Constructs of Quality Cacao Produce: An Alternative Scale.

abstract: This study aimed to develop and validate an alternative scale to identify the construct of quality cacao production. The researcher combined the technical and behavioral dimensions to understand how production practices and environmental conditions affect cacao quality. This studyemployed a non-experimental research design, a sequential exploratory factor analysis (EFA), and a 60-item survey questionnaire, based on a literature review and expert validation, with 300 respondents. An exploratory factor analysis was used to code and analyze the respondents' answers. The item statement with the highest Content Validity Ratio (CVR) was retained for the final survey questionnaire.In contrast, those statements in the itemthatfailedtoreachthe0.80thresholdwererejected.Atotalof 43 variables passedthis threshold. These extracted factors represent the multidimensional nature of cacao quality and include: farming management, post-harvest processing techniques, cultivation of cacao varieties, environmental conditions, farmers' socio-economic conditions, bean protection strategies, and health, nutrients, and growth. These constructs collectively form the validated frameworkthatexplainsthetechnicalandbehavioraldimensionsinfluencingcacao production quality among farmers.

Introduction,

Cacao *(Theobroma cacao*) plays a significant role in the agricultural industry due to its economic value and its importance as the primary ingredient in chocolate and other cocoa-based products. As demand for high-quality cocoa continues to grow, maintaining consistent cocoa quality has become an important concern for producers and stakeholders. Variations in farm practices, post-harvest handling, processing methods, and farmer behavior can greatly influence the flavor, purity, and physical characteristics of cacao beans. These inconsistencies may affect product quality, market competitiveness, profitability, and sustainability in cacao production. (Sukha, 2021). Hence, there is a need to establish a reliable scale to assess the quality of cacao produce, based on technical and behavioral factors, to improve production standards and ensure high-quality cacao output.

In cacao-growing regions such as Davao and Panay, efforts to improve cacao production quality and sustainability continue through training programs and enhanced post-harvest practices. According to Peñora (2024), local farmers and cooperatives in the Davao Region are encouraged to participate in capacity-building programs to improve post-harvest processing techniques. However, challenges such as inconsistent quality standards, limited access to reliable evaluation tools, and insufficient knowledge of market demands persist. These issues affect producers' ability to produce high-quality cacao that meets industry and international standards consistently. Therefore, there is a need to develop a localized, reliable assessment scale that focuses on the technical and behavioral aspects of quality cacao production to support sustainable practices and improve overall cacao quality.

Despite initiatives to enhance cacao production and sustainability, research systematically identifying and evaluating the factors influencing cacao quality remains limited, particularly in the Philippine context. Some existing studies focus on global trends or farming practices without providing actionable insights for local producers (Placencia et al., 2025), particularly in areas of Davao Oriental. The tools used, such as questionnaires to assess the cacao quality and its influencing factors, are underdeveloped. At the same time, some studies on variables like knowledge, attitude, and adoption are scarce and conducted abroad, mostly outside the Philippines. Addressing these gaps, the study seeks to develop and validate a questionnaire using Exploratory Factor Analysis (EFA) to uncover the dimensions influencing cacao quality, including technical and behavioral factors. The findings aim to improve production practices and enhance the global competitiveness of Philippine cacao, contributing to a more sustainable and resilient cacao industry, using Exploratory Factor Analysis.

To further explain farmers' technical and behavioral factors, this paper emphasizes the Theory of Planned Behavior (TPB) (Ajzen, 2020), which provides a widely used framework for predicting and explaining human behavior across different domains, including agriculture and sustainability. According to this theory, the character is largely influenced by behavioral intent, which is shaped by three (3) main components: attitudes toward the behavior, subjective norms, and perceived control over the behavior.

Another key component of TPB is perceived behavioral control, which refers to farmers' perceptions of their ability to implement a practice, based on the availability of resources, knowledge, infrastructure, and access to agricultural inputs. In cacao production, farmers who believe they have adequate technical knowledge, financial resources, and institutional support are more likely to adopt maintainable and quality-enhancing practices. When the farmers perceive fewer barriers and greater control over their farming activities, their intention to adopt improved agricultural practices becomes stronger, increasing the likelihood that these practices will actually be implemented (Rezaei, 2020).

Grounding this EFA study in existing literature, therefore, enables the empirical identification of latent constructs that shape cacao production systems. The reviewed studies collectively support potential dimensions in Cacao production. Through Exploratory Factor Analysis, these theoretically informed yet empirically untested dimensions can be statistically examined to determine how observable indicators cluster within the context of cacao production. This approach provides a data-driven foundation for developing and validating a model that explains the key factors driving sustainable, high-quality cacao production.

This study illustrates a model depicting the multifaceted factors influencing quality cacao production among farmers in the specified research locale.

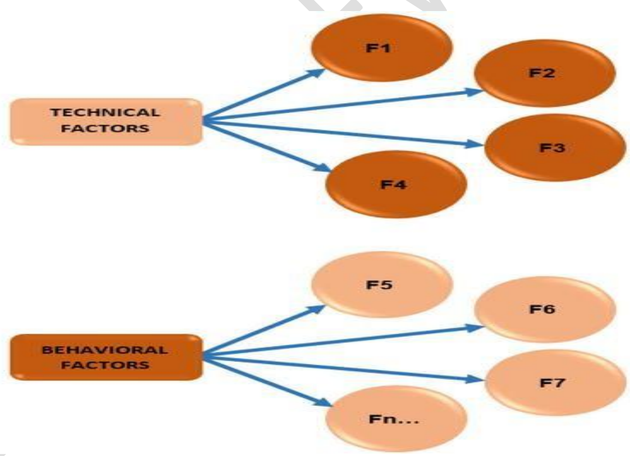

Figure 1. *The conceptual framework illustrates multifaceted factors influencing quality cacao production*

The conceptual framework integrates the Quality Management Theory and the Theory of Planned Behavior (TPB) to explain the factors influencing Quality Cacao Production. At its core, the framework positions of the Quality Cacao Production as the central goal, influenced by two main categories of factors: Technical Factors and Behavioral Factors. Then the Quality Management Theory supports the technical aspects, which emphasize the significance of Good Agricultural Practices (GAP), optimal fermentation, proper storage, and sustainable farming to achieve the consistent quality of cacao mentioned. At the same time, the Theory of Planned Behavior addressed behavioral dimensions, which focused on the farmers' behaviors, subjective norms, perceived behavioral control, and intentions that shape their adoption of quality-focused practices. By integrating these two (2) theories, the framework provides a more comprehensive understanding of how both technical excellence and human behavior interact to determine the quality of the cacao production, offering a foundation in identifying the specific factors (F1, F2, F3, ..., Fn) that can be addressed to enhance the productivity, sustainability, and global competitiveness.

Even though significant increases in cacao sustainability and quality have been achieved nationally and globally, research challenges remain, including a localized examination of the factors influencing cacao quality in the Philippine context. Existing studies focus on global production trends, such as certification systems and sustainability initiatives in major producing countries like Ghana and Côte d'Ivoire, and limited empirical research investigates the specific technical and behavioral determinants affecting smallholder farmers in regions like Davao Oriental.

Besides, the frameworks such as the Juran Quality Management Theory (1986) and the Icek Ajzen Theory of Planned Behavior (Ajzen, 2020) have been widely applied separately; there is an absence of joined models that combine production process standards with farmer behavioral intentions in assessing cacao quality. Validated with the context-specific instrument, particularly in the structured questionnaires that are subjected to exploratory factor analysis, which are also underdeveloped; limiting evidence-based interventions tailored to local conditions and constraining the industry's capacity to achieve consistent quality and global competitiveness.

This study is significant because it addresses the lack of validated, context-specific instruments for assessing quality in cacao production in the Philippine setting by developing and validating a constructed questionnaire using Exploratory Factor Analysis (EFA). This research provides a grounded tool for farmers, cooperatives, policymakers, and agricultural extension officers to evaluate the technical and behavioral dimensions of cacao production systematically. It also helps identify priority areas for the intervention, such as gaps in post-harvest processing, access to resources, farmer knowledge, and the adoption of quality-focused practices. Thereby supporting evidence-based capacity-building programs and policy formulation.

The study also contributes to theory by integrating the principles of the W. Edwards Deming Institute of 1981 (Juran, 1986) on quality management with the Icek Ajzen Theory of Planned Behavior into a single measurement framework. This combination enriches agricultural and sustainability research, which often examines technical production standards and farmer behavior separately.

Moreover, this study aligned with global development primacies, predominantly in the United Nations Sustainable Development Goal 12-Responsible Consumption and Production, by the promotion of quality standards and sustainable farming practices. Supporting this could improve the quality, sustainability, and market participation. The study contributes to building a more resilient, inclusive, and globally competitive cacao industry in the Philippines.

Methodology

These sectionsprovide the following: the research design;the participants and Sampling Technique; the design; the research instrument; the data gathering procedure; the data analysis procedure; and the ethical consideration for conducting this study.

Research Design

This study used a quantitative, non-experimental research approach to develop and validate an alternative scale for quality cocoa products. The quantitative, non-experimental research is appropriate for this study, which aims to describe variables and examine their relationships without manipulating the research environment or participants. This design allows the researcher to gather measurable data and objectively analyze, using statistical procedures, factors that influence the quality of cacao production.

The study used an Exploratory Factor Analysis as the primary statistical method to identify the underlying dimensions influencing the production of high-quality cacao beans. The. Exploratory Factor Analysis is commonly used in scale development and validation because it determines the number of common influences that explain the relations among the variables and identifies which items are grouped within a construct. According to Brace (2009), EFA is useful for assessing the suitability and variability of the data for factor analysis using measures such as the Kaiser-Meyer-Olkin (KMO) test and Bartlett's Test of Sphericity.

Participants and Sampling Technique

Thestudyparticipantswerefarmers growing cacaointhevicinityof Davao Oriental, Philippines, a region recognized as a growing cacao industry. These farmers are primarily smallholders or hold a portion that represents a significant unit of the cacao value chain, as their practices directly impact the quality and sustainability of cacao production. Participantswere selectedusingapurposive, nonprobability sampling method targeting farmers who met specific criteria relevant to this study, including varying levels of experience, farm sizes, and access to resources.Theapproachensuredadiverse, focusedsamplethatcaptures thechallenges faced by farmersand the opportunitiesin thisregion,including inconsistentqualitystandards, limitedtechnicalknowledge, andmarketaccess barriers.

This study used a sequential explanatory mixed-methods design, under the quantitative phase, followed by the qualitative phase. These phases involved a cacao farmer in Davao Oriental who is recognized for its growing contribution in the Philippines. In the quantitative phase, participants were purposively selectedtoprovidein-depthinsightsintotheirexperiencesandpracticesin cacao production. An open-ended questionguidedthe discussion.The quantitative findings explore participants' perceived challenges and adaptive practices.

Research Instrument

This study useda developed instrument implemented across the two (2) phases, a quantitative phase and aqualitative phase, consistent with the sequential explanatory mixed-methods design.

Quantitative Phase.The quantitative segment employed a structured survey questionnaire tomeasurethefactorsinfluencing thequalityof cacaoproduction among farmers. This instrument consisted of 60 items and covered the following main dimensions: seedling quality, fermentation practices, storage conditions, and product characteristics. The responsesweremeasuredusing a 5-pointLikertscale,ranging from 1 (Very Poor) to 5 (Very Good), to quantify participants' perceptions and practices. The mean scores were interpreted using the following descriptive equivalents: 4.21–5.00 as Very Good, indicating excellent performance and highly effective practices; 3.41–4.20 as Good, reflecting satisfactory in performance with minor areas for development; 2.61–3.40 as Acceptable, suggesting average performance that meets minimum standards; 1.81–2.60 as Poor, indicating below-average performance requiring significant improvement; and 1.00–1.80 as Very Poor, reflecting failure to meet basic standards and highly ineffective practices.

The questionnaire was developed through a laborious process that included reviewing related literature and existing tools, consulting farmers in the cacao industry, and consulting agricultural experts and relevant stakeholders. Then the questionnaire underwent content validation by an expert in the subject matter, yielding a CVI of 0.90, indicating that the items were relevant and representative of the constructs measured.

Following this, a pilottestwasconductedamong a smallgroupofcacaofarmers toevaluate the clarityandusability.Thisinstrumentdemonstratedexcellent internalconsistency, with areliability coefficient of 0.97, indicating that the items reliably measure the intended constructs: clarity and accessibility. The questionnaire was translated into Cebuano and English.

Qualitative Phase. The qualitative stage used a semi-structured consultationguidetogatherin-depthinsightsfromselectedparticipantsregardingtheir experiences, challenges, and practices in cacao production. The interview guide included an open-ended question that aligned with the main dimensions identified in the quantitative phase, allowing participants to elaborate on their responses and provide contextual explanations. This flexible format enabled the researcher to probe further into emerging themes while maintaining consistency across interviews. This instrument aims to provide actionable insights for improving the production of cacao through practices and sustainability in the Philippine cacao industry, particularly in Davao Oriental.

Data Gathering Procedure

This study commences with the preparation of the research instrument and the securing of necessary permissions to conduct the study. After obtaining approval, the researcher coordinated with cacao farmers and stakeholders in selected cacao-producing areas, particularly in Banaybanay, Davao Oriental. Participants are informed of the objectives and procedures of this study before the administration of the survey questionnaire.

Data collection was conducted by distributing validated survey questionnaires to selected respondents via purposive sampling. The participants were given enough time and clear instructions for answering the questionnaire to ensure precise and reliable responses. After the retrieval of completed questionnaires, responses were checked, organized, encoded, and prepared for statistical analysis

Data Analysis Procedure

The collected data were analyzed using Exploratory Factor Analysis to identify the underlying constructs influencing the quality of cacao production. The Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy and Bartlett's Test of Sphericity were used to determine the suitability of the data for factor analysis. Extraction of factors and rotation procedures were also conducted to identify the main dimensions of quality cacao production. Likewise, to test the reliability and internal consistency, Cronbach’s alpha was used to identify factors.

Ethical Consideration

Ethical considerations were carefully observed thru the conduct of the study to ensure protection of the participants’ rights, privacy, welfare which stipulated as follows: the participation in the study was voluntary; and informed accord was obtained before data collection; the participants were informed about the objectives of this study, the right to withdraw at any time without penalty, likewise the confidentiality of their responses; the researcher also ensured honesty, accuracy, and integrity in the gathering, analysis; and reporting of data while avoiding plagiarism, fabrication, and falsification of information. The study was conducted in accordance with the established ethical research standards and was approved by the University of Mindanao Ethics Review Committee. The ethical clearance was issued under the certification number the UMERC-2025-292, valid from June 10, 2025, until December 10, 2025.

Results and Discussion

This study revealed the results and interpretation of the gathered data. Information gathered through the survey questionnaire was analyzed using an Exploratory Factor Analysis.

Measures of Sampling Adequacy and Sphericity

Table1reveals theresultsoftheassessmentof the sample's adequacy and relevance for exploratory factor analysis, in accordance with Barlett’s test of Sphericity. A statistical technique was used to establish correlations among all items; the research instrument is significantly related. Instead, the Bartlett's Test of Sphericity determines whether the observed correlation matrix differs significantly from an identity matrix, thereby assessing whether the variables can be grouped into factors. As presented in the table below, the Bartlett's test of Sphericity generated an estimated chi-square value of 8954.673 with 1770 degrees of freedom and a significance level of .000, indicating that the correlation matrix identified fewer correlations than the matrix.Thisresultindicatesthatthevariablesareinterrelatedandthatfactor analysis is appropriate for identifying the constructs that define the quality of cacao production.

Moreover, the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy yielded a robust value of 0.871. These figures exceed the commonly accepted 0.5 threshold, indicating the data's suitability for EFA. According to Kaiser's standards, such a lofty KMO value indicates that the dataset is appropriate for identifying the factor differences. Furthermore, the Bartlett'stest of sphericitywasused to determine whether the correlation matrix (R-matrix) significantly deviates from an identity matrix (Brace, 2009).

Thestudy's results revealedastatistically significant ($p<0.01$),indicatingthat the variables in the dataset are consistent and exhibit patterned associations. These bolsters recognize that the dataset contains meaningful interrelationships among the variables, rendering it amenable to factor analysis.

Table 1. *MeasuresofSamplingAdequacyandSphericity*

Measurement		**Value**
Kaiser-Meyer-OlkinMeasureofSampling Adequacy.		*.871*
Bartlett'sTestof Sphericity	Approx.Chi- Square	*8954.673*
	Df	*1770*
	Sig.	*.000*

Scree Plot

Figure 2 represents scree plot resulting from the secondary Exploratory Factor Analysis undertaken within this investigation. The scree plot displays eigenvalues from the correlation matrix, with eigenvalues plotted on the vertical axis and factors on the horizontal axis (Perez Marulanda, 2025). By visual inspection of the plot, analysts can identify the point at which the eigenvalue magnitude declines notably, often called the "elbow" of the plot. This point indicates several significant factors derived from the data, whereas factors beyond this juncture contribute minimally to explaining the variance and are not considered significant.

In the context of the revealed structure in the scree plot, it is obvious that the instrument under analysis exhibits a multidimensional structure. The marked decline in the plotted line after the seventh factor supports retaining seven factors, which collectively capture the core constructs of quality cacao production. The use of scree plot analysis is consistent with prior studies on cacao production and sustainable farming practices, in which factor identification is guided by observable technical and behavioral indicators relevant to post-harvest management, environmental sustainability, and socio-cultural practices (Perez Marulanda, 2025).

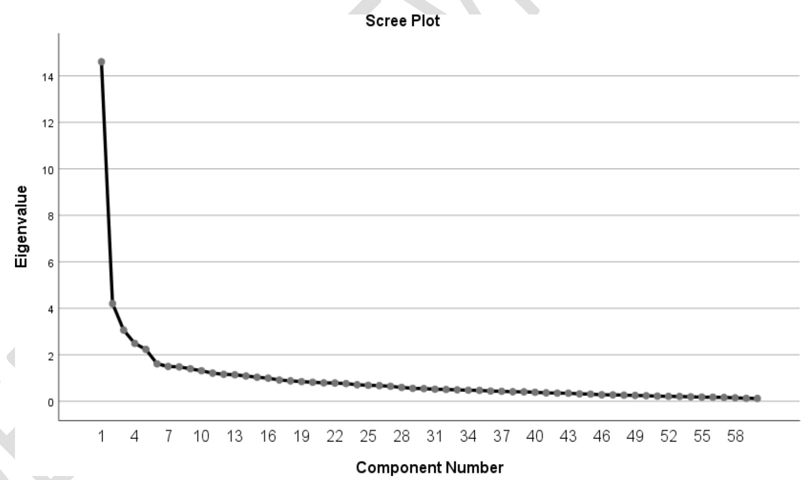

Figure 2. *Scree Plot*

Latent Roots Criterion of the Extracted Factors

In Table 2, it is revealed that the extracted factors from the latent roots' criterion, which portray the percentage of variance. Firstly, the factor has an initial 14.605 eigenvalue and 24.342%. variance. Second, the factor has with an initial 4.199 eigenvalue and 6.999% variance. Third, the factor has an initial 5.101 eigenvalue and 366.442% variance. Fourth, the factor obtained 4.147 eigenvalue and 40.589%. variance. Fifth, factor obtained an eigenvalue of 3.719 and variance got 44.308%. The sixth factor got a 2.684 eigenvalue with a variance of 46.992%. The seventh factor eigenvalue, at 2.684, and the variance of the overall factors explain 49.488% of the total variance, indicating that these underlying components effectively represent the data.

Although 15 dimensions have eigenvalues greater than 1, only 7 factors were retained because they accounted for nearly 50% of the total variance. The factors were labeled according to the nature of the items, i.e., the commonality loaded into each factor. To ensure reliability, it systematically removed items with factor loadings below 0.40, consistent with the rigorous criteria recognized in previous studies. Additionally, the researcher eliminated any factors with fewer than three item statements (Perez Marulanda, 2025). The Principal Component Analysis (PCA) was used to determine whether certain items measure common factors.

In contrast, factor rotation simplifies the factor matrix and maximizes each variable's loading on a single factor, facilitating easier interpretation (Perez Marulanda, 2025). The PCA for the extraction method and VARIMAX with Kaiser-Meyer-Olkin normalization as the rotation method were utilized. As a result, the researchers identified seven distinct factors that collectively represent the core constructs of quality cacao production.

Table 2.*Latent Roots Criterion of the Extracted Factors*

Factor	Eigenvalue	%ofvariance	Cumulative%
FarmingManagement	*14.605*	*24.342*	*24.342*
Post-harvestprocessing techniques	*4.199*	*6.999*	*31.341*
CultivatingCacaoVarieties	*3.061*	*5.101*	*36.442*
EnvironmentalCondition	*2.488*	*4.147*	*40.589*
Farmers'Socio-economicStatus	*2.231*	*3.719*	*44.308*
BeanProtectionStrategies	*1.61*	*2.684*	*46.992*
Health,Nutrients,andGrowth	*1.497*	*2.496*	*49.488*

Factor Load Structure of Quality Cacao Produce

In Table 3, the researcher presents the factor loadings and thematic analysis findings about the constructs of quality cacao production. Subsequent exploratory factor analysis. A set of forty-three (43) items out of sixty (60) original items was recognized.

Table 3.*Factor Load Structure of Cacao Production*

Item	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
44	0.71														
43	0.67														
45	0.65														
60	0.63														
22	0.62														
40	0.60														
16	0.55														
27	0.53														
4	0.48														
52		0.81													
53		0.78													
54		0.78													
51		0.77													
31		0.71													
50		0.58													
49		0.54													
20			0.85												
18			0.78												
21			0.76												
19			0.70												
59			0.41												
6				0.66											
3				0.65											
15				0.62											
8				0.53											
9				0.44											
1				0.41											
41					0.73										
39					0.63										
38					0.61										
10					0.46										

45					0.43										
13						0.65									
12						0.54									
14						0.53									
23						0.50									
17						0.49									
35							0.75								
36							0.71								
34							0.48								
37							0.48								

A total of 60 items were surveyed and processed in the data reduction analysis, which were then grouped into seven distinct factors that reflect the cacao quality. Each reflects an essential component that contributes to the whole quality of cacao production.

The seventeen items failed to meet the minimum requirement of 0.40 to be considered as a factor. The 17 items that were blocked during the rotation did not meet the coefficient criteria; therefore, they were removed from the analysis. Looking at cohesion according to the nature of each of the structures of items. As stated by Perez, Rudbeck, and Castro (2025) in their study on sustainable land- use and post-harvest management practices.

Extracted Quality Cacao Production

Shown in Table 4 are the thematic analysis and the corresponding factor loading from the Exploratory Factor Analysis. The results revealed seven major constructs that represent the Qualities of cacao production. Each has a distinct, interrelated aspect of cacao quality as follows: farming management; post-harvest processing techniques; cultivating cacao varieties; environmental conditions; farmers' socio-economic status; bean protection strategies; and health, Nutrition, and growth.

Farming Management is the first factor that got 24.342% variance explained. These practices emphasize the importance of effective farming management in producing high-quality cacao beans. Farming management practices such as proper seedling selection, pruning, harvesting at optimal maturity, and maintaining hygienic fermentation conditions contribute to consistent product quality and improved productivity. This finding supports the study of Perez, Rudbeck, and Castro (2025), which highlighted that sustainable land-use systems and improved farming management practices, including organic fertilization, irrigation systems, fermentation in wooden bins, and solar drying, enhance cacao productivity while supporting environmental sustainability.

Post-Harvest Processing Techniques is the second factor, with 31.341% of the variance explained. The findings indicate that effective post-harvest processing is crucial to maintaining the quality and marketability of cacao products. Proper handling practices, such as fermentation, drying, packaging, and quality evaluation, help preserve the flavor, texture, and overall quality of cacao beans from farm production to market distribution. This finding supports the study of Mougang (2024), which emphasized that proper fermentation and drying processes significantly improve the quality and market value of cacao beans. Similarly, Forte (2023) explained that post-harvest processes such as sorting, fermentation, drying, and storage are essential stages that influence the chemical composition, flavor development, and overall quality of cacao beans. (Cortez, 2023) reported that bean variety, geographical origin, and processing techniques significantly influence the chemical composition and sensory characteristics of cacao beans.

Cultivating Cacao Varieties is the third factor, got 36.442% variance explained, and the findings revealed that effective post-harvest processing plays a crucial role in maintaining the quality and marketability of cacao products. Proper handling practices, such as fermentation, drying, packaging, and quality evaluation, help preserve the flavor, texture, and overall quality of cacao beans from farm production to market distribution. This finding supports the study of Mougang et al. (2024), which emphasized that proper fermentation and drying processes significantly improve the quality and market value of cacao beans. Similarly, Forte (2023) explained that post-harvest processes such as sorting, fermentation, drying, and storage are essential stages that influence the chemical composition, flavor development, and overall quality of cacao beans. These results suggest that strengthening post-harvest processing practices can enhance product quality, increase consumer demand, and improve the competitiveness of cacao products in the market.

Environmental condition is the fourth factor, explaining 40.589% of the variance. According to Chery (2015), cacao trees are sensitive to environmental conditions, including soil fertility, temperature, and shade. Dense planting can sometimes prevent sunlight from reaching the lower leaves, reducing photosynthesis and fruit yield.

Furthermore, pre-harvest environmental and cultivation conditions, including seedlings' adaptability to local climate and proper shading, are essential for cacao productivity and quality (Perez Marulanda, 2025). Seedlings that adjust well to local climatic conditions and receive appropriate shade are more likely to thrive and produce high-quality cacao beans. Supporting this finding, Ariza-Salamanca (2023) emphasized that pre-harvest environmental management practices such as soil fertility improvement, climate adaptation, and agroforestry integration can significantly enhance cacao productivity and bean quality.

Farmers' Socio-economic Status is the fifth factor, accounting for 44.308% of the variance explained. These indicate that the farmers' socio-economic conditions influence the sustainability of cacao production. Agriculture (2016) mentioned the Agrarian Production Credit Program (Department of Agrarian Reform) and the Shared Service Facility Program (Department of Trade and Industry), government initiatives that aim to improve farmers' incomes and community welfare. Cacao farming contributes to increased agricultural productivity and provides long-term livelihood stability for farming communities. Farmers with larger households often engage in income-generating farm activities such as fermentation and post-harvest processing, which add value to cacao production.

This observation is supported by Peñora et al. (2024). In the same way, Maswadi, Oktoriana, and Suharyani (2018) found that while years of experience improve decision-making, they also increase farmers' ability to use technological innovations to raise selling prices, which could improve farmers' socio-economic status. In addition, socio-cultural aspects of farming communities also influence cacao production practices. Lucco García (2025) highlighted that cacao farming is closely connected with local traditions, environmental stewardship, and collective farming identity among rural communities. Recent studies also emphasize the importance of protecting rural identities and local knowledge systems in agricultural sustainability.

Table 4.*Factors of quality cacao production*

Item	ItemStatements	FactorLoading
	***Factor1**-FarmingManagement*	
44	Thecacaoseedlingsareinspectedforrootrot beforeplanting.	*0.71*
43	Thecacaoseedlings areregularlyprunedtoencouragestrongrootsystems.	*0.67*
45	Thecacaopodsare harvestedatthe peakoftheirripeness.	*0.65*
60	Thecacaoproductsareconsistentinflavorprofileacrossmultipleproduction batches.	*0.63*
22	Thecacaofermentationconditionsarehygienic and clean.	*0.62*
40	Thecacaoqualitymetricsalignwithconsumerexpectations.	*0.60*
16	Thecacaobeans'fermentationprocess producesconsistentbatches.	*0.55*
27	Thecacaostorageiswellprotectedfromenvironmental contaminants.	*0.53*
4	Thenumberofsproutsofthecacaoplantingmaterialsis consistent.	*0.48*
	***Factor2**-Post-HarvestProcessingTechniques*	
52	Thecacaoproductsaremarketedwithclearlabelingthatincludesingredientsourcing.	*0.81*
53	Thecacaoproductsareavailableinarangeofpackagingoptionsthatpreserve freshness.	*0.78*
54	Thecacaoplantingmaterialsarecertified byagricultural qualityorganizations	*0.78*
51	Thecacaoproductsmaintaintheirtextureandconsistencyaftermelting.	*0.77*
31	Thecacaoproductsareindemandbycustomers.	*0.71*
50	Thecacaoproductsareconsistentlyevaluatedthroughsensoryanalysis forflavor consistency.	*0.58*
49	Thecacaoproductsarefreefromartificialadditivesand preservatives.	*0.54*
	***Factor3**-CultivatingCacaovarieties*	
20	Thecacaofermentationprocessdevelops alevelof taste.	*0.85*
18	Thecacaofermentationprocessisappropriate.	*0.78*
21	Cacaofermentationtransformstherawbean,developingcomplexflavorprecursors.	*0.76*

19	Thecacaofermentationprocesseliminatesunwanted flavors.	*0.70*
59	The cacao beans' physical integrity is a critical factor in determining the final product’s texture.	*0.41*
	Factor4*-EnvironmentalCondition*	
6	The cacaoseedlingsweretransplantedfromthe nursery.	*0.66*
3	The cacaoseedlingscanadapttothe localclimate.	*0.65*
15	Thecacaobeansreflectdifferentvarieties.	*0.62*
8	The cacaoseedlingsareshaded bythe otherplants.	*0.53*
9	Thecacaoplantingmaterialsarestoredefficientlybefore planting.	*0.44*
1	Thecacaoseedlingscamefromahigh-qualityvariety.	*0.41*
	Factor5*-Farmer’sSocio-EconomicStatus*	
41	Thecacaoseedlingsundergoregularpestanddiseasechecks.	*0.73*
39	Thecacaoproducts’sustainabilityimpactslong-termcommunitybenefits.	*0.63*
38	Thecacaoqualityhasasustainabilitycertification	*0.61*
10	ThecacaoplantingmaterialsconformtoGoodAgricultural Practices.	*0.46*
45	Thecacaopodsareharvestedatthepeakoftheirripeness.	*0.43*
	Factor6*-BeansProtectionStrategies*	
13	Thecacaobeans’storageconditionsarewell-maintained.	*0.65*
12	Thecacaobeansareuniformlysized.	*0.54*
14	Thecacaobeans arefreefromcontaminationbyanyforeignparticles.	*0.53*
23	Thecacaofermentationismonitored.	*0.50*
17	Thecacaobeans’chemicalcompositionalignswithindustrystandards.	*0.49*
	Factor7*-Health, Nutrition,and Growth*	
35	Thecacaoproductsarewellblendedwithotherflavors.	*0.75*
36	Thecacaoproductcomplementsotheringredientsin recipes	*0.71*
34	Thecacao productsvisuallyconveytheirflavorcharacteristics	*0.48*
37	Thecacaoproductshavearesemblancetoeachotherinvarious batches.	*0.48*

Bean Protection Strategies,the sixth factor, accounted for 46.992% of the variance explained. This means that pests and diseases account for a large share of cacao losses. So, it is important to protect throughout the production cycle. Proper monitoring of fermentation processes and maintaining appropriate storage conditions help preventcontaminationandpreservethephysicalandchemicalpropertiesofcacao beans. This observation is consistent with the findings of Forte (2023), who emphasized that effective post-harvest handling practices, including fermentation monitoring, drying, and proper storage, are essential to maintaining cacao bean quality and meeting international market standards.

*Health,Nutrients,andGrowth*istheseventhfactor, explaining 49.488% of the variance. These indicate that blending and compatibility of cacao products with other flavors, as well as visual and sensory consistency, influence the quality of cacao production. Quintana-Fuentes (2025) found that a sufficient supply of nitrogen and potassium, particularly improves cacao formation and uniformity. Likewise, nutrient management leads to more consistent bean nutrient balance, which supports product uniformity and flavor stability.Inaddition,cacaobeanscontainimportantbiochemical compoundsthatcontributetoplantdefenseandhumanhealthbenefits.Studiesby Manga et al. (2024) reported that cacao contains polyphenols and other bioactive compounds withantioxidant properties, thereby enhancing thenutritionalvalueand functional qualities of cacao products.

Framework Developed for Quality Cacao Production

Figure 3 illustrates a key factor influencing cacao production. Categorized into two dimensions: technical factors and behavioral factors. Where the center lies, Quality Cacao Production, derived from the results of the Exploratory Factor Analysis on the construct of quality cacao production.

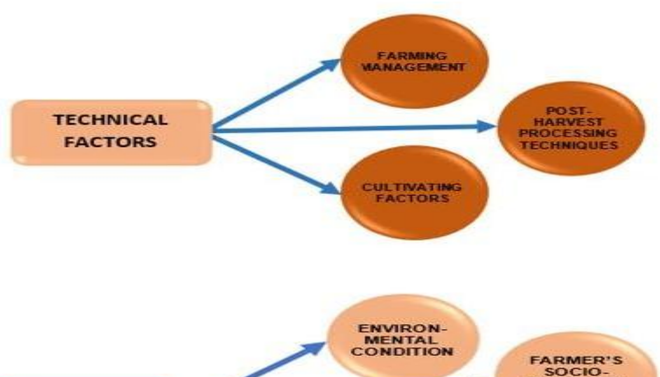

Figure 3.*Quality Cacao Framework*

Analysis revealed seven factors: farming management; post- harvest processing techniques; cultivating cacao varieties; environmental conditions; farmers' socio-economic status; bean protection strategies; and health, nutrient, and growth.

The thematic analysis identified seven clear factors that can influence the quality of cacao production. This framework, therefore, illustrated that cacao quality is shaped by a combination of technical and behavioral factors that work together to ensure productivity. practices. When combined, these theoretical perspectives provide a holistic framework that addresses both the technical management processes and the behavioral motivations that shape farmers' actions in producing high-quality cacao.

In addition, the frameworks suggest that improving cacao quality requires both systematic production standards and behavioral commitment from farmers and producers. In practice, this implies that cacao producers should strengthen quality control systems by implementing standardized procedures across all production stages from seedling inspection, pruning, and harvesting to fermentation and storage, while maintaining continuous monitoring and evaluation to preserve the desired flavor, aroma, and texture of cacao beans. At the same time, producers may benefit from pursuing agricultural certifications such as Good Agricultural Practices, which can enhance product credibility, improve labeling and packaging standards, and increase market trust among buyers and consumers.

Furthermore, improving post-harvest processes remains essential for maintaining the cacao quality. Farmers and processors should adopt structured fermentation and post-harvest guidelines that promote hygienic handling and effective monitoring of temperature and moisture during fermentation and drying. The integration of simple technologies or monitoring systems can significantly enhance the development of desirable cacao flavors. Producers may also explore evaluation and product innovation strategies, including physical quality testing, product development, and the blending of cacao varieties to create distinctive flavor profiles that expand market opportunities and strengthen competitiveness in the cacao industry.

The findings also highlighted the importance of responsible, sustainable farming practices. Policymakers and agricultural support agencies can improve cacao quality by promoting environmentally responsible farming methods, providing technical assistance, and offering incentives that support sustainable production systems while strengthening the livelihoods of farming communities. Such as the collaborative support structures, which can help ensure that the quality improvements are sustained over time.

Finally, while the present study identified key factors influencing cacao quality through exploratory analysis, further research is necessary to strengthen the measurement framework. Future researchers are encouraged to conduct confirmatory factor analysis (CFA) to validate the factor structure identified in this study and refine the measurement scale for assessing cacao quality production. Such efforts would contribute to developing a more robust and empirically validated model that can guide policy development, training programs, and quality assurance systems aimed at sustaining high-quality cacao production.

Conclusion

The findings also highlighted the importance of responsible, sustainable farming practices. Policymakers and agricultural support agencies can improve cacao quality by promoting environmentally responsible farming methods, providing technical assistance, and offering incentives that support sustainable production systems while strengthening the livelihoods of farming communities. Such as the collaborative support structures, which can help ensure that the quality improvements are sustained over time.

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