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Marketability of Nano-Fertilizers Among Local Farmers

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Abstract:

This study analyzed the marketability of nano-fertilizer among local farmers in the Province of Iloilo for the Calendar Year 2023. Quantitative data for this study was gathered from one hundred twenty (120) local farmer-respondents using a self-made questionnaire by the researcher that passed the validity and reliability testing. The variables included in this study are hectarage, location, kind of crops, number of years in farming, and net income per cropping. The study is divided into four (4) areas, namely, product, price, place, and promotion. The study results revealed that the overall level of marketability of nano fertilizers among local farmers in the areas of product, price, place, and promotion were all very high. There was a significant difference in the level of marketability of nano-fertilizers among local farmers in the areas of product when the respondents were grouped and compared according to the variables of hectarage, kind of crops, and number of years in farming. There was a significant difference in the level of marketability of nano fertilizers among local farmers in the area of price when the respondents were grouped and compared according to variables hectarage, location, number of years in farming, and net income per cropping. There was a significant difference in the level of marketability of nano-fertilizers among local farmers in the area of place when the respondents were grouped and compared according to the variables hectarage, number of years in farming, and net income per cropping. There was a significant difference in the level of marketability of nano-fertilizers among local farmers in the area of promotion when the respondents were grouped and compared according to the variables hectarage and net income per cropping.

Keywords: (nano-fertilizer, product, place, price, promotion)

Introduction:

Nature of the Problem

The widespread use of fertilizers is a result of the increased global demand for food. The commonly used chemical fertilizers may increase plant growth and output, but they have deleterious effects on the soil, the environment, and even human health. Therefore, nano-fertilizers are one of the most promising solutions or substitutes for conventional fertilizers. These engineered materials are composed of nanoparticles containing macro and micronutrients that are delivered to the plant rhizosphere in a regulated manner (Nongbet et al., 2022).Nanotechnology for the management of crops is used as an essential technology for enhancing crop productivity. Nanomaterials and nanostructures, such as carbon nanotubes, nanofibers, and quantum dots, are now exploited in agriculture research as biosensors for evaluating the quality of soil and fertilizer distribution. The purpose of nanoparticles is to minimize the spread of chemicals amount, reduce nutrient loss during fertilization, and increase the quality and yield with proper nutrients (Sangeetha et al., 2021).

The adoption of nanotechnology-based fertilizers in Iloilo Province has the potential to transform the local agricultural landscape by increasing productivity, reducing environmental impact, and contributing to sustainable agriculture. However, before widespread implementation, it is essential to conduct a comprehensive feasibility study to assess various aspects of nano-fertilizer use, including technical, economic, regulatory, environmental, and social considerations. Several intergovernmental organizations consider the long-term goal of developing sustainable food systems a high priority. Different agricultural management systems may impact the sustainability of food systems, as they may affect human health, animal well-being, food security, and environmental

sustainability. Natural agriculture presents an alternative way of farming that is perceived by many as a safer, better, farmer-friendly production system (Digal-and Placencia, 2019).

Despite the efforts of the Philippine government to promote organic agriculture, particularly rice, its rate of adoption still needs to grow. Factors that hindered the utilization of organic rice production practices were farmers' perceptions that yield declined with their use and that organic production practices were more laborious and time-consuming than conventional practices (Blanquita et al., 2016). Traditional agricultural practices often rely on conventional fertilizers, which may have limitations in terms of nutrient delivery, environmental impact, and efficiency. Nanotechnology offers a promising avenue to address these challenges by developing fertilizers at the nanoscale. These nano-fertilizers can enhance nutrient uptake, reduce nutrient loss, and improve overall crop yield and quality.Since this is the researcher's current line of business, this study will be helpful in gaining a deeper understanding of the technology. The idea of the use of these fertilizers started way back in 2019 and was materialized in 2020. Ever since, it has been helping a lot of farmers in the province. The researcher is an importer and national distributor of "Nutriboost Nano Plus Smart Fertilizer" in the country. Farmers nowadays focus on using new innovations and technologies for the enhancement of crop production. This is where our nano-fertilizer came to be and will also serve as the farmers' new best friend.

Current State of Knowledge

The development of cost-efficient and high-performing pesticides that are less harmful to the environment is critical. The new concepts of nanotechnology offer advantages to pesticides, like reducing their toxicity, improving the shelf-life, and increasing the solubility of poorly water-soluble pesticides, all of which could have positive effects on the environment (Mali et al., 2020; Worrall et al., 2018). This nanotechnology has revolutionized almost every aspect of our lives, especially in agriculture. Introducing nanofertilizer technology in agriculture can transform how we grow our crops and increase yields while minimizing environmental impact. Nanofertilizers can increase agricultural profits while lessening the environmental destruction caused by conventional fertilizers (Yadav et al., 2023).

Nanofertilizers, according to Sivarethinamohan and Sujatha (2021), were used for the growth and improvement of different crops, for example, nanoparticles of ZnO for chickpea, silicon dioxide and iron slag powder for maize, colloidal silica and NPK for tomato, TiO2 for spinach, gold, and sulfur fertilizers were used for the growth of grapes.The paper of Patel (2021) encourages farmers to return to organic farming while increasing crop yield and decreasing crop water requirements. Nanomaterials and different bio fertilizers were used to nurture the groundnut crop. Using these nano-organic products results in a 17-20% increase in overall production, and the cost-benefit ratio is 1.98, which is very effective compared to traditional inorganic farming.The pricing strategy of agricultural products causes the product demand and purchasing behavior of consumers. It also affects the income distribution of node enterprises and the overall profit of the agricultural supply chain as well (Wang et al., 2022).

Uniform pricing is a pricing strategy that sets a unified price for all products in the store or all products in the same category, and it has become increasingly popular over the past decades. Scare attention has been paid to investigating its impact on consumer behavior (Zeng et al., 2023). Price plays an essential role in the economy. They help to facilitate the distribution of goods and services to people who want them when these prices are allowed to change naturally without intervention. Price can also be seen as a measure of a product's value, insofar as people are willing to pay a certain monetary amount to buy it (Montevirgen, 2024).The product must be appropriately accessible to the target customers. This includes decisions on distribution channels and logistics (Ridge, 2023).

Tesoriero's (2022) article states that place signifies the way a product reaches the end consumer. Conventionally, it has referred to distributors, wholesalers, and retailers. Place as part of the marketing mix encompasses the complete process of taking a product from the manufacturer and making it accessible to the consumer, which can include all mediators and distributors. This can include in-person and online places, such as storefronts and websites (Herrity et al., 2023).

According to Ridge (2022), communication efforts must effectively convey the product's benefits and value proposition to entice and engage potential customers. According to Kotler, market segmentation is the practice of subdividing a market into distinct subsets of customers with common needs or characteristics. Brand recognition helps the customer identify the company and its products and services (Washington, 2022). The prospective use of nanoscale agrochemicals such as nano-fertilizers, nano-sensors, nano-pesticides, and nano-formulations in agriculture has transformed traditional agro-practices more sustainable and efficient. Multiple applications of nanotechnology exist in agriculture, including wastewater treatment, reducing the quality of polluted soil, and enhancing the output of crops via security in terms of sensors to detect pathogens (Singh et al., 2021).

There are potential uses of nanotechnology in all extents of the food industry, and it is capable of altering the taste and color of food according to the dietary requirements of the consumer. Thus, it is a requirement to enhance consumer understanding and approval of novel nano-based food and agricultural goods (Gondal and Tayyiba,

2022).The agricultural sector deals with enormous challenges such as rapid climatic changes, a decrease in soil fertility, macro and micronutrient deficiency, overuse of chemical fertilizers and pesticides, and heavy metal presence in the soil. Nanotechnology has vast contributions to sustainable agriculture by enhancing crop production, restoring and improving soil quality. It is applied in various aspects of agriculture such as nano-pesticide delivery, slow and controlled release of nanoparticles containing biofertilizers, transport of genetic materials for crop development, application of nano biosensors for rapid detection of phytopathogen and other biotic and abiotic stresses (Bose, 2021).

Theoretical Underpinnings

This study was anchored in Philip Kotler's marketing theory. Known to many as the "Father of Modern Marketing," Kotler's insights and principles continue to shape the strategies and philosophies of businesses worldwide. Kotler posits that understanding the customer's needs, desires, and behaviors is paramount. It's not merely about selling products or services but crafting experiences and solutions that resonate with the customer's personal narrative and aspirations. Kotler emphasizes the importance of value creation, underscoring that marketing is an exchange where both parties should benefit. One cannot discuss Kotler's principles without mentioning the marketing mix of the "Four Ps" – Product, Price, Place, and Promotion. These components must be carefully calibrated to meet the target market's unique characteristics. In embracing the principles mentioned, one gains more than just a set of rules; they gain a philosophical framework that champions adaptability, innovation, and a relentless focus on the customer experience (Ridge, 2023).

The findings of this study helped the researcher learn not just what the customers want but how successful the business would be by reaching and connecting with them. It also helped identify whatever problems and opportunities are available, refine the systems, and evaluate the marketing strategy. Also, the researcher was able to know the significance of agricultural concepts, how it has become an essential part of human civilization, be able to understand food production and management, and that further agricultural research can lead to new innovations, practices, and tools that help farmers produce more food.

Objectives of the Study

This study aimed to determine the level of marketability of nano-fertilizers among local farmers of a Province in Panay Island in Central Philippines for the Calendar Year 2024.

Research Methodology:

Research Design

This study utilized the descriptive research design, which is believed to be appropriate in measuring the level of marketability of nano-fertilizers among local farmers and whether a significant difference exists when grouped and compared according to the variables, hectarage, location, kind of crops, number of years in farming and net income per cropping.

Respondents of the Study

The study's respondents were 120 farmers of a Province in Panay Island in Central Philippines. Purposive sampling was used. Purposive sampling is a form of non-probability sampling in which researchers rely on their own judgment when choosing members of population to participate in the study. Researchers use purposive sampling when they want to access a particular subset of people, as all participants of a survey are selected because they fit a particular profile (Ames et al., 2019).

Instruments

A survey questionnaire was used in gathering the data to determine the level of marketability of nano-fertilizers among local farmers where it was subjected to validity (4.85=excellent) and reliability (0.898=good). The questionnaire was divided into two parts wherein part I deals with the profile of respondents in terms of hectarage, location, kind of crops, number of years in farming and net income per cropping. Part 2 contained the questionnaire proper consisting of 32 items. There were 8 line items per area. The respondents were asked to rate each item using the five-point Likert scale, which contains the following scores: 5 – Always; 4 – Often; 3 – Sometimes; 2 – Rarely; and 1 – Almost Never.

Procedure

After establishing the validity and reliability of the instruments, the researcher administered the questionnaire to the respondents and gave instructions on how to complete the questionnaire objectively and honestly. The survey questionnaire was printed and distributed to the respondents. After answering, their responses were saved,

retrieved, compiled, and then tabulated using statistical software. Using the proper statistical methods, the data acquired from the respondents' responses were tallied and tabulated. The raw data were translated into numerical ratings. The data were presented in tabular presentations, statistical derivations, and computer processing systems. The data were processed, and various statistical data were generated.

Analysis

A descriptive-analytical scheme was used to determine the level of marketability of nano-fertilizers among local farmers with mean as the tool, while comparative analytical scheme was used to test the significant difference in the level of marketability of nano-fertilizers among local farmers when grouped and compared according to the variables, hectarage, location, kind of crops, number of years in farming and net income per cropping with Mann-Whitney U test as the tool. Finally, the following rating scale and description was utilized in interpreting the results: 4.50-5.00=Very High Level; 3.50-4.49=High Level; 2.50-3.49=Moderate Level; 1.50-2.49=Low Level; 1.00-1.49=Very Low Level.

Ethical Consideration

The researcher ensures that respondents were given the free will to be involved in the study, their identity were not disclosed and they were assured of the confidentiality of the data gathered. After completion, all data stored in electronic gadgets were discarded in order to protect against unauthorized access or use of information. This research paper strived in earnest to minimize the risk of harm to its target respondents by assuring them of the confidentiality of their responses and protecting their anonymity throughout the entire research process. At the onset, this researcher secured their free, prior informed consent and assured them of their right to withdraw from their research participation if deemed necessary.

Data Analysis and Statistical Treatment

The analysis of the data gathered employed the descriptive analytical scheme and comparative analytical scheme.

Objective No. 1 used the descriptive analytical scheme to determine the respondent's demographic profile in terms of hectarage, location, kind of crops, number of years in farming, and net income per cropping.

Objective No. 2 used the descriptive analytical scheme to determine the level of marketability of nano-fertilizers among local farmers in the areas of product, price, place, and promotion.

Objective No. 3 used the comparative analytical scheme to determine if there is a significant difference in the level of marketability of nano-fertilizer among local farmers to when grouped and compared according to variables.

Statistical Tools

The following statistical tools were used to analyze the gathered data.

Objective No. 1 used frequency and percentage count in determining the profile of the respondents in terms of hectarage, location, kind of crops, number of years in farming, and net income per cropping. A frequency distribution is an overview of all the distinct values in some variable and the number of times they occur. It speaks of how frequencies are distributed over values. Frequency distributions are mostly used for summarizing categorical variables (Van den Berg, 2022). The percentage is computed to determine the proportion of part to a whole, such as a given number of respondents about the entire population. It is dividing the target demographic by the entire population, then multiplying the result by 100 to convert it to a percentage, said Maloney (2020).

Objective No. 2 used the mean to determine the level of marketability of nano-fertilizer among local farmers in the areas of product, price, place, and promotion. The mean, or average, is calculated by adding the scores and dividing the total by the number of scores. It is the arithmetic average of a set of given numbers (Cherry, 2020).
In interpreting the mean score range, the following were used:

Mean Score Range	Verbal Interpretation
4.50 – 5.00	Very High level
3.50 – 4.49	High level
2.50 – 3.49	Moderate level
1.50 – 2.49	Low level
1.00 – 1.49	Very low level

Objective No. 3 used the Mann-Whitney U test to determine if there is a significant difference in the level of marketability of nano-fertilizers among local farmers when grouped and compared according to variables.

The Mann-Whitney U test measures the differences between the two independent groups when the dependent variable is ordinal or continuous but not normally distributed. Although it is not always the case, it is

usually the non-parametric alternative to independent t-testing. This test allows the researcher to draw different conclusions about the data depending on the assumptions made about the data's distribution. These conclusions can range from simply stating whether the two populations differ to determining if there are differences in medians between groups (Lund et al., 2020).

The computed p-value was interpreted utilizing the following approach: Reject the null hypothesis if the p-value is less than or equal to 0.05 level of significance. Accept null hypothesis if p-value is greater than 0.05 level of significance.

Results and Discussion

This section presents the results pertaining to the objectives of the study.

Profile of the respondents in terms of Hectarage, Location, Kind of Crops, Number of Years in Farming, and Net Income per Cropping

Table 1
Profile of Respondents

Variables	Categories	Frequency	Percentage
Hectarage	Small (below 2.260 Hectares)	70	58.30
	Large (2.260 Hectares and above)	50	41.70
	Total	**120**	**100**
Location	Lowland	90	75.00
	Upland	30	25.00
	Total	**120**	**100**
Kinds of Crops	Rice	69	57.5
	Other Crops	51	42.5
	Total	**120**	**100**
Number of Years in Farming	Shorter (less than 25 years)	58	48.3
	Longer (25 years and more)	62	51.7
	Total	**120**	**100**
Net Income Per Cropping	Lower (below P52 000)	59	49.20
	Higher (P52 000 and above)	61	50.80
	Total	**120**	**100**

Table 1 presents the frequency and percentage distribution of the one hundred twenty (120) local farmers in terms of hectarage, location, kind of crops, number of years in farming, and net income per cropping in tabular form.

The respondents comprised 70 small-hectare landowners, or 58.30% of the total population, and 30 for large-hectare landowners, or 41.70% of the total population. The table also shows that 75% of the farmers are working in lowland areas and 25% in upland. 57.5% of the farmers are into rice cultivation, and 42.5% of the farmers are for other crops. There are 48.3% of the farmers who have spent less than 25 years in farming, while 51.7% of them were farmers who have been in the farming industry longer than 25 years. 49.20% of the respondents have a lower net income per cropping, while 50.80% of them received an income of P52,000 and above.

Level of Marketability of Nano-fertilizers among Local Farmers according to Product, Price, Place, and Promotion

Table 2
Level of Marketability of Nano-fertilizers among Local Farmers in the Area of Product

Items	Mean	Interpretation
1. The product provides essential nutrients that promote plant growth and enhance soil fertility.	4.93	Very High Level
2. The product is portable and easy to transport.	4.93	Very High Level
3. The product improves and increases the productivity of many crops.	4.74	Very High Level
4. The product has fast results.	4.72	Very High Level
5. The product is easy to prepare and apply to the crops.	4.80	Very High Level
6. The use of this product is beneficial to farmers.	4.86	Very High Level

7. The packaging design is unique, and the brand is trustworthy.	4.77	Very High Level
8. The product, with its nanotechnology, helps reduce nutrient loss on the crops.	4.73	Very High Level
Overall Mean	**4.81**	**Very High Level**

Table 2 shows the data on the level of marketability of nano-fertilizers among local farmers in the area of product. The overall mean score of 4.81, interpreted as a very high level, implies that there is a very high level of marketability in this area of study.

The highest mean score of 4.93 is found in items no. 1 and 2, which states, "The product provides essential nutrients that promote plant growth and enhance soil fertility" and "The product is portable and easy to transport," respectively. All of which were interpreted as very high levels. This means that the farmers are aware of the benefits of this nano-fertilizer, such as enhanced nutrient uptake, optimal plant growth, and increased yield. This nano-fertilizer has promising results compared to conventional fertilizers, which can contribute to environmental pollution. It has an exceptional coverage in one small package, a configurable solution based on crops and land area.

The lowest mean score of 4.72 is found in item no. 4, which states, "The product has fast results," and is interpreted as a very high level. It implies that there are still farmers who are hesitant to adopt this new technology. The LGUs have introduced them to nano-fertilizers through seminars, symposiums, and demonstrations that would convince these local farmers to accept this farming innovation and see its fast results.

The findings in the study of Singh et al. (2024) confirm that ensuring a safe food supply to protect the health and well-being of people worldwide needs advanced technology. Recent research has shown the potential of nanotechnology in improving the agriculture sector by enhancing the efficiency of agricultural inputs and providing solutions to agricultural problems for improving food productivity and security.

Table 3
Level of Marketability of Nano-fertilizers among Local Farmers in the Area of Price

Items	Mean	Interpretation
1. I find the product to be priced very reasonably.	4.71	Very High Level
2. The product offers good value for the price.	4.76	Very High Level
3. I perceive the product's price as fair.	4.72	Very High Level
4. I consider the price of the product to be competitive.	4.81	Very High Level
5. The price of the product aligns with its benefits.	4.72	Very High Level
6. I am willing to pay a premium for the quality of the product.	4.69	Very High Level
7. The price of the product justifies its effectiveness.	4.68	Very High Level
8. I expect that I don't regret buying the product.	4.63	Very High Level
Overall Mean	**4.71**	**Very High Level**

Statistics in Table 3 show the level of marketability of nano-fertilizers among local farmers in the area of price. It indicated that the overall mean score is 4.71, which is interpreted as a very high level. This implies that the respondents have a very high level of marketability in the given area of study.

The highest mean score of 4.81 is found in item no. 4, which states, "I consider the price of the product to be competitive", and interpreted as a very high level. This means that local farmers understand the cost of nano-fertilizers and the corresponding benefits and advantages they give to the farming process nowadays. Many have attested to its fast results as compared to their traditional method in the past.

The lowest mean score is found in item no. 8, which states, "I expect that I don't regret buying the product," and is interpreted as a very high level. This implies that the respondents are still determining whether this new technology in farming will deliver the best results as expected. Prices of this nano-fertilizer are competitive in the market, which guarantees affordability and cost-effectiveness.

The pricing strategy of agricultural products affects not only the product demand and purchasing behavior of consumers but also the income distribution of node enterprises and the overall profit of the agricultural supply chain (Wang et al., 2022).

The result also confirms in the study of Odjick (2022) that price sensitivity is one of the key factors surrounding companies' pricing choices. Customers are well informed about their purchases now and are sensitive to price because they want the maximum benefits for their money and time.

Table 4
Level of Marketability of Nano-fertilizers among Local Farmers in the Area of Place

Items	Mean	Interpretation

1. The place where I buy the product is accessible to farmers.	4.58	Very High Level
2. The product is available in both local and national markets.	4.62	Very High Level
3. The distribution of the product is available nationwide through the authorized distributor.	4.58	Very High Level
4. The contact numbers of the authorized distributor are provided.	4.51	Very High Level
5. The delivery of products is properly scheduled and covered.	4.58	Very High Level
6. I find this brand trustworthy and is believed to be beneficial in the agriculture industry.	4.63	Very High Level
7. The authorized distributor is knowledgeable of the product and can readily address my concerns.	4.58	Very High Level
8. The authorized distributor exhibits friendly customer service anywhere in the country.	4.53	Very High Level
Overall Mean	**4.58**	**Very High Level**

Table 4 shows the level of marketability of nano-fertilizers among local farmers in the area of the place. It indicated an overall mean score of 4.58 and was interpreted as a very high level. The results of the study imply that nano-fertilizers have a very high level of marketability among the local farmers in this area of study.

The highest mean score of 4.63 is found in item no. 6, which states, "I find this brand trustworthy and is believed to be beneficial in the agriculture industry," and interpreted as a very high level. This means that the respondents have built their trust in the use of nano-fertilizers, which is considered a nanotechnology breakthrough in agriculture because of their efficient and simplified crop application.

The lowest mean score is found in item 4, which states, "The contact numbers of the authorized distributor are provided," with a rating of 4.51, interpreted as a very high level. This implies that the respondents must be provided with the direct phone numbers of the authorized distributor so they can easily contact and order their nano-fertilizers. They are also being notified to transact only with legitimate and authorized distributors in the country.

Vishwal (2020) supports the findings of this study in his article; you might have the perfect product that will satisfy your customers' needs and offer high value. You need to have a process to make the product available for purchase in the consumer's market to make sales and earn a profit, which is the core motivation behind any business model. Place, in layman's terms, means distribution. This is because the place of production is different from the place of consumption. Place ensures the availability of products to the intended end consumer.

Table 5
Level of Marketability of Nano-fertilizers among Local Farmers in the Area of Promotion

Items	Mean	Interpretation
1. Promotions about nanofertilizer influence my purchase decisions.	4.75	Very High Level
2. I perceive the value offered by promotional deals.	4.70	Very High Level
3. I have a positive attitude towards promotional events or symposiums related to the product.	4.74	Very High Level
4. I am more likely to recommend the product due to promotions.	4.77	Very High Level
5. The product has important features that are very useful in agriculture.	4.73	Very High Level
6. Promotional activities influence my brand loyalty.	4.75	Very High Level
7. The product strengthens food security in terms of availability, access, utilization, and stability.	4.80	Very High Level
8. The authorized distributor ensures a smooth distribution process and maintains customer satisfaction.	4.77	Very High Level
Overall Mean	**4.75**	**Very High Level**

Table 5 shows the level of marketability of nano-fertilizers among local farmers in the area of promotion. It indicated an overall mean score of 4.75 and was interpreted as a very high level. This means that nano-fertilizers have a very high level of marketability among local farmers in this area of study.

The highest mean score of 4.80, interpreted as a very high level, is found in item no. 7, which states, "The product strengthens food security in terms of availability, access, utilization, and stability." This means the respondents believed this nano-fertilizer is the best alternative to traditional chemical fertilizers. Nano-fertilizers contribute to the enhanced nutrient utilization efficiency of plants and other crops.

On the other hand, the lowest mean score of 4.70 is found in item no. 2, which states, "I perceive the value offered by promotional deals," and is interpreted as a very high level. It implies that product promotion is important in increasing sales by expanding awareness of the product to buyers and its benefits to potential customers.

Communication efforts must effectively convey the product's benefits and value proposition to entice and engage potential customers. According to Kotler, market segmentation is the practice of subdividing a market into distinct subsets of customers with common needs or characteristics (Ridge, 2022).

The findings of the study correlate with the article of Sy-Gorembalem (2024), which states that the Department of Agriculture (DA), in partnership with the local government units, continues to support farmers by providing agricultural inputs such as fertilizer discount vouchers (FDV) to boost productivity towards food security. Beneficiaries can use the voucher to get inorganic fertilizers from DA-accredited merchants, dealers, and distributors in their municipality.

Comparative Analysis in the Level of Marketability of Nano-fertilizers among Local Farmers in the Areas of Product, Price, Place, and Promotion when grouped and compared according to Hectarage, Location, Kind of Crops, Number of Years in Farming, and Net Income per Cropping

Table 6
Difference in the Level of Marketability of Nano-fertilizers among Local Farmers in the Area of Product when grouped and compared according to variables

Variable	Category	N	Mean Rank	Mann Whitney U	p-value	*Sig. level*	Interpretation
Hectarage	Small	70	53.34	1249.000	0.004		Significant
	Large	50	70.52				
Location	Lowland	90	57.94	1120.000	0.128		Not Significant
	Upland	30	68.17				
Kinds of Crops	Rice	69	66.31	1358.500	0.020	0.05	Significant
	Other Crops	51	52.64				
Number of Years in Farming	Shorter	58	53.97	1419.500	0.030		Significant
	Longer	62	66.60				
Net Income Per Cropping	Lower	59	54.92	1470.500	0.059		Not Significant
	Higher	61	65.89				

Table 6 presents the different comparative analyses of the level of marketability of nano-fertilizers among local farmers in the area of a product when grouped and compared to hectarage, location, kind of crops, number of years in farming, and net income per cropping using the Mann Whitney *U* Test.

Based on the table, the computed p-value in terms of hectarage is 0.004 and interpreted as significant. Regarding location, it has a p-value of 0.128 and is interpreted as insignificant. Regarding the kind of crops, it has a p-value of 0.020 and is interpreted as significant. In terms of years in farming, it has a p-value of 0.030 and is interpreted as significant as well. In terms of net income per cropping, it has a p-value of 0.059 and is interpreted as not significant.

Hence, when the respondents were grouped according to hectarage, kind of crops, and number of years in farming, it achieved a p-value lesser than the 0.05 level of significance and was interpreted as significant.

Therefore, the null hypothesis states, "There is no significant difference in the level of marketability of nano-fertilizers among local farmers in the area of a product when the respondents are grouped and compared according to hectarage, kind of crops, and number of years in farming is thereby, "rejected."

However, in terms of location and net income per cropping, the p-values were 0.128 and 0.059, and both were interpreted as not significant.

Therefore, the null hypothesis that states, "There is no significant difference in the level of marketability of nano-fertilizers among local farmers in the area of a product when grouped and compared according to location and net income per cropping" is accepted.

This implies that hectarage, kind of crops, and number of years in farming significantly affect the marketability of nano fertilizers among local farmers in the product area. However, location and net income per cropping do not affect the level of marketability of nano-fertilizers among local farmers.

Thus, in the area of the product, the nano-fertilizers have a higher level of marketability among those with large farms (hectarage), with rice as the primary crop (kind of crops), and those who have longer years in farming. In other words, these variables significantly affect the level of marketability of nano-fertilizers among local farmers in the area of the product. It can be observed that those whose level of marketability of nano-fertilizers is lower gave lower mean scores to item no. 4 (The product has fast results). Therefore, educating farmers with small hectarage, those whose crops are other than rice, and those who are still new to farming on the long-term benefits of the use of nano-fertilizers for them to appreciate its effects on farming as a whole".

As supported by the study of Mali et al. (2020) and Worrall et al. (2018), the development of cost-efficient, high-performing pesticides that are less harmful to the environment is crucial. The new concepts such as nanotechnology can offer advantages to pesticides, like reducing toxicity, improving the shelf-life, and increasing the solubility of poorly water-soluble pesticides, all of which could have positive environmental impacts.

Table 7

Difference in the Level of Marketability of Nano-fertilizers among Local Farmers in the Area of Price when grouped and compared according to variables

Variable	Category	N	Mean Rank	Mann Whitney U	p-value	*Sig. level*	Interpretation
Hectarage	Small	70	52.74	1207.000	0.002		Significant
	Large	50	71.36				
Location	Lowland	90	57.17	1050.000	0.050		Significant
	Upland	30	70.50				
Kinds of Crops	Rice	69	61.41	1697.000	0.720	0.05	Not Significant
	Other Crops	51	59.27				
Number of Years in Farming	Shorter	58	54.41	1445.000	0.046		Significant
	Longer	62	66.19				
Net Income Per Cropping	Lower	59	49.96	1177.500	0.000		Significant
	Higher	61	70.70				

Table 7 presents the different comparative analyses of the level of marketability of nano-fertilizers among local farmers in the area of price when grouped and compared to hectarage, location, kind of crops, number of years in farming, and net income per cropping using the Mann Whitney *U* Test.

Based on the table, the computed p-value in terms of hectarage is 0.002 and interpreted as significant. In terms of location, it has a p-value of 0.050 and is interpreted as significant. In terms of the kind of crops, it has a p-value of 0.720 and is interpreted as not significant. In terms of years in farming, it has a p-value of 0.046 and is interpreted as significant. In terms of net income per cropping, it has a p-value of 0.000 and is interpreted as significant.

Hence, when the respondents were grouped according to hectarage, location, number of years in farming, and net income per cropping, it achieved a p-value lesser than the 0.05 level of significance and was interpreted as significant.

Therefore, the null hypothesis states, "There is no significant difference in the level of marketability of nano-fertilizers among local farmers in the area of price when the respondents are grouped and compared according to hectarage, location, number of years in farming, and net income per cropping is thereby, "rejected."

However, regarding the kind of crops, the p-value was 0.720 and interpreted as not significant. Therefore, the null hypothesis that states, "There is no significant difference in the level of marketability of nano-fertilizers among local farmers in the area of price when grouped and compared according to kind of crops," is accepted.

This implies that hectarage, location, number of years in farming, and net income per cropping significantly affect the level of marketability of nano-fertilizers among local farmers in the area of price. However, for the kind of crops, it does not affect the level of marketability of nano-fertilizers among local farmers.

Thus, in the area of price, the nano-fertilizers have a higher level of marketability among those with large farms (hectarage), those in the upland (location), those who have longer years in farming, and those with higher net income per cropping. In other words, these variables significantly affect the level of marketability of nano-fertilizers among local farmers in the area of price. It can be observed that those whose level of marketability of nano-fertilizers is lower gave lower mean scores to item no. 8 (I expect that I don't regret buying the product). Therefore, the farmers with small hectarages, those in the lowland, those who are still new to farming, and those who have lower net income shall be given adequate information on how to avail of discounts and have access the fertilizer discount vouchers to alleviate the cost of their expenses in buying nano-fertilizers.

Communication efforts must effectively convey the product's benefits and value proposition to entice and engage potential customers. According to Kotler, market segmentation is the practice of subdividing a market into distinct subsets of customers with common needs or characteristics (Ridge, 2022).

Table 8
Difference in the Level of Marketability of Nano-fertilizers among Local Farmers in the Area of Place when grouped and compared according to variables

Variable	Category	N	Mean Rank	Mann Whitney U	p-value	*Sig. level*	Interpretation
Hectarage	Small	70	52.30	1176.000	0.001	0.05	Significant
	Large	50	71.98				
Location	Lowland	90	57.86	1112.500	0.115		Not Significant
	Upland	30	68.42				
Kinds of Crops	Rice	69	59.58	1696.000	0.712		Not Significant

	Other Crops	51	61.75			
Number of Years in Farming	Shorter	58	53.57	1396.000	0.021	Significant
	Longer	62	66.98			
Net Income Per Cropping	Lower	59	49.70	1162.500	0.000	Significant
	Higher	61	70.94			

Table 8 presents the different comparative analyses of the level of marketability of nano-fertilizers among local farmers in the area of place when grouped and compared to hectarage, location, kind of crops, number of years in farming, and net income per cropping using the Mann Whitney *U* Test.

Based on the table, the computed p-value in terms of hectarage is 0.001 and interpreted as significant.

In terms of location, it has a p-value of 0.115 and is interpreted as not significant.

In terms of the kind of crops, it has a p-value of 0.712 and is interpreted as not significant. In terms of the number of years in farming, it has a p-value of 0.021 and is interpreted as significant. In terms of net income per cropping, it has a p-value of 0.000 and is interpreted as significant.

Hence, when the respondents were grouped according to hectarage, number of years in farming, and net income per cropping, it achieved a p-value lesser than the 0.05 level of significance and was interpreted as significant.

Therefore, the null hypothesis states, "There is no significant difference in the level of marketability of nano-fertilizers among local farmers in the area of place when the respondents are grouped and compared according to hectarage, number of years in farming, and net income per cropping is thereby, "rejected."

However, regarding location and kind of crops, the p-values were 0.115 and 0.712, and both were interpreted as not significant.

Therefore, the null hypothesis that states, "There is no significant difference in the level of marketability of nano-fertilizers among local farmers in the area of place when grouped and compared according to location and kind of crops," is accepted.

This implies that hectarage, number of years in farming, and net income per cropping significantly affect the level of marketability of nano fertilizers among local farmers in the area of the place. However, location and kind of crops do not affect the level of marketability of nano-fertilizers among local farmers.

Thus, in the area of the place, the nano-fertilizers have a higher level of marketability among those with small farms (hectarage), those who have longer years in farming, and those with higher net income per cropping. In other words, these variables significantly affect the level of marketability of nano-fertilizers among local farmers in the area of the place. It can be observed that those whose level of marketability of nano-fertilizers is lower gave lower mean scores to item no. 4 (The contact numbers of the authorized distributor are provided). Therefore, the farmers with large hectarages, those who are still new to farming, and those who have lower net income shall have access to the address and contact numbers of the authorized distributor of nano-fertilizer for a fast and easy transaction whenever they need to purchase the product. Farmer Cooperatives must assist these farmers with the issues and concerns.

Herrity et al. (2023) support this study, which states that place in the marketing mix encompasses the entire process of taking a product from the manufacturer and making it accessible to the consumer, which can include all intermediaries and distributors. This can include both in-person and online places, such as storefronts and websites.

Table 9
Difference in the Level of Marketability of Nano-fertilizers among Local Farmers in the Area of Promotion when grouped and compared according to variables

Variable	Category	N	Mean Rank	Mann Whitney U	p-value	*Sig. level*	Interpretation
Hectarage	Small	70	55.70	1414.000	0.041		Significant
	Large	50	67.22				
Location	Lowland	90	57.71	1099.000	0.082		Not Significant
	Upland	30	68.87				
Kinds of Crops	Rice	69	58.04	1589.500	0.302	0.05	Not Significant
	Other Crops	51	63.83				
Number of Years in Farming	Shorter	58	55.19	1490.000	0.064		Not Significant
	Longer	62	65.47				
Net Income Per Cropping	Lower	59	51.00	1238.500	0.001		Significant
	Higher	61	69.70				

Table 9 presents the different comparative analyses of the level of marketability of nano-fertilizers among local farmers in the area of promotion when grouped and compared to hectarage, location, kind of crops, number of years in farming, and net income per cropping using the Mann Whitney *U* Test.

Based on the table, the computed p-value in terms of hectarage is 0.041 and interpreted as significant. In terms of location, it has a p-value of 0.082 and is interpreted as not significant. In terms of the kind of crops, it has a p-value of 0.302 and is interpreted as not significant. In terms of the number of years in farming, it has a p-value of 0.064 and is interpreted as not significant. In terms of net income per cropping, it has a p-value of 0.001 and is interpreted as significant.

Hence, when the respondents were grouped according to hectarage and net income per cropping, a p-value of less than 0.05 was achieved and interpreted as significant. Therefore, the null hypothesis that states, "There is no significant difference in the level of marketability of nano-fertilizers among local farmers in the area of promotion when the respondents are grouped and compared according to hectarage, and net income per cropping is thereby, "rejected."

However, regarding location, kind of crops, and number of years in farming, the p-value was greater than the 0.05 significance level and interpreted as not significant.

Therefore, the null hypothesis states, "There is no significant difference in the level of marketability of nano-fertilizers among local farmers in the area of promotion when grouped and compared according to location, kind of crops, and the number of years in farming" is accepted.

This implies that hectarage and net income per cropping significantly affect the level of marketability of nano-fertilizers among local farmers in the area of promotion. However, location, kind of crops, and number of years in farming do not affect the level of marketability of nano-fertilizers among local farmers.

Thus, in the area of promotion, the nano-fertilizers have a higher level of marketability among those with large farms (hectarage) and those with higher net income per cropping. In other words, these variables significantly affect the level of marketability of nano-fertilizers among local farmers in the area of promotion. It can be observed that those whose level of marketability of nano-fertilizers is lower gave lower mean scores to item no. 2 (I perceive the value offered by promotional deals). Therefore, farmers with small hectarages and those with lower net incomes shall have the right to take advantage of promotional deals and other discounts on nano-fertilizers. The distribution of discount vouchers to poor farmers is a big help for them in cutting the cost of production for farm inputs.

The findings of the study correlate with the article of Sy-Gorembalem (2024), which states that the Department of Agriculture (DA), in partnership with the local government units, continues to support farmers by providing agricultural inputs such as fertilizer discount vouchers (FDV) to boost productivity towards food security. Beneficiaries can use the voucher to get inorganic fertilizers from DA-accredited merchants, dealers, and distributors in their municipality.

Conclusion

The Province of Iloilo is renowned for its diverse agricultural activities, including rice, sugarcane, fruit, and vegetable cultivation. In recent years, the agricultural sector has faced challenges such as labor shortages, unpredictable weather patterns, and the need for sustainable practices to boost yields. As agricultural practices continue to evolve in the coming years, there is an increasing demand for sustainable and efficient methods, such as the application of nanotechnology in farming for the optimization of crop yields while minimizing the impacts on the environment. There are still a lot of local farmers who are into the traditional farming methods that have been practiced for decades. However, farmers may have many great possibilities if they adopt modern technology in the farming industry through nano-fertilizers. International farming practices have influenced the people in our country to try new technology and discover for themselves what benefits and advantages it can offer. The application of nanotechnology in the agricultural sector greatly contributes to precision farming and makes crop production systems more efficient, sustainable, and safe for the environment.

In terms of product, local farmers were introduced to the nature of nano-fertilizers. They were informed of its benefits and advantages. Nano-fertilizers provide smart nutrient delivery to plants and other crops, evidenced by multiple studies that prove their crop productivity and environmental safety efficiency compared to ordinary and traditional fertilizers. Nano-fertilizers are nutrients encapsulated or coated within nanomaterial to enable controlled release and slow diffusion into the soil. Depending upon the application methods used, plants and crops absorb these nano-fertilizers by foliage or roots.

In terms of price, nano-fertilizers are affordable and cost-effective. Although the unit price of nano-fertilizers is higher, they have exceptional coverage in a tiny package and cut fertilizer transportation costs. Nano-fertilizers significantly help reduce the cost of production. According to the Philippine Rice Research Institute, local farmers can only lower the production cost if they switch to modern methods of farming. Iloilo is lucky to have a national distributor of this nano-fertilizer. They have an office in the city and see that stocks and orders are distributed to

the local farmers in different municipalities. Farmers' Cooperatives and LGUs also promote the adoption of nano-fertilizers among farmers because they are truly beneficial to the agriculture industry.

In terms of place, it is one of the essential aspects of the marketing mix. It plays a major role in the distribution and flow of goods because it ensures that the product is in the right place at the right time. Place covers the cycle in the marketing mix where the entire process of taking the product from the manufacturer and making it accessible to the target market takes place. Proper product placement helps customers find those products as soon as needed.

In terms of promotion is the most important aspect of any marketing mix. It is what one is selling and what the target market wants or needs. The role of a marketer is to define what a product does and its qualities. By employing effective promotional strategies, businesses can create a sense of urgency, build customer loyalty, increase brand visibility, and ultimately drive sales. Customers are more likely to consider buying the product when they perceive reasonable deals and discounts.

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