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Assessment of the utilization of modern agricultural machinery in rice production and its problems: A case from San Leonardo, Philippines

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Abstract: This study examines the relationship between the utilization of modern agricultural machinery and the business technical aspect of rice production of paddy field farmers in San Leonardo, Nueva Ecija, Philippines. The objective of this study is to assess the effectiveness of modern machinery on the business technical aspect of the farmers and the paddy field owners. The study utilized descriptive analysis to assess the use of modern agricultural machinery in rice production and its problems. The design was quantitative, using percentage, frequencies, and weighted mean. The results revealed that the majority of respondents have been operating for 11 to 20 years, owned 1 hectare of land that cultivate 2 times a year and harvest 86 rice sacks per hectare. Rice cultivation is happened during wet and dry season. To maximizing the land, farmers can try other crops while waiting for the season of rice cultivation. In agricultural mechanization, it concluded that plowing machines helps remove clods from the soil, transplanting rice seedlings and applying chemicals using machine can saves time. Harvester machine is suitable in small and large farmland for harvesting and may help farmers to save time, effort and total cost requirements. Local Government Unit to support through grants and funding the local rice farmers in maximizing utilization of machines that shows positive effect.

Keywords: *Agriculture, Business operations, Modern agricultural machinery, Rice farmers, Rice production.*

1. Introduction

The rapid development of agricultural mechanization and custom machine services in the Philippines has the potential to significantly impact the efficiency of rice production in the future. Mechanization, a vital component for agricultural crop production, has often been overlooked in developing nations. Limited access to agricultural power hampers the capacity to cultivate sufficient land, contributing to poverty. Expanding electricity supply to agriculture enables timely completion of tasks and cultivation of larger areas, resulting in increased food yields while preserving natural resources. The implementation of environmentally friendly technologies allows farmers to enhance agricultural production efficiency while minimizing power consumption.

Sustainable agricultural mechanization can substantially advance value chains and food systems *(Sustainable Agricultural Mechanization | Food and Agriculture Organization of the United Nations, n.d.)*. This is due to its ability to enhance the efficiency and effectiveness of postharvest, processing, marketing activities, and other functions in an environmentally friendly manner. Nevertheless, certain studies indicate that traditional agricultural methods play a crucial role in facilitating adaptation. Swiderska (n.d.) emphasizes the significance of traditional knowledge and crop varieties in adaptation. Traditional farmers, with their intricate farming practices, possess exceptional intuitive capabilities. They can forecast advantageous harvests, meteorological conditions, crop dynamics, soil conditions, and other elements.

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Modern farming, also referred to as mechanization or the utilization of advanced machinery, was introduced to farmers through technical progress. These agricultural practices offer numerous benefits that lead to heightened levels of agricultural output, sustainability, and economic advancement. In the Philippines, modern agriculture performs multiple crucial functions and plays a substantial role in the nation's economy and society. It involves applying contemporary scientific knowledge, technology, and agricultural methods to enhance productivity. Farming includes cultivating domesticated animals, fish, poultry, plants, and crops to produce food, clothes, and other essential resources for human survival. Farming has been a crucial element in human civilization's progress. Before the industrial revolution, most individuals engaged in farming to meet their everyday needs *(Define Modern Farming, n.d.)*.

Modern agricultural practices have substantially contributed to the agricultural sector in the Philippines. These approaches have enhanced productivity, increased agricultural yields, and optimized farming operations, trade, and food security. Nueva Ecija, a province in the Philippines, earned the title of the Rice Granary due to its prominent role in cultivating the country's primary food source throughout the twentieth century. The province's history did not primarily revolve around rice production, as it was initially regarded as a frontier region.

San Leonardo, a municipality within Nueva Ecija, has extensive farmland suitable for rice farming. The municipality's primary sources of income include poultry and crop cultivation, with significant farmland dedicated to rice. Mechanization in San Leonardo has allowed farmers to utilize modern agricultural machines, improving efficiency, productivity, and cost savings, thus increasing farmers' income. However, some farmers still harvest rice manually due to a lack of knowledge about modern machinery. Manual rice production can prolong the operational process and affect business efficiency.

The Department of Agriculture (DA), through the Philippine Center for Postharvest Development and Mechanization (PHILMECH), in partnership with the provincial government of Nueva Ecija, provides mechanized farming equipment and machinery to farmer-members of various cooperatives and associations in the region. This initiative has proven advantageous (Tecson, 2021). Studying agricultural mechanization can raise farmers' knowledge, improve farm operations and input efficiency, and lower production costs. New machines in rice production can enhance agricultural practices and technological advancement, significantly improving efficiency and productivity.

However, despite the benefits, there are several problems associated with using modern agricultural machinery in San Leonardo. The high cost of modern machinery can be prohibitive for many farmers (Sims & Kienzle, 2016). Additionally, there is often a lack of training and technical knowledge among farmers, leading to improper use and reduced effectiveness of the equipment (Mrema et al., 2018). Maintenance and repair pose significant challenges, particularly due to the limited availability of spare parts and skilled technicians (Diao et al., 2014). Inadequate infrastructure further hampers the effective use of machinery (Lal, 2004). Furthermore, there is resistance to adopting new practices among some farmers (Binswanger, 1986), and barriers to accessing credit and financing make it difficult for small-scale farmers to invest in modern machinery (Chisasa & Makina, 2012).

With the above context, the researchers aim to analyze the importance of utilization of modern machinery for the advancement of rice production in San Leonardo, and assess the effectiveness of modern machinery on the business technical aspect of the farmers and the paddy field owners. Studying the agricultural mechanization may raise farmers knowledge and efficiency of farm operations and inputs, and lowers production costs. New machines in rice production may enhance agricultural practices and advancement in technology which can significantly improve the efficiency and productivity of rice production.

Specifically, the following are the main research questions of the study:

- Describe the rice production operations of the respondents;
- Assess the utilization of modern agricultural machinery in rice production; and
- Determine the problems encountered of the rice farmers in the utilization of the modern agricultural machinery in rice production.

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1.1. Review of Related Literature

Modern Agricultural Machinery. The efficiency and productivity of agriculture have experienced significant improvements due to the transformative advancements facilitated by contemporary agricultural technology. The gadgets are designed to do several tasks associated with agricultural labor, including cultivation, harvesting, and overall farm administration. Agricultural products are now more productive and of higher quality thanks to technological advancements. Inefficient and squandering money, farmers who insist on using antiquated equipment are losing ground. The tractor and other revolutionary agricultural technologies are now considered antiquated. Significant advancements in agricultural productivity owe much to the utilization of contemporary farm machinery. Essential tools such as the Combine Harvester, Disc Harrow, Leveler, Power Harrow, Plough, Rotary Tiller, Tractor Trailer, Water Bowser, and Combine Harvester play pivotal roles in modern agriculture. This compilation serves to outline the latest agricultural equipment and their respective functions (Singh, 2021).

Agriculture machinery, commonly referred to as agricultural technology, plays a crucial role in enhancing agricultural productivity. As per Paredes (2024), it facilitates farmers in cultivating a larger quantity of crops within a shorter timeframe and with enhanced efficiency. The range of equipment encompasses many types of machinery, such as tractors, harvesters, animal feed mixers, and field-wide weed removers. In conclusion, these technological advancements have empowered farmers worldwide to enhance the profitability and productivity of their land production compared to previous methods. The utilization of appropriate agricultural gear can effectively facilitate the management of even the most modest parcels of land.

The majority of farmers utilize contemporary agricultural machinery, which enhances their productivity. San Leonardo possesses a substantial expanse of arable ground suitable for cultivating rice. The region possesses a thriving agricultural sector, characterized by extensive rice fields and fertile ground suitable for cultivating vegetables and poultry. Agricultural machinery can mitigate the effects of a scarcity of labor by automating certain tasks that would otherwise require human labor. This ensures the ongoing continuation of farming operations (Muscad, 2023).

Modern Farming. Modern farming encompasses the utilization of current scientific advancements, technological innovations, and agricultural methodologies with the aim of enhancing agricultural productivity. Farming is a crucial element in the progress of human civilization. Prior to the industrial revolution, the majority of individuals depended on agriculture to provide their daily needs, such as sustenance, clothing, and shelter. As a consequence of their adherence to conventional agricultural methods, their output was comparatively low and their understanding of the global economy was limited. However, there have been recent changes. Advancements in agriculture and farming technologies have led to a substantial increase in farming productivity *(Define Modern Farming, n.d.)*.

Phatak (2019) asserts that agricultural innovations have a positive impact on global crop productivity. This leads to the implementation of sustainable methods of agricultural production to meet the increasing food demand caused by rising wealth and population growth. A substantial section of the global population is engaged in the activities of farming and agribusiness, either through direct participation or indirect involvement. The application of modern agricultural technology improves the wide array of cultivation methods utilized by farmers. In addition to employing sophisticated gear and receiving substantial energy subsidies in the form of pesticides, fertilizers, and irrigation water, the system utilizes hybrid seeds of a specific crop variety.

Rice Production. Rice is the predominant staple food consumed by more than 50% of the global human population, especially in Asia and Africa. Lin and Quitzon (n.d) reported that almost 50% of the global population, encompassing nearly all of East and Southeast Asia, relies entirely on rice as their primary source of sustenance. Furthermore, people consume 95 percent of the world's rice production. Numerous nations engaged in rice grain production experience substantial post-harvest losses due to substandard road infrastructure, inadequate storage technologies, inefficient supply networks, and the limited capacity of farmers to transport their crop to retail marketplaces predominantly controlled by

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small-scale shopkeepers. The Philippines' rice or palay production in 2022 reached around 19.76 million metric tons, indicating a decline compared to the previous year (Balita,2023). Palay, sometimes referred to as paddy, serves as a fundamental dietary component in the Philippines. The Department of Agriculture reports that the Philippines continues to be a leading global rice producer, ranking 8th after China, Indonesia, India, and other Southeast Asian countries. Rice research is continuously conducted at many institutes and universities across the country to enhance rice production and support Filipino farmers in enhancing crop resilience and productivity.

Dorairaj and Govender (2023) proposed contemporary rice agricultural techniques, propose inventive approaches to rice cultivation, outline avenues for future research on sustainable rice farming, and furnish a plethora of knowledge to expedite the advancement of novel concepts, the implementation of advanced technologies, and inventive resolutions for resilient rice production.

2. Materials and Method

2.1. Research Method

The research employed a descriptive analysis approach to evaluate the effects of employing contemporary agricultural machinery on the progress of rice cultivation. This study employed a quantitative design, including statistical analysis techniques such as percentages, frequencies, weighted means, Pearson's correlation coefficient, and other methods to assess its impact.

Descriptive research serves as a valuable technique of data analysis, aimed at providing a comprehensive understanding of the data at hand. This approach involves describing, illustrating, or summarizing data points in a manner that facilitates the identification of patterns and insights that fulfill the requirements of the dataset (Rawat, n.d.). In essence, descriptive research allows researchers to paint a clear picture of the data, enabling them to uncover trends, relationships, and important characteristics that may be present within it. By meticulously examining and presenting data in a structured and meaningful way, descriptive research lays the groundwork for further analysis and decision-making processes.

2.2. Research Locale

The study was carried out in San Leonardo, Nueva Ecija, Philippines, where the respondents were identified. Respondents in this study were from different parts of San Leonardo of Nueva Ecija. The municipality of San Leonardo is part of the 4th district of Nueva Ecija and the municipal mayor is Hon. Froilan A. Nagaño. This diverse representation of respondents from different areas within San Leonardo provides a comprehensive understanding of the agricultural practices and challenges faced by the local farming community.

2.3. Respondents of the Study

The researchers got the total list of the respondents by giving a formal request letter to the municipal agriculturist of San Leonardo. The respondents were the rice farmers who are engaged in rice production. The sample size of the rice farmer is 304 from the total population of 1431.

2.4. Sample and Sampling Procedures

The data was collected by the researchers through the utilization of a purposive sampling technique. Purposive sampling is a group of non-probability sampling approaches that include intentionally selecting units based on the existence of specific traits that are deemed crucial for the sample. Purposive sampling involves the cautious selection of units. The participants must be proprietors of paddy fields located in San Leonardo, Nueva Ecija. The sample for this study consisted of 304 paddy field owners and farmers in San Leonardo who completed the questionnaire, in accordance with the predetermined selection criteria.

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The sample of participants in the study comprises 304 individuals, representing a frequency of 304 out of the overall population of 1431. The sample size for this study was determined using the Raosoft tool, with a confidence level of 95% and a margin of error of 5%.

2.5. Research Instrument

The data for this study was collected through the administration of a survey questionnaire and conducting face-to-face interviews with the respondents. The researchers devised a questionnaire with the aim of assessing the progress made in rice production through the utilization of modern agricultural machineries. Survey questionnaires are a collection of unbiased inquiries employed to obtain comprehensive insights from respondents in order to achieve the study's aims. The researchers developed survey questionnaire that comprised two sections.

The first section focused on the business and technical operations of rice growers. The researchers designed the instrument, which consisted of a checklist completed by the respondents.

Part II of the assessment pertains to the agricultural mechanization practices employed by rice producers in the region of San Leonardo. The agricultural process consists of four distinct components, namely plowing, transplanting seedlings, chemical application, and harvesting. The modified 4-point Likert scale was utilized, consisting of the following response options: (4) Strongly Agree, (3) Agree, (2) Disagree, and (1) Strongly Disagree. The respondents in the study were provided with instructions to evaluate the statement and provide responses to the questions. The researchers have developed a set of self-designed questions for this questionnaire.

Part III comprises open-ended questions pertaining to the challenges faced by respondents in relation to the implementation of agricultural mechanization. The participants were requested to express their candid viewpoints pertaining to the inquiries posed.

The validation of the research instrument was conducted, and subsequent revisions and recommendations were included into the final version. Additionally, interviews were conducted with professionals to assess the instrument's reliability and validity.

2.6. Data Gathering Procedures

After the approval of research topic entitled "Assessment of the Utilization of Modern Agricultural Machinery in Rice Production and Its Problems: A Case from San Leonardo, Philippines", the researchers begin to gather and collect related data and information from the Internet. The data gathered were used as a basis for the research questionnaires, which undergone confirmation by experts who provided opinions and suggestions to further improve the research instrument. A substantial share of the global population is engaged in farming and agribusiness, either through direct involvement or indirect participation. The application of modern agricultural technology improves the wide array of cultivation methods utilized by farmers. The results for the reliability of each of the variables were as follows: Plowing has 0.7937, Planting Rice Seedlings has 0.8214, Chemical Application has 0.8438, and Harvesting has 0.8171, which means that the instrument that has been utilized with a very good internal consistency. The validity of the research instrument was established by presenting the developed research instrument for the comments of the experts who rated the instrument with 4.12 as its weighted mean having a verbal interpretation of very good. After validation of the questionnaires, the researchers conducted a pilot test to ensure the accuracy, reliability, and effectiveness of the research instruments.

Thereafter, upon receiving positive reliability findings, the researchers asked their respective research advisers for permission to proceed with the study as the survey questionnaires involves in-person survey questionnaire. Then, the researchers are allowed to carry out the survey.

After receiving clearance, the researchers began approaching the owners of the paddy field to begin the study. There were questionnaire papers sent to the respondents. The researchers outlined the questions' contents and how to respond to them, including the modified 4-point Likert scale's scaling method, which asks for (4) "strongly agree" and (1) "strongly disagree" responses. The researchers

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made sure that the respondents' identities are kept private and anonymous, and they asked if they have any questions, they might have concerned the study. After thoroughly explaining everything to the respondents, researchers would then let the respondents to complete the questionnaire and guide their activities.

After the distribution, the information that were gathered from the answered questionnaire and tallied for the further interpretation.

2.7. Data Analysis Techniques

The information gathered from the community was encoded, tallied, and examined. The data collected were analyzed using statistical methods such as percentage, frequency distribution, weighted mean. The findings were translated using the scale below.

Table 1.
Scale for Interpretation.

Scale	Mean range	Interpretation	Description
4	3.26 – 4.00	Strongly agree	Highly in favor
3	2.51 – 3.25	Agree	In favor
2	1.76 – 2.50	Disagree	Not in favor
1	1.00 – 1.75	Strongly disagree	Highly not in favor

Table 1 shows the scales employed by the researchers to analyze and describe the data to assess the advancement of rice production by utilization of modern agricultural machinery. The **4-point Likert scale** used by researchers to identify the perspective of the respondents regarding the advancement of rice production using modern agricultural machinery.

Aside from the said scale, the researchers used the following statistical tools to classify, tabulate, and analyze the data per the objectives of the research study: In describing the rice production operation of the respondents, the researchers used frequency and percentage; to assess the utilization of modern agricultural machinery for the advancement of the rice production, the researchers employed weighted mean and ranking; and to describe the problems encountered by the rice farmers in utilizing modern agricultural machineries, the researchers utilized frequency and percentage.

3. Results

This chapter presents analyses and interprets all the data gathered through the textual and tabular form.

3.1. Description of Rice Production Operation of the Respondents

3.1.1. Years in Farming

Based on the findings on the years in farming, the majority of the respondents have been operating for 11-20 years with a percentage of 42%, whereas 17% of the years in farming between 21 years and above. Other findings show that some of the respondents have 1-5 years of farming (21%); 6-10 years (20%); and 21 years and above (17%).

3.1.2. Size of Farmland (In hectares)

The findings show that the 50% of the respondents have one (1) to two (2) hectares of farmland, whereas 3% have 5 hectares of farmland. Other findings show that some of the respondents have 3-4 hectares of farmland (43%); and other 4% of the respondents have less than 1 hectare and over 7 hectares of farmland.

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3.1.3. Frequency of Rice Cultivation in A Year

Based on the findings, the majority of the respondents' frequencies of number of rice seedling planting in a year is 2 times with the percentage of 100%.

3.1.4. Number of Sacks Harvest per Hectares

Based on the findings above, the majority of the respondents' frequencies of number of sacks harvest per hectares is 90 with the percentage of 30% whereas 3% is 111-128. Other findings show that some of the respondents have 81-86 harvested sacks of rice (20%); 99-104 sacks (20%); 75-80 sacks (9%); 87-92 sacks (9%); and105-110 sacks (9%).

3.2. Assessment of Modern Agricultural Machinery for the Advancement of Rice Production

3.2.1. Plowing

Table 2.
Assessment of modern agricultural machinery in terms of plowing.

Plowing	Weighted mean
1. Plowing machines like tractor, mold board plow, disc plow, etc. helps remove clods from the soil	3.82
2. Plowing machine helps dig up the soil for its soil fertility	3.64
3. Plowing the land using modern machine saves time	3.69
4. Plowing machine is suitable in small and large farmland	3.68
5. Use of plowing machines cut down costs of labor	3.61
Average weighted mean	3.69

Note: Legend: 1.00-1.75 Strongly disagree; 1.76- 2.50 Disagree; 2.51- 3.25 Agree; and 3.26-4.00 Strongly agree

The data indicates a strong consensus among respondents regarding the benefits of utilizing plowing machines in agriculture, with a weighted mean of 3.69 indicating a strong agreement. "Plowing machines, including tractors, mold board plows, and disc plows, garnered the highest weighted mean of 3.82, suggesting a resounding agreement with their effectiveness in removing clods from the soil. Furthermore, respondents strongly agreed, with a mean of 3.61, that the use of plowing machines significantly reduces labor costs, reinforcing the notion of their efficiency and cost-effectiveness.

3.2.2. Planting Rice Seedlings

Table 3.
Assessment of modern agricultural machinery in terms of planting rice seedlings.

Planting rice seedlings	Weighted mean
1. Using machine in transplanting rice seedlings saves time	3.51
2. Planting rice seeds using machine is suitable in large farmland	3.48
3. Using machine in transplanting seeds make uniform spacing and density	3.24
4. Using modern transplanting machine reduces work load and health risk in farmers	3.47
5. Use of machine in transplanting cut down costs of labor	3.41
Average weighted mean	3.41

Note: Legend: 1.00-1.75 Strongly disagree; 1.76- 2.50 Disagree; 2.51- 3.25 Agree; and 3.26-4.00 Strongly agree.

The data indicates a strong consensus among respondents regarding the benefits of using planting machines in rice farming, with a weighted mean of 3.41 signifying a strong agreement, described as "Highly in favor." Specifically, respondents strongly agreed, with a weighted mean of 3.51, that using machines for transplanting rice seedlings saves time, emphasizing the efficiency gained through mechanized planting processes. Additionally, respondents expressed agreement, with a mean of 3.24,

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that using machines for transplanting seeds results in uniform spacing and density, further enhancing the precision and effectiveness of planting operations.

3.2.3. Chemical Application

Table 4.
Assessment of modern agricultural machinery in terms of chemical application.

Chemical application	Weighted mean
1. Applying chemicals using machine can save time.	3.57
2. Chemical application using boom sprayer is efficient in large farmland.	3.55
3. Chemical application using mechanical sprayer helps spread the fertilizer uniformly	3.52
4. Chemical application using machine provides safety and lessen health risk	3.50
5. Chemical application using sprayer cut down the costs of labor	3.55
Average weighted mean	3.54

Note: Legend: 1.00-1.75 Strongly disagree; 1.76- 2.50 Disagree; 2.51- 3.25 Agree; and 3.26-4.00 Strongly agree.

The data reveals a strong consensus among respondents regarding the benefits of using chemical application machines in agriculture, with a weighted mean of 3.54 indicating a strong agreement, described as "Highly in favor." Specifically, respondents strongly agreed, with a weighted mean of 3.57, that applying chemicals using machines saves time, highlighting the efficiency gained through mechanized chemical application processes. Moreover, respondents expressed agreement, with a mean of 3.50, that chemical application using machines provides safety and reduces health risks, underscoring the importance of mechanized methods in promoting the well-being of farmers and agricultural workers.

Table 5.
Assessment of modern agricultural machinery in terms of harvesting.

Harvesting	Weighted mean
1. Using harvester machine improves the quality of rice harvested	3.53
2. Harvester machine is suitable in small and large farmland for harvesting	3.57
3. Using harvester machine makes palay clean and thorough separation to make rice	3.50
4. Using harvester machine reduces the loss of palay quantity	3.16
5. Mechanical harvesting of rice generally saves time, effort and total cost requirements	3.57
Average weighted mean	3.47

Note: Legend: 1.00-1.75 Strongly disagree; 1.76- 2.50 Disagree; 2.51- 3.25 Agree; and 3.26-4.00 Strongly agree.

3.2.4. Harvesting

The data reveals a strong consensus among respondents regarding the benefits of using harvesting machines in agriculture, with a weighted mean of 3.47 indicating a strong agreement, described as "Highly in favor." Specifically, respondents strongly agreed, with a weighted mean of 3.57, that the use of mechanical harvesting machines generally saves time, effort, and total cost requirements, emphasizing the efficiency gained through mechanized harvesting processes. Furthermore, respondents expressed agreement, with a mean of 3.16, that using harvesting machines reduces the loss of palay quantity, highlighting the role of mechanized harvesting in minimizing post-harvest losses and maximizing yields.

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3.3. Description of the problems encountered by the rice farmers in using Modern Agricultural Machinery

3.3.1. Description of the problems encountered by the rice farmers in terms of Plowing.

The findings indicate that engine breakdowns are the most common and frequently encountered issue faced by respondents when utilizing modern agricultural machinery for plowing, with 39% of respondents citing this problem. Also, 25% of the combined responses in other problems encountered include high maintenance costs, high cost of machines, and difficult to operate. In contrast, only 8% of respondents reported encountering the high cost of machinery as the fewest issue and 28% of the rice farmers have no problems at all.

3.3.2. Description of the Problems Encountered by the Rice Farmers in Terms of Planting Rice Seedling

The findings indicate that the most common and frequently encountered problem faced by respondents when utilizing modern agricultural machinery for planting rice seedlings is the reduction in the number of workers or farmers, with 37% of respondents citing this issue. 33% of the combined responses in other problems encountered include uneven planting spaces, reduction of work force for farmers, and not yet encountered using planting machines. In contrast, only 6% of respondents reported encountering the lack of knowledge in utilizing planting machines as the fewest issue and 24% of the rice farmers have no problems at all.

3.3.3. Description of The Problems Encountered by the Rice Farmers in Terms of Machines Chemical Application.

The findings reveal that the most common and frequently encountered problem faced by the rice farmers when utilizing agricultural machinery for chemical application is the high cost of the machines, with 36% of respondents citing this issue, other problem encountered is unbalanced portion of chemical spray with 32%. In contrast, only 18% of respondents reported encountering the weight of the machines as the least problematic issue and 14% of the rice farmers have no problems at all.

3.3.4. Description of the Problems Encountered by the Rice Farmers in Terms of Harvesting.

The findings indicate that the most common and frequently encountered problem faced by the rice farmers when utilizing harvester machines is the high rent and cost of the machines, with 35% of respondents citing this issue, and unpredicted engine breakdown of the machines with 28%. In contrast, only 15% of respondents reported encountering no problems with harvester machines and 15% of the rice farmers have no problems at all.

4. Discussion

4.1. Description of Rice Production Operation of the Respondents

Some of the rice farmers inherited growing rice, and farmers grew up on farms, so it became the main source of their income. According to the respondents, a substantial majority expressed that they have acquired substantial expertise in the sector over an extended period of time. Their enormous knowledge provides them with a significant advantage, especially in the field of rice farming. By actively participating in agricultural operations for many years, these individuals have acquired significant knowledge, refined their abilities, and cultivated a profound comprehension of the intricacies associated with rice farming. The extensive range of expertise possessed by individuals enables them to effectively handle many problems and make well-informed judgments during the cultivation process. Moreover, the enduring existence of these organisms in the domain is indicative of their exposure to and adjustment to diverse environmental circumstances, fluctuations in crop composition, and the continuous development of agricultural methodologies. In general, the duration of the respondents' experience in the particular domain not only indicates their commitment to agricultural activities but also emphasizes the significance of practical knowledge in promoting achievement and effectiveness in rice growing initiatives.

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In their study, Yagos and Demayo (2015) found that farmers with more than five years of experience in rice farming strongly believed that their experience played a crucial role in properly managing rice harvests. The results of this study indicate that the farmers placed significant value on their extensive experience in the field of rice production. Over the course of their ongoing engagement in agricultural pursuits, it is probable that these individuals have met a diverse range of obstacles, achievements, and educational prospects that are unique to the practice of rice cultivation. Through their significant practical experience, they have developed a profound comprehension of the complexities associated with rice crop management, encompassing elements such as soil conditions, water management, insect control, and crop rotation. Furthermore, the assurance demonstrated by these seasoned farmers in their capacity to oversee rice production arises from their direct familiarity with the indigenous agricultural terrain, meteorological trends, and regional disparities in rice farming methodologies. By engaging in extensive observation, experimentation, and adaptation, they have evolved a sophisticated strategy for managing rice crops that combines traditional knowledge with contemporary agricultural methods.

In terms of size of farmland, the respondents in the research are identified as small-scale farmers, with each individual overseeing agricultural operations that do not surpass a land area of one hectare. This suggests that the agricultural activities conducted by the individuals in question are of a relatively limited scope, since the cultivated land area generally does not surpass one hectare. The respondents themselves recognize the feasible dimensions of their agricultural properties, highlighting that directing their attention towards the land is quite effortless owing to its restricted scope. The respondents are able to allocate ample care and attention to their crops, including the planting and harvesting of rice, due to the manageable size of farming.

The results obtained from the research are consistent with the data presented by the Ballesteros (2019), which suggests that the mean size of agricultural land in the Philippines is 1.29 hectares. The aforementioned mean size is indicative of the widespread existence of small-scale or family-operated agricultural enterprises across the nation. The prevalence of small-scale farming in the agricultural sector of the Philippines is apparent, as indicated by the stated count of 5.56 million farms and holdings throughout the country. The significance of comprehending the distinct difficulties and possibilities linked to small-scale agriculture is highlighted by the prevalence of smallholder farms in the Philippines. Although smallholder farms may possess restricted land resources in comparison to bigger commercial enterprises, they frequently serve as crucial contributors to rural communities' livelihoods and national food security.

Furthermore, the compact dimensions of these farms can promote the implementation of sustainable and eco-friendly farming methods, as small-scale farmers are generally more intimately linked to their land and may be more likely to embrace conservation-focused strategies.

According to the data gathered in terms of frequency of rice cultivation in a year, a substantial majority of rice farmers partake in cultivation on two occasions annually, indicating their proficiency in optimizing land usage and augmenting crop yields. The respondents said that they engage in rice harvesting on a biannual basis, which corresponds to the prevailing wet and dry seasons in the Philippines. The period known as the rainy season generally encompasses the months of October to November, whilst the dry season is seen from March to April. The use of this dual cropping system enables farmers to effectively leverage the variations in seasonal circumstances, so optimizing the overall production of their land over the course of the year. Rice agriculture thrives during the rainy season, characterized by ample rainfall, due to the favorable moisture-rich conditions. On the other hand, the dry season offers advantageous circumstances for the cultivation of rice, as it is characterized by less precipitation and abundant sunshine, which facilitate the growth and maturation of plants.

The research conducted by Gutierrez et al. (2019) provides support for the observed seasonal cropping pattern, emphasizing the occurrence of two primary rice production seasons in the Philippines: the rainy season and the dry season. The agricultural calendar is designed to correspond with the

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inherent climate fluctuations seen in the area, enabling farmers to adjust their planting and harvesting timetables accordingly.

Rice producers may effectively manage their crops and maximize productivity by capitalizing on the unique benefits provided by each season. In rice-producing regions, the implementation of this dual cropping system not only serves to augment agricultural production, but also plays a significant role in bolstering food security and fostering economic stability. The significance of adaptive agricultural techniques that utilize the natural cycles of the environment is shown by the synchronization of rice production with the rainy and dry seasons, as supported by both frequency statistics and research findings. By strategically synchronizing agricultural practices with seasonal fluctuations, farmers in the Philippines may optimize crop yields, minimize potential hazards, and guarantee the enduring viability of rice cultivation.

There exists a considerable variation in rice yields per hectare. The majority of respondents reported harvesting rice quantities ranging from ninety (90) sacks per hectare, although the lowest recorded yield was two (2) sacks. The respondents in the study said that the average output of rice bags per acre during their harvesting activities varied between 80 and 110. The observed fluctuations in crop yields can be attributed to several variables, including soil fertility, crop management techniques, meteorological conditions, and the application of agricultural inputs.

The research conducted by Momblan (2019) is a tangible illustration of the achievement in rice cultivation, highlighting the adoption of organic rice farming methods by a farmer in Igbaras town. Despite being a novice in the field of organic farming, the farmer demonstrated remarkable productivity by attaining a noteworthy output of 90 bags of rice per acre. These findings emphasize the capacity of sustainable farming methods to improve production and make a positive impact on food security. It is crucial to acknowledge that attaining optimal yields in rice cultivation necessitates the integration of several elements, such as meticulous soil management, efficient pest and disease management, timely irrigation, and appropriate crop types. Furthermore, the use of novel agricultural practices, such as organic farming techniques, has the potential to augment crop productivity while concurrently fostering ecological sustainability and fortitude in the face of climate change.

The diverse array of yields documented by participants highlights the significance of comprehending the variables that impact rice cultivation and employing tactics to enhance crop productivity. Through the dissemination of success tales, such as the one exemplified by Momblan (2019), farmers may acquire knowledge from one another's encounters and delve into novel methodologies to enhance their own rice cultivation techniques.

4.2. Assessment of Modern Agricultural Machinery for the Advancement of Rice Production

There is a positive perception of plowing machines among respondents underscores their importance in modern agricultural practices, particularly in enhancing productivity and reducing manual labor requirements. The data also highlights the preference for machinery over traditional animal-powered methods when it comes to plowing. Respondents believe that utilizing machinery such as tractors and rototillers is more efficient and superior to relying on animals for plowing tasks.

Supporting this perspective, Munar et. al. (2021) emphasizes the pivotal role of farm machinery in various agricultural operations, including planting, cultivation, and harvesting. In the contemporary agricultural landscape, large-scale farming is increasingly reliant on heavy machinery such as tractors equipped with large plows. The tractor, in particular, is highlighted as a paramount agricultural tool, symbolizing the mechanization and efficiency that characterize modern farming practices. Overall, the convergence of respondent perceptions and expert insights underscores the transformative impact of farm machinery, particularly plowing machines, in revolutionizing agricultural practices. By embracing technological advancements and mechanization, farmers can achieve higher levels of efficiency, productivity, and sustainability in their operations, contributing to the advancement of the agricultural sector as a whole.

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In terms of planting rice seedling, there is positive perception of planting machines among respondents, highlighting their role in streamlining planting processes and improving overall efficiency.

Planting machines are recognized for their ability to rapidly plant seedlings or seeds while ensuring proper spacing and density, as noted by the respondents. Supporting this perspective, Shabl Team (2023) emphasizes the advantages of seeding machines, also known as planting machines, in facilitating the proper sowing of seeds at the correct depth and distance. These machines contribute to significant time and labor savings compared to manual planting methods, allowing farmers to efficiently sow seeds across large areas of land.

Overall, the convergence of respondent perceptions and expert insights underscores the transformative impact of planting machines in modern agricultural practices. By leveraging mechanized planting technologies, farmers can achieve higher levels of efficiency, precision, and productivity in their planting operations, ultimately contributing to the advancement and sustainability of the agricultural sector.

The research highlights the favorable view of chemical application machines among participants, stressing their function in simplifying chemical application procedures, improving effectiveness, and reducing health hazards linked to manual application.

Ravi Mishra – Medium (n.d.) underscores the importance of boom sprayers as essential machinery in agricultural practices, hence providing support for this viewpoint. These devices provide the accurate and efficient utilization of pesticides, herbicides, fertilizers, and other chemical substances, so enhancing crop well-being and production, while concurrently decreasing expenses and mitigating ecological consequences.

Boom sprayers have several advantages, such as enhanced productivity resulting from expedited application, accurate dispersion of chemicals, versatility in accommodating diverse crop varieties and field circumstances, cost-effectiveness, and less ecological impact. Farmers may enhance chemical utilization, improve crop productivity, and encourage sustainable agricultural methods by utilizing boom sprayers and other chemical application machinery.

In general, the alignment between the impressions of respondents and the insights provided by experts highlights the significant influence of chemical application machinery in contemporary agriculture. Farmers may improve the efficiency, safety, and environmental sustainability of their agricultural operations by using automated chemical application technology. This will eventually contribute to the progress and resilience of the agricultural sector.

Lastly, the research highlights the favorable opinion of harvesting machines among respondents, stressing their capacity to enhance the quality and efficiency of rice cultivation while simultaneously decreasing labor expenses and post-harvest wastage. In accordance with this viewpoint, Gitau (2023) underscores the expeditious expansion and widespread adoption of agricultural machinery, such as the combine harvester. The aforementioned machines provide sophisticated technology that integrates many activities, such as reaping, threshing, cleaning, and occasionally, bagging, into a unified and effective procedure. Combine harvesters enhance grain cleanliness, decrease reliance on manual labor, and generate cost savings for farmers by efficiently segregating weeds from grains and optimizing post-harvest procedures.

Combine harvesters offer advantages that go beyond improving efficiency. They help expedite farm preparation for the subsequent crop and decrease overall harvesting expenses, encompassing cutting and winnowing. Farmers may maximize output, reduce losses, and improve the sustainability of rice production by using mechanical harvesting technology.

In general, the alignment between the impressions of respondents and the insights provided by experts highlights the significant influence of harvesting equipment in contemporary agriculture. Farmers may enhance their operations, increase yields, and contribute to the progress and sustainability of the agricultural sector by implementing mechanical harvesting technology such as combine harvesters.

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4.3. Description of the Problems Encountered by the Rice Farmers in Using Modern Agricultural Machinery

Rice farmers face significant challenges due to engine breaks down, which can cause disruptions in their operations and result in delays in their cultivation efforts. The participants observed that instances of engine failures frequently transpire during the course of operation, hence impacting the operational efficiency of machines and necessitating expeditious repairs.

Engine problems in tractors, such as defective spark plugs, can result in operational challenges, such as difficult starts, decreased fuel efficiency, and diminished performance *(Maintenance and Troubleshooting | Tractor Engines | MalpasDirect | malpasDirect: Tractor Parts Online UK*, n.d.). The aforementioned concerns have the potential to exert a substantial influence on the operational efficiency and efficacy of agricultural machinery, hence resulting in disturbances to farming operations and potentially resulting in financial setbacks for farmers. Promptly and successfully addressing engine breakdowns and other mechanical difficulties is crucial to ensure the seamless operation of contemporary agricultural machines. The implementation of routine maintenance, prompt repairs, and appropriate machinery handling is necessary in order to prevent and alleviate these issues.

In general, the data underscores the difficulties encountered by farmers in the utilization of contemporary agricultural machinery, with a specific emphasis on engine malfunctions. To enhance productivity and efficiency in agricultural operations, farmers can optimize the performance and reliability of their gear by comprehending and resolving these difficulties.

Also, respondents highlighted that the high cost of planting machines deters them from adopting mechanized planting methods, leading them to continue using traditional manual planting techniques.

Respondents stated that the cost of acquiring planting machinery is excessively high, posing a challenge for them to buy such equipment and to reduce farmers or workers for them. Consequently, they choose to persist in employing manual techniques for sowing rice seeds, despite acknowledging the potential advantages of mechanized planting, such as diminishing the workforce and reducing labor expenses.

Hossen et al. (2018) emphasizes the benefits of employing rice transplanters, which substantially diminish labor demands and seed consumption in comparison to manual planting techniques. The efficiency of rice transplanters lies in their ability to transplant seedlings at a predetermined depth and spacing, hence optimizing planting density and reducing the need on manual labor. The utilization of this equipment optimizes the transplantation procedure, necessitating a just two personnel to accomplish planting tasks, with a daily transplantation capacity of two hectares.

The data highlights the capacity of mechanized planting technologies, such as rice transplanters, to effectively tackle the difficulties linked to human planting techniques, specifically in terms of diminishing labor expenses and enhancing productivity. Farmers can boost overall agricultural sustainability, improve production, and optimize planting operations by adopting mechanization.

The next discussion shows that the respondents emphasized that the expensive cost of purchasing or renting chemical application machines poses a significant barrier to their adoption, forcing them to resort to manual application methods. According to respondents, the prohibitive cost of acquiring and renting modern sprayer machines is a major obstacle in adopting mechanized spraying techniques. Despite recognizing the potential benefits of mechanization in improving spraying efficiency and productivity, farmers find it financially challenging to invest in such equipment. Consequently, they are compelled to continue with manual spraying methods, despite the limitations in efficiency and effectiveness. The study on Gautam et al. (2023) underscores the importance of modernization and mechanization in agricultural practices to enhance production and efficiency. However, it also acknowledges the significant barriers posed by the high cost and limited efficiency of available machinery. While there is a recognized need for mechanical equipment to improve agricultural operations, the current market offerings may not always align with the practical and financial realities faced by farmers. Addressing the cost and efficiency issues associated with agricultural machinery is crucial for facilitating the adoption of mechanized spraying techniques. Strategies such as government subsidies, technological innovations to improve equipment efficiency, and collaborative efforts between

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stakeholders can help make mechanized spraying more accessible and affordable for farmers. Overall, the findings highlight the complex challenges involved in adopting agricultural machinery for chemical application. By addressing cost barriers and improving the efficiency of available equipment, farmers can harness the benefits of mechanization to enhance spraying effectiveness, increase productivity, and contribute to sustainable agricultural practices.

Lastly, the respondents highlighted that while mechanized harvesting can improve operational productivity, the prohibitive cost of purchasing or renting combine harvesters poses a significant barrier to adoption. Despite recognizing the potential benefits of combine harvesters in speeding up and improving harvesting operations, respondents expressed difficulty in acquiring or renting these machines due to their high cost. The expense associated with purchasing or renting combine harvesters makes them inaccessible to many farmers, limiting their ability to mechanize harvesting processes and improve efficiency.

According to Precisionreports.Co (2023), one of the major disadvantages of combine harvesters is their high price, followed by their large size. These factors make it challenging for farmers to transport combine harvesters to distant farms and afford the cost of purchasing or renting them for personal use. As a result, combine harvesters are often rented rather than purchased by farmers, reflecting the financial constraints faced by individual farmers. Addressing the high cost and accessibility issues associated with combine harvesters is essential for promoting mechanized harvesting and improving agricultural productivity. Measures such as government subsidies, leasing programs, and cooperative arrangements among farmers can help make combine harvesters more affordable and accessible to a wider range of agricultural producers. Overall, while combine harvesters offer significant benefits in terms of operational efficiency and productivity, the high cost of acquisition remains a significant barrier to adoption for many farmers. By addressing cost and accessibility challenges, stakeholders can facilitate the widespread adoption of mechanized harvesting technologies, ultimately contributing to improved efficiency and sustainability in agriculture.

5. Conclusion

Based on the findings, the researchers were able draw the following conclusions: According to the results, it concluded that majority of the respondents have been operating for around twenty years and owned one hectare of land that they cultivated twice a year and harvested not more than eighty-six rice sacks per hectare.

In agricultural mechanization, it concluded that plowing machines helps remove clods from the soil, transplanting rice seedlings and applying chemicals using machine can saves time. Harvester machine is suitable in small and large farmland for harvesting and may help farmers to save time, effort and total cost requirements.

Based on the findings, the researchers are able to provide the following recommendations:

Farmers who have sufficient fund and capital and who are not yet engaged in the use of modern agricultural machineries, should investment in the said use of technology. It will make their production effective and efficient.

Farmers should attend and participate in different trainings and seminar about the use of modern agricultural machineries to increase their knowledge and expertise in the said technology. It will be an edge for them to have this knowledge for them to compete in the market.

Government may conduct seminar and trainings to beginning farmers on the proper utilization of modern agricultural machineries and its benefits to business technical aspect of the farmers. Also, government and non-government organizations are encouraged to support the local farmers in terms of grants and subsidies to implement full production of modern agricultural technologies.

Utilization of modern agricultural machineries has a relationship when it comes to rice production. This study recommends that students who are in the technical vocational livelihood strands continue their study in a higher level to increase their interests and knowledge in terms of modern agricultural machineries. The country will be benefited by these future agriculturists.

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For the future researchers, this study recommends to re-examine utilization of modern agricultural machineries in other crops in the province of Nueva Ecija, and to differentiate its result from this study.

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