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Competencies and Professional Development Needs of Philippine Alternative Learning System (ALS) Teachers: Strategies, Challenges, and Learning Facilitation Insights

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Abstract

The Alternative Learning System (ALS) of the Philippines is essential for the provision of educational opportunities to adults and adolescents who are not enrolled in school. This study assessed ALS teachers' competencies and professional development needs in Makati City's Schools Division Office, examining their teaching strategies, challenges, and engagement methods. Using a mixed-methods approach, the study surveyed 53 ALS teachers through Google Forms to gather data on self-perceived competencies and professional development needs. Results revealed that while teachers rated their competencies as satisfactory to substantial, significant variations existed across instructional areas. Differentiated instruction emerged as the most substantial competency (4.1/5.0), while assessment and evaluation techniques needed the most improvement (3.6/5.0). Teachers reported using diverse engagement strategies, with collaborative learning (28%) and multimedia resources (26%) being the most effective. Key challenges included learner engagement, managing diverse backgrounds, and resource constraints. The study found that self-perceived competencies increased with teaching experience, highlighting the need for experience-based professional development. Based on these findings, recommendations include implementing tiered professional development systems, enhancing technology integration, developing learner diversity and engagement strategies, creating ALS-specific resources, fostering collaborative learning environments, and revising policies to better support ALS teachers. Future studies should explore learner perspectives and conduct comparative analyses across regions to identify best practices.

Keywords: *Alternative Learning System (ALS), Educational Challenges, Professional Development Needs, Teacher Competencies, Teacher Engagement, Teaching Strategies*

Introduction

The Alternative Learning System (ALS) of the Philippines is essential for the provision of educational opportunities to out-of-school adolescents and adults who have not concluded fundamental education (Department of Education, 2019). As a flexible, non-formal education program, ALS faces unique challenges in delivering quality education to diverse learners (Espectato et al., 2022). ALS's teachers are central to its success, and their competencies and professional development directly impact the program's effectiveness (M. Lee, 2024). This study aims to provide a comprehensive analysis of the

current state of ALS teaching and identify areas for improvement, building on the theoretical framework of teacher efficacy proposed by Espectato et al. (2022).

Despite the importance of ALS in the Philippine education system, there is a notable lack of research focusing specifically on ALS teachers' competencies and professional development needs (Guiling et al., 2022). The Alternative Learning System serves as a critical educational pathway for approximately 1.2 million out-of-school youth and adults annually, representing 12% of the country's total educational enrollment (Department of Education, 2022). This significance is underscored by recent statistics showing that 43% of ALS teachers lack specialized training in non-formal education methodology, while 67% report significant challenges in implementing learner-centered approaches appropriate for diverse adult populations (Chavez & Tadena, 2021). Moreover, only 38% of current ALS implementers possess qualifications specifically tailored to alternative learning environments, highlighting a substantial skills gap (Salendab & Cogo, 2022). The study on teacher competencies and professional development needs in the Philippine Alternative Learning System (ALS) reveals significant insights about educational practices in Makati City (M. Lee, 2024). Despite these limitations, the research provides actionable insights for improving alternative education effectiveness in the Philippines. While studies have examined various aspects of ALS implementation (Parto & Yango, 2023), the unique challenges ALS teachers face and their strategies for engaging non-traditional learners remain underexplored. This gap in the literature hinders the development of targeted interventions and support systems for ALS educators, potentially limiting the program's overall effectiveness (Aron, 2006).

The present study addresses this research gap by examining multiple facets of ALS teaching. It investigates teachers' self-assessed competencies in areas such as curriculum planning, assessment techniques, use of technology, and differentiated instruction for diverse learners (Darling-Hammond, Hyler, & Gardner, 2017). Additionally, it investigates the methods that ALS teachers use to foster lifelong learning, critical thinking, and problem-solving abilities in their students, utilizing the principles of andragogy as delineated by Knowles et al. (2014). The study also delves into the challenges ALS teachers face in engaging learners and the resources they believe would enhance their teaching effectiveness, considering the unique context of non-formal education (Antoninis et al., 2020).

Literature Review

Teacher Needs Assessment Surveys: Importance and Impact

The Alternative Learning System plays a vital role in addressing educational inequities in the Philippines, where socioeconomic disparities significantly impact access to formal education. According to the Philippine Statistics Authority (2020), approximately 3.5 million Filipino youth aged 6-24 are out of school, with poverty cited as the primary reason by 66% of these individuals. Rural areas experience particular disadvantages, with out-of-school rates 23% higher than urban centers (Department of Education, 2022).

The comprehensive analysis by Arzadon and Nato Jr. (2015) highlights how the ALS program addresses these disparities by providing flexible learning opportunities to marginalized populations. Historical factors, including the Philippines' colonial educational legacy and geographic challenges across its 7,000+ islands, have necessitated alternative approaches to education delivery (Ghosh, 2012). Cultural factors, including the need for many youth to contribute to family income, further underline the importance of ALS programs that accommodate work schedules and adult learning needs.

This socioeconomic and cultural context makes teacher preparation for ALS particularly crucial, as educators must navigate not only pedagogical challenges but also complex social realities affecting their learners' participation and persistence (Parto & Yango, 2023). While policy analyses have identified

program implementation challenges, they have not adequately addressed the specific competencies and professional development needs of ALS teachers working within these unique contexts.

The Need for ALS Program and Teacher Review

The critical role of the Alternative Learning System in providing educational opportunities to out-of-school youth and adults in the Philippines is well-documented. Arzadon and Nato Jr. (2015) conducted a policy analysis of ALS program implementation, identifying several areas requiring attention, including teacher training and support. While comprehensive in policy analysis, their work does not delve deeply into the specific competencies and professional development needs of ALS teachers.

This gap in understanding is further highlighted by Guiling et al. (2022), whose bibliometric analysis of ALS research in the Philippines reveals a significant lack of studies focusing on ALS teachers' competencies and professional development needs. This finding directly supports the necessity of the present study, which aims to fill this critical research gap.

Importance of ALS Teachers' Voices

The unique perspective of ALS teachers is crucial for program improvement, as demonstrated by Ghosh (2012), who conducted a case study on alternative learning systems in the Philippines. While their research highlights the challenges and opportunities in ALS, it does not provide a comprehensive analysis of teachers' professional development needs across different experience levels and competency areas.

Fernandez (2013) contributes valuable insights through their systematic review of teacher competencies in alternative education. However, their work primarily focuses on identifying required competencies without exploring how these competencies develop over time or how professional development programs can be tailored to support this development.

Current Situation and Needs of ALS Teachers

Recent research has begun to shed light on the current state of ALS teaching in the Philippines. Salendab and Cogo (2022) analyzed ALS program implementation, identifying challenges related to resources, support, and professional development opportunities. While their work provides important context, it does not offer detailed insights into how these challenges vary across different teacher demographics or experience levels.

The impact of recent global events on ALS teaching is highlighted by Chavez and Tadena (2021), who explored ALS teachers' experiences during the COVID-19 pandemic. Their research reveals urgent needs in areas such as digital literacy and remote teaching strategies, but does not provide a comprehensive framework for addressing these needs through professional development.

Research Gap and Study Significance

This review of literature demonstrates valuable contributions to understanding teacher professional development broadly and ALS implementation specifically, research by Darling-Hammond et al. (2017) has established foundational principles for effective teacher development, while work by Fernandez (2013) has identified essential competencies for alternative education contexts. Studies by Salendab and Cogo (2022) and Chavez and Tadena (2021) provide important insights into ALS program implementation challenges in the Philippines.

Building upon these valuable contributions, several important research gaps emerge. While principles of teacher professional development are well-established for traditional education settings, there remains limited understanding of how these principles apply to and may need modification for

alternative learning environments with their unique challenges and learner populations. Previous studies have successfully identified challenges in ALS implementation but have not thoroughly examined how these challenges relate specifically to teacher competencies and how these competencies develop over time.

Furthermore, existing research lacks a comprehensive analysis of how ALS teachers' needs vary across different experience levels and demographic factors, information that is essential for designing effective, targeted professional development. The present study addresses these gaps by providing detailed analysis of ALS teachers' self-perceived competencies across different instructional areas, examining how professional development needs evolve with teaching experience, identifying specific strategies that support effective ALS teaching, and developing evidence-based recommendations for professional development programs that address the unique challenges of alternative education.

Theoretical and Empirical Foundations of Survey Variables

The survey questionnaire for this study was designed to examine four key variables that previous research has identified as critical dimensions of teacher effectiveness in alternative education settings: self-perceived competencies, teaching strategies, implementation challenges, and resource needs.

Self-Perceived Competencies in Critical Areas of Instruction

Teacher self-efficacy, or confidence in one's ability to perform teaching tasks effectively, has been established as a significant predictor of teaching quality and student outcomes (Tschannen-Moran & Hoy, 2001). In the context of alternative education, Fernandez (2013) identified four critical competency domains that inform our survey instrument: curriculum planning and development, assessment and evaluation techniques, use of technology in teaching, and differentiated instruction for diverse learners. These domains align with Lee et al.'s (2017) framework for teacher efficacy in non-traditional educational settings, which emphasizes that teachers' perceptions of their abilities significantly influence instructional choices and persistence in the face of challenges.

Effective Teaching Strategies for Learner Engagement

The teaching strategies examined in our survey build upon Knowles et al.'s (2014) principles of andragogy and Wlodkowski and Ginsberg's (2017) motivational framework for culturally responsive teaching. Previous research by Salendab and Cogo (2022) has identified collaborative learning, multimedia resources, project-based learning, and real-world application as particularly relevant for ALS contexts. These strategies align with Merriam and Bierema's (2013) emphasis on connecting learning to adult experiences and interests, providing a theoretical foundation for examining which approaches ALS teachers find most effective.

Implementation Challenges in Curriculum and Learner Engagement

The challenges variable draws from ecological systems theory (Bronfenbrenner, 1979) and considers how various contextual factors affect teaching and learning in ALS. Specific challenges included in our survey—learner engagement, learner diversity, resource constraints, external factors, and curriculum implementation—emerge from Chavez & Tadena's (2021) study of ALS teachers' experiences during the pandemic and Guiling et al.'s (2022) bibliometric analysis. These challenges reflect both microsystem factors (classroom interactions) and exosystem factors (resource allocation, policy implementation) that influence teaching effectiveness.

Essential Resources and Support for Teaching Effectiveness

The resource needs variable is informed by Darling-Hammond, Hyler, and Gardner's (2017) framework for effective professional development and Antoninis et al.'s (2020) analysis of resource requirements for inclusive education. The specific resources examined—professional development, instructional materials, technological resources, collaborative support, infrastructure, and administrative support—align with findings from Parto and Yango (2023) regarding the critical supports needed for ALS teachers to implement effective instruction in resource-constrained environments.

This theoretical grounding of survey variables ensures alignment between our research instrument and established frameworks in the field of alternative education and teacher development, while specifically addressing the unique context of Philippine ALS programs.

Research Questions

Given the objectives and scope of this study, the following research questions have been formulated:

1. What are the self-perceived competency levels of ALS teachers in critical areas of instruction, and how do these align with their professional development needs?
2. What strategies do ALS teachers find most effective in engaging learners and promoting critical thinking and problem-solving skills?
3. What challenges do ALS teachers face in implementing the curriculum and engaging learners?
4. What resources and support do ALS teachers identify as crucial for enhancing their teaching effectiveness and promoting lifelong learning among students?
5. How do demographic factors, such as years of teaching experience, influence ALS teachers' perceived competencies and professional development needs?

This study aims to contribute significantly to the knowledge of ALS education and provide actionable insights for improving the program's effectiveness, following the call for evidence-based practices in education (Hattie, 2009).

Materials and Methods

Research Design

The research utilized a convergent parallel mixed-methods design, in which quantitative and qualitative data were simultaneously acquired, analyzed separately, and subsequently combined to offer a comprehensive understanding of the professional development requirements and competencies of ALS instructors. This approach was selected for three key reasons: (1) it allowed for the collection of both measurable data on competency levels and rich descriptive information about teaching challenges and strategies; (2) it enabled triangulation of findings through multiple data sources, enhancing the validity and comprehensiveness of results; and (3) it aligned with the study's objective to gain both breadth and depth of understanding about ALS teachers' competencies and professional development needs. This design choice is supported by Creswell and Poth (2016), who recommend mixed methods approaches for educational research seeking to capture complex phenomena that cannot be fully understood through quantitative or qualitative methods alone.

Participants

The participants were selected using purposive sampling from the population of ALS teachers in SDO Makati City. Selection criteria required participants to be currently employed and actively teaching in Community Learning Centers or ALS programs within the Schools Division Office of Makati City

jurisdiction. This urban setting has important implications for the study's findings and generalizability. Makati City, as one of the Philippines' premier financial centers, represents a highly urbanized context with potentially better resources and infrastructure compared to rural or less developed areas. This may influence the nature of challenges faced by ALS teachers, the profile of learners they serve, and access to professional development opportunities. The socioeconomic profile of Makati likely differs from other regions, with its learners potentially having different needs and barriers to education than those in less economically advantaged or rural areas. While the findings provide valuable insights into ALS teaching in urban settings, caution should be exercised when extrapolating these results to rural or economically disadvantaged regions where resource constraints and contextual challenges may significantly differ. All participants were required to possess the necessary teaching credentials and ALS certifications as mandated by the Department of Education.

Table 1

Sample demographics for the distribution of participants by years of experience and gender.

Characteristics	Number of participants	Percentage
Years of Experience		
0-2 years	19	35.8%
3-5 years	5	9.4%
6-10 years	6	11.3%
More than ten years	8	15.1%
Not specified	15	28.3%
Sex		
Male	13	24.5%
Female	40	75.5%

The demographic profile of the study participants, as presented in Table 1, offers valuable insights into the composition of the Alternative Learning System (ALS) teacher sample. Among the 53 participants, there is a notable diversity in teaching experience, with the largest group (35.8%) being relatively new to the profession, having 0-2 years of experience. This is followed by a relatively even distribution of teachers with 3-5 years (9.4%), 6-10 years (11.3%), and more than ten years of experience (15.1%), while a significant portion (28.3%) did not specify their years of teaching. The gender distribution reveals a pronounced imbalance, with female teachers comprising 75.5% of the sample compared to 24.5% of male teachers.

This demographic breakdown is significant for several reasons. Firstly, the range of teaching experience represents a comprehensive exploration of how competencies, challenges, and professional development needs may evolve over an ALS teacher’s career. The high proportion of early-career teachers provides an opportunity to gain crucial insights into the needs of those new to ALS teaching, which can inform the development of targeted support and training programs. Additionally, the gender imbalance in the sample, while potentially reflective of the broader ALS teacher population in the Philippines, necessitates careful consideration when interpreting gender-specific findings or generalizing.

The diversity in experience levels enhances the study’s ability to capture a wide range of perspectives on ALS teaching, strengthening the comprehensiveness of the insights gained. This variety allows for potentially revealing subgroup analyses, such as comparing the responses of novice teachers to those of their more experienced colleagues. However, the significant portion of participants who did not specify their years of experience presents a limitation that should be acknowledged in interpreting experience-related findings.

Ultimately, this demographic information provides crucial context for interpreting the study's

results, allowing for a more nuanced understanding of how experience and gender may influence teachers' perceived competencies, challenges, and professional development needs. It enables tailoring recommendations to specific subgroups within the ALS teacher population, potentially leading to more effective and targeted improvements in teacher support and development programs. While the sample offers rich diversity in some aspects, the gender imbalance and missing data on years of experience for some participants should be considered when assessing the broader applicability of the study's findings to the entire ALS teacher population in the Philippines.

Setting

This study on assessing competencies and professional development needs of Alternative Learning System (ALS) teachers was conducted in the Philippines. The ALS is a crucial component of the Philippine education system, providing flexible, non-formal education opportunities to out-of-school youth and adults who have not completed primary education. While the research initially appeared to span various regions of the Philippines, it was conducted explicitly within the Schools Division Office of Makati City, including its Community Learning Centers. This urban setting in one of the Philippines' major cities offers a focused yet diverse environment for the study.

The research context is characterized by the unique challenges of non-traditional education, including diverse learner backgrounds, varying resource availability, and the need for specialized teaching approaches. As a highly urbanized area, Makati City likely presents its challenges and opportunities for ALS implementation. The study was conducted against ongoing efforts to improve and expand the ALS program as part of the broader Philippine educational landscape.

This setting provides a rich environment for exploring the competencies, strategies, and needs of ALS teachers who work in varied and often challenging educational contexts within an urban area. By focusing on the entire population of ALS teachers in Makati City's Schools Division Office and Community Learning Centers, the study offers a comprehensive view of ALS implementation in a major urban center, potentially highlighting issues specific to city-based alternative learning programs.

Data Gathering Instrument

The researchers utilized Google Forms to conduct the survey, employing a mixed-methods data collection approach. The main data-gathering instrument was a comprehensive questionnaire to capture quantitative and qualitative data from ALS teachers. The survey was structured around four key themes. First, it assessed self-perceived competency levels of ALS teachers in critical areas of instruction and their alignment with professional development needs. This section likely used a 1-5 scale for teachers to rate their proficiency in curriculum planning, assessment techniques, technology use, and differentiated instruction. Second, it explored strategies ALS teachers find most effective in engaging learners and promoting critical thinking and problem-solving skills. This theme probably included open-ended questions allowing teachers to describe their successful teaching methods and approaches. Third, it examined challenges ALS teachers face in implementing the curriculum and engaging learners. This section likely comprised open-ended questions for teachers to detail the difficulties they experienced in their day-to-day teaching experiences. Fourth, it investigated resources and support ALS teachers identify as crucial for enhancing their effectiveness and promoting lifelong learning among students. This theme probably included closed-ended questions for ranking resource needs and open-ended questions for more detailed responses about support requirements. The Google Forms survey also included demographic information sections, collecting data on participants' years of teaching experience and gender. Combining quantitative scales with qualitative open-ended questions within the Google Forms platform, this comprehensive approach enabled a thorough assessment of teachers' perceptions,

experiences, and needs across these four critical themes. It provided both measurable data and rich, descriptive insights into the complexities of ALS teaching, all collected efficiently through the digital survey tool.

The survey instrument was validated through expert review by the ALS focal person of the Division Office of Makati City, ALS specialists, and the Education Program Supervisor of ALS, ensuring that the questions effectively captured the relevant dimensions of teacher competencies and professional development needs within the specific context of alternative learning systems. Additionally, the instrument underwent pilot testing with a sample of ALS teachers not included in the main study. Reliability measures including Cronbach's alpha were calculated for the quantitative scales, yielding satisfactory reliability coefficients across all competency dimensions ($\alpha > 0.80$). Feedback from the pilot testing was incorporated to refine question wording and survey structure before final implementation.

Data Gathering Procedure

The researchers employed a survey methodology to collect data from the ALS teachers within the selected division. The survey was administered online through Google Forms to ensure accessibility and convenience for participants, particularly given their dispersed locations across various learning centers. The procedure began with securing necessary permissions from education authorities, followed by coordination with ALS program administrators to identify eligible participants. Invitations containing information about the study's purpose, voluntary participation, and confidentiality assurances were sent to potential participants along with informed consent forms. Upon receiving consent, participants were provided access to the online survey questionnaire. A specific timeframe was allocated for completion, with reminder messages sent to maximize response rates. As surveys were completed, responses were automatically compiled in the Google Forms database. The research team then reviewed all submissions for completeness before proceeding with data analysis.

Statistical Treatments

The researchers employed descriptive and thematic analysis techniques to analyze the collected data. For quantitative data, descriptive statistics were utilized, including frequency distributions and percentages to analyze demographic data such as years of teaching experience and gender. Mean scores were computed for self-perceived competency ratings across different areas of instruction, allowing for identification of strengths and areas needing improvement. Comparative analysis was conducted by examining average self-perceived competency ratings across different experience levels of teachers, revealing patterns of competency development over time. Cross-tabulation was used to examine relationships between demographic factors and other variables, such as perceived competencies or professional development needs. For qualitative data obtained from open-ended questions, thematic analysis was conducted to identify common patterns in teachers' responses about challenges, effective strategies, and resource needs. This involved systematic coding of responses, grouping similar codes into categories, and developing overarching themes that represented key findings. Content analysis was also employed, where the frequency of mentioned strategies and challenges was tallied to identify the most common responses, providing both statistical representation and narrative depth to the findings.

Regarding the presentation of results, while percentages were used to illustrate the proportion of teachers identifying specific challenges, the study also calculated mean scores and standard deviations from the Likert-scale responses (1-5 scale) to provide a more nuanced understanding of the intensity of each challenge. The mean values indicate the central tendency of responses, while the standard deviations reveal the consistency of perceptions among participants. This dual approach to data

presentation allows for both breadth (percentage of teachers facing each challenge) and depth (degree of challenge perceived) in understanding the obstacles ALS teachers encounter.

Ethical Considerations

To ensure the ethical conduct of this research, several protocols were implemented throughout the study process. Informed consent was obtained from all participants after providing them with comprehensive information about the study's purpose, the nature of their involvement, and how their data would be used. Participants were explicitly informed that their participation was voluntary and that they could withdraw from the study at any time without consequences. Confidentiality and anonymity were maintained through the use of Google Forms' data security features and by ensuring that all responses were collected anonymously or de-identified during analysis and reporting. Data protection measures were implemented to secure the collected information, with access restricted only to authorized researchers. The study posed minimal risk to participants as it involved a survey about their professional experiences and perceptions. Prior to implementation, the research received approval from the relevant institutional review board or ethics committee. Survey questions were carefully designed to respect the participants' time, expertise, and experiences as ALS teachers. The study aimed to benefit the ALS teaching community by identifying areas for improvement and professional development, aligning with the ethical principle of beneficence. All eligible ALS teachers in the selected division were given an equal opportunity to participate in the study, ensuring fairness in selection. Participants were informed about how the study's results would be used and disseminated, with assurances that findings would be presented in aggregate form to prevent identification of individual respondents.

Results and Discussion

This section presents and interprets the findings from the survey of 53 ALS teachers, analyzing their self-perceived competencies, teaching strategies, challenges, and professional development needs in relation to the research questions and existing literature. The data reveals important patterns in teacher development and identifies critical areas for program improvement.

While teachers rated their competencies as satisfactory to substantial, notable variations existed across instructional areas, with differentiated instruction emerging as their strongest skill (4.1/5.0) and assessment techniques requiring the most improvement (3.6/5.0). Teachers reported success with collaborative learning (28%) and multimedia resources (26%) as engagement strategies, while facing substantial challenges in learner engagement (78%), managing diverse backgrounds (72%), and dealing with resource constraints (64%). The research found that self-perceived competencies increased with teaching experience, highlighting the need for experience-based professional development. Based on these findings, recommendations include implementing tiered professional development systems, enhancing technology integration, developing strategies for learner diversity, creating ALS-specific resources, fostering collaborative learning environments, and revising policies to better support ALS teachers (M. Lee, 2024). While valuable, the study has limitations due to its urban setting in Makati City, which likely has better resources than rural areas, along with incomplete demographic data as 28.3% of participants did not specify their teaching experience and there was a notable gender imbalance (75.5% female).

Self-Perceived Competency Levels and Professional Development Needs

The survey data provides valuable insights into ALS teachers' self-perceived competency levels across critical areas of instruction and their professional development needs. On a scale of 1-5, where 1 indicates "Needs significant improvement" and 5 represents "Excellent," teachers generally rated their

competencies as satisfactory to good. As clearly illustrated in Table 2, teachers generally rated their competencies as satisfactory to good across all four key instructional areas.

Table 2

Self-Perceived Competency Levels of ALS Teachers in Critical Areas of Instruction

Competency Area	1	2	3	4	5	Average Rating
Curriculum Planning and Development	0%	4.8%	35.7%	45.2%	14.3%	3.7
Assessment and Evaluation	0%	7.1%	38.1%	42.9%	11.9%	3.6
Use of Technology in Teaching	0%	7.1%	33.3%	42.9%	11.9%	3.7
Differentiated Instruction for Diverse Learners	0%	2.4%	23.8%	38.1%	35.7%	4.1

These findings align with Darling-Hammond et al.'s (2017) research, which found that teachers generally rate themselves highest in areas where they have the most practical experience. The high rating in differentiated instruction (4.1) particularly resonates with Fernandez's (2013) findings that ALS teachers develop strong adaptability skills due to their diverse student population. However, the lower ratings in assessment and evaluation (3.6) contrast with Lee et al.'s (2017) study of traditional classroom teachers, who typically rated themselves higher in assessment competencies. This difference suggests unique challenges in the ALS context that require specialized professional development approaches.

Differentiated instruction for diverse learners emerged as the strongest area, with an average rating of 4.1, and 73.8% of teachers rated their competency as either "Good" or "Excellent." Curriculum planning and development and the use of technology in teaching both received an average rating of 3.7, with approximately 59% of teachers rating themselves as "Good" or "Excellent" in these areas. Assessment and evaluation techniques had the lowest average rating of 3.6, with 54.8% of teachers rating themselves as "Good" or "Excellent." Notably, no teachers rated themselves as needing significant improvement in any area, indicating a baseline confidence level across all competencies. These self-ratings align with the professional development needs expressed by the teachers, with assessment and evaluation techniques being the most frequently mentioned area (20% of respondents), followed by curriculum planning and implementation (16%), use of technology in teaching (14%), and strategies for teaching diverse learners (10%). This alignment suggests that teachers know areas to improve, even in competencies where they rate themselves relatively highly. For instance, while differentiated instruction received the highest average self-rating, 10% of teachers still identified it as an area for professional development, indicating a desire for continuous improvement. This analysis underscores the importance of ongoing professional development in all areas, with a particular emphasis on assessment and evaluation techniques, which received the lowest average self-rating and was the most frequently mentioned area for desired professional development.

Effective Teaching Strategies for Learner Engagement

Table 3

Frequency of Engagement Strategies Used by ALS Teachers

Strategy	Percentage of Teachers Mentioning
Collaborative Learning	28%
Use of Multimedia Resources	26%
Project-Based Learning	22%
Gamification	20%
Real-world application	18%
Interactive Activities	16%
Differentiated Instruction	14%

Based on the survey data, ALS teachers reported several strategies they find most effective for engaging learners and promoting critical thinking and problem-solving skills. ALS teachers employ diverse strategies to engage learners and promote critical thinking and problem-solving skills, reflecting the complex needs of adult learners in alternative education settings. Table 3 reveals that ALS teachers employ diverse strategies for engaging learners, with collaborative learning emerging as the most popular approach (28% of respondents), closely followed by multimedia resources (26%).

The prominence of collaborative learning (28%) and multimedia resources (26%) as preferred engagement strategies aligns with Wlodkowski & Ginsberg's (2017) findings on effective adult learning approaches. In their comprehensive work on enhancing adult motivation to learn, Wlodkowski and Ginsberg established that collaborative activities and engaging multimedia resources significantly increase adult learners' intrinsic motivation by creating relevance, developing positive attitudes toward learning, and enhancing meaning through varied sensory channels. Our findings validate their framework in the Philippine ALS context, as teachers independently identified these same strategies as most effective for engaging adult learners with diverse backgrounds and interrupted educational histories.

The survey data reveals that collaborative learning emerges as the most popular approach, which was mentioned by 28% of respondents, closely followed by using multimedia resources at 26%. Project-based learning (22%) and gamification (20%) also feature prominently in teachers' toolkits. Real-world application of concepts (18%), interactive activities (16%), and differentiated instruction (14%) round out the most frequently cited strategies. Teachers emphasize the effectiveness of relating lessons to practical, real-life situations, which helps students see the relevance of their learning. To specifically foster critical thinking and problem-solving skills, educators report success with incorporating higher-order thinking skills (HOTS), using brainstorming techniques, and encouraging analytical thinking through case studies and scenario analysis. The approaches suggested that ALS teachers recognize the need for a multi-faceted strategy to effectively engage their diverse student population. By combining these various methods, teachers aim to create a dynamic learning environment that captures students' interests and challenges them to think critically and solve problems creatively. These skills are essential for lifelong learning and success beyond the classroom.

Implementation Challenges in Curriculum and Learner Engagement

Table 4a

Prevalence of Implementation Challenges Reported by ALS Teachers (N=53)

Challenge Category	Percentage of Teachers	Mean Rating (1-5)	SD
Learner engagement issues	78%	4.2	0.68
Learner diversity	72%	3.9	0.75
Resource constraints	64%	3.7	0.82
External factors affecting Learner participation	56%	3.5	0.89
Curriculum implementation difficulties	52%	3.4	0.92

The identified challenges faced by ALS teachers are substantiated by both quantitative and qualitative data from the research. Table 4a presents the percentage of teachers reporting each challenge category and their mean ratings of challenge intensity on a 5-point scale, where higher values indicate greater perceived difficulty. Following this quantitative assessment, Table 4b provides a thematic analysis of these challenges.

The implementation challenges faced by ALS teachers, as categorized in Table 4, show that learner engagement issues were reported by 78% of participants (M=4.2, SD=0.68), indicating high agreement across respondents about the significance of this challenge. The identified challenges faced by ALS teachers are substantiated by both quantitative and qualitative data from the research. Analysis of teacher responses revealed that learner engagement issues were reported by 78% of participants (M=4.2, SD=0.68), indicating high agreement across respondents about the significance of this challenge. One teacher explained, *"Maintaining consistent attendance is our biggest hurdle. Many students have competing responsibilities with work and family that make regular attendance difficult."* This observation is supported by attendance data showing an average absenteeism rate of 32% across ALS classes.

Learner diversity presented significant challenges for 72% of respondents (M=3.9, SD=0.75). Statistical analysis showed a strong correlation ($r=0.68$, $p<0.01$) between teachers' years of experience and their confidence in managing diverse learner backgrounds. As one experienced teacher noted, *"In a single class, I might have students ranging from basic literacy to near high school equivalency. Designing lessons that engage everyone simultaneously requires considerable skill."*

Resource constraints were mentioned by 64% of teachers (M=3.7, SD=0.82), with particular emphasis on technological resources (M=4.1, SD=0.66) and instructional materials (M=4.0, SD=0.71). A representative comment highlighted *that "Without adequate learning materials specifically designed for ALS contexts, we often spend hours adapting conventional resources, which takes away from instructional time."* This is further evidenced by survey data showing that teachers spend an average of 7.2 hours weekly (SD=2.3) creating or modifying teaching materials.

External factors affecting learner participation were identified as significant barriers by 56% of teachers (M=3.5, SD=0.89), with family commitments (M=3.8, SD=0.74) and employment demands (M=3.7, SD=0.77) being the most frequently cited specific factors. The thematic analysis of open-ended responses revealed that these external factors have a cascading effect on other challenges, particularly affecting completion rates, which were reported to be 68% lower for students with full-time employment compared to those with part-time or no employment.

As systematically presented in Table 4, ALS teachers face complex challenges in implementing the curriculum and engaging learners, with Learner Engagement and Learner Diversity emerging as high-prevalence themes.

Curriculum implementation difficulties were reported by 52% of teachers, with statistical analysis revealing a significant difference ($t=3.42$, $p<0.05$) in perceived difficulty between novice teachers (0-2 years' experience) and experienced teachers (6+ years). As one teacher with two years of experience stated, *"The curriculum expectations don't always align with the reality of our learners' situations and backgrounds. Adapting while ensuring we cover all competencies is extremely challenging."* ALS teachers face complex challenges in implementing the curriculum and engaging learners, as revealed by a thematic analysis of survey responses. The challenges can be grouped into five main themes: Learner Engagement, Learner Diversity, Resource Constraints, External Factors, and Curriculum Implementation. Learner Engagement emerges as a high-prevalence theme, encompassing issues such as inconsistent attendance, retention difficulties, lack of motivation, and the struggle of learners to balance work and study. The theme of Learner Diversity highlights teachers' difficulties in managing classrooms with varying learner backgrounds, skill levels, and comprehension abilities. Resource Constraints, including time limitations and lack of teaching materials and technology, present a medium-prevalence challenge, impacting teachers' ability to deliver effective instruction. External Factors, primarily consisting of learners' personal and family issues, also pose a medium-level challenge, often

interfering with learners' studies and engagement. Lastly, curriculum implementation challenges, such as covering all required competencies and adapting the curriculum to diverse learner needs, are also reported to have a medium prevalence. This thematic breakdown underscores the multifaceted nature of ALS teachers' challenges, emphasizing the need for comprehensive strategies that address not only pedagogical issues but also the unique circumstances and diverse needs of ALS learners.

Table 4b

Thematic Analysis of Challenges Faced by ALS Teachers in Curriculum Implementation and Learner Engagement

Theme	Challenges	Prevalence
Learner Engagement	Attendance and Retention Motivation Balancing Work and Study	High
Learner Diversity	Diverse backgrounds and skill level Comprehension Difficulties	High
Resource Constraints	Time Limitations Lack of teaching materials	Medium
External Factors	Personal and family issues of learners	Medium
Curriculum Implementation	Covering all required competencies Adapting to diverse learners need	Medium

Essential Resources and Support for Teaching Effectiveness

The resources and support ALS teachers identified as crucial for enhancing their effectiveness, detailed in Table 5, prioritize Professional Development and Instructional Materials as high-priority needs. Based on the survey responses, ALS teachers identified several vital resources, and support needs as crucial for enhancing their effectiveness and promoting lifelong learning among students.

The high prioritization of professional development needs mirrors findings from Guiling et al.'s (2022) bibliometric analysis of ALS research. However, while their study emphasized technology infrastructure as the primary need, our findings suggest that teachers place equal importance on instructional materials and collaborative support. This difference may reflect the evolution of ALS needs since their study, particularly post-pandemic. The emphasis on peer learning opportunities aligns with Merriam and Bierema's (2013) findings about the importance of professional learning communities in adult education settings.

ALS teachers identified a range of resources and support as crucial for enhancing their teaching effectiveness and promoting lifelong learning among students, as revealed through a thematic analysis of survey responses. The most prevalent themes were Professional Development and Instructional Materials, categorized as high-priority needs. Professional Development encompasses a strong desire for training workshops, seminars, specialized training in technology use and managing diverse learners, and mentorship and coaching programs, aligning with Darling-Hammond et al.'s (2017) framework for effective teacher development that emphasizes sustained, content-focused learning opportunities. Equally important, Instructional Materials include high-quality learning modules, activity sheets, and assessment tools, reflecting the need for resources tailored to the unique ALS context, which supports Ramos' (2021) findings that context-specific materials significantly impact learning outcomes in alternative education settings. Technological Resources emerged as a medium-prevalence theme,

highlighting the growing importance of ICT tools, internet connectivity, and educational software in ALS classrooms, consistent with UNESCO's (2018) ICT Competency Framework for Teachers that identifies digital literacy as essential for 21st-century education. Collaborative Support, also of medium prevalence, underscores the value teachers place on peer learning opportunities, community involvement, and parental engagement programs, which Merriam and Bierema (2013) identify as critical components of effective adult learning environments that foster social construction of knowledge.

Table 5

Thematic Analysis of Resources and Support Identified by ALS Teachers as Crucial for Enhancing Teaching Effectiveness and Promoting Lifelong Learning

Theme	Identified Resources and Support	Prevalence
Professional Development	Training Workshops and Seminars Specialized training, e.g., technology use, diverse learners' management, mentorship and coaching program	High
Instructional Materials	High-Quality learning modules Activity sheets Assessment tools	High
Technological Resources	ICT Tools, e.g., computers and tablets Internet connectivity Educational software and application	Medium
Collaborative Support	Peer learning opportunities Community involvement Parental engagement programs	Medium
Infrastructure	Improved learning spaces Access to libraries or resource centers	Low
Administrative Support	Reduced Administrative workload Streamlined reporting processes	Low

Influence of Teaching Experience on Perceived Competencies

The survey data shows how years of teaching experience influence ALS teachers' perceived competencies and professional development needs. However, it is essential to note that the data has some limitations, as many respondents did not specify their years of experience. Table 6 demonstrates how years of teaching experience systematically influence self-perceived competencies, with a clear progression from novice to experienced educators across all competency areas

Table 6

Average Self-Perceived Competency Ratings by Years of Teaching Experience

Competency Area	0-2 years	3-5 years	6-10 years	10+ years
Curriculum planning and development	3.4	3.6	3.8	41.
Assessment and development techniques	3.3	3.5	3.7	4.0
Use of technology in teaching	3.5	3.6	3.8	3.9
Differentiated instruction for diverse learners	3.8	4.0	4.2	4.4

The data in Table 6 reveals a consistent pattern of increasing self-perceived competency with years of experience, with the most pronounced competency gap in curriculum planning (3.4 for novice teachers versus 4.1 for those with over ten years of experience). The observed pattern of increasing self-perceived competency with years of experience supports W. C. Lee et al.'s (2017) findings about teacher efficacy development. However, our results show a more pronounced competency gap in curriculum planning than their study found in traditional education settings. This difference aligns with Arzadon & Nato Jr.'s (2015) observation that ALS teaching requires unique curriculum adaptation skills that develop significantly with experience. Interestingly, the relatively consistent need for technology training across experience levels contradicts Desimone and Garet's (2015) findings that technology needs typically decrease with teaching experience, suggesting that ALS contexts may present unique technological challenges.

Analyzing how demographic factors, particularly years of teaching experience, influence ALS teachers' perceived competencies and professional development needs reveals several interesting trends consistent with established research on teacher development. The data shows a general increase in self-perceived competency across all areas as years of experience increase, aligning with Conway and Clark's (2003) developmental framework of teacher growth, which posits that teacher concerns evolve from self-survival to task management and finally to impact on students. Teachers with 0-2 years of experience tend to rate their competencies lower and express a greater need for basic training in ALS strategies and curriculum implementation, reflecting Huberman's (1989) "survival and discovery" phase of teacher development. Those with 3-5 years of experience show improved confidence and interest in more advanced professional development, corresponding to Berliner's (2004) "advanced beginner" stage where teachers begin to recognize contextual factors in instruction. The 6-10-year group rates their competencies higher, especially in differentiated instruction, and seeks specialized training in technology integration, consistent with Day et al.'s (2007) findings that mid-career teachers focus on expanding instructional repertoires. Teachers with over ten years of experience consistently rate their competencies the highest and focus on staying updated with the latest educational trends, supporting Tsui's (2009) characterization of expert teachers as maintaining currency in pedagogical knowledge. Notably, the competency gap between the least and most experienced teachers is most pronounced in curriculum planning and assessment techniques, which Darling-Hammond and Bransford (2005) identify as complex skills requiring substantial practical experience to master. At the same time, the use of technology shows the most minor variation across experience levels, consistent with Ertmer and Ottenbreit-Leftwich's (2010) observation that technological competency development follows different patterns than other pedagogical skills. Differentiated instruction receives the highest ratings across all experience levels, reflecting Tomlinson's (2014) finding that teachers at all career stages recognize differentiation as central to effective teaching in diverse classrooms.

Implication of the Results and Discussion

Tailored Professional Development

The varying self-perceived competency levels and professional development needs across different experience levels highlight the importance of tailored professional development programs for ALS teachers. This aligns with the findings of Darling-Hammond et al. (2017), who emphasize that effective teacher professional development should be content-focused, incorporate active learning, support collaboration, use models of effective practice, provide coaching and expert support, offer feedback and reflection, and be of sustained duration. For ALS, this could mean developing a tiered professional development system that addresses the specific needs of teachers at different career

stages, ensuring that novice and experienced educators receive targeted support to enhance their teaching effectiveness.

Technology Integration

The consistent need for technology-related training across all experience levels suggests a critical area for improvement in ALS. This reflects the global trend towards digital literacy in education, as UNESCO (2018) highlighted in their report on the ICT Competency Framework for Teachers. Integrating technology effectively into ALS could enhance learner engagement and prepare students for the digital demands of the modern workforce. ALS programs should prioritize the development of teachers' technological competencies, providing training on the use of educational technologies and digital resources that can support diverse learning needs and improve the overall quality of instruction.

Addressing Learner Diversity

The high self-perceived competency in differentiated instruction and the challenges of managing diverse learner backgrounds indicate a need for further support. This aligns with the principles of andragogy outlined by Knowles et al. (2015), which emphasize the importance of recognizing adult learners' diverse experiences and learning needs. ALS programs could benefit from further research and training on effective strategies for managing multi-level classrooms and addressing diverse learning needs. This might include developing specialized modules on differentiated instruction techniques tailored to the ALS context, helping teachers better navigate the complexities of teaching adult learners with varying backgrounds and skill levels.

Enhancing Learner Engagement and Retention

The challenges related to learner attendance, motivation, and retention suggest a need for innovative approaches to engage adult learners. This resonates with the work of (Darling-Hammond, Hyler, & Gardner, 2017; Wlodkowski & Ginsberg, 2017) on enhancing adult motivation to learn. ALS programs could explore strategies such as project-based learning, gamification, and real-world application of skills to increase learner engagement and persistence. By incorporating these evidence-based approaches, ALS teachers can create more dynamic and relevant learning experiences that resonate with adult learners' needs and aspirations, potentially improving attendance rates and overall program completion.

Resource Development

The identified need for better teaching materials and assessment tools suggests an opportunity for targeted resource development in ALS. This aligns with the findings of Ramos (2021), who highlighted the need for context-specific learning materials in ALS. Developing high-quality, ALS-specific resources could significantly enhance teaching effectiveness and learner outcomes. This might involve creating a repository of adaptable learning materials, assessment tools, and teaching guides that cater to the unique needs of ALS learners and the diverse contexts in which ALS programs operate.

Collaborative Learning Environments

The desire for peer learning opportunities and increased community involvement reflects the importance of creating collaborative learning environments. This aligns with the social constructivist approach to adult learning advocated by Merriam and Bierema (2013). ALS programs could benefit from establishing professional learning communities and fostering stronger connections with the broader community. ALS can enhance teacher professional growth and its programs' overall relevance and effectiveness by establishing platforms for teachers to share best practices, collaborate on curriculum development, and engage with community stakeholders.

Policy Implications

The findings have implications for ALS policy, particularly in teacher recruitment, retention, and support. As Cartoneros (2024) suggested, policies that recognize the unique challenges of ALS teaching and provide appropriate support systems are needed. This could include revising teacher preparation programs to include ALS-specific training and establishing career progression pathways for ALS teachers. Additionally, policies should address the resource constraints identified by teachers, ensuring adequate funding for teaching materials, technology, and professional development opportunities.

Continuous Improvement

The evolving professional development needs across different experience levels underscore the importance of fostering a culture of continuous improvement in ALS. This aligns with the concept of schools as learning organizations discussed by Kools and Stoll (2016). ALS programs could benefit from implementing systems for ongoing assessment and improvement of teaching practices. This might involve regular self-assessment exercises, peer review processes, and the integration of feedback mechanisms that allow for continuous refinement of teaching strategies and program delivery.

In conclusion, these implications suggest a need for a comprehensive approach to enhancing ALS teaching and learning. By tackling these areas through targeted interventions, policy reforms, and a commitment to continuous improvement, ALS can work towards providing more effective and engaging learning experiences for adult learners in the Philippines, ultimately contributing to the broader goals of educational access and lifelong learning.

Conclusion

As evidenced by the progression shown in Table 6, ALS teaching requires a distinct skill set that evolves significantly with experience, with self-perceived competencies increasing from satisfactory to substantial across all domains. This research on ALS teachers' competencies and professional development needs reveals several critical insights with far-reaching implications for educational policy and practice. The findings demonstrate that ALS teaching requires a distinct skill set that evolves significantly with experience, as evidenced by the consistent increase in self-perceived competencies among more experienced educators. This progression is not uniform across all domains, suggesting targeted professional development is essential throughout teachers' careers.

The study highlights a fundamental gap between current professional development offerings and the actual needs of ALS teachers. The marked difference in competency levels across experience groups indicates that professional development must evolve alongside teachers' career progression rather than following a standardized approach. This adaptive professional development is particularly crucial in assessment techniques and technology integration, which emerged as universal needs regardless of teaching experience.

The research underscores the interconnected nature of challenges in ALS education. While individual issues such as learner engagement and resource limitations were identified, these challenges form part of a complex ecosystem that requires comprehensive solutions rather than isolated interventions. The finding that collaborative learning strategies (28%) and multimedia resources (26%) are most effective for student engagement points to practical approaches that can be systematically implemented to improve learning outcomes.

Perhaps most significantly, this study reveals that enhancing ALS teaching effectiveness requires a multifaceted approach combining targeted professional development, appropriate resources, and supportive policies. The high rating in differentiated instruction (4.1/5.0) among experienced teachers

indicates that ALS educators develop adaptive expertise through practice, but need structured support in technical areas such as assessment (3.6/5.0) where competency development is less intuitive. The quantitative data presented in Tables 2-6 collectively demonstrates that enhancing ALS teaching effectiveness requires a multifaceted approach, addressing both the technical competencies where teachers scored lowest (assessment at 3.6/5.0) and building upon strengths in areas like differentiated instruction (4.1/5.0).

Recommendations

Based on these findings, several actionable recommendations emerge for policymakers, educational administrators, and training institutions:

Implement a tiered professional development system tailored to teachers' experience levels, with foundational skills training for novice teachers and specialized enhancement opportunities for veterans. This directly addresses the varying competency levels identified across experience groups.

Establish technology resource centers and training programs focusing specifically on digital literacy and educational technology integration. Given the consistent need for technology support across all experience levels, this represents a critical area for investment.

Develop comprehensive support systems for managing learner diversity and implementing flexible learning options. The high prevalence of learner engagement and diversity challenges requires structured approaches rather than leaving teachers to address these issues individually.

Create and distribute ALS-specific instructional materials and assessment tools that are contextually appropriate for alternative learning environments. This addresses the identified resource constraints while building on teachers' strong competency in differentiated instruction.

Establish collaborative learning communities among ALS teachers to facilitate knowledge sharing and peer support. This capitalizes on the finding that collaborative approaches are highly effective while addressing the expressed desire for peer learning opportunities.

Revise teacher preparation programs to include ALS-specific training and establish clear career progression pathways for ALS teachers. This systematic approach will help build a sustainable pipeline of qualified educators equipped to meet the unique challenges of alternative education.

These recommendations, aligned with the study's findings on teacher competencies, effective strategies, implementation challenges, and resource needs, provide a roadmap for strengthening the ALS system. By addressing these areas through coordinated efforts among stakeholders, the quality and effectiveness of alternative education in the Philippines can be significantly enhanced, ultimately improving educational outcomes for the underserved populations that ALS aims to support.

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Abstract

Assessing rabbit manure's potential as a biofuel source for small-scale internal combustion engines was the primary objective of this study. The research utilized rabbit manure as feedstock, which was inoculated with carabao manure. A total of 60 kilograms of rabbit manure was subjected to treatment using a 1:1 water-to-manure ratio with a retention time of 25 days. Additionally, a microbial inoculant comprising 10% carabao manure was incorporated into the digestion process. The design consists of a split-type biogas digester with gasholder storage and a three-stage gas cleaning system, an internal combustion engine connected to a DC generator, and a simple lighting circuit. Findings indicated that the pH level recorded at 7.75 resulted in alkalinity which helped the biogas production by preventing the slurry from acidity. The total dissolved solids (TDS) were recorded at 3137 ppm, and it increased to 6980 ppm. For the performance evaluation in fueling the engine using biogas, the engine operated for 80 seconds and generates an average power of 31.66 watts.

Keywords: *bioenergy, rabbit manure, small internal combustion engine, water quality*

Introduction

The Philippines' economy and population are becoming bigger, putting pressure on the country's energy supply, as it solely depends on imported fossil fuels. Much like the rest of the globe, the Philippines must decide whether to continue relying on imported fossil fuels or to increase its renewable energy technologies (Lloyd & Nakamura, 2022). The intense pressure and practical development for optimizing bio-green technologies have become a solution for rising renewable energy. Agriculture is the main industry in the Philippines, which produces a significant amount of agricultural waste. In rural areas where farming is a primary source of income and energy is scarce due to limited or unreliable grid connectivity to fully extend the power in rural households, the Biofuels Law of the Republic Act 9367, encourages the use of bio-based fuel sources as an alternative fuel. It offers the potential to create a locally sourced renewable energy within the rural areas and to reduce community reliance on fossil fuels. The available technology to utilize the agricultural waste was the biogas; a mixture of gases by breaking down organic matter without oxygen, consisting of specific quantities of methane and other chemical compositions (Mattocks, 1984). Biogas is a good alternative source of energy for internal combustion engines due to its increased mixing ability with air, clean-burning nature, and high-octane number that resists knocking (Kukoyi et al., 2015).

According to Adewuyi et al. (2019), numerous livestock and poultry animals are being raised in the Philippines; these include carabao, chicken, cattle, pigs, sheep, goats, and ducks. Economically, these animals are raised on a small and large scales, and their waste or manure commonly utilized as fertilizer through direct application. Another classified source of livestock manure is the rabbit, a herbivorous animal that feeds on grasses. Rabbits have been found to exhibit growth and reproductive performance under Philippine conditions that are comparable to those in other tropical countries (Alejo & Nicolas, 2021). One of the research thrusts of the Bulacan Agricultural State College (BASC) is to advance studies on the rabbit industry, which is emerging as a growing livestock sector in the Philippines.

As the production of rabbits increases, their waste will contribute to the waste-to-energy solutions making it sustainable for the farmers. In recent years, researchers have conducted studies to determine the biogas production potential of various livestock animals; however, there is a lack of studies assessing the capability of rabbit manure and duck manure. According to Liangwei et al. (2010), rabbit manure has biogas potential per cubic meter of the kilogram in the total solids under normal conditions which is comparable to duck manure at 0.082 and 0.098, respectively. Another researcher states that the methane potential of rabbit manure was the highest among duck and horse manure in terms of liter per kilogram of volatile solids (Perez et. al., 2021) under mesophilic conditions, which the biochemical methane potential of rabbit manure (325.53±1.9 L/kg of VS) was the highest among horse manure (245.20±3.8 L/kg of VS) and goat manure (111.88±13.2 L/kg of VS). In line with this, the researcher is trying to prove the statement in the Philippine setting, that provides insight to support and expand the use of bio-based green technologies while promotes rabbit farming.

In biogas production, direct thermal application-such as cooking, and industrial heating- are commonly used at the small scale. In the Philippines, research on compressing biogas for use in power machinery is still in progress. A review of the literature revealed that only a few studies have explored the use of compressed biogas in internal combustion engine though these have shown successful outcomes (Hernandez & Villanueva, 2017). Consequently, using biogas as fuel for power generation (e.g., mechanical, or electrical) remains uncommon at the small-scale. Therefore, the researcher intends to develop a biogas system for generating power using rabbit manure as feedstock in a small-scale set-up.

Generally, the study aimed to design, fabricate, and evaluate a biogas digester using rabbit manure as feedstock. Specifically, it aimed to: (a) design and fabricate a split-type biogas digester; (b) determine the water quality of rabbit slurry inoculated with carabao manure; and, (c) determine the biogas capability as fuel in running the 4-stroke small internal combustion engine. If proven effective, the attempt to harness rabbit manure as a fuel source for biogas power generation may help the country to decrease its reliance on fossil fuels.

Materials and Methods

Design and Fabrication

Design Set-up

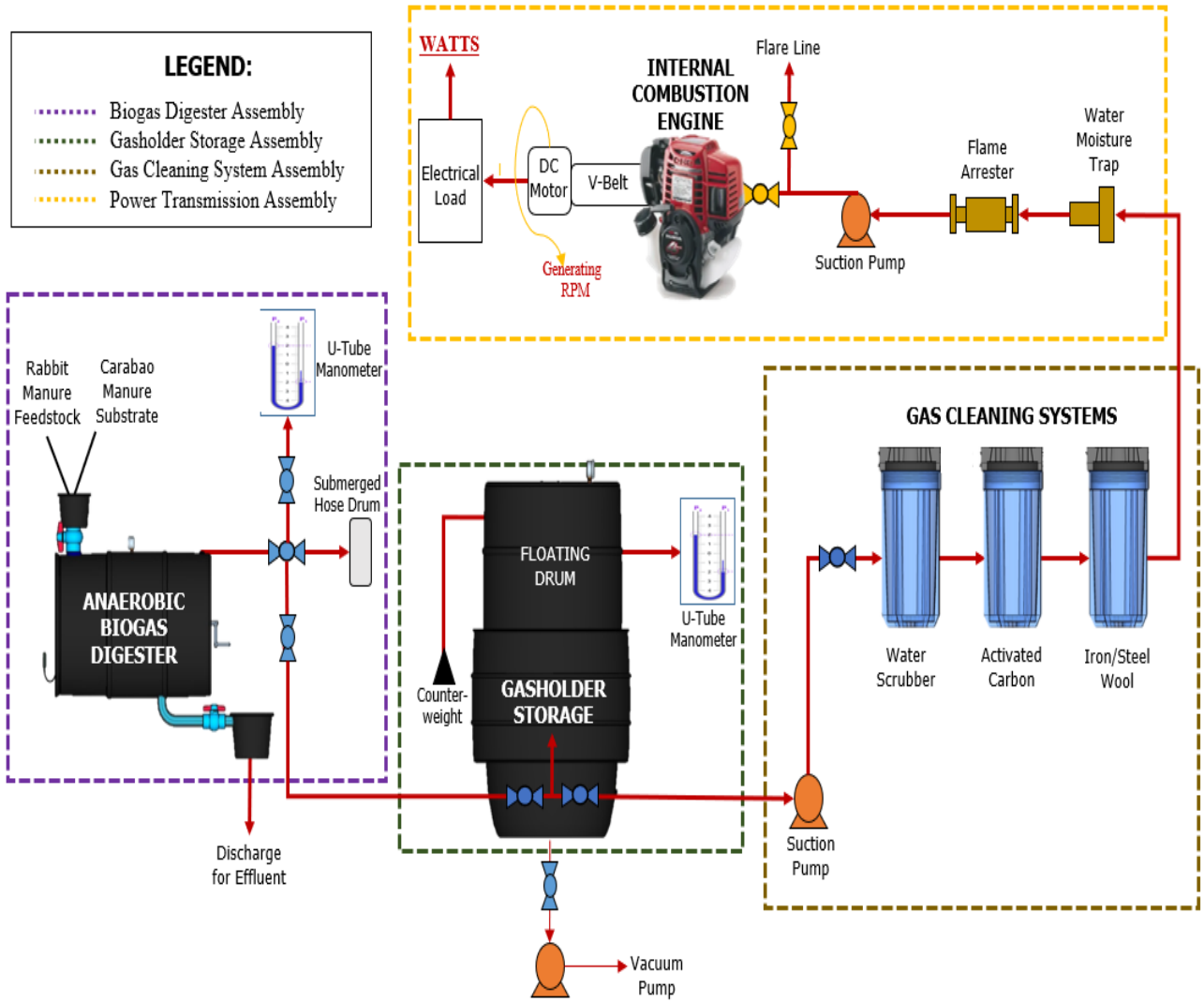
The schematic setup presents a visual representation of the study's flow of operation. Starting from the biogas digester assembly which was responsible for the generation of biogas. Usually, the biogas digester is constructed with brick masonry, stone masonry, ferro-cement, mild steel sheet, and fiber-reinforced plastic (Bai & Kumar, 2005). Thus, plastic has been widely used as it is non-corrosive, good insulators, cheaper, and easy to fabricate and maintain. The gasholder storage assembly was needed to control and store the generated raw biogas. It also used high-density polyethylene (HDPE) drum, as low-pressure holders-typically under 10 kilopascals-are commonly adopted for stability when

utilizing biogas for power generation (Bharate et al., 2020).

The gas cleaning systems was designed to filter and purify raw biogas. While it primarily consists of methane and carbon dioxide, it may also contain small amounts of impurities. These impurities can affect the engine for biogas utilization by causing corrosion and mechanical wear problems. Therefore, biogas must be purified to meet relevant standards and requirements before use (Deng, Wang, & Yi, 2020). Lastly, the power transmission assembly's main function is to convert the clean biogas into mechanical power using an internal combustion engine and then transform it into electrical power, as shown in Figure 1.

Figure 1

Schematic Diagram of the Study



Principle of Operation

Anaerobic digestion (AD) is a bacterial process in which organic carbon is transformed to its most oxidized state, CO_2, and its most reduced form, CH_4, via a series of oxidations and reductions. (Angelidaki & Kougias, 2018). The digestion process encompasses four stages: hydrolysis, acidogenesis,

acetogenesis, and methanogenesis, and the organism involved in each step is categorized as hydrolyzer, acidogen, acetogen, and methanogen, respectively (Divya et al., 2014). The methanogenic bacteria produced methane and carbon dioxide from the acetates and hydrogen by the methanogenesis process (Gerardi, 2003). A week later, the raw biogas can be transferred to its gasholder storage by opening the valve as methanogens starts to occur (Angelidaki & Kougias, 2018). The slurry temperature and system pressure are monitored over the 25 days retention time.

Design Consideration

The internal combustion engine must have the smallest displacement (cubic centimeter) available. The piston displacement was considered for choosing an engine as it determined how much fuel it could intake in the combustion chamber. The smaller the piston displacement, the less fuel the engine can intake, which consequently results in less air required for combustion. The engine was a Honda GX35T with 35.8 cubic centimeters of piston displacement that had a 4-stroke, single-cylinder gasoline engine. The gas must be purified so that it is compatible with the engine. A locally available small electric air pump was needed to suction out the store biogas in the gasholder storage, as well to deliver the purified biogas continuously to the engine without knocking. To prevent the backfire of the biogas, flare line was installed together with water moisture trap before delivering the purified biogas to engine. The importance of these installations is to prevent mechanical damage to the carburetor, which may occur due to biogas containing roughly 40% hydrogen and 60% methane when used for power generation (Mattocks, 1984).

The size of the digester was selected from the locally available drum size. The biogas production potential data for rabbit manure was the basis for the calculation of the biogas in terms of gas production. Table 1 presents the design data and parameters needed for sizing the biogas digester.

Table 1

Design Data and Parameters

Design Requirements	Data Requirements	References
Average Rabbit Manure Weight	0.039 kg	Gerardi (2003)
Rabbit Manure Total Solids	30%	Al Seadi et al, (2008)
Rabbit Manure Volatile Solids	66% of TS	
Biogas Production Potential for Rabbit Manure @ 25°C ± 1°C	0.174 m^3/kg	Liangwei et al. (2010)
Density of Rabbit Manure	950 kg/m^3	Gerardi (2003)
Density of Water	1000 kg/m^3	PAES 414-1 (2002)
Mesophilic Temperature	38°C	Kangle & Kore, (2014)
Volume Ratio of Solid to Gas	7:3	IRENA (2016)
Manure to Water Mixing Ratio	1:1	PAES 413 (2001)
Biogas Consumption of Gasoline Engine @ rated kW	0.398 m^3/hr.	Tambong, (1992)

Parts and Assembly

The biogas digester was responsible for the anaerobic digestion process. Since the gas comes with impurities, it must undergo a series of gas cleaning and conditioning processes. The engine also requires a stable amount of biogas, and a gasholder storage was needed as shown in Figure 2.

The batch-type biogas digester tank was made up of a 200-liter standard-size high-density polyethylene plastic drum. The feed funnel serves as the point of entry for the slurry, which later falls through the inlet tube. A stainless agitator was also inserted to prevent scum formation. The dimensions of the frame for the biogas digester were determined based on the size of the drum and its braces were

positioned along the sides of the frame to reduce the drum's movement. The inlet funnel was also supported by a U-bolt attached to an angle bar. The temperature gauge measured the temperature occurring within the digester and gasholder. A probe temperature was installed to measure the temperature of the slurry in the digester. A U-tube manometer was used to monitor daily pressure changes for safety purposes. The biogas produced was then pumped to the gas cleaning and conditioning assembly, shown in Figure 3.

Figure 2

Main Assembly

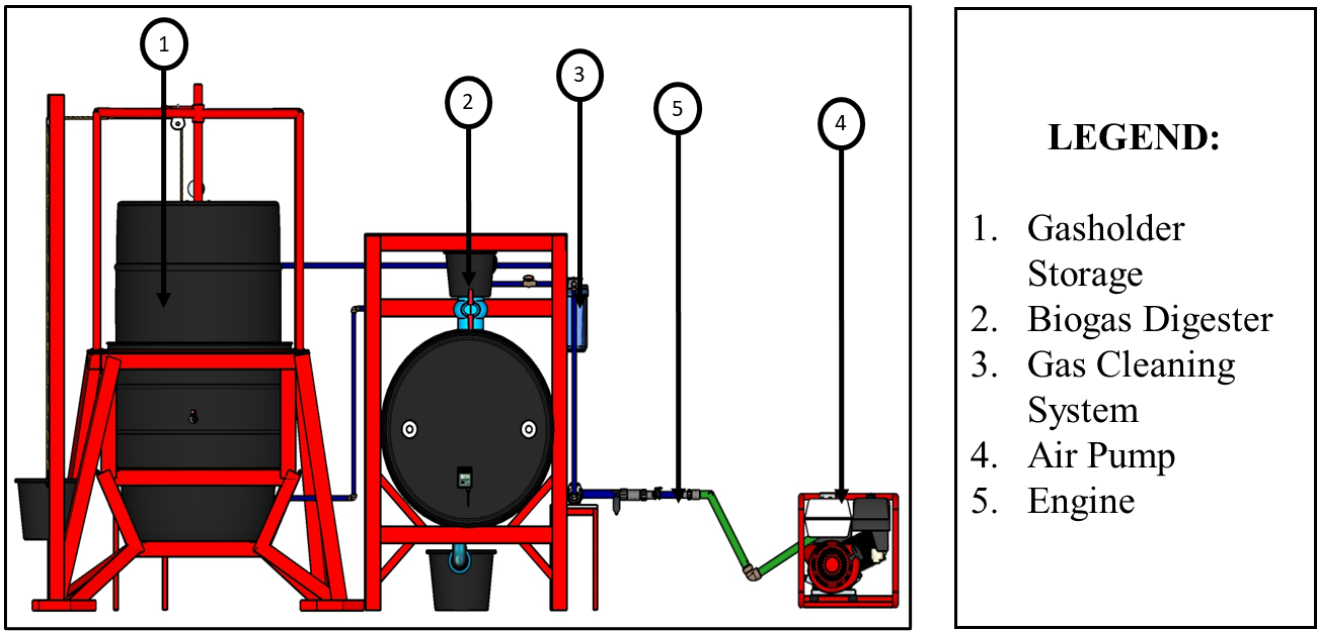
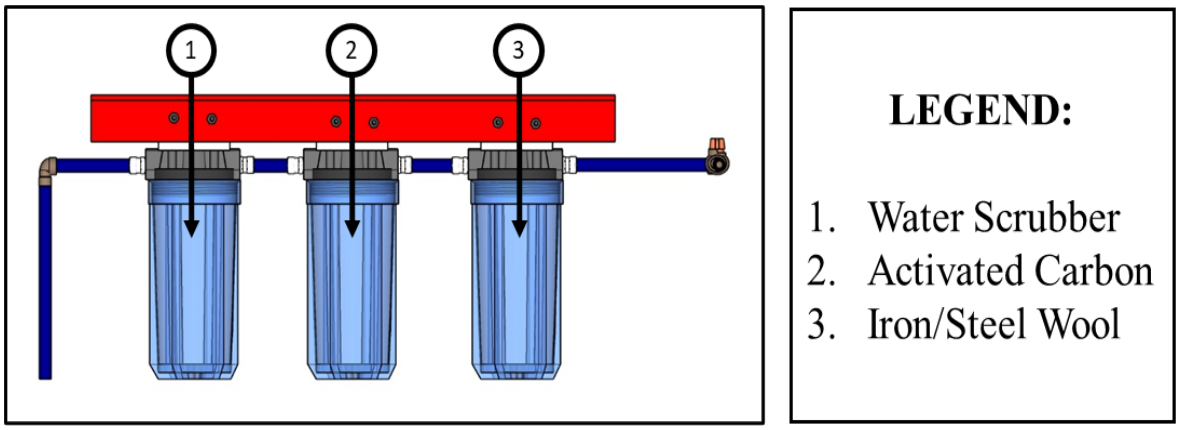


Figure 3

Gas Cleaning Assembly



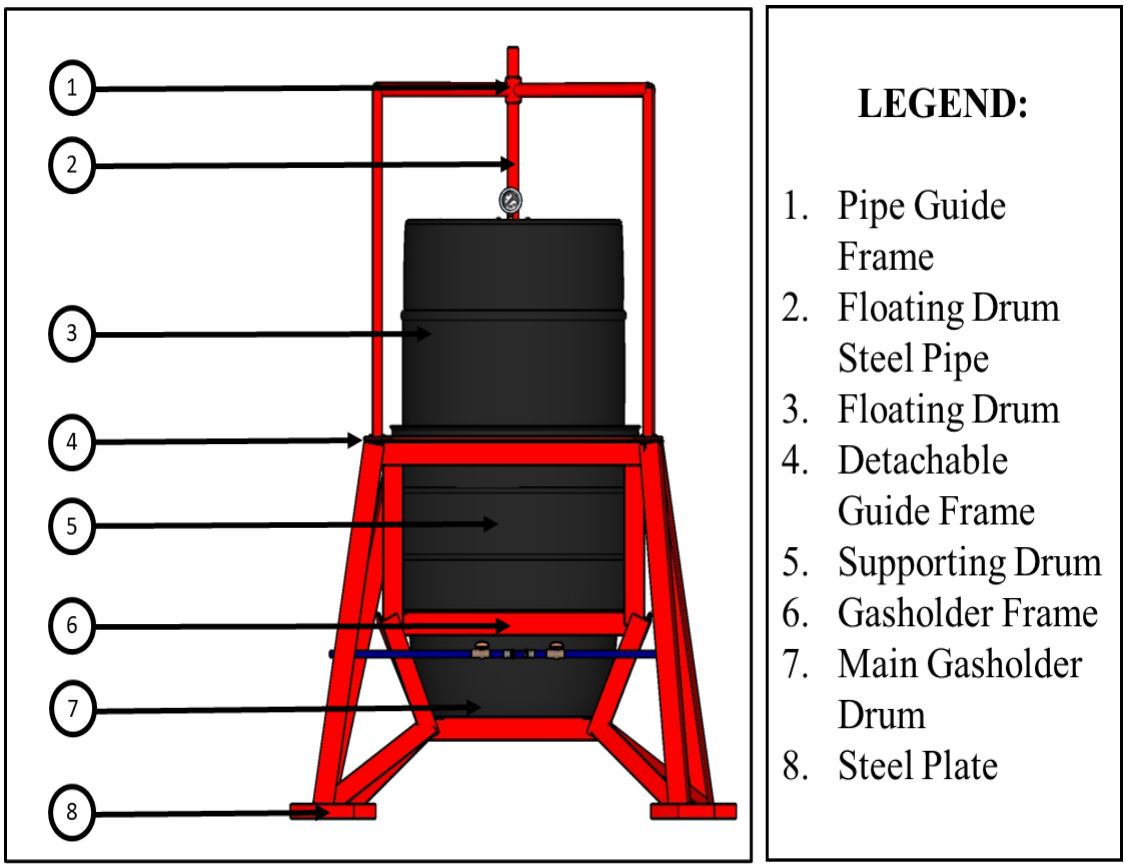
The water scrubber was intended to remove carbon dioxide for biogas upgrading and remove the saturated vapor of the raw biogas. The gas then passes through the second filter which is an activated carbon; a material that removes moisture and remaining impurities. It comprised a ½-inch Solutherm water filter, a ½-inch blue PVC pipe, a male adaptor, and a supporting frame for the water filter. The water filter was connected to an 8mm x 25mm stainless steel bolt with washer and knots. The procedure for sealing the digester pipelines and fittings involved the use of Teflon and PVC cement. Lastly, the gas

entered the third filter with an iron/steel wool to remove hydrogen sulfide and abrasive properties.

The gasholder storage has a total capacity of 360 liters which has a support guide frame to provide alignment for the floating drum. A meter line was put in place to assess the height of the gasholder drum. To optimize the thermal conditions for the microbial community, the drums were coated with enamel black paint and red oxide to its frame. The support guide frame provided alignment to the floating drum, which was attached to the movable frame. The steel plate was attached to the drum using four bolts, and a steel pipe was inserted into the guide frame. The guide frame's detachability was achieved through an 8mm x 25mm black iron bolt, with a washer and knots, which was affixed to the primary frame of the gasholder. The floating drum was equipped with a supporting drum that consisted of a 1/2-inch blue PVC ball valve to discharge the digestate. A 1/2-inch blue PVC ball valve was installed beneath the gasholder storage to vacuum the air inside the gasholder. The circular flat bar was formed to the supporting drum as it provides support during the biogas generation. The construction of the gasholder frame involves using 1/4 x 1-1/2-inch angle bars, while the guide frame comprises 1/2 x 3/4-inch black iron pipe. A 1/2 x 1/2-inch squared steel plate was the foundation for the gasholder frame. The researcher installed a U-tube manometer and temperature gauge to assess the pressure and temperature within the retention time while, a digital thermo-hygrometer was also used to monitor the outdoor conditions of the system such as ambient temperature and relative humidity. The design setup was shown in Figure 4.

Figure 4

Gasholder Storage Assembly



Slurry and Substrate Preparation

The fresh rabbit manure was collected from the College of Agriculture Rabbitry Demo Farm in Bulacan Agricultural State College, Pinaod, San Ildefonso, Bulacan. Before being loaded into the

digester, the material underwent size reduction through mechanical means to enhance the surface area for reaction. After reducing the manure's size, the foreign materials including paragrass, sawdust, rabbit fur, and other unrelated materials, were manually removed shown in Figure 5a.

Figure 5

Rabbit Manure Pre-Treatment: (a) manually removal of foreign materials, (b) manually feeding the digester

(a) (b)

A total of 135 liters of rabbit slurry mixed with substrate were subjected to treatment in a biogas digester. Carabao manure was utilized as an inoculant to enhance the performance of the biogas digester. The mixture comprised 60 liters of rabbit manure and 60 liters of water, and a carabao microbial inoculant of 15 liters was manually fed in the digester as shown in Figure 5b.

Water Quality Analysis

The water quality analysis was performed before and after the biogas production. The pH value expresses the acid concentration in aqueous systems. It should be presented as fewer than seven acid solutions while alkaline solutions are higher than seven. For the acetic acid decomposer bacteria to grow and develop properly, neutral pH promotes the growth of methane bacteria (methanogens), which has an impact on the biogas produced (Astuti et al, 2014). The study used a water quality tester that can quantify the pH level and total dissolved solids.

Engine Evaluation

Engine Generator Set-up and Retrofitting

A 24-volt DC motor running at 500 RPM was connected to an internal combustion engine. An engine with an idle speed of 3,100 rpm can power the DC motor. The transmission system was fabricated at the engineering machine shop, as shown in Figure 6a. The DC generator's design pitch diameter was 4 inches, while the engine pulley had a diameter of 2 inches with an A-single sieve belt 25 inches in length.

The carburetor was modified by incorporating a new biogas line. The connection used a 1/4-inch

x 2-inch G.I. nipple, a 1/4-inch tee, and a 1/4-inch brass valve for the fitting as shown in Figure 6b.

Figure 6.

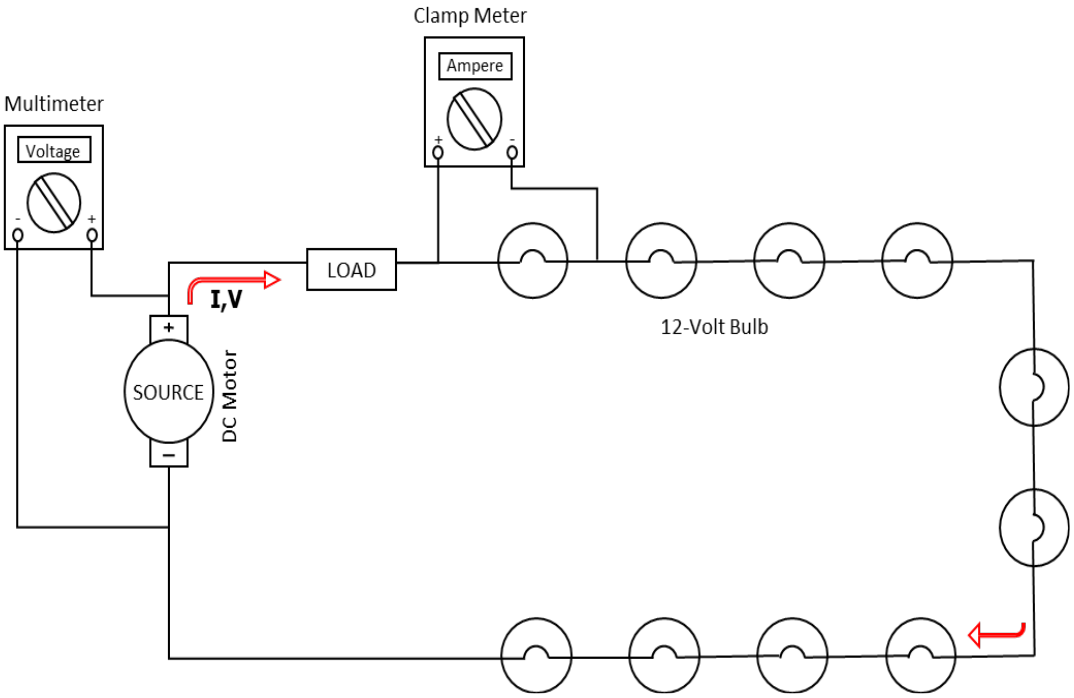
Engine Generator: (a) engine set-up with transmission system, (b) retrofitting

(a) (b)

Electrical Load

Figure 7.

Schematic Electrical Circuit Set-up



Before the operation of biogas, an electrical load was needed to ensure the flow of the current and voltage across the series circuit was working. The study used a 500 revolution per minute (RPM) of DC motor to produce electrical power which was subsequently distributed to a load side consisting of a 12-volt bulb. In the series circuit, the load side was measured using a clamp meter. The positive probe

of the clamp meter was attached to the connection, while the negative probe was attached to the bulb's connection to measure the current flowing through it. On the other hand, the multimeter's negative probe was attached to the source's ground line and, the positive probe connected to the circuit's load side, both of which were used to measure the voltage being distributed. The voltage output was recorded using a digital multimeter and clamp meter for the amperage as shown in Figure 7.

Engine Test Procedure

Figure 8

Engine test instrument set-up with simple lighting circuit.

The procedure for the evaluation of internal combustion engine performance for fueling the biogas started by ensuring all connections and fittings in the gasholder storage and gas cleaning system were intact, connecting the standard gas hose to the flame arrester line along with the air pump. Next, the electrical circuits were prepared and connected to a digital multimeter, which was then linked to the DC motor wires. To see if the multimeter detects the voltage and ampere flowing to it, the internal combustion engine was running, and checked if bulbs were all working.

While the engine was running, the biogas flare valve was monitored to see if a flame appeared. If so, gradually open the engine's retrofit valve line to slowly mix the biogas with air for its combustion process. In case of an unforeseen situation during the testing evaluation, a fire extinguisher was also taken into consideration as shown in Figure 8. Then, wait till the engine stops and start data analysis.

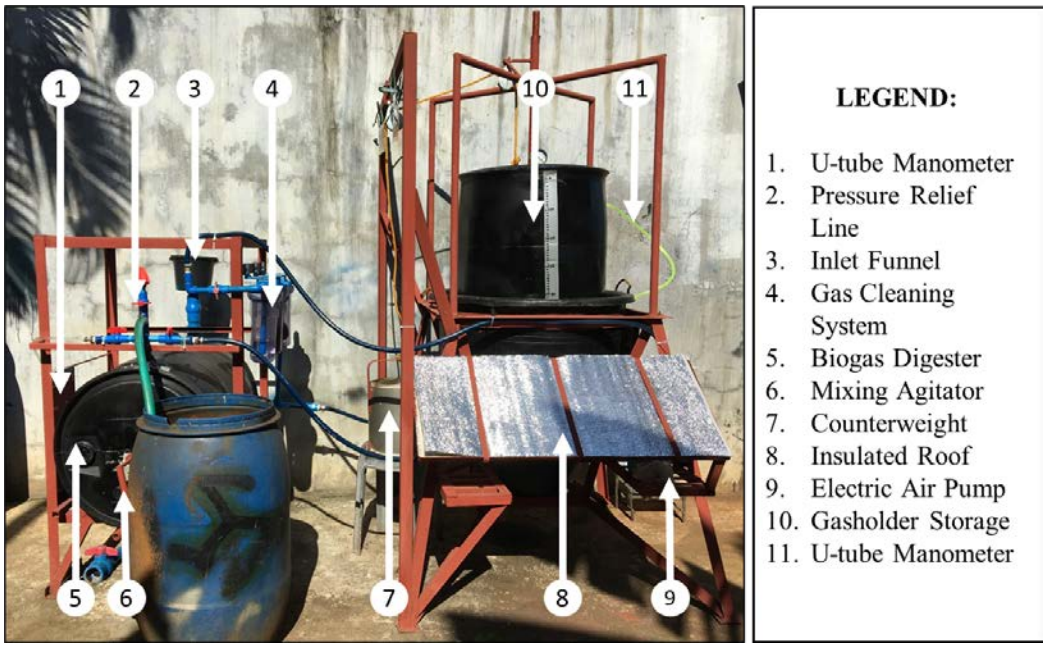
Results and Discussion

Design and Fabrication

The design fabricated setup presented in Figure 9 includes a biogas digester U-tube manometer, pressure relief line, inlet funnel, gasholder storage, gas cleaning system, electric air pump, and gasholder U-tube manometer. Insulated roof installation was also considered, as the air pump may be exposed to direct sunlight, leading to damage. The study also took into account the following: a counterweight with a pulley to ease the floating drum's movement when biogas production occurs; a pressure relief line drum as a safety precaution to ascertain whether biogas was generated through air bubbles; and a mixing agitator with the potential to prevent slurry in the scum formation.

Figure 9

Fabricated Set-up



Water Quality Analysis

The initial total dissolved solid (TDS) results were 3137 parts per million (ppm), and it increased to 6980 ppm measured using a water quality tester as shown in Table 2. The increase difference of 3843 ppm means that there was an increase in TDS. According to Zwain (2019), this could be due to the thermal environment for the rapid breaking down of the accumulated solids in the digester. The study recorded the daily digester temperature of 60°C from 10:00 am to 2:00 pm, indicating that it falls within the thermophilic temperature range. Another study by Ferrer et al. (2008) observed a similar finding in which TDS concentration increased after thermal pre-treatment of sludge at 70°C and the ability to dissolve organic compounds under thermophilic conditions resulted in a nearly tenfold increase in dissolved solids. The presence of toxic and harmful chemicals in the slurry suggests that it may not be suitable for direct application to soil. Prior treatment may be necessary.

Table 2

Water Quality Analysis

	Before Loading	After Loading	Result/Average Reduction Rate
pH Level	6.83	7.75	7.14
Total Dissolved Solids (parts per million)	3137	6980	-122.50

A pH value of 6.83 was obtained before, and after being treated with biogas for 25 cumulative days, the pH level increased to 7.75. The experiment of Astuti et al. (2013), demonstrated that methanogenic bacteria work best in a pH range of 7.5-8.3.

System Condition Observation

As highlighted in Table 3, which falls within the optimal range for mesophilic bacterial growth, according to Cheng et al., (2013). Mesophilic bacteria typically perform well at temperatures between

28°C and 45°C, indicating active production of methanogenic bacteria. Furthermore, Sarong et al. (2016) reported a reduction in CO_2 and N_2 concentrations at 45°C, which supports the growth of methanogens and Methanobacterium.

Table 3

Slurry Temperature Reading

Slurry Temperature Reading											
Day	7am	8am	9am	10am	11am	12nn	1pm	2pm	3pm	4pm	5pm
1	27.5	27.0	26.3	21.7	30.0	29.8	30.6	31.3	31.2	30.8	30.6
2	26.3	25.2	23.8	29.2	29.9	30.2	30.1	30.2	31.1	30.5	30.7
3	25.9	24.7	22.4	20.1	30.6	31.6	31.5	30.9	32.3	32.3	31.5
4	27.3	26.8	26.7	27.0	28.5	28.4	28.5	28.4	29.9	30.2	29.9
5	25.9	26.4	22.1	22.7	22.6	31.5	31.7	32.1	31.7	31.7	31.9
6	28.1	27.4	28.3	29.1	30.5	28.4	29.4	31.1	31.3	31.3	30.8
7	25.4	24.1	20.3	24.7	28.2	29.6	31.9	32.1	33.1	32.5	33.1
8	25.3	24.9	21.8	26.5	29.4	29.6	32.3	32.8	31.3	32.7	32.4
9	26.5	25.4	22.1	28.3	30.1	31.6	32.6	33.5	33.2	33.3	32.9
10	26.4	25.2	22.4	22.9	30.7	31.8	33.1	33.2	33.8	33.1	32.3
11	26.1	25.2	23.4	26.3	30.6	31.8	32.9	34.1	34.3	31.7	30.5
12	26.8	26.9	27.8	28.2	30.1	31.9	34.4	34.5	34.1	33.4	32.9
13	26.9	26.1	23.7	26.9	30.3	31.4	33.5	33.7	34.3	33.6	33.4
14	26.5	25.4	23.5	26.2	28.3	28.3	30.2	34.5	33.1	34.6	31.5
15	27.1	26.2	23.1	26.3	30.7	31.6	35.5	35.4	36.1	34.2	33.6
16	28.2	27.2	24.3	29.3	30.4	33.4	35.7	36.3	35.1	35.4	35.2
17	26.3	28.3	23.5	29.1	32.8	34.2	33.1	36.7	35.7	35.2	34.7
18	29.2	29.1	26.7	31.2	32.2	33.7	35.8	35.6	34.9	35.1	34.6
19	27.6	27.8	28.0	28.1	32.8	34.4	36.0	35.6	36.0	36.4	35.8
20	28.2	27.6	28.8	31.3	33.7	35.7	35.8	36.7	32.2	35.1	34.4
21	27.9	27.8	26.7	29.6	32.2	34.5	35.3	36.0	36.2	36.3	35.6
22	28.3	27.7	27.2	30.1	31.9	32.6	33.2	34.3	35.3	34.9	34.3
23	26.6	26.9	25.8	25.3	28.3	33.7	42.8	36.2	36.4	35.8	35.7
24	29.3	28.6	28.9	27.5	28.3	34.9	35.7	36.5	36.2	35.1	35.8
25	28.2	27.6	28.8	31.3	33.7	35.7	35.8	36.7	32.2	35.1	34.4

Figure 10

Post-observation: (a) water went down in the floating drum, (b) drum was flattened and, (c) negative pressure in gasholder

(a) (b) (c)

As illustrated in Figure 10a, the gasholder underwent flattening, resulting in the decrease of water from the floating drum yet, one of the advantages of HDPE drums is their economic and versatile nature with regards to deformation. The observed condition can be attributed to the quantity of biogas that was being drawn into the gas cleaning systems indicated in Figure 10b. As shown in Figure 10c, the pressure reading of the gasholder became negative due to the depletion of most of its gas.

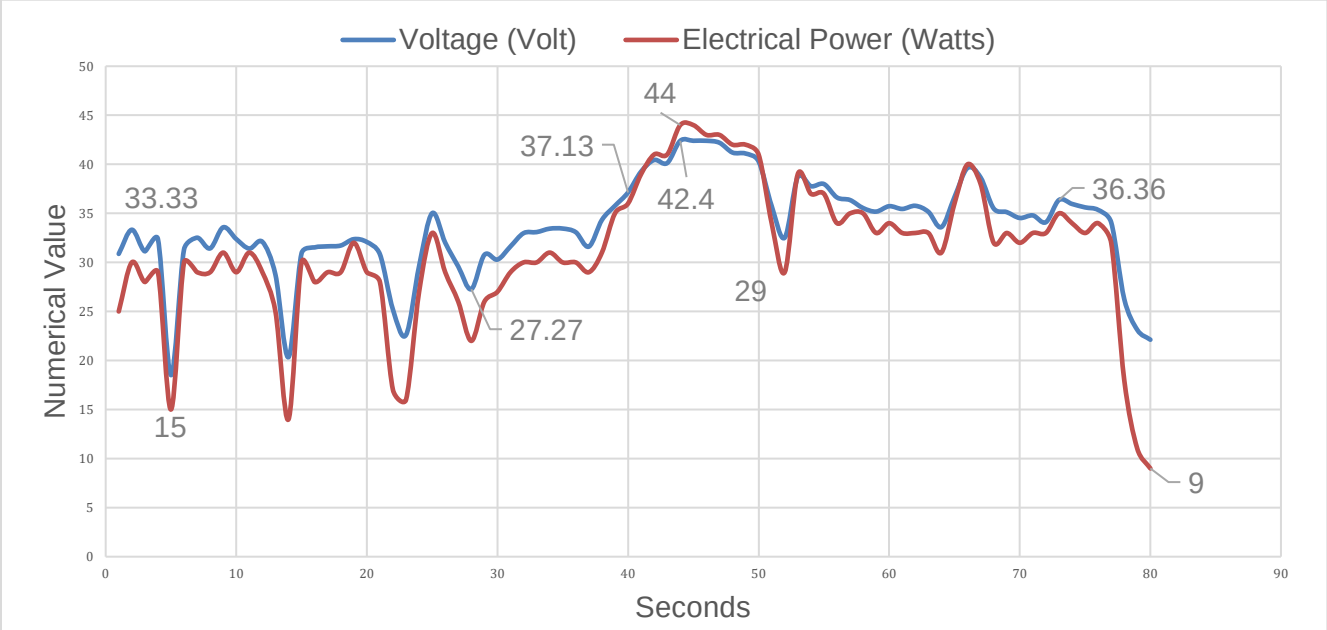
Engine Performance

The results indicated that during the trial, a voltage of 33.33 volts was supplied and a voltage drop of 15 volts occurred within 5 seconds of running. However, it was observed that the voltage dropped to 27.27 volts and then gradually increased to 37.13 volts over a period of 40 seconds, and a continuous increase in voltage to 42.40 volts. Hence, the generated average power was recorded at 44 watts in 45 seconds of runtime as it stopped generating at 9 watts in 80 seconds as shown in Figure 11.

The observed increase in power can be attributed to the higher energy input from the combustion of biogas in the engine. According to Bora et. al. (2014), it explains that as the biogas flows inside the combustion chamber, the engine speed increases due to the additional energy that biogas has. At that point, the electrical power from the circuit abruptly stopped. Based on the observation, this occurred because the biogas had been fully consumed. The combustion of the biogas inside the engine was operational until the engine shuts down at approximately 80 seconds. From the study of Kukoyi et al. (2015), excessive air intake during biogas combustion in internal combustion engines (ICE's) was a potential cause of reduced engine efficiency and concerns regarding biogas air to fuel intake for spark ignition engines.

Figure 11

Electrical Output Profile



Conclusion

The biogas can significantly contribute to the increasing demand for renewable energy as rabbit slurry, when used as feedstock inoculated with carabao manure, had the potential to fuel a 4-stroke small internal combustion engine. The designed split-type biogas digester with gasholder storage was effective

in producing biogas with rabbit manure as its feedstock. The piston displacement rate equation was considered in choosing the internal combustion engine's 35.8 cm^3 piston displacement. Blue flames were observed during biogas flaring, indicates the complete combustion of methane and carbon dioxide. The electrical output was recorded at a current of 0.928 amperes and supplied a peak voltage of 42.40 volts, which generated an average power of 31.66 watts at 80 seconds of run time.

With this finding, when a rabbit farm has 60 kilograms of rabbit manure, which is subjected to biogas production at 25 days of retention time, it can provide mechanical power of at least 32 watts and can scale up the system to explore the possibility of harnessing the rabbit manure towards power generation.

Recommendations

Future studies may investigate different mixing ratios of rabbit manure with a microbial substrate to quantify the most efficient inoculant. The design setup could incorporate new feedstock for biogas generation. In terms of the air-to-fuel ratio for fueling the biogas in an internal combustion engine, it is crucial to determine the optimal air-to-fuel ratio for efficient combustion within the combustion chamber. Additionally, a gas analysis should be conducted to characterize the biogas, specifically to quantify the levels of methane and carbon dioxide it generates.

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Assessment of the Intervention Design and Benefits of Sustainable Land Resource Management Approach (SLRMA) on Corn Farmers in Ilagan City, Isabela, Philippines

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Abstract

Sustainable farming systems have been acknowledged as an approach that balances the production of food and preservation of the environment. It involves practices that protect natural ecosystems such as soil conservation and water management, while also supporting the long-term economic viability for the farmers. To promote sustainable agriculture, various soil conservation technologies were introduced to corn farmers in Ilagan City, Isabela, Philippines through Sustainable Land Resource Management Approach (SLRMA). This study aimed to assess the intervention design and benefits of SLRMA to the 49 farmer-beneficiaries using the collected data on contour farming systems, crop diversification, training, and challenges encountered. A quantitative research design was utilized, incorporating descriptive and comparative approaches to examine and interpret the collected data. The analysis was focused on changes in production and profit before and after the implementation of SLRMA, using paired t-tests to compare these variables. Results revealed that SLRMA has had a positive and significant effect on farming practices and livelihoods, particularly for those with 2 to 5 years of participation. These beneficiaries experienced increased income, improved farming practices, and enhanced land productivity, including reduced soil erosion, restored cultivation areas, and higher crop yields. Beneficiaries with 5 years of involvement saw significant increases in ROI (from 16.54% to 147.81%), net income (from PhP5,504.45 to PhP45,724.45), and overall income (from PhP42,979.35 to PhP94,095.64). Similarly, 4-year, 3-year, and 2-year participants experienced notable improvements in ROI, net income, and overall income, with significant statistical results. On the other hand, only minimal changes with no significant impact on ROI and net income in the production were observed with 1-year participants. The study found that prolonged participation in the program was associated with higher income, but further analysis using more robust statistical methods is needed to determine the actual drivers of income changes. Based on the findings, recommendations include provision of additional support on manpower or financial assistance on the first year to ensure crop survival; evaluation of the suitability of the research design and methodologies employed for future researches; and formulation and implementation of strategic adaptation and upscaling plan for the SLRMA.

Keywords: *Contour Farming Systems, Corn Farmers, Crop Diversification, Soil Erosion, Sustainable Land Resource Management*

Introduction

With the Philippines' continuous growing population, conversion of agricultural lands into industrial, housing, and other facilities also continue to increase. With the decrease of arable areas in the lowland, people are forced to cultivate upland areas for food and feed production without considering the negative impact on the environment such as soil erosion and land degradation. Sustainable farming systems are increasingly recognized to address these issues. A sustainable farming system is an approach that balances the production of food and preservation of the environment. It involves practices that protect natural ecosystems such as soil conservation and water management, while also supporting the long-term economic viability for the farmers.

To help the farmers have a sustainable farming system that enhances productivity and increases income, the Bureau of Soils and Water Management (BSWM) through its Soil Conservation and Management Division (SCMD) promotes Sustainable Land Resource Management Approach (SLRMA) in sloping areas cultivated with corn crops. SLRMA is defined as a paradigm in managing upland areas for optimum and sustained agricultural production while restoring ecological balance for the benefit of most of the population (BSWM, 2019). Central to SLRMA are the key objectives of improving farmers' productivity and boosting their income through sustainable practices and appropriate technologies that prolong soil fertility. Project implementation involved the establishment of 20-hectare community-managed pilot farms in selected corn and cassava growing provinces of the country considered hot spots for land degradation - Ifugao, Isabela, Camarines Sur, Capiz, Zamboanga del Norte, and Bukidnon. To support the project's growth and successful expansion to 120 hectares, a four-year plan was implemented to provide assistance and resources to new areas, adding 20 hectares per site each year until 2023. However, the program's support was limited to the provision of planting materials, fertilizers, and basic tools for weeding and irrigation. Highlights of the approach include the application of contour farming systems to reduce soil erosion; crop diversification to increase source of income; and specialized capability enhancement training to capacitate the farmers in Sustainable Land Management (SLM).

Ilagan City, Isabela, being the Corn Capital of the Philippines, was strategically chosen to be one of the pilot sites for SLRMA due to its significant role in national corn production. According to the Philippine Statistics Authority (2022), Isabela has a total land area of 600,000 ha in which a great percentage of it is devoted to corn farming. In 2020 and 2021, the province produced 1,115,514 metric tons and 1,080,653 metric tons of corn, respectively, highlighting its importance to the agricultural economy. However, local farmers commonly engage in monocropping wherein they plant corn repeatedly over multiple seasons or years, which leaves them vulnerable to multiple risks such as typhoons, pest infestations, plant diseases, and the increasing cost and price volatility of farm inputs and outputs. These challenges underscore the need for sustainable interventions like SLRMA, which promotes contour farming systems, crop diversification, and other conservation practices aimed at building resilience and ensuring long-term land productivity.

This study assessed the design and implementation effectiveness of the training program under SLRMA, with particular emphasis on enhancing farmer knowledge and skills in sustainable farming practices. It also assessed the benefits gained from adopting contour farming systems and crop diversification, focusing on their contributions to environmental sustainability and agricultural productivity. Furthermore, the study analyzed the economic outcomes of SLRMA in terms of net income and ROI. Lastly, it identified problems encountered and lessons learned throughout the implementation process to support the continuous improvement of future sustainable land management initiatives.

Materials and Methods

A quantitative research design was utilized, incorporating descriptive and comparative approaches to examine and interpret the collected data. The data included contour farming systems, crop diversification, training, and challenges encountered by the SLRMA farmer-beneficiaries. The analysis focused on changes in production and profit before and after the implementation of SLRMA, using paired t-tests to compare these variables.

The respondents were the farmer-beneficiaries of the SLRMA in Ilagan City, Isabela, Philippines from 2019 to 2023. Having a limited number of farmer-beneficiaries for each year, the entire population served as the participants of the study. The research interview was conducted in October 2024 using a modified BSWM questionnaire, which featured a formal set of questions or a structured data collection tool composed of predefined, standardized questions presented in a consistent order to all respondents. It involved a five-point Likert scale to gather data systematically for consistent responses. Furthermore, secondary data from the SCMD, including information on production and marketing were also utilized in this study. The modified data gathering instruments were pre-tested and underwent reliability and validity analysis.

Table 1

Frequency distribution of farmer-beneficiaries of SLRMA over five years.

Year	Number of farmer-beneficiaries
2019	10
2020	9
2021	12
2022	10
2023	8
Total	**49**

Table 1 presents the frequency distribution of all farmer-beneficiaries of SLRMA over a five-year period, who served as the research respondents. The data collected from them were analyzed using the Statistical Package for the Social Sciences (SPSS) software to perform the necessary statistical computations. The farmers' profile in terms of age, sex, civil status, highest educational attainment, size of the farm, number of years residing in the area, number of years in farming, size of the family, number of family members working in the farm, and number of years as beneficiary of SLRMA were presented using frequency distribution, percentage, mean, and standard deviation. To test the relationship between the socio-demographic characteristics of the farmer-beneficiaries such as sex, civil status, and highest educational attainment, ANOVA was used. Multiple Linear Regression following Durbin-Watson's methodology was used to test the relationship between the socio-demographic profile, interventions introduced to the corn farmers and profitability of farmer-beneficiaries. A dependent t-test was used to describe the production and profit of the farmer-beneficiaries before and after the SLRMA was implemented.

Results and Discussion

Effectiveness of Contour Farming

Table 2 displays the analysis of the response of the farmer-beneficiaries on the effectiveness of contour farming in controlling soil erosion on the farms, including its effect on fertilizer application, crop yield, power and time requirement, and land improvement.

Table 2 shows that contour farming through SLRMA has generally had a positive impact on

farming practices, with respondents strongly agreeing that it has reduced soil erosion (mean of 4.469) and helped restore degraded land for cultivation (mean of 4.429). This aligned to the study of Choudhary et al. (2024) revealing that contour farming can significantly reduce soil loss by up to 49.5% and water loss by 30% compared to conventional perpendicular crop cultivation. This practice also decreases annual surface runoff by 10%, effectively mitigating soil erosion and conserving water.

There is also a notable increase in crop yields (mean of 4.041), aligning to the results of the review study of Farahani et al. (2016), stating that farmers practicing contour farming and strip cropping reported a 15-25% increase in yields over five years. However, the reduction in fertilizer use (mean of 3.612) and labor and time requirements for cultivation (mean of 3.776) showed more mixed results. The results imply that the adoption of contour farming is beneficial to farmers as it helps to maintain the health of the soil by reducing erosion, and it restores unusable lands. Through contour farming, production costs can also be reduced while at the same time, increasing crop yields.

Table 2

Effectiveness of Contour Farming

Statement	Mean	Median	Mode	Verbal Description
1. Soil erosion is no longer a problem in my farm after implementing SLRMA.	4.469	5	5	Strongly Agree
2. Fertilizer requirement of the crops was reduced.	3.612	3	3	Agree
3. Degraded portions of the farm can now be utilized and cultivated.	4.429	5	5	Strongly Agree
4. The amount of crop yield was increased.	4.041	4	4	Agree
5. Power and time requirement for cultivation was reduced.	3.776	4	3	Agree
Weighted Mean	**4.066**			**Agree**

Legend: Strongly Disagree (1.00 - 1.80); Disagree (1.81 - 2.60); Neither Agree nor Disagree (2.61 - 3.40); Agree (3.41 - 4.20); Strongly Agree (4.21 - 5.00)

Effectiveness of Crop Diversification

Table 3 displays the analysis of the response of the farmer-beneficiaries on the effectiveness of crop diversification in increasing income, lessening production cost, and withstanding price fluctuation, climate change, and pests and diseases.

As exhibited in Table 3, crop diversification is generally viewed as an effective strategy for enhancing farm income, with a mean of 4.510, indicating strong agreement and consistency among respondents. Adam and Abdulai (2024) found that crop diversification greatly boosts farm net returns while also reducing their variability. The practice is also considered effective in mitigating price fluctuations (mean of 4.224), with most participants agreeing it helps stabilize income. Nahar et al. (2024) revealed that households practicing greater crop diversification were more likely to be food secure or marginally food secure compared to less diversified households. It also plays a significant role in improving resilience to climate change, with a mean of 4.347, suggesting a generally positive perception. According to Vernooy (2022), in the context of climate change, diversification plays a significant role as it helps to increase yields, household incomes, and food security. Crop diversification is also recognized for its ability to increase profits by reducing production costs (mean of 4.245). However, while still viewed positively, its role in reducing risks from pests and diseases received a slightly lower mean of 4.020. These results imply that diversification of crops has significantly benefited the farmers as they experienced reduced production cost and increased income. It also enabled them to adapt to the changing weather conditions caused by climate change. Having diverse commodities increased their resilience to the very volatile price of produce.

Table 3

Effectiveness of Crop Diversification

Statement	Mean	Median	Mode	Verbal Description
1. Crop diversification is effective in increasing farm income.	4.510	5	5	Strongly Agree
2. Diversified farming is effective in helping to withstand price fluctuation of commodities.	4.224	4	4	Strongly Agree
3. The crop diversification technology is effective in providing resilience to highly variable weather conditions caused by climate change.	4.347	4	4	Strongly Agree
4. Crop Diversification is effective in increasing profits by reducing production cost.	4.245	4	4	Strongly Agree
5. Crop diversification is effective in reducing risk from pests and diseases.	4.020	4	4	Agree
Weighted Mean	**4.269**			**Strongly Agree**

Legend: Strongly Disagree (1.00 - 1.80); Disagree (1.81 - 2.60); Neither Agree nor Disagree (2.61 - 3.40); Agree (3.41 - 4.20); Strongly Agree (4.21 - 5.00)

Effectiveness of the Topics Discussed in the Training Conducted

A specialized capability enhancement training was conducted to ensure that farmer-beneficiaries fully understood the objectives of SLRMA and were equipped with the necessary skills to adopt the technologies aimed at improving agricultural production and environmental protection. The training program combined theoretical discussions on the benefits of SLRMA and sustainable land management practices with practical, hands-on activities. This approach allowed the farmer-beneficiaries to not only grasp the concept behind the technologies but also to gain direct experience with the actual field practices implemented under the project.

Table 4 shows that the training on soil erosion and sustainable farming practices had a significant positive impact on the farmer-beneficiaries. Most respondents strongly agreed that the training improved their understanding of soil erosion and its environmental effects, with a high mean of 4.714, indicating consistency across participants. Similarly, participants felt confident in their understanding of sustainable land management practices and how to apply them in farming to combat soil erosion, reflected by a mean of 4.653. Kansanga et al. (2021) found that increased awareness through training significantly influences the adoption of sustainable land management practices among smallholder farmers.

The A-Frame tool, with a mean of 4.796, was especially effective in helping participants identify optimal planting lines to reduce soil erosion, demonstrating a strong consensus on its usefulness. Wassif and Meselhy (2022) highlights the effectiveness of the A-Frame tool in identifying optimal planting lines to reduce soil erosion by preventing runoff and conserving soil. The training also helped participants understand the importance of farm planning for long-term land productivity, with a mean of 4.490, indicating strong agreement and consistency. In the study of Wonde et al. (2022), it was found that farmers who received training in farm planning and sustainable practices experienced notable improvements in crop yields and soil health.

While the responses were still positive regarding farm record-keeping, with a mean of 4.245, the result suggests some variability in how well participants applied this practice for planning and economic analysis. The study of Wulandari et al. (2023) reveals a significant positive relationship between financial

record training and farmers' likelihood to record farm finances, suggesting that targeted training can enhance record-keeping practices. However, Omotilewa et al. (2021) found that the common challenges hindering effective record-keeping include lack of understanding of its benefits, complexity of maintaining records for multiple plots, and limited literacy levels. Addressing these challenges through education and simplified record-keeping systems can improve adoption rates.

Table 4

Effectiveness of the Topics Discussed in the Training Conducted

Statement	Mean	Median	Mode	Verbal Description
1. After attending the training, I understand what soil erosion is and its effect on the environment.	4.714	5	5	Strongly Agree
2. I understand sustainable land management and soil conservation technologies and helped in my farming practice to address soil erosion and make my farming sustainable.	4.653	5	5	Strongly Agree
3. The idea of A-Frame helped me identify and locate lines where my fruit trees will be planted to help reduce soil erosion.	4.796	5	5	Strongly Agree
4. I was able to understand the importance of farm planning to maintain the productivity of the land for a longer period through soil conservation technologies.	4.490	5	4 and 5	Strongly Agree
5. I was able to practice farm record keeping and use it as a basis for planning and economic analysis.	4.245	4	5	Strongly Agree
Weighted Mean	**4.580**			**Strongly Agree**

Legend: *Strongly Disagree (1.00 - 1.80); Disagree (1.81 - 2.60); Neither Agree nor Disagree (2.61 - 3.40); Agree (3.41 - 4.20); Strongly Agree (4.21 - 5.00)*

Challenges Encountered by the Farmer-beneficiaries in Adopting SLRMA

Table 5 displays the analysis of response of the farmer-beneficiaries on the challenges that they might have encountered during the adoption of the technologies introduced to them through SLRMA.

Table 5 reveals that the farmer-beneficiaries largely disagreed with claims about the program's negative impacts on farms. Most respondents did not believe the program incurred high establishment costs (mean of 1.449) or required excessive labor (mean of 1.816). There was also strong disagreement about high maintenance costs (mean of 1.449) and the need for additional time compared to traditional farming practices (mean of 1.796). Gathagu et al. (2018) found that contour farming requires less labor and has lower implementation costs than structural practices. Also, the farmer-beneficiaries overwhelmingly rejected the idea that the program reduced corn production area (mean of 1.347), increased pests and diseases (mean of 1.714), or harmed soil productivity (mean of 1.041). This aligns with the statement of Huss et al. (2022) that integrating contour farming with other sustainable agricultural practices, such as crop rotation and intercropping, can further mitigate pest and disease issues. While there was moderate disagreement regarding increased water use (mean of 2.020), most participants strongly disagreed that the program caused marketing difficulties (mean of 1.204). Goldhamer et al. (1995) found that hedgerows can increase water usage during their establishment phase but become

more water-efficient over time. However, the program's impact on grazing areas received more varied responses, with a moderate level of agreement (mean = 2.347). This is likely because livestock tend to feed on the tree crops planted along the contour lines, which in turn reduces the available space for grazing.

Table 5

Challenges Encountered by the Farmer-beneficiaries in Adopting SLRMA

Statement	Mean	Median	Mode	Verbal Description
1. The implementation of the program produces high establishment costs for my farm.	1.449	1	1	Never
2. Implementing the program requires laborious activities that add more man-power.	1.816	2	2	Occasionally
3. The program requires high maintenance costs.	1.449	1	1	Never
4. The program requires additional time compared to old farming practice.	1.796	2	1 and 2	Never
5. The program results in reduced area for corn production that affects profitability.	1.347	1	1	Never
6. With this new program, more pests and diseases occur in the farm.	1.714	2	2	Never
7. The program reduces soil productivity due to inappropriateness of the technologies.	1.041	1	1	Never
8. The program requires a high volume of water.	2.020	2	3	Occasionally
9. The program resulted in difficulties in marketing the product.	1.204	1	1	Never
10. The program reduced the area for grazing.	2.347	3	3	Occasionally
Weighted Mean	**1.6183**			**Never**

Legend: *Strongly Disagree (1.00 - 1.80); Disagree (1.81 - 2.60); Neither Agree nor Disagree (2.61 - 3.40); Agree (3.41 - 4.20); Strongly Agree (4.21 - 5.00)*

Comparison of Net Income Before and After Implementation of Program

Table 6 presents the analysis of the net income of the farmer-beneficiaries before and after the implementation of SLRMA, considering varying durations of participation. Prior to the implementation of SLRMA, most farmer-beneficiaries practiced monocropping, predominantly wherein they tend to plant corn, which limited their income opportunities from other crops. Following the introduction of SLRMA, they began diversifying their crops by incorporating fruit trees into their landscapes. This shift toward crop diversification significantly contributed to the increase of their net income.

Table 6 compares net income before and after the implementation of SLRMA for farmer-beneficiaries with varying durations of participation (1 to 5 years). For beneficiaries with 5 years of participation, net income increased from PhP5,504.45 before the program to PhP45,724.45 after (T-value = 47.67, p-value = 0.000), showing a highly significant improvement. Similarly, for 4 years, net income rose from PhP11,414.68 to PhP39,084.68 (T-value = 30.11, p-value = 0.000), and for 3 years, it increased from a negative value of PhP9,058.49 to positive value of PhP14,692.38 (T-value = 28.83, p-value = 0.000). For 2 years of participation, net income increased from PhP10,662.95 to PhP38,119.95 (T-value

= 50.53, p-value = 0.000), all showing significant positive changes. However, for those with only 1 year of participation, net income decreased from PhP689.88 to negative value of PhP389.90 (T-value = -0.473, p-value = 0.651), with no statistically significant change. This is because the additional crops planted along the contour lines begin to bear fruit after the first year, generating more income starting on the second year. Additionally, Do et al. (2020) revealed in their study that combining fruit trees like longan and son tra with corn and forage grass generated 2.4 to 3.5 times higher average annual income, with productivity gains starting on the second year and increasing as the trees matured.

Table 6

Comparison of Net Income Before and After Implementation of Program

Number of Years (as Beneficiary)	Mean Before (PhP)	SD	Mean After (PhP)	Standard Deviation	T-value	P-value	Results
5	5504.45	12518.36	45724.45	11774.65	47.67	0.000	Significant
4	11414.68	5080.93	39084.68	6134.14	30.11	0.000	Significant
3	-9058.49	5384.54	14692.38	7420.40	28.83	0.000	Significant
2	10662.95	6595.50	38119.95	6839.36	50.53	0.000	Significant
1	689.88	4136.72	-389.90	7271.28	-0.473	0.651	Not Significant

*Legend: p=0.000 **Highly significant, p<0.05 *Significant*

Comparison of ROI Before and After Implementation of SLRMA

Table 7 displays the analysis of ROI of the farmer-beneficiaries before and after the implementation of SLRMA with varying durations of participation.

Table 7

Mean ROI (%) Before and Mean ROI (%)

Number of Years (as Beneficiary)	Mean Before	SD	Mean After	Standard Deviation	T-value	P-value	Results
5	16.54	31.84	147.81	92.62	5.18	0.001	Significant
4	28.07	15.42	136.37	26.49	11.19	0.000	Significant
3	-22.55	13.11	132.71	37.57	17.93	0.000	Significant
2	29.13	18.05	89.23	21.39	6.05	0.000	Significant
1	1.42	9.50	-.047	14.80	-.308	0.757	Not Significant

*Legend: p=0.000 **Highly significant, p<0.05 *Significant*

Conclusion

The study highlights observed improvements in net income among farmer-beneficiaries who engaged in agricultural interventions such as contour farming, crop diversification, and targeted training programs. While these findings suggest potential benefits in terms of productivity and resilience, the study does not establish a direct causal relationship between the interventions and income gains. Factors such as changes in corn market prices, input costs, and production levels were not controlled or analyzed in depth. Therefore, the results should be interpreted with caution. Prolonged participation in the program was associated with higher income, but further analysis using more robust statistical methods is needed to determine the actual drivers of income changes. To ensure lasting impact, future programs should be adaptive, address diverse farmer needs, and promote sustainable farming practices. These efforts can contribute to long-term agricultural productivity, environmental health, and economic stability for farming communities.

Recommendations

Based on the results of the study, the following are the plans and programs devised for further improvement of SLRMA to meet the needs of the farmer-beneficiaries:

1. Since the program is limited to provision of planting materials, fertilizers, and basic tools for weeding and irrigation, some farmer-beneficiaries are unable to deliver the necessary care and maintenance to the crops. This often leads to a high mortality rate in the first year. To address this, additional support and resources should be provided to ensure the successful establishment of the crops planted along the contour lines. Such support may include manpower or financial assistance to cover the labor needed for intensive care and maintenance during this critical period.
2. Future research should not only assess the challenges encountered by farmer-beneficiaries—particularly concerning income and net income—but also evaluate the suitability of the research design and methodologies employed in this study. This will help determine whether these approaches are appropriate for replication or require modification in future investigations. In particular, future studies are encouraged to employ multivariate statistical methods, such as regression analysis, to more accurately identify the specific factors that influence changes in income. Such follow-up assessments will be instrumental in refining the program's design and enhancing its overall effectiveness.
3. Based on the outcomes of the research, the BSWM and the respective Local Government Units should collaborate to formulate and implement a strategic adaptation and upscaling plan for the SLRMA. This plan should showcase the demonstrated benefits of the interventions to neighboring farming communities, thereby encouraging wider adoption. Furthermore, the program should be expanded to other parts of the country, particularly in sloping areas cultivated with corn, to maximize its impact on sustainable land management and farmer productivity.

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GIS-based Mapping of Crop Suitability Rating for the Re-Delineated Soil Types in Barangay Bantug, Science City of Muñoz, Nueva Ecija, Philippines

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Abstract

Crop suitability assessment is essential for land use planning, sustainable farming, and resource management prior to production. This research focused on the identification and re-delineation of soil types in the agricultural lands of Barangay Bantug, Science City of Muñoz, Nueva Ecija, and aimed to determine the suitability rating of the top five agricultural crops produced in the Philippines. With the use of the *Handbook for Soil Series Identification* in Nueva Ecija and the hydrometer method for soil texture determination of the surface soil (0–20 cm), six soil types were identified in Brgy. Bantug: Maligaya Clay, Maligaya Clay Loam, Maligaya Loam, Maligaya Silty Clay Loam, Maligaya Silty Clay and Bantog Clay Loam. The soil type map generated was used as land mapping units in crop suitability assessments of wetland rice, upland rice, corn, onion, mango, and sugarcane. In Maligaya Clay Loam and Bantog Clay Loam, all crops are potentially highly suitable. The permanent limitations from other land mapping units are basically related to the rooting condition, specifically the soil surface texture. The latest taxonomic classification based on secondary data indicates that the Maligaya Series is fine, smectitic, isohyperthermic, Typic Epiaquert, while the Bantog Series is very fine, mixed, isohyperthermic, Typic Endoaquert. The processes and maps used and produced from this research can benefit the local government unit in land use planning, the farmers in selecting crops to be produced, and future researchers in the identification and re-delineation of soil type maps for crop suitability assessment.

Keywords: *crop suitability assessment, soil series of Brgy. Bantug, soil type identification*

Introduction

The massive increase in Philippines' population is directly related to food needs. In order to secure the food requirements of the Filipino people, agricultural productions should be increased through time. Limiting factors in food production cause a decrease in agricultural productivity. To overcome this problem, we need precision agriculture, which focuses on "doing the right thing in the right place at the right time" (Davis et al., 1914). This involves the collection and analysis of data and taking action based on it (USGAO, 2024). Ultimately, the success of production depends on farmers' knowledge and management practice.

The diversity of soils in the Philippines support a wide range of crops. Varieties of food producing crops are continuously cultivated to suppress the hunger of Filipino people. Different crops have their own

preferred soil types. Plant and soil relationship is significant in bringing out the maximum yield The main reason why there is clustering of crops and vegetables in different regions or provinces in the Philippines is that the soil of one province can be different from that of another. Through proper soil survey and classification, soil differences have been identified and delineated.

Data about Philippine soil types can now be accessed by farmers through online website geoportal.gov.ph, but these data were based on small-scale mapping. This delineated map, produced in 1:250,000 scale, may have differences at barangay level boundaries. The re-delineation of soil type boundaries at a scale of 1:25,000 is more detailed than the available maps, which can improve the precision and accuracy of the previous maps in the selection of crops for food, feed, and fiber. Soil is one of the independent variables to be considered. The yield of different crops is highly dependent on soil characteristics. Through proper selection of suitable crops, maximum profit can be achieved.

Delineation is the process of producing maps with precise boundaries. This study was conducted to re-delineate the soil type map of Barangay Bantug, Science City of Muñoz in a larger scale, define its taxonomic classification based on updated secondary data and produce map that can be utilized to recommend suitable cropping patterns for a more productive, profitable and sustainable crop production system for the farmers.

Materials and Methods

Site Description

The study area is bounded on the west by Barangay Poblacion, which is the city proper of Science City of Muñoz, on the north by Barangay Balante and Bagong Sikat, on the east by Central Luzon State University (CLSU), on the south by Barangay Villa Nati, Sapang Cauayan and Villa Cuizon and on the southwest by Barangay Bakal 3, Talavera. Barangay Bantug is one of the biggest barangays in terms of land area and the most populated barangay in Science City of Muñoz. It has a total land area of 344 ha, and 657 ha are part of CLSU.

Barangay Bantug boundary was digitized using Google Earth Pro software. The extent of the boundary was identified by the presence of irrigation, roads, dikes, barangay arc and other landmarks. To separate the built-up areas from cultivated or agricultural areas, the built-up areas were also digitized and cut out from the boundary of Bantug. The built-up areas were marked in white on the map, and only agricultural lands were used for the soil type re-delineation.

Plotting of Sample Points

Using a soil probe with a depth of 50 cm, the 30–50 cm soil samples were collected from three points located within the 50 cm range of the sampling point generated by ArcGIS. By using this point generator, sampling points were distributed throughout the agricultural areas of Barangay Bantug without limitation. The number of the sampling points was 25, having a sample point density of 1:12.5 ha. The map has a scale of 1:25,000.

Collection of Soil Sample

The sampling points generated by ArcGIS 10.3 software were located using a Garmin (Montana 650) GPS device. Using a soil probe with 50cm depth the 30-50cm soil was collected on three points located within the 50 cm range of the sampling point generated by ArcGIS. These three points serve as replicates and were used as the soil samples for soil series determination; the 30–50 cm soil depth was used because it is below the cultivated soil, which has fewer disturbances. The soil sample collection method adopted was based on the Collado et. al. (2008) handbook with slight modification by the researcher. The surface soil (0–20 cm depth) was subjected to soil texture analysis in the laboratory using

the hydrometer method following the procedure from Domingo et. al. (2004).

Soil Type Identification

The process of soil series identification followed the procedure from the handbook *Simplified Keys to Soil Series: Nueva Ecija,* which was produced by the Philippine Rice Research Institute. It was slightly modified because of the digital sampling procedure. The collected soil samples from 30 cm to 50 cm depth were analyzed based on its color, texture, coarse fragments and mottles. The surface soils from 0-20 cm depth were subjected to soil texture analysis in the laboratory using the hydrometer method.

Verification/Reclassification of the Current Soil Taxonomic Classification

The current soil taxonomic classification of each delineated soil series was verified/reclassified using secondary data from Miura et. al. (1995). The identified properties of soil series from Miura et al. (1995) were used to determine the soil taxonomic name from differentiation of mineral soils and organic soils, epipedon, sub-surface horizon, soil moisture regime, soil temperature regime, order, suborder, great group, subgroup, particle size, to its mineralogical class.

Land Suitability Assessment

The land suitability of each soil type in Bantug, Science City of Muñoz was classified into two orders: *suitable* and *not suitable*. Each order was further classified into classes with symbols S1 (Highly Suitable), S2 (Moderately Suitable), S3 (Marginally Suitable), N1 (currently not suitable), and N2 (permanently not suitable) and lastly with its subclasses or limitations that are represented by t (annual average temperature), w (dry months; annual average rainfall), r (Soil drainage class; soil texture; soil depth), f (CEC; pH), n (total N, available P; exchangeable K), x (salinity), and s (slope; surface stoniness; rock outcrops). Land suitability evaluation of rice (wetland and upland), corn, coconut, mango, and banana, which are the top five agricultural crops according to the Philippine Statistics Authority (2016), was determined. Assessment of different crop requirements for soil characteristics was based on secondary data. The *FAO Guidelines* (1976), *Crop Suitability Evaluation* by Fiegalan et al. (2017), Sys et al. (1993), and Ritung et al. (2007) were used for crop suitability classification for mango.

Re-delineation of Soil Type and Land Suitability

From the method of soil series identification and soil texture analysis, the identified soil type of each soil sample was entered into each point generated by ArcGIS 10.3 software. Likewise, the noted GPS point with soil type data was interpolated. The produced soil type map, after interpolation was used as a basis for land mapping units and was also used for producing land suitability maps.

Production of Map

Re-delineation of the different soil types in barangay Bantug was plotted in a map using ArcGIS 10.3 software. Production of map was done through exporting the map in an image file.

Results and Discussion

Soil Types of Barangay Bantug

Barangay Bantug is comprised of two soil types: Maligaya Clay Loam and Maligaya Silt Loam (BSWM, 2013). In the re-delineation of the map with a scale of 1:25,000, a total of six soil types were identified from two soil series. These soil types are Maligaya Clay, Maligaya Clay Loam, Maligaya Loam, Maligaya Silty Clay Loam, Maligaya Silty Clay and Bantog Clay Loam. Figures 1 and 2 represent the delineated and re-delineated map of Barangay Bantug, respectively.

The re-delineated soil type map was limited only for the agricultural areas of Bantug, Science City of Muñoz. The agricultural area of Barangay Bantug has an area of 313 ha which is 79.34% of its total land area. The 658 ha area of Central Luzon State University located within the Barangay Bantug was excluded in the study. At a scale of 1:25,000, after the samples were subjected to soil series identification, the Maligaya and Bantog Series were identified. However, the Bantog Series was not identified in the Soil Type Map published on Geoportal.gov.ph by BSWM (2013). On the other hand, according to Cañete et al. (2016), the Bantog Series is present in Barangay Bantug, Science City of Muñoz, Nueva Ecija.

Figure 1

Original Soil Type Map of Barangay Bantug, Muñoz, Nueva Ecija, Philippines (BSWM, 2013)

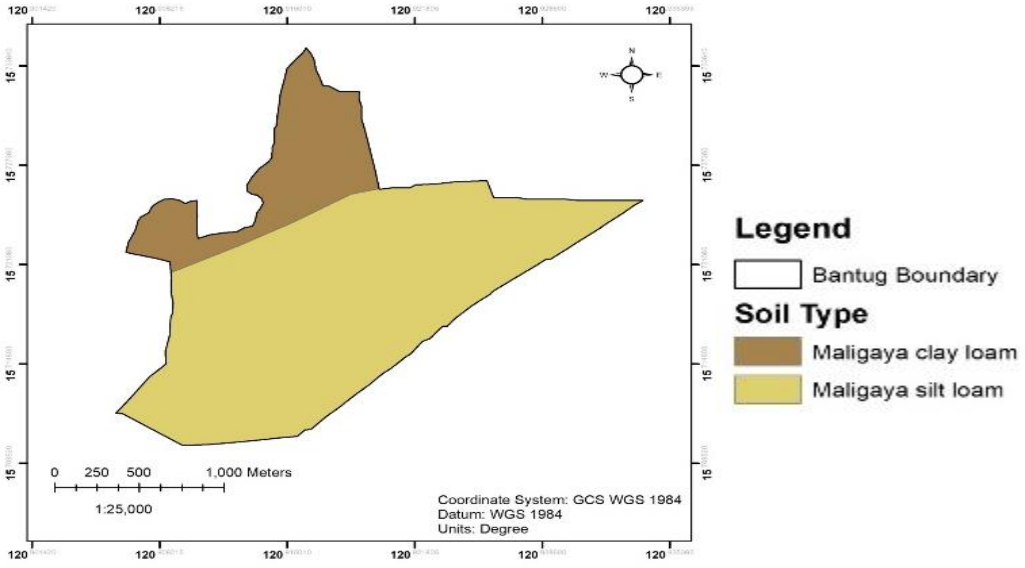


Figure 2

Re-Delineated Soil Type Map of Barangay Bantug, Muñoz, Nueva Ecija, Philippines

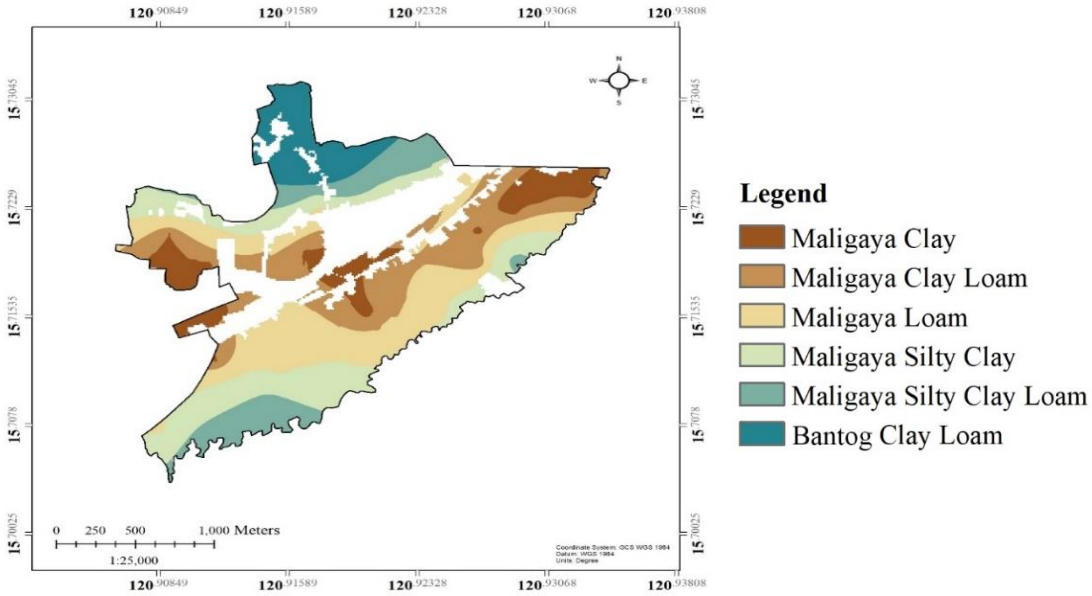


Table 1

Characteristics of Soil Types at Barangay Bantug, Munoz, Nueva Ecija, Philippines

Parameter	Soil Type Maligaya Clay (LMU 1)	Maligaya Clay Loam (LMU 2)	Maligaya Loam (LMU 3)	Maligaya Silty Clay (LMU 4)	Maligaya Silty Clay Loam (LMU 5)	Bantog Clay Loam\ (LMU 6)
t- Temperature Regime						
1. Annual Average Temp. (°C)[1]	27.7	27.7	27.7	27.7	27.7	27.7
w- Water Availability						
1. Dry months[1]	5	5	5	5	5	5
2. Annual Average Rainfall (mm)[1]	2139.3	2139.3	2139.3	2139.3	2139.3	2139.3
r- Rooting Condition						
1. Soil Drainage Class[2]	Imperfectly	Imperfectly	Imperfectly	Imperfectly	Imperfectly	well
2. Soil Texture (surface)[3]	Clay	Clay Loam	Loam	Silty Clay	Silty Clay Loam	Clay Loam
3. Rooting Depth[2]	150cm	150cm	150cm	150cm	150cm	150cm
f- Nutrient Retention						
1. CEC me/100g (surface)[2]	High	high	high	high	High	high
2. pH (surface)[2]	6.8-7.2	6.8-7.2	6.8-7.2	6.8-7.2	6.8-7.2	6.5-7.6
n- Nutrient Availability						
1. Total N (surface)[2]	Low	low	low	low	Low	medium
2. Available P2O5 (surface)[2]	High	high	high	high	high	high
3. Available K_2O (surface)[2]	Low	low	low	low	low	low
x- Toxicity						
1. Salinity						
s- Terrain						
1. Slope[2]	Flat	Flat	Flat	Flat	Flat	Flat
2. Surface Stoniness[2]	None	None	None	None	None	None
3. Rock outcrops[2]	None	None	None	None	None	None

[1]PAGASA, CLSU, [2] Collado et. al., (2008), [3]-Laboratory Analysis

Table 2

Current Crop Suitability Rating of Soil Types in Barangay Bantug, Muñoz, Nueva Ecija, Philippines

Soil Types	Wetland Rice	Crops				
		Upland Rice	Corn	Onion	Mango	Sugarcane
Maligaya Clay	S2wrn	S3r	S3r	Ntw	S3r	S3wr
Maligaya Clay Loam	S2wn	S2tr	S2trn	Ntw	S3r	S3w
Maligaya Loam	S2wrn	S2tr	S2trn	Ntw	S3r	S3w
Maligaya Silty Clay	S2wrn	S3r	S3r	Ntw	S3r	S3wr
Maligaya Silty Clay Loam	S2wrn	S2tr	S2trn	Ntw	S3r	S3w
Bantog Clay Loam	S3r	S3f	S2tfn	Ntw	S1	S3w

Table 3

Potential Crop Suitability Rating of Soil Types in Barangay Bantug, Muñoz, Nueva Ecija, Philippines

Soil Types	Wetland Rice	Crops				
		Upland Rice	Corn	Onion	Mango	Sugarcane
Maligaya Clay	S2r	S3r	S3r	S3r	S1	S3r
Maligaya Clay Loam	S1	S1	S1	S1	S1	S1
Maligaya Loam	S2r	S2r	S1	S1	S1	S1
Maligaya Silty Clay	S2r	S3r	S3r	S1	S1	S3r
Maligaya Silty Clay Loam	S2r	S1	S1	S2r	S1	S1
Bantog Clay Loam	S1	S1	S1	S1	S1	S1

Figure 3

Current Wetland Rice Suitability Rating Map

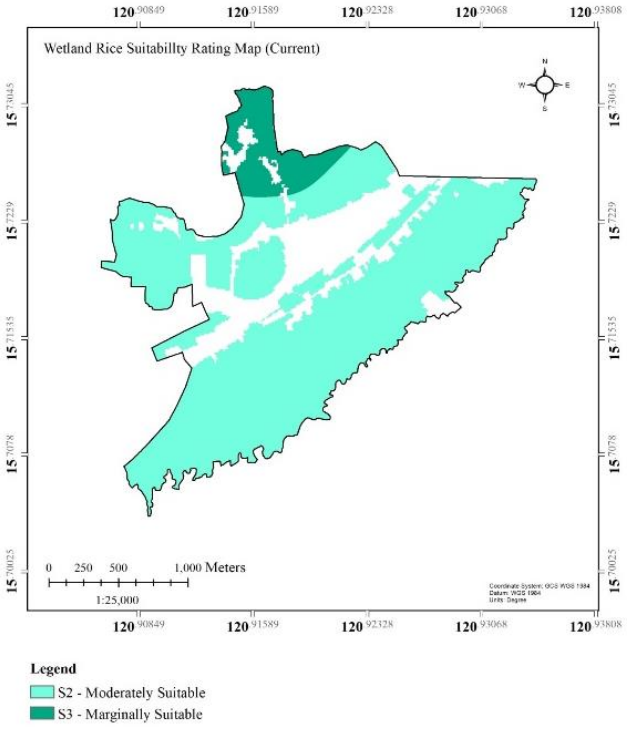


Figure 4

Potential Wetland Rice Suitability Rating Map

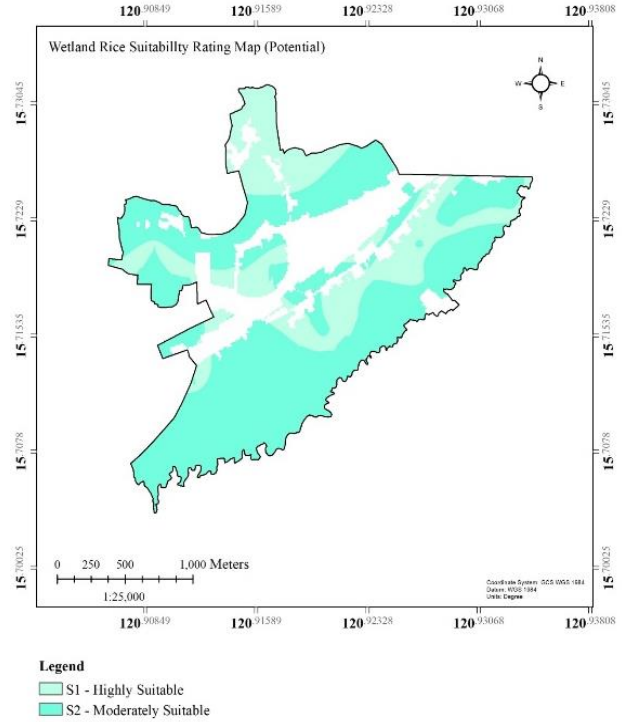


Figure 5

Current Upland Rice Suitability Rating Map

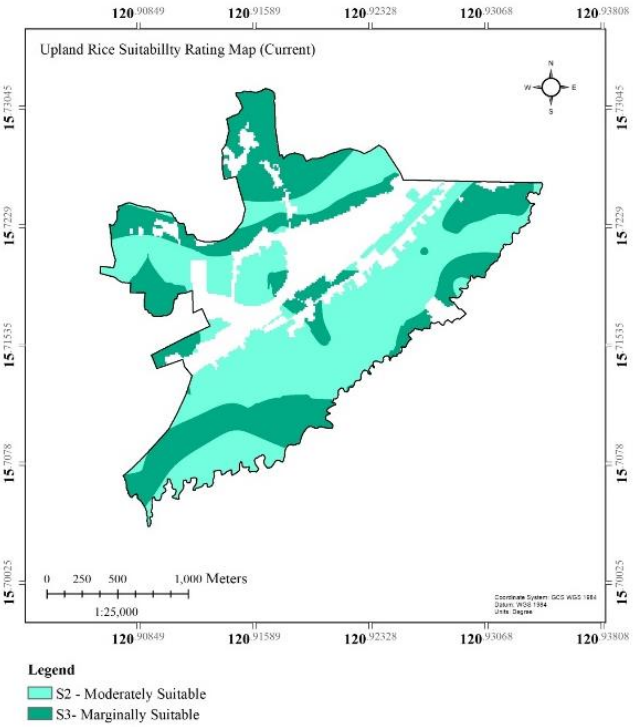


Figure 6

Potential Upland Rice Suitability Rating Map

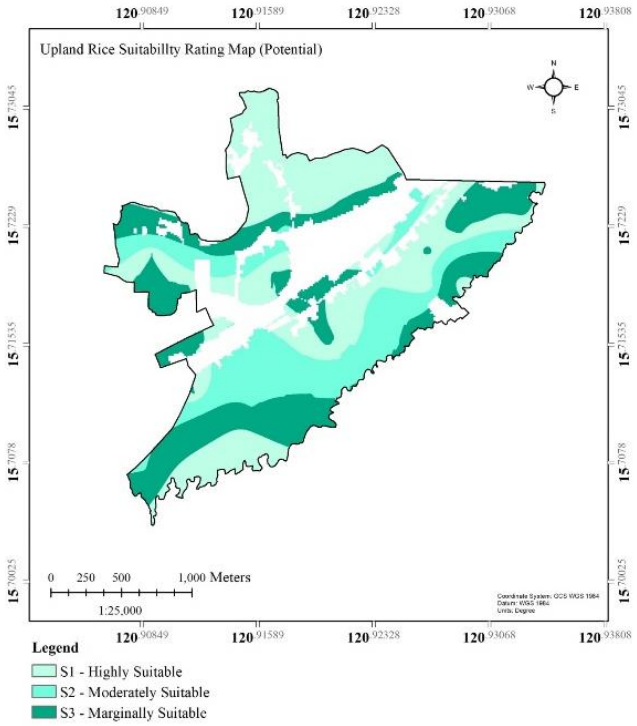


Figure 7

Current Corn Suitability Rating Map

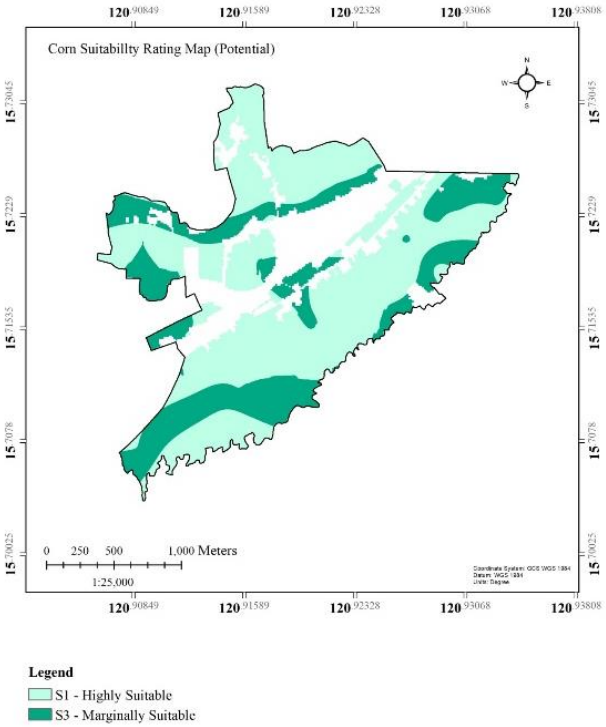


Figure 8

Potential Corn Suitability Rating Map

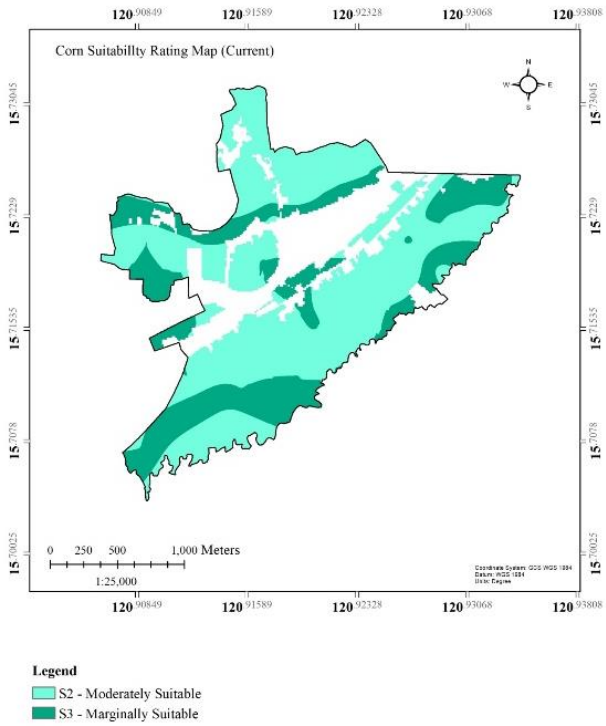


Figure 9

Current Onion Suitability Rating Map

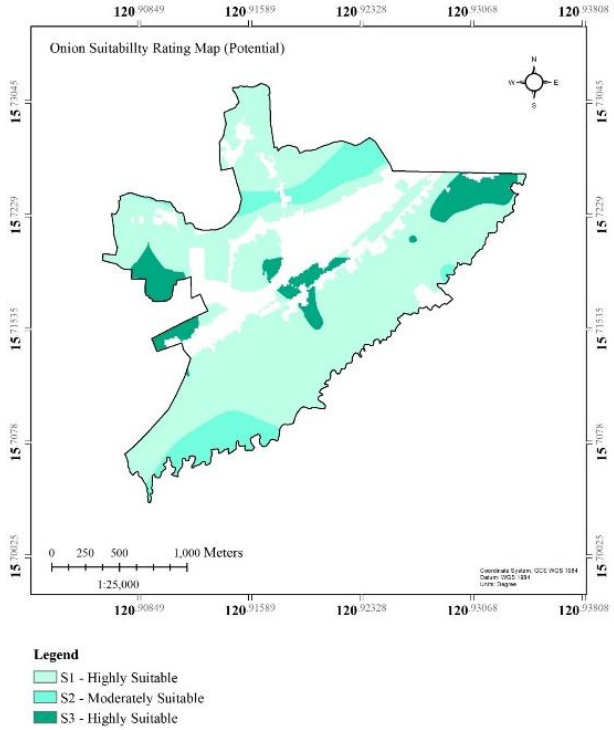


Figure 10

Potential Onion Suitability Rating Map

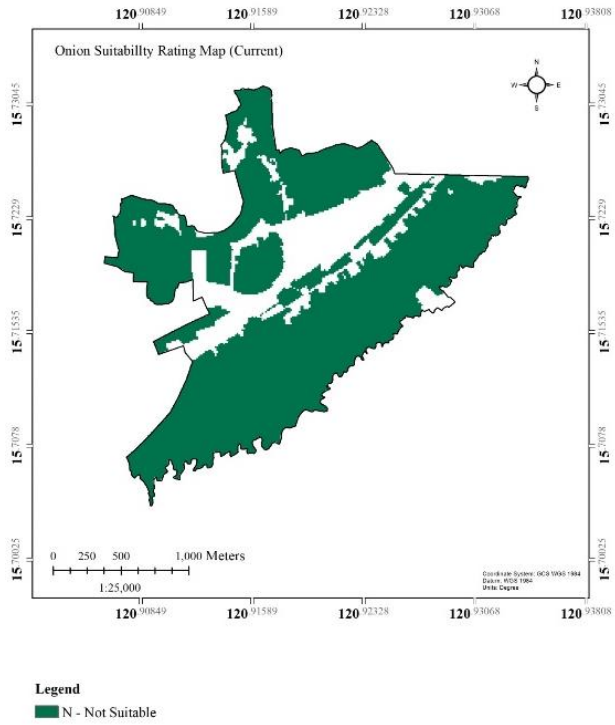


Figure 11

Current Mango Suitability Rating Map

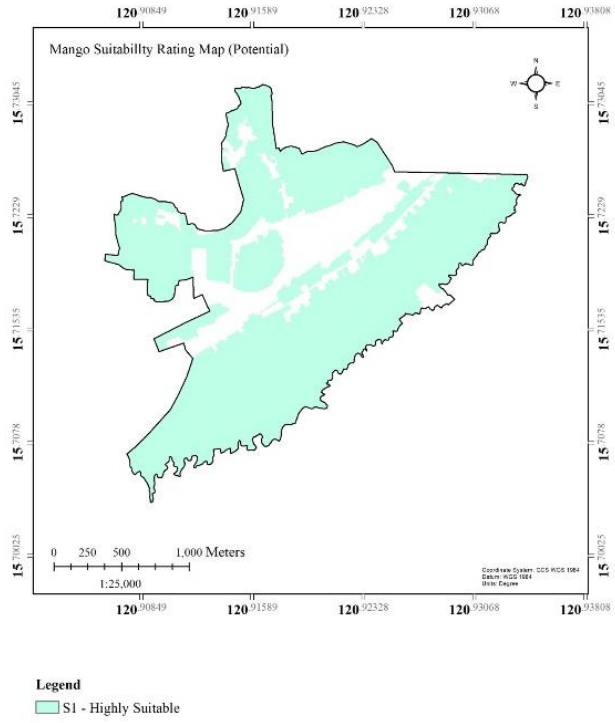


Figure 12

Potential Mango Suitability Rating Map

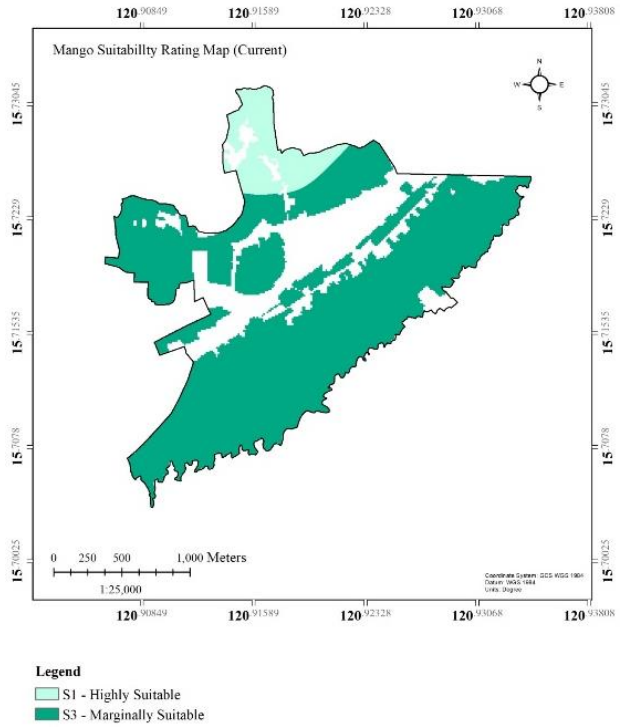


Figure 13

Current Sugarcane Suitability Rating Map

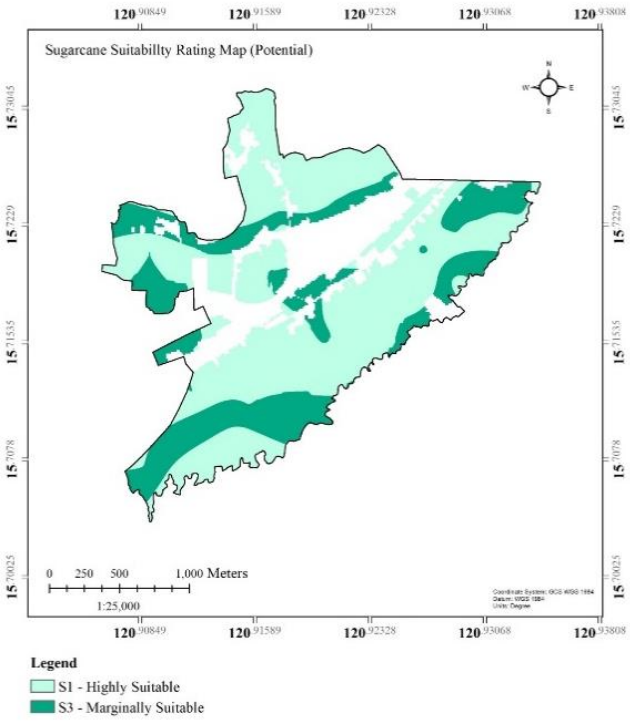
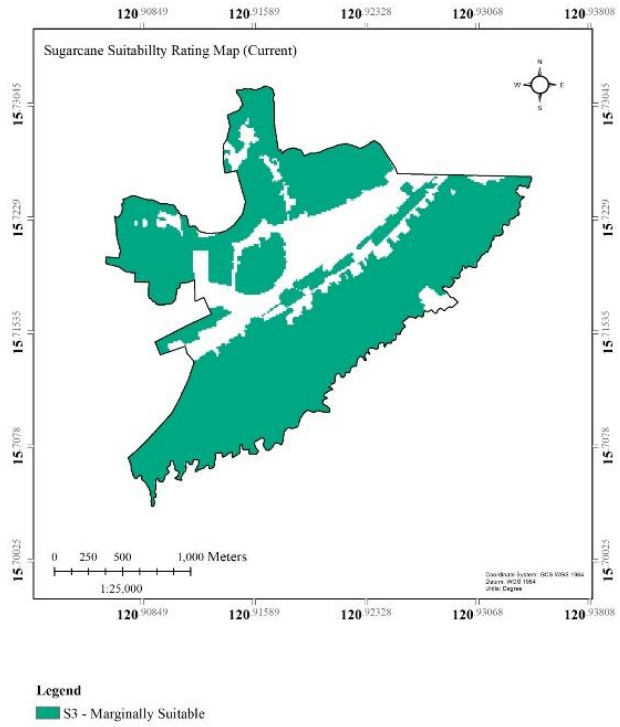


Figure 14

Potential Sugarcane Suitability Rating Map



Suitability Rating of Wetland Rice

The current suitability rating map (Figure 3) for wetland rice shows large areas are moderately suitable while the remaining areas are marginally suitable. The six soil types produced three suitability ratings: S3r, S2wn, and S2wrn. It shows that from six soil types four have the same suitability rating for wetland rice. Bantog Clay Loam has a suitability rating of S3r which is marginally suitable for wetland rice with rooting condition as major limitations. This rooting condition is brought by a limitation in drainage; it can be corrected and brought to S1 by providing dikes that controls the drainage supply in the area. The suitability rating S2wrn is for Maligaya Clay, Maligaya Loam, Maligaya Silty Clay Loam, and Maligaya Silty Clay. S2wrn can be corrected by supplying water through pump well, proper drainage management, and application of both organic and inorganic fertilizer. The Maligaya Clay Loam has a suitability rating of S2wn. The limitations were brought by water availability and nutrient availability. The water availability can be adjusted to S1 by irrigating the land in the month where there is lack of rainfall, while the nutrient availability can be solved by supplying inorganic and organic fertilizer.

After the limitations were corrected, potential land suitability rating for wetland rice was developed as shown in Figure 4. The rooting condition, especially the soil surface texture cannot be corrected making the suitability rating of LMU 1, 3, 4, and 5 moderately suitable for rice. The remaining LMU 2 and 6 are highly suitability for wetland rice.

Suitability Rating of Upland Rice

At present (Figure 5), Barangay Bantug has been shown to have moderate and marginal suitability for upland rice. There are three land suitability ratings that evaluated; S3r was rated to the Soil Type Maligaya Clay and Maligaya Silty Clay it was caused by the soil surface texture; S2tr was rated from Maligaya Clay Loam, Maligaya Loam, and Maligaya Silty Clay Loam; and S3f was rated from Bantog Clay

Loam. LMU 2, 3, and 5 limiting factors were temperature regime and rooting condition specifically soil drainage. LMU 1 and 4 have soil surface texture as major limitations while LMU 6 was nutrient retention, specifically the pH of soil surface.

As shown in Figure 6, S3r rating cannot be corrected because the soil surface texture is the limiting factor. LMU 2 and 5 were rated highly suitable from a rating S2tr, because the limiting factor temperature regime can become S1 by growing the rice plant during the month of December to March where average temperature is lower, while rooting condition was corrected by application of organic matter that can increase the water retention of the soil for good drainage. S3f suitability rating of Bantog Clay Loam can be corrected by applying organic fertilizer and liming.

Suitability Rating for Corn

As shown in Figure 7, there are moderately and marginally suitable lands in Barangay Bantug for corn. Maligaya Silty Clay and Maligaya Clay have a suitability rating of S3r for corn. Maligaya Clay Loam, Maligaya Loam, and Maligaya Silty Clay Loam have suitability rating of S2trn. Bantog Clay Loam has a suitability rating of S2tfn.

Figure 8 shows that the potential suitability rating in Barangay Bantug were highly suitable and marginally suitable for corn. The soil surface texture limitations were not corrected due to its almost permanent property, while the limitations brought by temperature regime, soil drainage, and nutrient retention can be corrected to become highly suitable by choosing heat-tolerant variety, constructing of dikes for drainage and applying organic material, respectively.

According to the Ministry of Food Production of Trinidad and Tobago (2013), although corn can grow well in all soil types, corn cropped in loose friable soil produced better result. Additionally, best soil texture for corn are silt loam or loam type soil according to Agricultural Training Institute (2014). Maligaya Clay and Maligaya Clay Loam are considered marginally suitable for corn because of their limitation in soil texture. Although corn can be produced in these soil types, they will produce a lower yield compared to other soil types.

Suitability Rating for Onion

Figure 9 shows that the current suitability rating of Barangay Bantug was not suitable for onion production. The rating was Ntw in all the land mapping units. The major limitations were caused by the temperature in the area, which is 27.7°C, and by the area's average precipitation of more than 1600 mm.

In application of proper management, as shown in Figure 10; from a not suitable rating the area becomes highly suitable, moderately suitable and marginally suitable. The temperature regime and water availability will not be excessive if onion is planted during the months when there is not too much rainfall and the average temperature is lower. These months are from November to April. Onion is best planted after the rice season. It cannot be planted year-round due to its specific climatic requirements.

Suitability Rating for Mango

Figure 11 shows that LMU 6 or Bantog Clay Loam is highly suitable for mango. LMU 1, 2, 3, 4, and 5 are marginally suitable because of the imperfectly soil drainage characteristics of Maligaya Series.

As shown in Figure 12, all land mapping units have become highly suitable in the area. The limiting factor, an imperfect soil drainage class, can be corrected through the application of large amounts of organic material, which can improve the land's drainage, making it suitable for mango production.

Suitability Rating for Sugarcane

As shown in Figure 13, Sugarcane is marginally suitable in Barangay Bantug. The limiting factors of LMU 1 and 4 were the water availability and rooting condition. The LMU 2, 3, 5, and 6 have water availability as major limitations.

In Figure 14, the potential suitability rating of Sugarcane in Barangay Bantug was highly suitable, moderately suitable and marginally suitable compared to the current suitability rating of marginally suitable in all land mapping units. The water availability was solved and become highly suitable because of the irrigation present in the area. The soil surface texture as a limiting factor in LMU 1 and 4 remain in the potential suitability rating.

Soil Series Classification

There are two soil series observed in Barangay Bantug, Science City of Muñoz, Nueva Ecija. These are Maligaya and Bantog Series. The taxonomic classifications were verified and reclassified using *Keys to Soil Taxonomy, Twelfth Edition* (USDA 2014). The secondary data of profile description of two soil series was from Miura et al. (1995).

Maligaya Series

According to Miura et al. (1995), the Maligaya Series has a surface horizon that exhibits a dark bluish-gray color in the matrix (gleyic horizon), which tests positive in a dipyridyl test, and the major part of the subsurface horizons is gray in color. Abundant filmy iron mottles are found in the surface, but no iron mottles below. Fine manganese concretions are found at a depth of more than 23 cm. Common fine calcareous nodules are present in the part deeper than 90 cm. The profile has a clay texture up to 120 cm, with silty clay below. Intersecting slickensides are developed throughout the profile, except in the surface horizon. It has very wide surface cracks ranging from 5 to 10 cm.

Table 4

Classification of Maligaya Series

Classification	Result	Maligaya Series[1]
Differentiae for Mineral Soils and Organic Soils	Mineral Soil	Organic matter in all soil horizons was below 3%, The profile was subjected to disturbances that cause low organic material accumulation.
Epipedon	Ochric Epipedon	The profile does not meet the criteria for any of the other seven epipedons due to its low organic carbon content and its massive, very hard structure when dry. It also has eluvial horizon that are at soil surface. It does not have rock structure and does not include finely stratified fresh sediments.
Sub-surface Horizon	Argillic Horizon	The profile has a diagnostic subsurface argillic horizon because of the evidence of clay illuviation. It also meets both the requirements of having a particle-size class of fine or clayey, and having a coefficient of linear extensibility greater than 0.04, along with a distinct wet and dry season.
Soil Moisture Regime	Aquic soil moisture regime	The profile has iron and manganese concretions that are brought by the reduction and oxidation of the soil. During reduction, there is a free dissolved

		oxygen cause by water saturation and biological activity.
Soil Temperature Regime	Isohyperthermic	The mean annual soil temperature is 22°C or higher.
Order	Vertisols	High montmorillonitic/smectitic type of clay — this type of clay is highly expansive and causes cracks that open and close periodically.
Suborder	Aquerts	Enough active ferrous iron to give a positive reaction to alpha,alpha-dypyridyl.
Great Group	Epiaquert	Other aquerts that have episaturation. The soil was from rice fields where the water table is perched on top of an impermeable layer.
Subgroup	Typic Epiaquert	It does not achieve all the requirements of any other subgroup category.
Particle size	Fine	Have less than 60 percent clay.
Minerology classes	Smectitic	Have more smectite minerals than any other single kind of clay mineral.

[1](Miura et. al., 1995)

Bantog Series

According to Miura et al. (1995), the Bantog Series has a matrix that shows a gray color in the upper 80 cm below the surface. The surface horizon is positive in dipyridyl test. Iron mottles are found throughout the profile; thread-like brown mottles below. Development of slickensides is found at a depth below 25 cm. The profile has clay textural class throughout. It has wide surface cracks ranges from 2 to 5 cm.

Table 5

Classification of Bantog Series

Classification	Result	Bantog Series[1]
Differentiae for Mineral Soils and Organic Soils	Mineral Soil	Organic matter in all soil horizons was below 4%. The profile was subjected to disturbances and cultivated every planting season, which caused low organic matter accumulation.
Epipedon	Ochric Epipedon	The profile does not qualify as any of the seven other epipedons because it lacks sufficient organic carbon and has a massive, very hard consistency when dry. It also has eluvial horizon that are at soil surface. It does not have rock structure and does not include finely stratified fresh sediments.
Sub-surface Horizon	Argillic Horizon	It has >90% clay accumulation It meets both the requirements of having a particle-size class of very fine or clayey and has higher than 0.04 coefficient of linear extensibility with distinct wet and dry season.
Soil Moisture Regime	Aquic soil moisture regime	There is free dissolved oxygen caused by water saturation and biological activity; the presence of iron and manganese concretion is brought by redoximophic process wherein there are times the soil is saturated with water.
Soil Temperature Regime	Isohyperthermic	The mean annual soil temperature is 22°C or higher.

Order	Vertisols	High montmorillonitic/smectitic type of clay — this type of clay is highly expansive and causes cracks that open and close periodically.
Suborder	Aquert	Enough active ferrous iron to give a positive reaction to alpha, alpha-dypyridyland 50% or more of chroma 2 or less if redox concentration is present.
Great Group	Endoaquert	Other aquerts that doesn't meet the criteria of other great group. It has endosaturation, meaning it is saturated with water in all layers. The liquid phase distribution increases with depth, as the percentage of water content rises in the lower layers.
Subgroup	Typic Endoaquert	Fails to meet the requirements of other subgroup category
Particle size	Very Fine	Have 60 percent or more clay.
Minerology classes	Mixed	There are kaolin minerals as well as smectite and vermiculite minerals.

[1] (Miura et. al., 1995)

Conclusion and Recommendation

The soil type classification, re-delineation, and crop suitability assessment of Barangay Bantug resulted in the identification of the Maligaya and Bantog Soil Series, which were further classified into six different soil types. Each soil type was used as land mapping units to determine the crop suitability rating of top five agricultural crops produce in the Philippines. Various crops have different suitability ratings which can be improved by application of several management practices. These management practices include fertilizer application, construction of dikes for drainage, selection of suitable varieties, application of irrigation water, and other soil physicochemical management practices.

The soil series classification updates in the present study could potentially provide farmers in the area with a better understanding of how these agricultural lands can be used with respect to their environmental and soil physicochemical properties. The local government unit can utilize the results of this research in the development of the barangay land use plan. Extension workers could interpret the maps to the farmers within the barangay for more effective communication. The process in soil type classification, re-delineation, and crop suitability assessment could also be adopted for regular updating of maps to assess the climate change impacts.

These re-delineated maps will guide them in selecting crops and adopting proper management practices that are suitable based in land characteristics and climatic data. The re-delineation of maps from small scale to more detailed GIS mapping can greatly help land users to improve crop production. This must be adopted by the government, extension workers, and capable agencies to be conducted on a larger scale—from the barangay to the national level.

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Growth Performance of Rabbits with Varying Dietary Levels of Job's Tear or Adlai Seeds (*Coix lacryma-jobi* L.)

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Abstract

This study evaluated the potential of Job's tears or adlai (*Coix lacryma-jobi* L.) seeds as an alternative feed ingredient for rabbit production. Using a 2x3 factorial in a Randomized Complete Block Design (RCBD), 54 male rabbits aged eight weeks from two breeds (Californian and New Zealand) were fed commercial feeds every morning in a 30-day feeding trial with varying amounts of adlai seeds (0%, 10%, and 20%), and fixed amount of 150 g napier grass in the afternoon. The nutritional analysis of the different feed formulation showed that the levels of moisture, crude protein, ash, fat, nitrogen-free extract, calcium, and phosphorus were either within or closely aligned with the recommended nutritional standards for growing rabbits. Growth performance was assessed through final body weight at 12 weeks old, average weight gain (AWG), average daily gain (ADG), feed intake (FI), and feed conversion ratio (FCR). Results showed no significant differences (P>0.05) in all the performance parameters across treatments, indicating that adlai seed inclusion did not adversely affect rabbit performance. These findings suggest that adlai seeds can be a sustainable component of rabbit diets. Its potential to enhance growth of rabbits may be explored in future studies by varying the percentage of adlai seeds in the feed formulation for various breeds and growth stages.

Keywords: *adlai, alternative feed, feeding trial, Job's tears, nutritional analysis, rabbit, sustainable livestock feed*

Introduction

Livestock farming in the Philippines commonly integrates production of forage crops, wherein locally-available forage crops can greatly affect the overall cost of production by lowering feed cost. Feed quality is also important in terms of the nutritional content of ingredients that are crucial to the growth and developments of animals, especially during times of low availability, high market demand, and high cost of feed ingredients. Among these farm animal species affected by feed concerns is rabbit, a small livestock that can sustainably supply a household's need for white meat or protein. In a year, one female rabbit or doe can give birth to enough offspring that could produce almost fifty kilograms of meat (Ugosor et al., 2016). Rabbits are highly adaptable to varying environmental conditions; they require minimal space, produce little waste, and can be easily cared for by women, children, elderly, or even persons with disability (Owen & Amakiri, 2010). They convert fodder efficiently into high-protein, low-calorie meat, and they are prolific breeders (Opoku, 2010; Mokoro et al., 2015). Rabbit farming is a sustainable and

affordable source of protein that can be tapped by communities being challenged by climate change, rising population, and evolving meat consumption patterns (Mutsami & Karl, 2020; Molina-Flores et al., 2020). Rabbit farming is a promising livestock enterprise in the Philippines, but rabbit raisers need a lot of support to make this venture successful (Dionisio et al., 2023).

A grain that has potential as alternative animal feed, and is considered to be an alternative for rice and corn, is adlai or Job's tears (*Coix lacryma-jobi* L.). It belongs to the Poaceae family and got its name from its tear-shaped seeds that are 8–12 mm long, with a hard shell of varying colors (Aradilla, 2018; Magpantay et al., 2021). Adlai can thrive in marginal soils and needs minimal cultivation, irrigation, or pest control efforts (Monteroyo & Aradilla, 2014; Dela Torre, 2018). It can be grown in the Philippines's three main island groups - Luzon, Visayas and Mindanao (De Jesus et al, 2015; Tangpos, 2022; Magallon & Cabahug, 2022). Adlai seeds contain 16.2% protein, 4.65% fat, and 79.17% carbohydrates (Kim et al., 2004; Yang et al., 2013). They are also sources of beneficial compounds, including amino acids, vitamins (notably B1), anti-inflammatory agents, antioxidants, and anti-cancer properties (Yu et al., 2008; Chen et al., 2012; Li et al., 2013; Lu et al., 2013).

Feed is the highest cost in livestock and poultry farming. In extensive rabbit production systems relying on local forages, alternative strategies are essential (Oseni & Lukefahr, 2014). Hence, this study consisted of a feeding trial to assess the effects of incorporating adlai seeds into rabbit diets by analyzing the nutritional composition of the formulated feeds and observing the rabbits' growth performance and overall health. Through this research, the aim was to determine whether adlai can serve as a sustainable potential feedstuff ingredient, thus contributing to the development of more resilient rabbit production systems.

Objectives of the Study

This study evaluated the potential of adlai seeds as feedstuff for rabbit production. Specifically, this study aimed to (a) assess the nutritional composition of crumbled rabbit pellets mixed with varying amount of adlai seeds, and (b) determine the final weight, average weight gain, feed intake, and feed conversion ratio of rabbits.

Materials and Methods

Experimental Design and Layout

This institutionally-approved research study was laid out in a 2x3 factorial in a Randomized Complete Block Design (RCBD), with breed as factor A, and the different amounts of feeding as factor B. The experimental treatments for Factor A were: A1 – Californian, and A2 – New Zealand White. Factor B included the different morning rations in a restricted feeding scheme: B1 – control or 0% adlai (50 g Commercial feeds); B2 – 10% adlai seeds (45 g CF:5 g AS); B3 – 20% adlai seeds (40 g CF:10 g AS). In the afternoon, each rabbit from all treatments was given 150 g of Napier grass as part of its daily roughage requirement. There was a total of six (6) treatment combinations (A1B1, A1B2, A1B3, A2B1, A2B2, and A2B3), and each had three (3) replications, for a total of 18 groups, to which the fifty-four (54) heads of eight-week-old male rabbits were randomly assigned. The rabbits were purchased at six weeks old and underwent acclimatization for two weeks prior to the experiment.

Preparation and Nutritional Analysis of Experimental Feeds

Whole adlai seeds were mixed with pelleted feeds, with the pellets crumbled into smaller pieces, about 2–3 per pellet. The variety of adlai was not properly identified by a botanist, so this is a limitation in the study. Feed samples, consisting of crumbled commercial rabbit pellets with or without adlai seeds, were submitted to the Regional Feed Laboratory, City of San Fernando, Pampanga. The nutritional

parameters analyzed were moisture, crude protein, ash, crude fat, calcium, phosphorus, salt, nitrogen-free extract, and metabolizable energy. Moisture was determined using the oven-drying method, crude protein by Kjeldahl method, ash by furnace-ignition method, crude fat and crude fiber by Ankom® filter bag technology, calcium content by titrimetry method, phosphorus content by vanadomolybdate method, salt content by Mohr method, and the nitrogen free extract and metabolizable energy by computation method.

Management of Experimental Rabbits

The experimental animals were purely confined in individual 0.56 m^2 screen-type cages, with individual feed and water bowls made of recycled plastic cups and bottles. Six-week-old rabbits were fed twice daily based on the experimental groupings, and water was made available at all times. The weight of each rabbit was measured before (at 8 wks. old) and after the feeding trial (at 12 wks. old) using a digital weighing scale with a 5 kg capacity and up to 0.01 gram precision. The feed intake was weighed daily within the 30-day feeding period, starting from March 1 to March 31, 2024. The feed allocation of 50 g of concentrates and 150 g of roughage per day is based on the farming practices of local rabbit producers in Bulacan and Nueva Ecija.

Statistical Analysis

The normality and homogeneity of the data were tested prior to determining significant differences among the treatments used in the experimental study. The data gathered were analyzed using Statistical Tool for Agricultural Research (STAR) software version 2.0, following the analysis of variance in a 2-factor factorial Randomized Complete Block Design (RCBD) to determine the effects of the treatments.

Results and Discussion

Nutritional Analysis

Table 1 presents the results of the nutritional analysis of feed formulations with varying amounts of adlai seeds, as determined by the Regional Feed Laboratory of Central Luzon region, located in the City of San Fernando, Pampanga.

Table 1

Nutritional Analysis of Feed Formulations with Varying Amount of Adlai Seeds

Parameters	Feed types with varying amounts of adlai		
	B1 - Control; 50 g Commercial feeds [CF] as AM meal)	B2-10% of adlai seeds [45 g CF:5g AS])	B3-20% of adlai seeds [40 g CF:10g AS]
% Moisture Content	7.7±0.1	8.1±0.1	9.3±0.1
% Crude Protein	15.0±0.5	13.1±0.4	13.3±0.5
% Ash Content	10.4±0.1	10.2±0.3	10.0±0.1
% Crude Fat	4.4±0.1	4.0±0.2	4.5±0.2
% Crude Fiber	17.8±0.7	18.4±0.5	17.1±0.6
% Calcium	1.0±0.2	1.1±0.3	1.4±0.3
% Phosphorus	0.5±0.1	0.5±0.1	0.4±0.1
% Salt	0.6±0.1	0.6±0.1	0.6±0.1
Nitrogen Free Extract, %	44.7	46.2	45.8
Metabolizable Energy, kcal/kg	2463.5	2415.5	2451.0

The moisture content of control or B1 (7.7%) is lower than those with adlai, wherein B2 (10% adlai) had 8.1% moisture, and B3 (20% adlai) had 9.3% moisture. The crude protein contents of B1 (15%), B2

(13.1%), B3 (13.3%) as well as the nitrogen free-extract (NFE) in B1 (44.7%), B2 (46.2%) and B3 (45.8%) is within the recommended range set by Michigan State University Extension (2017) for young rabbits, wherein ration should contain 12–15% crude protein and 43–47% nitrogen-free extract (carbohydrate).

The ash contents in BI (10.4%), B2 (10.2%), B3 (10%), and crude fat in B1 (4.4%), B2 (4%), B3 (4.5%) were higher than 4.0-6.5% ash or mineral content and 2–3.5% fat recommended by MSU Extension (2017). However, the crude fiber (CF) of B1 (17. 8%), B2 (18.4%), and B3 (17.1%) was lower than the recommended crude fiber range of 20–27% (MSU Extension, 2017).

The calcium contents of the feed formulations (B1 – 1.0%±0.2; B2 – 1.1%±0.3; and B3 – 1.4%±0.3) and their phosphorus contents (B1,B2 – 0.5%±0.1; B3 - 0.4%±0.1) are within the recommended 1.5: 1 to 2:1 recommended ratio (Halls, 2010). The metabolizable energy of feeds (B1 – 2463.5 kcal/kg; B2 – 2415.5 kcal/kg; and B3 – 2451.0 kcal/kg) are near the recommended ME for fattening rabbits which is 9.8 MJ or 2342.26 kcal/kg (Lukefahr, 2022).

Performance of Rabbits

Table 2

Production Performance of Californian and New Zealand White Rabbits Fed with Commercial Feeds and Varying Amounts of Adlai Seeds

Performance Parameters	Factor A - Breed	Factor B - Feed type with varying levels of adlai seeds B1 (100% Commercial Feed)	B2 (90 % CF, 10% Adlai Seeds)	B3 (80 % CF, 20% Adlai Seeds)	Factor A Mean
Initial wt., 8 wks. old (g)	A1 (Californian)	1,093.89	1,155.11	1,104.78	**1,117.93**
	A2 (NZ White)	1,055.00	1,201.11	1,165.89	**1,140.67**
	Factor B Mean	**1,074.45**	**1,178.11**	**1,135.33**	
Final wt., 12 wks. old (g)	A1 (Californian)	1,626.78	1,455.56	1,551.22	**1,544.52**
	A2 (NZ White)	1,564.67	1,597.32	1,617.00	**1,592.99**
	Factor B Mean	**1,595.72**	**1,526.44**	**1,584.11**	
Average weight gain (g)	A1 (Californian)	532.89	300.44	446.44	**426.59**
	A2 (NZ White)	509.67	396.20	451.11	**452.33**
	Factor B Mean	**521.28**	**348.32**	**448.78**	
Average daily gain (g)	A1 (Californian)	17.76	10.01	14.88	**14.22**
	A2 (NZ White)	16.99	13.20	15.04	**15.08**
	Factor B Mean	**17.37**	**11.61**	**14.96**	
Feed intake (g)	A1 (Californian)	1,496.11	1,487.22	1,495.78	**1,493.04**
	A2 (NZ White)	1,489.22	1,490.44	1,478.78	**1,486.15**
	Factor B Mean	**1,492.67**	**1,488.83**	**1,487.28**	
Feed conversion ratio (FCR)	A1 (Californian)	2.98	5.00	3.40	**3.79**
	A2 (NZ White)	3.06	3.85	3.76	**3.59**
	Factor B Mean	**3.02**	**4.47**	**3.58**	

The initial weight of experimental rabbits, which were eight weeks old before the experiment, was determined before the start of the feeding trial. The results indicate that the rabbits were relatively similar in size and weight at the beginning of the experiment. There was no significant difference in the initial weight results among the six groups from the 2x3 factorial design, ranging from 1,104.78 g to 1,201.11 g.

The final weight was determined after one month of feeding trial, or 10 weeks of age for the rabbits. There were no interaction effects observed between the breed and type of feed. The achieved final weight among the six groups ranged from 1,455.56 g (A1B2 – Californian, 10% adlai) to 1,626.78 g (A1B1 –

Californian, 0% adlai). There was also no significant effect by either of the two factors. The highest mean final weight among feed types was observed in the control group with 1,595.72 g, but has no significant difference to 1,584.11 g of B3 (20% adlai) and 1526.44 g of B2 (10% adlai). The higher mean for breed was for NZ White rabbits at 1592.99 g, but there was no significant difference to the 1,544.52 g of Californian rabbits. The results imply that replacing up to 20% of commercial feeds with adlai seeds has no significant effect on the weight of rabbits.

These results for body weight at 12 weeks of age for meat-type rabbits are close to, but slightly lower than, the two-month-old average weight of 1,640 g for New Zealand White rabbits raised in Bulacan, Philippines (Nicolas et al., 2019). This could be attributed to the hot environmental temperatures during the study, since it was conducted in the month of March, one of the hottest months in the country (Cabrera, 2024). Rabbits are sensitive to high environmental temperatures, and heat stress can reduce their body weight, weight gain and feed intake (Dahmani et al., 2022).

The average weight gain (AWG), determined by subtracting the initial weight at 8 wks from the final weight at 12 wks, and was likewise not affected by the two factors and their interaction. The achieved AWG after four weeks of feeding ranged from 300.44 g (A2B1 – 10% adlai, Californian) to 532.89 g (A1B1 – control, Californian). The related parameter which is average daily gain (ADG), was computed by dividing the AWG by 30, the number of days spent for the study. The highest mean ADG among feed types was observed in the control group at 17.31 g, but there was no significant difference compared to 14.96 g of B3 (20% adlai) and 11.61 g of B2 (10% adlai). The higher mean for breed was observed in NZ White rabbits at 15.08 g, but there was no significant difference compared to the 14.22 g of Californian rabbits.

The results on AWG and ADG also both imply that replacing up to 20% of commercial feeds with adlai seeds has no significant effect on the weight gain of meat-type rabbit breeds. The 15.08 g ADG obtained in this study for three months old New Zealand White rabbits is comparable to the 15.26 g ADG reported by Nicolas et al. (2019), for the same breed and age of rabbits. Compared to the reported ADG of rabbits raised in other tropical countries, such ADG is comparable to the results of Samkol (2009) with 14.0g ADG, but lower than that of Omer and Badr (2013) who obtained 19.91–23.09 g ADG.

The feed intake (FI), determined by subtracting the weight of all unconsumed feeds from the total daily ration, also show to be unaffected by the breed and feed types. Most daily rations are fully consumed by the rabbits, while on some days, only minimal leftovers or crumbs remain. The observed feed intake after four weeks of feeding ranged from 1,478.78 g (B3A2 – 20% adlai, NZW) to 1,496.11 g (A1B1 – control, Californian). The highest mean feed intake among feed types was observed in the control group at 1,492.67 g, but there was no significant difference compared to 1,488.83 g of B2 (10% adlai) and 1,487.28 g of B3 (20% adlai). The higher mean for breed was observed in Californian rabbits at 1,493.04 g, but there was no significant difference compared to 1,486.15 g of New Zealand White rabbits.

The results also imply that replacing up to 20% of commercial feeds with adlai seeds has no significant effect on the feed intake of both rabbit breeds. Rabbits have a high feed intake and fast metabolism, so they can still meet nutritional needs with forages that are low in energy and protein (de Blas & Wiseman, 2020). According to Sena et al., (2015), newly-weaned meat-type rabbits can consume about 4 to 6 ounces of food per day, according to size.

The feed conversion ratio (FCR) is the means of getting the feed efficiency in producing additional weight, with lower numbers signifying better efficiency. The FCR, which is determined by dividing the feed intake by the weight gain, was also not significantly affected by the rabbit breed and level of adlai on the feeds. The computed FCR ranged from 2.98 g (A1B1 – control, Californian) to 5.00 (A1B2 – 10% adlai,

NZW). The lowest computed FCR among feed types was observed in the control group at 3.02, but there was no significant difference compared to 4.47 of B2 (10% adlai) and 3.58 of B3 (20% adlai). The lower computed FCR for breed was observed in NZ White rabbits at 3.59, but there was no significant difference compared to 3.79 g of Californian rabbits. The results also imply that replacing up to 20% of commercial feeds with adlai seeds has no significant effect on the feed efficiency of both rabbit breeds. Maertens (2009) stressed that the use of diets with accurate nutrient level, coupled with appropriate feeding methods, are necessary for minimum losses and optimum digestive health and FCR. In this study, the obtained FCR of 2.98 to 5.00 from the experimental rabbits was comparable to the FCR reported in the study of Omer and Badr (2013) which ranged from 3.66 to 4.10, and in the 3.4–3.8 FCR observed in European farms as studied by Gidenne et al. (2017).

Conclusion

It was concluded from the findings of this study that incorporating adlai seeds in the diet of growing rabbits, regardless of breed and varying feeding levels, did not negatively affect growth performance. Therefore, Adlai seeds could be considered a potential feedstuff in rabbit diets without adverse effects on the growth performance.

Recommendations

Future studies may explore the use of pelleted adlai seeds with commercial feeds using pellet machine to mix it together for the improvement of feed efficiency. Varying the percentage of adlai seeds as main feeds to rabbit diet may enhance growth performance further, specifically if other breeds and the specific growth stages are also studied. Cultivating adlai locally, if there are available areas before raising rabbits is recommended for cheaper and sustainable feed resource for rabbit raisers. It is further recommended that future studies explore the utilization of adlai (*Coix lacryma-jobi* L.) seeds and other parts of the plant through various feed processing methods such as pelletizing, extrusion, or fermentation to further enhance feed efficiency and nutritional value.

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Growth and Carcass Traits of Chicken Supplemented with Preparations of Butterfly Pea (*Clitoria ternatea*) at Varying Inclusion Frequencies

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Abstract

The study was conducted to determine the growth performance and carcass traits of Cobb® Broiler broilers supplemented with different preparations of butterfly pea (*Clitoria ternatea*) at varying inclusion frequencies. The study used the 3x2 factorial in Completely Randomized Design, with the type of butterfly pea preparation as factor A (A1 – Control Group, A2 – butterfly pea flower (BPF) as fermented juice, and A3 – BPF decoction, both supplemented in drinking water (10%), whereas factor B was the frequency of supplementation (B1 – every day, B2 – every other day). Day-old Cobb broiler chicks with similar average weight of 50–60 grams were randomly distributed to six groups, which had three replicates each, and seven birds per replicate, for a total of 126 birds. The body weight, average weight gain, and feed conversion ratio revealed there was no interaction effect for the two factors, but there were highly significant differences among the control and BPF preparations, and between the two frequencies of supplementation. Butterfly pea flower-treated groups had better results than the control, with BPF-fermented juice (A2) having the best results, followed by BPF-decoction (A3). Between the frequencies, it was everyday supplementation (B1) that showed better performance values. No significant differences were observed on carcass traits including dressed weight, carcass percentage, and relative organ weights (liver, spleen, gizzard, and heart).

Keywords: *broiler, butterfly pea, chicken, ternatea*

Introduction

Chicken production continues to be one of the largest contributors to the animal industry in the Philippines, with positive growth rate in the last three years (2022–2024). With a total of 2.08 metric tons of chicken production in 2024, the great majority of 85.6% share belongs to broiler type, which are mostly from commercial farms. Bulacan province had the highest production in 2024, with 197.57 thousand metric tons of live weight (PSA, 2025).

Despite this reported growth and stability of the chicken industry, chicken farmers still face problems on reduced profits due to feed cost, low growth performance compared to neighboring countries, and market factors, among others. The Philippine government passed the Philippine Organic Agriculture Act of 2010, also known as Republic Act 10068, which provides guidelines that strengthen and encourage

livestock and poultry farmers to produce more organic products that are readily available in the community. Thus, the use of ethnoveterinary products has become more widespread in rural communities, but these are often not backed up by published research. The results on promising ethnoveterinary products may benefit both small-hold and commercial poultry farms, as well as the chicken-loving households and communities.

There is a great wealth of plant materials available in the Philippines that can be tapped to improve the performance and productivity of farmed animals. One of these is the butterfly pea or blue pea (*Clitoria ternatea*), a leguminous tree with solitary flowers of vibrant blue and white color that has medicinal and agricultural uses. In this study, the butterfly pea flower was made into fermented plant juice and decoction, and was tested on its effect on the growth performance and carcass traits of broiler chicken at varying inclusion frequencies.

Objectives of the Study

The general objective of this research was to evaluate the response of performance and carcass traits of broiler chicken supplemented with different preparations of butterfly pea (*Clitoria ternatea*) at varying inclusion frequencies.

Specifically, it sought to: (1) determine the effect of butterfly pea preparation on the performance traits of broiler chicken in terms of body weight (BW), feed conversion ratio (FCR), and average daily gain (ADG); and (2) to assess the effect on carcass traits including dressed weight, dressing percentage, and relative organ weights (liver, spleen, gizzard and heart).

Materials and Methods

Experimental Design and Layout

This institutionally-approved research followed the 3x2 factorial in a completely randomized design. The six groups were replicated thrice, with seven birds per replicate, for a total of 126 chickens. The study tested two factors, namely: the treatments and the frequency. The experimental treatments for Factor A (treatments): A1 – Control Group, or pure drinking water; A2 – butterfly pea flower fermented juice (10%) in drinking water; and A3 – butterfly pea flower decoction (10% in drinking water); and for Factor B (Frequency of administration): B1 – every day, B2 – every other day. The experimental lay-out was generated using *Statistical Tool for Agricultural Research* (STAR).

Experimental Animals

The study used only Class A, or premium quality, day-old Cobb broiler chicks with similar average weight of 50–60 grams. They were purchased from Poultrymax Omnis, Inc., located at Binayuyo St., Catmon, Santa Maria, Bulacan. The chicks were vaccinated with Newcastle disease vaccine B1B1 strain before dispatch from the hatchery. A total of 126 chicks with relatively uniform weight were divided into 18 groups or 7 chicks per replicate.

Different Preparations of Butterfly Pea

The butterfly pea flower preparations were made daily to ensure freshness. In preparing the butterfly pea flower fermented juice (BPF-FJ) concoction, 1 kg butterfly pea flower was chopped into small pieces and incorporated with 1 kg molasses. These were mixed thoroughly, then stored in a clean pail which was covered and sealed for 7 days. The juice was collected, and mixed with clean drinking water at a ratio of 100 mL BPF-FJ per 900 mL water.

The second treatment used butterfly pea flower decoction (BPF-D), which was obtained by sun drying, then boiling every 5 g dried flowers in 250 mL of water for five minutes. The flowers were pressed

gently during boiling in order to obtain more extract. The boiled extract was strained to remove all solid matter. To prepare 10% solution, each 100 mL of extract was added with 900 mL water.

In this research, the cultivars or variety of butterfly pea flower were not subjected to proper identification by experts, but the single flower type of dark blue color was used. Only mature flowers or those that have fully bloomed were collected and used in the making of decoction and fermented juice.

Housing and Brooding Management

The housing has a deep litter type of flooring, composed of concrete covered with rice hull and sawdust, and with the whole area divided into 18 compartments, each with seven birds. The space allocation was at least 1 sq ft per bird to meet the national standards. Each compartment that houses seven birds had an area of 7.1–7.3 sq ft, which was maintained from brooding until harvest. Big clumps on the litter flooring, caused by excess moisture and dirt, were removed regularly to maintain a dry and clean environment for the chickens.

An hour before stocking with the day-old chicks, installed light bulbs were turned on. When the chicks arrived, the researcher provided water with dextrose powder. Chick booster mash was sprinkled on the newspaper matting. An environmental temperature of 31–33°C was maintained during brooding with the help of a room thermometer, and to ensure that the chicks were comfortable, their behavior was observed. On the second week, an environmental temperature of 29–30°C was maintained, and starting the third week until harvest, the temperature was lowered to 26–28°C. The canvas used as curtain was raised in certain portions daily to improve the ventilation in the housing and humidity, although there was no instrument used to measure the relative humidity during the study.

Feeding Management

Ad libitum feeding management using commercial feeds was done all throughout the experiment. Chick booster mash was given during the first two weeks. Starting the third week, the birds were fed with broiler starter crumbles. Shifting from one class of feed to another was done gradually. Plastic bell-shaped feeders and waterers with capacity of two liters were used, both were allocated to each group of seven birds. Supplementation with fresh preparations of butterfly pea flower started on day 8 right after brooding. Instead of the usual drinking water, the butterfly pea flower–fermented juice and decoction were put in the waterers of experimental birds, either daily or every other day depending on their group. The butterfly pea flower–fermented juice (BPF-FJ) and decoction (BPF-D) were both accepted by the birds, with no changes on their usual water consumption compared to the previous days.

The daily water consumption of every group of seven birds ranged from about 500 mL in the first week, up to 2 L in the fifth week. The contents of 2 L-capacity waterers were not totally consumed by the birds until about the last 3–5 days of study, so by this time the containers were replenished with up to 250 mL in the afternoon.

Table 1

Guaranteed Feed Analysis of Chicken Feeds Used in the Study, as Provided by the Manufacturer

Nutrient	Booster	Starter
Crude Protein	21.50%	19.50%
Fiber	5.00%	Max. 6.00%
Fat	3.00%	Min. 3.00%
Calcium	0.90–1.10%	0.90% - 1.10%
Phosphorus	Min. 0.55%	Min. 0.55%
Moisture	Max. 12.00%	Max. 12.00%

Weighing

The experimental animals were weighed individually using a digital weighing scale of up to 0.01 gram precision on the 7th, 14th, 21st, 28th and 35th day.

Slaughtering and Carcass Evaluation

A total of 54 heads (3 heads per replicate) were selected for slaughter on day 35. These were fasted for 12 hours before slaughter. Prior to the slaughter process, the chickens were individually weighed again to determine their final live weight to be used in the carcass percentage computation. The research followed proper animal handling practices as well as the necessary steps in slaughtering the chickens, with supervision by licensed veterinarian. Following the slaughter, the carcasses were evaluated to assess the yield and characteristics. Weights of carcass was recorded, and the dressing percentage was calculated as carcass weight divided by live body weight. The weights of the edible visceral organs (liver, spleen, gizzard, heart) were also recorded and calculated as percentage of carcass weight.

Data Gathered

The following data were gathered: 1.) Performance - a) *body weight* – live weight of birds at day 7, 14, 21, 28 and 35; b) *average daily gain* – (final wt - initial weight) / (number of days); c) *Feed Conversion Ratio (FCR)* – (feed given) / (weight gain); and d) *mortality* – number of deaths; 2.) Carcass traits - a) *carcass weight*; b) *carcass percentage* – (dressed weight) / (live weight); and d) *relative organ weights* – wt of specific organ / dressed wt.

Statistical Analysis

The Analysis of Variance (ANOVA) in a Completely Randomized Design (CRD) was used to analyze the performance and carcass trait data, with the Statistical Tool for Agricultural Research (STAR) software. The mean differences were evaluated using Least Significant Differences (LSD) at 5% level.

Results and Discussion

Production Performance

Body Weight

The birds were given *ad libitum* commercial feeds. The butterfly pea preparations were introduced on day 8 and lasted until harvest. The daily water consumption of every group of seven birds ranged from about 500 mL in the first week, up to 2 L in the fifth week, and with no differences in the water consumption between control and experimental groups. The results on body weight are shown in Table 2. In summary, there were no interaction effects observed between the water supplementation and frequency from day 7 up to day 35. The type of water supplementation started to show significant effect from day 14, and this was maintained up to day 35. The frequency had a significant effect only on day 35, the last day of weighing.

On day 7, the mean body weight of chickens ranged from 253.67 g to 277 g in the six treatment groups. There was no significant difference among the different preparations of butterfly pea flower (Factor A), the frequencies of supplementation (Factor B). The results indicate that the birds were relatively similar in size and weight at the beginning of the experiment.

On day 14, the achieved body weight among the six groups ranged from 593.33 (A1B1 – control) to 666.67 g (A2B1 – BPF-FJ, everyday). Interestingly, the groups that received butterfly pea flower (BPF) supplementation showed significantly higher ($p = .02$) body weight compared to the control. The obtained mean in A3 (BPF-decoction) was 653.33 g, and in A2 (BPF-fermented juice) was 650 g, while it was

606.67 g in A1 (control). The frequency of supplementation had no significant effect on the body weight in this stage of production.

On day 21, the achieved body weight among the six groups ranged from 846.67 (A1B1, A1B2 – control) to 1,003.33 g (A2B2 – BPF-FJ, every other day). The supplementation had significant effect (p = .03), wherein chickens in A2 (BPF-FJ) obtained a mean body weight of 975 g, which was significantly different to A1 (control) with a mean of 846.67 g, but comparable to A3 (BPF-D) with a mean of 916.67 g. There was also no significant effect observed from the frequency of supplementation.

On day 28, the achieved body weight among the six groups ranged from 1,173.33 g (A1B1 – control) to 1,976.67 g (A2B1-BPF-FJ, everyday). The supplementation had significant effect (p = .02), wherein the body weight of chickens in A2 (BPF-FJ) still obtained a significantly different to A1 (control) but comparable to A3 (BPF-D). The mean for A2 was 1,450 g, which was different to A1's mean 1,243.33 g, but comparable to A3's 1,370 g. As with the previous weeks, there was also no significant effect from the frequency of BPF supplementation.

Table 2

Body Weight (grams) of Cobb® Broiler as Supplemented with Different Preparations of Butterfly Pea (Clitoria ternatea) at Varying Inclusion Frequencies

Age of Bird	Factor A - Treatment	Factor B - Frequency B1 (Every Day)	Factor B - Frequency B2 (Every Other Day)	Mean (Factor A)	p Value (Factor A)
Day 7	A1 (Control)	253.67	267.33	260.50	
	A2 (BPF-FJ)	272.00	264.33	268.17	.06
	A3 (BPF-D)	268.00	277.00	272.50	
	Mean (Factor B)	264.56	269.55		
	p Value (Factor B)	.21		p (combined) = .09	
Day 14	A1 (Control)	593.33	620.00	606.67$_b$	
	A2 (BPF-FJ)	666.67	633.33	650.00$_a$	0.02
	A3 (BPF-D)	650.00	656.67	653.33$_a$	
	Mean (Factor B)	636.67	636.67		
	p Value (Factor B)	1.00		p (combined) = .19	
Day 21	A1 (Control)	846.67	846.67	846.67$_b$	
	A2 (BPF-FJ)	946.67	1003.33	975.00$_a$	.03
	A3 (BPF-D)	900.00	933.33	916.67$_{ab}$	
	Mean (Factor B)	897.78	927.76		
	p Value (Factor B)	.41		p (combined) = .80	
Day 28	A1 (Control)	1173.33	1313.33	1243.33$_b$	
	A2 (BPF-FJ)	1456.67	1443.33	1450.00$_a$	.02
	A3 (BPF-D)	1336.67	1403.33	1370.00$_{ab}$	
	Mean (Factor B)	1322.22	1386.66		
	p Value (Factor B)	.23		p (combined) = .50	
Day 35	A1 (Control)	1813.33	1643.33	1728.33$_c$	
	A2 (BPF-FJ)	1976.67	1920.00	1948.33$_a$	.00
	A3 (BPF-D)	1856.67	1750.00	1803.33$_b$	
	Mean (Factor B)	1882.22$_a$	1771.11$_b$		
	p Value (Factor B)	.00		p (combined) = .15	

Note: In a row or column, means followed by different letter subscripts are significantly different at 5% level.

Finally, on day 35, the achieved body weight among the six groups ranged from 1,643.33 g (A1B1 – control) to 666.67 g (A2B1 – BPF-FJ, everyday). The supplementation had highly significant effect (p =

.00), wherein A2 (BPF-FJ) was highly significantly different to A3 (BPF-D) and A1 (control). The obtained mean body weight for these groups were 1,948.33 g, 1,803.33 g, and 1,728.33 g for A2, A3 and A1, respectively. Moreover, for the first time, the frequency had highly significant effect (p = .00) at day 35, whereas B1 (every day) with a mean of 1,882.22 g was significantly different at 1% to B2 (every other day) with a mean of 1,771.11 g.

The obtained live weight of the broiler chickens is within the range of market weight in the country, specifically on the 28th and 35th day of production, similar to published researches on broiler in the Philippines (Manuel, 2015; Nicolas, 2017; Plaza, 2017). The results revealed that supplementation with butterfly pea flower improved the body weight of broilers, with better effects from fermented juice compared to decoction. These results concur with the studies of Sapsuha et al. (2023) wherein butterfly pea flower extract supplementation had significantly higher bodyweight compared to unsupplemented chickens in Indonesia. There is limited research to explain the effect of butterfly pea flower (BPF) extract on increasing the weight of broiler chickens, but could be due to improved physiological or metabolic conditions from the beneficial effects of flavonoids, phenols and other phytochemicals in BPF. Published studies on beneficial effects of BPF in humans and animals include anti-oxidant, anti-inflammatory, anti-microbial, and anti-parasitic effects (Gomez & Kalamani, 2003; Muhammad Ezzudin & Rabeta, 2018; Putri et al., 2023).

ADG and FCR

The average daily gain (ADG) is the quotient of the total gain in weight of birds and the number of days of production. Table 3 shows the ADG of the chickens throughout the 35 days production period. Among the different preparations of butterfly pea (*Clitoria ternatea*), the overall highest ADG was in A2 (BPF-FJ) with 1,938.40 g mean ADG, followed by A3 (BPF-D) with 1,793.24 g, and the lowest was in A1 (control group) with 1,718.69 g. On the other hand, the mean for B1 (every day supplementation) was 1872.42 g, and for B2 (every other day) was 1,761.13 g.

Table 3

Average Gain in Weight (Grams) and Feed Conversion Ratio of Cobb® Broiler as Supplemented with Different Preparations of Butterfly Pea (Clitoria ternatea) at Varying Inclusion Frequencies

	Factor A - Treatment	Factor B - Frequency B1 (Every Day)	Factor B - Frequency B2 (Every Other Day)	Mean (Factor A)	p Value (Factor A)
Average daily gain (grams)	A1 (Control)	1803.94	1633.43	1718.69_{c}	
	A2 (BPF-FJ)	1966.59	1910.21	1938.40_{a}	0.00
	A3 (BPF-D)	1846.74	1739.74	1793.24_{b}	
	Mean (Factor B)	1872.42_{a}	1761.13_{b}		
	p Value (Factor B)	0.00		p (combined) = .15	
Feed conversion ratio	A1 (Control)	1.85	1.90	1.87_{b}	
	A2 (BPF-FJ)	1.54	1.70	1.62_{a}	0.03
	A3 (BPF-D)	1.68	1.69	1.68_{ab}	
	Mean (Factor B)	1.69	1.76		
	p Value (Factor B)	0.32		p (combined) = .69	

Note: In a row or column, means followed by different letter subscripts are significantly different at 5% level.

Analysis of variance showed there was no interaction effect for the type and frequency of supplementation, but both the type and frequency of BPF supplement had highly significant effect (p = .00) on ADG, where A2 was significantly different to A3 and A1, while B1 (every day) was highly significantly different to B2 (every other day).

The feed conversion ratio (FCR) or feed efficiency is the amount of feed consumed per kilogram increase in body weight, and lower FCR means better efficiency. The results on the FCR throughout the five weeks production period are shown in the third row of Table 3. Similar to ADG, these results on feed conversion efficiency revealed no interaction effect, and that supplementation with butterfly pea - fermented juice (10%) in drinking water and butterfly pea flower-decoction (10%) in drinking water improved the FCR of broilers. The overall best FCR was in A2 (BPF-FJ) with mean of 1.62, which was comparable to those supplemented with A3 (BPF-D) with mean FCR of 1.68. The control group (A1) had a mean FCR of 1.87. Interestingly, unlike the results for ADG, the results for FCR had no significant difference between the frequencies of supplementation. Daily supplementation (B1) had a mean of 1.69 which was comparable to alternate day supplementation (B2) with 1.76 computed FCR.

These results on ADG and FCR likewise agree with that of Sapsuha et al. (2023), wherein butterfly pea flower extract significantly improved the average daily gain and feed conversion ratio of broilers. These results further illustrate that BPF has good effects on chicken's growth performance, supporting the purported anti-oxidant and other beneficial effects of anthocyanins (Vidana Gamage et al., 2021) and other phytochemicals in BPF (Afrianto et al., 2020). The findings are consistent with other studies that reported enhanced ADG and FCR in chickens supplemented with herbal preparations in the drinking water (Manuel, 2015; Huervana, 2016; Haniarti et al., 2019).

Mortality Data

Table 4 shows the mortality rate on broiler affected by different preparations of butterfly pea (*Clitoria ternatea*) at varying inclusion frequencies. Mortality cases were observed in the first two weeks of production. The obtained average mortality rate for Treatment A1 was 1.17%, while Treatment A2 had 0.67% and Treatment A3 had 0.50%. Out of 126 experimental birds, a total of 14 were counted as mortality, majority (10) of them occurring on the first week. ANOVA revealed that different mixtures did not significantly affect the mortality rate of the Cobb® broiler.

Table 4

Mortality (%) of Cobb® Broiler as Supplemented with Different Preparations of Butterfly Pea (Clitoria ternatea) at Varying Inclusion Frequencies

Factor A - Treatment	Factor B - Frequency		Mean
	B1	B2	
A1 (Control)	1.66	0.67	1.17
A2 (BPF-FJ)	0.67	0.67	0.67
A3 (BPF-D)	0.33	0.67	0.50
Mean	0.89	0.67	

The first week of a chicken's life is the most critical, with the highest cases of mortality compared to other weeks of production stage, partly due to immature digestive and immune systems in the body (Ravindran & Abdollahi, 2021) and inadequate body heat regulation (Fairchild, 2012). The current study was conducted in December to January, the coldest months in the Philippines. First-week mortality was shown to be significantly related to many factors in the breeder farm, hatchery, and brooder house (Yassin et al., 2009). The mortality cases were not subjected to necropsy to properly diagnose the causes of death.

Although there were no statistically significant differences, the lower number of mortality cases in the experimental groups compared to the control may still support the purported medicinal benefits of butterfly pea flower (Gomez & Kalamani, 2003; Muhammad Ezzudin & Rabeta, 2018).

Carcass Traits of Broilers

The results on carcass traits are shown in Table 5, including the carcass weight, carcass percentage, and relative percentage of organ weights (liver, spleen, gizzard, heart) to dressed weight.

The dressed weight of chickens include the weight of the whole carcass when the head, feet, and internal organs of chickens are removed. The highest carcass weight among the treatments was A2 (BPF-FJ) with 1,336.67 g, which was significantly different from A3 (BPF-D) and A1 (control) with dressed weight of 1,190.00 g and 1,135 g, respectively. In terms of frequency of supplementation, B1 (everyday) had the higher dressed weight with 1,276.67 g, compared to B2 (every other day) with 1,164.44 g. Analysis of variance revealed that there were highly significant differences among types of treatments and frequencies (p = .00).

Table 5

Carcass Traits of Cobb® Broiler as Supplemented with Different Preparations of Butterfly Pea *(Clitoria ternatea*) at Varying Inclusion Frequencies

	Factor A - Treatment	Factor B - Frequency B1 (Every Day)	Factor B - Frequency B2 (Every Other Day)	Mean	p Value (Factor A)
Dressed weight (grams)	A1 (Control)	1196.67	1073.33	1135.00$_b$	
	A2 (BPF-FJ)	1383.33	1290.00	1336.67$_a$	0.00
	A3 (BPF-D)	1250.00	1130.00	1190.00$_b$	
	Mean	1276.67$_a$	1164.44$_b$		
	p Value (Factor B)	0.00		p (combined) = .93	
Carcass percentage (%) = dressed wt./live wt.	A1 (Control)	65.99	65.29	65.64	
	A2 (BPF-FJ)	69.94	67.19	68.57	
	A3 (BPF-D)	67.32	64.49	65.91	
	Mean	67.75	65.66		
Liver percentage (%) = liver wt./dressed wt.	A1 (Control)	0.11	0.12	0.12	
	A2 (BPF-FJ)	0.11	0.11	0.11	
	A3 (BPF-D)	0.12	0.11	0.12	
	Mean	0.11	0.11		
Spleen percentage (%) = spleen wt./dressed wt.	A1 (Control)	0.02	0.01	0.02	
	A2 (BPF-FJ)	0.01	0.01	0.01	
	A3 (BPF-D)	0.02	0.01	0.02	
	Mean	0.02	0.01		
Gizzard percentage (%) = gizzard wt./dressed wt.	A1 (Control)	0.09	0.08	0.09	
	A2 (BPF-FJ)	0.07	0.08	0.08	
	A3 (BPF-D)	0.09	0.08	0.09	
	Mean	0.08	0.08		
Heart percentage (%) = heart wt./dressed wt.	A1 (Control)	0.02	0.02	0.02	
	A2 (BPF-FJ)	0.02	0.02	0.02	
	A3 (BPF-D)	0.02	0.03	0.02	
	Mean	0.02	0.02		

Note: In a row or column, means followed by different letter subscripts are highly significantly different at 5% level.

The carcass percentage (%), or the ratio of dressed weight to live weight of chickens, ranged from 65% to 68% in the current study, and analysis of variance showed that there was not significant difference among the treatment groups whether in terms of BPF preparation, frequency, or both. The results on relative organ weights for the edible organs (liver, spleen, gizzard and heart) also revealed non-significant

differences among treatments and frequency. These results concur with published researches where carcass traits were mostly not affected by supplementation (Nicolas, 2017).

Conclusion

Based on the results of the experiment, the production performance, specifically body weight, average daily gain, and feed conversion ratio, revealed highly significant differences among different treatments and frequencies. Among treatments, butterfly pea flower–fermented juice (10%) in drinking water produced the best results, followed by butterfly pea flower–decoction. Between the frequencies, it was everyday supplementation that had the better obtained performance values.

No significant differences were observed among treatments and frequencies on dressed weight, carcass percentage, and relative organ weights for the edible organs such as liver, spleen, gizzard, and heart.

Recommendations

For improved broiler performance, butterfly pea flower (fermented plant juice) 10% in drinking water may be administered every day to broiler chickens starting day 8 of age. Further studies on the butterfly pea flower varieties in the province of Bulacan and in the country may be studied as supplement in feed and drinking water of broilers and other farm animals, to ascertain their beneficial effects on production performance, as affected by different environmental conditions, management practices, or physiological mechanisms.

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Workplace Challenges Based on Sexual Orientation Among LGBTQIA+ in the Restaurants of Calamba City

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Abstract

Challenges in the workplace can take many different forms, but it generally involves unfair treatment based on characteristics such as gender, gender identity, or sexual orientation. This study is an attempt to gain a thorough understanding of the discrimination experienced by employees at quick-service restaurants, guided by the *Gender Spectrum Theory* which refers to the idea that gender is a spectrum not limited to male or female, and that gender is externally communicated through behavior, clothing, haircut, voice and other forms of presentation. This study, which utilized a convergent mixed-method design, aimed to determine the top workplace challenges faced by employees in quick-service restaurants, explain discrimination based on those stated challenges, identify emerging themes, and, lastly, propose an action plan based on the results and findings. Respondents of the study included five (5) currently employed crew members from a quick-service restaurant in Calamba City. Findings revealed that lack of empowerment and career dissatisfaction were the top workplace challenges that the participants encountered. When asked to define gender discrimination, they indicated that it involves the right to express one's gender or the kind of person one is. The most prevalent difficulties they encountered had to do with their physical appearance. The themes that emerged are divided into the major themes of gender discrimination, gender equality, workplace discrimination, workplace challenges, and workplace policies. The findings emphasize the importance of integrating and implementing legal legislations like the Magna Carta for Women and the Safe Spaces Act to ensure equal opportunities for people of diverse SOGIESC.

Keywords: *gender, LGBTQIA, restaurant, sexual orientation, workplace challenges*

Introduction

The restaurant sector is dominated by men owing to the physically hard nature of the labor and the male-dominated nature of kitchen jobs. With an increasing number of women encountering workplace discrimination, sexual orientation-based inequality has also been a major problem. Twenty percent of Americans with diverse SOGIESC have faced discrimination in terms of job applications, salary, promotions, and exposure to discriminatory jokes because of their sexual orientation or gender identity, according to research published by *National Public Radio*, the *Robert Wood Johnson Foundation* and the *Harvard T.H. Chan School of Public Health* (2017). Other forms of discrimination include harassment related to restroom access, restrictive dress codes, misgendering, and intrusive questions (Guillermo,

2018). Transgender employees often face unique forms of harassment compared to other individuals with diverse SOGIESC, such as limited access to restrooms, misgendering through incorrect pronouns, tolerating intrusive or inappropriate questions, experiences of social exclusion, or deliberate avoidance (Rudin et al., 2020).

The United Nations Guiding Principles on Business and Human Rights offers organizations a foundation for providing a supportive workplace for all employees, regardless of their identities or gender. Having inclusive and diverse regulations protects people with diverse sexual orientation, gender identity and expression, and sex characteristics (SOGIESC) from workplace harassment and abuse. Additionally, as businesses become more inclusive of the people with diverse SOGIESC, they gain more than they lose, as it allows for increased creativity, productivity, and personal growth (Guillermo, 2018).

In the Philippine context, there are a number of legal frameworks aimed at promoting equality to eliminate discrimination against women and people with diverse SOGIESC, including the Magna Carta for Women (Republic Act No. 9710), the Safe Spaces Act (Republic Act No. 11313) and the pending SOGIE Equality Bill. Magna Carta for Women (2009) or Republic Act No. 9710, is a comprehensive law that aims to eliminate discrimination against women and promote gender equality. The law seeks to protect, fulfill, and promote the rights of Filipino women by recognizing and protecting their human rights. The Safe Spaces Act (2019), on the other hand, covers gender-based sexual harassment in public spaces, workplaces, educational institutions, and even in the online space. It defined gender-based sexual harassment (GBSH) as unwanted and uninvited sexual actions or remarks. The definition includes catcalling or unwanted remarks directed towards a person, persistent uninvited comments or gestures, relentless requests for personal details, statements of sexual comments and suggestions, public masturbation or flashing of private parts, verbal or physical advances, persistent telling of sexual jokes, and stalking. Finally, the SOGIE Equality Bill, which is still pending for implementation, affirms the rights of every individual, irrespective of their sexual orientation or gender identity. It aims to ensure equitable access to essential social services, opportunities, healthcare, protection, and justice for all, while actively recognizing and addressing the systematic barriers that faced by people with diverse SOGIESC.

Additionally, national GAD mandates require both public and private organizations to integrate gender and development into their systems, structures, policies, programs, processes, and procedures, as outlined in the Joint Memorandum Circular 2024-01 (2024), also known as the Localization of the Magna Carta of Women. This focuses on locally reinforcing equality laws for women. The Implementing Rules and Regulations (IRR) of Safe Spaces Act (2019) reinforce the accountability of local government units (LGUs) and employers in upholding and enforcing the law. Specifically, Section 19 of the IRR mandates that employers and individuals in positions of authority within an organization take proactive measures to prevent, address, and sanction gender-based sexual harassment (GBSH) by employees, regardless of whether such incidents occur inside or outside the workplace. These legal provisions collectively emphasize the duty of employers to cultivate a workplace culture that embraces inclusivity and ensures equal treatment for all—including men, women, and individuals with diverse SOGIESC.

However, despite this, according to the Philippine LGBT Chamber of Commerce's Corporate SOGIE Diversity and Inclusiveness (CSDI) Index, no Philippine-based companies have implemented policies to protect their employees from sexual orientation, gender identity, and expression (SOGIE) discrimination, despite a 73% acceptance rate of homosexuality among Filipinos (Poushter & Kent, 2020). The majority of businesses feel that safeguarding workers with diverse SOGIESC from discrimination is not a pressing problem, based on the notion that employees with diverse SOGIESC represent a tiny portion of the workforce. In addition, companies assume that inclusivity measures, such as establishing an all-gender restroom and giving insurance coverage for same-sex spouses, are costly, although there

are cheaper options (Casal, 2018; *CSDI Index*, 2018).

Despite improving legislation and public acceptance among people with diverse SOGIESC, discrimination based on sexual orientation has been a continuously explored research topic among scholars due to the prevailing issues. The study by Darroca et al. (2024) utilizes a qualitative narrative analysis to explore the practices related to hiring, promotion, and salary in the Filipino hospitality industry. The research reveals gender segregation, biases in leadership, and a lack of transparency in hiring and promotion processes. Women's responsibilities for childcare and household duties were identified as factors that limit their flexibility, career commitment, and access to training and advancement opportunities. Ahmed and Hammarstedt (2021), on the other hand, investigated whether customers and workers discriminate against gay and lesbian business owners in the US.

The study revealed that the sexual orientation of restaurant owners influenced participants' engagement, particularly in purchasing and applying for jobs. Sears et al. (2021) examine the employment discrimination and harassment against people with diverse SOGIESC. The reports show that 40% of workers with diverse SOGIESC experienced unfair treatment at work related to being fired, not hired, or harassment due to their sexual orientation. Moreover, 37.7% of the employees with diverse SOGIESC experienced at least one form of harassment at work, including physical and verbal slurs and even sexual harassment. Tshisa and van der Walt (2021) investigated Black queer employees' psychological well-being and their experience of workplace discrimination. Participants are said to have experienced derogatory comments, casual transphobia, non-inclusive organizational policies, and hostile working environments. In terms of their well-being, the participants have developed resilience to cope with workplace challenges by accepting, celebrating, and appreciating their identities.

Similarly, Ng et al. (2024) investigated the experiences of workplace discrimination and harassment among people with diverse SOGIESC in Singapore. Half of the participants (50.86%) reported experiencing at least one instance of harassment. Among them, 38.78% experienced verbal harassment through humiliating or offensive jokes.

Although previous literature has provided insights into workplace challenges related to sexual orientation, this research has not examined the restaurant industry, which is highly hierarchical and can exacerbate power imbalances, making it difficult for marginalized groups to report misconduct (Burrell et al., 2024). Moreover, it can be observed that all reviewed research focuses on a global setting, particularly in countries such as the US and Singapore. However, in the Philippines, which has a different geographical context due to the general public having high tolerance towards people with diverse SOGIESC compared to other Asian nations (Oducado, 2023) and a more progressive legal and institutional framework towards SOGIE, there are still negative experiences towards gay men and lesbians due to societal divide (Alibudbud, 2024).

Through the literature reviewed, it was identified that there is a research gap focused on the restaurant industry, leading the researchers to conduct a study focused on investigating the workplace challenges based on sexual discrimination experienced by employees working in quick-service restaurants. This highlighted not only the gaps in the policy implementation but also the pressing need for greater employer accountability and gender equality in a gender-stereotyped industry like the restaurant industry.

Materials and Methods

Combining descriptive and case study methods, this research used a convergent design. As defined by Creswell (2022), qualitative and quantitative data were collected simultaneously. In a convergent mixed-method design, both data sets provide different insights, and the combination offers

multiple angles and perspectives. The quantitative results yield general trends and relationships, while qualitative results provide an in-depth personal perspective of individuals. In this study, the quantitative data focused on identifying the demographic profile. In contrast, the qualitative data focuses on determining the experience of the participants towards discrimination based on sexual orientation in the workplace. With this method, the combination of the gathered data not only provided more information but also a more complete understanding of the topic being undertaken.

The researchers initially identified the workplace problems encountered by 100 restaurant workers in Calamba City, Laguna. The instrument was adapted from Ali's (2014) study entitled *Challenges Facing Female Employees in Quick Service Restaurants: A Case Study in Egypt*. While the qualitative phase involved five individuals, they were selected from the initial 100 using purposive sampling for in-depth interviews. The small sample size reflects both the exploratory nature of the research and the difficulty of identifying participants due to the sensitivity of the topic. This also implies that generalizing the study's findings should be done with caution. The following criteria were used to screen participants for the interview: (1) currently employed as restaurant personnel or crew; (2) individuals with diverse SOGIESC; and (3) at least three years of work experience in the restaurant industry. Structured interviews were conducted to explore their experiences of employment discrimination. To gain a comprehensive understanding of gender discrimination in quick-service restaurants, the researchers also designed a systematic questionnaire.

In the study, two types of data were gathered. Primary data refer to information obtained firsthand by the researchers. This includes survey questionnaires as well as the experiences and thoughts shared by the participants during structured interviews. Secondary data, on the other hand, refer to information gathered from already published books, journals, and other publications.

Before the questionnaires and guiding questions were distributed and the interviews conducted, these instruments were first evaluated and validated by the panel. Due to the limitations on face-to-face engagement imposed by COVID-19, the survey questionnaire was transferred to Google Forms upon approval. After the panel members approved the Google Form surveys, the researchers disseminated them to their respective respondents, who were instructed to complete the questionnaire as truthfully as possible.

As for the ethical considerations of the study, the researchers sought consultation and instrument validation from the campus chairperson of the Gender and Development Office to ensure that the questions would avoid causing any harm, discomfort, or distress toward the participants. Moreover, this led the researchers to use the *Harmonized Gender and Development Guidelines* (HGDG) to ensure that the research complied with the standards to be gender-responsive. Before conducting qualitative interviews with the target participants, the researchers prepared a letter of request and intent. This highlighted that their participation is voluntary and they have the right to withdraw at any time. It also included provisions that the results and findings will be utilized purely for academic purposes and that all responses would be kept strictly confidential. To protect participants' confidentiality, coding was used in all transcripts and reports in replacement of their names and the place of employment. To avoid researcher bias, triangulation was utilized to cross-check and validate findings through interview findings and related literature.

Quantitative data were analyzed using weighted mean and standard deviation. On the other hand, to analyze the qualitative data, the researchers began by preparing the data through transcription and translation of interview results, while also taking note of the observations and on-site analysis. The data were then transferred to a spreadsheet application to assign codes and categorize the responses. After the initial coding, codes were reviewed to combine similar ones. This was followed by using spreadsheet

applications to identify themes and generate a word cloud.

Results and Discussion

Workplace Challenges

Workplace challenges of employees with diverse SOGIESC of quick service restaurants are presented in Table 1. Respondents rated their experiences on workplace challenges based on Ali's (2014) research, suggesting lack of empowerment ($\bar{x}$ = 3.00, SD = 1.00) and career dissatisfaction ($\bar{x}$ = 2.80, SD = 1.10) as the most significant challenges. Although the composite mean of 2.19 (SD = 0.971) is overall moderate, the relatively high means of lack of empowerment and career dissatisfaction appear to be a pressing issue in the respondents' workplaces.

Table 1

Workplace Challenges of LGBTQIA+ Employees of Quick Service Restaurants

Workplace Challenges	Mean	SD	Interpretation
Too much workload	1.80	0.837	Slightly evident
Moral problems	2.40	0.894	Slightly evident
Low payment	2.40	1.140	Slightly evident
Physical Problems	2.20	0.837	Slightly evident
Uncomfortable work environment	2.60	1.342	Evident
Extra working hour without payment	2.60	0.894	Evident
Job is not combined with parenthood	1.80	0.837	Slightly evident
Ignoring personal opinion	2.40	1.342	Slightly evident
Difficult working condition	2.20	1.304	Slightly evident
Promotion discrimination	2.40	1.140	Evident
Disrespect from society	2.00	1.000	Slightly evident
Discrimination in evaluation	1.60	0.894	Slightly evident
Boring work routine	2.40	1.140	Evident
Lack of empowerment	3.00	1.000	Evident
Unsuitable working shift	2.00	1.000	Evident
Lack of motivation	2.20	1.095	Evident
Career dissatisfaction	2.80	1.095	Slightly evident
Payroll discrimination	2.20	1.304	Slightly evident
Lack of job responsibility	2.20	1.095	Slightly evident
High turnover	2.00	1.000	Slightly evident
Skills development problems	2.20	0.447	Slightly evident
Employment discrimination	2.40	1.140	Slightly evident
Lack of participation	2.40	1.140	Slightly evident
Lack of training opportunities	1.40	0.548	Slightly evident
Obligatory changes in my habits and traditions	1.60	0.548	Slightly evident
Lack of communication with colleagues and managers	2.60	1.140	Slightly evident
Difficulties when working as a team	2.40	0.548	Slightly evident
Unsuitable uniform	2.40	0.894	Slightly evident
Bad treatment from customers	1.60	0.548	Not evident
Family reject my career	1.80	1.304	Not evident
Difficulties in working with hair cover	1.80	0.837	Not evident
Composite Mean	**2.19**	**0.971**	**Slightly evident**

Legend: 4.00–3.50 = strongly evident; 3.49–2.50 = evident; 2.49–1.50 = slightly evident; 1.49–1.00 = not evident

The results of the study suggest that respondents are experiencing lack of empowerment which is considered under personal challenges (Ali, 2014). When employees are neither empowered nor motivated, the second-highest mean of career dissatisfaction tends to be common among respondents.

In relation, Lee et al. (2018) stated that empowering employees leads to stronger job performance, job satisfaction, and commitment to the organization.

In a highly stressful environment such as that of the quick service restaurants, the high workload experienced by everyone in the workplace can lead to the lack of empowerment and motivation from the managers. Lao and Borbon (2021) cited reasons like burnout, sense of underappreciation and undervaluation, unfair compensation, and unreasonable workload, excessive overtime, ineffective management, lack of clear alignment between work and corporate goals, and adverse workplace culture.

The conducted survey does not further explain why employees feel disempowered or whether discrimination plays a role in these results. To address this gap, the qualitative data focused on the participants' definition of gender discrimination, and gender equality, discrimination experiences, established policies in the workplace were investigated.

Discrimination Based on Sexual Orientation

Before beginning the qualitative interview, the demographic profile of the participants was gathered. Five participants, all aged between 22 and 23, were currently working in quick service restaurants in Calamba City. Three of the five participants are female. The researchers chose representatives from people with diverse SOGIESC. They reported earning a monthly income between ₱5,001 and ₱10,000, and all were employed as service crew. Two participants had been working for less than a year, two for 1–5 years, and one for 15–20 years.

When asked about their definition of gender discrimination, they mentioned the right to express what gender or type of person they are. Participant 1, a female bisexual, quoted:

> *Para sakin ang gender discrimination and gender equality ay same situation lang.* This issue is something that needs to be prevented because discriminating against someone just because of their identity is not a proper act of a normal person. *Ang pagiging lesbian, gay or any gender ay hinde isang krimen o kasalanan* and anyone has a freedom to express what gender or type of person they are and all people must be respected and treated as human for being a lesbian, gay, woman, man, bisexual or whatever gender identity a person has. (Gender discrimination and gender equality are the same thing. This is an issue that needs to be addressed, because discriminating against someone based solely on their identity is not the proper behavior of a decent person. Being lesbian, gay, or of any other gender is not a crime nor a sin, and everyone has the right to express their gender identity and who they are. All people—whether lesbian, gay, women, men, bisexuals, women, men, or of any identity—deserve to be respected and treated as human beings.)

From this response, it is evident that regardless of an individual's gender, all people must be respected and treated as humans, regardless of their SOGIESC. One of the most common challenges they experienced was related to their physical appearance. Participant 4, who is a homosexual female, shared that she was judged for cutting her hair and was assumed to be a lesbian without anyone knowing her reason for the haircut. Meanwhile, another participant, who is gay, was reminded to maintain a "standard" haircut for boys. Participant 5, who identified as gay, mentioned that:

> …Like *ng hair length hindi kami allowed na mag pahaba ng buhok at dapat laging proper hair cut tulad ng sa boys even Naka hair net kami*, hairband and Cup. They always say mga "*lalake" mag pagupit kayo ang hahaba na ng buhok nyo then titingin sila sakin then say ng " pati ikaw* ". my point is why are we not allowed, *anong pinag kaiba sa mga girls na naka duty na mahaba ang buhok*, *we're the same proper uniform na sinusunod*. They are know those Gays *na* hair is so much important part of our confident and It is part of our personality. ("…like the hair length, we

> are not allowed to have long hair and must have a proper hair cut for boys, even if we wear a hairnet, a hair band, and a cap. We would always hear them say, 'To all boys, you need to have your haircut done,' and then they would look at me and say, 'You included.' Why we are not allowed? What's the difference between us and the other girls who are also on duty with long hair and wearing the same uniform as we do? For us gays, hair is very important—it's part of our confidence and personality.")

These responses show that the physical appearance of employees with diverse SOGIESC remains a significant issue in their workplace. Although this concern is particularly prevalent among gay and transgender employees, the study also revealed that even individuals who do not identify within the SOGIESC spectrum were judged based on changes in their appearance. According to the *Gender Spectrum Theory* (Tharp, 2016), gender is not confined to the traditional binary of male and female but instead exists on a continuum with a wide range of identities and expressions. This suggests that when participants express themselves in ways that deviate from social norms or expectations—regardless of whether they identify as LGBTQIA+—they are often subject to judgment based on appearance. The concept of gender stereotyping further explains this phenomenon. Gender stereotyping refers to generalized views or preconceptions about the attributes, characteristics, or roles that men and women are expected to possess or perform (United Nations, 2014). Such stereotyping is harmful as it limits individuals of diverse SOGIESC in developing their personal abilities, pursuing professional careers, and making autonomous life choices. As a result of these experiences, participants often feel compelled to conform to expected norms.

For gay and transgender individuals, this is very important part of their identity, as it helps them to gain confidence while working. The findings coincides with the study of Sims (2018), stating that the restaurant industry often enforces strict dress codes that inadvertently perpetuate gender stereotypes, making it difficult for employees to express their identity. The lack of understanding of diversity within these establishments—and even across the industry—leads to increased pressure on gay and transgender individuals to conform to traditional appearance norms to just avoid discrimination.

These situations can explain the lack of empowerment that the respondents experienced in relation to the quantitative results of the study. Physical appearance, which is considered one of the main mediums of identity expression among participants, was being restricted by the management. The strict appearance code among employees led to the decreased feeling of belongingness in the organization and low self-confidence (Fletcher & Swiercyznski, 2023).

According to the ILO (2012), a significant number of transgender job applicants are denied employment during interviews solely based on their appearance. Common workplace challenges include the lack of access to identity documents that align with their affirmed gender and name, employer resistance to their gender expression—such as through clothing—and restrictions on using restrooms that match their gender identity. These issues are often compounded by heightened exposure to bullying and harassment from colleagues. Another challenge that they encounter pertains to the prejudices that society have towards persons with diverse SOGIESC. Participant 5 quoted:

> *I think yung time na na-experience ko yung discrimination and inequality is nung iba na yung treatment sakin dahil nga sa identity ko or gender ko if gay or bakla ka it means you're automatically a war freak, maingay, magulo at bastos kase some of those gay kahet hinde naten aminen may ganon klaseng bakla or gay so nag rereflect yung ganong tingen sa lahat so may time na iniiwasan ako maybe because of that issue dahil don wala akong magawa kung hinde hayaan sila. (*"I think the time I experienced discrimination and inequality was when others treated me differently because of my identity or my gender. If you are gay or lesbian it means you're automatically a war

freak, noisy, chaotic and rude because some gays are like that, so it reflects on other gays. So they avoided me and maybe because of that issue, I couldn't do anything but to let them.")

It shows that people often associate negative behavior with individuals of a different gender. Anti-gay arguments typically depend on a view of homosexuality as a behavior, whereas liberator arguments focus on homosexuality as an identity. These persist due to hostile environment (Maji et al., 2023), lack of comprehensive policies that protect employees with diverse SOGIESC (Sachdeva, 2024), and social stigma (Villarino et al., 2024).

Four out of five respondents stated that their restaurant had no policy on gender equality or discrimination. This lack of formal protection for employees with diverse SOGIESC is concerning given that there are legal and national frameworks in the Philippines that are put into place to promote equality and inclusive workplaces for all. This includes the Magna Carta for Women (Republic Act No. 9710), the Safe Spaces Act (Republic Act No. 11313) and the yet to be signed SOGIE Equality Bill. Mane (2023) stated that the absence of robust anti-discrimination laws further exacerbates the challenges faced by employees with diverse SOGIESC, who may fear retaliation for reporting incidents of discrimination. Amongst the participants, only one acknowledged having a gender and development policy. Participant 3 who identifies as a male homosexual, stated the following when asked whether the programs or policies in promoting gender equality are effective:

"I think no, but I hope that all restaurants or quick-service restaurants have a program and policies about gender discrimination and gender equality."

These findings suggest a disconnect between national legal mandates and the actual workplace practices. Through the lens of *Gender Spectrum Theory*, the lack of policy implementation further limits employees of diverse SOGIESC to conform with the norm and move within the barriers of gender binary, (Williams, 2022) thus limiting their authentic self and workplace inclusion.

There are several reasons why businesses should actively avoid fostering or permitting gender prejudice. Another reason is that doing so exposes firms to litigation, fines, and significant income loss. However, the some reasons are not as straightforward as simply avoiding a lawsuit. Ethical businesses choose to eliminate gender discrimination in the workplace because they aim to foster a culture and community that honors workers regardless of gender (*SelectOne*, 2019).

Table 2

Emerging Themes on Gender Stereotyping Based on Participant Statements

Themes	Statements
Stereotyping	"Being called tomboy even if they recognize themselves as lesbian or bisexual" "If you're a gay or lesbian, they are automatically classified to be war freak, noisy, chaotic and rude" "Just because they are lesbian, they were asked to do responsibilities for a man" "Transgenders should be allowed to be able to wear their preferred outfit, length of hair" "A straight participant was called lesbian after cutting her hair short"
Undervalued employees	"Extra workload without payment" "Lack of communication to colleagues and managers" "Bad treatment from customers" "No program or policy for gender discrimination" "Policy exists in the restaurant but not effective"

Table 2 presents the emerging themes from the participants' responses, highlighting issues stereotyping and the experience of being undervalued as employees.

Stereotyping emerged from the participants' responses, revealing that they were often placed into boxes simply because they are gay, lesbian, male, or female. Based on their statements, these stereotypes stemmed from labels, behaviors, assigned responsibilities, uniforms, and haircuts. For example, a female homosexual participant was judged when she cut her hair and was immediately assumed to be a lesbian, without anyone knowing the reason behind her haircut. It supports the lack of empowerment and career dissatisfaction reported on the quantitative results. This indicates that having short hair is often equated with being a lesbian, simply because it does not conform to conventional expressions of femininity—leading to unwarranted assumptions from others. Interpreted through the lens of *Gender Spectrum Theory*, the participants' experiences reveal how they are persistently confined within binary gender norms in the workplace. Tabassum and Nayak (2021) mention that stereotyping women leads to disempowerment. In the context of this research, when LGBTQIA+ individuals are stereotyped based on their physical appearance and what they are perceived to be capable or incapable of doing, it results in a lack of empowerment among them.

"Undervalued employees" is another theme that emerged from the participants' responses. It is based on the topics related to inadequate financial rewards, poor communication, mistreatment from customers, lack of policy provision, and ineffective implementation of policy related to gender discrimination. Just like stereotyping, being undervalued supports the quantitative results of lack of empowerment and career dissatisfaction. As Ridzki (2025) explained, as employees feel undervalued, their sense empowerment weakens, which can further lead to decrease in morale and productivity. Intersectionality theory helps explain how employees of diverse SOGIESC can be undervalued due to their gender because of overlapping social identities—like race, gender, sexuality, class, etc.—which interact to shape unique experiences of disadvantage in the workplace (Hudson et al., 2023).

Both themes of stereotyping and undervalued employees present the persistence of the issues related to the gaps in the implementation of national mandates of gender and development. Under the national legal frameworks of Magna Carta of Women (Republic Act No. 9710) and the Safe Spaces Act (Republic Act No. 11313) these may be constituted as a violation, especially since both of these frameworks mandates equality and inclusivity in the workplace.

Conclusion

In conclusion, the study highlights significant workplace challenges. Based on the results, there is an overall moderate workplace challenge experienced, however the lack of empowerment and career dissatisfaction emerged as crucial issues among LBGTQIA+ employees. Physical appearance brought by strict appearance policies, like uniform and hair cut attributes to stereotyping. The themes of stereotyping and feeling undervalued are closely related to the lack of empowerment and career dissatisfaction. These issues arise from defying gender norms in appearance, limitations placed on responsibilities, neglected financial rewards, poor communication, mistreatment from customers, and the lack of clear policies or the ineffective implementation of existing policies related to gender discrimination.

Recommendations

Based on the findings of the study, the researchers recommend that the Local Government of Calamba, through its Gender and Development Office and Business Processing and Licensing Office, pass a City Ordinance mandating the creation of a Gender Discrimination Policy in each establishment. This should be adopted by all tourism- and hospitality-related businesses as part of the requirements for

business permit renewal. After the initial submission of the policy crafted by each establishment, quarterly monitoring reports on its enforcement and implementation should be required.

Furthermore, future researchers may consider increasing the sample size and including a more diverse population, covering different service sectors and exploring intersecting identities such as age, socioeconomic class, and religion.

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Impact Assessment of the Coffee Rejuvenation and Rehabilitation Project to Coffee Farmers

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Abstract

This study assessed the impact of the coffee rejuvenation and rehabilitation project on coffee growers in Brgy. Talbak, Doña Remedios Trinidad, Bulacan. The study employed a descriptive research design to assess the impact of the project on 36 coffee farmers in the study area. The result characterized the socio-demographic and farm profiles, the usefulness of the intervention provided, the benefits of the project, and the problems encountered by coffee farmers. The majority of coffee farmers surveyed were male, married, and members of the farmers' group. Though many of them were elementary and high school undergraduates, they had already received training in coffee production and processing. The majority were owners of the farm and planted the Robusta variety of coffee. The findings showed that from 2018, coffee rejuvenation and rehabilitation have led to a decrease in production from an average of 257.25 kg to 142.28 kg and income from an average of ₱28,297.50 to ₱17,073.33. Timing is crucial for successful rejuvenation; ideally, it should begin during the rainy season or when soil moisture is sufficient to promote optimal plant recovery and minimize stress. Also, some external factors were observed to contribute to the decrease in coffee production. One of these was the insufficient technical training provided to coffee growers, as each farmer attended only an average of five to six trainings covering coffee production to marketing. Furthermore, the improper and insufficient application of fertilizer was also identified as a reason for the lower coffee yields. Lastly, given the observed decrease in production and income, ongoing and targeted assistance from local and regional agricultural offices and extension workers is crucial to effectively guide farmers through the revitalization process and ensure the long-term success and sustainability of coffee yield in the municipality.

Keywords: *coffee, coffee farmers, local, rehabilitation, rejuvenation*

Introduction

In 2024, the Philippines produced a total of 9.42 thousand metric tons of coffee, indicating a moderate level of national output within the global context. Robusta remained the dominant variety, accounting for 73.5% of the total production during the quarter, largely due to its higher yield potential, resilience to pests, and suitability to lowland growing conditions (Philippine Statistics Authority [PSA], 2023). Annual per capita consumption was estimated at 3.05 kg, reflecting not only the growing domestic demand but also the cultural significance of coffee in daily life. Despite this growing local market, coffee

exports remained modest, with coffee exports valued at only USD 217,000, mainly shipped to the United Arab Emirates, Japan, and Qatar (OEC.world, 2024). This low export value suggests that the Philippines has yet to scale up its competitiveness in the international coffee market, possibly due to limitations in quality consistency, branding, and production volume.

At the regional level, SOCSARGEN (South Cotabato, Cotabato, Sultan Kudarat, Sarangani, and General Santos) emerged as the country's leading coffee-producing area, contributing 3,150.40 metric tons, or 33.4% of total national output. This concentration of production highlights the region's favorable agro-climatic conditions and established farming systems. It was followed by Northern Mindanao (13.7%) and the Davao Region (12.3%), both known for their elevation advantages and long-standing agricultural infrastructure. Central Luzon, including parts of Bulacan, contributed 470.75 metric tons, a comparatively smaller share, but still indicative of its potential as a coffee-growing area.

One notable coffee-producing locality in Central Luzon is Brgy. Talbak, Doña Remedios Trinidad (DRT), Bulacan, recognized since 2002 as the "Coffee Capital of Bulacan" under the One Town, One Product (OTOP) program (Mananghaya, 2002). Occupying about one-third of Bulacan's total land area, DRT's topography and elevation averaging 542 feet, with slopes favorable for water drainage, making it ecologically suitable for quality coffee production. Although its elevation is lower than ideal for high-grade Arabica, the slopes still provide a good environment for Robusta, which dominates local production. However, coffee production in DRT has been on a downward trend, primarily due to the aging of coffee trees, many of which are 20 to 30 years old. These older trees tend to produce lower yields, are more vulnerable to pests and diseases, and require higher maintenance—contributing to diminished productivity and farmer profitability. This mirrors a broader trend observed in many smallholder coffee regions where farm rejuvenation is delayed due to limited resources.

In response, the Department of Agriculture launched a coffee rejuvenation and rehabilitation project in 2018. The initiative aimed to revitalize aging coffee trees and improve farmer livelihoods through a series of targeted interventions. 101 farmer beneficiaries participated, receiving technical training, farm equipment, and agricultural inputs, such as fertilizers and seedlings. These resources were intended to enhance cultivation practices, improve yields, and modernize production techniques. Prior to the project, local farmers sold their unprocessed coffee beans to a private company, which transported them to Batangas for value-adding and marketing—a system offered limited returns. With support from the government, the growers have since organized into a coffee farmers' association, enabling them to process and market their own coffee products locally. This shift signifies a transition from being raw material suppliers to active players in the value chain, potentially increasing their income and community development.

This study aims to evaluate the impact of the Department of Agriculture's coffee rejuvenation and rehabilitation project on coffee growers in Brgy. Talbak, Doña Remedios Trinidad, Bulacan. Specifically, it examines how the intervention has influenced coffee yield performance, farmer income levels, and local enterprise development. By interpreting production statistics and tracing their causes and outcomes, the study contributes to a better understanding of how targeted agricultural interventions can address systemic issues in local coffee farming and promote sustainable rural development.

Materials and Methods

The researcher used descriptive design in this study, focusing on socio-demographics of the coffee growers, farm profile, production, and marketing, the usefulness of the intervention, benefits of the project, and problems encountered by coffee growers, and the situation of coffee growers after rejuvenation. The researchers asked permission from the Provincial Agriculture Office of Bulacan to obtain the necessary documents needed to carry out the study. Data collection was carried out using the

survey method, which involved face-to-face interviews with selected respondents. A pre-tested questionnaire was used to gather the necessary information from 36 purposely selected coffee growers who served as respondents of the study. The survey questionnaire's content was subjected to reliability and validity test using Cronbach's alpha and pre-tested to 30 farmer respondents who shared the same characteristics but were not included as respondents of the study. The respondents were chosen from the 2018 list of coffee growers who benefited from the Department of Agriculture's coffee rehabilitation and rejuvenation project. The collected data was summarized, tabulated, and analyzed using statistical analysis software (Statistical Package for the Social Sciences [SPSS]). Percentages and frequencies were utilized to determine the socio-demographic characteristics of coffee growers, such as age, sex, civil status, and educational attainment. Additionally, they were applied to assess farm profile such as land tenure status, total farm size, area allocated for coffee cultivation, area dedicated to the project, total number of coffee trees, number of trees allocated for the project, and years of experience in coffee farming. Tests of means and standard deviation were used to determine the usefulness of the intervention provided, the benefits of the project, and the problems encountered by the coffee growers. The study followed basic ethical guidelines for research with people. All respondents gave their informed consent before joining the study.

Results and Discussion

Socio-Demographic Profile of Coffee Farmers

The socio-demographic profile of coffee producers in terms of gender, civil status, educational attainment and source of income is presented in Table 1.

Table 1

Socio-Demographic Profile of Coffee Farmers

Category	Frequency	Percentage
Age		
Young Adults (18-35)	1	2.78%
Middle-aged adults (36-55)	14	38.89%
Older adults (56 and above)	21	58.33%
Sex		
Male	34	94.44%
Female	2	5.56%
Civil Status		
Single	2	5.56%
Married	33	91.67%
Widow	1	2.78%
Highest Educational Attainment		
Elementary Level	11	30.56%
Elementary Graduate	6	16.67%
High School Level	11	30.56%
High School Graduate	6	16.67%
College Graduate	1	2.78%
Vocational	1	2.78%
Source of Income		
Farming	27	75%
Salary	4	11.11%
Business	5	13.89%

n = 36

The majority of coffee growers (58.33%) were classified as older adults, suggesting that younger people may not be interested in farming. This trend could lead to future challenges, such as a shortage of agricultural labor and decreased coffee production. Ngeywo et al. (2015) concluded that coffee growers had reached adulthood, with ages ranging from 50 to 70 years, indicating that they had attained their peak productivity. Furthermore, the study found that young adult participation in coffee cultivation was minimal both before and after the rejuvenation. This suggests a potential scarcity of coffee farmers in the coming years.

The majority of coffee growers (94.44%) were male, while females comprised only 5.56% of the population. Most growers (91.67%) were married, while the rest of them were single and widows. This suggests that coffee farming is mostly done by male heads of households, and women may have limited involvement in this work. It may also mean that decisions about farming and income are mainly made by men. To promote equal opportunities, it could be helpful to encourage more female participation and support women's roles in coffee farming. These findings are supported by Ngeywo et al. (2015), who stated that males were the empowered holders of farms rather than females, and that the majority of the farmers were married.

The table also shows that, in terms of educational attainment, most of the respondents were at the elementary and high school levels, each reflecting a high percentage of 30.56%. Additionally, the results indicated that the majority of the farmers relied on farming as their main source of income. This suggests that most respondents depend on farming for their livelihood, highlighting the need to support and strengthen this sector to help improve their economic well-being.

Farm Profile of Talbak Coffee Farmers

Long-Term Coffee Farming Experience

The participants' average of 28.78 years of experience in coffee farming indicates that they have a substantial background in coffee production. This extensive experience is important because it shows that these farmers have a comprehensive understanding of both the benefits and challenges of coffee cultivation. Specifically, they are well-equipped to adapt to changes in the market, economic conditions, and environmental factors, which are essential for maintaining a successful coffee farm. Results reveal that, experienced farmers are more likely to apply sustainable farming techniques and are better suited to dealing with these challenges. Since they personally recognize the possible long-term advantages of these techniques, Sarirahayu et al. (2018) also find that these farmers are more eager to engage in initiatives like farm rejuvenation.

Farm Size and Small-Scale Coffee Farming

The average farm size of 2.67 hectares, ranging from 0.5 to 3 hectares, indicates that most farmers in this study are small-scale producers. This characteristic aligns with global trends in coffee production, where smallholder farmers play a dominant role in the industry. The prevalence of small-scale farming in coffee production is significant because it highlights the importance of these operations in meeting global coffee demands.

Studies reveal that smallholder farmers can suffer from low yield, limited resources, and challenges using new technologies. Siles et al. (2022) determined that most of the world's coffee is produced on coffee farms ranging from 0.5 to 5 hectares. However, these farms often struggle with low yields due to limited access to modern agricultural technologies and required inputs such as fertilizers, herbicides, and mechanization. Quiroga et al. (2020) also noted how resource, technological, and infrastructure limitations cause smallholders to have reduced output. These results fit the observation of

the study that many farmers work with limited resources and land, therefore it is challenging to improve production efficiency.

Land Devoted to Coffee Rejuvenation Project

The average of 1.61 hectares set aside by farmers for coffee regeneration demonstrates their commitment to raising the yield of their crops. Maintaining older, lower-yielding coffee trees depends on rejuvenation, particularly in view of declining production and changing market needs. Maintaining the long-term viability and output of coffee farms depends on programs like transplanting aging coffee trees with better types (Willer and Kilcher, 2011). Coffee plants produce less as they age, hence rejuvenation is crucial to restore farm effectiveness. Furthermore, Djufry et al. (2022) emphasized that rejuvenation initiatives enhance both resilience to climate change and crop yields. When smallholder farmers have adequate resources and support systems, both essential to their long-term survival, they are more likely to engage in such ventures.

Table 2

Farm Profile of Talbak Coffee Farmers

Category	Frequency	Percentage
Tenurial Status		
Tenant	34	94.4%
Owner	2	5.6%
Total Farm Size		
Less than 1 hectare	4	11.1%
1.1- 2.0 hectares	18	50.0%
2.1-3.0 hectares	5	13.9%
More than 3.1 hectares	9	25.0%
Area Devoted in Coffee Farming		
Less than 1 hectare	5	13.9%
1.1- 2.0 hectares	26	72.2%
2.1-3.0 hectares	3	8.3%
More than 3.1 hectares	2	5.6%
Area Allotted in Coffee Project		
Less than 1 hectare	7	19.4%
1.1- 2.0 hectares	27	75.0%
More than 2.1	2	5.6%
Total Numbers of Coffee Trees		
Below 500 trees	1	2.8%
501-1000 trees	9	25%
1001-1500 trees	13	36.1%
1501-2000 trees	3	8.3%
More than 2001 trees	10	27.8%
Total Numbers of Coffee Trees Allotted in the Project		
Below 500 trees	1	2.8%
501-1000 trees	10	27.8%
1001-1500 trees	13	36.1%
1501-2000 trees	3	8.3%
More than 2001 trees	9	25%
Years of Experience in Coffee Farming		
Less than 15 years	2	8.3%
16- 20 years	21	58.3%
More than 31 years	12	33.33%

Number of Coffee Trees Devoted to Rejuvenation

The 1,558.33 coffee trees committed to rejuvenation efforts represent a major investment in raising farm output by replacing outdated, low-yielding trees with more durable, high-yielding varieties. This proactive approach reflects a greater desire among farmers to improve yields and attain better economic possibilities. Méndez et al. (2010) claim that rejuvenation by the introduction of better tree kinds can significantly raise coffee quality and production. Smallholder farmers who lack the means to replant their entire farm at once will find this particularly beneficial. Likewise, Department of Agriculture (2015) indicate that farmers who take part in government-sponsored rejuvenation programs or cooperatives are more likely to successfully implement new farming techniques and technologies because these programs offer essential financial and technical support that helps the process.

Land Tenure Status

The study revealed that majority of the coffee grower were tenants (94.4%) while 5.6% are farm owners. The large number of tenant farmers in this study has a significant impact on their willingness to invest in long-term projects like coffee rejuvenation. According to Djufry et al. (2022) and Mbudzya et al. (2022), having secure land tenure is critical for motivating farmers to make long-term investments, such as those needed for rejuvenating coffee farms. Without the guarantee of land security, tenants are likely to be reluctant to invest in costly farm improvements due to the possibility of losing access to the land.

Variety and Marketing Practices Coffee Growers

Table 3 shows the variety and marketing practices of coffee growers. This table provides an overview of coffee production, utilization, marketing, and market destination.

Table 3

Variety and Marketing Practices Before and After the Project

	Frequency	Percentage
Variety		
Liberica	0	
Robusta	36	100%
Arabica	0	
Excelsa	0	
Utilization of Produce		
Consumption and Sold	6	16.67%
Sold	30	83.33%
Give away	0	
Ways of Marketing		
Raw Beans	0	
Dried Beans	36	100%
Processed	0	
Market Destination		
Cooperatives	36	100%
Nestle	0	

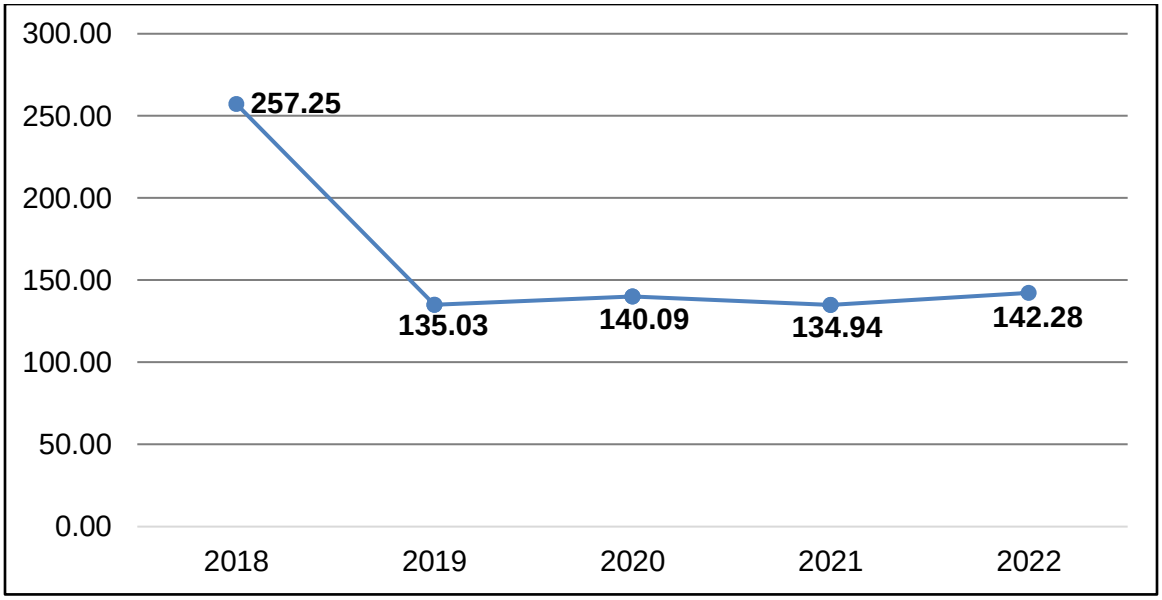
The results show that 100% of the coffee growers planted Robusta coffee on their farms because this variety can adapt well to the climate and topography of their area. This also suggests that farmers favor Robusta due to its ease of cultivation and greater reliability in local growing conditions. However, depending on just one variety could be risky if problems like pests or market changes affect Robusta coffee. This finding aligns with Aderolu et al. (2014), who stated that Robusta coffee was primarily cultivated in the region due to its resilience to temperature and soil conditions, as well as its capacity to

survive despite high sunlight intensity.

In terms of coffee utilization, 83.33% of respondents sold all of the coffee they produced, while 16.67% both consumed and sold their coffee. Regarding marketing, the respondents chose to sell their coffee in dried form, with 100% of the growers selling their harvest to the local cooperative, the majority (34) of whom were members. The coffee growers mentioned that in the past, they sold their produce to Nestlé, which was first transported to Batangas for processing. However, over time, they stopped selling to Nestlé due to the low prices offered. As a result, the organization received a processing facility, enabling them to handle their produce independently. Now, all members deliver their harvest to this facility for processing, which contributes to generating additional income for the organization.

Figure 1

Coffee Project's Average Production After Rejuvenation (kg)



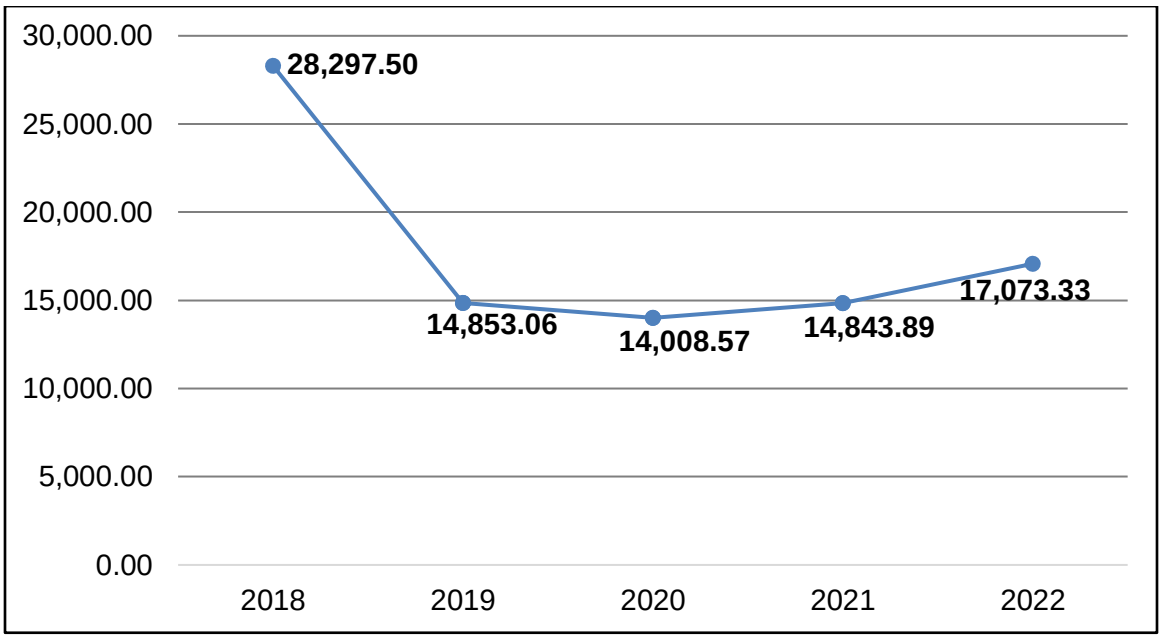
Following the coffee rehabilitation project in 2018, the Department of Agriculture initiated a rejuvenation program to revitalize old coffee plants and extend their productivity. As shown in Figure 1, coffee production decreased in 2019, averaging 135.03 kg, compared to 257.25 kg in 2018. However, the following year, production increased slightly by 1.06 kg, reaching an average of 140.09 kg in 2020. In 2021, production declined again to 134.94 kg. Furthermore, coffee production increased in 2022, with an average of 140.28 kg. This suggests that coffee revitalization negatively impacted production. According to respondents, one of the reasons for the lower yields was that some coffee trees failed to recover after rejuvenation.

Yearly income trends of coffee farmers following rejuvenation is shown in Figure 2. In 2018, coffee growers in Brgy. Talbak had an average income of ₱28,297.50. However, this amount declined to ₱14,853.06 in 2019 and further dropped to ₱14,008.57 in 2020. By 2021, there was a slight increase, maintaining an income of ₱14,008.57, which later rose to ₱17,073.33 in 2022.The decline in revenue after rejuvenation is consistent with earlier research findings. When coffee trees undergo rejuvenation techniques such as heavy pruning or stumping, they may face a temporary decline in yield. This occurs as the trees prioritize the regrowth of their leaves and branches instead of bearing fruit (Vaast et al., 2006). This corresponds with the income decline experienced in 2019 and 2020, a period when farmers faced difficulties stemming from reduced productivity.

The study indicates that rejuvenation affects the income of Talbak coffee growers, as coffee trees take time to recover after the process. Additionally, coffee growers highlighted those fluctuations in coffee bean prices also influenced income variations, with prices being high in some years and relatively low in others.

Figure 2

Coffee Farmers' Average Income per Year After Rejuvenation (PHP)



The Usefulness of Intervention Provided

In terms of the perceived usefulness of the interventions provided under the coffee rejuvenation and rehabilitation program, the respondents gave an overall weighted mean of 4.18 (SD = 0.95), which is verbally interpreted as *moderately very useful*. The provided farm inputs like fertilizers and other soil ameliorants obtained the highest mean score (M = 4.61; SD = 0.55) with a verbal interpretation of *very useful*. While the lowest gained mean was the provided technical assistance and the regular monitoring of the project was a mean score (M = 3.61; SD = 1.23) value with a verbal interpretation of *useful.* These findings suggest that the intervention provided to the respondents was moderately useful in improving their production and income, as they used it to support their coffee farming activities.

Table 4

The Usefulness of Intervention Provided

Indicator	Mean	SD	Verbal Interpretation
Conducts technical training on coffee rejuvenation and rehabilitation projection	4.47	0.88	very useful
Provides various farm equipment (for example pruning shear and chain saw)	4.03	1.13	moderately useful
Provides farm inputs (fertilizer and other ameliorants)	4.61	0.55	very useful
Provides technical assistance and regular monitoring of the project.	3.61	1.23	useful
Grand Total	**4.18**	**0.95**	**moderately useful**

Legend: 4.21–5.00 = very useful, 3.32–4.20 = moderately useful, 2.61–3.40 = useful, 1.81–2.60 = slightly useful, 1.00–1.80 = not useful

Benefits of the Project

In terms of the overall benefits of the project, the study revealed a high level of perceived benefit among coffee farmers (weighted mean = 3.53; SD = 0.88), as presented in Table 5. The improved quality of coffee beans produced the highest mean score (M = 3.89; SD = 0.78), verbally interpreted as *high*. It was noted that the respondent who chose to rehabilitate "pruning" only their coffee tree said that the quality of the coffee beans they produced had improved. Generally, pruning enhances the quality of coffee beans by eliminating diseased or damaged branches and improving sunlight exposure and air circulation throughout the tree (Viana, 2022). As a result, the organization was awarded a processing facility where they will prepare the obtained produce themselves. Currently, all of the members' produce is delivered to the processing plant to be processed, which can generate more income.

Table 5

Benefits of the Project

Indicator	Mean	SD	Verbal Interpretation
Low incidence of pest and diseases	3.75	0.77	high
Decrease cost of production	3.53	0.74	high
Increase in yield	3.25	1.05	moderate
Increase in income	3.25	1.08	moderate
Improve the quality of coffee bean produce	3.89	0.78	high
Grand Total	**3.53**	**0.88**	**high**

Legend: 4.21–5.00 = very high; 3.32–4.20 = high; 2.61–3.40 = moderate; 1.81–2.60 = low; 1.00–1.80 = very low

On the other hand, lower mean scores were observed for the increase in yield and increase in income, both with a mean of 3.25 and standard deviations of 1.05 and 1.08, respectively. However, these were still verbally interpreted as moderate. Based on the accounts of the interviewed farmers, rejuvenated trees often die because the timing of the intervention was not suitable. It was reported that rejuvenation was carried out during the dry season when there was no rain. Additionally, the trees selected for cutting and rejuvenation were already 20 to 30 years old.

Therefore, the yield and income of the coffee farmers did not increase either. According to some respondents, rejuvenation should be carried out at the beginning of the rainy season in regions with clear wet and dry cycles. This timing ensures adequate water availability and more favorable growing conditions to support the development of new coffee shoots.

Problems Encountered of Coffee Growers

Table 6 presents the problems encountered by the coffee farmers, which include poor attendance in technical training, irregular pruning practices, insufficient fertilizer application, and limited interaction with technical personnel.

Among the problems encountered, the highest mean score was for the lack of technical training in coffee production (M = 4.58; SD = 1.11), which was reported as being encountered *always*. Based on the interview, an average of five to six trainings were attended by each farmer regarding coffee production to marketing, usually done by the Department of Agriculture in collaboration with various agencies. These data indicate that one of the reasons for lower coffee production is not being able to apply sufficient fertilizers.

However, the lowest weighted mean score was recorded for access to technical people in coffee production (weighted mean = 3.81; SD = 1.56), with a verbal interpretation of *very often*. It can be noted that the number one problem of the coffee farmers in Brgy. Talbak, DRT, in the coffee rejuvenating and rehabilitation project was inability to regularly meet the technical person in coffee.

The training and farm visitation is usually conducted by LGUs through the agriculture extension workers of the Municipal Agriculture Office and Provincial Agriculture Office with the support of the Department of Agriculture and its attached agencies.

Table 6

Problem Encountered of Coffee Growers

Indicator	Mean	SD	Verbal Interpretation
Lack of technical training in coffee production that can enhance my knowledge and skills.	4.58	1.11	always
Difficulty to perform a regular pruning on many coffee trees	4.50	0.81	always
Availability fertilizer on my farm to enhance soil fertility and crop yield.	4.14	0.99	very often
Access to technical people in coffee (Research, Agricultural Extension Worker, and etc.)	3.81	1.56	very often
Grand Total	**4.26**	**1.12**	**always**

Legend: 4.21–5.00 = always; 3.32–4.20 = very often; 2.61–3.40 = sometimes; 1.81–2.60 = rarely; 1.00–1.80 = never

Conclusions

The impacts of the coffee rejuvenation and rehabilitation project in Brgy. Talbak, DRT earned notable advantages to the farming practices and profitability of the coffee farmers. These include lower frequency of pests and diseases, reduced production costs, and improved coffee bean quality. However, the project also led to a decline in coffee production, from an average of 257.25 kg to 142.28 kg, and a decrease in income, from an average of ₱28,297.50 to ₱17,073.33. This decline was attributed to the fact that the coffee trees subjected to rejuvenation and rehabilitation were over 30 years old and unable to recover. Additionally, the project was conducted during the summer season, which affected water availability, further limiting the coffee plants' ability to survive.

The coffee growers shared that they used to sell their harvest to Nestlé, which would then be transported to Batangas for processing. However, they eventually stopped doing so because the prices offered were too low. In response, the association was provided with a processing facility for government, allowing them to process their own coffee. Today, all members bring their harvests to this facility, helping the association earn additional income. Additionally, various government agencies have invited the association to present their processed coffee as part of efforts to establish new market linkages.

Recommendations

To address the decline in production and income, it is recommended that future coffee rejuvenation and rehabilitation projects focus on younger or more viable trees to ensure better recovery and productivity. The timing of project implementation should also take into account the seasonal availability of water to avoid placing stress on the plants. Moreover, continuous technical support and training should be provided to help farmers adopt better management practices. Strengthening the association's processing and marketing efforts should also be prioritized, including assistance in developing branding, improving product quality, and expanding market linkages to ensure higher and more stable income for coffee growers.

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The Southeast Asian Journal of Agriculture and Allied Sciences (SAJAAS) is the new research journal of Bulacan Agricultural State College. This journal will be an international double-blind peer-reviewed journal, with plans for open access and international indexing.

1. For the **Paper Format**, the article should be typed on a letter size bond paper (8.5 by 11 inches), with 1-inch margins on top, right, and bottom, and left. The text should be in Arial font size 11 with 1.15 line spacing. Downloadable templates for title page and blind copy can be accessed at the website. Papers may be submitted through the SAJAAS website *sajaas.basc.edu.ph* or via email to *sajaasjournal@basc.edu.ph*.

2. The **Title Page** contains the title of the article and the name and affiliation of the author/s. **The name of the author/s or their affiliations** shall not be indicated anywhere in the body of the paper.

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        3.2.1. The **Introduction** should help the reader understand how the study shall contribute to the current knowledge in the subject area. This section should clearly describe the problem or gaps in the current related research findings and the literature it addresses. It should also justify the significance of conducting this study leading to the statement of the purpose and objectives of the study.

        3.2.2. The **Materials and Methods** section should be clearly and concisely written. This section should provide enough information for a competent researcher to repeat the procedure and verify the results. This section identifies the type of research design used, sources and materials employed and important characteristics, sampling procedure, data collection techniques/ tools, time periods, study setting, as well as procedures for assessment of data. Statistical tests used must be cited and should specify the data analyzed. Authors should use the System International (SI) for the units. In case of use of machine, equipment, or supplies with trade names, use the generic name and write between parentheses the trade name with ®, manufacturer and the manufacturer's address of city, state and country. The trade name, if cannot be avoided, must be used only in the Materials and Methods section of the paper.

3.2.3. The **Results and Discussion** section should present a solution to the problem stated in the introduction. Subsections should make reading easier. If tables and figures are used to visually show the results, only the critical data should be restated in the text to emphasize evidence on which the conclusions are based. The data should also be interpreted in this section.

3.2.3.1. The **Tables** should carry a brief descriptive title that is no longer than 15 words, placed under the table number, and a legend or any footnotes appearing below the table. Tables should be self-explanatory and must replace lengthy explanations in the text that may not suffice without a table. In the body of the table, references to footnotes should be written in numerals. Each footnote should begin on a new line. To indicate significant differences among means within a row or column, superscript lowercase letters should be used. Tables must be strictly limited in numbers and contain only the essential data. Long and complicated tables should be avoided. Use horizontal lines table header and last column only and do not use vertical lines between columns. Do not cut tables in between pages if possible and fit their size to the window. The table text should be in font size of 11 with single spacing following the format of the sample table below.

3.2.3.2. When using **Quotations**, if the text or interview consists fewer than 40 words, incorporate it into the text within the paragraph and enclose it with double quotation marks (“”). If the direct quotations are stated in vernacular language, it should be italicized. Then, it will be followed by the English translation enclosed in parentheses. If the quotation consists more than 40 words, use block quotation instead of enclosing it with double quotation marks. Introduce the quotation using a different paragraph line stating the authors name and ending it with a colon (:).

3.2.3.3. The **Figures and Illustrations** should be simple, few and labelled completely. Figures should be prepared at final size for reproduction with a minimum type size of 9 points, Arial. The numbering of the figures will be dependent on the chronology of citation within the text. To direct the reader to the figure within the text, spell it out, i.e. “Figure 1”. All symbols, arrows, numbers, or letters used to identify parts of the illustrations should be explained in the legends. Where necessary, magnification should be shown by a scale marker drawn on the photograph. Figures should be saved as separate electronic files (.jpg) and submitted in .jpg format at least 300 dpi.

3.2.4. The **Conclusion** section presents the answers to the research questions or objectives of the study. The author may highlight here what he/she can conclude from the key findings but should be cautious to not just repeat what has already been stated in the result and discussion.

3.2.5. The **Recommendations** section may include the author/s their suggestions for advanced researchers of opportunities for future research based on the findings in this study. They may suggest a new direction, new objectives, and/or new method for the conduct of similar study in the future. They may also suggest ways on how the problem or gaps identified in the study can be better addressed by the concerned authorities.

3.2.6. The **References** section should reflect the text citation for each reference and vice versa while following the APA 7th edition citation format in alphabetical order.

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