Int. j. adv. multidisc. res. stud. 2024; 4(3):490-501

Received: 01-04-2024
Accepted: 11-05-2024

International Journal of Advanced Multidisciplinary Research and Studies

ISSN: 2583-049X

Seed for the Future: Agricultural Advancement and Innovation for Sustainability Food Systems in Tanza, Cavite

[1] Bansagan Kyla Trish, [2] Janapin Zeneth, [3] Patatag Mae, [4] Macanet April, [5] Lazaro Bryan Louis G
[1, 2, 3, 4, 5] Noveleta Senior High School, Noveleta, Cavite, Philippines

DOI: https://doi.org/10.62225/2583049X.2024.4.3.2814
Corresponding Author: **Bansagan Kyla Trish**

Abstract
Through the perspectives and adaptations of local farmers, this qualitative case study explores agricultural innovations and progress toward sustainable food systems in Tanza, Cavite. Using purposive sampling, the study included eight participants to investigate several important topics, including technology integration, the role of institutions and the government, and the continuous improvement of processes within the agricultural community. Six main themes are revealed by the results: an evolution from conventional to organic farming methods; the technological revolution enhancing productivity; overcoming challenges by innovative solutions; substantial government support affecting agricultural practices; the value of lifelong learning for ongoing development; and innovative farming methods such as the "rap giant" approach. These themes show how Tanza, Cavite, is experiencing a dynamic transition to more efficient and sustainable farming methods, supported by technology and legal structures that improve production, environmental sustainability, and community well-being.

Keywords: Agricultural, Farming, Methods, Sustainable, Technology

Introduction

There has been a significant slowdown in the growth of Agricultural production. The global yield of major grain crops is only about 1% per year, much lower than the world population growth (Hemathilake & Gunathilake, 2022) [18]. Agriculture significantly contributes to the economic system, and it has been producing crucial foodstuffs for decades (Ismail, 2021) [20].

In addition, Agricultural practices that promote the development of agriculture in an environmentally responsible way are referred to as sustainability farming. These procedures reduce the use of resources. Sustainable agricultural practices are being developed to replace traditional farming practices and minimize the use of natural resources and human capital. They also include the elimination of tillage, Integrated Pest Management, and so forth (Tang, 2020) [41].

The most important keys to ensuring the sustainability of food production are technologies that conserve agricultural resources. The adoption of such input-intensive farming practices frequently causes input-intensive nutrient depletions. The use of modern heavy farm implements like the combine harvester, rotavator, and seed cum fertilizer drill is increasing day by day (Sarkar *et al*., 2020) [38].

According to the Food and Agriculture Organization of the United Nations (2024), agriculture has struggled to fulfill the rising food demand due to a shortage of arable land and environmental stressors, including different challenges that food and agriculture production systems have been facing, such as increasing demand for the continuously growing population, rising hunger, and malnutrition, adverse climate change effects, overexploitation of natural resources, loss of biodiversity, and food loss and waste.

Therefore, the lack of land in areas with severe population pressures leads to a reduction or elimination of the sowing season, soil fertility decreasing, and farm income falling due to property fragmentation. In addition, landless people or run small farms intrude on natural forests to find additional undeveloped land, which modifies the environment's carbon source-sink dynamics. Furthermore, not only does low farm income make food insecurity worse, but it also makes it more difficult for small farms to implement some adaptation technologies to climate change (Maja & Ayano, 2021) [30].

Several farming areas are particularly affected by changes in climate patterns. The effects of climate change on soil salinity are susceptible in semiarid, coastal, and desert agricultural regions (Corwin, 2020) [10]. Regarding lowering the use of natural resources, waste and loss reductions reduce the amount of water and land use, but their efficacy is diminished by

environmental impact heterogeneity. If losses in the value chain result in ecological damage downstream, the effectiveness of waste reduction will be enhanced compared to cuts in loss. However, horizontal heterogeneity in the supply chain along the value chain also mitigates this (Cattaneo *et al*., 2021) [8].

As global worries about climate change, population expansion, and food scarcity mount, there is a pressing need to create effective techniques for implementing agricultural practices that promote both sustainability and ecological well-being, including the production of sufficient and stable human food, feed, and fiber to meet the needs of an overflowing population.

This study will look at the many initiatives taken by people and organizations aiming to improve farming techniques and practices and create a food system that benefits both current and future generations while balancing economic, environmental, and social factors, including the development of sustainable agriculture, such as reducing adverse effects on the environment, protecting precious natural resources, and enhancing resilience against shock in the future and involving nutritious and healthy foods by facilitating the ingestion of a wide variety of secure, nutritious, and healthy foods.

This study's outcomes may guide policymakers when formulating comprehensive policy recommendations aligned with long-term goals focused on achieving beneficial objectives, completing the mission successfully, achieving the milestone benchmark breakthrough, and attaining targeted achievement

Objectives of the Study

This qualitative research aims to investigate and study the agricultural innovations and advancement for the food system's sustainability in Tanza Cavite. This research sought to answer the following specific questions, (1) determine how local farmers perceive the challenges associated with traditional agricultural practices; (2) identify what factors influence their adoption of new sustainable agricultural innovations; (3) determine the innovative agricultural practices and technologies that are currently being implemented or explored by farmers, agricultural cooperatives, and other stakeholders; (4) identify how these practices impact productivity, environmental sustainability, and community well-being; (5) determine how local institutions, policies, and support systems (government agencies, NGOs, agricultural extension services, etc.) affect the adoption of agricultural innovations for sustainable food systems; (6) identify what insights can be learned from successful examples of community-driven agricultural innovation and collaboration.

Materials and Methods

This article provides a comprehensive overview of qualitative research, particularly focusing on the case study methodology. It underscores the significance of qualitative approaches in understanding human emotions and behaviors, especially in complex fields like agriculture. The case study method is an in-depth analysis of a specific subject that offers rich, contextual insights. According to Adam (2020), case study methods allow researchers to obtain detailed, descriptive information about participants' viewpoints, experiences, and surroundings. While acknowledging the subjectivity and the challenges in generalizing findings, the article also highlights the value of case studies for gaining detailed knowledge about specific events. The discussion extends to modern techniques such as precision farming and innovative systems like vertical farming, emphasizing their role in enhancing agricultural sustainability. The primary aim of the article is to equip students and novice researchers with a clear understanding of qualitative research principles and their application in real-world scenarios, mainly through the use of case studies.

In terms of data gathering, the procedure involves semi-structured interviews with ten farmers from Tanza, Cavite, aiming to understand their challenges, current practices, and potential solutions for improving farming operations. The process includes defining research objectives, identifying the target population, creating interview questions, conducting a pilot test, choosing participants, arranging and carrying out interviews, recording the interviews, organizing and analyzing the data, verifying the results, and reporting and distributing the findings. This method ensures flexibility, consistency, and credibility in collecting and analyzing data.

The study uses purposive sampling to select eight experienced farmers aged 20 and above from Tanza, Cavite, focusing on those likely to have relevant experiences. Purposive sampling is frequent in qualitative and mixed-methods research. It is especially effective when looking for information-rich situations or making the most of limited resources, but it is prone to research flaws such as observer bias (Nikolopoulou, 2023). Thematic analysis is employed to analyze the data, identifying patterns and themes that provide insights into sustainable agriculture in Tanza. This analysis is usually used to describe a group of texts, such as an interview, or collection of transcript. It examines how the reported information relates to specific research questions or prompts a fresh conceptual or theoretical comprehension (Lochmiller, 2021) [27]. The gathered data will go through a coding process in order to generate codes. The coding procedure determines how all of the responses they collected are transcriptional.

Results and Discussion

This section follows the qualitative approach and provides the analysis and interpretation of the study on the research problem. The content of this chapter is the responses of the participants gathered through a personal interview method. Through the interview, participants were able to answer the set of questions.

Theme 1: The Evolution of Farming Practices

This theme investigates and explores the evolution of agricultural practices, emphasizing traditional farming methods and organic traditional farming methods, which implement environmentally sustainable concepts. It includes the traditional methods some farmers still use and the advantages of organic agricultural processes. The core idea is that different strategies, procedures, methods, and promotion practices contribute to more sustainable agriculture.

Traditional and Organic Farming: Organic farming is an environmentally friendly and sustainable agricultural practice that supports health, resource conservation, protecting the environment, and product quality improvement (Parajuli *et al*., 2020) [33]. However, because of their natural advantages and less harmful effects, traditional

farming practices are frequently employed by farmers searching for environmentally beneficial methods (Acheampong *et al*., 2022) [1]. Based on these studies, both traditional and organic farming is widely used in agriculture to preserve resources, maintain the environment, and enhance output. However, conventional farming requires the use of both chemical and manual labor. According to Niko,

> *"Naka depende ako sa mga marunong na ka-edad kong tradition farmer…so conventional farming yung ginawa ko dahil halos tatlong taon na naka depende ako sa kemikal, sa mga synthetic atsaka dun sa mga paraan na manual"*

The statement emphasizes the use of traditional farming techniques is stable and sustainable when facing such a shortage of resources and climate change. By preserving soil, water, and crop forms, these strategies illustrate a comprehensive approach to agriculture that promotes the sustainability of agroecosystems (Katel *et al*., 2022; Bisht *et al*., 2020) [24, 7]. The findings support the conventional agricultural techniques that Niko employed, such as manual work and the use of synthetics and pesticides. This approach used to be more reliable and resilient.

Additionally, other farmers prefer traditional methods, such as manual methods, including old equipment. Ignacio said that,

> *"Ang pagtatanim namin dito Mano Mano, tulad Nung paggamit ng asada, sariling bungkal"*

This statement concerns manual techniques that require active participation and include old-fashioned, self-working tools; there is still an affection for manual methods. The preference could result from the control and comfort that come with human activities compared to the idea that machines are less demanding or intimate. Furthermore, it is well known that organic and chemical-free farming methods are prioritized in traditional farming systems, which is consistent with ecological sustainability principles (Acheampong *et al*., 2022) [1].

On the other hand, Livestock farming as part of agricultural farming is where different kinds of animals have been taken care of including pigs, cows, chickens and carabaos. Freddy shared that,

> *"Marami na kasi akong na kuwanan eh katulad ng pag-aalaga ng baboy napasali ako dun ang pag-aalaga ng baboy sa organic din yun"*

The statement is about his vast expertise raising organic animals, with a particular focus on pig care. They studied animal health, productivity, and efficiency, demonstrating the value of sustainable farming practices in modern society. Sharma *et al*. (2021) state that this method facilitates the monitoring and identification of livestock, which is very beneficial for animal welfare and growth monitoring.

Promoting and Practicing Organic Farming: By keeping the environment's natural cycles for recovery, enhancing the amount of organic materials used in agricultural techniques could mitigate harmful effects on the environment. Food quality may also be enhanced by organic farming. The use of chemical pesticides, fertilizers, growth hormones, and feed additives for animal production may be mostly avoided in organic farming. If more farmers embrace organic farming methods, the productivity differences that have been shown could increase even more because organic farming requires more knowledge (Gamage *et al*., 2023) [16]. These studies discuss the potential advantages of organic agricultural practices for food quality and environmental sustainability. Including improvements in human health, environmental protection, and sustainable agriculture. Luis stated that,

> *"Sa pamamaraan, dahil nung nasa Department of Agriculture ako ay organic farming na ang ipinaaalam namin sa mga magsasaka kaya yun nadin ang ginawa kong daan sa pagsasaka"*

Gaining greater knowledge concerning the uptake of organic farming can help you manage it more skillfully. To encourage the adoption of organic farming, agricultural educators play a crucial role in information exchange, training, and encouraging conventional farmers to convert to organic farming (Sapbamrer & Thammachai, 2021) [39]. This study backs up Luis' claim that they were inspired to employ such methods in their farming plans based on their personal experience and the background information they have gained from their time in the agricultural industry.

The advantages of organic practice enhance the popularity and sustainability. A significant benefit is the possibility of increased income for farmers and decreased external input costs, which results in improved profitability. Moreover, through the creation of more employment opportunities and an increase in people's purchasing power, organic farming can contribute to food security (Chiphang *et al*., 2022) [9]. Its contributions to food security are crucial as they facilitate employment creation and enhance purchasing power. Niko said that,

> *"Kung gumagamit ka parin ng chemical o synthetic, makakabawas ka nang gastos dahil gumagamit ka ng organic at napapaganda mo pa yung ano…napapaganda mo yung…uh yung lupa atsaka s'yempre yung. Nagiging friendly ka doon sa ating kalikasan"*

Moreover, Luis shares the same perspective on using organic practices. They believe that organic farming is eco-friendly and reduces the financial needs for farming. He stated that,

> *"sa organic farming kumukondisyon yung lupa at gumaganda yung mga pananim…di na gumagastos ng malaki, nakakabawas narinng gastos dahil mababa lang ang halaga ng organic farming, sa mga bagong pamamaraan ay nakukuha nalang namin minsan dito sa…tabi tabi nalang yung mga ginagawa naming pataba"*

Additionally, according to Ignacio's statement, organic practices improve crop yields and make harvesting more accessible, including the well-monitored crops. He said that,

> *"Pag chemical. Mas napapadali yung pag aani, at nababantayan ng maayos ang tanim"*

According to Pouil (2023) [35], organic farming has numerous advantages, such as better soil and water quality, increased biodiversity, and environmental conservation. Research has demonstrated that organic farming encourages just interactions and a high standard of living for every individual involved. The study's support statement suggests that using chemicals in agriculture can have benefits, such as making harvesting more accessible and improving crop monitoring. Moreover, the advantage of organic output compared to their synthetic or chemical counterparts focuses on their potential to enhance soil quality and decrease costs. In addition, adopting organic alternatives can improve soil quality through the local production of fertilizers. And contribute positively to the environment.

Applying an efficient organic process**.** Enhancing agricultural organization management is crucial for raising the effectiveness of organic farming. Organic fertilizers enhance the soil with organic matter and micronutrients, improving soil structure and moisture retention, and supplying plants with vital nutrients in a slow-release form (Gao *et al*., 2020) [37]. The study emphasizes the benefits of organic fertilizers, such as wood vinegar, in agriculture as a cost-effective, eco-friendly alternative to chemical fertilizers. Luis stated that,

> *"Kasi sa organic fertilizer hindi na masyadong magastos, ang organic fertilizer ginagamit namin kapag magtatanim, tulad ng wood vinegar, pagnag tatanim nag I spray kami"*

Therefore, Cesar states that agricultural practices have changed from traditional to modern methods. He said that,

> *"And then sa mga pataba, dati traditional lang yung mga ano lang ba mga tae tae, ngayon gumagamit na ng fertilizer gaya ng 'Ureya' tsaka yung 'Umplet' so ayun mas mabilis yung pagtubo ng halaman nun"*

The statements indicate a move toward more effective and economical fertilization techniques. Expressly, they point to a shift in agricultural practices away from traditional manure and toward contemporary synthetic fertilizers like "Urea" and "Complete," as well as a preference for organic fertilizers like wood vinegar during planting. Conventional farming methods have always been essential to agricultural systems worldwide. To increase productivity and sustainability, however, combining old knowledge with contemporary methods has grown increasingly common (Helfand & Taylor, 2021) [19]. Therefore, conventional farming has been improved to modern agriculture using technologies and practices.

Traditional agricultural methods have been an essential component of agriculture for several generations. They preserve a wealth of information that has been passed down through the centuries. These practices, firmly founded in regional customs and traditions, often use sustainable methods that prioritize environmental harmony and community well-being. Research has shown that using traditional farming methods promotes biodiversity, delivers year-round crops, and considerably reduces the need for agrochemicals (Bisht *et al*., 2020) [7]. Traditional agricultural methods' typical components are manual work that depends on essentials and follow-through to generational practices passed down verbally or by demonstration. Freddie said that,

> "*ang ginagawa ko ay sibling tray para pagka yung pag inilagay buhay na siya, buhay na siya hindi yung katulad nung sa, sa. Magsisimula sa buto, pagka kasi sa buto pa nanggagaling… minsan marami kang kalaban dun eh"*

Other farmers have used Manual labor, as they were what they have been learning since they started farming. According to Mikhaylov *et al*. (2023) [29], manual farming has been a significant component of agriculture. Historically, methods like planting, harvesting, and weeding were primarily performed by hand. Freddie outlines his work on a sibling tray, where they assure that once something is placed there, it quickly comes to life, as opposed to starting from the bone, where there are sometimes many adversaries. These methods are mainly used by farmers, especially the traditional farmers. Moreover, conventional farming is often used to sustain environmental needs and community well-being.

Theme 2: The Technological Revolution in Agriculture

This theme pertains to the influence of technology on the agricultural industry, containing the benefits of technological advancements and their ongoing integration and adaptation into modern farming methods. And how this innovation and technology contribute to the enhancement and production of modern agriculture. This implies the advantages of researching, applying, and adapting according to various discoveries and technology.

Technology and Innovation in Farming: Technology and innovation are vital to agriculture's progress because they increase the reliability, productivity, and adaptability of food production. Multiple investigations have shown the importance of agricultural technology innovation in enhancing agricultural practices and enhancing public health (Liu *et al*., 2021; Usman *et al*., 2021). According to these studies, it is vital to promote the process, increase efficiency, and ensure the sustainability of the agricultural system. Farmers can improve productivity, decrease environmental harm, and ultimately enhance agricultural results by implementing innovative practices and technological advancements. Implementing technologies that farmers can adapt is crucial in enhancing food production sustainability. Niko stated that,

> *"Nagkaroon tayo mga makinarya atsaka nag pinag-aralan ko rin yung mga teknolohiyang inaalok ng departrantment of agriculture atsaka ng ibang ahensya ng gobyerno, so nakita ko na puwede s'yang i-adapt."*

It is crucial to consider a number of agricultural sector innovation and modernization strategies in order to research and apply agricultural machinery and technology in an efficient manner. Agricultural mechanization can experience advancements, including automated navigation, precise operations, and the incorporation of information technologies such as the Internet of Things, big data, and intelligent control. (Yin *et al*., 2022) [47]. The results of this study provide evidence to support utilizing agricultural mechanization and technologies to improve the sustainability, resilience, and efficiency of food production.

Participants in seminars acquire new insights regarding technology and the various uses of machinery that can be adopted by farmers to modernize agricultural practices. Cesar said that,

> *"Merong mga seminar na binibigay mga bagong kaalaman 'yon dun kami required kaming umattend doon kung may. Pagbabago sa technology ina-adapt din namin, ganun yung ginagawa namin"*

Seminars help farmers organize themselves to foster local adaptation and establish an environment appropriate to the utilization of conservation agriculture (Malhi *et al*., 2021) [28]. This study supports the advocates for a proactive learning process that involves attending seminars to learn about technological advancements, enabling participants to adapt and continue operations or development, and promoting continuous learning and adaptation to changing technology.

Several types of benefits that come with agricultural technology could alter farming practices and boost output. A notable benefit is the potential for significant cost savings and resource optimization. The application of artificial intelligence (AI) in the agricultural industry has the potential to mitigate various issues, including labor needs, working hours, soil compaction, and output costs (Mohr & Kühl, 2021). In agriculture, significant cost savings and increased productivity are possible with artificial intelligence. Luis stated that,

> *"Mayroon nang mga makinarya na galing sa gobyerno, tulad ng traktura, handtraktor, Yung traktura pang bungkal ng lupa, Yung handtraktor naman pang tubig sa palayan"*

Additionally, Gio also stated that they receive machinery and technologies that the government provides, including fertilizers.

> *"Ah ano tulad po ng. Itinutulong nila yung katulad po ng solar 'yan patubig yun malaking bagay yun sa'min, tapos yung katulad ng traktura hindi na kami mag mamanu manu pa yun malaking tulong 'yon tapos binibigay din ng ano. Minsan nabibigyan kami dito ng fertilizer mga binhi 'yon."*

In both statements, the government provides machinery that could aid producers in their modernization of agriculture. Technologies that were a big help to the farmer and free fertilization could lessen their expenses.

Combining organic farming practices with contemporary technology presents a potentially beneficial area for agricultural method improvement. Transparency, environmental sustainability, and productivity can all be improved in organic farming operations by utilizing digital agricultural technology, such as precision and smart farming (Duncan *et al*., 2022). This research emphasizes the effectiveness of integrating modern technology with organic practices, therefore raising agricultural systems' resilience, productivity, and efficiency. Various farmers employ modern technology like wood vinegar, composted barley, and organic fertilizer. Luis stated that,

> *"Gumagamit kami ng makabagong teknolohiya, gumagamit na lang kami ng barey compost, barely cost, wood vinegar, Isang uri ang food vinegar ng organic fertilizer"*

Furthermore, Ignacio implies the significant advancement in farming methods due to the introduction of modern technology towards more efficient and less labor-intensive approaches. He said that,

> *"Ngayon may makabago ng equipment tulad ng handtraktor, traktura na may kultibeytor, tulad Nung paglilinis ng damo, dati ginagamit halabas, Ngayon meron ng grass cutter"*

These claims generate emphasis to the various types of modern technology, such as machinery, that have been developing. It also states that old-fashioned materials have been improving with new and more accessible and productive use. Preservation agriculture uses various tools and processes to increase productivity and sustainability, including mechanical transplanters and zero tillage (Dev *et al*., 2023) [12]. Utilizing modern technologies will benefit the productivity of agricultural systems.

Effective Planting with Advanced Equipment. Despite familiarity with agricultural operations, the agricultural business is becoming more data-centric and requires precise, advanced data and technologies than ever before. The Internet of Things (IoT) is one of the many information and communication technologies that are advancing the agriculture business (Nawab *et al*., 2021). Seeds can be planted at the correct depth and spacing using tractors equipped with accuracy planting systems and soil sensors. These devices can also monitor soil conditions and modify planting procedures as necessary. This contributes to improving the crop development potential of the permeable soil. Cesar said that,

> "*Sa ngayon gumagamit kami ng. Panibagong fertilizer sa pagsaka yung pag-araro meron ng ano traktura….So mabilis 'yon, dati kasi kalabaw, ngayon traktura na siya, so mabilis na yung paga-gawa n'ya."*

In addition, Ignacio said that the previous agricultural practice was so successful that it was replaced by machinery despite being extremely challenging.

> "*Yung sinaunang gamit medyo mahirap talaga kasi syempri Mano Mano mapapagod ka talaga, Hindi tulad ngayon palibhasa may makabago ng equipment, Ngayon gumagamit na kami ng dimakina"*

Freddy's statement highlights the use of machinery for the purpose of plowing the soil. He said that,

> *"Sa pag gamit ng traktora ano…binunuhaghag nito un lupa"*

When a tractor is used in agriculture, its heavy machinery applies pressure to the soil, breaking up compacted layers and creating voids between soil particles. This loosening of

the soil promotes better root growth for crops and increases water infiltration, hence improving overall soil health and production. Mechanization has been shown to improve agricultural productivity and economic results by having a favorable effect on various crop types' costs, output values, revenue, and return puts (Peng *et al*., 2022) [36]. This study highlights the advantage of machinery toward sustainable agriculture and modern farming.

Theme 3: Overcoming Obstacles in Agriculture

This theme includes a broad range of challenges that farmers as well as other agricultural professionals encounter, along with the strategies they use to deal with them. Ultimately, by addressing challenges in the agricultural sector, we will unlock its potential to feed the growing global population, reduce poverty, and encourage rural development—all the while protecting the environment for coming generations.

Challenges and Solutions in Farming: Factors like lack of land, water and access to capital restricted food production in many regions are one of the challenges in farming. However, as the population grows, farmers are leaving their lands fallow less and less. To meet the demand, the majority of small-scale farmers plant once a year, which causes significant loss of nutrients and soil erosion. As a result, these farmers are forced to give up farming and move to new territory in order to continue the process (Jouzi *et al*., 2017) [21]. Innovative solutions are available to address them and by adopting leveraging technology, the agricultural industry has the potential to improve in sustainability, resilience, and ability to provide the world's increasing food needs in a changing environment (Doshi *et al*., 2020). Niko said that,

> *"Sobrang tinamaan yung. Halaga ng ating mga ginagamit na fertilizer, dahil ang Pilipinas naka depende sa. Ibang bansa doon sa mga synthetic fertilizer. So dun talaga nahirapan ang. Karami- ang halos lahat ng ating farmer kasi ang ating mga farmer halos na sa tansya ko. 95 o 98% ng farmer natin ay naka depende sa chemical at synthetic."*

The statement emphasizes an issue of the Philippine agriculture industry, specifically the impact on farmers of relying on imported synthetic fertilizer. Additionally, it refers to the issue of increased fertilizer costs and shortages, which put farmers through hardship and lower output and income.

> *"Nagmahal nang. Husto halos nagdoble triple ang presyo, samantalang ang halaga naman ng produkto ay hindi naman nagbabago"*

In order to offer beneficial solutions for farmers, it is critical to confront the challenges and obstacles that hinder the implementation of agricultural technology. The distribution of agricultural innovations to producers is an essential component (Aldillah & Wahyuni, 2021). This study emphasizes the criticality of surpassing barriers in order to implement agricultural technology effectively and guarantee rapid delivery of innovations to producers. Farmers share their knowledge in different ways. Some prefer investigating and trying the said practices before offering them to others. Others use seminars and share knowledge practices by hosting, and some of them teach other farmers who need their help manually.

However, Niko stated that the experience of offering beneficial solutions to others is by investigating before sharing methods.

> *"So pagnakita namin na s'ya ay…makakatulong o effective naman, so saka pa lang namin s'ya ino-offer sa. Ibang farmer."*

Then, Luis provided seminars to her co-farmers to share his new knowledge so that everyone could adapt.

> *"Nagpapatawag ng pulong para ipaalam at malaman ng lahat kung paano gagamitin yung makabagong pamamaraan."*

Lastly, Freddy prefers manually teaching and providing suggestions to his co-farmers.

> *"Kung halimbawa uh. Merong i-spray sila kahit pesticide na papatayin nila yung.. i-sprayan nila… na hindi naman nawawala, sabi ko uh binibigyan ko sila ng suggest na… pag mag i-spray kayo hapon"*

Modern technology adoption and farming practice advancement depend on the exchange of agricultural information. According to Norton and Alwang (2020) [32], agricultural extension services are crucial in helping farmers receive information from research, facilitating knowledge transfer, and enhancing management techniques. This supports the statements about the various approaches farmers employ to share their knowledge, encompassing self-discovery, seminars, and direct instruction to enhance the agricultural community and advance farming techniques. Fulfilling the demands sufficiently. The algorithm allows clients to adjust privacy parameters based on data sensitivity, providing personalized privacy protection. A strict privacy proof and simulation on synthetic and real data sets have demonstrated the scheme's success in producing high-quality models and fulfilling privacy protection demands (Xiaoying *et al*., 2023). Expectations to a demand on it. Luis said that,

> *"Sapat naman yun at Ang aming kasamahan kahit maraming sinu suplayan"*

In the context of supplies, sustainable agriculture refers to maintaining the availability and quality of resources along the supply chain while guaranteeing the long-term profitability of agricultural operations. As an illustration of the increased interest in incorporating sustainability practices into agricultural operations, Kamble *et al*. (2020) [23] highlight the need for sustainable performance in data-driven agriculture supply chains.It generally involves a combination of elements such as effective land management, suitable crop selection, exploitation of current technologies, and sustainable farming methods to meet market needs while guaranteeing environmental stewardship.

Theme 4: The Role of Government in Agriculture

This theme looks at the several ways the government supports and influences agricultural practices. Through a variety of programs, including financial aid, policy

formulation, and the provision of machinery and equipment, organizations worldwide have a substantial impact on agricultural practices. This theme's primary goal is to encourage the execution of government initiatives and services, including funding, equipment, and help.

Government Support and Policies: The policies and support of the government have a considerable impact on the agriculture sector (Laborde *et al*., 2021). On the other hand, government regulations may have a big influence on the adoption of creative farming techniques (Clune, 2020). These studies emphasize the influence of various organizations by providing seminars and assistance in newly implemented practices. Agricultural organizations such as LGU, DAR, and MIA greatly help farmers by providing assistance and support. Luis said that,

> *"suportado naman kami ng LGU, ng Department of agriculture, at Hindi lang Department of agriculture ang Nakakatulong sa Amin halos lahat ng ahensya nag departamento, tulad ng MIA at DAR ay Nakakatulong din sa Amin ng Malaki"*

Receiving assistance from government organizations: Farmers could find these cooperatives very helpful in enhancing their productivity and overcoming obstacles in the agricultural industry. Moreover, studies have demonstrated that organizations that provide technical assistance substantially improve agricultural productivity across numerous locations (Franco *et al*., 2021). Farmers can increase their output and productivity by utilizing the knowledge and tools supplied by these organizations. This study supports Luis' statement that organizations are helpful in enhancing their productivity and overcoming obstacles in the agricultural industry.

Furthermore, certain organizations received assistance in the form of complimentary seedlings, fertilizers, equipment, and trucks, all of which they put to use in an innovative method. Cesar stated that,

> *"Merong samahan na magsasaka na tinatawag nilang 'tres cruses agrarian reform beneficiares' doon sa samahan na 'yon lahat ng. Tulong galing gobyerno pinaparating sa mga bawat miyembro gaya ng buto, yun yung buto na pinamimigay libre 'yon, tapos mga fertilizer libre rin 'yon halos lahat ng. Equipment libre din yung pinagbibigayan ng gobyerno, kahit 'yong traktura na ginagamit meron din tayo galing gobyerno 'yon."*

This statement emphasizes the role of this organization in facilitating government assistance for individual producers. The aid provided by the government consists of the provision of free seeds, fertilizers, and agricultural items to every member. Additionally, this assistance includes the provision of trucks. The profitability of early globalizing enterprises can be positively impacted by individual government and nongovernment support, according to Faroque *et al*. (2021) [14], with the size and age of the firms reducing these benefits. The objective of such assistance is to strengthen agricultural methodologies and increase the output of producers.

Obtaining machinery regularly offered by governments to aid farmers in need is standard (Liu *et al*., 202). This study highlights the standard equipment and support that the government offers to assist farmers. Luis stated that,

> *"Mayroon nang mga makinarya na galing sa gobyerno, tulad ng traktura, handtraktor, Yung traktura pang bungkal ng lupa, yung handtraktor naman pang tubig sa palayan."*

Governments offer financial incentives known as farm machinery subsidies, or equipment and machinery for agriculture purchase subsidies, to motivate farmers to acquire innovative agricultural machinery (Yang *et al*., 2023) [46]. This supports Luis statement, the advantage of machinery that the government provides with different uses as it helps farmers in sustainable agricultural farming.

Additionally, Maria states the significant reductions in the gardening budget due to financial restrictions. This condition resembles our current predicament. She said,

> *"Sa financial, tulad nyan binibigyan kami Malaki Ang kabawasan sa pag hahalaman namin tulad ngayon"*

Financial aid provided by the government. This discusses the state regulation of agricultural firms globally and financial support. It highlights two programs in economically developed countries: state subsidies when commodity prices fall below a predetermined amount and income of agricultural enterprises below a specified amount (Dustova, 2023). Subsidies generated by commodity price reductions, as well as income support for agricultural firms that fall below predetermined levels.

Supporting Agricultural Sales: By putting up market information systems, farmers may obtain up-to-date information on prices and demand and use that knowledge to make informed decisions about sales and output. Promotional activities help to raise awareness and distinguish local agricultural products, such as going to trade events and utilizing digital marketing. Supportive policies like lowered trade barriers and transit subsidies can further facilitate agricultural sales (De Andrade *et al*., 2023) [11]. This research included in this section most likely focus on tactics and initiatives intended to increase sales of agricultural products.

Meanwhile, Cesar's statement emphasizes the positive role of local government in supporting farmers by purchasing their produce. It shows that local farmers are supported and the local economy is strengthened by the purchasing and distribution of their products by the local government. Cesar stated that,

> *"Kahit papano yung mga na ha-harvest namin ang bumibili naman ay dito ng local na. Local goverment dito sa Tanza sila yung. Namimigay ng ating mga produkto so nakakatulong."*

On the other hand, Niko shares his steps in farming to seek guidance from expert friends and family members on what to plant and how to care for his crops. He relies on their knowledge to direct his farming operations. He said that,

> *"Unang ginawa ko lang nagtanong tanong dun ako sa kaibigan sa mga kamag-anakna. Mahuhusay sa pagsasaka…sa kanila ako naka depende kung ano yung dapat mong gawin sa aking pagtatanim."*

The significance of extension services in assisting smallholder farmers to address the numerous challenges of agricultural production cannot be overstated. To far, nevertheless, not much research has been done to assess how agricultural extension agents' capacities may be improved in order to better assist smallholder farmers in managing the risks and effects of climate change. Antwi-Agyei (2021) [34] aims to ascertain the most effective ways in which agricultural extension agents in Ghana may support smallholder farmers in navigating and minimizing the effects of climate change on food production. In an effort to strengthen smallholder farmers' capacity to support agricultural output, this article explores how agricultural extension agents can strengthen their abilities to assist smallholder farmers in managing the risks and effects of climate change.

Theme 5: Lifelong Learning in Agriculture

This theme points out farmers' commitment to enhancing their agricultural practices. Farmers continuously learn knowledge and adjust their methods to improve their harvests, minimize expenses, and establish sustainable agricultural requirements. The main idea of this theme is to demonstrate farmers' dedication to implementing sustainable agricultural methods.

Learning and Implementation in Farming: A comprehensive approach is necessary to enhance agricultural learning and implementation. According to Ha *et al*. (2020), community learning is essential to the use of production models that are climate-resilient. This study highlights how important it is to put methods-based initiatives into practice in order to improve agriculture education. Nevertheless, integrating recently learned information into climate-resilient technology is as important. To improve aspirations through adaptation learning in agriculture, one must understand and implement effective adaptation strategies. Adaptation from and endurance to climate change: Numerous studies can provide farmers with valuable information to enhance their agricultural practices (Alhassan, 2020). The aspiration of farmers in their farming could be a passion for them to improve their productivity even though they experience struggles. That's what Freddy stated.

> *"Pero mula noon di na ako sumali sa meeting meeting, pero naandun parin yun sa puso ko, kung paano ang mag produce, mag-gawa, mag. Magsarbad ng kuwan"*

Adoption of sustainable techniques has been found to be indicated by favorable beliefs about sustainable agriculture (Yacoub & Diab, 2021) [45]. This study implied in Freddy's statement that farmers passionate about farming were purely the process and the practices they used in their farming.

Implementing learned practices**.** Using artificial intelligence, smart farming tackles agriculture's sustainability issues. Water management, soil compatibility categorization, crop selection, and yield prediction all depend on machine learning, deep learning, and time series analysis. These methods are applied in the forecasting of crop yield production, crop demand, and commodities prices (Akkemi *et al*., 2023). These implemented practices had been investigated and adapted by the farmers. Moreover, other farmers use their new learning to lessen the cost in farming.

Meanwhile, Niko said all he does, and other farmers are applying it to their farms.

> *"Kasi lahat ng…pinag aaralan namin ginagawa din namin o ina-apply din namin sa bukid"*

Then, there were times that farmers doubted whether it was effective or not. Niko stated that,

> *"Kung makita mo na. Effective, why not hindi mo subukan"*

More of that, there were new ways in which they can use it on farms, so they can harvest quickly. Luis said that,

> *"Gumamit ako ng makabagong pamamaraan para iwas sa gastos, paramaganda din ang kita"*

On the other hand, when you think that you're still doing that seedling. Victor said that,

> *"Habang nag tatanim ka nag aaral ka, halimbawa sa ganitong season na ito ganito Yung kulang sa susunod na taon I a upgrade mo na"*

The negative effects of traditional farming techniques can be lessened by implementing sustainable practices in agriculture (Yacoub & Diab, 2021) [45]. The statements emphasize the use of new practice to better harvest, learn and apply the methods in farming to have a better output.

Prioritizing specific plant growth seasonal focuses: Setting aside time to plant and harvest particular plants requires a thorough understanding of the needs that each type of plant has, including those pertaining to temperature, sunlight, water, and nutrients. It is possible for farmers to create a planting calendar or schedule that specifies when agricultural activities must be carried out throughout the year, assuring that crops are grown during the most productive seasons (Fourcaud *et al*., 2020). These studies may focus on how this kind of tactical planning helps to increase yield and guarantee that crops are grown in the most productive seasons. Victor said that,

> *"Sa ganitong season nato, ganitong halaman yung mabilis paunlarin. Yun yung itatanim naming halaman, kasi dito sa atin pag tag ulan hindi basta basta magtatanim ng kamatis, sasi nanjan na masisira yung tanim, mabubulok yung tanim mo"*

The statement emphasizes how farmers change their planting choices to optimize production and reduce hazards in an achievable way.

Implementing Natural Farming Practices. An economical farming technique called Zero Budget Natural Farming (ZBNF) is being used in Andhra Pradesh, India. It focuses on lowering farmers' costs by enhancing yields and farm health with locally obtained, non-synthetic inputs. Through extension and training initiatives, the state hopes to introduce ZBNF to all 6 million farmers. According to data, ZBNF and non-ZBNF farmers differ significantly in their yields and incomes, which has a favorable effect on crop health and household well-being (2020). In order to ensure long-term agricultural sustainability, natural farming methods emphasize soil health and biodiversity over the use

of synthetic fertilizers and pesticides. It fortifies coordinating with natural processes to improve agricultural and environmental sustainability over the long run. Maria stated that,

> "kamatis tinatanim namin sa time ng tag Araw Yung ibang gulay naman pweding itanim sa tag ulan, tulad ng sitaw, okra, upon, Yan pwedi sa tag ulan Yan"

Moreover, the other does not use chemicals on the plants, thus it is critical to maintain them safe and unaffected. Ignacio said that,

> "Yung sarili naming pamamaraan tulad ng Hindi na kami gumagamit ng chemical, halimbawa sa insekto gumagamit na lang kami ng dinikdik na sili para di masyadong nakakaapekto sa halaman"

To promote a more ecological approach to agriculture, nature farming entails growing crops without artificial fertilizers and pesticides (Sinong *et al*., 2021) [40]. Instead, they use natural pesticides to prevent insects, causing minimal plant damage. Additionally, the importance of timing in vegetable gardening states that while tomatoes thrive in summer heat, vegetables take advantage of increased soil moisture levels for growth and development.

Theme 6: Unique and Specific Farming Techniques

This theme is based on unconventional farming techniques and creative approaches that outperform traditional ways. One innovative method of plant growth is the use of alternative farm products as food. The goal of this theme is to offer substitute agricultural products that farmers can use to lessen the usage of chemicals and their negative effects.

When adopting specific agricultural practices, farmers must consider various contributors and factors that impact their decision-making. The adoption of sustainable farming practices by smallholder farmers in different regions has been the subject of research, highlighting the main influences and challenges farmers encounter (Oyetunde-Usman *et al*., 2021). This study explains the complex method by which producers make decisions about adopting agricultural practices. In order to promote agricultural progress, it is essential to contemplate unique methods and processes that can facilitate the creation of alternative agricultural products. Insights from a multitude of studies can provide useful strategies in this process. Niko stated that,

> *"P-produce ng mga..uh…mga fertilizer na mga alternibong mga fertilizer saka mga polyar, mga pang spray, na nariyan lang sa paligid…eh..maka-makapagbabawas nang gastos"*

This statement pertained to the recent discovery of solutional practices as an appropriate replacement. The close distance of this affordable fertilizer and its discovery benefited the producers. Plants grow with a rap giant: The best growing conditions must be provided, pests and diseases must be successfully controlled, and soil fertility must be preserved by techniques like crop rotation and fertilizer (Altaf *et al*., 2023) [4]. However, other interacting factors also influence the use of farm chemicals. Freddy stated that,

> *"Marami na kasi sa kemikal kasi ngayon…merong marami na kasing kuwan eh marami na kasing lumalabas na… kaniya kaniyang kuwan eh, sa- sa kemikal kasi halimbawa katulad ng. Ng abono, pampabunga, pagkatapos lalagyan mo ng merong tinatawag na 'rap giant' para lumaki"*

According to Freddy's statement, chemicals are still widely used in agriculture nowadays, especially in fertilizers and growth boosters like "rap giant". In contemporary intensive agricultural systems, the use of chemical fertilizers in agriculture has become standard practice (Lin *et al*., 2020) [26]. It suggests that a good deal of farmers fertilize their crops and encourage plant growth by using different chemical products.

Soil preparation to harvest profits. It is essential to concentrate on soil preparation methods that improve soil quality and yield in order to maximize harvest profitability. Enhancing soil quality and raising profitability are largely dependent on proper soil accumulation achieved by proper preparation (Joseph, 2020) [22]. The study emphasizes the connection between soil quality and profitability, underscoring the significance of proper soil accumulation through effective preparation. Victor said that,

> *"Yung pamamaraan, Yung ihahanda mo Yung taniman, ikukundisyon mo Yung lupa,tapos Ipi prepare Kong paano gagamitin, Kong Anong klasing gulay Ang itatanim"*

Meanwhile, Gio shared his preparations with other farmers who needed his guidance. He said,

> *"Ganito po yung. May nagpupunta dito nagtatanong sa'min kung pa'no daw s'ya itanim, yun po tinuturo ko sa kanila. I-prepare mo muna nila ikama muna nila bago nila taniman"*

Additionally, Gio added his method in farming by planting a product, watered immediately, counting for a week, to know if the planted seed has germinated. He said,

> *"Tapos didiligin s'ya, pag ano uh Pag kalaglag namin ng binhi bibilang kami nang isang linggo bago s'ya sumibo"*

These statements emphasize the different methods that farmers conduct in their farming. The way the soil is prepared affects the growing circumstances that planted trees receive in an important manner. For example, in order to minimize the risk of seedling mortality during site preparation, the choice of soil scarification needs to be area-specific (Lidman *et al*., 2023) [25]. Farmers have their own way to prepare soil, however, the method they used is somehow based on their own investigation and adaptation in modern farming.

Conclusion

In summary, those involved in agriculture face a multitude of difficulties, including resource constraint, soil degradation, and dependency on artificial inputs. Nevertheless, creative approaches are being adopted to overcome these obstacles and introduce sustainable farming methods. Farmers are increasing productivity while

maintaining the integrity of the environment by integrating technology, sustainable practices, and continual education. These initiatives cover a variety of techniques, such as implementing Zero Budget Natural Farming (ZBNF) to reduce dependency on artificial inputs and embracing AI-driven smart farming for soil management. Furthermore, farmers use lifelong learning tools to improve their practices and adjust to changing agricultural landscapes, underscoring the significance of ongoing learning and adaptation.

Adoption of these advances is greatly aided by local policies and institutions. Support is given by government departments and agricultural associations in the form of grants, policy proposals, and tools and equipment. Extension programs help farms overcome obstacles and adopt sustainable practices even more. Despite challenges, community-driven cooperation promotes distinctive farming methods that are adapted to regional requirements and place a focus on biodiversity, soil health, and environmental sustainability. Tanza, Cavite is paving the way for resilient, effective, and sustainable agricultural systems that benefit farmers and the larger community by combining these strategies.

References

1. Acheampong EO, Sloan S, Sayer J, Macgregor CJ. African forest-fringe farmers benefit from modern farming practices despite high environmental impacts. Land. 2022; 11(2):145. Doi: https://doi.org/10.3390/land11020145
2. Akkem Y, Biswas SK, Varanasi A. Smart farming using artificial intelligence review. Engineering Applications of Artificial Intelligence. 2023; 120:105899. https://www.sciencedirect.com/science/article/abs/pii/S0952197623000830
3. Alam MK. A systematic qualitative case study: questions, data collection, NVivo analysis and saturation. Qualitative Research in Organizations and Management. 2020; 16(1):1-31. Doi: https://doi.org/10.1108/qrom-09-2019-1825
4. Altaf MA, Sharma N, Singh JB, Samota MK, Sankhyan P, Singh B, *et al*. Mechanistic insights on melatonin-mediated plant growth regulation and hormonal cross-talk process in solanaceous vegetables. Scientia Horticulturae. 2023; 308:111570. Doi: https://doi.org/10.1016/j.scienta.2022.111570
5. Antwi-Agyei P, Stringer LC. Improving the effectiveness of agricultural extension services in supporting farmers to adapt to climate change: Insights from northeastern Ghana. Climate Risk Management. 2021; 32:100304. https://www.sciencedirect.com/science/article/pii/S2212096321000334.
6. Bharucha ZP, Mitjans SB, Pretty J. Towards redesign at scale through zero budget natural farming in Andhra Pradesh, India. International Journal of Agricultural Sustainability. 2020; 18(1):1-20. https://www.tandfonline.com/doi/full/10.1080/14735903.2019.1694465
7. Bisht IS, Rana JC, Ahlawat SP. The future of smallholder farming in India: Some sustainability considerations. Sustainability. 2020; 12(9):3751. Doi: https://doi.org/10.3390/su12093751
8. Cattaneo A, Sánchez MV, Torero M, Vos R. Reducing food loss and waste: Five challenges for policy and research. Food Policy. 2021; 98:101974. Doi: https://doi.org/10.1016/j.foodpol.2020.101974
9. Chiphang S, Singh R, Feroze S. Is organic rice bean (vigna umbellata) farmers economically better off? An empirical analysis. IJEE. 2022; 58(1):17-20. Doi: https://doi.org/10.48165/ijee.2022.58104
10. Corwin DL. Climate change impacts on soil salinity in agricultural areas. European Journal of Soil Science. 2020; 72(2):842-862. Doi: https://doi.org/10.1111/ejss.13010
11. De Andrade LA, Santos CHB, Frezarin ET, Sales LR, Rigobelo EC. Plant Growth-Promoting rhizobacteria for sustainable agricultural production. Microorganisms. 2023; 11(4):1088. Doi: https://doi.org/10.3390/microorganisms11041088
12. Dev P, Khandelwal S, Yadav SC, Arya V, Mali HR, Poonam, *et al*. Conservation agriculture for sustainable agriculture. International Journal of Plant & Amp; Soil Science. 2023; 35(5):1-11. Doi: https://doi.org/10.9734/ijpss/2023/v35i52828
13. Ericson-Lidman E, Strandberg G. Meanings of being a change agent in implementing a new organisational culture in home care services: A phenomenological hermeneutic study. Nordic Journal of Nursing Research. 2023; 43(1):205715852311575. Doi: https://doi.org/10.1177/20571585231157505
14. Faroque A, Sultana H, Ahmed J, Ahmed F, Rahman M. The standalone and resource-bundling effects of government and nongovernment institutional support on early internationalizing firms' performance. Critical Perspectives on International Business. 2021; 18(3):411-442. Doi: https://doi.org/10.1108/cpoib-06-2020-0076
15. Fourcaud T, Zhang XP, Stokes A, Lambers H, Körner C. Plant Growth Modelling and applications: The increasing importance of plant architecture in growth models. Annals of Botany (Print). 2007; 101(8):1053-1063. Doi: https://doi.org/10.1093/aob/mcn050
16. Gamage A, Gangahagedara R, Gamage J, Jayasinghe N, Kodikara N, Suraweera P, *et al*. Role of organic farming for achieving sustainability in agriculture. Farming System. 2023; 1(1):100005. Doi: https://doi.org/10.1016/j.farsys.2023.100005
17. Gao C, El-Sawah AM, Ali DFI, Hamoud YA, Shaghaleh H, Sheteiwy MS. The Integration of Bio and Organic Fertilizers Improve Plant Growth, Grain Yield, Quality and Metabolism of Hybrid Maize (Zea mays L.). Agronomy. 2020b; 10(3):319. Doi: https://doi.org/10.3390/agronomy10030319
18. Hemathilake D, Gunathilake DMCC. Agricultural productivity and food supply to meet increased demands. In Elsevier eBooks. 2022; 539-553. Doi: https://doi.org/10.1016/b978-0-323-91001-9.00016-5
19. Helfand SM, Taylor M. The inverse relationship between farm size and productivity: Refocusing the debate. Food Policy. 2021; 99:101977. Doi: https://doi.org/10.1016/j.foodpol.2020.101977
20. Ismail M. What is agriculture and its importance, April 3, 2021? https://www.linkedin.com/pulse/what-agriculture-its-importance-muhammad-ismail
21. Jouzi Z, Azadi H, Taheri F, Zarafshani K, Gebrehiwot K, Van Passel S, *et al*. Organic Farming and Small-Scale Farmers: Main opportunities and challenges.

Ecological Economics. 2017; 132:144-154. Doi: https://doi.org/10.1016/j.ecolecon.2016.10.016
22. Joseph A. Novel methods for crop prediction based on influencing parameters in Indian regions using data mining. International Journal of Engineering and Advanced Technology. 2020; 9(3):3391-3398. Doi: https://doi.org/10.35940/ijeat.c6230.029320
23. Kamble S, Gunasekaran A, Gawankar S. Achieving sustainable performance in a data-driven agriculture supply chain: A review for research and applications. International Journal of Production Economics. 2020; 219:179-194. Doi: https://doi.org/10.1016/j.ijpe.2019.05.022
24. Katel S, Mandal HR, Subedi D, Koirala S, Timsina S, Poudel A. Climate smart agriculture for food security, adaptation, and migration: A review. Turkish Journal of Agriculture - Food Science and Technology. 2022; 10(8).
25. Lidman FD, Karlsson M, Lundmark T, Sängstuvall L, Holmström E. Birch establishes anywhere! So, what is there to know about natural regeneration and direct seeding of birch? New Forests. 2023; 55(1):157-171. Doi: https://doi.org/10.1007/s11056-023-09971-z
26. Lin Y, Zhao X, Bao E, Li J, Zou Z, Cao K. Bio-organic fertilizer with reduced rates of chemical fertilization improves soil fertility and enhances tomato yield and quality. Scientific Reports. 2020; 10(1). Doi: https://doi.org/10.1038/s41598-019-56954-2
27. Lochmiller CR. Conducting Thematic Analysis with Qualitative Data. The Qualitative Report, 2021. Doi: https://doi.org/10.46743/2160-3715/2021.5008
28. Malhi GS, Kaur M, Kaushik P. Impact of climate change on agriculture and its mitigation strategies: A review. Sustainability. 2021; 13(3):1318. Doi: https://doi.org/10.3390/su13031318
29. Mikhaylov DM, Iskandarov ZS, Grudovich EV, Rakovec IRI, Shazhaev S, Emam HGI, *et al*. Application of audio analysis in cultivated insect farms in uzbekistan. IOP Conference Series: Earth and Environmental Science. 2023; 1142(1):012102. Doi: https://doi.org/10.1088/1755-1315/1142/1/012102
30. Maja MM, Ayano SF. The impact of population growth on natural resources and farmers' capacity to adapt to climate change in Low-Income countries, 2021. https://www.semanticscholar.org/paper/The-Impact-of-Population-Growth-on-Natural-and-to-Maja-Ayano/2174b337cc68ec25c46e32582b8aa0fb25286178
31. Khan N, Ray RL, Sargani GR, Ihtidham M, Khayyam M. Current progress and future prospects of agriculture technology: Gateway to sustainable agriculture. Sustainability. 2021; 13(9):4883. https://www.mdpi.com/2071-1050/13/9/4883
32. Norton GW, Alwang J. Changes in agricultural extension and implications for farmer adoption of new practices. Applied Economic Perspectives and Policy. 2020; 42(1):8-20. Doi: https://doi.org/10.1002/aepp.13008
33. Parajuli S, Shrestha J, Ghimire S. Organic farming in Nepal: A viable option for food security and agricultural sustainability. Archives of Agriculture and Environmental Science. 2020; 5(2):223-230. Doi: https://doi.org/10.26832/24566632.2020.0502021
34. Antwi-Agyei P, Stringer LC. Improving the effectiveness of agricultural extension services in supporting farmers to adapt to climate change: Insights from northeastern Ghana. Climate Risk Management. 2021; 32:100304. https://www.sciencedirect.com/science/article/pii/S2212096321000334.
35. Pouil S. Assessing the environmental impacts of conventional and organic scenarios of rainbow trout farming in France, 2023. Doi: https://doi.org/10.1101/2023.09.15.557864
36. Peng J, Zhao Z, Liu D. Impact of agricultural mechanization on agricultural production, income, and mechanism: Evidence from Hubei province, china. Frontiers in Environmental Science. 2022; 10. Doi: https://doi.org/10.3389/fenvs.2022.838686
37. Gao C, El-Sawah AM, Ali DF, Alhaj Hamoud Y, Shaghaleh H, Sheteiwy MS. The integration of bio and organic fertilizers improve plant growth, grain yield, quality and metabolism of hybrid maize (Zea mays L.). Agronomy. 2020; 10(3):319. Doi: https://doi.org/10.3390/agronomy10030319
38. Sarkar S, Skalický M, Hossain A, Brestič M, Saha S, Garai S, *et al*. Management of crop residues for improving input use efficiency and agricultural sustainability. Sustainability. 2020; 12(23):9808. Doi: https://doi.org/10.3390/su12239808
39. Sapbamrer R, Thammachai A. A systematic review of factors influencing farmers' adoption of organic farming. Sustainability. 2021; 13(7):3842. Doi: https://doi.org/10.3390/su13073842
40. Sinong GF, Yasuda M, Nara Y, Lee CG, Dastogeer KMG, Tabuchi H, *et al*. Distinct root microbial communities in nature farming rice harbor bacterial strains with plant growth-promoting traits. Frontiers in Sustainable Food Systems. 2021; 4. Doi: https://doi.org/10.3389/fsufs.2020.629942\
41. Tang J. Sustainable Agriculture. ArcGIS StoryMaps, September 1, 2020. https://storymaps.arcgis.com/stories/8af8c2c735f14f0c85e7038c0c2b9dca
42. Tomaszewski L, Zarestky J, Gonzalez E. Planning Qualitative research: Design and decision making for new researchers. International Journal of Qualitative Methods. 2020; 19:160940692096717. Doi: https://doi.org/10.1177/1609406920967174
43. Shen X, Jiang H, Chen Y, Wang B, Gao L. Pldp-fl: Federated learning with personalized local differential privacy. Entropy. 2023; 25(3):485. https://www.mdpi.com/1099-4300/25/3/485
44. Akkem Y, Biswas SK, Varanasi A. Smart farming using artificial intelligence: A review. Engineering Applications of Artificial Intelligence. 2023; 120:105899. https://www.sciencedirect.com/science/article/abs/pii/S0952197623000830
45. Yacoub M, Diab A. Farmers' behavioral gaps concerning sustainable agriculture in kharga oasis, new valley governorate, Egypt. Alexandria Science Exchange Journal. 2021; 42(2):423-433. Doi: https://doi.org/10.21608/asejaiqjsae.2021.171647
46. Yang T, Chandio AA, Zhang A, Liu Y. Do farm subsidies effectively increase grain production? Evidence from major grain-producing regions of china. Foods. 2023; 12(7):1435. Doi: https://doi.org/10.3390/foods12071435

47. Yin S, Wang Y, Xu J. Developing a conceptual partner matching framework for digital green innovation of agricultural high-end equipment manufacturing system toward agriculture 5.0: A novel niche field model combined with fuzzy vikor. Frontiers in Psychology. 2022; 13. Doi: https://doi.org/10.3389/fpsyg.2022.924109
48. Bharucha ZP, Mitjans SB, Pretty J. Towards redesign at scale through zero budget natural farming in Andhra Pradesh, India. International Journal of Agricultural Sustainability. 2020; 18(1):1-20. https://www.tandfonline.com/doi/full/10.1080/14735903.2019.1694465