characteristics. Such components contribute to the distinctive flavor and aroma associated with calamansi beverages. In addition, Siner et al. (2020) examined the blood glucose response to a calamansi drink among healthy adults and reported a calculated glycemic index of 37 for the particular beverage formulation evaluated. Although this finding should not be generalized to all calamansi products because formulations may differ, it provides additional evidence supporting scientific interest in calamansi-based beverages.

Ginger (*Zingiber officinale*), meanwhile, is widely utilized as a spice and food ingredient because of its characteristic pungent flavor and aroma. It contains several phytochemical constituents, particularly gingerols and shogaols, which have been investigated for their biological properties. Ghasemzadeh et al. (2010) reported antioxidant activity as well as phenolic and flavonoid contents in young ginger varieties, while Dugasani et al. (2010) demonstrated antioxidant and anti-inflammatory activities of major gingerols and shogaol under experimental conditions. Similarly, Min et al. (2017) examined phytochemical concentrations and antioxidant capacities in ginger rhizomes and leaves. Collectively, these findings establish ginger as a potentially useful ingredient in food product development because it contributes not only a distinctive sensory character but also naturally occurring bioactive compounds.

Despite these desirable characteristics, incorporating ginger into beverages requires careful formulation because its strong flavor may substantially influence consumer acceptance. Increasing the amount of ginger can intensify pungency, aroma, and lingering flavor, whereas insufficient amounts may not noticeably contribute to the product's sensory profile. Thus, determining an appropriate concentration is important when combining ginger with an acidic, strongly flavored ingredient such as calamansi. Sensory evaluation is particularly relevant because technical development does not necessarily ensure consumers will find the resulting product acceptable.

Consumer acceptability is essential in food product development because sensory attributes influence consumers' willingness to consume and potentially purchase a product. Taste, aroma, aftertaste, and color provide important information regarding how consumers perceive a newly developed beverage, while general acceptability reflects their overall response to the formulation. Variations in ingredient proportions can alter these attributes and, in turn, affect product preference. For calamansi-ginger concentrate, ginger concentration is particularly important because it can modify calamansi's naturally sour citrus character and create differences in taste, aroma, aftertaste, and overall sensory experience. Consequently, sensory evaluation of different formulations is necessary to identify a concentration that produces a desirable balance between the two ingredients.

Developing calamansi and ginger into a concentrate also provides an opportunity for value addition. Concentration allows fruit-based ingredients to be processed into a form that can subsequently be diluted or incorporated into beverages and other products. The combination of calamansi and ginger is particularly relevant because the acidity and citrus character of calamansi can be complemented by the warm and pungent sensory qualities of ginger. However, an effective formulation requires more than simply combining the two ingredients. The proportion of ginger extract must be considered carefully because concentration variations may produce different levels of sensory acceptability.

Although calamansi and ginger have been studied separately for their chemical composition and functional properties, comparatively little attention has been given to their combined use as a concentrated beverage and to how varying ginger concentrations affect the sensory acceptability of such a product. Existing literature provides evidence concerning the volatile and phenolic composition of calamansi (Cheong et al., 2012), the characteristics of calamansi beverages (Siner et al., 2020), and the antioxidant and anti-inflammatory properties associated with ginger constituents (Dugasani et al., 2010; Ghasemzadeh et al., 2010; Min et al., 2017). However, these studies do not establish the ginger extract level consumers may prefer when calamansi and ginger are formulated together as a concentrate. This represents an important product-development concern because a nutritionally promising formulation must also achieve satisfactory sensory acceptability.

Addressing this gap may provide useful information for developing a value-added beverage using ingredients readily available in local communities. It may also provide practical guidance on incorporating ginger into calamansi concentrate based on consumer sensory responses. Rather than assuming that increasing or decreasing ginger concentration automatically improves the product, empirical sensory evaluation can identify how different formulations are perceived and determine which formulation offers the most acceptable sensory characteristics.

Therefore, this study aimed to develop a calamansi-ginger concentrate and determine its acceptability in terms of taste, aroma, aftertaste, color, and general acceptability. Specifically, different concentrations of ginger extract were incorporated into calamansi juice and compared with a control formulation to determine how variations in ginger concentration affected the sensory characteristics and overall acceptability of the developed product. The findings were intended to provide an empirical basis for identifying a suitable calamansi-ginger formulation for further product development and potential utilization.

METHODOLOGY

Research Design

The study used an experimental research design with a Completely Randomized Design (CRD) to develop and assess the acceptability of calamansi-ginger concentrate. Researchers prepared four treatments, including the control, and replicated each three times, resulting in 12 experimental units. Treatment A consisted of 5% ginger extract per kilogram of calamansi juice; Treatment B contained 10% ginger extract; Treatment C contained 15% ginger extract; while Treatment D served as the control and consisted of pure calamansi juice without ginger extract. The developed formulations were evaluated for taste, aroma, aftertaste, color, and general acceptability.

Table 1. Experimental treatments of the calamansi-ginger concentrate

Treatment	Formulation
Treatment A	5% ginger extract per kilogram of calamansi juice
Treatment B	10% ginger extract per kilogram of calamansi juice
Treatment C	15% ginger extract per kilogram of calamansi juice
Treatment D	Control – pure calamansi juice without ginger extract

Selection of Calamansi and Ginger

The study used mature calamansi fruits with dark green skin to prepare the concentrate. The researchers collected the fruits locally in Guimaras. The study also used mature ginger, approximately nine to ten months old. The researchers obtained the ginger either from the local market or directly from local ginger farmers.

Extraction of Calamansi Juice

The researchers thoroughly washed the calamansi fruits with tap water and sanitized them by soaking them for 30 minutes in a brine solution containing 15% salt per liter of water. After sanitization, the fruits were sliced while submerged in the brine solution and squeezed to extract the juice. The extracted juice was strained to remove pulp and other solids. The strained calamansi juice was covered and set aside to prevent contamination before further processing.

Extraction of Ginger Juice

The mature ginger was peeled, washed thoroughly, and sliced into smaller pieces. Small portions of the sliced ginger were placed in a juice extractor to obtain the juice. The extracted ginger juice was collected in a clean container and strained to remove solid particles. It was then covered until further use in preparing the different formulations.

Preparation of the Calamansi-Ginger Concentrate

The strained calamansi juice and ginger extract were combined according to the specified treatment formulations. In a separate container, mix water, sugar, and salt thoroughly until the sugar fully dissolves. The mixture was then strained to remove unwanted particles.

The calamansi-ginger juice and the water-sugar-salt mixture were combined in a casserole and stirred thoroughly. The mixture was heated over high heat until it reached boiling point. The heat was then reduced to medium, and the mixture was stirred occasionally to prevent burning. Cooking was continued for 45 minutes. After cooking, the concentrate was allowed to cool to approximately 40°C before being transferred into plastic bottles. The prepared formulations were subsequently subjected to acceptability evaluation.

Acceptability Evaluation

The acceptability of the developed calamansi-ginger concentrate was evaluated by 50 respondents using a 9-point hedonic scale, ranging from 1 (dislike extremely) to 9 (like extremely). Respondents evaluated each formulation for taste, aroma, aftertaste, color, and general acceptability. The 9-point hedonic scale is commonly used to measure the degree of liking and acceptability of food products (Lim, 2011).

Data Analysis

The acceptability evaluation data were analyzed using the mean and one-way Analysis of Variance (ANOVA) for the Completely Randomized Design. The mean was used to determine the acceptability of the different calamansi-ginger concentrate formulations in terms of taste, aroma, aftertaste, color, and general acceptability. When significant differences among treatment means were identified, a Multiple Range Test was used to determine the differences among the treatments.

RESULTS AND DISCUSSIONS

Development of Calamansi-Ginger Concentrate

Four formulations were prepared to determine an appropriate combination of calamansi juice and ginger extract. Treatment A contained 5% ginger extract per kilogram of calamansi juice, Treatment B contained 10%, Treatment C contained 15%, while Treatment D served as the control with no ginger extract.

The development process involved separately extracting calamansi and ginger juices, formulating them with water, sugar, and salt, and then heating them as described in the methodology. Using different concentrations of ginger extract allowed the developed formulations to be compared systematically in terms of sensory acceptability. Thus, all four formulations were subjected to sensory evaluation, and their relative suitability was determined based on respondents' ratings.

The formulation approach is comparable with previous product-development research involving calamansi and ginger. Albiso et al. (2018), in developing calamansi nip with ginger extract, similarly evaluated a control and formulations containing 5%, 10%, and 15% ginger extract through sensory evaluation. Their study demonstrates the relevance of varying ginger concentration when developing calamansi-based products because formulation changes can affect consumer preference. However, the most acceptable formulation identified in their study differed from that obtained in the present investigation, emphasizing that acceptability should be determined empirically for the specific product being developed.

Acceptability of the Calamansi-Ginger Concentrate

The second objective determined the acceptability of the developed calamansi-ginger concentrate in terms of taste, aroma, aftertaste, color, and general acceptability. Table 2 presents the sensory evaluation results for the four formulations.

Table 1. Acceptability of the calamansi-ginger concentrate in terms of taste, aroma, aftertaste, color, and general acceptability

Treatment	Taste	Aroma	Aftertaste	Color	General Acceptability
A – 5% ginger extract	7.00 ^c	7.33	7.33 ^b	7.33	7.00 ^b
B – 10% ginger extract	8.33 ^{ab}	7.33	8.33 ^{ab}	7.67	8.00 ^{ab}
C – 15% ginger extract	9.00 ^a	8.33	8.67 ^a	8.00	9.00 ^a
D – Control	7.67 ^{bc}	7.67	7.33 ^b	7.33	7.67 ^b
F-test	*	ns	*	ns	*
CV (%)	8.1	7.5	7.3	9.3	7.3

Note. Means within a column bearing different superscript letters are significantly different based on the multiple range test reported in the study. * = significant; ns = not significant.

Taste

Taste differed significantly among the four formulations. Treatment C, containing 15% ginger extract, obtained the highest mean rating of 9.00, followed by Treatment B at 8.33, the control at 7.67, and Treatment A at 7.00. The significant F-test indicates that varying the ginger extract concentration affected respondents' taste evaluation of the calamansi-ginger concentrate.

The mean pattern indicates that the formulation with the highest ginger concentration was the most acceptable in terms of taste. Based on the superscript groupings, Treatment C differed significantly from Treatment A and the control, whereas Treatment B shared statistical groupings with the higher- and lower-rated treatments. Thus, the results support the preference for the 15% formulation within the concentrations tested but should not be interpreted as evidence that concentrations beyond 15% would produce further improvement.

The result reinforces the importance of ingredient proportion in sensory product development. A Philippine study by Albiso et al. (2018) likewise reported differences in the acceptability of calamansi products formulated with different concentrations of ginger extract. Interestingly, their study found the 5% formulation to be more acceptable, whereas the present study obtained the highest taste rating at 15%. This difference suggests that the sensory effect of ginger concentration may depend on the particular formulation, processing method, accompanying ingredients, and characteristics of the finished product. Therefore, establish an optimal ginger concentration for the product under development rather than generalizing across different calamansi-based beverages.

Aroma

Mean aroma ratings ranged from 7.33 to 8.33. Treatment C had the highest mean (8.33), followed by the control (7.67), while Treatments A and B both had 7.33. Despite these numerical differences, the F-test was not significant. The result indicates that varying the ginger extract concentration from 5% to 15% did not produce statistically significant differences in the respondents' acceptance of the aroma. Consequently, although Treatment C recorded the highest numerical mean, it cannot be concluded statistically that its aroma was preferred over those of the other formulations. The appropriate interpretation is that the four formulations were comparable in terms of aroma acceptability.

A similar pattern has been observed in other beverage-development research, where changes in ingredient levels influenced some sensory characteristics but not aroma. For example, research involving different levels of calamansi and stevia in a ready-to-drink beverage reported significant effects on flavor, taste, and general acceptability but not on aroma and color. This supports the broader observation that formulation changes do not necessarily affect all sensory attributes in the same manner.

Aftertaste

Significant differences were also observed in aftertaste. Treatment C obtained the highest mean rating of 8.67, followed by Treatment B at 8.33, while Treatment A and the control both obtained 7.33. The significant F-test demonstrates that ginger extract concentration affected the acceptability of the product's aftertaste.

Based on the multiple range groupings, Treatment C differed significantly from Treatment A and the control, whereas Treatment B occupied an intermediate statistical grouping. The findings therefore indicate that the 15% ginger formulation produced the most acceptable aftertaste among the treatments evaluated.

The aftertaste findings complement the taste results because both sensory attributes showed significant treatment effects and their highest means occurred in Treatment C. This suggests that the amount of ginger incorporated into the formulation influenced not only the concentrate's immediate taste but also the sensory impression remaining after consumption. Nevertheless, the finding pertains specifically to sensory acceptability and should not be interpreted as evidence of nutritional or therapeutic superiority of the 15% formulation.

Color

For color, Treatment C had the highest mean score of 8.00, followed by Treatment B at 7.67, while Treatment A and the control both scored 7.33. However, the F-test showed no significant difference among the treatments.

This indicates that the different concentrations of ginger extract did not significantly affect the respondents' acceptance of the product's color. Although the mean ratings showed slight numerical variation, these differences were insufficient to establish statistical differences among formulations. Accordingly, all four treatments may be regarded as comparable in color acceptability.

This finding is consistent with sensory product-development research showing that varying ingredient concentrations may not produce perceptible differences in beverage color. In the previously reported calamansi-containing beverage study, color and aroma similarly did not differ significantly among formulations even when other sensory characteristics were affected.

General Acceptability

General acceptability differed significantly among the formulations. Treatment C obtained the highest mean rating of 9.00, followed by Treatment B at 8.00, the control at 7.67, and Treatment A at 7.00. The significant F-test demonstrates that ginger extract concentration influenced the overall acceptability of the calamansi-ginger concentrate.

Based on the multiple range test, Treatment C differed significantly from Treatment A and the control, while Treatment B fell into an intermediate group. The results indicate that the formulation containing 15% ginger extract was the most acceptable overall among the concentrations evaluated. This finding is consistent with its performance for taste and aftertaste, for which Treatment C likewise obtained the highest mean ratings.

The results further demonstrate that overall sensory acceptance was not determined equally by every sensory characteristic. Treatment differences were significant for taste, aftertaste, and general acceptability, whereas aroma and

color did not differ significantly. Thus, the sensory advantage of the 15% formulation was primarily associated with flavor perception rather than aroma or visual appearance.

Comparable beverage-development studies demonstrate the importance of evaluating individual sensory attributes rather than relying solely on general acceptability. Sensory evaluation identifies differences among formulations and provides an empirical basis for selecting a formulation for subsequent product development. Philippine research on kalamansi nip with ginger extract similarly employed sensory evaluation to distinguish the acceptability of formulations with different ginger concentrations, although its preferred concentration differed from the present study.

The study successfully developed four calamansi-ginger concentrate formulations: three ginger extract concentrations and a control. Sensory evaluation showed that ginger concentration significantly affected taste, aftertaste, and general acceptability, but did not significantly affect aroma and color. Among the formulations evaluated, Treatment C (15% ginger extract) received the highest mean ratings for taste, aftertaste, color, and general acceptability, and also the highest reported aroma means in Table 1. However, because aroma and color did not differ significantly among treatments, the preference for Treatment C is statistically supported primarily by its taste, aftertaste, and general acceptability results.

These findings identify the 15% ginger extract formulation as the most acceptable formulation within the concentrations evaluated in this study. The present data do not support conclusions about nutritional composition, antioxidant activity, microbial safety, shelf life, profitability, or marketability because these variables were not measured.

CONCLUSIONS

The study demonstrated the feasibility of developing a calamansi-ginger concentrate using varying levels of ginger extract. The sensory evaluation showed that ginger concentration influenced the acceptability of the product, particularly in terms of taste, aftertaste, and general acceptability, while aroma and color remained comparable across the formulations. Among the treatments evaluated, the formulation containing 15% ginger extract showed the highest acceptability, indicating that this level provided the most preferred sensory characteristics under the conditions of the study. These findings highlight the importance of ingredient proportion in developing an acceptable calamansi-ginger concentrate and provide a basis for further refinement and evaluation of the product.

REFERENCES

- Albiso, E. S., Palacio, E. M., & Buencillo, G. D. (2018). Development of kalamansi nip with ginger extract. *SPAMAST Research Journal*, 1(1), 14–34. <https://doi.org/10.64656/spamastrj.v1i1.2>
- Cheong, M. W., Chong, Z. S., Liu, S. Q., Zhou, W., Curran, P., & Yu, B. (2012). Characterization of calamansi (*Citrus microcarpa*). Part I: Volatiles, aromatic profiles and phenolic acids in the peel. *Food Chemistry*, 134(2), 686–695. <https://doi.org/10.1016/j.foodchem.2012.02.162>
- Dugasani, S., Pichika, M. R., Nadarajah, V. D., Balijepalli, M. K., Tandra, S., & Korlakunta, J. N. (2010). Comparative antioxidant and anti-inflammatory effects of [6]-gingerol, [8]-gingerol, [10]-gingerol and [6]-shogaol. *Journal of Ethnopharmacology*, 127(2), 515–520. <https://doi.org/10.1016/j.jep.2009.10.004>
- Ghasemzadeh, A., Jaafar, H. Z. E., & Rahmat, A. (2010). Antioxidant activities, total phenolics and flavonoids content in two varieties of Malaysia young ginger (*Zingiber officinale* Roscoe). *Molecules*, 15(6), 4324–4333. <https://doi.org/10.3390/molecules15064324>
- Lim, J. (2011). Hedonic scaling: A review of methods and theory. *Food Quality and Preference*, 22(8), 733–747. <https://doi.org/10.1016/j.foodqual.2011.05.008>
- Min, B. R., Marsh, L. E., Brathwaite, K., & Daramola, A. O. (2017). Effects of tissue culture and mycorrhiza applications in organic farming on concentrations of phytochemicals and antioxidant capacities in ginger (*Zingiber officinale* Roscoe) rhizomes and leaves. *Journal of Food Science*, 82(4), 873–881. <https://doi.org/10.1111/1750-3841.13661>
- Siner, A., Sevanesan, M. S., Ambomai, T., Abd Wahab, Z., & Lasem, L. (2020). Blood glucose response to a calamansi drink in healthy adults: A non-randomised study. *BMC Research Notes*, 13, Article 404. <https://doi.org/10.1186/s13104-020-05250-8>