Agritourism in Central Luzon, Philippines: Status, Challenges, and Pathways to Sustainable Growth

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ABSTRACT. This study explores the status, challenges, and pathways to sustainable growth in Central Luzon, Philippines agritourism. Data from agritourism trainers, farm owners, trainees, and stakeholders are analyzed using a descriptive research design and statistical tools such as Multivariate Tests, Wilks' Lambda (Exact Statistic), and Spearman's Rank-Order Correlation. The research identifies significant variations in agritourism status across site characteristics and underscores the importance of tailored management approaches. Moreover, it reveals a positive correlation between knowledge acquisition and utilization, emphasizing the role of training in enhancing agritourism practices. Despite challenges like waste management and bureaucratic hurdles, agritourism is recognized as a valuable driver of economic development in Central Luzon, offering opportunities for rural communities and sustainable agriculture. This study's implications inform policymakers, educators, and government officials, providing insights for agritourism program development and policy formulation, ultimately contributing to regional economic growth and community well-being.

1.0. Introduction

The global context of agritourism reveals a paradigm shift in the agricultural sector worldwide (Misra & Ghosh, 2024; Kumar, 2024; Yamagishi et al., 2021). Notably, regions such as Asia and Europe have witnessed a surge in agritourism activities (Ruland & Carrapatoso, 2022). This global trend underscores the universality of the challenges and opportunities faced by family farms venturing into agritourism (Brune et al., 2023). In exploring this phenomenon within the Philippines, specifically in the context of Central Luzon, this study delves into the local intricacies and nuances of agritourism development. Yusuf and Wulandari's (2023) study identifies various challenges in agritourism development, including agribusiness management, impact management, institutional and support facilities, and risk mitigation. This research places a significant emphasis on the pivotal role of model design in agritourism development, considering dimensions of sustainability, involved actors, and the support system. Sustainable strategies for agritourism development revolve around value addition through product and service diversification, sustainable marketing, network and partnership development, environmental conservation, and the empowerment of the local community, ultimately emphasizing the importance of achieving sustainable growth.

In the Philippines, agritourism is not merely an economic venture but also a cultural bridge (Yamagishi et al., 2021). Agritourism transcends its economic dimensions, serving as a cultural bridge that fosters understanding and connection between visitors and local communities. Through experiences such as cultural exchanges, preservation of heritage, celebration of local cuisine, cultural events, educational initiatives (Canson & Caelian, 2022), and showcasing artisanal crafts, agritourism intertwines agricultural practices with the cultural fabric of a region. This multifaceted approach provides economic benefits and promotes a deeper appreciation for local traditions, creating a sustainable and enriching form of tourism that goes beyond financial considerations.

In a harmonious extension of this cultural enrichment, a parallel effort is made to assess the status of the Kalamay Festival in Iloilo. This evaluation encompasses economic, social, environmental, and cultural aspects, examining opportunities and challenges related to accessibility, accommodation, attraction, amenities, and awareness (Franciliso & Estores, 2020). The proposed festival development plan, grounded in this comprehensive assessment, aligns seamlessly with the ethos of agritourism, contributing to the continuous improvement of

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the festival. It reflects shared values of cultural preservation and supports the overall sustainable development of the region's tourism landscape.

On the other hand, once limited to traditional food production, family farms have transformed into multifaceted spaces (Brandth & Haugen, 2011; Ohe, 2022). They serve as both economic engines, supplementing incomes, and cultural ambassadors, connecting urbanized visitors with the origins of their food (Kaefer, 2022; Zhang et al., 2019). In a globalized world where urbanization is rampant, agritourism offers a unique sanctuary for tourists, allowing them to reconnect with nature, spirituality, and heritage amidst rural simplicity (Joyner et al., 2018). The gap in the existing literature becomes evident when considering the complexities of this transition. While there is growing enthusiasm for agritourism, there is a notable absence of comprehensive studies addressing its environmental implications, particularly in the Philippines. As family farms transition into agritourism, they move from conventional agricultural practices to managing the diverse needs of tourists. This shift necessitates a careful balancing act to preserve natural resources and environmental sustainability.

In contrast, the challenges in the destination stem from the negative impacts of tourism. Residents exhibit a positive perception of the environmental effects of tourism but express negative sentiments regarding its economic impacts. Overall, the positive impacts of tourism tend to outweigh the negatives. Thematic analysis reveals three overarching themes: economic tourism impact, environmental tourism impact, and sociocultural tourism impact. Sub-themes include the effects of tourism on road development, tourism as a source of residents' income, and the increase in land value attributable to tourism (Serfino et al., 2022).

Moreover, the existing literature predominantly focuses on the economic benefits of agritourism, such as increased revenue streams and direct-to-consumer experiences (Sznajder et al., 2009; Zvavahera & Chigora, 2023). While these aspects are undeniably crucial, the environmental dimensions of this transition have been underexplored. Understanding the environmental impacts is pivotal for the long-term viability of agritourism in the Philippines, especially in a region like Central Luzon, where agricultural landscapes are diverse and environmentally sensitive.

The Philippines, endowed with abundant agricultural land, is well-positioned for farm tourism. To maximize this potential and counteract low agricultural yields, essential initiatives in physical attributes, product development, education, training, management, entrepreneurship, marketing, customer relations, and government support are indispensable. However, the lack of skills, training, and capital among farmers hampers the conversion of their farms into tourism sites, underscoring the imperative to cultivate entrepreneurial and hospitality skills (Yamagishi et al., 2021).

This research aims to fill a critical gap by aligning with the legislative frameworks of the Philippines, focusing on sustainable agricultural practices outlined in the Farm Tourism Development Act of 2016 or Republic Act 10816 (Official Gazette of the Republic of the Philippines, 2016) and the Agriculture and Fisheries Modernization Act of 1997 or Republic Act 8435 (Official Gazette of the Republic of the Philippines, 1997). The study seeks to shed light on the environmental dimensions of agritourism, addressing specific research questions about the status of agritourism in Central Luzon, the challenges faced, and potential pathways for achieving sustainable growth. By providing essential insights for policymakers, agricultural practitioners, and local communities, the research aims to contribute to the formulation of guidelines ensuring that agritourism activities are economically beneficial and environmentally responsible, safeguarding the natural resources that underpin this transformative industry.

Aligned with legal frameworks, this research comprehensively explores various aspects, offering a holistic understanding of the regulatory landscape and assessing opportunities for sustainable agritourism practices. Focused on Central Luzon, the study addresses key research questions related to characteristics, status, knowledge/skills of respondents, utilization of acquired knowledge and skills, differences across agritourism site characteristics, the relationship between knowledge acquisition and utilization, and challenges in site management. The researcher aims to provide nuanced insights for informed decision-making and strategic planning in the evolving agritourism sector of Central Luzon through this comprehensive exploration.

2.0. Methodology

Research Design. This study adopted a descriptive research design. The descriptive approach was chosen because it allowed for identifying characteristics, frequencies, trends, correlations, and categories related to agritourism in Central Luzon. Descriptive analysis facilitated the systematic and accurate description of the agritourism landscape, encompassing a wide range of phenomena.

Respondents or Sources of Data: The study utilized simple random sampling to secure representation from crucial stakeholders in Central Luzon's agritourism sector, encompassing farm owners, Agricultural Training Institute trainers,

trainees, and other stakeholders. The diverse sample of 379 participants—contributed insights through interviews and questionnaires. This strategic approach sought to encompass a broad spectrum of perspectives, bolstering the validity of statistical analyses for inferential purposes. Interviews were conducted with cultural and linguistic sensitivity, facilitated by a bilingual questionnaire for effective communication.

Data Gathering Procedure. To ensure the questionnaire's validity, a panel of experts, including academicians from agricultural universities, leaders in farm tourism, and experienced trainers, conducted a rigorous validation process. After this validation, a pilot test of the instrument was implemented among farmers who were not part of the initial study cohort. Valuable feedback from this trial run was carefully considered and applied to fine-tune the questionnaire, resulting in its final and improved version.

The data-gathering process entailed conducting interviews with a diverse set of identified respondents, primarily focusing on farm owners (129), trainers (67), trainees (92), and other stakeholders (91). In total, 379 participants associated with farm tourism or agritourism sites provided valuable insights and responses to the questionnaire. Each interview was approached with cultural and linguistic sensitivity, recognizing the bilingual nature of the questionnaire to ensure effective communication and understanding.

Mode of Data Analysis. This study employed a robust analytical approach, utilizing various statistical techniques to comprehensively assess the status and challenges of agritourism in Central Luzon. Multivariate Tests, specifically Wilks' Lambda, were employed to investigate differences in agritourism status concerning site characteristics like type, land area, hospitality services, and lodging accommodations, offering a nuanced understanding of their interrelations. Spearman's Rank-Order Correlation was applied to explore the intricate relationship between knowledge acquisition and its practical utilization in agritourism, providing valuable insights into the complex dynamics within the industry. Descriptive analysis succinctly summarized and clarified the collected data, offering a clear overview crucial for drawing meaningful conclusions from the research findings. These meticulous analyses generated valuable insights, forming the foundation for informed recommendations and strategies for fostering sustainable agritourism growth in Central Luzon.

3.0. Results and Discussion

Characteristics of Agritourism Sites

The characteristics of agritourism sites in Central Luzon were examined to gain insights into the diversity of offerings within the sector. The results revealed seven primary characteristics:

Category: The majority of the respondents (30%) focused on health and food tourism farms, followed by educational and entertainment farms (28%), natural and ecotourism farms (23%), and recreational and sports tourism farms (20%). This diversity in categories reflects the multifaceted nature of agritourism in the region, catering to a range of visitor interests.

Type: Respondents identified various agritourism sites, with ecotourism, integrated farm tourism, and seaside tourism being the most common (17% each). Culture tourism and heritage tourism were the least represented types (10%). This diversity underscores the region's capacity to offer a wide array of agritourism experiences.

Land Area or Farm Size: Approximately 44% of respondents owned and operated agritourism sites with land areas ranging from 16 to 19.99 hectares. Another 33% managed sites spanning 20 hectares or more, while 22% operated sites covering 8 hectares or more. The variation in land sizes suggests varying resource availability and management challenges among agritourism sites.

Original Use of the Land: Farming emerged as the most common original land use, with 44% of respondents having previously used the land for agricultural purposes. Raising animals or poultry was the second most prevalent use (38%), while 19% of respondents reported that the land had not been previously used for any industry. The historical use of the land underscores the agricultural roots of many agritourism sites.

Status of Ownership: A significant proportion of respondents (56%) were landowners, indicating a sense of ownership and long-term commitment to their agritourism ventures. Meanwhile, 22% operated as tenants or renters, reflecting different operational dynamics and potential challenges.

Average Number of Tourists Per Month: Approximately 44% of respondents reported hosting 200 or more tourists each month, while 33% accommodated 300 or more visitors. Only 22% of respondents attracted an average of 400 or more monthly visitors. These figures highlight the varying scales of agritourism operations, with some sites experiencing higher visitation rates than others.

Activities Provided in Agritourism Sites: The majority of respondents (88.9%) offered educational tours, U-pick and U-harvest activities, and classes, seminars, and workshops. In contrast, winery activities were the least provided (22.3%). These findings emphasize educational and hands-on experiences in agritourism sites, aligning with

the region's commitment to promoting agricultural awareness and learning.

Agritourism Services: In terms of hospitality services, all respondents (100%) provided food stands and food services, along with take-out options. Other services, such as catering or customized meals, Deli Stores, and Pasalubong Centers, were offered by 88.9% of respondents. However, cookouts, barbecues, or picnics were provided by only 66.7% of respondents. Regarding hosting services, all respondents offered relaxation and related therapeutic services, while 55.6% provided services for weddings, private parties, corporate events, or business retreats. Concerning lodging and accommodations, 88.9% of respondents engaged in campsites and bed and breakfast services, while 77.8% operated cottages, cabins, and farm vacation options. Hotels, inns, lodges, or resorts were less prevalent, with 55.6% of respondents offering these accommodations. These service offerings demonstrate the diverse range of experiences available to agritourism visitors, catering to various preferences and needs.

The characteristics of agritourism sites in Central Luzon are indicative of the region's rich and diverse agritourism landscape. The diversity in categories, types, land sizes, and original land use underscores the adaptability of the agritourism sector to different contexts and preferences. The diverse agritourism sites were the focus of Esguerra's (2020) study, which characterized farmers, analyzed operations, and identified best practices and challenges. The study focused on family-run farms affiliated with tourism and agriculture organizations, ensuring safety standards. Local and international visitors engaged in services like classes and tours. Best practices included trust-building, referrals, hands-on operations, and strict financial monitoring. Challenges encompassed labor shortages, niche market status, price fluctuations, seasonal dynamics, staff skill gaps, and significant capital needs. These insights lay the foundation for enhancing the region's agritourism sector through a targeted development plan. Despite this adaptability, agritourism farmers, guided by intrinsic motives, actively preserve tangible heritage on their farmlands. The study underscores the robust connection between farmland, farmer, and agritourism attributes and the motivations driving heritage preservation. However, despite the evident effectiveness of agritourism in this aspect, there is a potential oversight by farmers on economic opportunities linked with these resources, posing a risk to the sustainability of their conservation efforts (Valdivia & Barbieri, 2014). The prevalence of landowners among respondents indicates a long-term commitment to agritourism, often rooted in a profound connection to the land. The diverse visitation rates observed across agritourism sites underscore the importance of implementing tailored marketing and development strategies to optimize the sector's potential. Notably, entrance fees range from Php200 to Php500, reflecting the varied pricing structures within the industry.

Moreover, the extensive provision of educational activities, including tours, workshops, and U-pick experiences, highlights the region's commitment to promoting agricultural awareness and learning among visitors. Baipai et al.'s (2023) study identifies challenges in agritourism, such as a lack of activities, funding constraints, and uncoordinated efforts among stakeholders, raising concerns about its impact on agricultural production. The study recommends enabling policies and coordinated efforts to boost agritourism, aligning with the educational focus of bridging the urban-rural gap and fostering agricultural appreciation. In contrast, Chen et al.'s (2020) study on student exchange programs (SEPs) in educational tourism reveals rich learning opportunities for exchange students. It explores the positive impact of SEPs on students' education and career choices. Transitioning to a different context, a recent study evaluates a leading Philippine state university's potential as an educational tourism destination using the 6As of tourism, highlighting opportunities for promoting and enhancing resources, particularly in farm and nature attractions, with a key focus on improving accessibility (Canson & Caelian, 2022).

The diversity of hospitality, hosting, and lodging services offered by agritourism sites reflects the sector's capacity to cater to a wide range of visitor preferences. The availability of these services enhances the overall visitor experience and contributes to the sector's growth and sustainability. Mahmoodi et al.'s (2022) study underscores the more advanced state of agritourism development in Poland compared to Iran, emphasizing the need for Iranian authorities to implement additional measures for effective management and growth. This study is one of the pioneering comprehensive comparisons of agritourism development in both countries. Concurrently, Tovmasyan et al.'s (2020) research underscores the crucial role of agritourism in rural development, particularly in Armenian regions such as Lori and Tavush. The study reveals diverse tourism opportunities stemming from their abundant resource potential, including historical-cultural, eco, agro, gastronomic, and adventure tourism.

Status of Agritourism: A Community Perspective

The evaluation of agritourism status within this study encompasses its impact on the local community, specifically in terms of economic and environmental aspects. This research catalyzes raising community awareness about the significance

of agritourism in Central Luzon. Shedding light on the subject empowers individuals to recognize and appreciate the contributions of agritourism to their region. Furthermore, this study assessed agritourism objectives at nine selected agritourism sites and gathered feedback from 379 respondents within the region to gauge the effectiveness of the supervision provided by the Agricultural Training Institute (ATI). The respondents were randomly selected from these agritourism sites, contributing diverse perspectives on achieving objectives in the context of the broader agritourism landscape.

The extent of ATI's supervision practices in agritourism management plays a pivotal role in ensuring the delivery of authentic farm or ranch experiences, the facilitation of educational activities, the provision of high-quality customer service, the maintenance of essential public facilities, the preservation of a safe and accessible environment, the cultivation of positive community relations, and the strategic planning for financial sustainability.

This study aligns with previous research that emphasizes the economic and environmental benefits of agritourism for rural communities (Ammirator et al., 2020). It also echoes the findings by Cavalleri et al. (2022), which highlight the role of community awareness and education in promoting sustainable agritourism.

In terms of supervision and management, Athukorala (2017) stressed the significance of effective oversight and guidance by relevant authorities, such as the Agricultural Training Institute (ATI), in ensuring the success and sustainability of agritourism initiatives. The results of this study corroborate these findings, highlighting the positive impact of ATI's management practices on the overall success of agritourism sites.

However, as noted by Lupi et al. (2017), variations in the impact of agritourism on different communities may exist, suggesting that local factors and context play a significant role. While this study reports high levels of attainment of agritourism objectives, further research may explore regional disparities and their underlying causes.

These comparisons and contrasts with existing literature reinforce the importance of agritourism as a means of community development, emphasizing the need for continued research and tailored strategies to maximize its benefits while addressing potential challenges.

Assessing the Acquired Knowledge and Skills of Respondents in Agritourism

Agritourism operations vary widely, encompassing both small seasonal enterprises with limited consumer services and expansive year-round activities offering a multitude of services. This section delves into evaluating respondents' acquired knowledge and skills in agritourism, encompassing areas such as production technology, pre-production to post-harvest processes, marketing, and financial literacy. The results reveal the following:

Production Technology: Most respondents perceived themselves to possess a high level of knowledge in production technology, consistently scoring high across all task indicators. The overall weighted mean for this category was 3.94, underscoring their proficiency in this aspect (Che et al., 2005).

Pre-production to Post-Harvest: Respondents demonstrated a commendable understanding of pre-production to post-harvest processes, with an overall weighted mean of 4.10, signifying a high level of competence. This proficiency contributes to the efficiency and success of agritourism ventures (Ammirator et al., 2020).

Marketing: The computed weighted mean for respondents' acquired knowledge in marketing stood at 3.96, aligning with a high descriptive rating. This aptitude in marketing is pivotal for attracting visitors and ensuring the sustainability of agritourism sites (Tseng et al., 2019).

Financial Literacy: On average, respondents reported a high level of knowledge in financial literacy, with a computed mean value of 4.02. This proficiency is instrumental in the strategic management of resources and the long-term financial sustainability of agritourism endeavors (Shen, 2017).

Utilization of Acquired Knowledge and Skills in Farming Activities

Agritourism is recognized as a pivotal driver of farm diversification and an essential contributor to enhancing farm income. The Agricultural Training Institute (ATI) significantly promotes agritourism, fostering a potent partnership between the agricultural sector and tourism. This study aims to elucidate how farms harness agritourism opportunities, focusing on the extent to which farmer-respondents leverage their acquired knowledge and skills in production technology, pre-production to post-harvest processes, marketing, and financial literacy.

The study unveils its findings from a survey encompassing nine (9) agritourism sites and involving 379 farmer trainees in Central Luzon. The survey results shed light on the ongoing progression of agritourism within the agribusiness sector, underscoring the deliberate adoption of agritourism programs in the surveyed areas. The results manifest as follows:

Production Technology Utilization: The computed average weighted mean for all task

indicators related to the utilization of production technology yielded an overall weighted mean of 4.04. This signifies a high level of utilization, emphasizing the practical application of acquired knowledge and skills by farmers in this domain (Tshuma, 2022).

Pre-production to Post-Harvest Utilization: Respondents largely perceived themselves to possess a high level of competence across task indicators pertaining to pre-production to post-harvest processes. The overall weighted mean for this category was 3.89, indicating a commendable degree of utilization in these essential farming activities (Ammirator et al., 2020).

Marketing Utilization: The overall weighted mean for the utilization of marketing stood at 4.40, firmly placing it in the high category. This underscores the farmers' adeptness in leveraging their marketing knowledge and skills, a vital component of agritourism success (Zhang et al., 2018).

Financial Literacy Utilization: The computed weighted means for overall responses regarding the utilization of financial literacy averaged 3.77. This denotes a high level of utilization, highlighting the farmers' proficiency in managing financial aspects, crucial for the sustainability of agritourism endeavors (Ikbal Bahua, 2023).

Relationship of Agritourism Status Across Site Characteristics

The Multivariate Test results unequivocally reject the null hypothesis at the 0.05 level of significance, indicating a significant multivariate effect in relation to the characteristics of agritourism sites, namely type, land area, hospitality services, and lodging and accommodation. Wilks' Lambda (Exact Statistic) value of 0.023 further reinforces this result. Consequently, it becomes evident that it is imperative to tailor agritourism strategies to align with specific site characteristics, including type, scale, and the array of enterprises involved. This entails a nuanced approach to effectively manage and plan agritourism ventures in diverse settings (Barbieri, 2013).

Relationship Between the Extent of Acquired Knowledge and Utilization

The Spearman-Rho correlation analysis revealed significant associations between knowledge acquisition and its utilization across various stages of agritourism. While a weak inverse correlation was found between knowledge acquisition and pre-production activities ($r = -0.112$, $p = 0.029$), moderate to weak positive correlations were observed with production ($r = 0.261$, $p = 0.000$) and post-harvest activities ($r = 0.140$, $p = 0.006$). Overall, a positive correlation ($r = 0.178$, $p = 0.000$) emphasized the substantial link between knowledge acquisition and practical application throughout the agritourism process. These results underscore the pivotal role of knowledge in driving effective utilization across diverse facets of agritourism, supporting the findings of Fahim et al. (2023).

Extent of Concern Regarding Agritourism Site Management Challenges

Owners of agritourism learning sites exhibit a heightened level of concern regarding environmental management issues, particularly waste management associated with tourist activities, despite the presence of signages. Simultaneously, establishing farm tourism sites is perceived as cumbersome and paperwork-intensive. This sentiment reflects the multifaceted challenges and hardships encountered in agritourism, underlining the need for proactive solutions and support mechanisms (Pal & Murdia, 2017; Calina et al., 2017).

Implications of Agritourism for Sustainable Economic Growth

Agritourism, as illuminated by this study, holds significant implications for sustainable economic development in Central Luzon and the broader Philippines. The findings provide a foundation for multifaceted actions and initiatives that can spur economic growth and foster resilience within the agritourism sector:

Policy Development and Enhancement: Policymakers and government officials can utilize the comprehensive insights provided by this study to craft well-informed policies and program initiatives aimed at bolstering the agritourism sector. This includes devising strategies to address the identified challenges, stimulating investment, and creating an enabling environment for agritourism operators (Sgroi et al., 2018).

Strengthening Local Governance: The study's data can empower local government officials, from barangay to regional levels, to assess their strengths and weaknesses in supporting agritourism activities within their jurisdictions. This self-assessment can lead to more efficient and effective programs aligning with local needs and resources (Che et al., 2005; Ciani, 2017; Mishchuk et al., 2022).

Educational Enhancement: Educational institutions can use this study to revise curricula and co-curricular activities, ensuring that students are adequately prepared and equipped with the knowledge and skills required to contribute to agritourism development. This educational emphasis can nurture a pool of future leaders poised to facilitate economic growth and related development.

National Government Support: The national government can adopt the study's findings to

strengthen the leadership and administrative capabilities of officials involved in agritourism. This support can manifest through training, seminars, workshops, technical assistance, and financial aid. Additionally, it can serve as a foundation for targeted research efforts that guide policymaking at the national level (Brzozowska & Niedziółka, 2016).

Legislation for Agritourism: Legislators can draw upon the study's insights to create legislation that fosters tangible development in the agritourism sector across the entire country. These laws can provide a robust legal framework for agritourism operations, ensuring their sustainability and economic contributions (Donia et al., 2018).

The implications of this research transcend data collection and analysis, extending into actionable strategies that can drive sustainable economic growth through the cultivation and expansion of agritourism. In harnessing these implications, stakeholders at all levels can play pivotal roles in advancing the agritourism sector and fostering broader economic development.

4.0. Conclusion

The in-depth study on agritourism in Central Luzon, Philippines, has provided invaluable insights into the current landscape, challenges, and avenues for sustainable development within the region. The research uncovered diverse agritourism sites, predominantly focusing on health and food tourism farms, which offered engaging educational experiences and entertainment, attracting a substantial monthly visitor count. Remarkably, farmers and stakeholders engaged in agritourism showcased a high level of proficiency in crucial areas such as production technology, marketing, and financial literacy. This proficiency underscored the efficacy of training programs, indicating that these initiatives have successfully equipped individuals for the complexities of agritourism. Moreover, the study highlighted the practical application of the acquired knowledge and skills in farming activities, indicating a promising future for agritourism ventures in Central Luzon. Through rigorous statistical analyses, the research illuminated the influence of specific site characteristics, including type, land area, hospitality services, and lodging and accommodation, on agritourism status. These findings emphasized the necessity for tailored strategies and targeted information dissemination, ensuring effective management and planning of agritourism activities based on individual site attributes. Furthermore, the study revealed significant positive correlations between the extent of knowledge acquisition and its utilization in various facets of agritourism, underscoring the perpetual need for continuous education and skill development among agritourism stakeholders to maintain the industry's growth and sustainability.

5.0. Limitations of the Findings

The findings of this study, while valuable, are subject to certain limitations. Firstly, the geographic scope, confined to Central Luzon, may not comprehensively capture agritourism dynamics in other regions or countries. There is a potential sampling bias as the data primarily emanates from willing agritourism sites, potentially neglecting non-participating sites with differing characteristics. Additionally, reliance on self-reported data introduces the possibility of biases, impacting the accuracy of responses. The study provides a snapshot, making it susceptible to temporal factors and potentially outdated in the face of the rapidly evolving agritourism industry. Moreover, while the study yields valuable insights into Central Luzon's agritourism, establishing universal causality and generalizability is limited due to the observational nature of the research. Incorporating Spearman's Rank-Order Correlation as a statistical tool aligns with these considerations. Lastly, the choice of specific statistical tools carries inherent assumptions and limitations, influencing the depth of the findings. Acknowledging these limitations is essential for a nuanced understanding of the research outcomes, emphasizing the need for cautious interpretation and inspiring future studies to comprehensively address these constraints.

6.0. Practical Value of the Paper

This study offers practical insights crucial for agritourism stakeholders in Central Luzon. Agritourism operators can enhance visitor experiences by tailoring offerings to market demands identified in the study. Policymakers gain targeted insights for crafting supportive policies, while development agencies can design focused training programs, addressing specific skill gaps among agritourism stakeholders. In aligning offerings with visitor interests, this research provides actionable guidance, ensuring sustainable economic and sociocultural benefits for agritourism ventures in the region.

7.0. Directions for Future Research

Future research in agritourism should prioritize comparative regional studies to understand diverse dynamics across different regions nationally and internationally, offering tailored strategies for development. Longitudinal studies are vital to tracking evolving trends and visitor preferences over time, enabling adaptive strategies for sustained growth. Furthermore, there is a crucial need for in-depth investigations into agritourism's sociocultural impact,

focusing on its influence on local communities, social structures, and cultural preservation. Additionally, research should explore the integration of technology to enhance visitor experiences, streamline operations, and expand the reach of agritourism ventures in an increasingly digital landscape.

8.0. Declaration of Conflict of Interest

This study did not receive any funding.

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Key Success Factors and Entrepreneurial Orientations of The Beneficiaries of the One Town, One Product (OTOP) Program in the Province of Tarlac

Review of Integrative Business & Economics Research

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ABSTRACT

This research aimed to describe the key success factors and entrepreneurial orientations of the beneficiaries of DTI OTOP Program in the province of Tarlac. The descriptive/correlational research was employed with 30 respondents. Half of the 30 businesses surveyed have 10-99 employees. Majority was earning revenues of PhP 5,000,000.00 or less and has recently invested PhP 5,000,000.00 or less. The entrepreneur and enterprise key success factors were extremely important to the respondents, network is very important and business environment is mildly important. The entrepreneurs are neutral on innovativeness and competitiveness, highly proactive, risk takers, and not practicing autonomy. The entrepreneur, enterprise, and business environment have relation to employment generation, as does the enterprise with sales. Innovativeness and risk taking have a positive effect on employment generation, and higher significance on sales. Risk taking has high significance to investment. The entrepreneur, enterprise, and business environment KSFs impact employment generation, and network to sales and investment. Innovativeness and risk taking have a direct influence on employment generation, while innovativeness, being proactive, risk taking, and competitive aggressiveness have a positive impact on average sales and investment. This study supports the relevance of success factors and entrepreneurial orientation towards the attainment of good business performance.

Keywords: key success factors; entrepreneurial orientations; one town, one product (OTOP) program, enterprises

I. INTRODUCTION

Small and medium size firms make up a large component of the business sectors of the developing countries, including the Philippines. In the 2013 figures provided by the Philippine Statistics Authority (PSA), the Philippines has a total of 941,174 businesses comprising of 99.6% micro, small, and medium enterprises (MSMEs) and 0.4% large enterprises.

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The significance and gravity of contribution of the small and medium sized businesses make them a very indispensable part of the economic sector of every country. Governments from around the world came up with some projects benefiting the small businesses to further help them survive and continue improving the economic output, employment, as well as the preservation of culture through the manufacture of local products. A very good model of assistance to SMEs was the OVOP (One Village One Product) in Japan.

The need to support local businesses has prompted other countries to study the model of OVOP Program of Japan, and they were inspired by the results. To date, OTOP programs were implemented in South Asian countries, including the Philippines.

OTOP-Philippines is a multi-sectorial program of the Philippine government, which started in 2004, which aimed at assisting local businesses, and involving the national government agencies (NGAs), local government units (LGUs), and the private sector. The assistance package available to entrepreneurs includes business counseling, skills and entrepreneurial training, latest technologies, marketing, and product designs and development.

The OTOP Program has significantly produced outputs during the incumbency of President Gloria Macapagal-Arroyo and President Benigno Aquino, Jr.

The assistance given to small and medium sized businesses by the government and private sectors has apparently given them the leverage to grow and prosper. The success of many businesses may also be attributed to the personal characteristics of the people who manage them, or they may have prospered by effective financial management, innovation, adaptation, and planning. Or it may be because of a recipe for success that come from the entrepreneur, the business itself, the people around, or the environment where the enterprise operates. These may be collectively called key success factors or KSFs.

Aside from the key success factors, another idea that could possibly contribute to the growth and success of an enterprise is the entrepreneur's orientation.

Entrepreneurial orientation (EO) is a description of how a firm formulates or chooses its strategies based on managerial philosophies. Through the years, entrepreneurial orientation has become one of the most studied concepts in the field of entrepreneurship. The first researches on EO have identified the core ideas of innovativeness, proactiveness, and risk-taking as possible orientations on entrepreneurial strategy formulation. Past researches uncovered the significant influence of EO on the performance of the firm.

The entrepreneur himself defines the entrepreneurial orientation of a firm because

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in the first place, he is the decision maker. It is like the personality of the business itself.

The Province of Tarlac has been a recipient of the OTOP program of the Department of Trade and Industry. In its initial six (6) year run that is from 2004-2010 the project has unquestionably produced successful businesses. Some of the well-known OTOP products of Tarlac are iniruban, sweet potato products, bamboo products, sugarcane, and chicharon, among others. Some of these products have turned as inspirations in coming up with local festivals, the most popular of which is the Chicharon Festival in the town of Camiling.

This study was conceptualized primarily to describe the key success factors and entrepreneurial orientations of the entrepreneur-beneficiaries of the OTOP Program in the Province of Tarlac in the hope of providing a recipe for success for budding and existing entrepreneurs in the area.

Statement of the Problem

The main problem of this research was to describe the key success factors and entrepreneurial orientations of the beneficiaries of the DTI OTOP (One Town, One Product) program in the province of Tarlac.

More specifically, it sought to give light on the following queries:

1. How are the businesses of the beneficiaries of the OTOP program in the Province of Tarlac described on:
   1.1. employment generation;
   1.2. average sales for the past three years; and
   1.3. amount of investment?
2. How do the beneficiaries of the OTOP Program describe the key success factors (KSFs) clustered according to:
   2.1. entrepreneur;
   2.2. enterprise;
   2.3. network; and
   2.4. business environment?
3. How are the entrepreneurial orientations of the beneficiaries described along:
   3.1. innovativeness;
   3.2. proactiveness;
   3.3. risk taking;
   3.4. competitive aggressiveness; and
   3.5. autonomy?
4. How do the performance variables of the businesses relate to:
   4.1. key success factors; and

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4.2. entrepreneurial orientations of the beneficiaries?

5. To what extent do the key success factors and the entrepreneurial orientations influence the performance of the businesses?

6. What is the implication of the study to Business Administration?

Hypothesis

From the statements of the problem, the following hypotheses were hereunto tested.

Ho1 There is no significant relationship between the performance variables and the key success factors and entrepreneurial orientations of the OTOP beneficiaries.

Ho2 The key success factors and the entrepreneurial orientations of the OTOP beneficiaries have no significant influence on the performance of their businesses.

II. METHODOLOGY

The descriptive/correlational research was employed in this study. When it comes to sampling design, complete enumeration was used.

The researcher used the questionnaire in gathering data. The tool was divided into two parts: the first part is for the SMEs and the second part catered to the entrepreneurs.

The respondents in this study were the 30 successful entrepreneur-beneficiaries of the OTOP Program in the province of Tarlac.

The data were processed using statistical tools such as percentage, frequency, ranking, mean and standard deviation to aid in data analysis. The information was presented in tables to facilitate easier interpretation by the researcher.

For the relationship between two variables, more specifically performance with entrepreneurial orientations and performance with key success factors, the Pearson's correlation coefficient was used. Analysis on the possible causation between success factors and performance and between entrepreneurial orientation and performance were also determined using multiple regression analysis.

In the interpretation of the results in key success factors and entrepreneurial orientations, the following were utilized.

Importance Scale and Verbal Descriptions

Average Rating	Verbal Description
1.00-1.49	Not important
1.50-2.49	Not very important
2.50-3.49	Mildly important
3.50-4.49	Very important
4.50-5.00	Extremely important

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Entrepreneurial Orientation Scale Average Ratings and Verbal Descriptions

Entrepreneurial Orientations Scale Average Ratings	1.00-2.19	2.20-3.39	3.40-4.59	4.60-5.79	5.80-7.00
Verbal Descriptions	Very low	Low	Moderate	High	Very high

III. RESULTS

1. Performance of the Businesses

1.1.Employment Generation

Table 1 shows the firms' performance on employment generation.

Table 1

Employment Generation

N=30

No. of Employees	**F**	**%**
10-99	15	50
1-9	14	46.67
100-199	1	3.33
Total	**30**	**100**

Out of the 30 businesses surveyed, there were 15, which have 10-99 employees, while 14 were employing between 1-9 people. Meanwhile, there was one business with more than a hundred employees. This is the crochet business in the town of Ramos, Tarlac, which, at its peak of operations, has given employment to 150 people in the barangay where it is located.

Based on the MSME classification used in the Philippines, those with 10-99 employees are categorized as small business. On the other hand, businesses employing 1-9 are in the "micro business" category while firms with 100-199 employees are considered medium sized businesses.

The results indicate that the businesses operating under the OTOP program in the province of Tarlac are generally on a micro and small scale. This is consistent with the findings in several researches about businesses in the country which state that majority of them belong to micro and small businesses. Worth mentioning is the DTI 2013 report provided by the Philippine Statistics Authority (PSA). Of the 941,174 establishments in the Philippines, 99.6% (937,327) are micro, small, and medium enterprises (MSMEs) and the remaining 0.4% (3,847) are large enterprises. Of the total number of MSMEs, 90.3% (846,817) are micro enterprises, 9.3% (86,762) are small

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enterprises, and 0.4% (3,748) is medium enterprises.

Interestingly, these small businesses fuel the economy of our country. Their growing number makes them an indispensable part of the economic life of our nation. They are the engines of growth and progress in the cities and countryside. They make use of the local resources and talents, helping alleviate their economic statuses.

1.2.Average Sales for the Past Three Years

Table 2 illustrates the average sales of the 30 firms for the past three (3) years.

Table 2
Average Sales for the Past 3 Years
N=30

Average Sales for the Past 3 Years	F	%
PhP5,000,000.00 or less	25	83.34
PhP5,000,001.00-PhP10,000,000.00	2	6.67
PhP10,000,001.00-PhP15,000,000.00	1	3.33
PhP15,000,001.00-PhP20,000,000.00	1	3.33
PhP35,000,001.00-PhP40,000,000.00	1	3.33
Total	**30**	**100**

Majority of the businesses surveyed, that is 25 out of 30, were earning revenues of PhP 5,000,000.00 or less. Of the 25 businesses, 17 of them have average revenues of less than a million pesos a year. These were the micro businesses involved in sugarcane products, wine, meat business, food processing, delicacies, crochet, and handicrafts. On the other hand, there were two (2) which generated sales between PhP5,000,001.00 to PhP10,000,000.00. They were involved in native cakes and large scale and commercialized meat-processing business. The rest have the power to sell products amounting to PhP10,000,000 up to PhP40,000,000.00. These were the businesses that export local vegetables and restaurant business.

Judging from the findings, the bulk of the OTOP businesses do not have that earning power yet because they belong to the micro and small businesses. But many of them consider their sales to be satisfactory. Even though they have small earnings, they still manage to sustain their operations and be of help to the local economy, contributing to the tax revenues and employing people. They also promote local products and effectively utilize the skills of the people in the communities where they belong.

1.3.Amount of Investment

Table 3 shows the investment scenario of the OTOP business-beneficiaries.

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Table 3

Amount of Investment

N=30

Amount of Investment	F	%
PhP5,000,000.00 or less	28	93.34
PhP5,000,001.00-PhP10,000,000	1	3.33
PhP15,000,001.00-PhP20,000,000.00	1	3.33
Total	**30**	**100**

The data reveals that majority, that is 28 of the firms surveyed, have invested PhP5,000,000.00 or less in the recent years. Of the 28, eight (8) of them have millions worth of investment, with the rest in hundreds and tens of thousands of pesos. There were two (2) which became bigger by more than PhP5,000,000.00 up to PhP20,000,000.00.

From the data discussed, the firms under the OTOP program in the province of Tarlac have modest to considerable amount of investment in the recent years, which is true for many micro, small and medium scale businesses nowadays. The entrepreneurs seemed to have learned the power of investment to their businesses so they started pouring in money to increase their inventories and make them more equipped in providing satisfaction to their customers.

2. Key Success Factors

2.1.Entrepreneur

Table 4 presents the entrepreneur-related key success factors and how the entrepreneurs described their importance in the achievement of success. The average ratings were described using the verbal descriptions.

Table 4

Entrepreneur

Entrepreneur Related Key Success Factors	Mean	Verbal Descriptions
Good Management Skills	4.60	Extremely important
Charisma, Friendliness	4.53	Extremely important
Previous Working Experience	4.17	Very important
Hardwork	4.83	Extremely important
Ability to Manage Personnel	4.40	Very important
Social Skills	4.17	Very important
Reputation for Honesty	4.77	Extremely important
Key Success Factor Entrepreneur	**4.50**	**Extremely important**

There were seven (7) key success factors related to entrepreneur: good management skills, charisma or friendliness, previous work experience, hard work, ability to manage personnel, social skills, and reputation for honesty. These factors were

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combined to give the entrepreneur key success factor of the respondents a mean equivalent of 4.50, which is extremely important according to the importance scale. This means that the entrepreneur is a key to business success. Highly associated with the said key success factor is the application of managerial skills, exercise of interpersonal skills with the clients, and giving much time and effort to make the business flourish. And also related is the practice of honesty in all the dealings with the clients, suppliers, and other stakeholders.

The respondents gave due consideration to the specific entrepreneur-related key success factors. The factors were either extremely important or very important. Those that were extremely important were good management skills (4.60), charisma or friendliness (4.53), hard work (4.83) and reputation for honesty (4.77). Meanwhile, previous working experience (4.17), ability to manage personnel (4.40), and social skills (4.17) were considered to be very important to the OTOP entrepreneur-beneficiaries. These findings corroborated some results generated by the researches of Zimmerman and Chu (2013), Bouazza et. al. (2015), and Stefanovic et. al (2010) that good general management, management capacities, interpersonal skills, and leadership skills are success factors in business.

From the findings, the entrepreneur-beneficiaries of the OTOP program in Tarlac were very particular with the skills that will make their business work and were also concerned with the way they deal with the customers. They prefer to be cordial and appealing to attract customers to buy their products. They spend enough time, give their full effort and do the extra mile in their businesses simply because these are their bread and butter. Also, in whatever they do, they try to be fair and truthful to all in terms of the products and services they offer. They believe that they will never go wrong with honesty.

Furthermore, they place great importance to what they have learned from the past, particularly in business, and they include that in their arsenal of business weapons to be able to operate successfully. They put premium when it comes to managing their people because they believe that effectively managed personnel can serve as ambassadors of goodwill for the business. This is also their way of exercising social responsibility. The entrepreneur-beneficiaries likewise put emphasis on effective interaction and communication with the clients and other stakeholders as a way of creating better understanding, leading to more business transactions, which will definitely benefit the businessman.

2.2.Enterprise

Table 5 shows the key success factors related to the enterprise and how the

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entrepreneurs define their significance to their businesses.

Table 5

Enterprise

Enterprise Related Key Success Factors	Mean	Verbal Descriptions
Appropriate Training	4.33	Very important
Marketing/Sales Promotion	4.67	Extremely important
Good Product at Competitive Price	4.67	Extremely important
Good Customer Service	4.70	Extremely important
Maintenance of Accurate Records	4.43	Very important
Key Success Factor Enterprise	**4.56**	**Extremely important**

Enterprise related key success factors consisted of operational systems and strategies, and market offerings: appropriate training, marketing/sales promotion, good product at competitive price, good customer service and maintenance of good records. All of these are essential tools for the business to have smooth and productive operations and to effectively deal with the customers.

From the data presented, the overall rating for the enterprise related key success factor is 4.56, which suggests extreme importance to the respondents. Like what was stated earlier, the success factors related to the enterprise are essential tools for the business to have smooth and productive operations and to make it more responsive to the needs of the customers. The employees can function productively when they are provided with the necessary training. Products can be disposed if they are good enough for the customers, priced reasonably, or marketed using proven marketing and sales promotion strategies. Customers will likewise make a repeat purchase because of these, aside from the quality service given to them by the business. And the business can have an effective financial management if there is a good record keeping. All of these are what make enterprise related key success factors indispensable tools for the respondents.

The data shows that good customer service (4.70), marketing/sales promotion and good product at competitive price (both 4.67) were extremely important to the respondents. On the other hand, appropriate training (4.33) and maintenance of accurate records (4.43) were considered to be very important to the entrepreneurs. The data again partially supported the findings of the studies of Zimmerman and Chu (2013), Bouazza et. al. (2015), and Stefanovic et. al. (2010) that appropriate training, accurate record keeping, marketing, and competitive product and service are indispensable to entrepreneurial success.

From the results of the survey, it can be deduced that the entrepreneur-beneficiaries of the OTOP Program greatly consider not just business and personnel development strategies, but good products as well to compete well with other

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businesses. The strategies were in line with the needs of the employees to provide customers the service they deserve and consistent with the basic idea in marketing, that is, the creation of products that are truly needed by the people. One of the strategies also adheres to the requirement in marketing that products must be communicated and promoted to gain attention from the customers, which may lead to purchase.

Moreover, the respondents seem to value the importance of monitoring the progress of their business through the regular maintenance of accurate records. They are very interested in their sales and expenses and use these records to determine whether their business is doing well or not. The respondents were very well aware of the basics of financial management and that is the religious record keeping of all the cash inflows and outflows to monitor the flow of cash and make an informed decision when it comes to finances.

2.3. Network

Table 6 is an illustration of the importance given by the respondents to the network-related key success factors.

Table 6

Network

Network Related Key Success Factors	Mean	Verbal Descriptions
Support of Family and Friends	4.40	Very important
Position in the Society	2.83	Mildly important
Key Success Factor Network	**3.62**	**Very important**

In this research, the network-related key success factor is comprised of the support of family and friends and position in the society. Family members and friends may serve as weapons in creating a much larger network that can help the entrepreneur promote or finance the business. Likewise, a position in the society may give the businessman the opportunity to meet other people who can possibly serve the same purpose as the family members and friends.

The data presented on the table illustrates the significance of network-related key success factors to the entrepreneur-beneficiaries. The overall mean was 3.62, which indicates that network, in general, is very important to the respondents.

Exploring deeply into the network-related key success factors, the entrepreneurs consider their family and friends as stronger allies in their network. With a mean of 4.40, these people are considered to be very important for them. However, position in the society, with a mean of 2.83, is not regarded well by the respondents in the creation of their so-called “network”. Thus, it is deemed mildly important for them. The level of importance given is not that high, but it is still deemed as an important factor to business success. The perception of significance of societal position as a success factor

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coincides with the finding in the study of Stefanovic et. al. (2010).

Judging on the findings, the respondents still prefer their family and friends as the "movers" in their network. The entrepreneurs wanted to have a close business network related by blood and years of association and friendship. The preference given to family members is understandable since Filipinos are known to be very close with their family. In the Philippines, it is common to have extended families in residential compounds where close relatives live next to each other. Family members are trusted allies of the Filipino entrepreneur. The same preference is also given to friends. Local businessmen want their friends to be closer to them. This is because Filipinos are friendly people. They believe in what their friends can do for them. This belief extends in business. It is also a known fact that Filipino entrepreneurs rely on their friends to promote or finance their business. When a business is in the introduction period, friends are usually the first ones being invited to try the products they offer. And these people undoubtedly do their share of helping their entrepreneur friend further grow the business.

The respondents, in building their network, seldom use position in the society. It is because few of them were not lucky enough to be given some distinction or position in the society where they belong. For those who have the position, they take advantage of it but for many of the respondents, the readily available allies of family members and friends are still favored to comprise their business network.

2.4. Business Environment

Table 7 shows the respondents' perceived importance on the key success factors connected with business environment.

Table 7

Business Environment

Business Environment Key Success Factor	Mean	Verbal Descriptions
Satisfactory Government Support	4.27	Very important
Access to Capital	4.40	Very important
Political Involvement	1.57	Not very important
Key Success Factor Business Environment	**3.41**	**Mildly important**

As shown in the table, the key success factors on the business environment centered on the government support, access to capital, and political involvement. These forces provide the things necessary for the business to further achieve growth and success. Government assistance projects may help improve the skills of the entrepreneur and the employees, the business system or procedures, or even its products and the way of dealing with the customers. Additional capital can make it possible for the business in procuring more inventories, machines and other inputs. Political involvement may

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create sound business environment for the entrepreneurs.

The overall mean for the business environment key success factor was 3.41; clearly showing that it is mildly important for the entrepreneur respondents in the study.

Digging deeper into the specific key success factors, two (2) were considered very important by the respondents: satisfactory government support (4.27) and access to capital (4.40). Political involvement (1.57) is not very important to the respondents. But it still has a little importance to the entrepreneur-respondents. These data are consistent with the results in the studies of Zimmerman and Chu (2015) and Bouazza et. al (2015) claiming that political association and access to external financing are connected to firm's success.

From the results, we can construe that the beneficiaries of the OTOP program in the province are very open when it comes to government support and access to capital. They regarded these as a big boost to their entrepreneurial undertaking, supporting their claims to these factors as "very important" to their success. Many Filipino entrepreneurs are not that armed when it comes to business so whatever assistance being offered to them are greatly embraced. A case in point is the OTOP program in the province, which has offered a lot to the entrepreneur respondents when it comes to developing their entrepreneurial skills, their systems, techniques, products, and even the technology when it comes to production and manufacturing. The OTOP program was considered by many beneficiaries to have further led their business to success. Many opportunities were opened because of their involvement and cooperation with the OTOP program and brought them to new business horizons. Another resource that is lacking among small businesses in the country is capital. Some of the entrepreneur respondents, however, were lucky enough to have accessed some sources of financing which have led them to expanding their businesses.

The entrepreneur respondents were seldom involved in politics or do not see politics affecting their business that much which is why they believe that political involvement is not that very important to business success. Many Filipino businessmen distrust the institution of politics with all of its complexities and pressures. They try to move away from it as much as possible and concentrate more on the things that will surely give them a bigger chance of success in their businesses.

3. Entrepreneurial Orientations

3.1. Innovativeness

Table 8 depicts the degree of innovativeness of the entrepreneur-beneficiaries of the OTOP program in the province of Tarlac.

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Table 8

Innovativeness

Innovativeness	Mean	Verbal Descriptions
Emphasis on R&D, technological leadership, and innovations	5.10	High
Very many new lines of products or services are offered	3.47	Moderate
Dramatic changes in the product or service lines	4.83	High
Innovativeness Entrepreneurial Orientation Mean	**4.47**	**Moderate**

As seen on the table, the average rating for innovativeness among the 30 respondents is 4.47, which means that the subjects are on the middle side of innovativeness based on the 5-point scale used in describing the entrepreneurial orientations. Significant efforts were initiated on product improvements. But the entrepreneurs are offering less product lines compared to their counterparts from the other provinces. Among them are the entrepreneurs selling okra, handicrafts, chicharon, and tinapa.

More specifically, the entrepreneurs have high emphasis on the use of latest product research, technologies, and innovative strategies with an average rating of 5.10. When it comes to the number of product offerings, the mean rating of 3.47 signals that the respondents do not have very good performance on that aspect of innovativeness. This is because they have no additional products for the past five (5) years. On the aspect of product changes or improvements, the average rating of 4.83 signifies that the beneficiaries are strongly inclined with that strategy. The entrepreneur who produces chichacorn, for example, produces products, that is different from that in Ilocos because it is whiter and crispier. In Paniqui, water lilly based products are produced with more enhancements in the design, and a restaurant in Tarlac City produces cakes and pastries with a significant twist, which is a big deal for the customers.

Interpreting the findings, innovativeness cannot be strongly counted as a focus or direction of the beneficiaries of the OTOP program in the province of Tarlac. Although there are signs in the products of some entrepreneurs, generally speaking, they are not yet that innovative. In relation to product improvement and product changes, they are showing signs that they are on that track. The same is true on the use of latest product research, technologies, and innovations. The respondents need to learn more about the art and benefits of product innovation so they could compete more successfully with the other OTOP products in the country.

3.2. Proactiveness

Table 9 presents how proactive the entrepreneur-beneficiaries are in their business

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operations.

Table 9

Proactiveness

Proactiveness	Mean	Verbal Descriptions
Initiates actions responded to by competitors	5	High
First to introduce new products/services, administrative techniques, and operating technologies	5.07	High
Adopts a very competitive, "undo the competitors" posture	4.33	Moderate
Proactiveness Entrepreneurial Orientation Mean	**4.80**	**High**

The average rating of the entrepreneurs on proactiveness is 4.80, which is in the bracket of 4.60-5.79 on the EO (entrepreneurial orientation) scale. This means that the entrepreneur-respondents have a high sense of proactiveness or reactiveness.

Looking at the specific parameters of being proactive, the respondents have high tendency to initiate actions worth emulating by other businessmen (5), and also with the strong inclination to first introduce new products, techniques and technologies in the market (5.07). In terms of competitiveness, the respondents adopt the neutral side (4.33).

There are realizations in the findings. The entrepreneur respondents are forward looking. They make things happen. They know the benefits of being the first in starting fresh moves and actions in the industry, and in pioneering new products, techniques, and technologies. Businesses can capitalize on these strategies, and can even use them to their advantage. The entrepreneurs, however, have their soft side when it comes to their competitors. They are not the type of players in the so-called "Red Ocean Strategy" where there is intense competition among the business firms and entrepreneurs. As such, there is friendly competition. The respondents seem to value their co-existence with their competitors. From the interviews conducted, there were those who said that they were happy seeing their competitors doing well in their business and providing the needs of their families.

3.3. Risk Taking

The entrepreneur-beneficiaries' manners of taking risk are shown in Table 10.

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Table 10

Risk Taking

Risk Taking	Mean	Verbal Descriptions
A strong proclivity for high risk projects with high returns	4.67	High
Bold ranging acts are explored owing to the nature of the environment	5	High
Adopts a bold, aggressive posture to maximize probability of exploiting potential opportunities	5.03	High
Risk Taking Entrepreneurial Orientation Mean	**4.90**	**High**

As can be gleaned from the table, the overall risk taking rating of the 30 respondents is 4.90, which is described as high on the entrepreneurial orientation scale. On the particular indicators, the entrepreneur-beneficiaries, just like the overall description for proactiveness, have a leaning towards being a high risk taker: attraction or predilection to high risk projects is 4.67, adoption of bold, wide ranging acts is 5, and implementation of aggressive moves for opportunities is 5.03.

Similar status on the state of responsiveness previously discussed can be extended in risk taking among the 30 entrepreneur-respondents. The entrepreneur-beneficiaries of the OTOP program, in broad spectrum, like to take chances. They are bold in their strategies. Several circumstances still prevent many entrepreneurs from being converted into this kind of status, but obviously for the respondents, they seem to know the idea that the greater the risk one has entered into, the greater the possible rewards that can be possibly reaped in the future. The entrepreneur respondents welcome risky business opportunities and explore them with a wide range of strategies. They will do whatever they can to fully exploit some breaks in business. No stones will be left unturned in matters of business opportunities.

This conclusion agrees with the findings about Filipino entrepreneurs. In literatures, local entrepreneurs are either risk averse, risk takers, or calculated risk takers. Many Filipino entrepreneurs are largely calculated risk takers, making sense of the risks they encounter, and evaluating them whether they are reasonable for the business or not. But the respondents in this research belong to the other breed of entrepreneurs on risk taking. They are way above the common Filipino businessmen.

3.4. Competitive Aggressiveness

Table 11 is a depiction of the competitive aggressiveness EO of the 30 beneficiaries of the OTOP program in Tarlac.

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Table 11

Competitive Aggressiveness

Competitive Aggressiveness	Mean	Verbal Descriptions
Strong tendency to be ahead of the competitors in introducing novel products or ideas	4.33	Moderate
My firm is very aggressive and intensely competitive	4.43	Moderate
Competitive Aggressiveness Entrepreneurial Orientation Mean	**4.38**	**Moderate**

The mean rating for the competitive aggressiveness of the 30 entrepreneur-respondents is 4.38. This signifies that the entrepreneurs' competitive aggressiveness is on the neutral side based on the EO scale average rating bracket.

On the specific parameters of competitive aggressiveness, the respondents tend to stay in the middle of the game. The average rating on the aspect of race against competitors in introducing novel ideas or products was 4.33, while in the degree of firm aggressiveness and competitiveness, the mean rating was 4.43.

The results support the conclusion that the entrepreneur-beneficiaries are on the safe side when it comes to competitive aggressiveness. They do not take chances at competition and seem to maintain the status quo. They are not interested at the possible reward when competing with others became successful. Also, they do not want the complications and pressures of competing and seem to like the harmonious co-existence with other competitors. They seem to be happy seeing their competitors still operating in the market.

From the interviews among the respondents, what matters most to them is they survive the daily living requirements. They do not aim for very high sales and profits. Reasonable profit is enough for them. They would be happy seeing their competitors making money everyday and provide also for their families

3.5. Autonomy

Table 12 presents the autonomy inside the firms managed by the 30 entrepreneur-beneficiaries.

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Table 12

Autonomy

Autonomy	Mean	Verbal Descriptions
Managers guide the work of teams or individuals	4.83	High
The manager provides the primary impetus for pursuing business opportunities	5.53	High
Supervisory approval is sought by individuals/employees for pursuing business opportunities	5.73	High
The manager plays a major role in identifying and selecting entrepreneurial opportunities.	5.77	High
Autonomy Entrepreneurial Orientation Mean	**5.47**	**High**

The table shows that the average rating for the autonomy EO is 5.47. This figure leans towards the situation where the manager is the powerful person on matters of work guidance, and decision-making on business opportunities.

The average ratings for the parameters under the autonomy EO support overall rating for the autonomy EO. Work guidance is implemented at a high level (4.83). There is a strong inclination towards the strategy where the manager is the initiator of business opportunities (5.53). Also, supervisor approval is highly required when individuals or teams decide on business breaks (5.73), and the manager plays a major role in identifying and selecting the prospects the business pursues (5.77).

Based on the findings, the entrepreneur-beneficiaries are not advocates of autonomy or freedom at work or in making decisions. This is not because the entrepreneurs do not trust their employees, but because they prefer to take matters into their own hands. They are still more knowledgeable on what business opportunities to pursue and explore and that is why they are the final decision makers.

The respondents also want to make sure that all things are going smoothly inside the organization, thus, regular supervision and guidance is necessary. Moreover, the entrepreneurs want to ensure that the outputs, whether that is work or products, are of the best quality. This is one way of maintaining the good reputation of their business.

4. Relationship of the Performance Variables with the Key Success Factors and Entrepreneurial Orientation

4.1.1. Relationship of Employment Generation to Key Success Factors

Table 13 shows the relationship of employment generation to the key success factors of the entrepreneur respondents.

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Table 13

Relationship of Employment Generation to Key Success Factors

VARIABLES CORRELATED	COEFFICIENT OF CORRELATION	RELATIONSHIP
Employment generation x Entrepreneur	.4349	Significant
Employment generation x Enterprise	.3774	Significant
Employment generation x Network	.1460	Not Significant
Employment generation x Business Environment	.4599	Highly significant
Critical values at two tail test .349 at 5% level .449 at 1% level		

As seen from the data presented, more important among the key success factors with significance in employment generation is business environment (r=.4599). This means that a very good business environment will create a situation where a business firm will hire more employees. Other factors such as entrepreneur (r=.4349) and enterprise (r=.3774) also have positive relation on employment generation. Network has no relation or significance.

How the business environment factors affect employment is depicted in Table 14.

Table 14

Relationship of Business Environment Related Key Success Factors to Employment Generation

BUSINESS ENVIRONMENT RELATED KEY SUCCESS FACTORS	COEFFICIENT OF CORRELATION, r
	Employment Generation
Satisfactory Government Support	0.5758**
Access to Capital	0.5934**
Political Involvement	0.2117ns
Critical values at two tail test .349 at 5% level .449 at 1% level	

Legend: not significant (ns) Significant (*) Highly significant (**)

Satisfactory government support like One Town, One Product (OTOP) project, promotions, networking and others, as well as making funds available for micro, small and medium sized businesses can contribute to growth, thus making it imperative to employ more people. The OTOP project of the government, alone, has been instrumental in the increase in the network and expansion of the market of local enterprises. The need to sustain the demand for their products brought them to use the

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strategy of hiring more employees. Additional capital also enabled the entrepreneurs to purchase more raw materials and machines, and has also provided the leverage to engage more employees working for them to further sustain their operations and be of service to the community by providing more products to the people.

Table 15 illustrates how the entrepreneur related key success factors relate to employment generation.

Table 15

Relationship of Entrepreneur Related Key Success Factors to Employment Generation

ENTREPRENEUR RELATED KEY SUCCESS FACTORS	COEFFICIENT OF CORRELATION, r
	Employment Generation
Good Management Skills	0.4445*
Charisma, Friendliness	0.4377*
Previous Working Experience	0.4030*
Hard Work	0.4667**
Ability to Manage Personnel	0.4252*
Social Skills	0.4030*
Reputation for Honesty	0.4609**
Critical values at two tail test .349 at 5% level, .449 at 1% level	

Legend: not significant (ns) Significant (*) Highly significant (**)

There were two (2) highly significant entrepreneur related key success factors related to employment: reputation for honesty (r=0.4609) and hard work (r=0.4667). The more the entrepreneur is being honest with regard to the human resource needs of the firm and the higher the value for hard work is, the more employees will be hired for the business. Meanwhile, good management skills, charisma, previous working experience, ability to manage personnel, and social skills all have positive connections to employment generation.

Table 16 shows the connection of the enterprise related key success factors to the generation of employment.

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Table 16
Relationship of Enterprise Related Key Success Factors to Employment Generation

ENTERPRISE RELATED KEY SUCCESS FACTORS	COEFFICIENT OF CORRELATION, r
	Employment Generation
Appropriate Training	0.3583*
Marketing/Sales Promotion	0.3865*
Good Product at Competitive Price	0.3865*
Good Customer Service	0.3889*
Maintenance of Accurate Records	0.3666*
Critical values at two tail test .349 at 5% level .449 at 1% level	

Legend: not significant (ns) Significant (*) Highly significant (**)

It is clearly illustrated in the table that all the enterprise related key success factors have significant effects to employment, and good customer service has the highest coefficient of correlation among them. Human resource is definitely necessary in providing satisfactory customer service. Proper training in business management, including managing people, stresses the importance of employees in business operations. Creating and promoting products also necessitate people to be more effective. The management of business records will be more efficient when the business has the right number of staff.

The findings support the conclusion that business environment, entrepreneur, and enterprise provide positive direction to employment generation among the firms managed by the entrepreneur-beneficiaries. The power of government assistance and capital, the knowledge and skills of the entrepreneur, and the systems and offerings of the enterprise are precursors of growth in business that can be maintained by employing more people. Employment generation has been a serious problem in the country, with many people having a hard time being deployed in jobs that suit them. Based on the conclusion, the power of the entrepreneur, enterprise, and business environment as key success factors must be capitalized to help solve this big issue in the country.

4.1.2. Relationship of Average Sales to Key Success Factors

Table 17 shows the relationship of average sales to the key success factors: entrepreneur, enterprise, network, and business environment.

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Table 17

Relationship of Average Sales to Key Success Factors

VARIABLES CORRELATED	COEFFICIENT OF CORRELATION	RELATIONSHIP
Average sales x Entrepreneur	.018	Not significant
Average sales x Enterprise	.382	Significant
Average sales x Network	-.132	Not significant
Average sales x Business Environment	-.061	Not significant
Critical values at two tail test .349 at 5% level .449 at 1% level		

From the data, all of the key success factors do not affect the average sales of the firms managed by the entrepreneur-beneficiaries, except for the enterprise (r=.382) key success factor. The enterprise has positive relationship with sales and that means that effectively managed business will generate more revenues. This is the case of the micro, small, and medium enterprises subjected in this study. They have survived the many years of their existence because they have the arsenal of business tools needed to respond to the circumstances.

The specific enterprise related key success factors with a direct relation to sales generation are presented in Table 18.

Table 18

Relationship of Enterprise Related Key Success Factors to Average Sales

ENTERPRISE RELATED KEY SUCCESS FACTORS	COEFFICIENT OF CORRELATION, r
	Average Sales
Appropriate Training	0.3627*
Marketing/Sales Promotion	0.3912*
Good Product at Competitive Price	0.3912*
Good Customer Service	0.3937*
Maintenance of Accurate Records	0.3711*
Critical values at two tail test .349 at 5% level .449 at 1% level	

Legend: not significant (ns) Significant (*) Highly significant (**)

The specific success factors of appropriate training for the employees, marketing/promotion, good product at competitive price, good customer service, and maintenance of accurate records associated with the enterprise key success factor can be

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correlated with average sales. The sales generated by the firms managed by the entrepreneur-beneficiaries depend on these factors. The purchase of product actually starts from a good product with a reasonable price. Customers can't resist a good product, more so if it is even more practical to buy it because of its low price and benefits. The product will also go a long way when it is properly marketed and promoted by someone with exceptional customer service. A product, with all its benefits, must be properly communicated to the customers in order for them to appreciate it. And customers tend to have a repeat purchase when served by people with the right skills and attitude towards them. Good record keeping can also provide a clear picture of cost and expenses, thus providing a more reasonable pricing for products that can encourage purchase among customers, which translate into sales for the business.

Deciphering the data, it is right to say that the enterprise key success factor, featuring the elements of good product, promotion, and customer service, is a driver of sales among the small and medium enterprises in the OTOP program in the province of Tarlac.

4.1.3. Relationship of Investment to Key Success Factors

Table 19 shows the kinds of relationship investment have on the key success factors.

Table 19

Relationship of Investment to Key Success Factors

VARIABLES CORRELATED	COEFFICIENT OF CORRELATION	RELATIONSHIP
Investment x Entrepreneur	-.047	Not significant
Investment x Enterprise	-.066	Not significant
Investment x Network	-.423	Significant
Investment x Business Environment	-.149	Not Significant
Critical values at two tail test .349 at 5% level .449 at 1% level		

Only one (1) key success factor has significant relationship with investment and that is the network. And surprisingly, it has negative effect on investment. That means, as the entrepreneur expands the network, the less is the support when it comes to funding. In the Philippines, there are cases where the people close to a person are also the same people who are difficult to borrow money from for business. The closeness of the entrepreneur to friends and family members makes it easy to forget the money borrowed for business. And this is where the latter have learned their lessons. But they can also lend their support in other aspects, like promoting the products through word of mouth, thus also helping the businessman in return.

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Table 20 shows the association of network to investment.

Table 20

Relationship of Network Related Key Success Factors to Investment

NETWORK RELATED KEY SUCCESS FACTORS	COEFFICIENT OF CORRELATION, r
	Investment
Support of family and friends	-0.5141**
Position in the society	-0.3306ns
Critical values at two tail test .349 at 5% level .449 at 1% level	

Legend: not significant (ns) Significant (*) Highly significant (**)

The data from the table stresses the significant but highly negative relationship of friends and family members to investment. Meanwhile, position in the society has no effect on investment.

Judging from the data, none among the key success factors can cause a positive direction for the investment as performance variable.

4.2.1. Relationship of Employment Generation to Entrepreneurial Orientation

Table 21 depicts the correlation of employment generation to the entrepreneurial orientations: innovativeness, proactiveness or reactiveness, risk taking, competitive aggressiveness, and autonomy. Their effects on hiring employees were determined.

Table 21

Relationship of Employment Generation to Entrepreneurial Orientations

VARIABLES CORRELATED	COEFFICIENT OF CORRELATION	RELATIONSHIP
Employment generation x Innovativeness	.364	Significant
Employment generation x Proactiveness	-.034	Not significant
Employment generation x Risk Taking	.3748	Significant
Employment generation x Competitive aggressiveness	-.0519	Not significant
Employment generation x Autonomy	.022	Not significant
Critical values at two tail test .349 at 5% level .449 at 1% level		

There are two (2) entrepreneurial orientations that have a positive effect on employment generation: innovativeness (r=.364) and risk taking (r=.3748). Responsiveness, competitive aggressiveness, and autonomy were discovered to have no connection with the said performance variable.

Table 22 provides the specific innovativeness factors with relation to employment generation.

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Table 22

Relationship of Innovativeness to Employment Generation

INNOVATIVENESS	COEFFICIENT OF CORRELATION, r
	Employment Generation
Emphasis on R&D, technological leadership, and innovations	0.4153*
Very many new lines of products or services are offered	0.2825ns
Dramatic changes in the product or service lines	0.3933*
Critical values at two tail test .349 at 5% level .449 at 1% level	

Legend: not significant (ns) Significant (*) Highly significant (**)

The practice of innovativeness has positive correlation with employment generation. Looking at the parameters for innovativeness on Table 24, the emphasis on research and development and use of technology and innovations has significant effects on the number of employees hired. The employment of this strategy means additional people for the business. The same is true when there are breakthroughs in the products or services made by the enterprise. Products and processes have to be changed, improved, and adjusted, and that makes it labor intensive. It necessitates products to be much different from what was earlier offered in the market. They are either more embellished, tastier, more appealing, or responds better to customer needs. And those demands can be delivered if the entrepreneur has more manpower to do the other work required to create better products for the market. Thus, the more innovative the entrepreneur is, the greater is the need for workers.

Table 23 shows the connection of risk taking to employment generation.

Table 23

Relationship of Risk Taking to Employment Generation

RISK TAKING	COEFFICIENT OF CORRELATION, r
	Employment Generation
A strong proclivity for high risk projects with high returns	0.3572*
Bold ranging acts are explored owing to the nature of the environment	0.3824*
Adopts a bold, aggressive posture to maximize probability of exploiting potential opportunities	0.3847*
Critical values at two tail test .349 at 5% level .449 at 1% level	

Legend: not significant (ns) Significant (*) Highly significant (**)

Another entrepreneurial orientation with direct effect on employment generation

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is risk taking. Based on the table, all of the parameters are significantly related, indicating close connection to employment creation. The penchant to explore high-risk projects or decisions to explore bold wide-ranging actions to help achieve the firm's objectives requires the hiring of people. It can be considered as a risky undertaking because sometimes, an entrepreneur is not sure about the consistency in the work attitude and ethics of the people hired. At first, they present their good side but afterwards, they may lessen their productivity or lose their motivation. Further, hiring many people may be good for the business firm but there might be situations where they would possibly turn into liabilities. These are some reasons why hiring people sometimes could be very detrimental for the firm. But because the entrepreneur has the tolerance for risk, hiring more people can also be considered as an aggressive move to make the business move forward.

The findings indicate that the entrepreneur's desire to make better products and his tolerance for risks creates a situation where employees are highly welcome to enter the business firm.

4.2.2. Relationship of Average Sales to Entrepreneurial Orientations

The correlations of average sales and entrepreneurial orientations of the entrepreneur-beneficiaries are illustrated in Table 24.

Table 24

Relationship of Average Sales to Entrepreneurial Orientations

VARIABLES CORRELATED	COEFFICIENT OF CORRELATION	RELATIONSHIP
Average sales x Innovativeness	-.452	Highly significant
Average sales x Proactiveness	.443	Significant
Average sales x Risk taking	.531	Highly significant
Average sales x Competitive Aggressiveness	.376	Significant
Average sales x Autonomy	.019	Not significant
Critical values at two tail test =.349 at 5% level, .449 at 1% level		

There are two (2) entrepreneurial orientations with highly significant effects on average sales: innovativeness (-.452) and risk taking (r=.531). However, innovativeness has negative effect on sales, which means high innovativeness translates to lower sales. Proactiveness (r=.443) and competitive aggressiveness (r=.376), on the other hand, have significant effects. These findings imply that being responsive and competitively aggressive can help the entrepreneur generate revenues for the business. Meanwhile, autonomy has no significance to the performance variable.

Table 25 summarizes the relationship of innovativeness to average sales.

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Table 25

Relationship of Innovativeness to Average Sales

INNOVATIVENESS	COEFFICIENT OF CORRELATION, r
	Average Sales
Emphasis on R&D, technological leadership, and innovations	-0.5157**
Very many new lines of products or services are offered	-0.3508*
Dramatic changes in the product or service lines	-0.4884**
Critical values at two tail test=.349 at 5% level, .449 at 1% level	

Legend: not significant (ns) Significant (*) Highly significant (**)

The effort to improve products can really have a higher effect on sales but on a negative side. This implies that the more innovative the product is, the lower its sales would be.

All of the parameters pertaining to innovation have negative relationship to average sales, which seem to be unlikely, but upon closer consideration, over innovation in a product can sometimes make it unwanted because of the learning curve involved. Products are purchased based on their fitness for use. This is true to senior citizens and people who do not want complicated things. And such products also tend to be more expensive than others. As such, the demand is low thereby affecting sales.

The relationships of the particular parameters of risk taking to average sales are recapped in Table 26.

Table 26

Relationship of Risk Taking to Average Sales

RISK TAKING	COEFFICIENT OF CORRELATION, r
	Average Sales
A strong proclivity for high risk projects with high returns	0.5060**
Bold ranging acts are explored owing to the nature of the environment	0.5418**
Adopts a bold, aggressive posture to maximize probability of exploiting potential opportunities	0.5450**
Critical values at two tail test=.349 at 5% level, .449 at 1% level	

Legend: not significant (ns) Significant (*) Highly significant (**)

The risk taking EO also has a bold effect on sales. An entrepreneur who is considered a risk taker is fond of exploring some opportunities, which are less rosy for some, but seen to give positive returns, including increase in sales. This is proven in the highly significant relationships of the risk taking parameters to average sales as shown in the previous table.

Table 27 explores the relationship of proactiveness to average sales

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Table 27

Relationship of Proactiveness to Average Sales

PROACTIVENESS	COEFFICIENT OF CORRELATION, r
	Average Sales
Initiates actions responded to by competitors	0.4614**
First to introduce new products/services, administrative techniques, and operating technologies	0.4679**
Adopts a very competitive, "undo the competitors" posture	0.3996*
Critical values at two tail test .349 at 5% level .449 at 1% level	

Legend: not significant (ns) Significant (*) Highly significant (**)

In the case of proactiveness, the positive relationship among the specific variables to sales is understandable since a pioneering work or effort will make a mark on the customers. A first mover in making some actions and in introducing new products, techniques and technologies has its own set of advantages and positive results on sales.

Table 28 shows the relationship of competitive aggressiveness to average sales.

Table 28

Relationship of Competitive Aggressiveness to Average Sales

COMPETITIVE AGGRESSIVENESS	COEFFICIENT OF CORRELATION, r
	Average Sales
Strong tendency to be ahead of the competitors in introducing novel products or ideas	0.371*
My firm is very aggressive and intensely competitive	0.380*
Critical values at two tail test .349 at 5% level .449 at 1% level	

Legend: not significant (ns) Significant (*) Highly significant (**)

On the side of competitive aggressiveness, an entrepreneur who will tend to be intensely competitive, coming up with some strategies that will win the customers, will produce revenues for the business. The desire to be ahead in rolling out new products will also have the same result for the company.

Unfortunately, in the case of the respondents, autonomy has no correlation with average sales.

From the results, one can't help but think that being responsive, bold, and competitive will certainly move mountains for the entrepreneur, especially in the case of sales. If the entrepreneur wants to generate a lot of money, then he must learn how to have the aforementioned qualities.

4.2.3. Relationship of Investment to Entrepreneurial Orientations

Findings on the correlation between investment and the entrepreneurial orientations

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are presented in Table 29.

Table 29

Relationship of Investment to Entrepreneurial Orientations

VARIABLES CORRELATED	COEFFICIENT OF CORRELATION	RELATIONSHIP
Investment x Innovativeness	-.411	Significant
Investment x Proactiveness	.391	Significant
Investment x Risk taking	.529	Highly significant
Investment x Competitive aggressiveness	.381	Significant
Investment x Autonomy	-.028	Not Significant
Critical values at two tail test=.349 at 5% level, .449 at 1% level		

A notable finding in this case is the high significance of risk taking (r=.529) to investment. On the other hand, being proactive (r=.391), and competitively aggressive (r=.381) have significant relationship to investment. This implies that the presence of these qualities on the entrepreneur may well have a say on the money that is invested in the business. Innovativeness has a negative effect on investment while autonomy has no relation at all.

Table 30 provides a summary of the connection of risk taking parameters to investment.

Table 30

Relationship of Risk Taking to Investment

RISK TAKING	COEFFICIENT OF CORRELATION, r
	Investment
A strong proclivity for high risk projects with high returns	0.5041**
Bold ranging acts are explored owing to the nature of the environment	0.5397**
Adopts a bold, aggressive posture to maximize probability of exploiting potential opportunities	0.5430**
Critical values at two tail test=.349 at 5% level, .449 at 1% level	

Legend: not significant (ns) Significant (*) Highly significant (**)

All the parameters have high significance to investment. This denotes that if a person is a risk taker, the higher is the amount of money that will be invested in the firm. A risk taker does whatever it takes to make the business prosper, including the channeling of funds to the business in order to make the necessary purchases and to be able to implement some strategies.

Table 31 illustrates the relationship of proactiveness to investment.

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Table 31

Relationship of Proactiveness to Investment

PROACTIVENESS	COEFFICIENT OF CORRELATION, r
	Investment
Initiates actions responded to by competitors	0.4072*
First to introduce new products/services, administrative techniques, and operating technologies	0.4129*
Adopts a very competitive, "undo the competitors" posture	0.3527*
Critical values at two tail test .349 at 5% level .449 at 1% level	

Legend: not significant (ns) Significant (*) Highly significant (**)

The factors related to proactiveness have significance to investment. That means being reactive to situation entails the spending of money. Being proactive requires the constant thinking and implementation of strategies to be ahead of the game and this also needs money. To many people, advertising a new product is a simple strategy but it involves many hours of researching and planning. That alone is already a big investment. The cost of developing a novel product is a different case, as well as the adoption of new systems or techniques, or the latest technologies. These strategies also require the budget office to release funds for the effective implementation.

Table 32 lists the parameters on competitive aggressiveness and their relationship to investment.

Table 32

Relationship of Competitive Aggressiveness to Investment

COMPETITIVE AGGRESSIVENESS	COEFFICIENT OF CORRELATION, r
	Investment
Strong tendency to be ahead of the competitors in introducing novel products or ideas	0.3766*
My firm is very aggressive and intensely competitive	0.3853*
Critical values at two tail test .349 at 5% level .449 at 1% level	

Legend: not significant (ns) Significant (*) Highly significant (**)

The specific measures for competitive aggressiveness have positive relation to investment as depicted in the table. The desire to be ahead in rolling out new products and to make the firm very aggressive and intensely competitive must be coupled with the relentless search for possible sources of funds and investing them for the purposes mentioned.

By being competitively aggressive, the constant dream to outwit the competitors

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takes the entrepreneur into the tedious activities of researching, planning, testing, and others to effectively win the battle against the competitors. And again, those require the channeling of funds into the business. There seem to be endless reasons why an entrepreneur needs to invest, but the focus to become aggressive and competitive necessitates being voracious on the generation and utilization of funds.

The relationship of innovativeness to investment is shown in Table 33.

Table 33

Relationship Innovativeness to Investment

INNOVATIVENESS	**COEFFICIENT OF CORRELATION, r**
	Investment
Emphasis on R&D, technological leadership, and innovations	-0.4689**
Very many new lines of products or services are offered	-0.3190ns
Dramatic changes in the product or service lines	-0.4441*
Critical values at two tail test .349 at 5% level .449 at 1% level	

Legend: not significant (ns) Significant (*) Highly significant (**)

Remarkably, innovativeness has an indirect relation to investment. The specific measures support this finding. The focus on innovation and dramatic improvements in the product or service lines entails a lower amount of fund utilization. This is because of the learning experienced in the production, which has significantly reduced the need for funds. And also, Filipino entrepreneurs are known to exercise innovation using simple, tried and tested ways, siphoning less money from the budget.

Thus, it can be deduced from the results that again being responsive to situations, bold, and competitive will definitely develop the greed of the entrepreneur for money. However, the money will not go to him personally but will be put into productive use hoping that his business will be more competitive but still relevant and responsive to the society's needs.

5. Influence of Key Success Factors and Entrepreneurial Orientations to Performance

5.1.1. Influence of Key Success Factors to Employment Generation

The influences of key success factors to employment generation are shown in Table 34.

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Table 34

Influence of Key Success Factors to Employment Generation

KEY SUCCESS FACTORS	COEFFICIENT OF REGRESSION	PROBABILITY
Entrepreneur	14.23	.0473*
Enterprise	-19.96	.0348*
Network	-.4123	.9554 ns
Business Environment	18.17	.0180*
Multiple Coefficient of Determination=30.40% Overall Probability=.0358		

Legend: not significant (ns) significant(*) highly significant(**)

One can see clearly from the table that key success factors such as entrepreneur, enterprise, and business environment have significant influences to employment generation. The network factor has no significant contribution to the said performance variable. Considering the probability of each significant key success factor, the business environment (p=.0180) has the greatest impact, followed by enterprise (p=.0348) then the entrepreneur (p=.0473).

The results imply that a good business environment, effective enterprise and skilled entrepreneur are predictors of employment generation.

The multiple coefficient of determination of 30.40% to the generation of employment is attributed to the change in the business environment, enterprise, and entrepreneur. It further means that there are about 69.60% variables, which are unaccounted for. This means that there are other key success factors not included in this study which are possible predictors of employment generation.

5.1.2. Influence of Key Success Factors to Average Sales

The influences of the key success factors to average sales are presented in Table 35.

Table 35

Influence of Key Success Factors to Average Sales

KEY SUCCESS FACTORS	COEFFICIENT OF REGRESSION	PROBABILITY
Entrepreneur	3199964.88	.5820ns
Enterprise	-1611408.1	.7949ns
Network	15292654.6	.0464*
Business Environment	291276.76	.9406ns
Multiple Coefficient of Determination=10.29% Overall Probability=.0494		

Legend: not significant (ns) significant(*) highly significant(**)

The table shows that only one key success factor has a positive impact on average

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sales, and that is network (p=.0464). This suggests that the network of the entrepreneur is a catalyst of sales. The friends and family members of the entrepreneurs subjected in the study assist them in promoting their products, thereby driving up their sales. The other key success factors have no significant contributions in generating revenues.

The multiple coefficient of determination of 10.29% means that average sales may be credited to the network of the entrepreneur-respondents. This further implies that there are about 89.71% other variables with possible influences on average sales, which were not taken into account in this study.

5.1.3. Influence of Key Success Factors to Investment

Table 36 reveals the way the success factors impact investment.

Table 36

Influence of Key Success Factors to Investment

KEY SUCCESS FACTORS	COEFFICIENT OF REGRESSION	PROBABILITY
Entrepreneur	916881.83	.7333ns
Enterprise	311502.88	.9413ns
Network	-1005009	.0328*
Business Environment	-470011.9	.7957ns
Multiple Coefficient of Determination=12.06% Overall Probability=.0480		

Legend: not significant (ns) significant(*) highly significant(**)

It is illustrated in the table that network key success factor (p=.0328) has significant influence on investment. This leads to the conclusion that network can forecast the outcome of investment for the business. The other key success factors such as entrepreneur (p=.7333), enterprise (p=.9413), and business environment (p=.7957) have no impact on investment.

The multiple coefficient of determination of 12.06% indicates that that there are about

87.94% variables that are unaccounted for. This means that there is a big chance that other key success factors, which can forecast investment may be further discovered.

5.2.1. Influence of Entrepreneurial Orientations to Employment Generation

The way employment generation is influenced by the entrepreneurial orientations is presented in Table 37.

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Table 37

Influence of Entrepreneurial Orientations to Employment Generation

ENTREPRENEURIAL ORIENTATIONS	COEFFICIENT OF REGRESSION	PROBABILITY
Innovativeness	9.083	.0191*
Proactiveness	-3.430	.6283ns
Risk Taking	-8.327	.0345*
Competitive Aggressiveness	0.9575	.8904ns
Autonomy	0.9935	.8306ns
Multiple Coefficient of Determination = 17.52% Overall Probability = .03612		

Legend: not significant (ns) significant(*) highly significant (**)

From the data, innovativeness (p=.0191) and risk taking (p=.0345) have significant influence to employment generation. However, innovativeness has greater impact on hiring more employees than risk taking. Other entrepreneurial orientations, more specifically, proactiveness (p=.6283), competitive aggressiveness (p=.8904) and autonomy (.8306) have no significant contributions to employment generation.

The data implies that an out of the box thinking and taking risks are predictors of employment generation.

The multiple coefficient of determination of 17.52% implies that there are about 82.48% variables, which are not considered. This means that there are other "possible" undiscovered entrepreneurial orientations, which may predict employment generation. This further implies that 17.52% variance in the generation of employment is attributed to the change in the entrepreneur's innovativeness and risk taker attitude.

5.2.2. Influence of Entrepreneurial Orientations to Average Sales

Table 38 shows the influence of entrepreneurial orientations to average sales.

Table 38

Influence of Entrepreneurial Orientations to Average Sales

ENTREPRENEURIAL ORIENTATIONS	COEFFICIENT OF REGRESSION	PROBABILITY
Innovativeness	-4899544	.0052**
Proactiveness	1607307	.0340*
Risk Taking	7303434.6	.0016**
Competitive Aggressiveness	-1862482	.0273*
Autonomy	378062.2	.7306ns
Multiple Coefficient of Determination = 65.16%, Overall Probability = .0051		

Legend: not significant (ns) significant(*) highly significant (**)

It reveals that innovativeness (p=.0052), proactiveness (p=.0340), risk taking

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(p=.0016), and competitive aggressiveness (p=.0273) have positive impacts on average sales. Based on the probability, risk taking is the greatest influencer of sales, followed by innovativeness. Competitive aggressiveness and proactiveness have lower influences, thereby contributing less to the multiple coefficient of determination. Autonomy has no significant contribution to the said performance variable.

The multiple coefficient of determination of 65.61% means that average sales may be credited to the innovativeness, proactiveness, risk taking, and competitive aggressiveness of the entrepreneur. This further implies that there are about 34.84% other variables with possible influences on average sales.

5.2.3. Influence of Entrepreneurial Orientations on Investment

Table 39 depicts the power of entrepreneurial orientations on investment.

Table 39

Influence of Entrepreneurial Orientations to Investment

ENTRERENEURIAL ORIENTATIONS	COEFFICIENT OF REGRESSION	PROBABILITY
Innovativeness	-2746999	.0006**
Proactiveness	1039047	.0160*
Risk Taking	1039047	.0002**
Competitive Aggressiveness	3856971	.0131*
Autonomy	-1127329	.8914ns
Multiple Coefficient of Determination = 74.51%/Overall Probability = .0094		

Legend: not significant (ns) significant(*) highly significant (**)

There are four (4) orientations with significant influence on investment. These are risk taking (p=.0002) with the highest influence, followed by innovativeness (p=.0006). Proactiveness (p=.0160) and competitive aggressiveness (p=.0131) have lower influences on investment. The presence of influences in these entrepreneurial orientations means they can determine the direction of investment. Being innovative, proactive, risk taker, and aggressive with the competitors can predict the amount of investment in the firm.

The 74.51% variance in investment leads into the conclusion that any change in it may be attributed to the change in the four (4) orientations, with risk taking leading the pack, followed by innovativeness, competitive aggressiveness, and proactiveness.

6. Implication of the Study to Business Administration

This study on key success factors and entrepreneurial orientations of the entrepreneur-beneficiaries of the OTOP program in the province of Tarlac is very significant to the field of Business Administration and small business management in

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the country. It supports the relevance of success factors and entrepreneurial orientation in the quest towards the attainment of good business performance. The evaluation on the relationships and influences of the success factors and entrepreneurial orientations on performance, along with the knowledge that were generated from it, may be explored by the entrepreneurs which possibly help them craft their own recipes of entrepreneurial success. This great output may be extended to future businessmen, and may also serve as inspiration to students taking up business and entrepreneurship, teachers, researchers, and agencies related to business.

Since there were key success factors and entrepreneurial orientations that were found to have relationship with each of the performance variables, we partially reject Hypothesis 1.

Hypothesis 1. There is no significant relationship between the performance variables and the key success factors and the entrepreneurial orientations of the OTOP beneficiaries.

And also, based on the results that some success factors and entrepreneurial orientations have influence on each of the performance variables, we relatively reject the second hypothesis.

Hypothesis 2. The key success factors and the entrepreneurial orientations of the OTOP beneficiaries have no significant impact on the performance of their businesses.

APPENDIX

APPENDIX A
QUESTIONNAIRE

Name of business: _____

Address: _____

Year established: _____

Name of owner/owners: _____

I. Performance Indicators

Employment Generated: _____ (from start to present)

Average Sales for the past 3 years: _____

Investment: _____ (from start to present)

II. Key Success Factors*

1. What are the things that made your business successful? For every key success factor identified, describe the degree of importance.

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Key Success Factors	**Importance**				
	Unimportant (1)	Not very important (2)	Mildly important (3)	Very Important (4)	Extremely important (5)
1. Good management skills					
2. Charisma, friendliness					
3. Previous business experience					
4. Hardwork					
5. Ability to manage personnel					
6. Social skills					
7. Reputation for honesty					
8. Appropriate training					
9. Marketing /sales promotion					
10. Good product at competitive price					
11. Good customer service					
12. Maintenance of accurate records					
13. Support of family and friends					
14. Position in society					
15. Satisfactory government					

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support					
16. Access to capital					
17. Political involvement					

The questionnaire was developed by Hung M. Chu (Chu and Katsioloudes, 2001)

Items 1- 7: Entrepreneur

Items 8-12: Enterprise

Items 13-14: Network

Items 15-17: Business environment

II. A. Entrepreneurial Orientation

1. How do you define your focus as an entrepreneur? Describe the intensity of that focus.

EO Scale**

Innovativeness		
In general, I the manager of my firm favor….		
A strong emphasis on the marketing of tried-and-true products or services.	1 2 3 4 5 6 7	A strong emphasis on R&D, technological leadership, and innovations.
How many lines of products or services has your firm marketed in the past five years (or since its establishment)?		
No new lines of products or services.	1 2 3 4 5 6 7	Very many new lines of products or services.
Changes in product or service lines have been mostly of a minor nature.	1 2 3 4 5 6 7	Changes in product or service lines have usually been quite dramatic.
Proactiveness		
In dealing with the competitors, I…		
Typically respond to actions which competitors initiate.	1 2 3 4 5 6 7	Typically initiate actions to which competitors then respond.
Seldom have the first business to introduce new products/services, administrative techniques, operating technologies, etc.	1 2 3 4 5 6 7	Often have the first business to introduce new products/services, administrative techniques, operating technologies, etc.
Typically seek to avoid competitive clashes, prefering a "live-and-let live" posture.	1 2 3 4 5 6 7	Typically adopt a very competitive, "undo-the-competitors" posture.
Risk Taking		
In general, I as the manager have…		
A strong proclivity for low-		A strong proclivity for high

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risk projects(with normal and certain rates of return).	1 2 3 4 5 6 7	risk projects (with chances of very high returns).
In general. I as the manager believe that….		
Owing to the nature of the environment , it is best to explore it gradually via cautious, incremental behavior.	1 2 3 4 5 6 7	Owing to the nature of the environment, bold wide-ranging acts are necessary to achieve the firm's objectives.
When confronted with decision-making situations involving uncertainty , I….		
Typically adopt a cautious "wait-and see" posture in order to minimize the probability of making costly decisions.	1 2 3 4 5 6 7	Typically adopt a bold, aggressive posture in order to maximize the probability of exploiting potential opportunities.
Competitive Aggresiveness		
In general, I being the entrepreneur have a….		
Strong tendency to "follow the leader" in introducing new products or ideas.	1 2 3 4 5 6 7	Strong tendency to be ahead of other competitors in introducing novel ideas or products.
My firm makes no special effort to take business from competition.	1 2 3 4 5 6 7	My firm is very aggressive and intensely competitive.
Autonomy		
The firm…		
Supports the efforts of individuals and/or teams that work autonomously.	1 2 3 4 5 6 7	Requires individuals or teams to rely on the manager to guide their work.
In general, I as the entrepreneur believe that….		
The best results occur when individuals and/or teams decide for themselves what business opportunities to pursue.	1 2 3 4 5 6 7	The best results occur when the manager provide the primary impetus for pursuing business opportunities.
In my firm		
Individuals/employees, and/or teams pursuing business opportunities make decisions on their own without constantly refering to their supervisors.	1 2 3 4 5 6 7	Individuals/employees and or teams pursuing business opportunities are expected to obtain approval from their supervisors before making decisions.
Employee initiatives and inputs play a major role in identifying and selecting he entrepreneurial	1 2 3 4 5 6 7	The manager plays a major role in identifying and selecting the entrepreneurial

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opportunities the firm or business pursues.		opportunities the business pursues.

*****Adopted from the studies of Miller/Covin and Slevin (1989), Lumpkin and Dess (2001) and Lumpkin, Cogliser, and Schneider (2009)***

APPENDIX B
Active OTOP Tarlac Beneficiaries

Name of Business	Entrepreneur	Company Address	Product Line
1. Aroma Anao	Perry Grande	Pob. 1, Anao, Tarlac	Ylang Ylang essential oil, perfumes
2. Biossence	Ronald Guerrero	Brgy. Sa. Jose South, Anao, Tarlac	Soaps and detergents
3. Francia's Mango Delicacies	Ma. Lourdes Francia	Brgy. San Roque, Bamban, Tarlac	Choco-mango delicacies
4. Consolacion Dela Cruz Meat Dealer	Consolacion Dela Cruz	Camiling Public Market, Camiling, Tarlac	Chicharon Camiling, processed meat
5. Lilia Martin Meat Dealer	Lilia Martin	Camiling Public Market, Camiling, Tarlac	Chicharon Camiling, processed meat
6. Rosalina Soriano Meat Stall	Rosalina Soriano	Camiling Public Market, Camiling, Tarlac	Chicharon Camiling, processed meat
7. Mila's Tinapa Factory	Mila Tolentino	Brgy. Talaga, Capas, Tarlac	Tinapa (smoked fish) processing
8.Talaga Smoked Fish	Maria Tuazon	Brgy. Talaga, Capas, Tarlac	Tinapa (smoked fish) processing
9. Luisa's Meat Products	Luisa Gutierrez	Brgy. San Jose, Concepcion, Tarlac	Tocino, longganisa, ham, hotdog
10. Stacy's Food Products	Luisa Gutierrez	Brgy. San Jose, Concepcion, Tarlac	Tocino, longganisa, ham, hotdog
11.Stephen's Meat Products	Yolanda Tiamzon	Brgy. San Jose, Concepcion, Tarlac	Tocino, longganisa, chicharon
12. Gene's Sugarcane-Based Products	Eugene Capinding	Brgy. Danzo, Gerona, Tarlac	Processed sugarcane, panucha, vinegar
13. Yadao Sugarcane Products	Naty Yadao	Gerona, Tarlac	Sugarcane based products
14.W. Balaba Upgraded Muscovado Plant	Apolonio Balaba	Brgy. Malayep, Gerona, Tarlac	Muscovado sugar blocks
15. AITI Agro Coop, Inc.	Helen Matsuoka	Brgy. San Roque, La Paz, Tarlac	Fresh okra

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16. Great Eastern, Inc.	Sonny Lumbang	Brgy. Balanoy, La Paz, Tarlac	Fresh okra
17.Greenstar Phils., Inc	Rolando Sarte	Brgy. Caramutan, La Paz, Tarlac	Fresh okra
18. HI-LAS Marketing	Bobby Amores	Brgy. Sierra, La Paz, Tarlac	Fresh okra
19. Sungreen Farms	Aurea Calimlim	Brgy. Dumarais, La Paz, Tarlac	Fresh okra
20. Nambalan Woodcraft and Furniture	Teofilo Bacho	Brgy. Nambalan, Mayantoc, Tarlac	Wooden furniture
21. Don Benito Sweetpotato Wine	Vida Bagamaspad	Poblacion, Moncada, Tarlac	Wine
22. Paniqui Water Lily	Sylvia Soriano	Poblacion, Paniqui, Tarlac	Water lily bags, novelty items
23. Tresvalles Corn Husk Flowers	Beth Tresvalles	Poblacion, Pura, Tarlac	Corn husk handicrafts
24. R. Molina Food Products	Rodolfo Molina	Brgy. Linao, Pura, Tarlac	Chichacorn (Corn crunch)
25. Linao Farmers MPCI	Cerelino Gamboa	Brgy. Linao, Pura, Tarlac	Corn production
26. AMREY Fashion Wear	Amelia Beltran	Brgy. Guiteb, Ramos, Tarlac	Crochet and knitted blouses
27. D' New Ramos Crochet	Saturnina Buccat	Brgy. Pance, Ramos, Tarlac	Crochet blouses and dresses
28. DUFMAC Brooms	Roseller Toledo	Poblacion, San Clemente, Tarlac	Tiger grass production, soft brooms manufacturing
29. Western Furniture MPCI	Samuel Tababa	Brgy. Iba, San Jose, Tarlac	Wooden furniture, door, jambs
30. San Manuel Malunggay	Jose Villa Agustin, Jr.	Poblacion, San Manuel, Tarlac	Malunggay production
31. Wood Inspirations Crafts	Karmen Blesilda Pascual	Gabay Street, Pob. East, Sta.Ignacia, Tarlac	Bamboo based products
32. Pascasio Pottery	Tony Pascasio	Poblacion, Sta. Ignacia, Tarlac	Pottery products
33. 3FGR Enterprise	Rico Ramos	Brgy. Calingcuan, Tarlac City	Home made peanut butter, processed fruit jams
34. Betty's Native Cakes	Jean Junio	18 San Roque, Tarlac City	Native cakes
35. Cindy's Bakeshop	Benigno Chua	Poblacion, Tarlac City	Cakes, breads, and pastries
36. Gertie's Bakeshop	Gertrudes Garcia	Capitol Gardens Subd., Tarlac City	Cakes, breads, and pastries

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37. Homemade by URDU	Myrna Agatha Joy Sarinas	Burgos St., Tarlac City	
38. Kevynel's Food Products	Hector Ramos	Zone 5, Maliwalo, Tarlac City	Sweet beans
39. Lita's Delicacies	Carmelita Yumang	Brgy. Baras Baras, Tarlac City	Pastillas, barquiron, tamarind candy
40. Macapinlac Cake House	Henry Macapinlac	Poblacion, Tarlac City	Cakes and pastries
41. Potter's Hand Processed Foods	Susan Dy	Blossomville Subd., Tarlac City	Chili garlic paste, vinegar, Chinese bagoong
42. Rosemary's Bakeshop	Divina Fernandez	Brgy. San Rafael, Tarlac City	Yema roll, baked products
43. Tita Glo's Delicacies	Ma. Gloria Capaz	18 San Roque, Tarlac City	Brownies
44. Lalapac Sugarcane Farmers MPC	Noly Lorenzo	Brgy. Lalapac, Victoria, Tarlac	Processed sugarcane, panucha, vinegar, basi wine

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An Overview of Smart Farming Production Technology for the Advancement of Home-grown Farmers in the Philippines

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ABSTRACT

This article explores the technologies that can be used to establish smart farming in the Philippines, as well as the various smart systems that have been used to aid home-grown farmers. The emergence of smart agriculture and farming is a method that heavily integrates digital technology in order to increase food production while minimizing input costs. The importance of this technology has a significant effect on farmers and investors as a result of technological advancements. It should also be recognized that numerous promotions requiring government funding for the establishment of smart farming technology in the Philippines has been addressed.

Keywords: Smart Farming; Hydroponics; Aquaponics; Aeroponics

INTRODUCTION

In the Philippines, almost half of the population lives in rural areas and relies on agriculture for a living; among them are indigenous people, landless farmers, and fishermen [1]. In general, farmers on different islands in the Philippines operate independently using conventional methods, and their management of farm produce to end-users is facilitated at low prices by middlemen. Micro-propagation protocols for bananas, coconuts, legumes, and oilseed crops are well known [2].

In the first quarter of 2021, the value of agricultural output fell by -3.3 percent at constant 2018 rates. This was attributed to a decrease in livestock and poultry demand. Crops and fisheries, on the other hand, also increased productivity [3]. Despite this condition, the Philippines is working to modernize and improve its agriculture industry, with both the government and private firms encouraging the use of advanced technologies and smart farming practices to raise harvests and reduce losses [4].

Agriculture's creation was a watershed moment in human history. The willingness of fully modern humans to change the atmosphere to produce enough food to support population growth is the first major improvement in the relationship between fully modern individuals and society. Agriculture ushered in a slew of new developments, ranging from the use of fire and cooked food to self-driving machinery [5].

Hence, smart farming is seen as the agricultural future because it produces higher quality crops by making farms more intelligent in sensing their controlling parameters [6].

SIGNIFICANCE OF SMART FARMING TECHNOLOGY

Agriculture routinely uses sophisticated technologies such as robots, temperature and moisture sensors, aerial images, and GPS technology. These cutting-edge devices, precision agriculture, and robotic systems enable businesses to be more profitable, efficient, safe, and environmentally friendly [7].

Thus, technology is critical to the development of the farming industry and the improvement of agribusiness. Researchers have successfully grown crops in deserts and other harsh environments using genetic engineering, which involves inserting traits into established genes in order to produce pest-resistant, drought-resistant, and plant pathogen-resistant crops.

Moreover, this technology will enhance insect or pest resistance, herbicide or drought tolerance, and disease resistance, providing farmers with a new tool for increasing crop yield. Farmers have used plant breeding and selection techniques to increase crop yield with the assistance of researchers. Technology is also used to protect crops by tracking growth and detecting plant diseases. Without the physical involvement of farmers, automation allows for the consistent distribution of fertilizers, pesticides, and water throughout fields [8].

Lastly, innovative agriculture ensures that new farming and agricultural development models emerge, introducing innovative techniques on how food is produced and distributed. These methods allow more economies and regions to keep up with changing trends and meet the demands of modern living while ensuring sustainably grown food. [9].

SMART FARMING TECHNOLOGY

Hydroponics Farming

Hydroponic farming is a method of growing plants in water without soil using mineral nutrient solutions. The hydroponic gardener controls the nutrient content of the liquid solution used to water the plants [10].

Common Types of Hydroponics System

1. Nutrient Film Technique (NFT)

A method of cultivating plants in which plant roots grow in shallow and circulating hydroponic nutrient layers, allowing plants to receive adequate water, nutrients, and oxygen. Plants grow in layers of polyethylene, with plant roots immersed in nutrient-rich water that is constantly pumped by a pump [11].

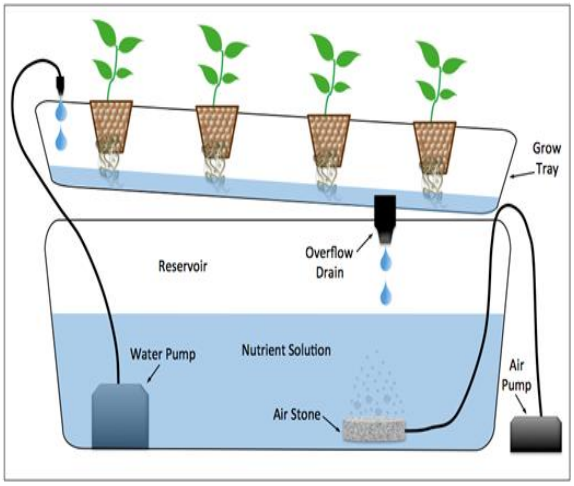

Figure 1. Diagram of the Nutrient Film Technique (NFT) hydroponic system [12]

2. Wick Systems

It is considered the most basic hydroponic device. The Wick system is classified as a passive system, which means it has no moving parts. Your unique Growth Technology nutrient solution is drawn up into the expanding medium through a number of wicks from the bottom reservoir. This device will work with a number of mediums, including perlite, soil, and coco [13].

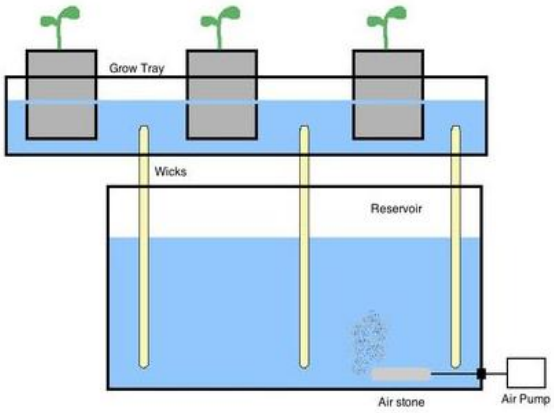

Figure 2. Diagram of the Wick System [14]

3. Deep Water Culture (DWC)

It is a hydroponic method of plant production by suspending the roots of the plant in a solution of oxygenated, rich in nutrients. This system uses rectangular tanks of less than one foot deep filled with a nutrient-rich solution and plants floating on

Styrofoam panels, also known as Deep Flow Technique (DFT), Floating Raft Technology (FRT), or Raceway [15].

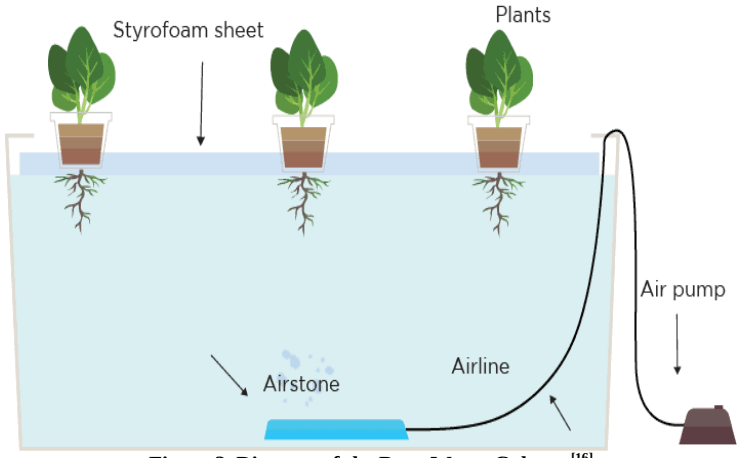

Figure 3. Diagram of the Deep Water Culture [16]

4. Ebb and Flow (Flood and Drain)

It is a hydroponics technique that involves flooding the growth media with nutrient solution for a set period of time, after which the unabsorbed nutrient is returned to the tank. Normally, this hydroponics device uses a timer to fill the water, resulting in inefficient usage of nutrient solution [17].

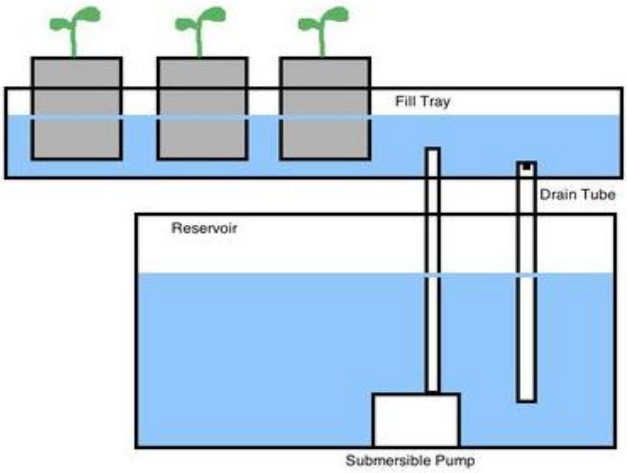

Figure 4. Diagram of the Ebb and Flow [18]

Aquaponics Farming

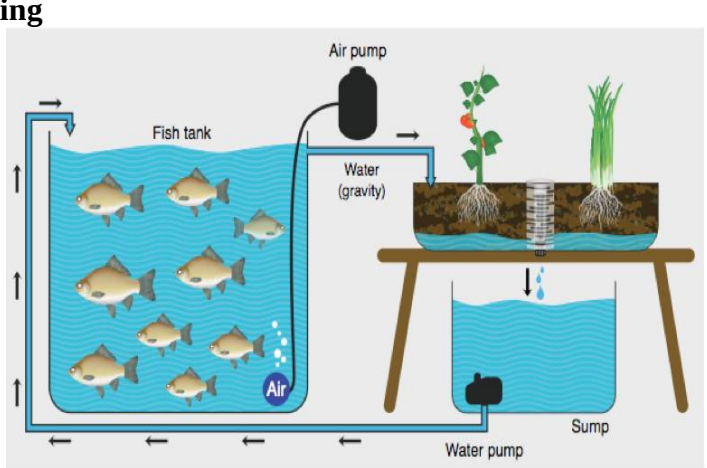

Figure. 5. Diagram of the Aquaponics [19]

In an aquaponics system, water from an aquaculture system is fed into a hydroponic system where by-products' are broken down by nitrifying bacteria first into nitrites and then into nitrates, which are used as nutrients by the plants [19]. A symbiotic relationship between two food production disciplines: (1) aquaculture, the farming of aquatic species, and (2) hydroponics, the cultivation of plants in water without soil. Aquaponics is a closed recirculating device that incorporates the two. A typical recirculating aquaculture system filters and eliminates organic matter ("waste") that accumulates in the water, ensuring that the water is safe for the fish [20].

Aeroponics Farming

In Aeroponics, the nutrient solution is sprayed onto the roots by moving it through misters inside the root region, either continuously or several times per hour [21].

The plant you want to develop is suspended in an air space with an atmosphere that is either completely closed or semi-closed. As a result, it is best achieved in a closed, regulated environment where you can monitor the amount of light, air, and nutrient-rich water spray that is fed into the plant [22].

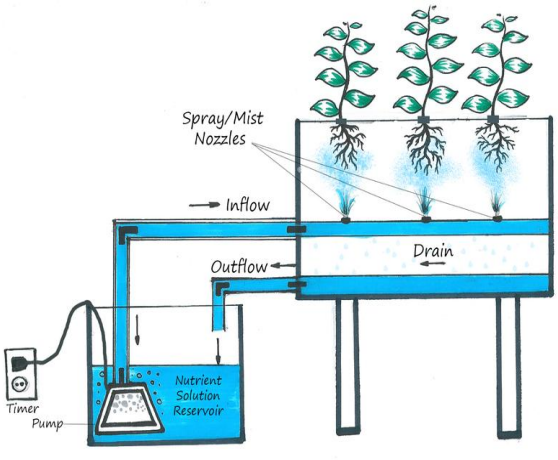

Figure 6. Diagram of Aeroponics [22]

GOVERNMENT SUPPORT TO SMART FARMING

In the Philippines, the local government, led by the Department of Agriculture, is aiming for a 2.5 percent growth this year through further incorporation of technology in agriculture to increase productivity, connectivity, and service delivery to beneficiaries. By focusing on and closely implementing 'Agriculture 4.0,' or the fourth agricultural revolution that encourages the use of smart farming technology, the country would have a better chance of having a better 2021 in terms of agriculture [23].

Agriculture Secretary William Dar released a memorandum to all DA executives, attached agencies and companies, services, and regional offices directing them to "pursue an inclusive approach on these main strategies to accelerate the transition into a new and industrialized Philippine agriculture." [24].

Another agency distinguished in its Labor Market Intelligence report "Soils to Satellites," the Technical Education and Skills Development Authority (TESDA) has been published covering practical topics such as automation in smart greenhouses, agricultural drones, IoT solutions to agricultural problems, and case studies in selected ASEAN countries in smart agriculture applications [25].

CONCLUSION

Some technologies will need to be developed specifically for agriculture, while other technologies already developed for other areas could be adapted to the modern agricultural domain such as autonomous vehicles, artificial intelligence and machine vision and smart farming.

Moreover, as farming in the Philippines faces several problems, proactive solutions like ICT must be implemented together with the full support of the government. Similarly, other major players, such as multinational companies, agricultural and fisheries industry leaders and organizations, and agricultural state

universities and colleges (SUCs), should work together to elevate home-grown farmers in the country.

Lastly, if modern agriculture is applied widely in the near future, millions of farmers will be able to benefit from the acquisition and development of smart farming production technology.

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On-Campus Solar Energy: A Review Towards Green Technology

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Abstract: *This review paper discusses renewable energy, specifically solar photovoltaic (PV) energy, which provides benefits in selecting the proper technology for campuses. This study aims to direct scholarly attention to the processes that underpin strategic renewable energy investment decisions, as well as how these decisions are influenced by national energy policy. It discusses three (3) common PV technologies that could be adopted by universities and colleges in support of the renewable energy in the Philippines. Different benefits and drawbacks in using solar energy were also discussed. The proposed approach framework was presented. Finally, the status of solar energy in the Philippines and the innovative initiatives of higher education institutions in the Philippines were highlighted.*

Keywords: Renewable Energy, Solar Photovoltaic, Thin film Solar Cells Technology, Mono Silicon Solar Cells Technology, Polysilicon Solar Cells Technology.

I. INTRODUCTION

Solar energy is solar radiation that can produce heat, cause chemical processes, or generate electricity. The overall amount of solar energy incident on Earth exceeds the world's current and projected energy needs by a large margin. This highly distributed source has the ability to meet all future energy needs if properly exploited. Solar energy, in contrast to the finite fossil fuels coal, petroleum, and natural gas, is predicted to become increasingly popular as a renewable energy source in the twenty-first century due to its limitless supply and nonpolluting nature [1]. New renewable energy has gotten a lot of attention as a potential future energy source that might play a big role in developing a long-term energy supply system [2].

In the Philippines, Republic Act (RA) No. 9513 also known as Renewable Energy Act of 2008, has been crafted to accelerate the exploitation and development of renewable energy resources such as, but not limited to, biomas, solar, wind, hydro, geothermal and ocean energy through the adoption of sustainable energy development strategies to reduce the country's exposure to price fluctuations in the international markets, the effects of which spiral down to almost all sectors of the economy, to increase the utilization of renewable energy by institutionalizing the development of national and local capabilities in the use of renewable energy systems, and promoting its efficient and cost-effective commercial application by providing and nonfiscal incentives, to establish the necessary infrastructure and mechanism to carry out with the protection of health and the environment; and to establish the necessary infrastructure and mechanism to carry out the mandates specified in this Act and other existing laws [3].

Universities and Colleges in the Philippines continue to expound the development of renewable energy by installing solar panels in their respective campuses. Strategic adoption and implementation of solar energy in higher education institution is a big challenge not only on financial budget.

Renewable energy technology investments are becoming increasingly popular as a way to boost growth and speed up the recovery from the recent financial crisis. Despite their popularity and the numerous policies enacted to encourage these technologies, the adoption of RE projects has lagged behind predictions. This low adoption is attributable to a lack of adequate funding as well as a reluctance to invest in these technologies [4].

Renewable energy sources (RES) have a large potential to contribute to the sustainable development (SD) of specific territories by providing them with a wide variety of socioeconomic and environmental benefits. However, the existing

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literature has put much emphasis on the environmental benefits (including the reduction of global and local pollutants), while socioeconomic impacts have not received a comparable attention. These include diversification of energy supply, enhanced regional and rural development opportunities, creation of a domestic industry and employment opportunities. With the exception of the diversification and security of energy supply, these benefits have usually been mentioned, but their analysis has been too general (i.e., mostly at the national level) and a focus on the regional and, even more so, the local level, has been lacking. At most, studies provide scattered evidence of some of those regional and local benefits, but without an integrated conceptual framework to analyze them [5].

The management and exploitation of renewable energy sources is now recognized as central to sustainable development. Environmental concerns, recurring oil crises and market weaknesses, combined with the availability of power from natural resources and resulting possibilities for job creation and energy independence, have all pushed developed and developing countries towards new energy [6].

Electric energy security is essential, yet the high cost and limited sources of fossil fuels, in addition to the need to reduce greenhouse gasses emission, have made renewable resources attractive in world energy-based economies. The potential for renewable energy resources is enormous because they can, in principle, exponentially exceed the world's energy demand; therefore, these types of resources will have a significant share in the future global energy portfolio, much of which is now concentrating on advancing their pool of renewable energy resources. Accordingly, this paper presents how renewable energy resources are currently being used, scientific developments to improve their use, their future prospects, and their deployment. Additionally, their paper represents the impact of power electronics and smart grid technologies that can enable the proportionate share of renewable energy resources [7].

Electricity market is undergoing a tremendous transformation throughout the world. A drastic reduction of carbon emission cannot be realized if renewable energy resources are not increased in share of generation mix. Currently, most of the traditional mechanisms, including regulatory policies, fiscal incentives and public financing, are initiated from and heavily relied on policymakers and governments. However, not only these schemes do not necessarily align with business interests of investors, but also the motivations for renewable energy developments are always initiated by governments. In order to realize the full potential of renewable energy investment, an innovative approach is necessary to motivate investors and lessen government expenditures [8].

Major developments, as well as remaining challenges and the associated research opportunities, are evaluated for three technologically distinct approaches to solar energy utilization: solar electricity, solar thermal, and solar fuels technologies. Much progress has been made, but research opportunities are still present for all approaches. Both evolutionary and revolutionary technology development, involving foundational research, applied research, learning by doing, demonstration projects, and deployment at scale will be needed to continue this technology-innovation ecosystem. Most of the approaches still offer the potential to provide much higher efficiencies, much lower costs, improved scalability, and new functionality, relative to the embodiments of solar energy-conversion systems that have been developed to date [9].

II. PHOTOVOLTAIC SOLAR SYSTEM

Solar photovoltaic (PV) systems are semiconductor devices that convert sunlight into DC power by the transfer of electrons. They are a mature technology with a life expectancy of 20–30 years. The energy conversion process is divided into two stages: the generation of an electron-hole pair through light absorption in semiconductor material, and the subsequent separation of the electron to the negative terminal and the hole to the positive terminal by the device's structure to supply electricity [10].

Figure 1 illustrates how the electrical energy generated by such a solar system can be supplied into the electrical network while maintaining pre-defined quality and reliability criteria and without causing disruption to the network's normal operation. An inverter connects the PV array to the network by converting the DC output of the array PV panels to an AC output waveform that matches the voltage and frequency of the local network. It's worth noting that the system depicted in Figure 1 lacks any energy storage capability; this is the typical architecture of many contemporary grid-connected photovoltaic systems [11].

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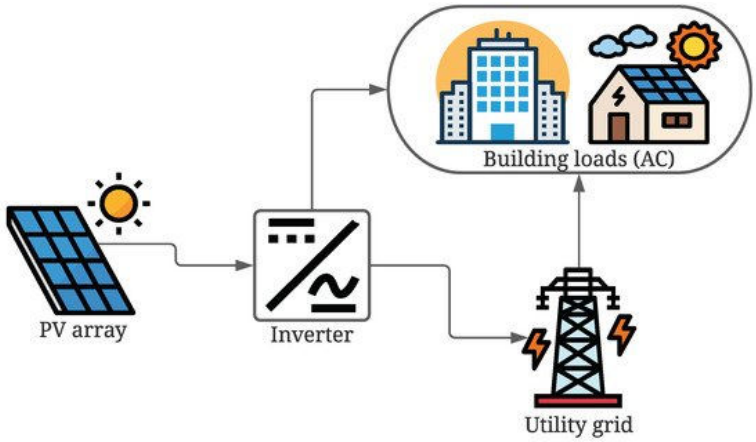

Figure 1: Layout of the grid-connected photovoltaic system [11]

III. Common Types of Solar Panels

3.1 Thin Film Solar Cells Technology

Cells Thin film solar cells are made up of micron-thick photon-absorbing material layers placed on a flexible substrate to convert light energy into electrical energy (via the photovoltaic effect). Thin-film solar cells were first developed in the United States in the 1970s by researchers at the University of Delaware's Institute of Energy Conversion. As technology advanced, the worldwide thin-film photovoltaic market grew at an unprecedented rate in the early twenty-first century, and was expected to continue to rise. Several types of thin-film solar cells are widely used because of their relatively low cost and their efficiency in producing electricity [12].

There are three main types of thin-film solar cells, depending on the type of semiconductor used: amorphous silicon (a-Si), cadmium telluride (CdTe) and copper indium gallium diselenide (CIGS). Amorphous silicon is basically a trimmed-down version of the traditional silicon-wafer cell. As such, a-Si is well understood and is commonly used in solar-powered electronics [13].

Thin-film solar cells made of amorphous silicon are the most developed. The duality is commonly p-i-n (or n-i-p), with the p-layer and n-layer mostly employed for producing an internal electric field (i-layer) made of amorphous silicon. The i-layer is typically 0.2–0.5 m thick due to the high absorption capacity of amorphous silicon. It has an absorption frequency of 1.1 to 1.7 eV [14].

A thin-film cell efficiency of 16.5 percent in cadmium telluride (CdTe) has been obtained, whereas the current record module efficiency is 10.6 percent. In 2002, CdTe accounted for 0.7 percent of global cell manufacturing, the majority of which was for indoor usage in consumer products. The efficiency of commercial modules is often less than 7%. A glass superstrate and a layer of transparent conducting oxide (TCO) as front contact, a near-transparent n-type cadmium sulphide (CdS) window layer, p-type CdTe, and a metallic rear contact make up the fundamental structure. The module is divided into cells by scribing the contact films, which are then connected in series to provide the needed voltage [15]. Cu (In1-x Gax) Se2 nanocrystalline bulk semiconductor is used as the absorber material in copper-indium-gallium-diselenide (CIGS) thin-film solar cells, which are multilayer thin-film devices. In compared to silicon wafer-based solar cells, CIGS thin film solar cells have a low-cost substrate and monolithic interconnection of individual cells in a module. CIGS have a good energy band gap, which is another advantage of this compound semiconductor. The band gap of the absorber should theoretically be between 1.0 and 1.8 eV, with 1.5 eV being the ideal value [16].

3.2 Mono Silicon Solar Cells Technology

Monocrystalline silicon solar cells, which are produced from pure silicon on thin silicon wafers, are the most common and oldest technology. Monocrystalline silicon is formed up of organized crystal formations in which each atom is perfectly aligned [17].

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These cells are comprised of monocrystalline silicon in its purest form. Silicon has a single continuous crystal lattice structure in these cells, with nearly no flaws or impurities. Monocrystalline cells' main advantage is their high efficiency, which is typically around 15%. The disadvantage of these cells is that monocrystalline silicon requires a sophisticated production process, resulting in slightly higher costs than alternative technologies [18].

3.3 Polysilicon Solar Cells Technology

Polycrystalline silicon (polysilicon) is a substance made up of tiny silicon crystals that convert sunlight into electricity and is used to make crystalline silicon PV modules. Because the cells are formed in a huge block of numerous crystals rather than individually, polycrystalline panels are slightly less expensive and less efficient than monocrystalline panels. Polycrystalline has a mosaic or shattered-glass appearance due to the crystals. To construct the individual cells that make up the solar panel, the block of silicon is split into wafers, just as monocrystalline cells [19].

IV. Common Benefits of Solar Energy

4.1 Solar Power Is Good for the Environment

Solar energy has numerous environmental advantages. Switching to solar energy will help conserve important resources, reduce air pollution, and safeguard our environment from global warming's destructive consequences. Solar panels and systems allow us to utilize the sun's clean, renewable energy while also protecting the environment [20].

Furthermore, solar energy is particularly environmentally friendly because it may decrease 40 million tons of CO2 emissions per year with the establishment of solar grids that only meet 1% of global electric energy demand [21].

4.2 Solar can Drastically Reduce or Eliminate Your Electric Bills

Solar power systems could reduce, if not eliminate, office building's electric. This money saving can have an enormous effect on large and small enterprises. Installing a solar power system means that you pay a prepayment of nearly 40 years of energy, but only a fraction of the electricity you currently pay for. Your current energy bills are probably significantly more expensive per unit than what you would spend on solar electricity [22].

These incentives reduce the effective cost of a rooftop solar panel installation for the average homeowner. A targeted discount scheme in one U.S. county resulted in 47 people installing rooftop solar panels, saving each home an estimated average of $1250 per year on their power bills and resulting in a total effective reduction of 206 metric tons of carbon dioxide emissions [23].

4.3Versatile installation

Solar energy is inexhaustible, more reliable, requires less maintenance, is silent and is more versatile as it can be installed in cities as well as in rural areas [24]. This feature, combined with the system's simplicity and adaptability, makes it easier to construct small-scale solar projects, with the added benefit of being able to scale up depending on the demands at any given time [25].

V. Common Drawbacks of Solar Energy

5.1 Location and Sunlight Availability

The season has an impact on solar efficacy. During summer or dry season, more electricity is generated than what people really need because the earth is oriented such that the sun is closer to the Earth [26]. It is also noted that during cloudy days solar panels normally generate 30 % – 50 % of their optimum generation and during heavy rain solar panels generate 10 % – 20 % of their optimum generation [27].

5.2 High Initial Cost

The high initial cost of installation is one of the major hurdles in the development of renewable energy [28]. Solar panels would provide significant long-term benefits, but the initial expenses can be prohibitive. It could cost an arm and a leg to buy solar panels, depending on the business you choose. It is even more difficult to estimate the total cost of

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installation without the assistance of manufacturers. It could take anything from 10 to 15 years to break even on your initial investment [29].

VI. Approach Framework

The proposed approach is a three-step framework. By applying the approach, renewable energy global market leaders and trends will be identified and analyzed based on: (1) economics and renewable energy policy, (2) specific renewable energy sectors that presents the most attractive investment opportunity, (3) and finally the most promising renewable energy investment vehicles for investors. Other stakeholders can also use the developed framework, such as consumers and policymakers, to make socio-economic decisions and assess renewable energy investments [8].

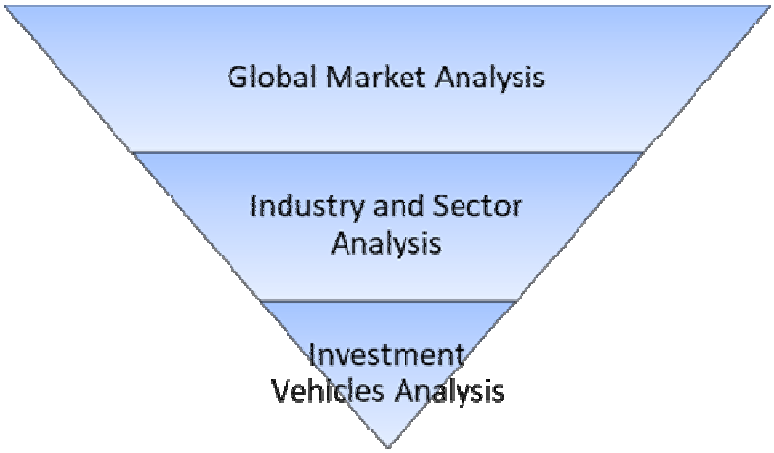

Figure 2: The proposed approach is a three-step framework [8]

VII. Status of Solar Energy in the Philippines

According to a study by Ateneo de Manila University, renewables already account for 30% of national power generation capacity, with hydropower accounting for 16% of the total and geothermal energy accounting for 8%. However, in 2018, they accounted for 23.4 percent of total generation. Renewable Portfolio Standard guidelines, enacted in 2017, require energy companies to source or create at least 35% of their electricity needs from renewable sources by 2030, in order to meet the Renewable Energy Act's requirement that renewables account for 35% of capacity [30].

Industry appears to be moving in the same direction as these goals. AC Energy, the energy division of Philippine conglomerate Ayala Corporation, said in April 2020 that it would phase out coal investments entirely by 2030, delivering a strong message to the rest of the industrial sector about the necessity of sustainable energy. Meralco announced four months later that it would increase its energy capacity by 3000 MW over the next five to seven years, with renewables accounting for one-third of that capacity. MG D Renewable Energy is working on a 50-MW solar farm in Bulacan that is expected to be completed in early 2021 [30].

VIII. Solar Energy Initiatives of Philippine Higher Education Institutions

There are a few initiatives of Philippine higher education institutions in terms of solar energy implementation that could be identified. The Philippine government has also been supportive of this cause in order to advocate for access to modern energy services and renewable energy.

The La Consolacion College Manila (LCCM) has initiated its Solar Photovoltaic (PV) Net Metering Facility in 2014. The LCCM Solar Facility is the Department of Energy's first solar project for academic institutions. The installed capacity of Phase I is 42.84kW, while Phase II of the project would add 90.27kW, bringing the total capacity to 133.11kW [31]. The project aims to underscore the country's goal of energy sustainability.

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Other universities and colleges have also followed the lead of LCCM. Manuel Luis Quezon University (MLQU), St. Scholastica's College – Manila, St. Scholastica's Academy – Marikina, University of Perpetual Help, and Miriam College are among the other academic institutions that have indicated interest in a Solar PV net-metering facility on their campuses [31].

The Urdaneta City Campus, Sta. Maria Campus, Binmaley Campus, and Infanta Campus of Pangasinan State University (PSU) use more than 590,000-kilowatt hours (kWh) of electricity each year. The PSU is looking for ways to reduce the cost of their activities as well as their environmental impact. Solar energy is one viable option for generating electricity on the four (4) campuses. Both financial and non-financial benefits from the university's usage of solar were assessed through discussions and meetings. A solar photovoltaic rooftop system has been demonstrated to be the cheapest option, with a payback period of nine and a half (9.5) years and a cost of ten PHP (Philippine Peso) per kWh. From the 3,360 square meters of rooftop space that is now accessible, up to 336,000 kWh, or 57 percent of the four (4) campuses' power demand, might be produced with solar energy in 2018 [32].

Moreover, the Mariano Marcos State University has a project entitled "Renewable Energy Park Model for Education, Research and Extension Towards Agro-Industrialization and Inclusive Development", this is to establish a feasible and viable RnE Park through R&D integration of biomass, hydro, solar and wind energy innovative technologies for a sustained, cleaner and greener agricultural productivity, strengthen MMSU faculty and staff to pursue 6P's (product, publications, people and services, partners, process and policy) metrics deliverables on R&D under the Republic Act No. 10055-The Technology Transfer Act of 2009, To create an interactive life-long learning RETs live laboratory for students, faculty, researchers, farmers, industries, collaborators and other stakeholders; and To showcase the socio-cultural and techno-economic viabilities of RETs optimum designs, low-cost, efficient and life-cycle and impact assessment (LCIA)-based smart RETs model structures that sustain the promotion and development of institutional knowledge exchange, capacitation and development of sustainable partnerships [33].

Meanwhile, solar energy devices that use nanostructures are being pursued through collaborative approach by research groups from the University of the Philippines, Ateneo de Manila University, and De La Salle University. It focuses on solid state-based and dye sensitized-based solar cells [34].

Lastly, the Tarlac Agricultural university uses solar street lights and solar pumps for irrigation. This helps the university observe austerity measures in consuming electricity power. The establishment of solar farm in the university through public-private partnership is also in review.

IX. Conclusion

The sources of energy play vital roles and are required to support quality of life in practically every practical system. The speed of production of energy is a driving factor for industry and progress and a major indicator in society's improvement. It is very important to note that different types of solar panel must be identified to know the capability of each technology.

The three-step framework identified in the study is an acceptable approach in the implementation of solar energy projects and programs. However, the need to adhere to all the steps is emphasized for its effective and efficient application.

Finally, the support of government and the proactive involvement of its agencies such as the Department of Energy and the Department of Science and Technology are critical in the successful implementation and adoption of solar energy in the campuses of various Philippine higher education institutions.

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BIOGRAPHY

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FULL PAPER

ESTABLISHMENT OF THE CAPILLARY IRRIGATION (*CAPILLARIGATION*) SYSTEM FOR SWEETPOTATO

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Abstract

During extreme drought periods when it is already too risky to plant rice, farmers are usually advised to plant other crops to maximize the use of limited water supply so they can have an alternate income source. Sweetpotato (*Ipomoea batatas*) is commonly planted in rainfed areas or during drought. In this study, the capillarigation system of Philippine Rice Research Institute was tried and evaluated as an alternative irrigation method for sweetpotato production and compared its performance with manual irrigation. The experiment was carried out with four treatments, three of which were represented by the different settings of the *capillarigation* system to effect varying rates of water applications (T_1: 100% depth of riser, T_2: 50% depth of riser, T_3: 25% depth of riser) and the farmers' common practice of manual irrigation serving as the control (T_0). Results showed that the vine length and storage root length and width were not significantly affected by the treatments employed. However, the number of stem vines, storage root weight, and water productivity were significantly influenced. T_1 significantly had the highest average storage root weight of 196.9 kg. On the other hand, water productivity was significantly highest in T_3 with 394.5g harvested root per liter of water used.

Keywords: *Capillarigation System, Climate Change, Drip Irrigation, Drought, El Niño, Irrigation, Sweetpotato*

Introduction

The entire world is experiencing climate change. The World Meteorological Organization (WMO) reported an increasing trend in the global annual mean temperature in the past 45 years. Their recent reports showed that 2020 was one of the three warmest years (2016 as warmest) on record, which is 1.2 ± 0.1 °C above baseline years of 1850 -1900 (WMO, 2021). Climate change has been affecting the lives and livelihood (WMO, 2021) especially in the developing countries (Porio et al., 2018). In the Philippines, the agricultural sector is highly affected. In 2016, for example, there was a decrease in rice production due to typhoon occurrences, dry spell, and drought (PSA, 2018).

Rice production requires a lot of water, estimated to be on the average of 1,432 L per kg of paddy grains produced under an irrigated lowland production system. Thus, planting rice during periods of forecasted El Niño or when there is uncertainty of water supply is risky (Stuecker et al., 2018; Lansigan et al., 2000). Initial investments such as land preparation, seeds, and fertilizer may be wasted if the available water supply is no longer enough to sustain the growth of the rice crop. With this, farmers ought to adapt crop diversification so that their income will not be solely dependent on rice production. Thus, an alternative crop like sweetpotato, which is drought tolerant and requires less water (Siqinbatu et al., 2014) than rice can be planted. Sweetpotato can also substitute rice as staple food (Portilla and Pagaduan, 2014).

Sweetpotato production has high potential of increasing farmers' income. It ranked 5th in terms of value of production with PhP 1.054 million value, next to onion, mango, string beans, and coconut (PSA, 2021b). Central Luzon is the third largest sweetpotato producer in the Philippines with 10.1% share in 546.89 thousand MT produce (PSA, 2021a). In this region, 73.8% of the 2020 sweetpotato production is accounted from Tarlac (PSA, 2021b); thereby, making the province the largest commercial producer of sweetpotato (Pagcaliwangan, 2016).

Although sweetpotato is drought tolerant and can withstand limited water (Siqinbatu, 2014), irrigation is still critical as it affects root yield. Decreased water supply resulted in decreased storage root weight (Ekanayakem and Collins, 2004; Felix et al., 2015) while excessive water also affects root development (Pardales and Yamauchi, 2003). Thus, the need to check water management.

Technologies like drip irrigation is an efficient way of utilizing water (Maisiri et al., 2005; Megersa and Abdulahi, 2015). However, the system needs relatively high initial investment (Ali, 2022; Rowe et al., 2014). Thus, a more economical water efficient system like the capillary irrigation technology or *capillarigation* developed by the Philippine Rice Research Institute (PhilRice), which makes use of capillary wicks (Orge and Sawey, 2019) can be employed.

The system of irrigating plants by capillary action has been adopted in several studies (Semanda, 2018). However, research on this area has not progressed for large scale plant production (Million et al., 2007). The *capillarigation* system showed good performance in green pepper fields (Orge and Sawey, 2019), paving opportunities in exploring its application to other crops.

This study evaluated the applicability of the *capillarigation* system for sweetpotato production. Specifically, it aimed to: (a) set-up the system in plots prepared for planting sweetpotato, (b) determine the volume of water applied in relation to system's setting, and (c) evaluate system performance in terms of the crop's agronomic characteristics and yield parameters.

Materials and Methods

The capillarigation system components

This experiment used the *capillarigation* system developed by the Philippine Rice Research Institute (PhilRice) as a low-cost alternative to drip irrigation of rice-based crops especially when water supply is limited and that planting of rice is no longer possible. Its layout is almost similar to the drip irrigation except that capillary wicks are used as means of dispensing water (Figure 1) instead of the emitter or dripper, which is typically used in the drip irrigation system. It was designed to be a do-it-yourself type of irrigation system maximizing the use of local and recycled materials. More details in the design and setting up of the system are provided in the two publications of Orge and Sawey (2017, 2019).

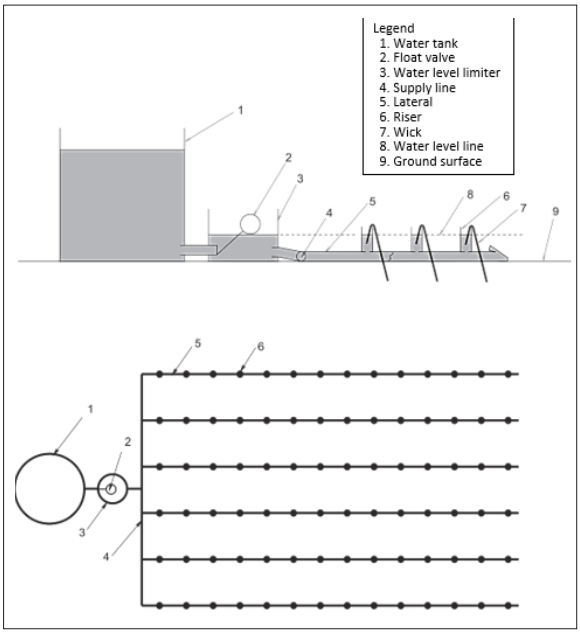

Figure 1. Schematic layout of the *capillarigation* system (Orge and Sawey, 2017)

In this study, a 200 L plastic cylindrical container was used as water tank and a 16 L plastic pail as water level limiter. For the water supply and distribution lines, a 12.5 mm (1/2") diameter PVC pipes cut into desired lengths were used and complemented with PVC tee fittings and elbows. The same size of PVC was also used for the risers, which were individually cut into 18 cm length. Commercially available cotton rope was used as capillary wicks. To minimize water loss due to evaporation, each wick was covered with recycled plastic drinking straw.

Field layout and establishment

This study was conducted in Brgy. Paul, Mangatarem, Pangasinan from August 2020 to June 2021. The field used was idle (fallowed) prior to the setting up of this study. Land preparation was done using 4W tractor-mounted rotavator to remove the weeds and loosen the soil to attain a good tilth suitable for planting.

To create variations in the rate of application of water using the *capillarigation* system, the depth of water relative to the height of the riser varied in this study by changing the location of the float valve relative to the height of the 16 L pail used as water level limiter. This variation resulted incorresponding changes in the freeboard i.e., the difference in height between the riser and the water level inside the riser.

Table 1 presents the treatments of the study. T_1, T_2, and T_3 represent the settings of the *capillarigation* system, which were described in terms of the volume of water inside the water level limiter with its height corresponding to the height of water in the riser. In T_1, for example, the amount of water in the secondary tank is 7 L, which corresponds to a fully filled riser. On the other hand, in T_3, the 2 L volume of water in the secondary tank corresponds to a riser that has only a water height of ¼ (25%) of its height. Manual irrigation was also added in the treatment to serve as the control (T_0) and as basis in comparing the performance of the *capillarigation* system with the existing irrigation practice.

Table 1. Treatment used.

Treatment Code	Description
T_0	Control; manual irrigation
T_1	*Capillarigation* setup; 7 L maximum level; 100% depth of riser (every other day monitoring)
T_2	*Capillarigation* setup; 3 L maximum level; 50% depth of riser (once a week monitoring)
T_3	*Capillarigation* setup; 2 L maximum level; 25% depth of riser (once a month monitoring)

Figure 2 shows a setup of the *capillarigation* system, typical for T_1, T_2, and T_3. As shown, the distance between rows (ridge) was 100 cm and each row had an effective length of 3 m just enough to accommodate 10 hills of sweetpotato spaced at 30 cm between hills. Each hill was planted with 1 cut vine.

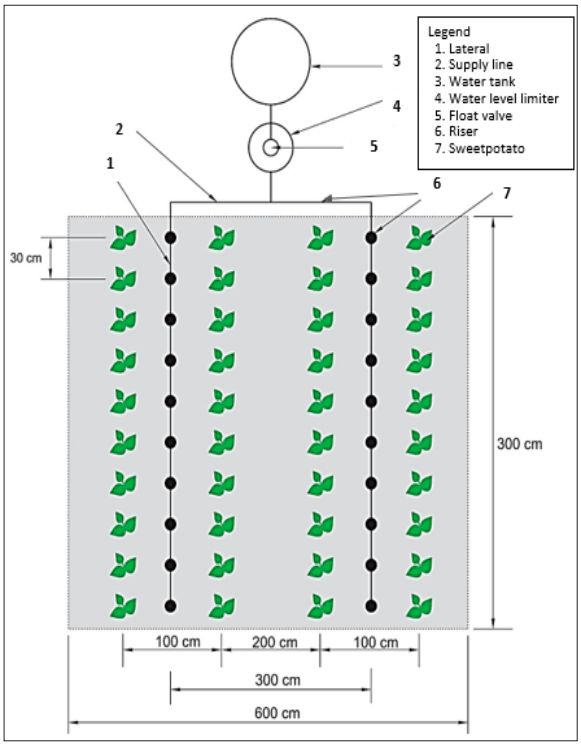

Figure 2. Layout of the *capillarigation* system established for sweetpotato production in the study.

Data gathered

The following data were used in evaluating the performance of the *capillarigation* system (represented at different settings) relative to that of the control (manual irrigation):

1. Volume of water applied. For the plots using the *capillarigation* system, the volume of water supplied to the plants was determined based on the total amount of water added to the initially-filled tank devoted for each treatment. For the control, volume of water was supplied through a plastic pail. The volume of water applied per plant was computed using the formula:

   $V = V_t / n$

   Where:

   V_t = total accumulated volume of water applied throughout the crop growth

   n = number of plants

2. Plant parameters. Data were collected immediately after harvesting. Plant parameters were determined in terms of the following:
   a. length and width of storage roots
   b. length of sweetpotato vines
   c. number of the vine stems
3. Yield. This was determined by taking the root yield of five randomly selected plants representing each treatment.
4. Water productivity. This was computed using the formula:

   $E_{wu} = Y/V_t$

   Where:

   V_t = total accumulated volume of water applied throughout the crop growth.

   Y= total crop yield in the area

Data analysis

Data were analyzed in a randomized complete block design using Statistical Tool for Agricultural Research (STAR). Further analysis was run by STAR for comparison of treatment means using Least Significant Difference (LSD).

Results and Discussion

General information

Figure 3 shows the *capillarigation* system established in plots planted with Super Bureau variety (VSP 6). Aside from being easy to assemble, the system components can easily be purchased in local stores (Appendix Table 1). The sweetpotato planting materials were sourced out from the Rootcrops Research and Training Center based at the Tarlac Agricultural University, Malacampa, Camiling, Tarlac. Two rainfall occurred during the study; however, these were not documented. Sweetpotatoes were harvested after 4 months from the planting date.

Figure 3. The *capillarigation* system installed in sweetpotato plots.

Volume of water supplied

As shown in Figure 4, the highest volume consumed in the whole duration of cropping was T_1 (235 L). This is followed by the control setup with 160 liters. T_2 and T_1 were supplied with 47 L and 8 L for the whole growing season, respectively. It was observed that storage roots were still produced in T_2 and T_3, which indicates that sweetpotato can be grown during scarce water conditions.

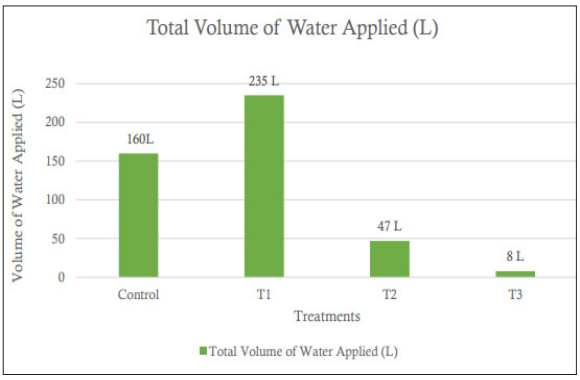

Figure 4. Total volume of water applied in each of the treatments.

Growth parameters

The *capillarigation* system was evaluated based on sweetpotato agronomic characteristics including storage roots yield. Table 2 shows the growth parameters of sweetpotato in terms of vine length and number of vines. T_1 has the longest vine produced, followed by control, T_2 and T_3. However, analysis of variance showed that vine length is not significantly different among treatments. Li et.al (2021) found that more water promotes growth of sweetpotato shoot. Similarly, vine lengthened with increased irrigation (Gajanayake and Reddy, 2016). It can be noted that these studies involved deficit irrigation treatments, which is not the case in this research.

Result of this study agrees with Sokoto and Gaya (2016), which concluded that irrigation interval had no significant effect on the vine length because the supplied water was sufficient enough for vine growth. On the other hand, the average number of vines had significant differences among treatments with T_1 having the most number of vines. This was followed by those plants under control, and then T_2 and T_3 which were not significantly different from each other. Gomes and Carr (2001) showed that vine production is higher in wet season than in dry season. Vine number also increased with more irrigation (Saqib, et.al, 2017). Both the length and number of vines contributed to the vine yield. Furthermore, increasing irrigation frequency caused higher vine yield (Saqib, et al., 2017, Biswal et al., 2017). Above-ground growth can be increased to promote source capacity, which leads to higher vine yield and eventually, high harvest (Li et al, 2021).

Table 2. Growth parameters of sweetpotato under different treatments

Treatment	Vine length, cm	No. of vines
T_0 - Control; Manual Irrigation	196.0	3.8 ab
T_1 - 7 L maximum level; 100% depth of riser	213.8	4.4 a
T_2 - 3 L maximum level; 50% depth of riser	189.0	3.4 b
T_3 - 2 L maximum level; 25% depth of riser	146.6	3.6 b
	ns	*

Yield parameters

Storage root length, storage root diameter, and storage root weight increase with irrigation frequency or shorter irrigation interval (Saqib et al., 2017; Nedunchezhiyan et al., 2012). However, this is not the case for this study's storage root diameter and length (Table 3). All treatments produced roots, which length and width do not significantly differ from each other. This can be due to the insignificant difference in vine length, which directly affects yield parameters (Saqib, et al., 2017). Root length and diameter were higher in longer irrigation intervals; however, root diameter does not significantly vary (Abu El-Fotoh, et al., 2019). Storage root length and width are parameters related to assessing quality of harvest (Bryan et al., 2003; Abd El-Baky et al., 2010; Villordon et al., 2018). All treatments in this study produced relatively similar quality of storage roots while the weight of harvested roots significantly varied (Table 3). Storage roots weight was highest in T_1, followed by control, T_3, and T_2 (Figure 5). This can be attributed to the vine yield in each of the treatment. Increasing irrigation frequency also increased root yield (Nedunchezhiyan et al., 2012), which is supported by the yield result from T_3, T_1, and control irrigation. However, T_3 produced higher storage roots yield than T_2, which was watered more frequently. This could mean that certain irrigation level could affect storage root yield. Almost similar observations were also noted by Thompson, Smittle, and Hall (1992); Gajanayake and Reddy (2016); and Li et al., (2021). This is where water use efficiency or water productivity comes in to assess the resource utilization of a technology (Maisiri et al., 2005; Mergesa and Abdulahi, 2015).

Water productivity

In this study, water productivity was significantly affected by the different treatments (Figure 6). It can be observed that T_3 with a maximum water level of 2 L or 25% depth of riser had significantly highest storage root produced per liter of water supplied with 394.50 g per liter. It is followed by T_2 with 57.28 g of storage roots produced. Control and T_1 produced 20.58 and 17.69 g of storage roots per liter, respectively. While other studies showed that increasing irrigation levels increased water use efficiency (Laurie, Plooy and Laurie, 2009; Mantovani et al., 2013; Zhang et al., 2018), this study matches results gathered by Nedunchezhiyan, Gangandhara, Ray (2012) and Li et al., (2021), who found that water is more efficiently utilized at lower irrigation levels. This may indicate that with less amount of water applied through *capillarigation*, especially in T_3 and T_2, sweetpotato can maximize or save water resource. This also shows that sweetpotato, despite limited water supply, can still be productive (Siqinbatu et al., 2014). It should also be noted that the crop was established during the last two months of rainy season and first 2 months of dry season. Solis et al. (2014) reported that soil moisture status for the first 30 days after transplanting (DAT) affected root development. Despite T_3 having very low amount of irrigation, the rainfall occurrences might have supplied just enough moisture within 30 DAT;

Table 3. Sweetpotato yield parameters of the different treatments.

Treatment	Storage root length (cm)	Storage root width (cm)	Storage root weight (g)
T_0- Control; Manual irrigation	3.49	1.98	164.60 b
T_1 - 7 L Maximum level; 100% depth of riser	4.48	2.40	207.80 a
T_2 - 3 L Maximum level; 50% depth of riser	3.93	1.83	134.60 c
T_3 - 2 L Maximum level; 25% depth of riser	3.31	1.88	157.80 bc
	ns	ns	*

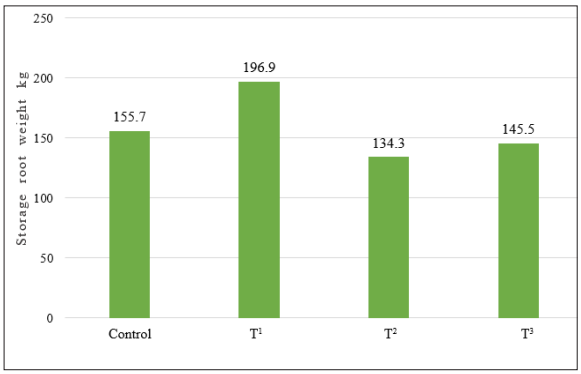

Figure 5. Total actual weight of harvested sweetpotato storage roots from each treatment.

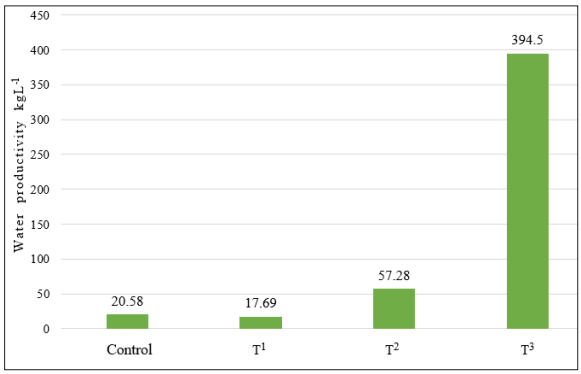

Figure 6. Water productivity of each treatment.

thereby, producing storage roots. Certain genotypes have the ability to be productive amid less water (Solis et al., 2014; Andrade et al., 2016), which could mean that the variety used in this study might also be drought-tolerant. Irrigation method did not affect water use efficiency (Onder et al., 2015). Results from T_1 and control, which employed different irrigation systems, were not significantly different. However, if storage root yield is considered, T_1 showed more advantages.

Conclusion

In this study, the PhilRice-developed *capillarigation* system was used to irrigate plots planted with sweetpotato and compared its performance, measured in terms of the crop's growth (number of vines and vine length) and yield parameters (storage root dimensions and weight), with the traditional, manual method of irrigation. The *capillarigation* system was operated in three settings, each setting representing a treatment, with the manual irrigation as the control. The following conclusion are drawn from the study results:

1. The *capillarigation* system can be an alternative irrigation method for sweetpotato. Under optimum setting, water application is more efficient than the conventional practice of manual irrigation;

2. The adjustments on the water level at the secondary tank, which were represented by the three treatments (T_1, T_2, and T_3), can be a practical way of varying the water application rate. Results show that a 100% level setting (T_1) led to the highest crop yield while the highest water productivity was recorded at 25% (T_3). Setting to be used is based on field condition. T_3 setting could be the best option in areas with limited water. However, if water supply is good, the best option is to target for the highest yield;

3. The installation of the *capillarigation* system may require an added cost. However, this can be compensated by savings in labor cost as once installed, the plots are already self-watering. System components can also be made from recycled materials, which can significantly lower down its investment cost.

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Annex Table 1. Cost of materials for the capillarigation setup (3 treatments).

Materials	Quantity/Unit	Unit Price	Actual Cost (PhP)
Plastic drum (200 L)	3 pcs	700	2,100.00
Plastic pail (16 L)	3 pcs	100	300.00
Plastic floater	3 pcs	50	150.00
PVC pipes, 12.5 mm (1/2 in) x 3m	20 pcs	20	400.00
Cotton rope	1 roll	50	50.00
Plastic faucet	3 pcs	20	60.00
Plastic drinking straw	1 pack	20	20.00
PVC tee fittings	35 pcs	10	350.00
Sealants	2 tubes	35	70.00
Elbows, 12.5 mm (1/2 in)	9 pcs	10	90.00
Material Cost			3,590.00
Labor Cost			1,200.00
Total Cost			4,790.00

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Biochar from Corn Waste as Biofilter in a Recirculating Aquaculture System

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Abstract: ***The use of biofilter with the application of biochar technology for the improvement of water in a recirculating aquaculture system (RAS) provides a lot of advantages in aquaculture production. The research aimed to devise a biofilter system for the enhancement of TAN and un-ionized ammonia levels in a RAS using biochar from corn cobs for Nile tilapia Oreochromis niloticus production. It has five main parts: fish tank, biochar filtration tank, sediment filter, sludge filter and pump. The fish tank used is a 1 m^3 plastic cubical tank. The biochar filtration tank with a height of 85 cm and a diameter of 30 cm. The sludge filter has a height of 52 cm with a diameter of 13 cm. An electric water pump was used to recirculate the water. The system was fabricated and were able to effectively enhance the level of total ammonia nitrogen (TAN) at a rate of 0.56 ppm per hour for every 1kg biochar and 0.72 ppm per hour for the reduction of un-ionized ammonia. The devised biofilter proved to reduce the level of TAN by 9.45 ppm and un-ionized ammonia levels by 2.18 ppm in 6 hours and 30 minutes using corn cob biochar.***

Keywords: Biochar, Biofilter, Recirculating Aquaculture Systems (RAS), Total Ammonia Nitrogen (TAN), Un-ionized ammonia

I. INTRODUCTION

Research and studies about biochar technology are vastly growing over the years because of its multidisciplinary approach and different applications. Biochar is a carbon- rich solid material produced by thermal decomposition of organic material or biomass in the absence or under limited supply of oxygen (Lehman and Joseph, 2009).

Ammonia and nitrite are toxic to fish. Ammonia in water occurs in two forms: ionized ammonium (NH_4^+) and un-ionized ammonia (NH_3). The latter, NH_3, is highly toxic to fish in small concentrations and should be kept at levels below 0.05 mg/l. The total amount of NH_3 and NH_4^+ remains in proportion to one another for a given temperature and pH, and a decrease in one form will be compensated by conversion of the other. The amount of un-ionized ammonia in the water is directly proportional to the temperature and pH. As the temperature and pH increase, the amount of NH_3 relative to NH_4^+ also increases. The ammonia poisoning of fish is as imminent danger in a RAS (Helfrich and Libey, 2019). With this, a biofiltration system plays a vital role in maintaining a good aquaculture water quality.

Recirculating Aquaculture Systems (RAS) has been in existence, in one form or another, since the mid-1950s. However, only in the past few years has its potential to grow fish on a commercial scale been realized. New water quality technology, testing and monitoring instrumentation, and computer enhanced system design programs, much of it developed for the wastewater treatment industry, have been incorporated and have revolutionized our ability to grow fish in tank culture. Nevertheless, despite its apparent potential, RAS should be considered a high-risk, experimental form of agriculture at this time. It can be used to culture high densities of fish annually, but its ability to do so economically remains to be demonstrated, conclusively and repeatedly (Helfrich and Libey, 2019).

With these characteristics, a potential to develop biochar from corn cobs for improving TAN and un-ionized ammonia levels in a RAS shows a potential researchable area since corn cobs are abundant in supply, low-cost, and readily available in the area. With the expansion of tilapia culture, together with the shortage of freshwater and competition of the water use into different applications, and with the growing number of human populations through the years, tilapia farming has been shifted from traditional semi-intensive systems to more intensive production systems such as the production in fish tanks and fish cages with the use of a RAS.

RAS is characterized by its ability to support extremely high stocking densities and high net production with a limited volume of water requirements. However, high stocking density will result in high fish wastes which are toxic ammonia compounds in the form of TAN and un-ionized ammonia excreted into the water and uneaten feed particles that need to be removed.

Biochar has the potential role in improving aquaculture water quality in fish culture by lowering the level of TAN and un-ionized ammonia in a RAS.

Also corn cobs has a potential media in improving aquaculture water. The use of charcoal for water purification to remove unwanted dissolved organic pollutants is well established. However, there has been limited research on the potential of biochar to improve the quality of aquaculture water in RAS for fish production. Therefore, the project will contribute to the aquaculture sector by establishing the potential of biochar filtration in improving the quality of aquaculture water specifically in reducing the TAN concentration.

II. MATERIALS AND METHODS

A. Preparation and Carbonization of Corn Cobs

Corn cobs samples were collected. Impurities and other foreign materials were removed to attain the uniformity of the samples. A pyrolytic converter was used to carbonize the corn cobs. For each batch of the biomass samples, ten kilograms (10 kg) of samples were loaded inside the kiln. Rice hulls were fed around the fuel feeder every 20 min and when the fire reached the top feeder until the samples were fully carbonized.

The biomass samples were subjected to heat with minimum presence of oxygen at an average of five hours. Carbonized samples were left inside the kiln overnight to release the heat inside the kiln and to make sure that it would not become ash when in contact with air. After carbonization, samples were crushed to achieve uniformity then sieved manually within wire mesh sizes of 1 and 5 mm to attain a 1-5 mm biochar sample size. Figure 1 shows biochar production and utilization method.

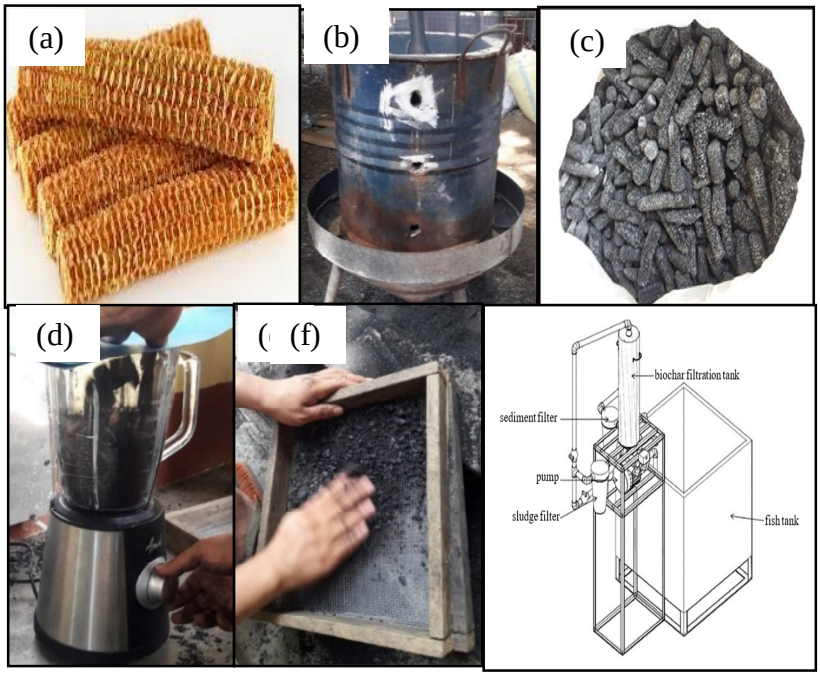

Fig 1. Biochar production and utilization (a) corn cobs (b) pyrolytic converter (c) carbonized biochar from corn cobs (d) crushing of samples (e) sieving (f) biochar filtration system

B. Devising a Biochar Filtration System in RAS

A biochar filtration system for the reduction of TAN and un-ionized ammonia, removal of the feed residues, and aeration in grow out tank was devised. The system was devised from the principle of operation of a commercial water filtration system (Figure 2). The first stage of the system aimed to remove the feed residues by suctioning the bottom layer of the tank using a water pump. After the residues were filtered, the water was then transported to the biochar container wherein the TAN was adsorbed and reduced. To avoid the black coloring of the water in the biochar container, another filter system was installed. Lastly, the filtered water was released back to the fish tanks.

The flow of water into the tank was then used as aeration in the fish tanks during the biochar filtration process. With this, there was no need for an aerator to provide for the desired dissolved oxygen level during the operation of the biochar filtration system.

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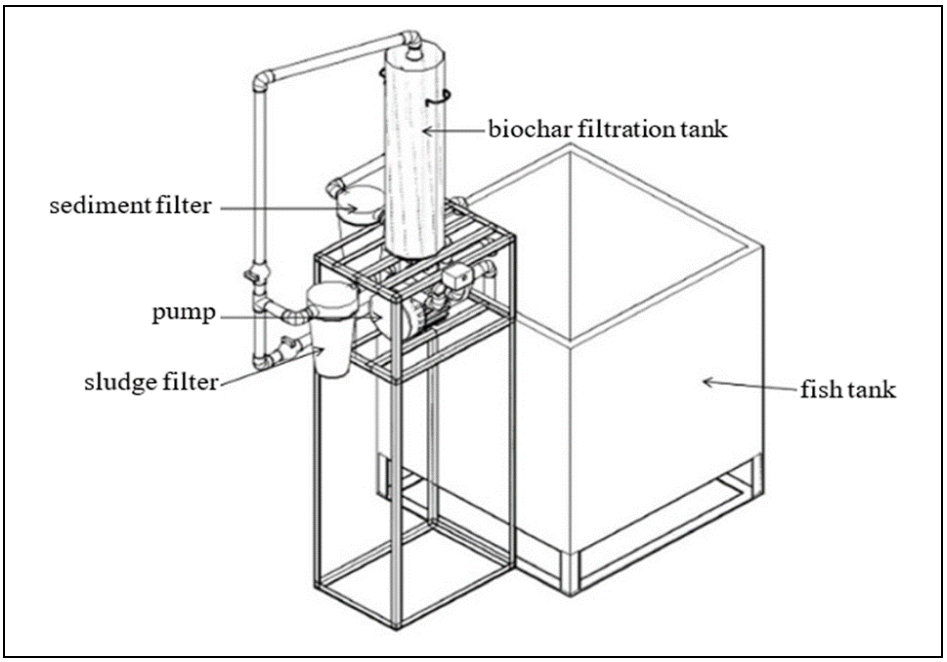

Fig 2. The biochar filtration system

C. Un-ionized Ammonia Adsorption Capacity of Biochar

Un-ionized ammonia (NH_3) which was more toxic to fish than ionized ammonia (NH_4^+) was calculated from total ammonia readings (Emerson *et al.*, 1975). Total ammonia is the sum of ammonia (NH_3) and ammonium (NH_4^+) concentrations. A multi-parameter tester was used to determine the adsorption capacity of biochar in terms of the total ammonia.

D. Amount of TAN Adsorbed and Removal Efficiency using Biochar

The amount of TAN adsorbed and removal efficiency of using biochar was computed using Equation 1.

$$q_e = V/W \times (C_f - C_i) \qquad \text{(Equation 1)}$$

where: q_e - the amount of TAN and un-ionized ammonia removed ($mg \cdot g^{-1}$)
C_f - final TAN concentration, ($mg \cdot L^{-1}$)
C_i - initial TAN concentration, ($mg \cdot L^{-1}$)
V - volume of the aquaculture water in tank, L
W - weight of the biochar, g

Two basic approaches were used in interpreting the experimental results for adsorptive capacity. Nameni et al (2008) computed the percent of MB adsorbed (adsorption efficiency, %) using the formula in Equation 2.

$$\% \text{ TAN adsorbed} = [(C_i - C_f) / C_i] \times 100 \qquad \text{(Equation 2)}$$

where: C_i - initial concentration,
C_f - final concentration

E. Statistical Analysis

Paired t-test was performed for the validation of the results in an actual RAS using the devised biochar filtration systems. Comparison among treatment means was analyzed using Duncan Multiple Range Test (DMRT) at 5% level of significance.

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III.RESULTS AND DISCUSSION

A. Corn Cob Properties

Corn cobs properties were determined by performing proximate analysis. Properties such as percent moisture, volatile combustible matter, ash and carbon content were determined to assess its quality. The higher the fixed carbon from biomass, the higher the biochar yield.

Proximate analysis revealed that the percent moisture of the corn cobs samples was 4.43 percent. Results revealed that the amount of water in biochar is within the acceptable value and much lower than the accepted moisture content of 10%. The moisture content has no effect on the adsorptive property of the biochar. Hence, if the moisture content is high, the more susceptible is the carbon to fungi growth, thus, the shelf life is reduced.

The carbon, oxygen and hydrogen component of corn cobs also known as the volatile combustible matter revealed a 14%. The result of the volatile matter is considered excellent which means that the carbonization is prolonged and at a high temperature. This also signifies that the corn cobs used is of good quality. The ash content of the biochar samples revealed that corn cob has only 6.65% which was within the acceptable values. The desirable value of ash content of activated carbon ranges from 1-20 % as mentioned by Abdul (2007). Ash content dictates the quality of an activated carbon since it reduces its mechanical strength. Corn cob has fixed carbon content of 80.3%.

The amount of TAN adsorbed and removal efficiency using biochar was attributed to thermolysis of cellulose. This cellulose or lignin is considered as the main component of biochar which formed carboxyl groups. This functional groups were the basis for the effective adsorption of ammonia (Asada, *et.al*. 2002).

B. Biochar Filtration in a Recirculating Aquaculture Systems

The devised biochar filtration system in RAS (Figure 3) aimed to enhance the TAN and un-ionized ammonia level in RAS. It also served as a device to take in the sludge and sediment particles from grow out tank; filter the accumulated sludge, solid particles, and sediments; and for additional aeration inside the tank during the biochar filtration process.

The biochar filtration system was composed of five main parts, namely: fish tank, pump, biochar filtration tank, sediment filter, sludge filter and pump. The fish tank used for Nile tilapia production was a 1 m^3 plastic cubical tank. The biochar filtration tank with a height of 85 cm and a diameter of 30 cm was filled with 5-9 mm gravel at the bottom, 1 kg of 5-10 mm corn cob above the gravel, and then followed by 1-5 mm of sand on top of the corn cob (Figure 4).

Fig 3. The devised biochar filtration system

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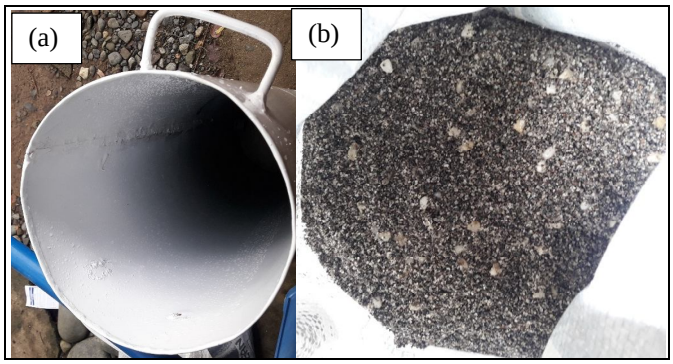

Fig 4. The biochar container (a) the biochar container (c) fine sand

The sediment filter aims to filter the sediments as well as the black coloring of the water when mixed with biochar (Figure 5). The sludge filter was used to filter the accumulated sludge and other solid particles inside the tank such as unconsumed feeds and fish excreta that settled at the bottom part of the tank (Figure 6). A sweeper/ suction pipe was connected to the filter to suck the sludge particles below the experimental tank. Also, this served as a first stage filtration so that the sludge particles were not transported to the biochar container. The sludge filter has a height of 52 cm with an inside diameter of 12 cm and an outside diameter of 13 cm.
An electric water pump was used to circulate the aquaculture water from the experimental tank, passing it through the sludge/solid filter, to the biochar filtration tank, to the sediment filter tank and lastly, to transport back the water to the experimental tank;

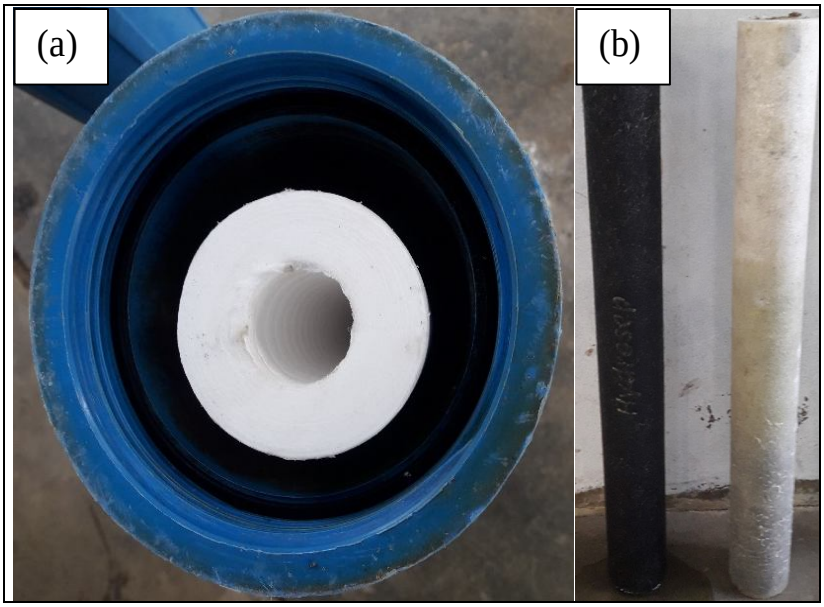

Fig. 5. The sediment filter (A) top view (B) filter media

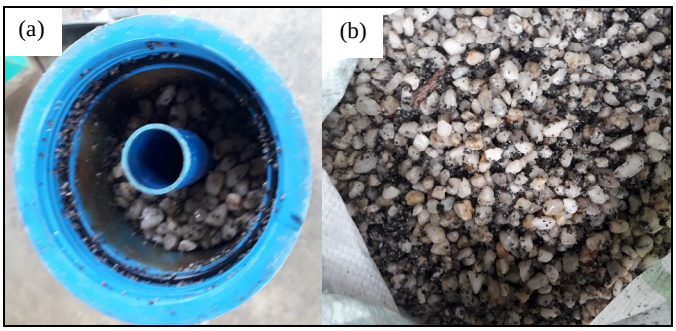

Fig. 6. The sludge filter (a) top view (b) gravel particles

C. Operation of a Biochar Filtration System

The biochar filtration system was operated by pumping the water from the RAS tank passing to the sludge filter then filled up to the biochar container wherein biochar filtration takes place. The aquaculture water was then pass through to the sediment filter then flows back to the RAS tank (Figure 7).

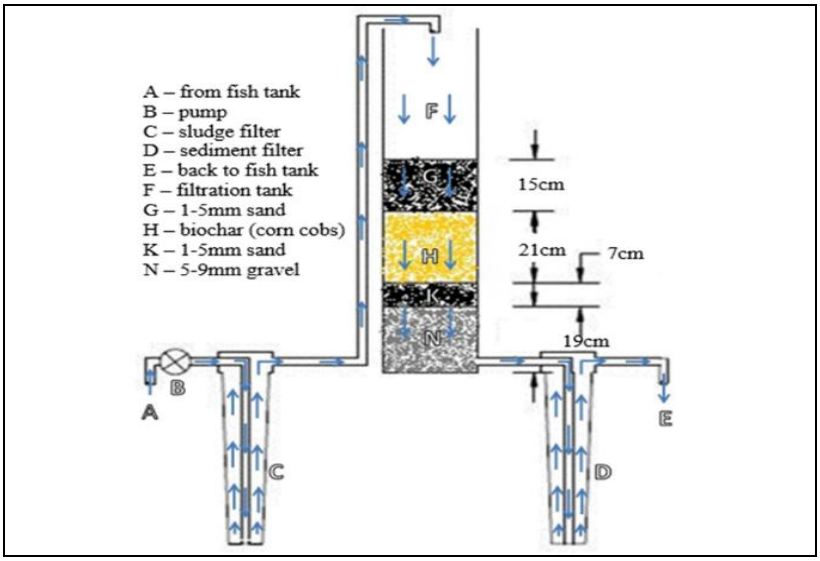

Fig. 7. Flow diagram of the biochar filtration system

D. Performance of the Devised Biochar Filtration System in a RAS

The performance of the devised biochar filtration system was evaluated through actual validation of the TAN and un-ionized ammonia reduction in an actual fish production environment (fish tank) in a RAS and was compared to the fish tank without biochar filtration.

E. TAN Reduction using the Biochar Filtration System

Results of the TAN reduction using the biochar filtration system revealed that for eight hours of operating the biochar filtration system, there is an evident enhancement of TAN in the grow-out tank. First run showed a decrease of 4.48 ppm from 6.12 ppm to 1.64 ppm. Another run showed a 4.47 ppm decrease from 5.8 to 1.33 ppm and lastly, a decrease of 3.35 ppm from the initial reading of 4.97 to 1.43 ppm (Figure 8).

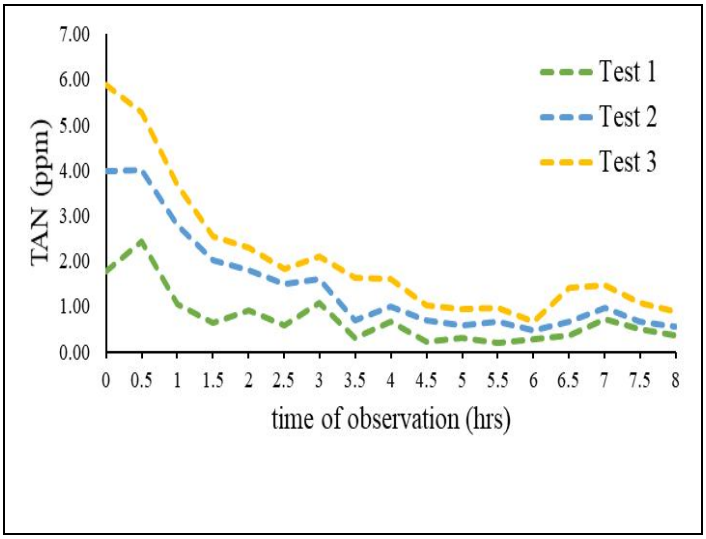

Fig.8. TAN reduction using biochar filtration system

F. Un-ionized Ammonia Reduction using Biochar Filtration System

Un-ionized ammonia reduction using biochar filtration system was calculated from total ammonia readings (Emerson, et al., 1975). Data showed that the average un-ionized ammonia levels were above the desirable level (Figure 11). The ideal un-ionized ammonia level for fish production was 0.01 ppm.

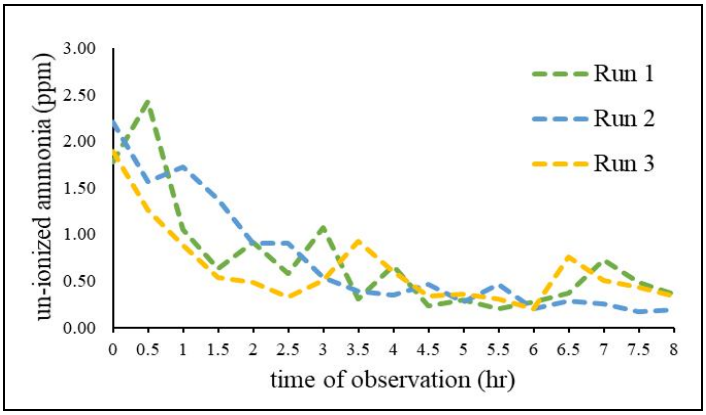

Fig. 9. Un-ionized ammonia reduction using the biochar filtration system

G. TAN Reduction at Different Stages of Biochar Filtration

The amount of TAN reduced at different filter stages was measured and evaluated. Results revealed that RAS tank had the lowest TAN reduction of 3.45 ppm after seven-hours of observation at a rate of 0.49 ppm per hour.

Time of observation (hr)	RAS Tank (ppm)	Filter 1 (Sludge Filter) (ppm)	Filter 2 (Biochar Filter) (ppm)	Filter 3 (Sediment Filter) (ppm)
0.0	4.97	5.20	5.35	5.17
0.5	5.03	4.80	3.09	3.72
1.0	4.73	4.56	3.94	3.93
1.5	4.26	4.19	3.77	3.78
2.0	4.01	3.97	2.80	3.01
2.5	3.55	3.22	2.08	2.23
3.0	2.87	2.66	1.90	1.86
3.5	2.43	2.33	1.71	1.65
4.0	2.09	1.98	1.53	1.57
4.5	2.01	1.92	1.23	1.42
5.0	1.86	1.70	1.15	1.11
5.5	1.67	1.75	1.09	1.03
6.0	1.73	1.64	1.26	1.15
6.5	1.55	1.71	1.05	1.08
7.0	1.52	1.43	1.12	1.10

Table 1. TAN reduction at different stages of biochar filtration

Biochar filtration (biochar filter) tank had the highest TAN reduction of 4.23 ppm with a rate of 0.60 ppm per hour, followed by the sediment filter of 4.07 ppm at a rate of 0.58 ppm per hour. Next was the sludge filter with 3.77 ppm at a rate 0.54 ppm per hour (Table 2). Results revealed that at the first filter (sludge), there was no significant difference on the reduction of TAN after passing through it while there was a significant difference on the second filter (biochar filter) before and after the biochar filtration. On the last filter, (sediment filter) results showed that there was no significant difference before and after passing.

IV. CONCLUSIONS

Results indicated that biofilter using corn cobs has a potential for the enhancement of TAN and un-ionized ammonia levels in RAS. It can be concluded that the percent moisture of the corn cobs samples was 4.43 percent, volatile combustible matter of 14%, ash content of 6.65% and fixed carbon content of 80.3%. The biochar filtration system successfully reduced the level of TAN at a rate of 0.56 ppm per hour for every 1kg biochar and 0.72 ppm per hour for the reduction of un-ionized ammonia in a 1 cubic meter fish tank under RAS. These results indicated that unutilized corn cobs in a biofilter can be used to mitigate the negative effect of un-ionized ammonia in a RAS.

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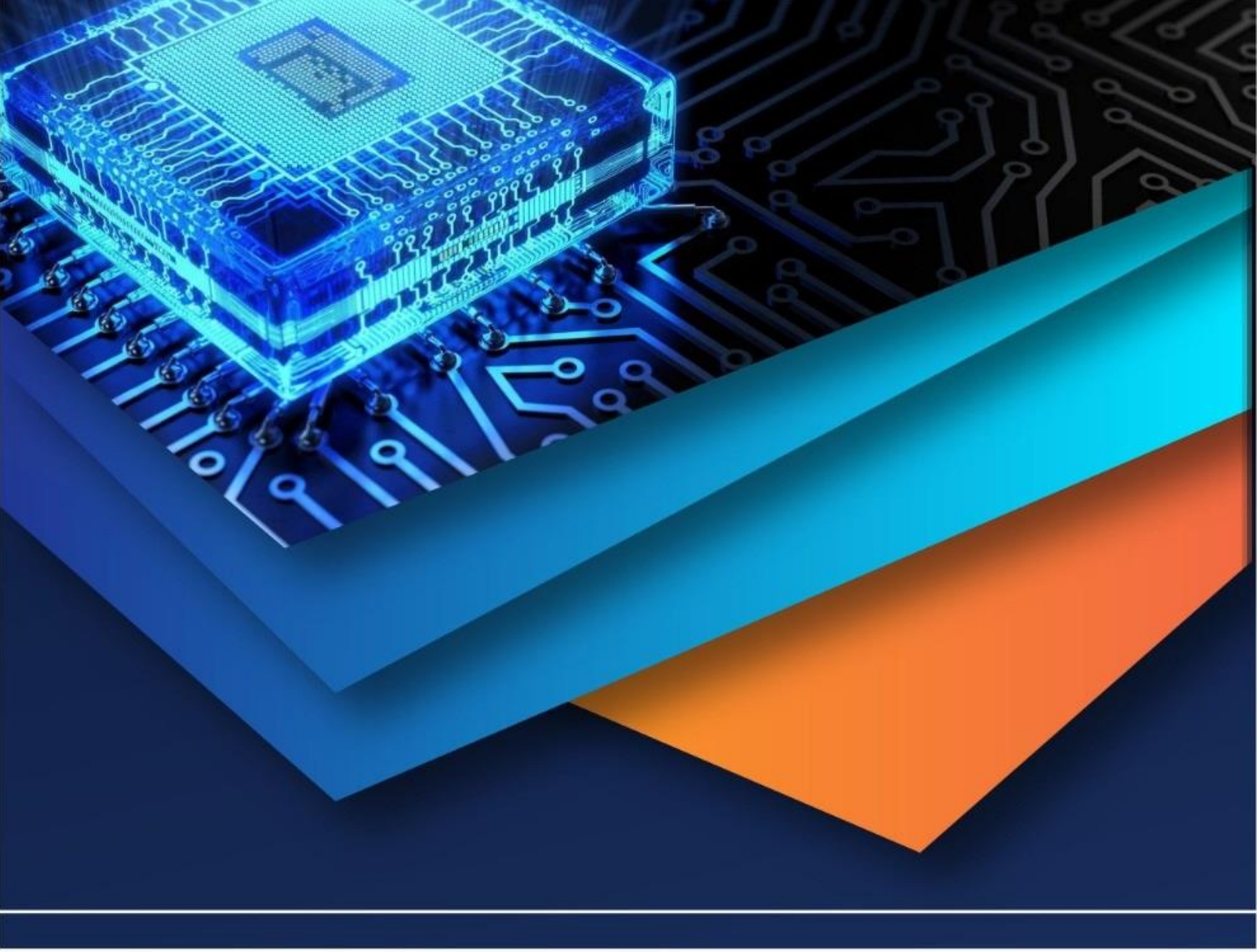

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ASSESSMENT OF VITALITY OF PANGASINAN LANGUAGE IN THE MUNICIPALITY OF SAN CARLOS CITY: BASIS FOR A RECOVERY PLAN IN LANGUAGE ENDANGERMENT

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ABSTRACT

Globally, languages are disappearing at an unprecedented rate. To establish successful strategic options on how to protect the language's survival, members of linguistic communities must be knowledgeable of the reasons for language extinction or endangerment. This paper discusses how the number of people who speak Pangasinan, which is the eighth most common language in the Philippines, is decreasing over time and how this is affecting the language. It gives an outline of the Pangasinan language's current vitality and covers the Philippines' language policy history. It also considers a situation in which globalization may provide unexpected chances for language revitalization. This study seeks to serve as a springboard for future research and aids teachers and other relevant educational personnel in identifying, comprehending, assessing, and implementing appropriate language-endangerment remedies. The authors also provide suggestions for future research based on their findings.

Keywords: Pangasinan, language endangerment, language extinction, language vitality, language policy

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INTRODUCTION

Reading, writing, speaking, and listening are the four skills that must be mastered in order to be considered proficient in any language. The last skill (writing) is acquired after mastery of the other three. People don't typically see it as something that comes easily to them. It must be learned and practiced in a systematic and organized way or setting. It necessitates both cognitive and linguistic abilities. This competence requires the learner's capacity to produce and communicate ideas through text (Urga, 2014). Nowadays, the language system is comprehensive. The language system influences educational thinking. Each individual has corresponding credits for their language. According to Gbollie and Harriett (2017), a language is a unit of work in a subject or instruction method. Therefore, when we talk about language, we refer to the media of a person interested and willing to share what they think to communicate correctly or deliver the message.

Language vitality is a process of purposive, conscious or unconscious, psychological, sociological, philosophical, and scientific learning that brings the development of every individual to their fullest extent and the development of the society they live in. It is an integral part of individuals' development according to society's needs and demands that enable them to fulfill their responsibilities and possibilities. So, it is needed to protect languages from extinction. It is an essential element of culture and a means of communication. By using language, everyone can build and express their emotions, intentions, values, norms, notions, and practices, nurturing their understanding and strengthening their social life. It presents some factors for identifying the identity of individuals and groups. Therefore, language is technically essential to the attainment of development goals and for progress towards sustainable development.

According to Krauss (2017), approximately 6,000 languages spoken around the world may no longer be adopted by the next generation. The elderlies in San Carlos City are mostly fluent in their native language, Pangasinan, but some fail to transmit it to younger generations. As a result, grandparents, parents, and the elderlies refrain from conversing with their children in their native tongues. Children's communication and vocabulary needs are not met. Therefore, they adapt and utilize other languages. So with that, the effect is a lower rate of the use of native languages and causes a decrease in the linguistic competence of their native language.

In addition to that, Wurm (2018) agrees with Batibo (2013) that the primary cause of language endangerment is the stronger two or more languages that overpower the weaker language. When this situation happens, it could be either the stronger language kicks the weaker ones or the softer language shifts to a more robust language. In this paper, language endangerment is defined as a gap in language use. So it is an important parameter to assess the vitality of the Pangasinan language. It may serve as a foundation for the recovery of plans in cases of language endangerment.

Moreover, this study is a foundation for educational implications and recommendations regarding communication skills. As a result, it helps develop everyone's knowledge of being a global citizen. It also helps them learn about inequalities, discrimination, and injustices that affect their community and connect to other countries' issues and problems. Through the vitality of language and developmental strategies, people learn to adjust themselves, remain balanced with the people around them and create healthy relationships.

San Carlos City, just like most of the cities in the Philippines, has been implementing action for development and recovery plans for their language endangerment, which is the Pangasinan language. The Local Government Unit is taking all the chances to ensure the quality of their language despite these trying times. For this reason, the researchers came up with developing and modifying the Pangasinan vitality assessment in San Carlos City. The researchers also want to maximize the platform to solve language endangerment and make it the basis for a recovery plan. This research will take place in San Carlos City, Pangasinan from 2021 to 2022. Hence, as the researchers proceed to the study, it aims to discern the vitality of Pangasinan in the Municipality of San Carlos City, record feasible solutions to aid this error, and shed light on the language endangerment as a basis for the recovery plan.

Furthermore, Mühlhäusler (2011) brings out the connection between language, culture, and biodiversity. The vitality of languages over time becomes part of environmental conditions. Language enables individuals to become more efficient environmental users. Hence, if people adapt themselves to certain areas, their language adjusts to particular settings also. If the language dies, the vast indigenous technical knowledge will disappear. As a result, traditional knowledge acquired over time throughout many world environments has expanded the bounds of science.

RESEARCH METHOD

2.1. The Language Situation of Pangasinan

In the cities of San Carlos and Dagupan, half a million people speak the Pangasinan language. Pangasinan is the most difficult Philippine language to learn. Those people who hold this opinion are the Ilocanos, Kapampangan, and Tagalog. These people find the language is unique and different from their language because it is confusing. This complexity, whether actual or imagined, is not brought up in conversation with all of the citizens of the country.

It is also claimed that attrition is increasing, both in terms of the number of speakers and the variety of communicative settings in which it is employed. Consequently, it is in a precarious situation. However, there is evidence that shows that native speakers of Pangasinan still find it to be the most effective way to express who they are and how they feel. Pangasinan does not have to be endangered if the language continues to serve these important communicative functions and the community realizes this. "Resistance to Filipino/Tagalog might be linked to regionalism," according to the article "More on National Language Month." However, it is doubtful that regionalism is the driving force behind speakers' desire to continue speaking their native dialect. The truth is that no second language can fulfill all of the complex communicative needs that people have for a language.

2.2. Changing Language Usage Trends among the Pangasinan Speakers

The Pangasinan language is at risk of extinction in San Carlos City. Immigration, urbanization, and the province's increasing population rates are all issues. (Anderson, 2017). Some Pangasinenses were purely Pangasinan and could not speak Ilocano. Pangasinenses are almost universally conversant in the indigenous language, which is quickly becoming the lingua franca. It is used in traditional song and dance competitions, marriages, indigenous healings, and house blessings. For some young individuals, Filipino is a far superior language to their native Pangasinan. As a result, Iloko and Filipino language communication tools are evident, with Pangasinan being the exclusive language of some.

San Carlos is the Pangasinan’s heartland city, as mentioned by Fabregas (2012), who studied the use of Pangasinan, Filipino, and English in terms of employment. People of all professions, according to the survey, speak Pangasinan, English, Filipino, and a little bit of Iloko. However, several professionals and semi-professionals, such as doctors and lawyers, used English, Filipino, and Pangasinan in their respective work environments. Non-professionals, such as blue-collar workers, are likely to use Pangasinan and Filipino in their workplaces because they speak little English. Semi- and non-professionals utilized Pangasinan and Filipino in both official and informal settings. In casual situations, all groups utilized English. These studies support the relevance of language in both formal and informal interaction.

Furthermore, UNESCO (2017) asserts that casual discussions and social functions in Tagalog, Pangasinan, or Iloko are used due to strong ties to San Carlos City, where the Pangasinan language is dominant. Tagalog allows persons with a vague understanding of Pangasinan to communicate. People utilize their most inclusive language, even switching to English when required, as the prevailing attitude is courtesy.

2.3. Overview of the Philippines' Language Viability

Most of the areas in the Philippine language fall under and can be classified according to five major factors. These include (1) the fact that Filipinos have been ruled by various countries for a long period of time, (2) the fact that foreigners have taken over the settlements of ethnic communities, (3) changes in environmental and agricultural systems, (4) the fact that people are migrating both within and outside the country, and (5) the fact that national educational policies tend to make Filipinos homogenize. Ethnology lists 169 existing Philippine languages, Negritos speak 32 of them. (Gordon 2015). The Negrito population as a whole speaks endangered languages (Headland 2011). As seen in Table 1, almost 90% of Filipinos speak nine "major" languages. Industrializing, nationalizing, and globalizing influences are encroaching on all 160 lesser and mid-sized Philippine languages, as well as some "big" languages.

Table 1: Major Philippine languages, according to the 2010 Census

Language	**Native Speaker (millions)**	**Percentage of Population**
Tagalog	17	24%
Cebuano	15	21%
Ilocano	8	11%
Hiligaynon (3 dialects)	7	10%
Bicolano (5 dialects)	3.5	7%
Waray-Waray	2.4	4.6%
Kapampangan	1.9	3.7%
Pangasinan	1.1	2.3%
Maginadanao (2 dialects)	1	1.7%
Total	**56.9**	**87%**

Source: Gordon 2015

2.4. Language Strategies

According to Song (2018), language strategies are crucial because they help people improve their communication and efficiency. According to Anderson (2013), the term "strategies" is sometimes used to refer to the speakers' purposeful efforts to improve their speaking skills. This aligns with a series of sample definitions of language strategies as helpful practices that speakers utilize when they are having trouble understanding a language. Because of these points, it is clear that the point of adopting language methods is to improve people's ability to communicate and think.

2.5. Language Vitality Assessment

The speakers' attitude in San Carlos City described the effects based on how they assessed its vitality. There are a diverse range of factors that go into determining whether or not a language is endangered. Among these are the following: (1) the transmission of language from one generation to the next; (2) the actual number of speakers; (3) the percentage of individuals who utilize the language; (4) the currently available linguistic domains; (5) the media's response to new domains; and (6) the materials for teaching language proficiency. Governmental and institutional attitudes and policies, as well as community people's attitudes toward their languages, are used to assess language attitudes. The evaluation of documentation's urgency is the final assessment. Among six factors, the language transmitted and the attitudes of the community members are affected. It evaluates whether the language is passed on to succeeding generations. According to the principles of persistence and stability, a language is considered to be in a vulnerable state if it is no longer used.

Table 2. Criteria for the assessment of the intergenerational language transmission

Condensed language transmission between generations		
Safe	5	The language is utilized by people of all ages.
Stable but in danger	5-	People of all ages use the language in most contexts, with fragmented multigenerational transfer.
Unsafe	4	Many but not all children or families of a specific community speak use their language as their primary language.
Definitely endangered	3	The language is no longer taught to children at home as their mother tongue.
Severely endangered	2	Only grandparents and older generations speak the language; the parent

		generation may still understand it.
Critically endangered	1	The youngest people who speak the language are great-grandparents, and it is not used in everyday life.
Extinct	0	Nobody speaks or remembers the language.

As seen above, the Pangasinan language is at level 4, which is "unsafe" in terms of the degree of endangerment. It shows evidence, especially that most residents of San Carlos City prefer Filipino to be their first language. In some studies, some people preferred home languages even though most of them grew up in multilingual homes (Filipino, Pangasinan, English, and Ilocano). Rosario (2010) says that Filipino dominates the choice of the most preferred home language.

UNESCO grades the speakers' viewpoints according to their language. The equivalent grade below reflects how San Carlos City residents feel about their native tongue.

Table 3 Criteria for the assessment of the community members' attitudes toward their language

Grade	Community members' attitudes toward their own language.
5	All members hold their language in high regard and desire its promotion.
4	Most members support linguistic preservation.
3	Many members care about keeping languages alive, while others don't care or may even want languages to die out.
2	Some members care about keeping languages alive, while others don't care or may even want languages to die out.
1	Only a few members care about keeping languages alive, while others don't care or may even want languages to die out.
0	Nobody cares if the language is endangered; everyone prefers to use the language that is dominant.

Based on the factor, the attitudes presented before are translated into two grades. The attitudes of the parents interviewed would have a grade of 4, while the attitudes of their children, who are of a younger generation, would fall under grade 2. In terms of parents' generation view, the language symbolizes group identity. On the other hand, the younger generation's perception is a crucial factor for more economic development and advancement. Claiming the Pangasinan language is unsafe because of different generations' perceptions, especially from its speakers, is grounded on reality. These individuals and groups should acknowledge that the Pangasinan language is revitalized.

2.6 Revitalization of the Pangasinan Language

The revitalization of the Pangasinan language was started in 2000 by an organization called Ulupan na Pansiansiay Salitan Pangasinan (UPSP). This organization published Pangasinan dictionaries and a collection of Pangasinan folk literature. It also has a quarterly magazine (Balon Silew) which is being distributed in some cities and municipalities in the province. It also aims to develop Pangasinan as a literary language. It has a collection of short stories called "saray antikey ya tongtong," a novelette called "nobelita," poems called "saray anlong", and essays called "saray salaysay." It also has a full-length movie called "Pangasinan."

This attempt to develop Pangasinan as a language for film and literature elevates the status of the language, mainly because it is perceived as being used only at home and in the local community. Creating more works of literature in the language may also prove helpful in the process of creating learning materials for the language. The teachers need not worry much about the available materials written in Pangasinan which can be used in their teaching.

It is also worth noting that the local government of Pangasinan is doing its part in revitalizing the Pangasinan language. The former governor, Amado Espino, Jr., believes that "Pangasinan is a dying language, and to avoid it going extinct, every Pangasinense, young and old, should do something about it" (Manila Bulletin Publishing Corporation, 2010). The governor is serious about helping to preserve and revitalize the history, culture, and language of Pangasinan. In fact, at the outset of his term in 2007, he directed all department heads to use Pangasinan during their meetings. All provincial government

employees must also use the language in their offices and all programs. The government also shows support for the projects of UPSP by providing financial assistance for their publications. A Pangasinan Writers' Conference is also set up to encourage more Pangasinan writers and develop more written materials in the language (Elduayan, 2011, personal interview). They go through the process on derived variables (to deal with absolute values and insufficient data).

CONCLUSION AND IMPLICATION

Language vitality develops through a progression of interrelated organizational roles. Since language can be formal (as defined by organizational conditions and relationships) or informative (as described by simple social interaction patterns), every school in San Carlos City has additional learning on sustaining the educational system and high quality of education, which contributed to the study's success. With this, people learn how to develop themselves and become productive individuals, which could contribute a lot to their future lives. Someday, the city of San Carlos City can use the plan to save languages that are in danger of dying out.

As the development of technology continues, its effects also continue for every person. Understanding the vitality and risk of a single city or town is critical. People are confronted with this endangerment. As countries, regions, and cities navigate this transition, the top priorities must be protecting and re-creating language recovery plans. It should take bold, quick steps to boost economic activity and develop good strategies for each at-risk economy and individual. Since this is new to all, we need to move to the re-opening phase, which strikes a balance between allowing an individual to have reasonable satisfaction and knowledge of language's vitality. They will also need to find the right balance and sequencing of health, the educational system, and social policy interventions to produce sustainable outcomes and implement and sustain policy interventions. To make each country and the city's education system fairer and more equal, there is also a need to take specific steps in dealing with growing inequality and the different effects of language loss.

This research comes down to the significance of the findings. It implies contributing to the children, parents, teachers, and future researchers' ability to cope with this language endangerment. The study's aim to assess the Pangasinan language's vitality in San Carlos City is a foundation for a language recovery plan. The main goal of this research is to find out how the recovery plans for San Carlos City affect the people who live there. Even when the social impact of language endangerment is acknowledged, a massive divide or divergence is visible. The presented information and its benefits to everyone are pretty different. In some aspects, the connections between people and language regarding its influences are evident as the modern world grows and adapts to other transitions.

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Agile Management Skills of Sports Coaches: An In-Depth Assessment

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Abstract — Problem-solving, time management, communication, and honing athletes' talents are all vital aspects of agile management. This study examines the agile management skills of sports coaches in the Higher Education Institutions of Tarlac Province, along with forming, norming, and performing. It also identified the profile of the coaches and used the descriptive-correlation research method with thirty-two respondents. Frequency counts, percentages, weighted mean, Pearson-r, and t-test were utilized to treat the study's data.

Particular interest is gained in the analyses of the profile of the coaches, agile management skills, and the innovative work plan as an output. Further, the study concluded that most of the sports coaches are 23-34 years old, male, have a monthly family income of 23,382.00-46,761.00, with MA units, 6-15 years of service, have 1-3 memberships to professional organizations, received gold medals and handling badminton sports. The level of agile management skills of sports coaches is relatively exercised. Age, highest educational attainment, years of service, training, and sports they handle are linked with their abilities. By and large, there is a vigorous indication to suggest intensive provision of a higher level of experience and training for all the coaches because these are correlated with their agile management skills.

Moreover, this literature frame suggests that interest in boosting more of sports coaches' desires, awareness, and yearnings to manage their skills should be strengthened. Coaches may be constantly offered opportunities for their development at all levels of the coaching landscape.

Keywords — Forming, Norming, Performing,

I. Introduction

The significance of sports and sporting ethics has been qualified since ancient times, particularly those advocated through human values that help the development of a cohesive personality. In this setting, developing rules and establishing a regulatory framework to safeguard and promote sport's principles and objectives became important. Aside from that, sports and physical education are both fundamental human rights. Sport has evolved into a global phenomenon in which people participate in various aspects of it by watching video sporting events

or actively participating in the administration or management of these events, and as the number of professional athletes and coaches grows exponentially, a plethora of relationships that necessitate legislation emerges. Sports law investigates the notions of sport, sports activities, and sporting life, as well as the issues that occur within the sports scene and the legal practices that apply to them. (Sportiva, 2021)

The Philippine Sports Commission was created and established under Republic Act No. 6847, which defined its powers, functions, and responsibilities. The Philippine Sports Commission adopted the policy of promoting physical education, encouraging and sustaining the empowerment of sports in the Philippines to foster physical fitness, self-discipline, teamwork, and excellence for the development of a healthy and vigilant citizenry through a unified national sports promotion and development.

Likewise, The Department of Education shall implement Republic Act No. 5708, denoting an act providing for the fostering and financing of an Integrated Physical Education and Sports Development Program for Philippine Schools, which was founded on an integrated physical education and sports development program in all Philippine schools, by the following guiding principles. (1) Physical education aims to instill a proper understanding of the value of physical and mental development in individual and social activities. These things can be accomplished through a coach's innovative qualities and the coaching process' creative process.

Brent (2018) noted that organizations that want to capitalize on knowledge-based personnel need to change their management style to one that is consultative and participatory. Coaching is a common term for this approach. Managers must shift from a typical function of managing and monitoring employee performance to a more consultative role when coaching. Coaching is a method of forming a relationship between management and an employee, resulting in a shared understanding of what needs to be attained and how the coach should accomplish it.

By giving timely feedback, recognition, clarity, and support, coaching promotes a motivating climate for performance, improves the match between an employee's actual and expected performance, and raises the possibility of an employee's success. Coaching is a term used in the performance management cycle to provide continuous feedback and support to an employee throughout the year. Coaching allows employees to hear about parts of their performance in "real-time" and participate in determining how to adapt or adjust their behavior for success effectively. (Johnson, 2020)

Simply, coaching is a practice that focuses on the now and now rather than the distant past or future to improve performance. While there are different coaching approaches, we focus as a facilitator of learning rather than as an expert. There is a significant distinction between teaching and assisting someone in learning. Fundamentally, the coach's role is to assist the individual in improving their performance: in other words, to assist them in education. Good coaches believe each person has the answer to their difficulties but recognize that they may require assistance in

finding it. Coaching is established on the premise that each person has the solutions to their challenges. The coach is not a subject expert; instead, they are concerned with assisting the individual in realizing their full potential. The emphasis is on the athlete and what is going on within their heads. A coach does not have to be a specific person; anyone, whether peers, subordinates, or superiors, can use a coaching technique with others (Skillsyouned.com, 2021)

Coaches have an important role in sports, performing instructional, organizational, strategic, and social connection functions, and their interactions with athletes impact both skill development and psychosocial consequences. (Smith et al., 2017)

Athletes are assisted in reaching their most significant potential by sports coaches. They are in charge of coaching athletes in a sport by analyzing their performances, teaching relevant skills, and encouraging them. However, you also control the athlete's life and sport-related guidance. As a result, the coach will play a wide range of roles, including instructor, assessor, friend, mentor, facilitator, chauffeur, demonstrator, adviser, supporter, fact seeker, motivator, counselor, organizer, planner, and the Fountain of All Knowledge. In sports, the coach's job is to provide the ideal learning environment and develop ways to motivate the athletes. Most athletes are highly motivated, so the challenge is to keep them motivated while generating excitement and enthusiasm. (Topendsports, 2020)

Gedge (2016) outlined essential aspects of agile coaching to assist teams in learning to self-organize and employees in shifting their attitudes away from command and control and up-front planning and toward accepting uncertainty, devolving responsibility, and valuing experimentation and learning. Agile coaches contribute unique expertise to organizations and assist in the training of corporate teams in the agile approach, as well as managing the development of agile teams to ensure organizational goals are fulfilled, and tasks are fulfilled quickly. In a word, agile coaches assist a company in transitioning from command-and-control management to collaborative, team-based workplaces. (Tokdemir, 2019)

An internal coach or an external coach can both undertake agile coaching. An external coach might be someone from outside the team but from the same organization or an external consultant. An internal coach is someone who works in the same team. When mentoring people, an agile coach must take into account a variety of elements. The agile coach must have a balanced perspective when dealing with many teams. They should not have strong opinions and should stick to their core ideals. Every prospect requires the agile coach to comprehend the complexity within the group – social, psychological, and political. The coach must have models that are models and make sense, as well as a map of the current state of the team. Agile coaching should ideally be non-intrusive. Therefore the agile coach should aim to guide the section on the proper path without interfering. Finally, coaching should be practiced for the benefit of the group, with an emphasis on individual development (Reeva, 2019)

According to Madan (2020), Agile coaching possesses expert-level knowledge of current lean-agile processes, is highly experienced in team facilitation, and has acquired professional coaching and mentoring skills. Coaches with these talents are likely to work with numerous teams or a program, begin new groups, mentor others, or spend a lot of time working with management and dealing with obstacles that aren't directly within their control.

Hawks (2015) also mentioned that organizations embracing agile development or having difficulties with it frequently seek assistance from an agile coach. Agile coaches usually have more excellent experience with agile processes and procedures and can help the team get through difficult spots until they can figure things out on their own. An agile coach may demonstrate how agile practices work for inexperienced teams or engage in more listening and questioning to improve the team. Agile coaches, on the other hand, traditionally spend all of their time focused on the coaching job and are not team members. A different variant, the player-coach, addresses this constraint.

Tengberg's (2015) study concluded that many doctoral students fail to complete their studies within the allowable time frame, partly because of problems related to the research and supervision process. Surveys showed that most post-graduate students are generally satisfied with their dissertation supervision. However, these studies also reveal some students think their supervisors meet with them too infrequently, lack motivation in their dissertation topics, and provide poor practical assistance. Furthermore, most countries witnessed a significant turnover in the labor market as people near retirement. Because this is the case at higher educational institutions, the belief is that there will be teaching and research opportunities. Therefore, the new doctoral students who plan to enter academia after earning their post-graduate degree are necessitated. In response to these complaints, this conceptual paper examined the use of the **agile approach**–which has achieved awards and approval in software development–in the post-graduate dissertation process. In the teaching/learning sphere, coaches can use the agile approach in iterative meetings between post-graduate students and supervisors for dissertation planning, direction, and evaluation. The focus of the emphasis, the so-called Sprints, is on communication and response throughout the whole process. The paper was based on theories on teaching/learning and the author's personal experience with the agile approach. The use of the agile approach and technique, which can lessen the time required for doctoral studies, may thus add to the number of graduates with doctoral degrees.

The agile coach is a catalyst, change agent, and servant leader who provides professional facilitation, teaching, and mentoring to help organizations realize their plan and achieve excellent results for organizations, teams, managers, and leaders who want to create a productive, empowered, high-performing, and adaptable culture. Unlike traditional project management and consulting, the agile coach lives and works by agile ideals, principles, and practices. They want to make clients less reliant on them. Finally, agile coaches achieve achievements by prioritizing the

development of people's and teams' capacities, over-optimizing for immediate, short-term results (Lopez, 2017)

LITERATURE REVIEW

Agile coaches are accustomed to the traits of innocent and defenseless sports organizations, such as. Agile coaching professionals owe it to athletes to explain what's best for them. This always includes assisting athletes in accepting complete accountability for their own learning. This typically requires the coach to pass up opportunities to take on more responsibility (Gedge, 2016).

In addition, successful game management is essential for any squad. Knowing when to use substitutes, timeouts, fouls, and other strategies can mean the difference between regaining momentum and succumbing to a 15+ point or 2+ goal run. The game plan must be managed by the coach. In an agile sports endeavor, the coach makes use of analytics and player feedback to develop and sell a strategy. The agile managers are in charge of compiling in-depth reports for forthcoming games and providing coaching advice while the game is in progress. They are in charge of keeping track of the game's data, which, when supplemented with an analytical or stats tool, can help the coaching staff make quick choices (Holman, 2018)

Nagarro.com (2022) revealed that as agile managers/coaches, it is crucial that we assist teams in creating their winning scenarios. This could entail accomplishing the strategic goals determined for the current year and increasing happiness. Each and every project management action includes coaching and mentoring. In coaching, team members' talents are developed and nurtured, and they are inspired to complete projects successfully. Similar to this, agile project management includes agile coaching as a key component, and agile adaptable leaders are accountable for it. The project manager or agile leader must act as both a coach and a mentor during agile coaching. Agile coaching involves enhancing a person's skills and inspiring them to adopt productive work practices. Here, the agile coach's job is to help the individual go to the next level by coordinating their goals with those of the organization. An internal coach or an external coach can both provide agile coaching. The difference between an external coach and an internal coach is that the latter might be either a consultant from outside the team or a member of the same organization. When mentoring people, an agile coach must take many things into account. A few of these are outlined here. While working with many teams, the agile coach must maintain a balanced viewpoint. They should not be opinionated and should adhere to their values. They also need to understand the team's complexities on all levels, including social, psychological, and political. They need to have models that make sense and map the team's current situation. Finally, they should ideally be non-intrusive, so they should try to steer the team in the right direction without getting in the way (Chandana, 2021)

According to Henriksen's (2016) research, there are several aspects that can influence the success of an agile project. It explicitly checked which agile practices are necessary for an agile project to succeed. A case study was undertaken among participants in agile projects in order to

figure this out. He went on to say that there has been a movement in project management, particularly in software project management, from traditional plan-based project management to agile event-driven project management. For a long time, agile project management has been viewed as the next big thing that will transform the software industry. Agile is a concept that has been around for a while, and while awareness and use are growing, agile is not always the best solution. It is critical to know when to adopt agile and which success elements to consider if you want to be successful.

The study of Khalil, et.al (2018) aimed at analyzing these questions through a longitudinal case study. The study has been conducted in a French telecommunication company that strives to become agile. It adopted a qualitative approach for collecting and analyzing data. The findings highlighted the reasons that drive organizations to become "agile" and stress on the contingency factors that affect the implementation of "agile" practices and tools in a "lightweight" organizational structure. The transition to an "agile" organization remains a challenge. Despite the increasing number of empirical research regarding "agile" software development, "agile" management and engineering practices are still difficult to implement within large organizations. There is no formal framework on which organizations may rely to become "agile" in terms of knowledge. The application of these emergent strategies appears to be constrained by a number of contextual constraints, such as team size and distribution.

Cojocaru, et al. (2022) evaluated the obstacles and opportunities of technology, as well as the benefits of adopting an Agile Management style to improve Physical Education and Sports teaching, learning, and practice (PES). Therefore, a survey was conducted on PES teachers and trainers, as they have a clear perspective on the field and their views are therefore very important and relevant to the study, even if they do not have solutions for all the challenges facing them. They were invited to provide their professional perspectives on the impact of digital methods and applications on performance sportsmen, athletes, and students' sporting results. The survey, which included 144 participants, largely consisted of multiple-choice questions with Likert scale ratings and open-ended questions that allowed respondents to provide solutions and openly express their opinions. The impact of Agile Management on the selection and deployment of PES technology was illustrated in this paper. Because of the COVID-19 pandemic, educational institutions and sports clubs have had to change their management strategies.

Adaptability is the first of five key concepts identified by Haak (2017). This method has the advantage of delivering benefits over the course of the project rather than all at once at the end. That pays off not just for the customer, but for the team’s morale and confidence. With agile, one zooms out to start, looks through a wide lens, and then adapts as one learns about new conditions and parameters. Second, there's effectiveness. In a similar vein, anyone on the agile project management team, as well as the client or customer, is empowered to recognize and respond to changing requirements or goals at any time, allowing the product to reach the market sooner. Agile project management has been described as continuous sprints in these circumstances, with

planning and execution occurring in waves. Third, with agile project management, all parties are given the opportunity to contribute to the end goal. Collaboration fosters trust and accountability, as well as ensuring that one bad idea does not go uncontested, jeopardizing the entire process. Disruption is the fourth element. Changing culture, priorities, and goals are all part of becoming agile. And that can be difficult. However, when all stakeholders are on board, management becomes much easier. Standards and expectations change, and it ultimately succeeds. The last option is straightforwardness.

II. Methodology

This is a quantitative analysis study. The descriptive research design was deemed relevant and appropriate because the main purpose is to determine the extent of the practice of the agile management skills of coaches at Higher Education Institutions in the Province of Tarlac along with forming, norming and performing.

The respondents of the study were the coaches of the Higher Education Institutions in the Province of Tarlac during the first semester of the SY 2021-2022.

Table 1. The Population of the Study

Higher Educational Institutions in the Province of Tarlac	**Number of Respondent-Coaches**
Tarlac State University	10
Dominican College of Tarlac	5
OLRA College Foundation	1
Tarlac Agricultural University	16
TOTAL	**32**

A researcher-made questionnaire was utilized in this study that was patterned from the related studies. It was made in accordance with the objectives of the present study. The questionnaire consisted of various parts: Part I of the instrument focused on the profile of the coaches in terms of their age, sex, monthly family income, highest educational attainment, years of experience as coach, no. of memberships to professional sports organizations and no. of relevant training/seminars attended, no. of awards as a coach and events/sports handled. Part II involved the agile management skills of coaches of Higher Education Institutions in the Province of Tarlac along with forming, norming and performing. The researcher sent a letter of intent to the University Presidents of the Institutions in the Province of Tarlac requesting permission to conduct the study. After receiving approval from the Presidents, the researcher sent a letter of intent to the respondents of the study.

The researcher then distributed the questionnaires to the participants using Google Forms. The agile management skills of coaches in the Higher Education Institutions were rated by

respondents. The data and results of the study were analyzed. The descriptive survey was employed to answer the questionnaire of data. Permission was obtained from the Offices of the President of the Higher Education Institutions and to all the Sports Directors for the floating of the questionnaire to gather the needed data. The data that was gathered was analyzed through the utilization of the Jeffreys's Amazing Statistics Program (JAPS). In determining the profile of respondents, the frequency counts and percentages were used.

$$\text{Percentage: } \% = \left(\frac{f}{N}\right) \times 100$$

where f = frequency, or the number of cases in any category
N = the number of cases in all categories

Likewise, the average weighted mean was utilized to determine the extent of the agile management skills of coaches at Higher Education Institutions in the Province of Tarlac, along with forming, norming, and performing.

$$x = \frac{\sum_{i=1}^{n} (x_i * w_i)}{\sum_{i=1}^{n} w_i}$$

Σ = summation

w = the weights.

x = the value.

The following scale was adopted:

Numerical Values	Mean Range	Scale	Descriptive Rating	Interpretation
4	3.26 – 4.00		Highly Practiced	If the skill is very well executed and extremely done at all times
3	2.51 – 3.25		Moderately Practiced	If the skill is executed and modestly done most of the times
2	1.76 – 2.50		Slightly Practiced	If the skill is slimly executed and sometimes done
1	1.00 – 1.75		Least Practiced	If the skill is sparingly executed and very seldom done

To identify the significant relationship between the extent of the practice of the agile management skills of coaches in their profile variables of coaches Higher Education Institutions in the Province of Tarlac chi-square and Cramer's V was used.

$$\chi^2 = \sum_{j=1}^{k} \frac{(f_{b_j} - f_{e_j})^2}{f_{e_j}}$$

whereby

k = the number of cells

fb = the observed absolute frequency within cell j

fe = the expected absolute frequency within cell j

The calculated chi-square test statistic is afterwards tested for significance.

$$\text{Cramer's V} = \sqrt{\frac{\chi^2}{n \cdot \min(r-1, c-1)}}$$

whereby

n = sample size

r = the number of rows

c = the number of columns

III. Results and Discussion

Profile of the Sports Coaches of the Higher Education Institutions in the Province of Tarlac

Age. The table shows that most of the coaches are 25-34 years old, as indicated by the frequency of 15 or 46.86%. Ten (10) or 31.25% are 35-49 years old, and four (4) or 12.50 % are 50 and above. Moreover, three (3) or 9.38% are 24 years old and below. The data imply that most of the coaches are young adults.

Sex. It is reflected on the table that most coaches are males, as indicated by the frequency of 27 or 84.38%, while only five (5) or 15.63% are females. The data suggest that although coaching is not gender-specific, males still undeniably dominate it. On this note, coaching is likely significant among males.

As affirmed by the data-driven research conducted by Leasca et al. (2020), within the women's sports arena, female intercollegiate coaches face stark biases that male coaches do not. Equally, the report produced by the Institute for Diversity and Ethics and Sport (TIDES), as cited by Elsesser (2019), that there has been little change and that men still dominate coaching when it comes to college sports.

Monthly Family Income. It is reflected in the table that most sports coaches have a monthly family income of 23,382.00-46,761.00, which has been categorized as lower middle class with a frequency of 12 or 37.50%. This is followed by those with an income of 11,691.00-23,381.00 (low income but not poor), as evidenced by the frequency of 7 or 21.88%. Six (6) or 18.75% have a monthly income of 46,762.00-81,832.00 (middle class), and four (4) or 12.50% belong to the poor as reflected with an income that ranges from 11,690.00 and below. Two (2) or 6.25% of the coaches' families have a family income of 81,833.00-140,284.00, categorized as upper middle income. However, one (1) coach or 3.13% enjoys a salary ranging from 140 285.00-233,806.00 (upper income but not rich).

Highest Educational Attainment. The table shows that most coaches are still on their way to completing their Masters' degrees, as indicated by the frequency of 13 or 40.63%. Seven (7) or 21.88% and five (5) or 15.63% are Master's Degree and DA/Ph.D./EdD graduates, respectively. However, four (4) or 12.50% are still pursuing their Doctoral degree, and three (3) or 9.38% are just graduates of Baccalaureate Degree.

Table 2. Profile of the Sports Coaches of the Higher Education Institutions in the Province of Tarlac

n=32

Profile	Categories	Frequency	Percentage
Age	**25-34 years old**	**15**	**46.86**
	35-49 years old	10	31.25
	50 and above	4	12.50
	24 years old and below	3	9.38
Sex	**Male**	**27**	**84.38**
	Female	5	15.63
Monthly Family Income	**23,382.00-46,761.00**	**12**	**37.50**
	11,691.00-23,381.00	7	21.88
	46,762.00-81,832.00	6	18.75
	11,690.00 and below	4	12.50
	81,833.00-140,284.00	2	6.25
	140, 285.00-233,806.00	1	3.13
	233, 807.00 and above	0	0.00
Highest Educational Attainment	**BS Degree with MA units**	**13**	**40.63**
	Master's Degree	7	21.88
	DA/PhD/EdD	5	15.63
	with Doctoral units	4	12.50
	Baccalaureate Degree	3	9.38
Years of Experience as a Coach	**6-15 years**	**15**	**46.88**
	5 years and below	12	37.50
	26 years and above	3	9.38
	16-25 years	2	6.25
Number of Memberships to Professional Organizations	**1-3**	**16**	**50.00**
	None	10	31.25
	4-6	5	15.63
	7 and above	1	3.13
Number of Related In-Service Trainings, Conferences and Seminars	**7 and above**	**14**	**43.75**
	1-3	12	37.50
	4-6	4	12.50
	None	2	6.25

The data imply that though educational attainment is given a premium at the tertiary level in the country, which counts as an excellent percentage for promotion, this is not, however, reflective of the study's results. Hence, the desire to complete the Master's degree accounts because most respondents are on their way to embark on their post-graduate studies.

Y**ears of Experience as a Coach.** It is reflected from the table that coaches have been serving 6-15 years, as indicated by the frequency of 15 or 46.88%. Twelve (12) or 37.50% have been making a coaching career for five years and below, and three (3) of them or 9.38% served as a coach for 26 years and above. However, only 2 or 6.25% have exemplified a coaching service for 16-25 years. This indicates that the experience is grounded on the age of respondents; it is tantamount to saying that their service as a coach goes with it. "The younger the age, the lesser the number of years of coaching," imparts.

Number of Memberships to Professional Organizations. It is seen on the table that most of the respondents have 1-3 memberships to professional organizations, as evidenced by the frequency of 16 or 50.00%. There has been one (1) or 3.13% and five (5) or 15.63% with seven and above and 4-6 memberships. Moreover, ten (10) or 31.25% have no affiliations. This indicates that the coaches are active in joining sports and related organizations because these are avenues for great opportunities for peer collaboration and support aside from acquiring new knowledge from the experts.

A number of Related In-Service Trainings, Conferences, and Seminars. Data shows that most respondents had attended seven and above seminars, as indicated by the frequency of 14 or 43.75%, while only 2 or 6.25% never attended meetings related to sports coaching. The data implies that participation in professional development training and enhancement programs is necessary because their participation in activity indicates its significance to their field of endeavour.

Because sports need teamwork and the development of social skills, participation in training aids in developing good character. Being in training gives one the chance to establish meaningful self-awareness. Now is the moment to observe reactions and develop suitable responses to challenging circumstances. Instead of just broadening the selection of sports facilities that are available to students, universities need to focus on training investments to meet sports development demands (Harrow, 2016)

Profile of the Coaches as to the Awards Received and Sports/Events Handled

Awards Received. It is shown on the table that four (4) or 12.50% of the coaches have received gold medals in the national competitions. Eight (8) or 25.00% have achieved gold medals at the regional level. Likewise, four (4) or 12.50% got gold medals at the local level. The data implies distinction in the field of sports because at least there are achievements acquired by the coaches though minimal. Hence, other coaches are encouraged to step up and desire to have awards that can be conclusive of their merit.

Table 3. Profile of the Coaches as to the Awards Received and Sports/Events Handled

N=32

Profile	Categories	Frequency	Percentage
Awards Received as Coach			
	National **(Gold)**	**4**	**12.50**
	(Silver)	0	0.00
	(Bronze)	0	0.00
	Regional **(Gold)**	**8**	**25.00**
	(Silver)	0	0.00
	(Bronze)	0	0.00
	Local **(Gold)**	**4**	**12.50**
	(Silver)	1	3.16
	(Bronze)	0	0.00
Events/Sports Handled	Badminton	5	15.63
	Basketball	4	12.50
	Volleyball	4	12.50
	Chess	3	9.38
	Taekwondo	3	9.38
	Archery	2	6.25
	Athletics	2	6.25
	Table Tennis	2	6.25
	Karatedo	1	3.13
	Speak Takraw	1	3.13
	Swimming	1	3.13
	Softball	1	3.13
	Arnis	1	3.13
	Beach Volleyball	1	3.13
	Lawn Tennis	1	3.13

Coaches are disreputable for avoiding the spotlight. It is a selfless job that involves assisting others in achieving their goals. For the majority of coaches, seeing them on the podium is enough. Coaches are rewarded in various ways, but one of the most rewarding is seeing athletes mature and move away to maintain a balanced existence in sport. The best instructors are generally those who work in the shadows, pleased to watch an athlete win an Olympic medal and recalling how awkward they were when they first began their sports career (Hooper, 2017)

Events/Sports Handled. The table shows that most coaches handle badminton as indicated by the frequency of 5 or 15.63%. Four (4) coaches or 12.50% each handle basketball and volleyball: three coaches or 9.38% each for chess and Taekwondo. Besides, two coaches, or 6.25%

each for archery, athletics, and table tennis, while an individual coach or 3.13% handles Karatedo, speak takraw, swimming, softball, arnis, beach volleyball, and lawn tennis.

According to Ordoñez (2019), coaching is a growing practice in the Philippines that provides a new path for Filipinos to reach their full potential, personally and professionally. In addition, in the Philippine Sports Commission's National Sports Coaching Certification Course, around 300 coaches got online sports specialized lectures on athletics, badminton, and volleyball to help them improve more.

The Extent of Practice of the Agile Management Skills of Coaches of Higher Education Institutions in the Province of Tarlac

In Terms of Forming

During the forming stage, members avoid disagreement and are more concerned with themselves, their performance, and whether it will be acceptable to the group. At this point, the first leaders will emerge. Individuals will be assessing and forming opinions on the other members of the group, what they may bring to it, and whether they belong within it during the forming stage, which often has a solid social component because it is spent getting to know the rest of the group while forming interpersonal relationships.

The table shows that the coaches highly practice the agreement with the rules and regulations of the team with the players, as evidenced by the mean of 3.48. Rules are deemed to be the factors in establishing rapport between coaches. On this note, this implies that before the selection and recruitment of players in the school, they emphasized the value of compliance and allegiance to the rules and the policies being implemented.

Likewise, developing training techniques and robust sports competition system has been moderately practiced, as supported by the mean of 3.31. It indicates that since coaches are highly spirited and it is their passion to handle athletes within the bounds of their expertise, techniques in coaching are in place. The system of competition is always taken into its most significant consideration.

When coaches build sound training procedures, players gain more control and mindfulness, which leads to them discovering their tone of sports skills and paying attention to them to a more significant level (Moen et al., 2015)

Table 4. The extent of Practice of the Agile Management Skills of Coaches of Higher Education Institutions in the Province of Tarlac in Terms of Forming

N=32

Indicators	**Mean**	**Verbal Description**
Agrees with the rules and regulations of the team.	3.48	Highly Practiced
Develops training techniques and strong sports competition system.	3.31	Moderately Practiced
Shows inexperienced teams how agile practices work and does more listening and asking questions to help the team improves	3.13	Moderately Practiced
Develops an action mechanism to create viable sports team	2.94	Moderately Practiced
Settles unclear policies and mechanisms on practice, team plays and rollouts	2.94	Moderately Practiced
Leads the team through strong recruitment and selection procedure	2.66	Moderately Practiced
Generates sustainable and feasible coaching process	2.63	Moderately Practiced
Weighted Mean	**3.01**	**Moderately Practiced**

Legend:

3.26 – 4.00	Highly Practiced
2.51 – 3.25	Moderately Practiced
1.76 – 2.50	Slightly Practiced
1.00 – 1.75	Least Practiced

The coaches also moderately practice the indicator, show inexperienced teams how agile practices work, and pay more attention and ask questions to help the group develop, as indicated by the mean of 3.13. This means that openness in the group is encouraged. The freedom to express oneself in the team is positively urged. On the same wavelength, the coaches moderately practice the development of an action mechanism to create a viable sports team with a mean of 2.94. This indicates that whatever challenges arise because these are all innate in a sports team, the coaches deal with these with the scheme or a policy so that these conflicts will not become more severe and critical. They have the established flow to follow in effectively dealing with the problems within the team setting.

Teams with high performance are more pull than push. High-performance coaches understand how to instill energy and passion in their teams. Players feel inspired, as though they are working toward a common goal and that what they are doing is critical. A team that was

constantly in dispute and disagreement, a team that was walking on eggshells and scared to speak up or express genuine feelings (Folkman, 2016).

Settling unclear policies and mechanisms on practice, the team plays, and roll-outs have been moderately practiced by the coaches as supported by the mean of 2.94. This is indicative of the pre-judgment skills of the coaches that they know if there are unclear policies in the team like the scheduling of the practice and the game plan during competitions. They manage the players by considering the welfare of the team and the players.

Similarly, leading the team through solid recruitment and selection procedure has been moderately practiced by the coaches as supported by the mean of 2.63. This implies that the coaches are guided by the rules of recruitment and selection procedure for them to have the highest potential athletes capable of bringing honor to the school.

It could be gleaned from the table that generating a sustainable and feasible coaching process has been assessed as moderately practiced, as indicated by the mean of 2.63. This means that the coaches tend to establish a coaching process seen in their individual sports coaching programs. They see that their sports development program in their specific field is quite strong, and all details of the coaching mechanisms are being transpired.

Overall, the coaches moderately practiced their agile management skills in forming, as evidenced by the weighted mean of 3.01.

In Terms of Norming

Norming is observed when the coach begins to be respected by the players/athletes, accepts his authority, shows a more vital dedication to the group's objectives, and performs much better. Here, the team is more assured, and motivation levels rise. As individual conflicts are resolved, and team members can accept one another's skills and qualities, the group starts to come together. Additionally, they become more at ease asking for assistance and giving the other group members and themselves constructive criticism.

Overall, the coaches moderately practiced their agile management skills in norming, supported by the weighted mean of 3.02.

As to the specific indicators, the table shows that understanding the complexities within the team in every prospect social, psychological, and political has been moderately practiced, as supported by the mean of 3.25. This implies that the coaches have the heart to understand that everything that happens in the team is not exactly perfect. All sides are being considered because it is believed that sports are not only the school but it is also multi-dimensional. Coaching is multilayered, structural, dynamic, and socially engaging because it addresses so many aspects of the past and couples them with the intricacies of the present. This is a crucial tool for every coach

to have in their toolkit, as it will enhance everyone's professional, personal, and athletic development. (Smith, 2020)

The table further shows that the coaches have moderately practiced helping the team to shift from command-and-control management practices to collaborative, team-centric environments, as indicated by the mean of 3.22. This means that a democratic way of management is exercised over just the autocratic method.

Likewise, mentoring the potential players on coaching strategies has been moderately practiced by the coaches, as indicated by the mean of 3.13. This means that coaches are giving pieces of advice to the performing players to become coaches in the future.

Monitoring the development of agile teams to ensure goals are effectively achieved and tasks are efficiently accomplished has been moderately practiced by the coaches as supported by the mean of 3.00. The data imply that the coaches monitor the success of the team and that all the set multilevel objectives are fulfilled.

Likely, spending significant time working with sports managers and engaging with obstacles outside the direct control of teams has been moderately practiced by the coaches as supported by the mean of 2.84. Collaboration is the key that this data implies.

Table 5. The extent of Practice of the Agile Management Skills of Coaches Higher Education Institutions in the Province of Tarlac in Terms of Norming

N=32

Indicators	**Mean**	**Verbal Description**
Understands the complexities within the team in every prospect social, psychological, and political	3.25	Moderately Practiced
Helps the team to shift from command-and-control management practices to collaborative, team-centric environments	3.22	Moderately Practiced
Mentors the potential players on coaching strategies	3.13	Moderately Practiced
Monitors the development of agile teams to ensure goals are effectively achieved and tasks are efficiently accomplished.	3.00	Moderately Practiced
Spends significant time working with sports managers and engages with obstacles outside the direct control of teams	2.84	Moderately Practiced
Is non-intrusive and should try to steer the team in the right direction without getting in their way.	2.84	Moderately Practiced
Brings specific skills to organizations and helps train corporate teams on the agile methodology	2.84	Moderately Practiced
Weighted Mean	**3.02**	**Moderately Practiced**

Legend:

3.26 – 4.00	Highly Practiced
2.51 – 3.25	Moderately Practiced
1.76 – 2.50	Slightly Practiced
1.00 – 1.75	Least Practiced

The coaches have moderately practiced being non-intrusive and should try to steer the team in the right direction without getting in their way, as indicated by the mean of 2.84. This suggests that the coaches consider the welfare of the group.

Similarly, the coaches have moderately practiced bringing specific skills to organizations and helping corporate train teams on the agile methodology, as indicated by the mean of 2.84.

In Terms of Performing

Performing happens when the coach and the team reach their full potential, and as team members become more accustomed to responsibility, structure, and hard work, their roles on the

team become more fluid. Athletes who have reached the performing stage of group growth are more understanding of the shortcomings of their colleagues. They accept them with an all-encompassing attitude. As a result, the team is making the most progress possible, and everyone is giving their best effort.

The table shows that the coaches have moderately practiced the agile management skills of coaches of Higher Education Institutions in the Province of Tarlac in terms of performance, as indicated by the weighted mean of 3.11.

Moreover, it could be gleaned from the table that the coaches assessed executing "experienced" ability with agile processes and techniques as moderately practiced, as indicated by the mean of 3.19. This implies that the outstanding power of coaches is seen in their execution. That is why the coach who will be designated is the one who has profound knowledge, aptitude, and expertise in the sports being handled.

Likewise, the coaches have assessed that practicing the team through rough patches until they can find their way as moderate as indicated by the mean of 3.19.

Other indicators which are evaluated as moderately practiced are the following entries that are arranged in descending means: demonstrates non-usual yet alternative variations of skills (3.06), shows exceptional sports coaching proficiency (3.06), and addresses limitations of players (3.19).

It could be seen further on the table that the coach has moderately practiced achieving excellent results for the players to emulate, as evidenced by the mean of 3.13.

This means that the coaches intend to make themselves role models to which the players should look up.

Table 6. Extent of Practice of the Agile Management Skills of Coaches of Higher Education Institutions in the Province of Tarlac in Terms of Performing

N=32

Indicators	**Mean**	**Verbal Description**
Executes "experienced" ability with agile process and techniques.	3.19	Moderately Practiced
Practices the team through rough patches until they can find their own way	3.19	Moderately Practiced
Demonstrates non-usual yet alternative variations of skills.	3.06	Moderately Practiced
Shows exceptional sports coaching proficiency.	3.06	Moderately Practiced
Addresses limitations of players.	3.19	Moderately Practiced
Achieves excellent results for the players to emulate	3.13	Moderately Practiced
Drives results by focusing on developing the capabilities of players over optimizing for immediate, short-term results	2.97	Moderately Practiced
Weighted Mean	**3.11**	**Moderately Practiced**

Legend:
3.26 – 4.00 Highly Practiced
2.51 – 3.25 Moderately Practiced
1.76 – 2.50 Slightly Practiced
1.00 – 1.75 Least Practiced

The coaches have also moderately practiced driving results by focusing on developing players' capabilities by over-optimizing for immediate, short-term results, as indicated by the mean of 2.97.

Significant Relationship Between the Extent of Practice of the Agile Management Skills of Coaches Across Their Profile Variables

Spearman's Rho results revealed that age has correlated with the agile management skills of coaches along with forming (0.34, sig=0.03) and norming (0.36, sig=0.04). This means that the older the coaches, the higher their skills to handle and put in place all procedures that govern sports coaching. This may be attributed to their experience as manifested in the very crucial age in managing players at all costs and means.

Table 8. Significant Relationship Between the Extent of Practice of the Agile Management Skills of Coaches Across Their Identified Variables

N=32

Variables		Forming	Norming	Performing
Age	Spearman's Rho	**0.34**	**0.36**	0.33
	p-value	**0.03**	**0.04**	0.85
Monthly Family Income	Spearman's Rho	0.31	0.19	0.23
	p-value	0.08	0.29	0.21
Highest Educational Attainment	Spearman's Rho	**0.35**	0.16	0.31
	p-value	**0.05**	0.39	0.09
Years of Experience as a Coach	Spearman's Rho	**0.48**	**0.35**	0.24
	p-value	**0.01**	**0.05**	0.18
Number of Memberships to Professional Sports Organizations	Spearman's Rho	0.22	0.23	0.12
	p-value	0.24	0.211	0.53
Number of Relevant Seminars Attended	Spearman's Rho	0.28	**0.49**	0.30
	p-value	0.12	**0.01**	0.09

Similarly, the highest educational attainment of coaches is connected with their skills in forming, as indicated in Spearman's Rho results of 0.35 (sig=0.05). Since the significance value is lower than the significance level, the hypothesis is hereby rejected. The data imply that the more knowledge coaches adopted from their schooling in post-graduate studies, the better their agile management skills contribute to this may be credited to their exposure and learnings acquired from their professors and peers.

In like manner, the years of experience as a coach have also been very significant in their agile management skills, especially in forming and norming, as revealed by Spearman's Rho results of (0.48, sig=0.01) and 0.35 (sig=0.05), respectively. The data is indicative of the experience and the high level of know-how of coaches. Their agile management skills are boosted by the number of years of exposure to the sports they handle.

Lastly, the number of relevant seminars attended has also been very substantial in the agile management skills of coaches, as supported by Spearman's Rho results of 0.49(sig=0.01). This means that seminars are indeed very crucial in the development of coaches. The data also imply that the more conferences attended, the higher the tendency to increase the agile management skills of coaches.

Significant Relationship Between the Extent of Practice of the Agile Management Skills of Coaches Across their Sex, Awards Received and Sports/Events Handled

Cramer's V results revealed that there is no significant relationship between the extent of the practice of the agile management skills of coaches along with forming, norming, and performing and their sex, awards received, and sports/events handled.

Table 9: Significant Relationship Between the Extent of Practice of the Agile Management Skills of Coaches Across Their Identified Variables

N=32

	Forming			**Norming**			**Performing**		
	x^2	*p-value*	*Cramer's V*	*x^2*	*p-value*	*Cramer's V*	*x^2*	*p-value*	*Cramer's V*
Sex	7.48	0.06	0.48	7.19	0.07	0.47	8.56	0.04	0.52
Awards Received as Coach	17.60	0.82	0.43	22.16	0.57	0.48	20.98	0.64	0.47
Sports/Events Handled	**14.60**	**0.05**	**0.03**	**4.16**	**0.00**	**0.00**	**5.98**	**0.04**	**0.00**

It is imperative to conclude that sex has no importance in better equipping coaches in the practice of their agile management skills. The gender is of no consequence as to how they manage the athletes, as indicated in the p-values of 0.06 (sig=0.48), 0.07 (sig=0.47), and 0.04 (sig=0.52) for forming, norming and performing, respectively.

It also means that awards received as a coach would not help coaches to be more creative, flexible, and critical thinkers in catering to the needs and interests of the players and athletes.

However, there is a significant relationship between sports/events handled and the extent of agile management skills in all areas, as revealed by the p values of 0.05 (sig=0.03), 0.00 (sig=0.00), and 0.04 (sig=0.00), respectively which are all lower than the 0.05 level of significance.

Moreover, coaches may also improve coaches' forming, norming, and performing skills. Once enhanced, athletes may also improve creativity, flexibility, and thinking skills, directly benefiting coaches' potential and abilities. Therefore, coaches may also develop players' performance. Specifically, significant and immediate relationships were identified between the awards received and the agile management skills in forming, norming, and performing.

Meanwhile, coaches have a big impact on achievement in both the professional and collegiate ranks, according to uchicago.edu (2017), notably with their experience in the sports they handle and their leadership. Furthermore, rapid technological advancements have had an impact on sports coaches' abilities. To improve their coaching skills, higher education institutions have

steadily integrated modern technologies into the coaching process and curriculum (Carkanji, et al, 2020).

In the same tone, Table 10 also presents the innovative work plan in a tabular form to improve the agile management skills of coaches of Higher Education Institutions in the Province of Tarlac.

Table 10: Innovative Work Plan to Improve the Agile Management Skills of Coaches of Higher Education Institutions in the Province of Tarlac

Area of Concern	Process	Objectives	Strategy	Personnel Involved	Budgetary Requirement	Expected Outcome
Forming						
Leads the team through solid recruitment and selection procedure	**Robust Enlistment Scheme**	• To institutionalize the extensive recruitment and selection process of players that the coaches execute. .	Most comprehensive structure for the dissemination of information on the recruitment process	Sports Directors and Coordinators Sports Coaches	19,000.00	A sturdy scheme of coaches for recruitment and selection has been recognized.
	Selection Structure Management	• To establish a more concrete and viable arrangement of procedures for selection and recruitment	Administration of a potent structure for athlete selection	Sports Directors and Coordinators Sports Coaches	18,000.00	The selection structure is extensively formed.
Generates sustainable and feasible coaching process	**Innovative Coaching Mechanism**	• To put in place a coaching process that is up-to-date and more sustainable.	Innovative and Up-to-date Coaching Strategy	Sports Directors and Coordinators Sports Coaches Athletes	18,000.00	A creative coaching process is crafted.
Norming						
It is non-intrusive and should try to steer the team in the right direction without getting in their way.	**Eclectic way of Athlete Management**	• Construct a style of coaching that motivates the athletes and apply being democratic and autocratic, if needed.	Administer best types of coaching styles depending on the types of athletes being handled	Coaches Athletes	2,000.00	A more systemic administration of athletes is promoted.
It brings specific skills to organizations and helps train corporate	**Skill-Target Development**	• To develop the skills of coaches in training the team	Skills Enhancement Programs	Sports Directors and Coordinators Coaches	10,000.00	The skills of the coaches are improved.

teams on the agile methodology. **Performing**						
Drives results by focusing on developing the capabilities of players over-optimizing for immediate, short-term results	**Achievement Long-Term Goal over Enabling Goal**	• To inculcate to the coaches the value of the long-term rather than the short one and to appreciate the value of the product of time and determination.	Goal Appreciation	Sports Directors and Coordinators Coaches	------	The coaches much appreciate long-term over short-term goal.
TOTAL					**67,000.00**	

IV. Conclusion and Recommendation

The study concluded that most sports coaches are 23-34 years old, male, have a monthly family income of 23,382.00-46,761.00, with MA units, 6-15 years of service, and have 1-3 memberships to professional organizations, received gold medals, and handling badminton sports.

The level of agile management skills of sports coaches is relatively exercised. Age, highest educational attainment, years of service, trainings, and sports they handle are linked with the agile management skills of sports coaches. The proposed work plan is deemed very significant in improving the agile management skills of sports coaches.

In light with the prevailing conclusions, the study recommends that the sports coaches may take the opportunity to embark on their graduate studies and be exposed to training and organization affiliations for further enhancement of knowledge and expertise. Further, the Commission on Higher Education (CHEd) may offer scholarships distinctly intended for the teachers of Physical Education and sports because most of the scholarships are along with core disciplines.

An interest in boosting more of the sports coaches' desires, awareness, and yearnings on managing their skills. Players and athletes should be given much priority. Of course, the welfare of the coaches should also be given such attention by providing them with the necessary coaching knowledge, aptitudes, and mindsets.

A provision of a higher level of experience and training for all the coaches because these are correlated with their agile management skills. Likewise, older coaches have more profound value in coaching. That is why they give them more opportunities for the support they need. The

work plan is ready for implementation to improve sports coaches' agile management skills, especially in the Higher Education Institutions of Tarlac Province.

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SITE SUITABILITY ASSESSMENT AND CLIMATE VULNERABILITY FOR SWEETPOTATO IN MONCADA, TARLAC, PHILIPPINES

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ABSTRACT

Sweetpotato is a very resilient crop, needs plenty of sunshine, can tolerate drought to some extent but cannot survive water logging, on the other hand, storage roots are sensitive to changes in soil temperature, depending on the stage of its root development. Majority of the farm areas in sweetpotato production are lowland to hilly in which some of the farm lands are highly affected by flood, drought and erosion. Thus, there is a need to assess areas which are vulnerable to climate changes. Moreover, there is a need to evaluate possible suitable areas to meet the increasing demands in sweetpotato delicacies. To address this problem, identifying suitable sites for sweetpotato production and generating climate vulnerability maps could help farmers and local government units (LGU) to assess the proper use of different resource maps for decision making and planning. Five parameters (land use, soil type, groundwater, slope and road accessibility) were used in suitability assessment while the bioclimatic factors, hazards and the existing sweetpotato areas were used for the climate vulnerability analysis. Data were gathered from different agencies and field survey that was processed using MaxEnt and GIS software. Based on the result, majority of the municipality were suitable to highly suitable for sweetpotato production. On the other hand, climate vulnerability assessment shows that the effect climate and hazards to these areas was moderate to extremely vulnerable to these changes in the coming years.

KEYWORDS: Site assessment, Climate vulnerability, Sweetpotato.

1 INTRODUCTION

Sweetpotato is an important staple and emergency food in many countries and is appreciated for its very high nutritional value, both of the tubers and of the young aerial parts.[1] It is also considered as a vegetable, a snack food, ingredients in animal diets and now being used for processed products. Sweetpotatoes are of tropical origin, warm climates is well adapt and grow best during summer. A well- drained sandy loam is desired and heavy clay soils should be avoided as they can delay root development, causing in growth cracks and poor root shape. Sweetpotato needs plenty of sunshine, but shade causes yield reduction.[2] Sweetpotato can tolerate drought to some extent but cannot survive water logging.[3]

The Philippines is reported as one of the most affected countries in terms of climate related risks to agriculture.[4] Crops are both affected by extreme weather as well as the different climate hazards. These include typhoon, landslides, flooding and soil erosion and the magnitude and incidence of these hazards is projected to rise under a climate change scenario.[5] Rainfall is becoming more variable and temperatures are rising consequently leading to increase occurrence of droughts and floods, and changes in the timing and length of growing seasons.[6] Exposure and sensitivity together describe the potential impact that climate change can have on a system.

Site specific sustainable agro-techniques through well designed research is important to improve sweetpotato productivity. Areas, where sweetpotato is already staple food has great potential to improve the farming practices. Thus, identifying a suitable site for sweetpotato production and generating a climate vulnerability map could help farmers and Local Government Units for decision making and planning.

2 MATERIALS AND METHODS

2.1 Study Area

The area for this study focused on the land of Tarlac Province where the total area of 3,053.45 km^2 (305,345 ha) with 37 barangays (Figure 1). Tarlac has dry and wet season. Sweetpotato is the pride of Tarlac, as the province is one of the largest commercial producers of rootcrop in the country. In this study, the three (3) barangay with the largest areas in the municipality was chosen.

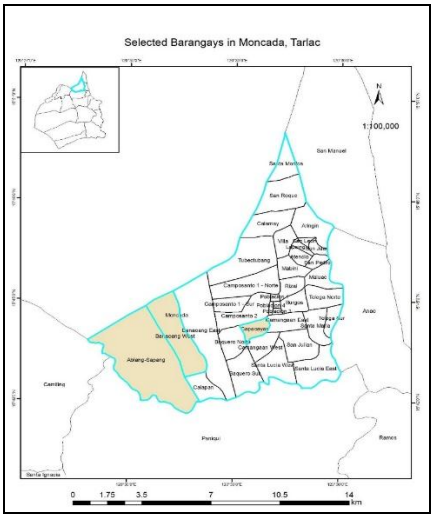


Fig. 1: Map of Moncada, Tarlac, Philippines.

2.2 Site Suitability Analysis

Secondary data and demographic data was collected from different Government organizations. Primary data was gathered through key informant interviews (KIIs) and focus group discussion (FGDs) in relation to sweetpotato areas and the existing farmer practices and management in sweetpotato production.

The five parameters used for the site suitability analysis were processed and analyzed using ArcGIS software. The given parameters are the soil type, slope, land use, groundwater and road accessibility (Figure 2).[7] The identified categories of each parameters have a different score based on its suitability.

The site suitability scoring and weighting system was based in five different parameters with suitability scoring (Table 1). Developing the suitability map of the municipality were done by overlaying the reclassified suitability parameters with their corresponding weights using the Equation 1. Then, it was classified into five suitability classes (Table 2).

Suitability Score = (Land use)*30 + (Soil type)*10 + Groundwater)*5 (1)
+ (Slope)*3 + (Road accessibility)*2

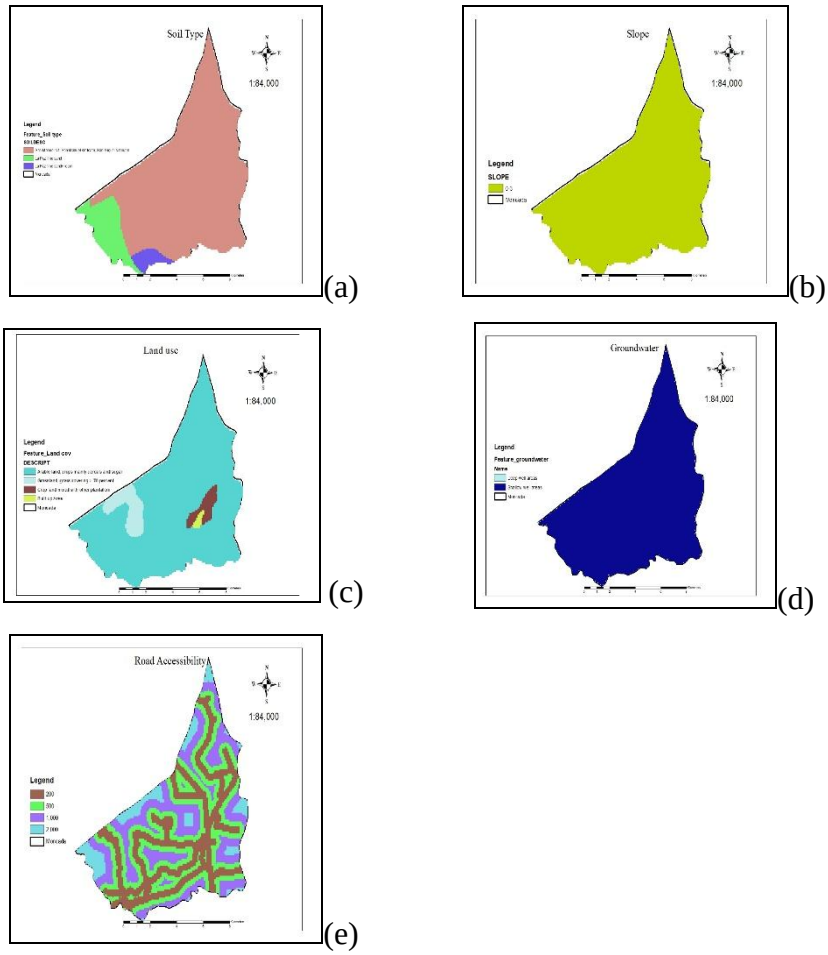


Fig. 2: Site Suitability Parameters Maps (a) Soil type Map (b) Slope Map (c) Land use Map (d) Groundwater Map (e) Road accessibility Map.

Table 1: The Suitability Scoring and Weighting.

Parameters	Category	Scoring	Weighting
Land use	Arable land Grassland, grass covering >70% Build-up area	10 7 0	30
Soil type	Sandy loam Clayloam Fine sand Other types	10 8 5 1	10
Groundwater	Deep well areas Shallow well areas	10 7	5
Slope	0-3 3-8 8-15 15-30 30 and up	10 8 6 2 0	3
Road accessibility (Buffer, meter)	0-200 200-500 500-1000	10 7 4	2

Table 2: The Suitability Classes.

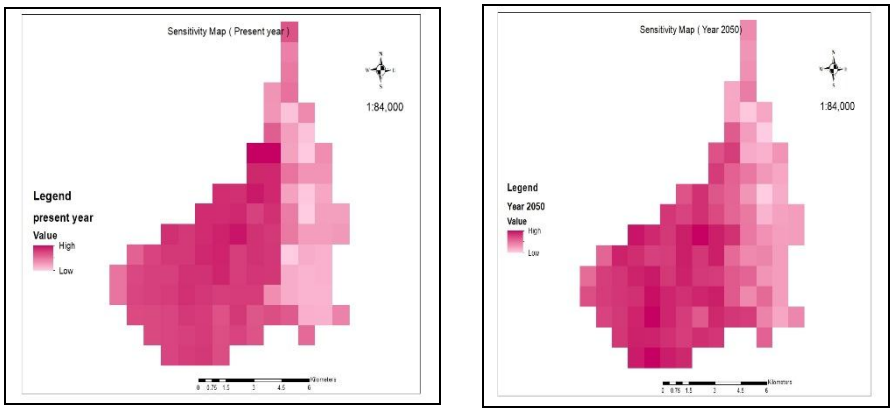
Class	Suitability Score
Highly Suitable	14-13.0001
Moderately Suitable	13-12.0001
Suitable	12-11.0001
Less Suitable	11-10.0001
Not Suitable	10-0.0000

2.3 Climate Vulnerability (Sensitivity-Hazard) Analysis

Sensitivity and exposure together describe the potential impact that climate change can have on a system. This was done by overlaying the sensitivity and hazard within the municipality.

Exposure I. Sensitivity analysis (changes of temperature and precipitation)

Sensitivity analysis was done by identifying the existing crop distribution through focus group discussion in participation of the Municipal Agriculture staff and sweetpotato farmers and the incorporation of bioclimatic data (temperature and rainfall) from the WorldClim. This was processed on the MaxEnt software, a species distribution model (SDM)[4] to produce the sensitivity map (Figure 3).



(a) **(b)**

Fig. 3: Sensitivity Map (a) Sensitivity Map of Present Year, (b) Sensitivity Map of Year 2050.

Exposure II. Hazards

Exposure represents the climate conditions that stimuli against extreme changes. The hazards such as typhoon, flood, erosion and drought (Figure 4) was considered which mostly affects the area. Secondary data on these hazards were gathered from different organizations and agencies. Hazard weights identification (Table 3) were participated by PDRRMC/MDRRMC staff and AEWs.

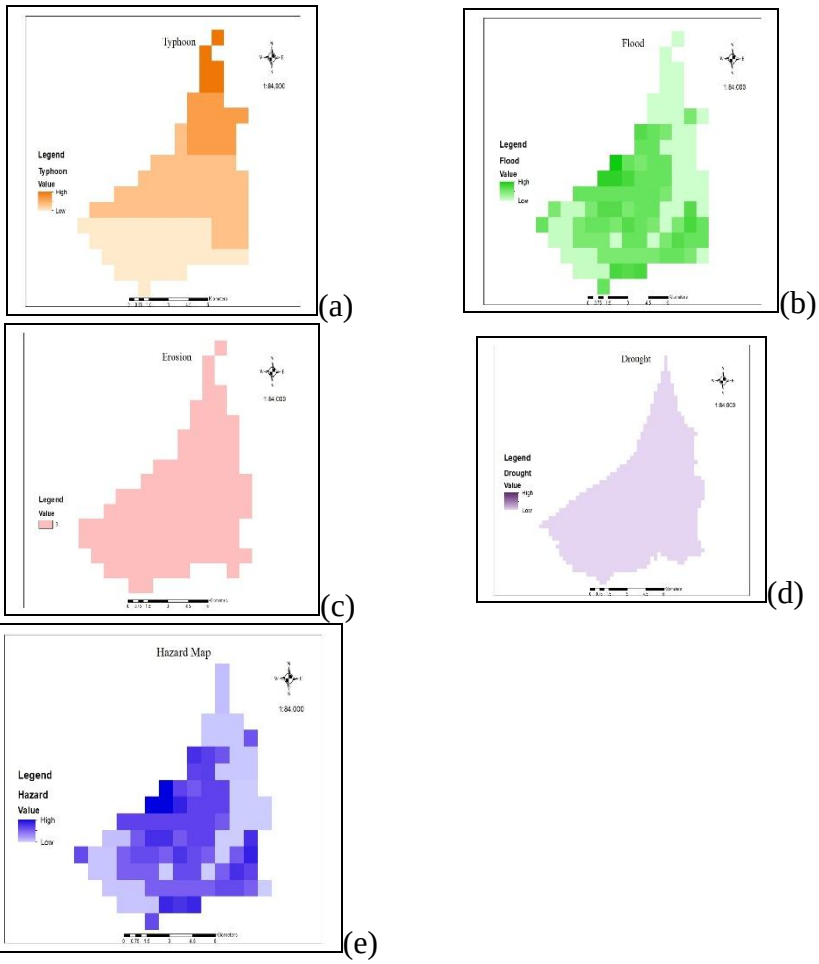


Fig. 4: Hazard Maps (a) Typhoon Map (b) Flood-prone Map (c) Erosion Map (d) Drought Map (e) Final Hazard Map.

Table 3: Hazard Weights.

Exposure II. Biophysical	Probability of Occurrence	National Economy	Food Security	Houshold Income	Key Natural Resources to Sustain Productivity	Weight
Typhoon	3	3	4	4	1	15
Flood	3	4	4	4	1	16
Erosion	1	1	1	1	1	5
Drought (Agricultural/Hydrological)	3	3	3	3	3	15

Note: Weighting the natural hazards into a climate risk exposure

Probability of occurrence: 1 in 1 year = 5, every 5 years = 3, 1 every 10 years = 1

Impact: Insignificant = 1, minor = 2, moderate = 3, significant = 4, disastrous = 5

3 RESULTS AND DISCUSSION

3.1 Sweetpotato Production Areas

The largest area for sweetpotato production in province of Tarlac is Moncada. Three barangays in Moncada were selected in the inventory of the existing crops. The largest area with sweeetpotato production is Ablang Sapang followed by Banaoang West and lastly, Capaoayan having a total farm area of 352.8 hectares with 317 number of famers, 50.9 hectares with 57 numbers of farmers and 3.5 hectares with 2 numbers of farmers, respectively (Figure 5).

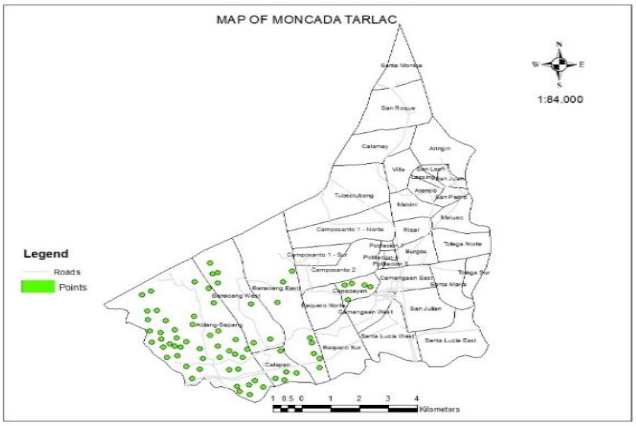


Fig. 5: Sweetpotato Production Areas with 3 Selected Barangays.

3.2 Site Suitability Map

The suitability map shows that the area in Municipality are classified as moderately suitable to highly suitable for sweetpotato production (Figure 6).

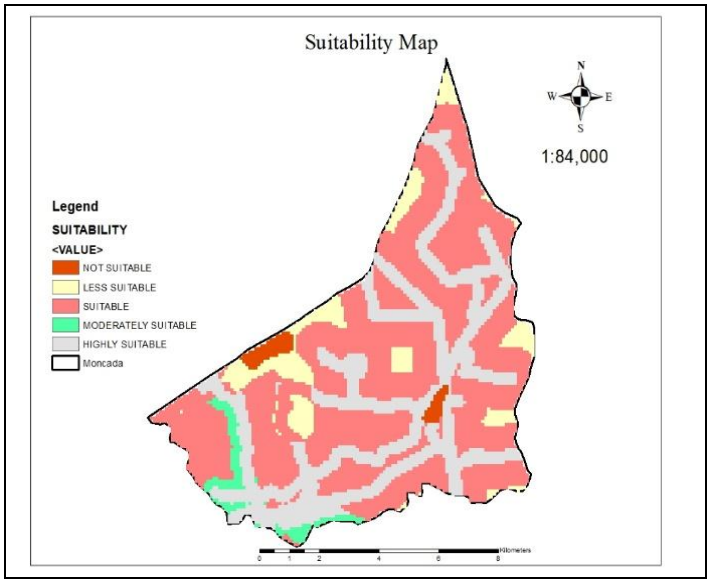
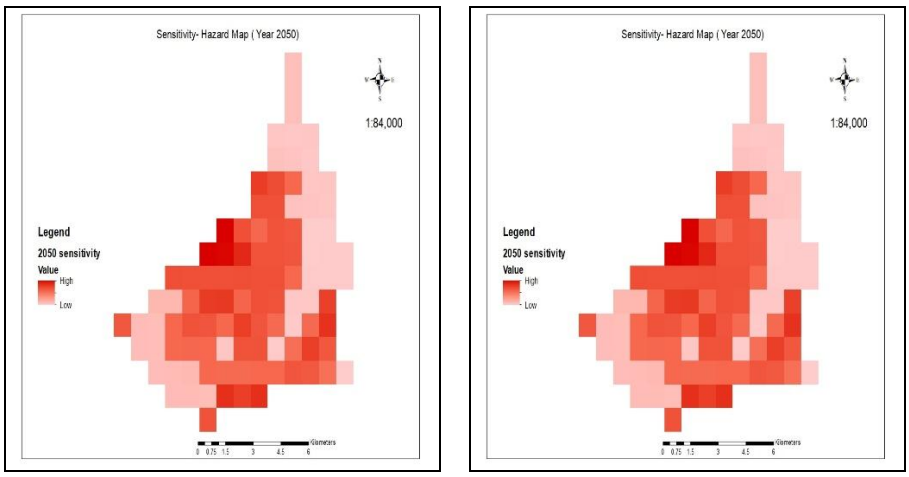


Fig. 6: Site Suitability Map of Sweetpotato in Moncada, Tarlac, Philippines.

3.3 Climate Vulnerability (Sensitivity-Hazard) Map

The impact of the sensitivity-hazard from the present up to year 2050 is moderate to extreme because of the changes in climate (Figure 7). This means that area is vulnerable for crop production.



(a) **(b)**

Fig. 7: Sensitivity-Hazard Map of Sweetpotato in Moncada, Tarlac, Philippines.

4 CONCLUSION

The area of the selected barangays in this study were found out that it is highly suitable, moderately suitable and suitable for sweetpotato production based on the parameters. The information of the impact of climate in the area is also identified together with the hazards defining the risks posed by climate change. This study provides information on sweetpotato that can be used for identifying measures to adapt to climate change impacts.

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Nitrogen Deficiency Mobile Application for Rice Plant through Image Processing Techniques

Geraldin B. Dela Cruz

Abstract: ***Driven by the opportunity that digital devices and robust information are readily available, the development and application of new techniques and tools in agriculture are challenging and rewarding processes. This includes techniques learned that is based on traditional methods, practices, experiences, environmental patterns and human capability. The most sought technique comes from human intelligence that is dynamic, adaptive and robust. Nitrogen deficiency in rice plants can be determined via the color of the leaves. It is dependent on the depth of the green pigment in the color spectrum present in the leaves. Based on these characteristics, the application of computational artificial intelligence and machine vision can be adopted to create assistive technologies for agriculture. In this paper, a mobile application is developed and implemented that can be used to assist rice farmers determine nitrogen deficiency, through the leaf color in rice plants. The application can be used alternatively or together with the traditional protocol of nitrogen fertilizer management. It is mobile, simple and it also addresses some drawbacks of the human eye to distinguish color depths brought about by other factors, like sunlight, shading, humidity, temperature, etc. It utilizes image processing techniques to digitally captured images represented in numerically transformed Red, Green, and Blue color formats. The digital images are then normalized to remove the effects of illumination and then compared using the image/pixel subtraction technique with the base color images converted and extracted from the leaf color chart standard. Eventually, the application determines nitrogen deficiency and suggests the concentration and volume of fertilizer to be applied to the rice plants. Accuracy of the technique is determined by computing the Z statistic score.***

Keywords**:** ***Algorithms, image processing, fertilizer management, mobile application.***

I. INTRODUCTION

Fertilizer management is governed by processes triggered by specific events and attributes from the environment and most especially from the crop. The method is based on a standard protocol developed by researchers together with the farmers with years of tests and trials. This fertilization protocol is a tedious activity especially for the rice (*Oryza Sativa L.*) plant, it is not as easy as just throwing nutrients into the soil and everything will just be fine. There are some issues to be considered, such as applying too much fertilizer and the plant becomes succulent and susceptible to insect and disease. Too little and the plant grows poorly and unproductive. In the Philippines, majority of the farmers cultivate their farms the traditional way. These farmers apply fertilizers not only based on plant condition but also take into consideration predetermined dates after seeding or transplanting. Not following holistically the protocols established for fertilizer management, farmers suffer the consequences of bad fertilizer management, thus lesser harvest yield. Fertilizers must be applied only when necessary and based on the crops' nutritional status. However, most farmers rely on the age (days after transplanting) of the rice plant and not on its condition. Consequently, this causes a deficiency in the required nutrient of a plant from the fertilizer in terms of growth, development, and yield. Moreover, there are some unaware farmers, that applying fertilizer too soon, will result to undesirable effects on growth and yield of rice and thus have a significant addition to the production cost which is not ideal [1].

II. RELATED WORKS

There have been many developed methods of the proper application of fertilizer [2]. One of the most effective means to determine the volume and when to apply fertilizer is to use the developed Leaf Color Chart (LCC). The LCC is used to assess the plant Nitrogen (N) status. It is an inexpensive tool consisting of four (4) color shades from yellowish green to dark green. The color strips are fabricated with veins resembling those of rice leaves. The assessment will depend on the greenness of the leaf matched to the LCC window. Each window defines a level of N status. This method however, limits the capability of the human eye to distinguish from the colors given in the chart from the colors of the rice plant leaf as evidenced in the findings of the on-farm evaluation. The color matching is relative to the person's color perception so it is recommended that the same person should do the matching. The use of the LCC is also limited to a period of a day due to the effect of sunlight to the colors, both of the leaf and the chart [3], [4].

In the Philippines, the on-farm evaluation of the LCC technique has demonstrated its usefulness for real-time nitrogen management in rice. The increase in N-use efficiency was due to slightly less, same or higher yields grain, with lower levels of N application in the LCC-monitored fields. Savings in N fertilizer of -14 to +53 kg per hectare were realized in farmers' fields of other collaborating countries [5].The work of P. Sanyal and U. Bhattacharya explained that rice deficiencies in the balance of mineral levels can be identified by detecting the change in the appearance of rice leaves [6]. This work is also supported by P. Murakami et al, that changes in foliar color are a valuable indicator of plant nutrition and health.

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The leaf color is measured with visual scales and inexpensive plant color guides that are easy to use, but not quantitatively rigorous, or by employing sophisticated instrumentation including chlorophyll meters, reflectometers, and spectrophotometers that are costly and may require special training [7].

The International Rice Research Institute (IRRI), and the Department of Agriculture (DA) in the Philippines, initiated the NM Rice Mobile application. It applies the concept of Site Specific Nutrient Management (SSNM), a set of scientific principles for optimally supplying rice with essential nutrients. The LCC is covered by SSNM. Farmers dial a toll-free number and a voice response will follow which will direct them to a set of 12 to 15 questions related to the status of the rice plant. Eventually, a text message will be sent to the farmer's phone containing recommendations on fertilizer application duly customized for his field. The mobile application is available in Tagalog, Cebuano, and Ilocano dialects [8].

The paper of S. Pongnumkol, P. Chaovalit and N. Surasvadi, presented a review of the capability of smart phones to becoming a very useful tool in agriculture, mainly to their mobility that matches the nature of farming, the cost efficiency and accessibility of computing power. It systematically reviewed smart phone applications that utilize built-in sensors to agricultural solutions [9].

Similarly, the work of V. Patodkar et al, presents a developed android software application for sustainable development for farmers. The application assists the farmer in decision making regarding selection of fertilizer, pesticide and time to do particular farming actions. It combines internet and mobile communications with Global Positioning System (GPS) [10].

The system developed by Sanjana, Sivasamy, Jayanth [11] consisted of a mobile application which enables farmers to take digital images of plants using their mobile phones and send it to a central server where the central system analyzes the pictures based on visual symptoms using image processing algorithms to measure the disease type. An expert group will be available to check the status of the image analysis data and provide suggestions based on the report and their knowledge, which is then sent to the farmer as a notification in the application.

Based on the insights from these pieces of literatures, this project aims to apply digital processing techniques in a mobile application that can be used as a tool to assist rice farmers in fertilizer management of the rice plant based on the LCC framework and its guidelines.

The project intends to implement the image normalization technique as a preprocessing method and the digital image pixel subtraction technique as the processing algorithm into a mobile phone application [12]-[14].

The application is to be used in the rice paddy field as an assistive technology for rice plant farmers. It aims also to archive data sampled from the rice field to be used as baseline comparative statistics by other researchers. The framework of the study was inclined on the use of smart mobile phone technology, image processing and rice farming technologies.

III. SYSTEM ARCHITECTURE

A. Application architecture

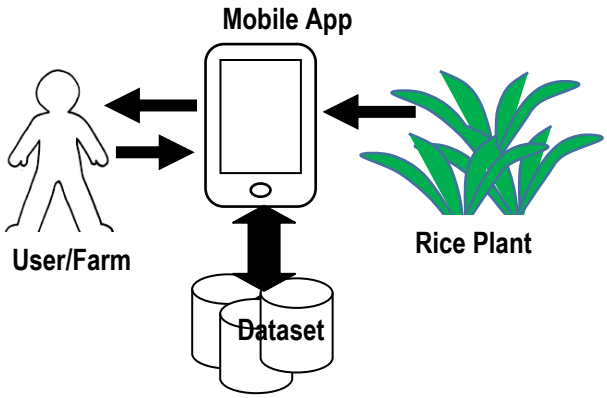


Fig. 1.A system view of the application.

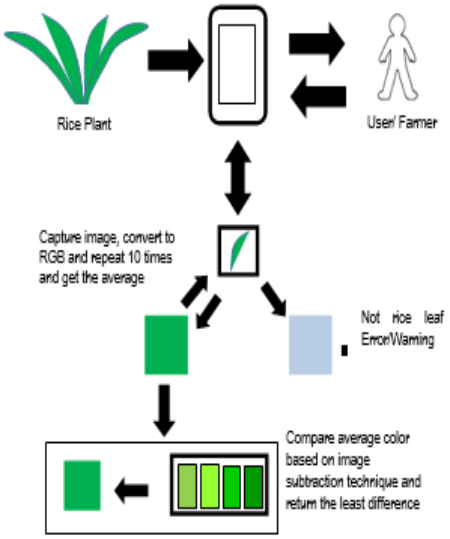
Shown in Fig. 1, is the conceptual framework of the system: the mobile phone application processes sample images of leaves taken from rice plants in the field through its built-in camera device, these images are processed and eventually references the average image against the digitized LCC dataset. This process determines the nitrogen deficiency of the rice plant. The number of samples is dependent on the size of the rice field. Ideally, more samples from a large area, the better the outcome of the mobile application. However, the LCC standard suggests that five (5) leaf samples per hectare taken randomly from the field are sufficient to represent the whole area.

The intelligence of the application relies on the digitized LCC dataset that is used as the basis in determining the nitrogen content of the captured rice plant leaf color. The whole process is integrated into the mobile application: the user launches the application and through the camera of the phone, to take samples of the rice plant leaf. The application converts the images one at a time, calculates the average of the samples and performs image comparison. The method uses the color depths of the captured image from the base image and compares it from the digitized LCC database. Subsequently, the application displays the result, suggesting the amount of fertilizer to be applied. The results are archived in the database for future reference and further study.

B. Computational processing of the application

Fig. 2 presents the computational algorithm of the mobile application. The system takes sample images of rice leaves in the rice field. These images are then processed by converting it to its equivalent Red, Green, Blue (RGB) formats. By subtracting the average value of the sample images from the value of the baseline LCC images present in the application, consequently, a resulting near accurate color value is returned. If the sample images are out the range, then the user is alerted that the image is not a rice leaf. The same procedure is done until the captured image is valid. While the application captures the images, it also records the ten greenness values of the rice leaves.

The average greenness values of the ten images are also stored. The average greenness value of the sample images is then subtracted from the baseline values per window of the digitized LCC. After this process, the indicative result based on the interpretation of the greenness value is displayed. Included in the indicative result is the fertilizer recommendation accordingly to the specified window.



The average computed color equivalent is subtracted from the baseline LCC colors and returns the least difference among the four baseline LCC colors.

Average color matrix

123	124	125	126	127
128	129	130	131	132
133	134	135	136	137
138	139	140	141	142
143	144	145	146	147

–

Base LCC Colors

123	124	125	126	127
128	129	130	131	132
133	134	135	136	137
138	139	140	141	142
143	144	144	145	147

Fig. 2. Processing mechanism of the mobile application.

The RGB color space of the captured bitmap image is used as the numerical representation of the image. The RGB data value of each pixel's color sample has three numerical values to represent the colors Red, Green, and Blue. These three RGB components are three 8-bit numbers for each pixel. Each 8-bit RGB component can have 256 possible values, ranging from 0 to 255.

To get the area of concern from the image, the height and width of the bitmap is first calculated, which is denoted by:

$$Z = (0...x, 0...y) \quad (1)$$

Where:
Z = bitmap image
x = x coordinate plane
y = y coordinate plane

The color value of each pixel is represented in (2) denoted by:

$$P_{(x,\,y)} = (R, G, B) \quad (2)$$

Where:

$P_{(x,\,y)}$ = pixel in the x and y coordinate plane
(R,G,B) = (0...255, 0...255, 0...255)

Color normalization is also applied to the pixels to reduce the effects of light. Normalization of the color space of the image removes highlighted regions and shadows this makes it easier to detect the color of the leaf. Based on equation (2), the normalization method is presented below:

$$Total = (R + G + B) \quad (3)$$

$$R' = round((R / Total) * 255) \quad (4)$$

$$G' = round((G / Total) * 255) \quad (5)$$

$$B' = round((B / Total) * 255) \quad (6)$$

Thus, the normalized images are denoted by the equation in (7):

$$P1 \mid 2_{(x.y)} = (R', G', B') \quad (7)$$

The pixel subtraction technique is as simple as taking two images as input parameters, this mechanism produces a third image whose pixel values are simply the difference of the corresponding pixel values from the two images. It is also often possible to just use a single image as input and subtract a constant value from all the pixels. Some versions of this technique produce the absolute difference between pixel values, rather than the straightforward signed output.

The subtraction of two images can be performed straightforwardly in a single pass using the formula in equation (8).

$$[Q_{(i,\,j)} = P1_{(i,\,j)} - P2_{(i,\,j)}] \quad (8)$$

Where :
Q = the output value
P1 = the first image value
P2 = second image value

Or the absolute differences between the two input images can be computed from equation (9).

$$[Q_{(i,\,j)} = \mid P1_{(i,\,j)} - P2_{(i,\,j)} \mid] \quad (9)$$

Or simply subtract a constant value C from a single image if desired using the formula in equation (10):

$$[Q_{(i,\,j)} = P1_{(i,\,j)} - C] \quad (10)$$

Where:
P1 = first image value
C = baseline image value

The green (G) color component value in a pixel is simply extracted separately to produce the nearest output value.

IV. RESULTS

A. Detection Testing

Tests were conducted on the premise that the algorithm may result and interpret colors from other leaves other than of the rice leaf. Thus, a mechanism was integrated to accurately identify whether the captured image is that of a rice leaf.
Shown in Fig. 3, is the result after capturing thru the mobile phone camera the rice leaf. The image presents the confirmation of the object being a rice leaf which does not display warning or notification of an error. The application converts the image and saves it in RGB format

Fig. 3. Correct rice leaf image.

Fig. 4 and Fig. 5 shows the status screen of the mobile application when a different leaf or an object with the same color of a rice leaf is captured. It is capable of determining that the image taken is not a rice leaf, resulting in the notification display of an error-warning to the user. Not only the difference in color but also the difference between the two objects can be detected, even though the object captured has a similar color with a rice leaf. Fig. 6 shows the indicative results when the application correctly determines the captured image that is of a rice leaf. Consequently, the result of the detection process is displayed. In this case, the leaf is in category 4 of the LCC, which means the plant requires a certain amount of fertilizer. The application will also display the required volume of the fertilizer that should be applied in the rice field.

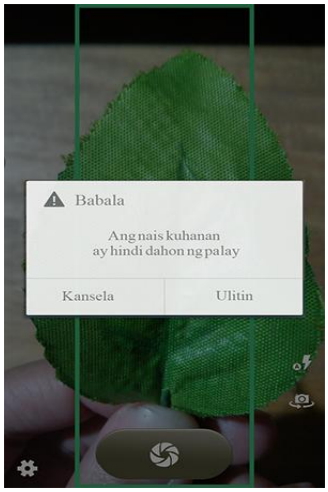


Fig. 4.Error detection warning for a different leaf with similar color.

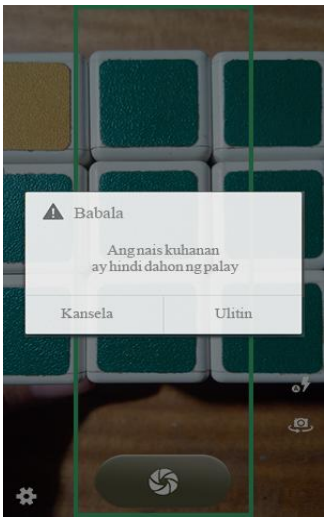


Fig. 5.Error detection warning for a different object with a green color.

Fig. 6.The indicative result when fertilizer deficiency is detected from the rice leaf.

Fig. 7.The indicative result when rice the plant is not fertilizer deficient.

Fig. 7 shows the result when the processed data from the captured image is within category 5 of the LCC, which means, not fertilizer deficient. The application will display a notification to the user that there is no need for fertilizer to be applied to the rice field.

B. Actual Field Test Results

The test data were gathered from the five (5) week actual field testing. The process was synchronized with the growth stages of the rice plant, to get the real colors of the rice plant throughout its different growth stages. The Z-test statistic was used to verify and validate the hypothesis that the developed mobile application using the image subtraction technique does not have a significant difference with the traditional LCC.

The field test consisted of a rice field of approximately three hectares. The area was divided equally into three zones (Area 1, Area 2 and Area 3) due to the geographical contours and for an equal number of samples per area sampled. Thirty (30) leaf sample pictures were taken from each area randomly, these thirty samples were also divided into three (3), so that ten (10) leaf samples for each strip one area, for a total of ninety (90) leaf samples each week.

The field test was done from the vegetation and milking stages of the rice plant, giving a total of 450 leaf samples, with an average of 45 samples. During the field tests, the researchers also synchronized the use of the traditional LCC. This was done so that readings are consistent with the LCC due to the leaf's condition for a short time. This is to lessen the effect of other factors like sunlight, moisture, wind, temperature, shading, etc.

Table- 1: The success rates of the system in the field test

Week	Area 1			Area 2			Area 3		
	a	*b*	*c*	*a*	*b*	*C*	*a*	*b*	*c*
1	6	6	6	8	8	8	6	6	6
2	6	6	6	8	8	8	6	6	6
3	6	6	6	8	8	8	6	6	6
4	7	7	7	7	7	8	9	7	9
5	7	7	7	8	8	8	9	7	10

[a] *$n = 45$ $\bar{x} = 7.08$ $\sigma = 0.03$

Table 1, shows the success rates readings of the mobile application in comparison to the LCC. The study assumed that the null hypothesis is equal to, Ho = 5, which is the mean success rate of the mobile application and the alternate hypothesis is greater than H1 > 5. To test the hypotheses if the application has no significant difference between the traditional LCC, the z-test statistics is employed.

To compute for the z-test statistic the formula in equation (11) is used. The alpha level considered by defaults is 5% (0.05). The rejection region area in the z-table is 0.05, which is equal to a z-score of 1.645.

$$Z = \frac{\bar{X} - \mu_0}{\sigma / \sqrt{n}} \tag{11}$$

Where:

Z = the test statistic, $\bar{x}$ = mean score, σ = standard deviation, n = population, sample, and μ_0 = null hypothesis

Continuing with the computation, the equation is used straightforward. The Z statistic value is then derived in (12):

$$Z = \frac{7.08 - 5.0}{0.03 / \sqrt{45}} = 1.033 \tag{12}$$

Comparing the computed Z-statistic test result score of 1.033 with the z score of 1.645, it shows that the computed Z statistic test score is less than the Z score prescribed in the Z table. This suggests that the null hypothesis is not rejected. Further, the results imply that using the mobile application can be an effective assistive technology for rice farmers and as efficient as the LCC. The accurateness of the system is assured as it has been proven thru statistical analysis that the mobile application does provide significant and similar results compare to the traditional LCC.

V. CONCLUSION

A mobile application was developed and the proposed method was successfully implemented. The results of the field experiment demonstrated that machine vision can be a tool to assist farmers in detecting the level of nitrogen deficiency of rice plant, by implementing image processing techniques as the mechanism. Specifically, the intelligence of the developed system is the application of the image or pixel subtraction algorithm. By using digitally captured bitmap images with their corresponding RGB numerical formats. This technique was proven to be easily executed as a function in the application, using an android based smart phone.

Field test results suggested that the developed mobile application is comparable to the traditional LCC standard. Meaning, they are complementary with each other or can be used individually without a significant difference in their outputs. Similarly, the statistical test result also implies that machine vision can be used as an assistive technology to rice farmers, specific to the detection of nitrogen deficiency of rice plants presented in this study. The implemented detection algorithm for nitrogen deficiency is accurate and efficient. Future endeavors to include other variables like temperature, time of the day, and age of the plant may be considered for the improvement of the application. To cover a larger area and for faster acquisition of images, an unmanned aerial vehicle is also being considered.

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Hydroponics Reservoir Temperature Monitoring and Controlling System under Greenhouse Condition

Amy Lizbeth J. Rico

Abstract: ***An automated reservoir temperature monitoring and controlling system for hydroponic system was developed, calibrated and validated in this study. The automated monitoring and controlling system was developed to monitor and control the reservoir temperature of nutrient solution in hydroponic system. The greenhouse available at the Center for Hydroponics and Aquaponics Technology (CHAT) and locally available materials and hardware for the hydroponics and automation were used in the development of the system. These devices were designed and assembled based on the conceptual framework of the study. The reservoir temperature sensor sends signal to the microcontroller which triggers the turning on/off of water chiller and the mixer. The instruments used were calibrated prior to the performance evaluation and obtained calibration equation for the water temperature sensor is y = x + 0.37. Validation of the automated reservoir temperature monitoring and controlling system was done and the recorded maximum temperature is 31 °C and the minimum temperature is 24 °C. The lettuce planted during the validation has an average height of 14.61 cm and the average leaf count of 12 for the lettuce crops during the 4th week after planting. A total of 4.78 kg of lettuce crop was harvested with an average of 20.6 grams per lettuce crop was obtained. Based on the performance evaluation and validation done on the automated reservoir temperature monitoring and controlling system, it was found to be reliable. This system becomes useful in reducing labor cost, and allows for real-time monitoring of reservoir temperature, therefore increasing farmers' crop productivity and income.***

Index Terms: automation, greenhouse, hydroponics, reservoir temperature, sensor

I. INTRODUCTION

In the present scenario, almost everything can be controlled and operated automatically, but there are still a few important sectors in our country where automation has not been adopted or not been put to a full-fledged use, perhaps because of several reasons such as cost. Agriculture has been one of the primary occupations of man since early civilizations and even today manual interventions in farming are inevitable. Without automation in hydroponics, many growers spend approximately 15-30 minutes a day testing and correcting the system levels. This means that beginning growers will often spend more time on testing parameters until the farmers familiarize themselves with the nutrient levels needed. Also, farmers tend to over-correct one or two of the variables. The automated reservoir temperature monitoring and controlling system keeps the system levels stable and provides the optimal environment for the plants which results to bigger and healthier plants.

Hence, this study is conceptualized to develop an automated system by monitoring the reservoir temperature of the nutrient solution in a hydroponic system for optimum plant growth as this factor can greatly affect the growth of lettuce. Specifically, the study aimed to; (1) install an automated reservoir temperature monitoring and controlling mechanism for the nutrient solution, (2) evaluate the performance of the automated monitoring and controlling device, and (3) determine the response of lettuce on the automated monitoring and controlling device

II. MATERIAL AND METHODS

A. Conceptualization of the Study

The conceptual paradigm of the study is presented in Figure 1. The study aimed to monitor and control the reservoir temperature of the nutrient solution using hydroponic system under greenhouse condition. Through this process, time and labor can be saved as well as real time monitoring of the parameters can be achieved.

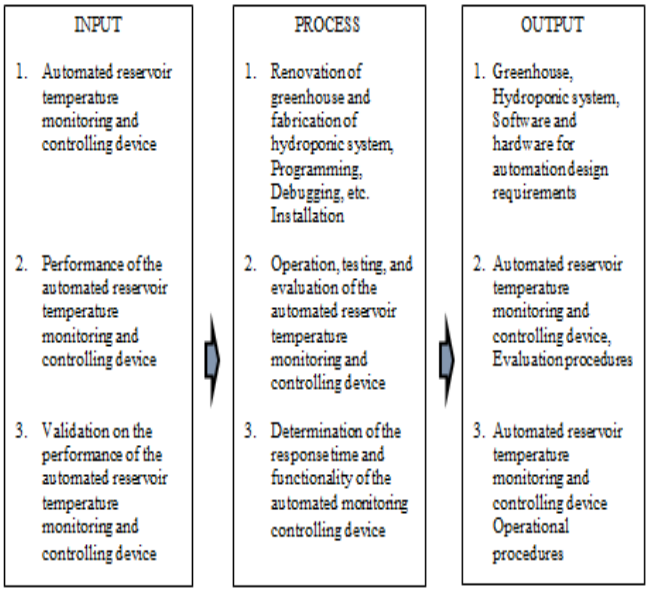

Figure 1. Conceptual framework of the study.

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B. The Production System

The automated hydroponic system used in the study is composed of the structural system, the hydroponic system, and the automation system.The automated reservoir temperature monitoring and controlling was tested in one of the greenhouse facilities located at the Center for Hydroponics and Aquaponics Technology (CHAT) measuring 3.0 meters in width, 4.0 meters in length, and 3.5 in meters height. The frames of the greenhouse are made from 2.54 cm galvanized iron pipes bended and welded together to form a Quonset-type structure. The structure is provided with three roof covers: the insect-proof net in the inner side, the ultraviolet- resistant plastic film in the middle and the gravy woven net shade on the outer side that offers strength and improve aerodynamics to withstand strong wind gust and heavy rains. The available water supply and power supply was used in the operation of the hydroponics system.

The recirculating tube culture system was used in hydroponic system. The hydroponic system was enclosed in the structural system. The grow pipes used was 300.0 cm in length and 0.075 cm diameter. A slope of 1 cm/100 cm of the pipe length was employed for the water to flow through the pipe with ease. The PVC pipes were drilled with 5.08 cm diameter holes and were spaced at 16.5 cm between holes (center to center) and made in 2-layer and 4-column pipe layout. A 150 L reservoir served as the source of water in the hydroponics system where the water was pumped to each growing tubes. The water flow in the hydroponic system was run by a 65-watt submersible pump, 1-2 liters/min flow for each growing tube that lifts the water to the upper layer of the growing tubes. A mixer inside the reservoir was installed to equally dispense the nutrient solution to the reservoir water.

Figure 2 shows the set-up of the automated pH monitoring and controlling device. The automation system served as the main component of the study and was composed of the controls, sensors, and hardware.

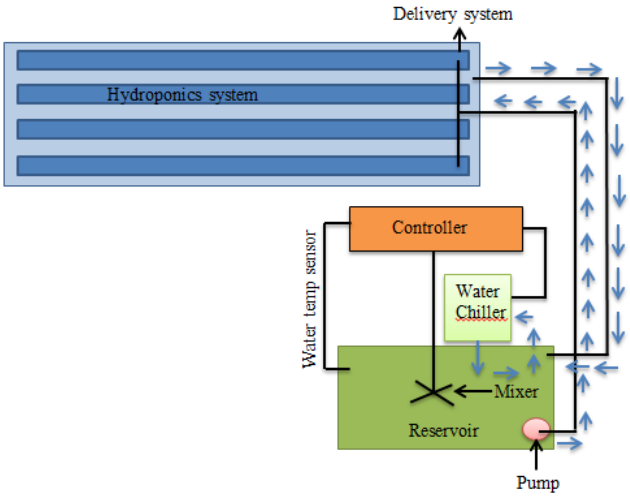

Figure 2. Set-up of the automated reservoir temperature monitoring and controlling device

C. Automation of the Reservoir Temperature Monitoring and Controlling Device

The automated reservoir temperature monitoring and controlling device basically monitor and control the temperature of the nutrient solution in a hydroponic system under greenhouse condition. Sensors were used to determine the reservoir temperature in the reservoir. The block diagram shown in Figure 3 is the layout of the hardware design that was used for the automated monitoring and controlling device. A microcontroller using the Arduino platform was used in programming the automation of the reservoir temperature monitoring and controlling device. Using this data, the microcontroller adjusts the temperature of the water in the system by turning on the mixer and the water chiller

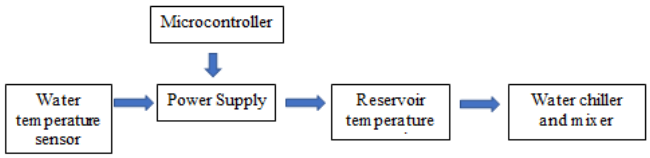

Figure 3. Block diagram of the automated reservoir temperature monitoring and controlling system

Shown in Figure 4 is the flow diagram of the automation used in the study. The LCD is initialized when the automation system is turned on. The reservoir temperature range of 24ºC - 30ºC for the nutrient solution was entered in the system. These ranges determine when the chiller and the mixer will be turned on. and determined using the water temperature sensor submersed into the reservoir. If the reservoir temperature reading is above 30ºC , the sensor sends signal to the microcontroller to trigger the chiller and the mixer to turn on. When the entered reservoir temperature range is attained, the sensors send signal the microcontroller to turn off the chiller and the mixer.

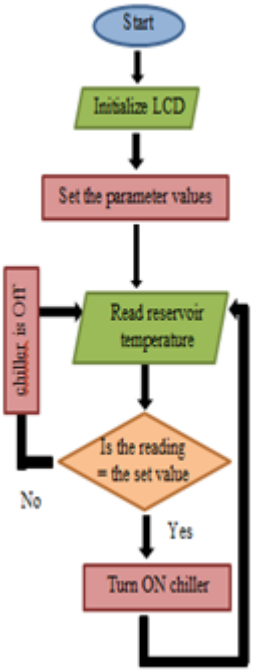

Figure 4. Flow diagram of the automated system

D. Calibration of the Water Temperature Sensor

The water temperature sensor was calibrated in order to achieve precision and accuracy.

The hourly reading for 24-hour period in the sensor was compared with the reading from the calibrated instruments. The difference in reading from the sensor and the calibrated instrument were recorded and graphed. Linear regression of the sensor reading and the calibrated instruments was obtained. The equation from the linear regression was inputted into the program for the water temperature sensor.

E. Final Testing

The reservoir temperature was monitored every day based on their response to the whole system. Automatic turning on of the device when the parameters are beyond the threshold range, response time of the device to be able to attain the threshold range, and automatic turning off of the devices when threshold range is attained were among the data gathered and recorded.

F. Lettuce Production

The leafy variety of lettuce (*Lollo rossa*) was used as planting material in the automated hydroponics system as this is commonly used as planting material in hydroponics system. Media composed of carbonized rice hull, sand and rice hull was used as planting media in the automated hydroponics system since these contain most nutrients needed by the plants. The planting cups containing 2-3 lettuce seeds were placed in cups. The cups were placed on individual cut-outs of the growing tubes. The net cups should touch the flowing water in the growing tubes to avoid the plants to be dehydrated. The pump continuously lifts the water and nutrient solution allowing the roots to avail of the nutrients. The reservoir temperature level of the nutrient solution was maintained at a range of 24ºC - 30ºC level which is the recommended reservoir temperature level for lettuce production under hydroponics system. At this reservoir temperature level, the needed nutrients were made available to the lettuce plants. These parameters were maintained throughout the growing stage until harvesting stage of the lettuce. The lettuce was harvested 27 days after planting.

G. Validation

Validation refers to the process of checking that a system meets the specifications and that it fulfils its intended purpose. In the automated hydroponics system, the data gathered from the final testing was analysed and graphed. The automation system was modified to optimize the production system based on the data gathered. Another growing cycle of the lettuce was planted in the automated hydroponics system. Response of the system was monitored from planting to harvesting of the lettuce. The gathered data during validation was compared from the gathered data from the final testing. The differences from the two growing cycle and their relationship was obtained.

III. RESULTS AND DISCUSSION

The microcontroller used in the automated hydroponics system is Arduino Mega 2560 which served as the brain of the system and served as the trigger. It also processes the sensor data. Most of the parts were connected to the Arduino using simple jumper wires and the wires were soldered to ensure that they would not get loose. All of the electronic parts were then placed into plastic enclosure to protect delicate electronic parts from dust and moisture.

A. Installation of the Automated Reservoir Temperature Monitoring and Controlling System for Nutrient Solution

The microcontroller used in the automated hydroponics system is Arduino Mega 2560 which served as the brain of the system and served as the trigger. It also processes the sensor data. Most of the parts were connected to the Arduino using simple jumper wires and the wires were soldered to ensure that they would not get loose. All of the electronic parts were then placed into plastic enclosure (Figure 5) to protect delicate electronic parts from dust and moisture.

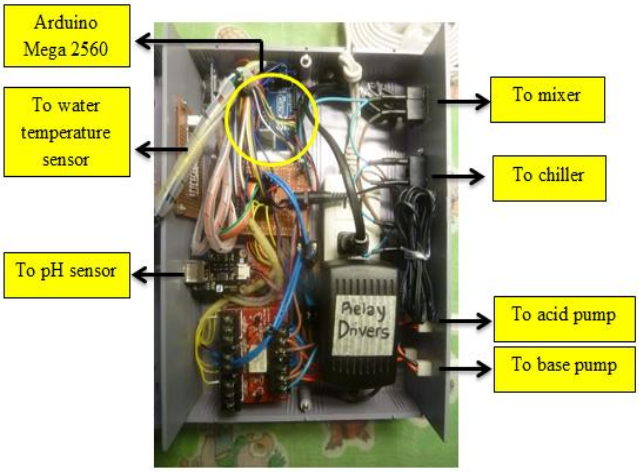

Figure 5. Electronic parts used in the automated hydroponic system

B. Water Temperature Sensor

The DS18B20 water temperature sensor shown in Figure 6 was used to determine the temperature of the reservoir in the hydroponics systems. The water temperature sensor was submerged to the reservoir and sends trigger signals to the microcontroller to activate the chiller thermostat and the mixer in the reservoir.

Figure 6. The water temperature sensor used in the study

C. Calibration of the pH Monitoring and Controlling System

Calibration of the reservoir temperature sensor used was done at the Center for Hydroponics and Aquaponics Technology in a 24-hour period before the data gathering. The reading from the sensor and calibrated instrument was obtained, recorded and graphed.

The graph of the calibration for the reservoir temperature sensor is shown in Figure 7. The graphs show linear relationship between the sensor reading and the instrument reading which also obtained an r^2 of 0.84. Based on the data gathered, the calibration equation for the reservoir temperature is $y = x + 0.37$. This equation was inputted in the program for the automation of the hydroponics system.

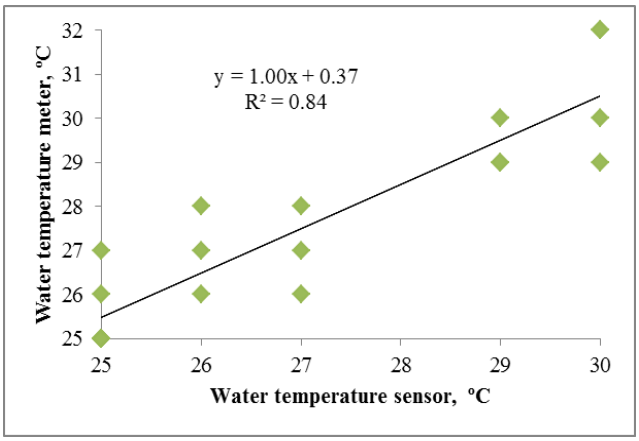

Figure 7. Calibration curve for water temperature sensor

D. Performance Evaluation

Based on the results, the obtained maximum reservoir temperature is 31ºC and minimum is 22ºC. The ability of the system to respond to the set threshold level, the response time of the system to the parameters, and the difference from the calibrated instrument were observed to be able to determine the reliability of the automated hydroponics system. Results showed that turning on of the chiller and mixer when the reading is beyond the threshold range is attained immediately after the reading is beyond the set value in the hydroponics system.

E. Validation of the Automated Reservoir Temperature Monitoring and Controlling System

During the validation period, the system was observed based on the criteria set for the reservoir temperature of the nutrient solution. Based on the results, the reservoir temperature reading and responses were accepted during the validation. Similar performance of the system during the validation and during the performance evaluation was observed. During the validation of the automated temperature monitoring and controlling system, the growth and number of leaves of the lettuce (test crop) were gathered and recorded weekly and the yield of the lettuce was obtained during harvesting. The lettuce crops obtained a total yield of 4.78 kg and an average of 20.6 grams per crop.

IV. CONCLUSIONS

Based on the objectives, the following conclusions were drawn:

1. the installed automated reservoir temperature controller was able to maintain the desired condition for the hydroponic system;
2. based on the observed successes and failures in monitoring the reservoir temperature, the performance of the developed automated reservoir temperature controller was found to be reliable, and;
3. the automated reservoir temperature controlling and monitoring device was able to grow lettuce with yield and responses similar to normal growing conditions.

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AUTHORS PROFILE

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