INVESTIGATING THE IMPACT OF AGROTECHNOLOGY ON THE FOOD SECURITY IN MALAYSIA

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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INVESTIGATING THE IMPACT OF AGROTECHNOLOGY ON THE FOOD SECURITY IN MALAYSIA.

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Report submitted in fulfilment of the requirement for the degree of Bachelor of Technology Management (Technology Innovation) with Honours

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DECLARATION

I declare that this thesis research project of title “Investigating the impact of agrotechnology on the Food Security in Malaysia”. is the result of my own research except the citied in the references. The research project has not been for any degree and is not concurrently submitted in candidature of any other degree.

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APPROVAL

I hereby declare that I have read this thesis research and in my opinion this thesis is sufficient in terms of scope and quality for the award of Bachelor of Technology Management and Technopreneurship with Honours

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/

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Date : 08 FEBRUARI 2024

DEDICATION

I would particularly like to thank my parents, CHIN CHUAN WEN and TAN CHUAN KEE, for their contributions to the success of this research project. This report will be dedicated to them because I wish to express my gratitude for the sacrifices, they made for me during my time at this university. The second recipients of this dedication are my siblings, who provided guidance, financial assistance, and moral support in the creation of this report. Next, I'd like to express my gratitude to my supervisor, Dr Murzidah binti Ahmad Murad, and to my companions who provided a great deal of assistance during the completion of this Final Year Project.

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Abstract

This study aims to investigate the impact of agrotechnology on food security in Malaysia by examining three key factors: agriculture practices, farmers' profile, and institution and market factors. Agrotechnology refers to the application of modern agricultural techniques, such as precision farming, biotechnology, and smart farming, to enhance productivity and efficiency in the agricultural sector. The study will employ a quantitative methods approach, combining quantitative surveys with farmers and agricultural experts. The data collected will be using encompass surveying, analysis of secondary data sources, and statistical analysis. By employing these techniques, can be gather comprehensive and reliable quantitative data to evaluate the effects of agrotechnology on food security indicators to identify the relationship between agrotechnology adoption and food security outcomes in Malaysia. The findings of this research will provide valuable insights into the impact of agrotechnology on food security in Malaysia. It will contribute to the development of evidence-based policies and strategies for promoting sustainable agricultural practices and improving food production, availability, and access in the country.

Abstract

Kajian ini bertujuan untuk menyelidik impak agroteknologi ke atas keselamatan makanan di Malaysia dengan meneliti tiga faktor utama: amalan pertanian, profil petani, dan faktor institusi dan pasaran. Agroteknologi merujuk kepada penggunaan teknik pertanian moden, seperti pertanian presisi, bioteknologi, dan pertanian pintar, untuk meningkatkan produktiviti dan kecekapan dalam sektor pertanian. Kajian ini akan menggunakan pendekatan kaedah kuantitatif, menggabungkan tinjauan kuantitatif dengan petani dan pakar pertanian. Data yang dikumpulkan akan menggunakan merangkumi tinjauan, analisis sumber data sekunder, dan analisis statistik. Dengan menggunakan teknik ini, boleh dikumpulkan data kuantitatif yang komprehensif dan boleh dipercayai untuk menilai kesan agroteknologi ke atas petunjuk keselamatan makanan untuk mengenal pasti hubungan antara penggunaan agroteknologi dan hasil keselamatan makanan di Malaysia. Penemuan penyelidikan ini akan memberikan pandangan berharga mengenai impak agroteknologi ke atas keselamatan makanan di Malaysia. kajian ini akan menyumbang kepada pembangunan dasar dan strategi berasaskan bukti untuk mempromosikan amalan pertanian yang mampan dan meningkatkan pengeluaran, ketersediaan, dan akses makanan di negara Malaysia.

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CHAPTER 1

INTRODUCTION

1.0 Introduction

The research chapter one will be discussed on the background of study related to the impact of agrotechnology on the food security in Malaysia. The research will be following by the development of problem statement, research questions, and research objectives, scope, limitation of research, significant of study and an overview of the study.

1.1 Background of Study

With the world's population growing too fast, foreign organizations and countries all over the world may need to work together to solve the problem of food security. Basically, every country is trying to make sure there is a steady amount of food to match every need, and this seems to be a big problem, especially in countries that are developing. Following by Thomas Malthus publication entitled (An Essay on the Principle of Population). Thomas Malthus has asked a question is whether these countries can keep up with rising food demand, and if so, for how long(London, 1998). He said that after a certain amount of time, our linearly increasing food supply will not be able to keep up with the rapidly increasing population.(Ran Abramitzky and Fabio Braggion, 2018)

Access to enough healthy food is an important and growing issue worldwide, and the COVID-19 pandemic has made it even worse. Up to 30% of the world's population may not have enough to eat by 2020, a 4% increase from the previous year, but with large variations across regions("The State of Food Security and Nutrition in the World 2021," 2021a). Food insecurity is highest in the African region, where more than half (59%) say they do not have easy access to food. The pandemic has hit hardest in Latin America and the Caribbean, where the number of people who don't have enough to eat has increased by nearly 10% in just over a year. Today, 41% of the population lives undernourished. In Asia, the number of people who don't know where their next meal will come from has increased between 3% and 26% in 2020("The State of Food Security and Nutrition in the World 2021," 2021a). The pandemic has shown how fragile our food systems are, especially in developing economies that depend on large-scale agriculture and foreign food trade. Without help, the number of undernourished people is projected to rise by another 10% by 2050, and even more in the event of another world catastrophe.

Rising food insecurity is not unique to Malaysia. Malaysia's low hunger score in the 2022 GHI, with a modest increase from 10.9 in 2014 to 12.5 in 2022 (Malaysia - Global Hunger Index (GHI) ,2022), may indicate increased food insecurity due to the pandemic. According to the 2014 Malaysian Adult Nutrition Survey, between 33% and 39% of low-income households experienced undernourishment at that time, affecting as many as 25% of the population (Ali Zainuddin et al., 2014). According to the study, a whopping 22% of respondents said they had skipped a meal or reduced the size of a meal due to lack of money, while 21% said they had had to provide their children with fewer food options(Ali Zainuddin et al., 2014). Given that stunting and wasting among Malaysian children have increased by 4% and 2%, respectively, since

2014 (Malaysia - Global Hunger Index (GHI) ,2014.), this prevalence is projected to be even higher by 2022. Over the next 40 years, Malaysia's food security gap is projected to increase to 40% if it does not provide an equitable supply of cheap and nutritious food (Ahmed et al., 2016).

The current research focuses on the impact of agrotechnology on Malaysia's food security. Malaysia, located in Southeast Asia, benefits from a warm climate with an average temperature of 25.4 degrees, facilitating year-round agricultural growth. While agriculture, forestry, and fishing were once the pillars of Malaysia's economy, their contribution to the country's GDP has declined significantly since the 1970s. The number of people working in farming has also decreased substantially. Rice, the main food crop, is predominantly grown on small farms, but yields have experienced a gradual decline over the years. The decrease can be attributed to adverse weather conditions and the migration of agricultural workers to urban industrial jobs. As a result, Malaysia relies on rice imports, mainly from Thailand, to meet its domestic demand. The research aims to explore how agrotechnology can address these challenges and enhance Malaysia's food security.(Malaysia - Rice Production, Rubber, Palm Oil, Forest Plantation Scheme | Britannica, 2020)

The socio-technical process of implementing technological innovations is called digitization and is becoming more and more common (Anitei et al., 2021). Digitization is expected to have a profound impact on everyday life(Yoo et al., 2010), agricultural productivity, and supply chains and systems for food, fibre, and bioenergy(M. J. Smith & Smith, 2018). Early signs of this transition are already evident. Different types of digitalization in agricultural production systems, value chains and food systems more generally present some ideas for the agricultural industry. These include smart(Blok & Gremmen, 2018), precision farming, decision-making farming, digital farming(Shepherd et al., 2020a), Agriculture 4.0(Smart Farming, 2022), and so-called digital agriculture. Whatever the precise term, digitization means management on and off the farm tasks in larger value chains and food systems focus on various types of data on location, weather, behaviour, phytosanitary status, consumption, energy use, prices and economic information to using sensors, machines, drones and satellites to monitor animals, soil, water, plants, and people. Through continuous monitoring or targeted big data scientific queries, use the collected data to analyse the past, predict the future, and make more timely or accurate judgments (Janssen et al., 2017).

Therefore, it is expected that the digitalization of agriculture will lead to technological optimization of food systems, value chains and production systems. Additionally, it has been suggested that it can help address social issues related to agriculture, such as food provenance and traceability, animal welfare in livestock farming, and the environmental impact of various agricultural practices (Balafoutis et al., 2017). Furthermore, digitization is expected to enhance the monitoring of crises and controversies in agricultural chains sectors and use of ubiquitous data for knowledge exchange and learning. There are high hopes for the further spread of digital technologies and their transformative potential (Shepherd et al., 2020). Over the past 20 years, the adoption of digital technologies has been most pronounced in the agricultural sector, such as planting and viticulture through precision farming techniques, and to a lesser extent in animal-based agriculture (Borchers & Bewley, 2015).

In conclusion, the issue of food security is a key global concern, especially in developing countries. Food insecurity has been exacerbated by the COVID-19 pandemic, with a large portion of the global population unable to get enough to eat. Malaysia, as a case study, faces its own challenges in ensuring food security. Food insecurity has increased in the country, especially during the COVID-19 pandemic. Changing food consumption patterns, reliance on imports and insufficient access to nutritious options all exacerbate the problem. Digitization and technological advances in agriculture offer opportunities to address food security challenges. Concepts such as precision agriculture, digital agriculture and data-driven decision-making can optimize food systems, increase productivity and address social and environmental issues. Adoption of digital technologies in agriculture has been on the rise, but further research and implementation are needed to realize their full transformative potential.

1.2 Problem Statement

In the past few years, the problem of food security has become more important as the world's population keeps growing and the effects of climate change get worse(Dawson et al., 2016). Malaysia is not an exception to these global trends. In the last few decades, the country's economy has grown a lot, but the farm sector has not kept up with this growth(Molotoks et al., 2021). This means that most of Malaysia's food needs are met by imports, which makes the country sensitive to changes in food prices around the world. Agrotechnology might be able to help solve some of the problems in Malaysia's farming industry. This includes increasing food yields, cutting down on crop losses caused by pests and diseases, and making the land more fertile. Agrotechnology, which is the application of science and technology to farmland to improve efficiency, output, and sustainability, is one possible answer to this issue(Hall et al., 2017). This can be done in many ways, such as by using genetically changed foods, precision agriculture, or digital tools to run farming operations. The goal of this study is to find out how agrotechnology affects Malaysia's food security.

Even though agrotechnology could be helpful, there are also worries about how it will affect small farms and rural areas. Many of these groups still use old ways of farming because they don't have the means to switch to new methods. There is also a chance that big farming companies will take over the market, putting smaller farms out of business and making the gap between rich and poor even wider(Agriculture Overview, 2023.). To fully understand how agrotechnology will affect Malaysia's food security, it is important to think about both the benefits and the risks. This needs a multidisciplinary method that considers the social, economic, and environmental issues that affect agriculture in Malaysia. One possible benefit of agrotechnology is that it can help to make more food, which can make food security better(McKinsey, 2023).

We will do surveys with farmers, officials, and other important people in the Malaysian agricultural field to get information. One possible benefit of agrotechnology is that it can help farmers make more food, which can improve food security by making sure there is more food to eat(Adopt Advanced Technology, AI to Boost Farm Yields and Ensure Food Security, 2023.). For example, precise agriculture methods like soil and weather sensors, crop modelling, and irrigation management systems can help farms maximise crop yields by reducing waste, minimising the use of inputs like fertiliser and water, and improving food quality.

But using agrotechnology in farmland could also have some negative effects. For instance, the use of genetically modified crops can cause people to worry about their safety and how they affect the environment, as well as the possibility of monopolies in the seed business. Also, digital tools and technology can make inequality in agriculture worse by lowering the need for manual labour, which could lead to farmers losing jobs and having different incomes. Given these possible pros and cons, it is important to think carefully about how agrotechnology will affect Malaysia's food security. This will take a thorough and nuanced look at all the things that affect food security, such as agricultural output, the price, availability, and safety of food, as well as other things.

In the end, the results of this study will have important effects on lawmakers and other people involved in the farming sector of Malaysia. By figuring out the possible pros and cons of agrotechnology and figuring out how it affects food security in Malaysia, we can come up with better policies and practises to make sure that everyone in Malaysia has access to safe, healthy food.

1.3 Research Questions

The research question is proposed in this study is:

1. What is the relationship between agricultural practices, with food security in Malaysia?
2. What is the relationship between profile of farmers, with food security in Malaysia?
3. What is the relationship between institution and market, with food security in Malaysia?

1.4 Research Objectives

The research objectives developed in this study are as follow:

1. To examine the relationship between agricultural practices with food security in Malaysia.
2. To examine the relationship between profile of farmers with food security in Malaysia.
3. To examine the relationship between institution and market with food security in Malaysia.

1.5 Scope of Research

The scope of research investigating the impact of agricultural technology on food security in Malaysia can be broad and multifaceted. Following are some potential areas to be considered within the scope of this study such like Agrotechnology Adoption. To assess the current status of adoption of agrotechnology practices such as precision farming, hydroponics, vertical farming and greenhouse cultivation in the

Malaysian agricultural sector to identify key factors influencing agrotechnology practices Factor in farmers' adoption rates and the challenges they face. Assessing the Feasibility and Benefits of Adopting Agricultural Technology for Smallholder Farmers in Malaysia. Analyse how technology transfer, capacity building programs and access to finance support small farmers in adopting and benefiting from agricultural technology practices, ultimately improving their livelihoods and food security. Analyse the socio-economic impacts of the adoption of agricultural technologies on different stakeholders, including farmers, consumers and wider society. Assess the affordability, accessibility and acceptability of agricultural technology-driven products and their impact on food prices, nutrition and food equity.

1.6 Significant of Study

Research investigating the impact of agricultural technology on food security in Malaysia has important implications in the field of agricultural management. Food security is a critical global issue and Malaysia is no exception. Ensuring adequate and sustainable food production is critical to the well-being and stability of nations. By investigating the impact of agricultural technology on food security, the study aims to identify ways to increase agricultural productivity, improve food availability and reduce dependence on imports. Agricultural technology refers to the use of advanced techniques, tools and knowledge to enhance agricultural practices. Understanding the impact of agricultural technology on food security in Malaysia can help identify specific interventions that can improve agricultural productivity. This includes studying the effectiveness of modern farming methods, precision agriculture, biotechnology, crop diversification and other technological advances. Researching the impact of agricultural technologies on food security involves assessing the sustainability of agricultural practices. Like many other countries, Malaysia faces challenges such as limited land supply, water scarcity, climate change and environmental degradation. The research could explore how agricultural technologies can contribute to sustainable agriculture by minimizing resource use, mitigating environmental impact and improving long-term resilience.

The findings of this study can inform policy makers, agricultural managers and stakeholders about the most effective strategies to improve food security. It can provide insights into resource allocation, R&D investment, policy development, and implementation of agricultural technology-driven programs. The research contributes to evidence-based decision-making and contributes to the development of agricultural policies and management practices in Malaysia. Enhancing food security through agricultural technologies can have a positive economic impact. By increasing agricultural productivity and reducing dependence on food imports, Malaysia can increase its self-sufficiency and reduce its economic burden. Additionally, advances in agricultural technology can lead to the development of new industries, job creation, and economic growth, thereby contributing to the overall prosperity of the nation.

In conclusion, studying the impact of agricultural technology on food security in Malaysia is of great value in addressing food security challenges, improving agricultural productivity, promoting sustainable practices, informing policy and management decisions, and promoting economic growth.

1.7 Conclusion

In conclusion, the impact of agrotechnology on food security in Malaysia requires careful consideration of the benefits and risks associated with its adoption. Agrotechnology, which encompasses innovative techniques, tools, and technologies applied in agriculture, has the potential to significantly enhance agricultural productivity, improve sustainability, and contribute to overall food security in the country. By understanding the intricate relationships between various factors such as agricultural practices, farmers' profiles, institutions, markets, and food security, and stakeholders can develop effective policies and practices that ensure access to safe and healthy food for all Malaysians.

One of the key advantages of agrotechnology lies in its ability to increase agricultural productivity. Advanced techniques like precision farming, hydroponics, and vertical farming enable farmers to optimize resource allocation, minimize waste, and maximize yields. These technologies, coupled with improved crop varieties and pest management practices, can lead to higher crop production and greater food availability. Furthermore, agrotechnology can contribute to enhancing sustainability in Malaysian agriculture. Sustainable farming practices, including integrated pest management, organic farming, and conservation agriculture, can be facilitated by the adoption of appropriate technologies. These practices help conserve natural resources, reduce the use of harmful chemicals, protect biodiversity, and promote ecological balance. By integrating sustainable practices with agrotechnology, Malaysia can achieve long-term food security while minimizing the negative environmental impacts associated with conventional agriculture.

However, it is crucial to address the potential risks and challenges associated with agrotechnology adoption. Small-scale farmers, who constitute a significant portion of Malaysia's agricultural workforce, may face barriers in accessing and adopting advanced technologies due to factors such as cost, knowledge gaps, and limited infrastructure. It is essential to provide adequate support, training, and financial assistance to ensure equitable access to agrotechnology benefits across all segments of the farming community.

In conclusion, the adoption of agrotechnology in Malaysia has the potential to significantly enhance agricultural productivity, sustainability, and overall food security. However, it requires careful consideration of the benefits and risks associated with its implementation. By understanding the interplay between agricultural practices, farmers' profiles, institutions, markets, and food security, effective policies and practices can be developed to ensure equitable access to safe and healthy food for all Malaysians. This research aims to contribute to the ongoing efforts to improve agricultural productivity, sustainability, and overall food security in Malaysia, ultimately leading to a more resilient and food-secure nation.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

The research chapter two will be discussed on the literature review of study related to the impact of agrotechnology on the food security in Malaysia. The first part will be discussion the definition of independent variable and dependent variable that is agriculture practices, farmers profile, and institution and market factor and food security. The second part will discussion of research framework and the relationship between independent variable and dependent variable.

2.1 Agriculture practices

Traditional agriculture is characterized by a high proportion of manual labour and low productivity, requiring the participation of nearly one-third of the population. Agriculture 1.0 refers to this period, which endured until the middle of the 20th century. In the 1950s, the second phase of agricultural development - Agriculture 2.0 or the "Green Revolution" - began. This necessitates the advancement of agronomy, the implementation of mechanized systems for animal and plant reproduction, and the creation of new fertilizers and pesticides. There have been significant changes in agricultural knowledge systems that have had a positive effect on yield and productivity increases. (Lenore Newman, 2021)

Agriculture 3.0 or "Precision Agriculture" began with the introduction of geolocation-based including satellite-based remote mechanical systems for the administration of agricultural mechanisms. Agriculture 3.0 is characterized by the rapid advancement of biotechnology and genetic engineering, the differentiation of agricultural products based on data analysis including that derived from remote sensors, and the optimization of agricultural production by reducing costs and increasing profits.

Agriculture 4.0, also known as "digital agriculture" or "smart agriculture," has emerged as a result of the continued development of information technology in agricultural production. Artificial intelligence, big data, the Internet of Things, virtual and augmented reality, 3D printing, quantum computing, blockchain, and robotics are the primary technologies of Agriculture 4.0. Modern production techniques for low-cost microelectronic components and their miniaturization have enabled the development of autonomous robotic systems for automated control of agricultural resources and mechanisms. Using cloud storage and high-throughput communication technologies, agricultural management decisions can be made in real time. AI systems assist in recognizing reality and controlling drones, tractors, automobiles, and combines. Agriculture 4.0 is a modern era of agricultural development, as its methods and instruments are utilized in agricultural production in all developed nations.

In the field of agricultural science, research into Agriculture 4.0 and Agriculture 5.0 is at its peak. We will study the content, factors and conditions, methods and main theoretical and methodological approaches of the technological stages of modern agricultural growth and their impact on food production and food security. Agriculture expert Evan D. G. Fraser and author Andrew Rima's are the authors of Empires of Food: Feast, Famine, and the Rise and Fall of Civilization. In it, they talk about how food crises have occurred time and time again throughout history and suggest ways to stop them. By 2100, around 10 billion people will need food systems that do not produce CO2, are resilient to extreme weather, and deliver social and economic benefits to everyone in the food chain. In these circumstances, we need new ways to make sure everyone has enough to eat. Food and agricultural systems must find a way to meet the demand for enough healthy, affordable food and the vital need for ecosystems to grow in a sustainable way. We must move from the digital agriculture revolution to Agriculture 5.0 (Fraser & Campbell, 2019).

Digital agriculture is often defined by scientific research as the use of better methods to process and understand digital data in agricultural production and management systems. "Digital Agriculture" is mean by the term "Precision Agriculture" that has been developed. According to them, the digital base of agriculture is composed of different types of output and data for making optimal decisions, which makes management and marketing more effective (Soma & Nuckchady, 2021).

2.1.1 Agricultural Robots

Agricultural robots are exposed to extremely dynamic environments but need to touch, sense, and manipulate crops and their surroundings in a precise manner, which requires reducing environmental impact while increasing productivity (De Baerdemaeker et al., 2001). Although industrial automation platforms with high precision and speed are available, their application in agriculture is limited due to our uncertain environment and uncertain tasks being a huge obstacle. Including Off-Peak Demand Growing Fruits and Vegetables Requires Multiple Factors.

Automation and robotics in closed factory production and other settings (Ramin Shamshiri et al., 2018). Field robots with irrigation, leaf removal and harvesting manipulators and end effectors should be used for such tasks in dynamic, complex and uncertain environments. Consider the health of various configurations of plant size and shape, stems, branches, leaves, fruit colour, texture, obstacles, and weather effects to operate effectively in the real world. In the context of harvesting, sensing mechanisms must identify fruit ripeness in the presence of various disturbances in an unpredictable heterogeneous environment, while actuators must execute motion and path planning to navigate within a plant system or tree canopy. Minimal bumping for deft grip and removal of soft products. An industrial robot is responsible for selecting and placing solid bolts on an assembly line.

In conclusion, the use of automation and robotics in agriculture, particularly for tasks like harvesting, is challenging due to the dynamic and uncertain nature of agricultural environments. Agricultural robots need to consider various factors such as plant characteristics, obstacles, and weather effects to operate effectively. They must have sensing mechanisms to identify fruit ripeness amidst disturbances and actuators for precise motion and path planning. Specialized field robots are needed to perform tasks in agricultural settings and can help increase productivity while reducing environmental impact.

2.1.2 Precision Agriculture

As the world's population continues to increase, the importance of sustainable agricultural practises grows. Precision agriculture is a new technology that can assist producers in advancing sustainable agricultural practises. Precision agriculture employs data and technology to monitor and track multiple environmental factors, such as soil type, precipitation levels, and air and water temperature. This information is then used to modify agricultural practises in order to maximise crop yields while minimising environmental impact. Precision agriculture can assist farmers in optimising irrigation schedules, thereby reducing the quantity of water used while still ensuring adequate crop nutrition. It can also be used to monitor soil conditions, allowing producers to apply only the quantity of fertiliser and other nutrients required to maintain healthy soil(Roberts et al., 2021).

Because of this, the agricultural industry is under more stress than ever before (Seelan et al., 2020). Traditional ways of managing farms have been combined with new sensing and moving technologies and better information and communication technologies (ICT) to help solve these problems. Precision agriculture, also called "smart farming" or "precision farming," is based on the idea of "producing more with less." It has the potential to help meet the growing demand for food while ensuring the sustainability of primary production. It does this by managing production in a more precise and resource-efficient way. PA technologies are used at key points in the crop growth cycle, like when the land is being prepared, seeds are being planted, crops are being managed, and crops are being picked. Precision farming technologies have helped farmers raise crops and fruits, but they have also helped farmers raise animals (Precision Farming, 2017).

In conclusion, precision agriculture, also known as smart farming or precision farming, is a technology-driven approach that utilizes data and technology to optimize agricultural practices. By monitoring environmental factors and leveraging information and communication technologies, precision agriculture enables farmers to make informed decisions that maximize crop yields while minimizing environmental impact. It helps farmers optimize irrigation schedules, manage soil conditions, and apply nutrients efficiently. Precision agriculture has the potential to meet the growing demand for food while ensuring the sustainability of primary production, making it a crucial tool in advancing sustainable agricultural practices for a rapidly increasing global population.

2.1.3 Artificial Intelligence

Agriculture plays a vital role in our daily lives and is essential to the continuation of life on Earth. The application of Artificial Intelligence (AI) in this industry is blatantly apparent and expanding rapidly. Soil management, crop management, weed management, water management, and weather forecasting have been identified as the most important actionable areas in agriculture. Any impacts or distractions in these areas can hinder economic expansion. Industries and producers anticipate a solution that is less expensive and performs effectively at scale. In this sector, robotics has undergone extensive testing and improved over the years. Agriculture relies heavily on automation to reduce the complexity and monotony of manual labour. From the consumer's vantage point, maximising yield with high quality and less chemical influence has been the objective. This application of AI in agriculture will save crop by alerting or warning about impending natural disasters and recommending the ways.

Agriculture is the solid foundation that keeps the economy thriving. The data has become digital and is so large that it requires large storage spaces, just like big data. These services are provided by cloud service providers and aid in storing, scanning, analysing, interpreting, visualising, and making sound decisions (Sonka, 2016). Various database-driven recommendations were made to identify and resolve extant issues in the field of Agriculture at the time. Later, decision support systems are introduced to provide extended support.

Computerised AI systems are utilised to detect ailing plants earlier and recommend remedial measures to restore them to full health. Multiple artificial models based on neural networks have been proposed for disease control(Chandra Karmokar et al., 2015). Typically, the models depend on the vegetation and weather conditions. A cultivator must implement chemical, physical, and biological measures for effective disease management and control [20]. However, achieving this is difficult and time- and cost-intensive . Computer Vision Systems and Genetic Algorithm techniques can multitask and operate at high speeds, thereby saving time and money to some extent. Web-Based Intelligent Disease Diagnosis System (WIDDS) provides flawless accuracy and rapid response to crop disease(WSSA Fact Sheets, 2023).

AI-based services and ML-based image recognition algorithms can help to precisely identify weeds and apply herbicides only to targeted areas instead of entire fields and projects, analysing the shortest path to eradication(Zhang et al., 2021). A study showed that crop yields can be reduced by 50% if the plants are not controlled(Zhang et al., 2021). Another report confirmed that production has been significantly reduced to about 50% - 75% (Rajpurohit et al., 2017). Regardless of the situation, weeds can have both positive and negative effects on ecosystems. Using artificial intelligence, vegetation can be monitored effectively and efficiently. In a short amount of time, AI using learned vector quantization demonstrated high weed identification rates.

In conclusion, the application of Artificial Intelligence (AI) in agriculture has the potential to revolutionize the industry and address key challenges. AI can help improve soil management, crop management, weed management, water management, and weather forecasting. By utilizing AI technologies such as robotics, computer vision systems, and machine learning algorithms, farmers can automate tasks, detect diseases and pests early, and optimize resource usage. This can lead to increased crop yield, reduced chemical usage, and improved efficiency in agricultural practices. Furthermore, AI systems can provide real-time data analysis, decision support, and disease diagnosis, aiding farmers in making informed decisions and taking timely actions. Overall, AI in agriculture offers the promise of sustainable and productive farming practices, contributing to food security and economic growth.

2.1.4 Climate-smart agriculture (CSA)

Climate-smart agriculture (CSA) is essential to address the interconnected issues between food security and climate change(Climate-Smart Agriculture, 2020.). It is an integrated approach to managing agricultural systems (including croplands, livestock, forests and fisheries) to reduce greenhouse gas emissions, increase climate resilience and increase agricultural productivity. Climate change and extreme weather events pose risks to agricultural production and food and nutrition security can be mitigated by implementing CSA practices (Tabe-Ojong et al., 2023).

The link between CSA and food security is that CSA can strengthen the resilience of agricultural systems to the impacts of climate change. Yield declines, market volatility, and harm to rural livelihoods and food security are some of the impacts of climate change on agricultural production(Lewis & Rudnick, 2019) . The negative impact of climate change on crop productivity can be mitigated by adopting climate-smart agricultural practices, such as no-tillage, integrated soil fertility management, nitrogen use efficiency, and alternating watering and drying (de Pinto et al., 2020). Improving agricultural productivity is essential to ensure food security in the face of a growing global population and changing eating habits.

In addition, CSA incorporates strategies to improve resource use efficiency, enhance adaptive capacity, and promote sustainable natural resource management in agriculture. These strategies include crop diversification, agroforestry, water resource management and sustainable soil and nutrient management practices. The CSA seeks to increase the resilience of agricultural systems so that they can better withstand climate-related shocks and stresses through the implementation of these measures. This helps maintain and improve local, regional and global food security. Scientists studied the long-term effects of adopting CSA technologies and practices on global food security and greenhouse gas (GHG) emissions. Focusing on key commodities such as maize, wheat and rice, these studies show that the adoption of CSA practices can improve food security and reduce greenhouse gas emissions in agricultural production systems (De Pintoid et al., 2020).

Climate-smart agriculture plays a vital role in ensuring food security in the context of climate change. By implementing CSA practices, agricultural systems become more resilient, adaptive, and sustainable, increasing agricultural productivity and reducing food production risk. The integration of climate-smart strategies and technologies enables the agricultural sector to effectively address the challenges posed by climate change while meeting the food needs of a growing global population.

2.2 Farmers profile

The profile of farmers, including their knowledge, skills, resources and access to markets and technologies, have been widely recognized as factors affecting food security. The image of farmers plays an important role in determining their ability to contribute to the overall food supply. Agricultural productivity is an important aspect of food security and is largely influenced by farmers' knowledge and skills. (Kiptot et al., 2014).

Well-trained farmers have in-depth knowledge of crop management techniques, soil fertility, and pest and disease control, which allows them to optimize production systems (Bhoi et al., 2020). This knowledge enables farmers to make informed decisions and adopt appropriate farming practices, resulting in higher yields and improved crop quality. Access to resources is another important aspect related to the farmer profile and its impact on food security. Access to adequate land, water, seeds and fertilizers is critical for farmers to farm effectively.

Farmers who can make good use of these resources can optimize resource use, maximize production potential and contribute to food supply. Furthermore, farmers' access to markets and their ability to sell their produce at fair prices are critical to achieving food security(Tadesse et al., 2018). Efficient market linkages and infrastructure play an important role in ensuring that farmers are able to market their products effectively, thereby increasing their income and incentives to produce food (Gebreegziabher et al., 2019). In addition, fair trade practices and policies that support farmers to obtain fair prices for their products can incentivize investment in agriculture, thereby increasing food production. In the face of climate change, the profile of farmers also affects their ability to address climate-related challenges and ensure sustainable food production.

Farmers who have the knowledge and resources to implement climate-smart agricultural practices such as water conservation, agroforestry and drought-resistant crop varieties are better able to adapt to changing climatic conditions (Dossou-Yovo & Saito, 2021). These practices increase farmers' resilience to extreme weather events, reduce the vulnerability of food systems to climate impacts, and ultimately contribute to improved food security. Furthermore, small farmers, often with limited resources and access to markets, play a key role in food production, especially in developing countries(Jayne et al., 2014). Supporting small farmers through initiatives such as capacity building, access to credit facilities and market infrastructure can increase their productivity and make a significant contribution to food security at local and national level.

In conclusion, the profile of farmers, including their knowledge, skills, resources and access to markets, have a major impact on food security. Scientific research has highlighted the importance of investing in the capacity of farmers and providing them with resources and supporting policies to increase productivity and incomes, thereby improving the availability and access to food (Lowder et al., 2021).

2.2.1 Farmers education Level

In the field of agriculture, the function of farmer education in the introduction and adoption of agricultural technologies is the subject of scientific inquiry. Numerous studies have investigated the connection between farmers' education and their use of agricultural technology.

"Education of farmers is crucial to the introduction and implementation of agricultural technologies. Regional location, education level, age, and membership in Farmer Based Organisations (FBOs) are significant determinants of smallholder technology adoption, according to research(Adams & Jumpah, 2021). Educative programmes and initiatives that integrate the Agricultural Education (AE) and

Environmental Education (EE) frameworks have been identified as promising avenues to increase farmers' participation in agricultural technology and support sustainable agricultural systems (Reilly et al., 2022a).Continuing education is necessary to keep farmers abreast of rapid advances in technology, science, business management, and other disciplines that have a direct impact on agricultural operations (Farmer Education, 2023). There is a correlation between farmers' education or training, their technical knowledge, and their crop production, according to studies (Rasanjali et al., 2021). In addition, agricultural technology is the key to significantly increasing food production to satisfy the needs of a growing population, making the education and adoption of agricultural technology imperative. These results highlight the significance of farmer education in facilitating the successful introduction and adoption of agricultural technology.

In conclusion, continuing education is essential to keep farmers abreast of rapid advances in technology, science, business management, and other related disciplines that directly affect farming operations. The research also identified a correlation between farmers' education or training, their technical knowledge and crop production. Given the importance of increasing food production to meet the demands of a growing population, the education and adoption of agricultural techniques is imperative. Findings Highlight Importance of Farmer Education in Facilitating Successful Introduction and Adoption of Agricultural Technology

2.2.2 Farmers Social

Farmer social networks are an important part of ensuring food security because they make it easier for farmers to share information, resources, and work together. Farmers can use these networks to find out about better ways to grow, market trends, and ways to respond to climate change. This helps them be more productive and resilient. Social networks also give farmers a place to share resources like seeds, tools, and machines. This cuts down on costs and makes farming more efficient.

The sharing of knowledge and information is an important part of the social networks of farmers. Pests, diseases, and climate change are all problems that farmers often have to deal with. By joining social networks, farmers can learn from each other's experiences and get useful tips on how to control pests and diseases and grow in a way that is good for the environment(Dhanaraju et al., 2022). This sharing of information helps farmers make better choices and improve their farming techniques, which leads to more crops and more food.

Also, farmers' social networks help ensure food security by working together. Farmers can form cooperatives, farming groups, or associations through these networks. This lets them work together to solve problems like getting loans, getting supplies, and selling their crops. Farmers can get better prices for their crops if they work together. They can also pool their money to buy new farming tools and improve their buying power with buyers and sellers of inputs. This group effort not only makes farming more profitable, but also makes sure that the community will always have enough food.

Social networks are a big part of how farmers build their social capital. Trust, helping each other out, and having the same rules are all important parts of social capital that help farms work together well and deal with shocks and problems as a group(Slijper et al., 2022). When there are natural disasters or changes in the market, farmers can turn to each other for help, knowledge, and mental support through farmer social networks. This way that social networks make people more resilient helps farms deal with bad things that happen and get back on their feet. This protects food production and ensures food security in times of instability.

Kenya's Nyando Integrated Water Resources Management (IWRM) project shows how farmers' social networks can affect food security. A study by Muthamia et al. (2017) found that the project's network of farms made a big difference in the region's food security(Kivuva, 2017). These networks make it easier for farmers to share information about how to farm in a way that is good for the environment, how to handle water, and how to connect to markets. This helps farmers make more money and produce more food. The study also shows how social networks help farmers deal with the effects of climate change, like droughts and storms, by making it easier for them to share early warning information and help each other.

In conclusion, farmers' social networks have big effects on food security because they make it easier for farms to share information, resources, and work together. These networks help farmers get better knowledge, improve their farming methods, and work together to solve problems they all face. Farmers' social networks add to the stability and sustainability of food production systems by building social capital and encouraging resilience. This makes sure that communities have enough food to eat.

2.2.3 Farm income and profitability

When assessing the acceptance and efficacy of agrotechnology in the agricultural sector, farm income and profitability are extremely important. Measuring a farm's income and profitability gives farmers useful information about their financial health and is a key sign of their ability to stay in business. This evaluation considers several indicators that measure the financial success of agricultural activities. These indicators include gross and net farm income, return on investment, and cost of production.

Gross farm income is the total amount of money made from agricultural output before the costs of production are taken out. It shows the size and value of agricultural output as a whole. In contrast, net farm income considers costs connected with agricultural output, such as input costs, labour costs, and overhead costs, giving a truer measure of profitability (Bravo-Ureta et al., 2017). It is the amount of money left over after these costs are taken out of the farm's gross income.

Return on investment (ROI) is a key measure used to figure out how profitable agricultural investments are and how well agrotechnology is being used (Dessart et al., 2019). It figures out how much money was made or lost from the money put into agricultural operations. A better return on investment (ROI) means that the business is more profitable and uses its resources more efficiently. This shows that adopting agrotechnology has a good effect.

A cost of production study is needed to figure out if an agricultural business is financially possible and if it can last. It involves figuring out how much things like seeds, fertilizer, chemicals, tools, labour, and other "overhead" costs cost during the production process (Fausti & Wang, 2018). By looking at the cost of production, farmers can find places where they can save money, work more efficiently, and make more money.

Accurate measurement of farm income and profitability is vital for farmers, policymakers, and researchers to make informed decisions regarding the adoption and promotion of agrotechnology. It provides an evidence-based understanding of the economic implications and benefits associated with incorporating technological advancements in agriculture. Moreover, this assessment allows for comparisons across different farms, regions, and time periods, enabling the identification of best practices and strategies to enhance agricultural productivity and profitability.

2.2.4 Gender and demographics

The analysis of gender composition and demographics in the agricultural sector is a fundamental metric that is essential to comprehending the complex dynamics of agricultural systems. Researchers and policymakers can gain valuable insights into the underlying social and economic aspects of agricultural practices by delving into the intricate details of gender representation and age distribution among producers. These insights are essential for the design of effective interventions and policies aimed at fostering inclusive and sustainable agricultural development.

FAO has identified the proportion of female producers as a key indicator of gender equality and women's empowerment in the agricultural sector. Female participation in agriculture not only contributes to improved food security and poverty reduction, but also acts as a catalyst for the achievement of broader gender equality objectives(Steele-Perkins & Ph, 2023.). Understanding the extent of women's participation in agriculture enables the identification of potential obstacles and difficulties they confront, such as limited access to resources, technology, and decision-making processes. Such knowledge allows for the formulation of targeted strategies to address these disparities and empower women in agriculture.

In addition to gender representation, adolescent participation in agriculture is a crucial factor to consider (Cecchini et al., 2018). To facilitate intergenerational knowledge transfer, ensure the long-term sustainability of the sector, and mitigate the risks associated with an aging farming population, it is essential to encourage and support young people to partake in agricultural activities. By evaluating youth participation in agriculture, policymakers can identify strategies to attract and retain young talent, promote agricultural entrepreneurship, and provide adequate training and educational opportunities tailored to the needs and aspirations of the younger generation.

Further, the average age of producers provides vital insight into the demographic trends of the agricultural workforce. A rising average age among farmers may be indicative of an aging population, which can have substantial effects on agricultural productivity, rural development, and food security(Girdziute et al., 2022). Understanding the demographic shifts and potential challenges associated with an aging agricultural population enables policymakers to devise interventions that promote the well-being and livelihoods of older farmers while assuring a seamless transition for the next generation.

In conclusion, the analysis of gender composition and demographics in agriculture is an indispensable instrument for comprehending the sector's complex dynamics and socioeconomic dimensions. It allows policymakers and stakeholders to devise strategies based on evidence that promote gender equality, adolescent engagement, and sustainable agricultural development. By addressing gender disparities, facilitating adolescent engagement, and responding proactively to demographic changes, societies can realize the full potential of their agricultural systems and work toward achieving inclusive and resilient food systems.

2.3 Institution and market factor

The availability, accessibility, and affordability of food for individuals and communities is largely influenced by institutional and market factors that play a critical role in determining food security outcomes. Many policies, regulations and mechanisms governing the production, distribution and utilization of food fall into this category. Understanding their impact is critical to addressing food insecurity and developing strategies to ensure equitable and sustainable access to nutritious food for all (OECD FAO,2023).

Institutional factors refer to the formal and customary norms, institutions and organizations that regulate food system governance. Agriculture, trade, land tenure and social protection policies and programs have a major impact on food security outcomes. For example, agricultural policies that prioritize large-scale commercial farming may overlook the important role that small producers play in local food production. This reduces agricultural diversity and local self-sufficiency, making communities more vulnerable to external disturbances and price fluctuations. In addition, institutional factors, including land tenure systems and property rights, also affect food security. In some regions, insecure land tenure arrangements prevent producers from investing in land, implementing sustainable agricultural practices or accessing credit for agricultural inputs. This erodes productivity and resilience, leading to reduced food availability and increased likelihood of food insecurity(FAO Food Price,2023).

In contrast, market factors include the dynamics of food production, distribution and consumption within the broader economic context. These elements include supply chains, pricing mechanisms, market competition and consumer behaviour. As market forces determine the availability and affordability of food, they have a major impact on food security(FAO Food Price Index ,2023). For example, when a few dominant players such as large agribusinesses or retailers dominate a market, they can control prices and limit market access for small producers. This can lead to lower incomes for producers and higher prices for consumers, reducing the cost of nutritious food and exacerbating food insecurity. Inadequate infrastructure and transport networks can also limit the reach and efficiency of food distribution systems, especially in remote and poor areas, exacerbating food access problems. Jones and Smith (2018) analyse the role of government agricultural policies in sub-Saharan Africa to demonstrate the impact of institutional and market factors on food security(H. Smith & Jones, 2018). The study shows that policies favouring export cash crop production while neglecting staple food crops lead to greater dependence on imported food and reduce food availability and affordability for local populations. This shows how policy decisions can have a significant impact on food security outcomes.

Institutional and market factors have a major impact on food security outcomes. The availability, accessibility and affordability of food depend largely on government policies, land tenure systems, market dynamics and consumer behaviour. Understanding the complex relationship between these factors is critical to designing effective interventions to promote sustainable and equitable food systems and ensure food security for all.

2.3.1 Policy and Regulation

Policies and regulations play a vital role in ensuring food security in Malaysia. These measures aim to address food production, distribution, access and security. The government intends to increase agricultural productivity, improve food quality, and promote equitable access to nutritious food for all Malaysians through the implementation of appropriate policies and regulations.

The National Food Security Policy (NFSP) is an important policy initiative in Malaysia. Launched in 2011, the NFSP focuses on increasing domestic food production, reducing dependence on food imports, and ensuring people have access to affordable, nutritious food. The policy emphasizes sustainable agricultural practices, technological advancement and agricultural research and development to increase the productivity and food self-sufficiency of the agricultural sector. In support of the National Food Security Programme, the Malaysian government has enacted several regulations to regulate and promote sustainable agricultural practices(Suffian & Suffian, 2023).

The Pesticides Act 1974 and the Fertilizers and Pesticides (Control of Use) Regulations 2004 aim to ensure the safe and responsible use of pesticides and fertilizers respectively in agriculture. These regulations help protect the environment, reduce health hazards and maintain the integrity of agricultural products. In addition, the government has established institutions and institutions responsible for monitoring food safety and quality. The Food Act 1983 and the Food Regulations 1985 are administered by the Food Safety and Quality Division of the Ministry of Health. These regulations establish food labelling, hygiene and sanitation standards, and inspection and enforcement frameworks to ensure that food consumed by Malaysians meets the necessary safety requirements.

In addition to production and safety regulations, policies and initiatives have been developed to promote access to nutrient-dense food for vulnerable groups. For example, food assistance programs are designed to help low-income families and individuals obtain affordable and adequate food supplies. The program provides nutritional assistance, financial assistance, and capacity building initiatives to marginalized groups to enhance their food security. Additionally, the government promotes community participation and urban farming through programs such as the Community Agriculture (CBA) program and the Urban Agriculture Program (UAP) (Mozaffarian et al., 2018). These programs are designed to enable communities to grow their own food, increase their access to fresh and nutritious produce, and reduce their reliance on commercial food sources.

In Malaysia, policies and regulations have a huge impact on food safety. National food security policies are supported by numerous regulations and initiatives that promote sustainable agriculture, ensure food safety and quality, and expand access to nutritious food. However, continuous monitoring, evaluation and revision of policies and regulations are required to address urgent challenges and achieve the country's long-term food security goals.

2.3.2 Access on Resources and Services

Food security in Malaysia depends significantly on access to resources and services. The nation's capacity to produce, distribute, and obtain enough food that is both safe and nutritious is directly impacted by the accessibility and availability of critical resources and services. The influence of resources and services on food security in Malaysia will be discussed in this paragraph, with an emphasis on important elements including land, water, technology, infrastructure, and social welfare programmes.

For agricultural productivity, land access is a crucial resource. The availability and security of agricultural land tenure have a big impact on food security in Malaysia. Food production is being challenged by the fast conversion of agricultural land to non-agricultural uses as a result of urbanisation, industrialisation, and land-use changes

(Pouwels et al., 2017). Providing stable land tenure, adopting land-use regulations that prioritise food production, and ensuring access to land for small-scale farmers may all increase agricultural output and support food security. Another essential resource for agricultural productivity is water. Because of Malaysia's varying rainfall patterns and water supply, effective water management is crucial for ensuring food security. For crops to remain productive, access to water for irrigation is essential, especially in areas with limited water supply. Enhancing agricultural productivity and ensuring the availability of water for food production are both possible with the use of sustainable water management practises, such as water harvesting, effective irrigation systems, and water conservation measures (FAO, 2018).

Technology has a big impact on increasing food security and agricultural output. Crop yields may be increased, and post-harvest losses can be decreased with the right technology, such as better seeds, fertilisers, equipment, and pest control techniques. Adoption of contemporary farming methods and precision agriculture tools, such as data analytics and remote sensing, can support effective resource management and sustainable agricultural practises (FAO, 2019). Improving food security in Malaysia requires fostering agricultural technology research and development, information sharing, and capacity building. For guaranteeing effective food distribution and access, infrastructure development, including transportation, storage, and market facilities, is essential. Reducing post-harvest losses and connecting food producers and consumers are made easier by adequate transportation networks, storage facilities, and market infrastructure. Investments in rural infrastructure, such as cold storage facilities and road networks, can increase small farmers' access to markets and boost the effectiveness of food value chains. To provide timely and cheap access to food and support food security, infrastructural connection in remote and rural regions may be improved.

In Malaysia, underprivileged individuals' food insecurity is largely addressed by social welfare programmes and safety nets. Programmes like the National Food Security Policy and several social assistance efforts are designed to target low-income households and offer them help, including access to reasonably priced and wholesome food. These programmes include actions that increase access to food and reduce poverty-related food insecurity, such as direct cash transfers, food subsidies, and school feeding programmes. Enhancing and strengthening social welfare programmes can aid Malaysia's food security and reduce the consequences of poverty.

In conclusion, access to resources and services, such as land, water, technology, infrastructure, and social welfare programmes, has a significant impact on food security in Malaysia. Ensuring access to agricultural land, effective water management, appropriate technologies, and robust infrastructure can improve food production, distribution, and access. Programmes for social welfare are also essential in alleviating food insecurity among disadvantaged groups. To achieve sustained food security in Malaysia, it is critical for the government, decision-makers, and stakeholders to give priority to and invest in these important sectors.

2.3.3 Investment in agriculture

Investment in agriculture is essential for advancing sustainable practises, maintaining food security, and stimulating agricultural growth. This metric includes an evaluation of financial commitments made by the public and commercial sectors to agricultural research, infrastructure improvement, and technological innovation. To analyse this issue thoroughly, a number of indicators are used, such as the amount spent on agricultural research and development (R&D), the availability of finance to farmers, and the use of modern farming practises.

Agricultural R&D spending, which indicates the financial resources allotted to research and innovation in the agricultural industry, is a crucial measure of investment in agriculture. It includes support for scientific research, technical progress, and the creation of better agricultural methods. Spending more money on agricultural R&D has been associated with improved crop yields, increased agricultural productivity, and the creation of resilient farming systems (Jaeger & Humphreys, 1988).

Another important factor affecting farmer investment in agriculture is their ability to access finance facilities. Farmers may buy necessary agricultural supplies, make investments in machinery and equipment, and use cutting-edge farming techniques when they have access to enough and reasonable loans. It is essential in helping farmers make decisions and make the transition to more effective and sustainable farming practises (Chandio et al., 2021).

The use of contemporary farming methods is another crucial sign of agricultural investment. This includes the use of cutting-edge technologies, precision agriculture practises, and environmentally friendly farming practises. Investments in agricultural extension services, training programmes, and infrastructure development assist the adoption of these practises. The modern farming practises can help to improve agricultural output, resource efficiency, and environmental sustainability.

In the conclusion, using of modern farming techniques, access to financing for farmers, and investment in agricultural R&D are all essential for the development of the sector, food security, and sustainability. To secure the long-term development of the agricultural industry and the well-being of farming communities, policymakers, agricultural organisations, and stakeholders must prioritise and increase investment in these areas.

2.3.4 Price stability

Price stability is essential for guaranteeing food security and promoting sustainable economic growth. It entails a comprehensive analysis of the volatility and stability of food prices over a specified time period. Researchers and policymakers can gain a comprehensive comprehension of the dynamics at play by employing multiple indicators, such as price indices, price fluctuations, and the degree of price transmission along the food supply chain. Price indices serve as quantitative measurements, enabling comparisons and analyses of price trends over time. These indices provide valuable insight into the general direction and magnitude of food market price fluctuations.

In addition, assessing the extent of price volatility, which is frequently quantified by standard deviation or variance, provides a deeper understanding of the uncertainty and risk associated with food prices. Higher volatility indicates a greater degree of instability and unpredictability in price fluctuations, which may pose difficulties for both producers and consumers in terms of planning and decision-making (Minot, 2014).

Furthermore, analysing the degree of price transmission along the food supply chain provides valuable insights into the efficacy of price adjustments from agricultural production to final consumer prices. Examining the degree to which price changes at one level of the supply chain are transmitted and reflected at subsequent levels is the focus of this evaluation. Price transmission efficiency ensures that price changes are effectively communicated throughout the supply chain, resulting in equitable returns for producers and reasonable prices for consumers (Chouayet & Rezitis, 2016). Understanding the factors that influence price transmission is essential for identifying potential bottlenecks, market imperfections, and policy interventions that may impede or facilitate the smooth propagation of price adjustments.

In conclusion, evaluating price stability in the food sector necessitates a multidimensional approach that includes indicators such as price indices, price fluctuations, and the degree of price transmission along the food supply chain. This exhaustive analysis enables policymakers and stakeholders to assess the volatility, stability, and efficacy of price movements, thereby facilitating the development of targeted interventions to promote food security and economic stability.

2.4 Food security

FAO defines food security as the condition in which all people have constant physical, social, and economic access to sufficient, safe, and nutritious food that satisfies their dietary requirements and food preferences for an active and healthy existence. It encompasses the availability, accessibility, utilisation, and stability of food supplies. Food security is a complex challenge influenced by several factors, including population growth, climate change, poverty, and unequal resource distribution.

The availability of a sufficient food supply is one of the most important aspects of food security. This necessitates the use of sustainable agricultural practises, investments in agricultural infrastructure, and technological advances in farming states that sustainable agriculture promotes environmentally benign practises that maximise productivity while minimising adverse effects on natural resources(Thilsted et al., 2016). It consists of practises such as agroecology, conservation agriculture, and organic farming, which improve soil fertility, biodiversity, and water management. Investing in agricultural infrastructure, such as irrigation systems, storage facilities, and transportation networks, is necessary for efficient food production, post-harvest management, and distribution note that technological advances, such as precision agriculture, genetic engineering, and digital tools, can also increase agricultural productivity and resilience.

Another essential element of food security is access to sustenance. Even if sustenance is available, it must be available to everyone regardless of socioeconomic status. Poverty, unemployment, and income distribution inequalities can hinder a person's ability to afford and gain access to nutritious sustenance. Effective social protection systems, such as income support programmes, safety nets, and targeted interventions, are crucial to ensuring that vulnerable populations have access to food (FAO et al., 2015). In addition, enhancing rural infrastructure, enhancing small-scale producers' market access, and fostering fair trade can contribute to equitable food distribution.

Food security is also dependent on the nutritional value and safety of the food supply. Diets deficient in essential nutrients can result in malnutrition and other health problems. Therefore, it is essential to promote diverse and balanced diets that include a diversity of nutrient-dense foods (FAO, 2014). This includes encouraging the consumption of fruits, vegetables, whole cereals, legumes, and animal-source foods that are rich in essential vitamins, minerals, and proteins (FAO et al., 2018). In addition, assuring food safety by implementing appropriate food handling, storage, and hygiene practises is essential for preventing foodborne illness and contamination.

To address the complex challenges of food security, governments, international organisations, civil society, and the private sector must collaborate. International agreements and frameworks provide an action plan for achieving food security and eliminating poverty. The United Nations' Sustainable Development Goals (SDGs) include Goal 2: Zero Hunger, which seeks to eliminate hunger, attain food security, enhance nutrition, and promote sustainable agriculture by 2030 (United Nations, 2015). Implementing policies that prioritise investment in agriculture, research and development, sustainable land management, and adaptation to climate change are essential measures towards enhancing food security (FAO, 2020).

In conclusion, food security is a complex issue that necessitates consideration of multiple dimensions, including availability, access, utilisation, and food supply stability. Sustainable agricultural practises, infrastructure investment, social protection systems, and nutrition promotion.

2.4.1 Food Productivity

Food security and food productivity are closely intertwined, with one significantly influencing the other. Food security refers to the availability, accessibility, and utilization of food that ensures people have the necessary nutrition for a healthy and active life. On the other hand, food productivity relates to the capacity of agricultural systems to produce an adequate quantity of food to meet the demands of a growing population. This paragraph will discuss the relationship between food security and food productivity in a scientific tone, supported by relevant citations.

Food security is dependent on food productivity as it determines the availability of food. Higher agricultural productivity leads to increased food production, ensuring a stable supply of food for both local consumption and export. According to a study by Balogun, F. A. et al. (2020), increased food productivity positively impacts food availability, contributing to improved food security levels. When farmers are able to produce more food, it reduces the risk of scarcity and helps meet the nutritional needs of communities. Therefore, enhancing food productivity is crucial for achieving food security(Balogun, F. A. et al. 2020).

Moreover, food productivity plays a crucial role in enhancing the accessibility of food. Adequate food production enables countries to reduce their dependence on imports and become self-sufficient in meeting their nutritional requirements. This is particularly important for developing countries, where a high reliance on imports can make them vulnerable to price fluctuations and supply disruptions. According to a report by the Food and Agriculture Organization (FAO, 2019), increasing food productivity is essential for improving food accessibility and reducing dependence on external sources. By producing more food domestically, countries can ensure that their populations have consistent access to affordable and nutritious food.

Furthermore, the relationship between food security and food productivity extends to food utilization. Food productivity influences the diversity and quality of the food available. A diverse and nutritious food supply is crucial for addressing malnutrition and promoting overall health and well-being(Sihite, 2022). The importance of food productivity in enhancing dietary diversity and nutritional outcomes. When agricultural systems prioritize the production of diverse crops and livestock, it helps improve the nutritional value of diets and reduces the prevalence of nutrient deficiencies.

In conclusion, food security and food productivity are intricately connected, and their relationship is crucial for addressing global hunger and malnutrition. Food productivity directly impacts food availability, accessibility, and utilization, all of which are essential components of food security. By increasing agricultural productivity, countries can ensure a stable food supply, reduce reliance on imports, and enhance the diversity and quality of available food. It is vital to prioritize investments and policies that promote sustainable and resilient agricultural systems to improve food productivity and ultimately achieve global food security.

2.4.2 Stability of food supply

The stability of the food supply is a key measure of how reliable and consistent food access and availability are over different time periods. This multifaceted measure looks at many things that affect the stability of the food system as a whole. Some of these factors are agricultural productivity, climate resilience, market instability, and emergency preparedness. In order to maintain a stable food supply, agricultural productivity is crucial. It means that agricultural systems are able to create enough food to meet the needs of the people on a regular basis. High productivity is important for keeping the food supply stable because it lowers the chance of food shortages and price changes. (Ball et al., 2018) say that better farming methods, access to current tools, and the use of high-quality seeds and fertilizers are the most important ways to increase agricultural productivity.

Climate adaptability is another important part of the stability of food supplies. It means how well agricultural systems can handle and bounce back from climate-related problems like droughts, floods, and other extreme weather. As the effects of climate change become more frequent and severe, it has become very important to make sure that food supply systems are resilient. (Lipper et al., 2014a) found that using climate-smart agricultural techniques, like conservation agriculture and water management, can make food systems more resilient and less likely to be affected by climate shocks.

The stability of the food supply is greatly affected by how volatile the market is. Changes in food prices, which can be caused by things like changes in demand, supply problems, or the state of the global economy, can have a big impact on how much food is available and how easy it is to get. The stable markets with clear prices, good delivery systems, and good market control can help keep food supplies stable and reduce market volatility(Torero, 2016). In times of crises or tragedies, being ready for emergencies is also essential for maintaining food supply stability. Food and Agriculture Organization of the United Nations ((FAO, 2021)). Adequate planning and preparation measures, such as backup plans, early warning systems, and storing strategic food stocks, can help countries react quickly to crises and reduce delays in the food supply chain.

In conclusion, the stability of the food supply is a multi-factor indicator that looks at agricultural productivity, climate resilience, market volatility, and emergency preparedness. Improving these things is important to make sure that food is always available and easy to get, and to keep the population's food security safe.

2.4.3 Access to food

Access to food is a key part of food security. It is made up of many different factors that affect a person's ability to physically and financially get enough healthy food to eat. This thorough measurement takes into account a number of things that all affect how easy it is to get food. (Remans et al., 2019) say that a person's wealth is a key factor because it has a big effect on their buying power and ability to afford a wide range of food choices. Having enough money makes it easier to buy healthy things, which is good for your health and well-being as a whole.

Affordability is a key part of food availability. It means that food prices are in line with what people can afford (Remans et al., 2019). Even though higher wage levels usually make food more affordable, it is important to think about the inequalities that may exist, as some populations or social groups may have trouble meeting their nutritional needs over and over again. People may not be able to get a wide and balanced diet because food prices are too high, especially if the cost of healthy foods is more than they can afford. Access to food is also affected by transportation facilities, which is especially important for people who live in remote or underserved places (Jones et al., 2013). People can get to food markets and grocery stores quickly and easily when there are good, reliable transportation networks in place. This gives them access to a wide range of food choices. Inadequate transportation infrastructure, like a lack of public transportation or long routes to food stores, can make it hard for people to get healthy food. This makes food poverty worse and affects marginalized groups more than others.

To deal with the many different parts of food access, we need methods that are both broad and integrated. The policy measures also can include ways to help people make more money, like income redistribution programs or minimum wage policies, with the goal of lowering income differences and making it easier for people to buy things. Also, programs that work to make food more affordable, like subsidies or focused help programs, can help needy groups deal with the effects of high food prices. For everyone to have equal access to food supplies (Jones et al., 2013), transportation needs to be better, especially in underserved places. Investing in public transportation, building up infrastructure, and coming up with new ideas like mobile markets or community-based food places can make people more mobile and make it easier for them to get to healthy food choices.

In conclusion, measuring access to food involves a wide range of interconnected factors, such as income levels, food prices, how easy it is to get to food, and how well the transportation system works. By knowing and addressing these many different aspects, policymakers and other interested parties can come up with effective strategies and measures to increase everyone's access to healthy food, which will improve food security and general well-being.

2.4.4 Dietary diversity

Dietary variety is a key measurement that is often used to evaluate food security. It is also a key factor in figuring out how healthy and well-nourished a person or family is. It is an objective way to measure the range and quality of dietary trends (Chen et al., 2018). The significance of a varied diet lies in its capacity to provide a wide range of essential macronutrients and micronutrients derived from a variety of food sources, which are essential for meeting nutritional needs and preventing malnutrition.

A diverse diet includes foods from various food categories, including but not limited to cereals, legumes, fruits, vegetables, dairy products, and foods derived from animals(Legal & Office, 2016). Each dietary category contributes distinctive nutritional components, ensuring a balanced and complete intake of essential nutrients such as proteins, carbohydrates, vitamins, and minerals. This variety of foods promotes optimal health, growth, and development, especially in vulnerable populations (Chen et al., 2018).Policymakers and researchers can obtain valuable insights into the adequacy and equilibrium of a population's food consumption patterns by measuring dietary diversity. In turn, this knowledge enables the identification of potential dietary gaps or deficiencies that may contribute to suboptimal nutrition and compromised food security. Understanding the dietary diversity of social also facilitates the development of targeted interventions and policies intended to increase access to and consumption of a wide variety of nutrient-dense foods. This strategy can reduce the likelihood of nutrient deficiency, micronutrient imbalance, and diet-related health problems, thereby enhancing food security .

In addition, the evaluation of dietary diversity is a useful tool for elucidating the complex relationship between diet and health outcomes. Researchers can identify potential risk factors associated with malnutrition, chronic diseases, and other adverse health effects by analysing the consumption of various food groups. This data facilitates the development of evidence-based strategies and interventions to promote optimal nutrition and well-being among populations, thereby strengthening the foundations of food security.

In conclusion, the measurement of dietary diversity provides crucial insights into the quality and sufficiency of food consumption patterns, allowing for the evaluation of food security and formulation of effective interventions. By considering the variety of food groups ingested, policymakers and researchers can address nutritional deficiencies, improve access to diverse and nutritious food sources, and ultimately contribute to enhanced food security and better health outcomes for individuals and communities.

2.5 Framework

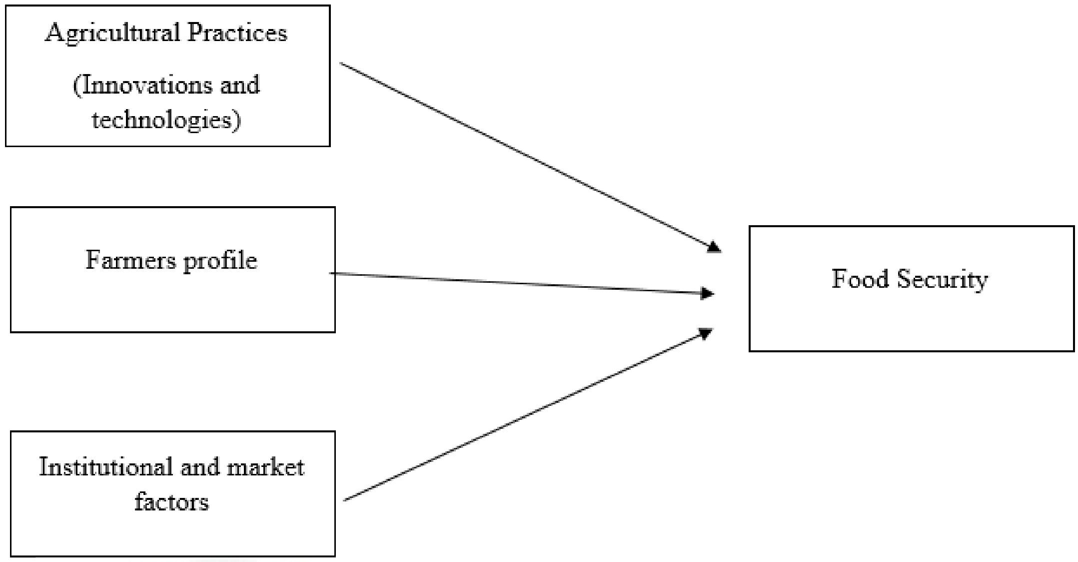

Figure 2.1 The Proposed Framework

This Conceptual Framework are draws on previous research on viewing. In this conceptual framework will identify the relationship between food security and the pace of technological transformation in agriculture, taking into account the impact of global challenges, based on research by leading scientists. Considering the history of technological change in agriculture through the evolution from traditional food systems to Agriculture 5.0. (Baryshnikova, 2022)The research centres on agricultural technology as a strategy for adapting to climate change, with an emphasis on increasing producers' productivity and assisting them in coping with climate change.

Food security is defined as the provision of sufficient, nutritious and healthy food (Lipper et al., 2014b). The impacts of climate change on food supply, stability, access and utilization are negative. It affects crop parasites and diseases, soil water retention capacity, soil fertility and crop yields, all of which have a direct impact on agricultural production. Indirect impacts occur through impacts on agricultural demand, income distribution and economic growth. The effects of climate change are likely to drive up commodity prices, leading to reduced food consumption and increased food insecurity. Although food demand does not respond abruptly to price changes, the impact can still be felt, especially in areas with constrained natural resources.

Climate change can also lead to changes in food system activities, affecting food availability. Follow the conceptual framework to illustrate the significant contribution of agrotechnology to food security. Climate change poses hazards to agricultural productivity and stability. Changes in climate indicators such as temperature and precipitation can affect production seasons, pest and disease patterns and crop types(Arslan et al., 2014). These factors lead to changes in food system activities that reduce food availability. However, adoption of agrotechnology by farmers is expected to bring “triple win” benefits, including food security benefits, adaptation benefits and mitigation benefits. Both producers and the environment benefit from increased productivity, reduced greenhouse gas emissions, increased resilience to changing climatic conditions, and the resulting impact(Hermans et al., 2023).

All of these agrotechnology benefits are expected to increase household food security. Adoption of agrotechnology in small-scale agricultural systems may improve household food security by promoting agrotechnology adaptation and system resilience. agrotechnology practices are conceptualized as agricultural practices that conform to the agrotechnology profile(Arslan et al., 2014). These practices are identified from an inventory of practices adopted in the field of study. Conservation agriculture (minimum tillage, leaving crop residues in the field), agroforestry, use of organic fertilizers, crop rotation, crop diversification (cereal/legume intercropping), mulching, wetland use, planting for drought and heat tolerance Crops, Planting Established agricultural practices include cover crops, soil conservation techniques, integrated crop-livestock management, improved grazing, efficient manure management and dieback control.(Lambrecht et al., 2014)

2.6 The link between Agricultural Practices and food security

Several studies have investigated the links between agricultural practices and food security as subjects of scientific inquiry. Agricultural practices are critical to food security, especially in developing countries. Agricultural progress is critical for structural transformation in developing economies, and food security is a key indicator of economic development (Adelaja & George, 2021). Sustainable agricultural systems and practices, such as sustainable intensification, conservation tillage, crop diversification, and agroforestry, have the potential to contribute to food security by increasing sustainable agricultural yields and protecting the environment (Rehman et al., 2022).

When analysing the link between agricultural practices and food security, researchers considered a number of factors. For example, a study in Madagascar investigated the relationship between agricultural practices, household characteristics and food security. The findings show that agricultural practices as well as demographic and socioeconomic factors are associated with food security outcomes for rural populations (Herrera et al., 2021). In addition, foreign direct investment (FDI) in agriculture related to food security is analysed. Using correlation analysis, specific effects models, and 2SLS techniques, (Yao et al., 2020) researchers sought to understand the impact of agricultural FDI on food security in Belt and Road Initiative (BRI) countries.

In addition to food security, agricultural practices affect sustainability, environmental performance, farmers' livelihoods and human health. Improving environmental performance, achieving sustainable development goals, improving farmers' livelihoods and creating a good working environment in agriculture (Gaffney et al., 2019) requires sound science, innovation and optimized resource use. Furthermore, efforts must be made to sustainably increase agricultural production, strengthen global supply chains, reduce food loss and waste, and guarantee access to nutrient-dense food for those suffering from hunger and malnutrition(Food Security and Nutrition, 2022) .

The relationship between agricultural practices and food security is a complex and multifaceted area of scientific research. Numerous studies have highlighted the importance of agricultural practices for promoting food security, sustainable agricultural yields and environmental sustainability. Understanding the relationship between agricultural practices, socioeconomic factors and demographic characteristics is critical to addressing food security and implementing effective agricultural strategies.

H0: There is a significant relationship between agricultural practices and food security in Malaysia.

H1: There is not significant relationship between agricultural practices and food security in Malaysia.

2.7 The link between Farmers Profile and food security

The relationship between farmer profile and food security has been investigated by scientists. Understanding the relationship between these factors is essential for the development of effective food security strategies. Numerous studies have examined this correlation and emphasised the significance of farmer characteristics with regard to food security(Herrera et al., 2021).

Farmers' socioeconomic status, agricultural practises, access to resources, and levels of education play a significant role in determining food security outcomes. It has been demonstrated that investments in agriculture, such as upgrading irrigation systems and cultivating drought-resistant crops, reduce price and income volatility and improve food security for households with limited access to food markets (Reilly et al., 2022b).

In addition, the profile of farmers, such as their agricultural practises and production relationships, influence the food security outcomes of their households. Various pathways, such as direct consumption and farm income, are utilised by producers to increase their food security, according to research. Changing production relations and regaining control over agricultural inputs, such as seedlings, can contribute to improved food security. Moreover, the spatial diversity of agriculture-related causes of undernourishment emphasises the significance of recognising and comprehending effective interventions tailored to each country's particular circumstances (Pawlak & Kołodziejczak, 2020).

In conclusion, the relationship between farmer profile and food security is a crucial area of scientific study. Food security outcomes are determined in part by socioeconomic status, agricultural practises, access to resources, and production relationships. Understanding these relationships is essential for devising targeted interventions and strategies to increase farmers' and communities' food security.

H0: There is a significant relationship between Farmers profile and food security in Malaysia.

H1: There is not significant relationship between Farmers profile and food security in Malaysia.

2.8 The link between Institutional and market factors and food security

In the scientific literature, the relationship between institutional and market factors and food security has been extensively examined. Understanding how these factors affect food security is essential for developing effective policies and interventions to combat global poverty and ensure that everyone has access to nutritious food. Numerous studies have cast light on this relationship and uncovered important insights.

Institutional factors play a crucial role in establishing the basis for food security. For instance, research has emphasised the significance of institutions as the basis for addressing food security issues. Creating an enabling environment that promotes food security (Subramaniam et al., 2020) requires effective institutional arrangements and governance mechanisms. In addition, the integrity of institutions has been identified as a major determinant of food security. Countries with superior institutional quality typically have greater food security (Jiren et al., 2021).

In addition, market factors play a crucial role in determining food security outcomes. Market dynamics such as food prices and market accessibility have been studied in relation to food security. Food availability and accessibility can be substantially impacted by fluctuating food prices, particularly for vulnerable populations. Increasing food security requires ensuring stable and affordable food prices through effective market mechanisms (Cadieux & Blumberg, 2019).

Moreover, the relationship between institutional factors and market dynamics is an essential research topic. It has been demonstrated through research that formal and informal institutions interact with market systems to influence food security outcomes. The decline or functioning of informal institutions can be influenced by formal institution interventions and changes, which can have an effect on food security (Jiren et al., 2021). Understanding these dynamics is necessary for designing policies that foster supportive institutional frameworks and market systems in order to increase food security.

According to the scientific literature, the relationship between institutional and market factors and food security is evident. Achieving food security objectives requires effective institutional structures, sound governance, and robust market systems. Local and global food security can be enhanced by policies and interventions that resolve institutional deficiencies, improve market dynamics, and promote institutional-market interactions.

H0: There is a significant relationship between Institutional and market factors which food security.

H1: There is not significant relationship between Institutional and market factors which food security.

2.9 Conclusion

In conclusion, thar have three hypotheses regarding the relationship between three factor and DV have been proposed with the support of prior studies.

CHAPTER 3

RESEARCH METHODOLOGY

3.0 Introduction

The research methodology using for this study will be covered in more detail in this chapter, along with how the study will be carried out to meet its goals. According to Crotty, "Research Methodology is a comprehensive strategy that silhouettes our choice and use of particular methods relating them to the anticipated outcome"(Crotty, 1998). Research technique can be summed up as a method for methodically addressing research challenges. The method utilised for data collection and the direction of the research would be described in the research methodology. As a result, we start by talking about study designs, methodological choices, research philosophies, and research methods. The method of data collecting, research plan, creation of questionnaires, sampling design, pilot test, and time horizons are then mentioned. Last but not least, the subject of data analysis, which covers data validity and dependability, will conclude this chapter.

3.1 Research design

Research design can be defined as the coherent and logical integration of various components in the research with the overall strategy chosen to ensure that the research problems are effectively addressed, and it can be thought of as the framework or blueprint for data collection, measurement, and analysis(Hunziker & Blankenagel, 2021). In the research, descriptive research is chosen because descriptive research focuses on describing the current state event (Bhabra & Sparks, 2022), in this study, the impact of agricultural technology on food security, in addition to the descriptive explore relationships between variables, as correlational research highlights how things happen are related(Bhabra & Sparks, 2022), and in this study, mainly agricultural technologies affecting food productivity and adoption of agricultural technologies by Malaysian agricultural groups.

3.2 Methodological Choice

Methodological types in research describe the different ways that researchers collect and look at data. In the social sciences, there are three main types of research methods that are often used: quantitative, qualitative, and mixed methods. Each method has its own features and goals, which help researchers answer specific research questions and learn as much as possible about the thing they are studying.

The quantitative study will collect and analysed numbers of survey. It focuses on measuring factors and using statistical analysis to find trends, connections, and results that can be used in a wide range of situations. This method often uses a large number of samples and uses organised polls, studies, or the study of additional data(Daniel, 2016). On the other hand, qualitative research focuses on using non-numerical data to learn more about and understand social events in depth. This method involves getting rich, detailed data like conversations, notes, or textual analysis. This lets scholars look into complex social processes, meanings, and readings. Qualitative study often uses smaller samples, which give more in-depth information about how and why people think and feel the way they do(Ecarnot et al., 2022). In a single study, mixed methods research uses both quantitative and qualitative methods. It tries to take advantage of the best parts of both methods to get a full picture of the study question. Researchers who use mixed methods collect and look at both numbers and other kinds of information. This lets them check their results against each other and see how they fit together(Dawadi et al., 2021).

In the end, quantitative, qualitative, and mixed methods are all different types of study methods used in the social sciences. Quantitative research focuses on numerical data analysis, qualitative research emphasises non-numerical data examination, and mixed methods join the two. In this research, the researcher will be using the quantitative methods to measure factors and using statistical analysis to find trends and connections.

3.3 Research Philosophies

Research philosophy, which is also called a perspective or mindset, is the basis for doing research and helps researchers figure out how to build knowledge. They show what the researcher really thinks about truth, how knowledge works, and what their job is in the study process. Positivism, interpretivism, and critical theory are the three main study approaches that are frequently used in social science research.

Positivism, which is often linked to quantitative study, is based on the idea that there is an objective world that can be watched, measured, and studied using observational methods. Positivists try to find broad rules and patterns that explain how social things work. They stress impartiality, the use of factors that can be measured, and the use of the strict scientific method(Dawadi et al., 2021). On the other hand, like qualitative study, it puts an emphasis on how reality is changeable and built by society. Interpretations think that people give their events meaning, and that it is important to understand these subjective meanings to understand social processes. They often use methods like in-depth conversations, observing participants, and text analysis to get rich data that is sensitive to context(Daniel, 2016).

Critical theory, which has its roots in the social sciences and arts, examines how social systems and power relationships affect people's lives. By looking at problems like injustice, abuse, and social justice, critical thinkers try to change and question the way society works. They often use a mix of quantitative and qualitative methods to look at social structures and find out how power is distributed in ways that aren't obvious(Dawadi et al., 2021).

In short, research views like positivism, interpretivism, and critical theory tell researchers what they should believe and how they should go about building knowledge. Critical theory aims to question current power structures and bring about social change. Positivism emphasises truth and factual observation, interpretivism emphasises personal meaning and contextual understanding. By using different research theories, scholars can use different methods and points of view to study social events and learn more about them. This research is proposed to be conducted quantitatively; therefore, positivism paradigm approach is considered to verify the theory deducted.

3.4 Research Approaches

Research methodology refers to the strategies and procedures a researcher employs in conducting research. A common research approach is the deductive approach, which is closely related to positivism and encourages the use of quantitative research methods. Deductive methods involve testing specific hypotheses drawn from established theories or general principles and gathering data to confirm or refute those hypotheses. Starting with theory and progressing gradually to empirical observation and data analysis, the approach follows a structured and systematic procedure.

As a philosophy of research, positivism presupposes the existence of an objective reality that can be studied through empirical observation and measurement. It emphasizes the use of quantitative methods to acquire and analyse data in an effort to discover general patterns and regularities that explain social phenomena(Hejvani & Vasheghani Farahani, 2018). Positivists employ a deductive approach in which they start with a set of hypotheses based on established theories or general principles, and then design their studies to test these hypotheses.

A deductive approach within a positivist framework has many benefits. It enables researchers to rigorously and objectively test specific hypotheses, resulting in measurable results. The use of quantitative data facilitates statistical analysis, allowing generalizations and comparisons across samples and contexts. However, it must be recognized that deductive approaches may miss context-specific nuances and subjective experiences that are more effectively captured by qualitative approaches(Hejvani & Vasheghani Farahani, 2018).

In conclusion, deductive method is a research method combined with positivism and quantitative research. It involves testing specific hypotheses drawn from existing theories or general principles. By adopting this approach, researchers can systematically collect and analyse quantitative data to confirm or refute their hypotheses, contributing to the accumulation of knowledge in the field.

3.5 Data Collection

Data collection is an important part of research. This is when scholars gather information and proof to answer their research questions or test their theories. Data collection is primarily concerned with the organised gathering of numerical data that can be analysed statistically in the setting of positivism, which supports the use of quantitative methods in research. Quantitative methods of collecting data try to measure factors, gather accurate and objective information, and come up with numbers that can be used to generalise to a bigger community(Johnson, Burke & Christensen, 2014). The Data gathering can be broken down into two main parts: primary data and secondary data. Both primary and secondary facts are needed to understand the topic of the study better and more clearly.

One of the primary data collection techniques is surveying. A well-designed questionnaire can be developed to gather information from farmers, agricultural experts, and other stakeholders involved in the agrotechnology sector. The questionnaire should include both closed-ended and Likert scale questions to allow for quantitative analysis. The survey can be administered in person, or using online platforms, depending on the feasibility and accessibility of the target population.

Another valuable technique is the analysis of secondary data sources. Existing databases and records maintained by governmental and non-governmental organizations can provide quantitative data on various indicators related to agrotechnology and food security in Malaysia. This data can include information on crop yields, agricultural inputs, technology adoption rates, food production trends, and consumption patterns. By analyzing this secondary data, researchers can identify correlations and trends, allowing for a comprehensive assessment of the impact of agrotechnology on food security.

In summary, the data collection techniques for investigating the impact of agrotechnology on food security in Malaysia using quantitative methods encompass surveying, analysis of secondary data sources, and statistical analysis. By employing these techniques, researchers can gather comprehensive and reliable quantitative data to evaluate the effects of agrotechnology on food security indicators.

3.5.1 Primary Data

Primary data are original data collected directly from the source for a particular research study in the context of research. It is distinct from secondary data, which refers to information that has already been collected for a different purpose. The accumulation of primary data is typically associated with quantitative research methods, which adhere to the positivist philosophy and strive to collect objective and measurable information to answer research questions(Canals, 2017).

Primary data collection involves the active participation of researchers in the process of data collection. In order to collect information directly from participants or the research setting, researchers design and implement data collection instruments, such as questionnaires and experiments. This gives researchers control over the data acquisition procedure and ensures that the collected data is tailored to the specific research objectives. Typical primary data collection methods for quantitative research include surveys, experiments, and structured observations. Surveys involve the administration of standardised questionnaires to collect information from participants, typically via in-person interviews, online forms, or printed surveys. Experiments test causal relationships through the manipulation of variables and measurement of outcomes. In a controlled environment, structured observations entail the systematic recording of predetermined behaviours or events. Researchers have the advantage of having data that is directly relevant to their research queries and specific to their study objectives when they collect primary data. This allows them to analyse the data in accordance with their research objectives and hypotheses.

In conclusion, primary data refers to original data collected directly from the source for a specific research study. In quantitative research, primary data collection techniques such as surveys, experiments, and structured observations are frequently used to collect objective and quantifiable information. Researchers have control over the data collection procedure, enabling them to collect data pertinent to their research goals. When obtaining primary data, it is essential to address ethical considerations and be aware of potential biases.

3.5.2 Secondary Data

In research, "secondary data" refers to already-existing information that has been gathered by another party for a different reason but may be used in future research projects. It differs from primary data, which is information that is actually gathered by researchers for their own research. In quantitative research, which adheres to the positivist philosophy and aims to analyse objective and quantifiable facts, secondary data gathering techniques are frequently used. The many types of secondary data include databases, papers, reports, surveys, and publicly accessible records. Secondary data may be found in sources including academic databases, government databases, research institutes, and internet repositories. Compared to gathering data from scratch, researchers can save time, money, and effort by using secondary data(Canals, 2017). Secondary data in quantitative research can be utilised to answer research questions, test theories, or provide analyses more context. To get significant insights and reach conclusions, researchers use statistical approaches to the analysis of secondary data.

However, it is crucial for researchers to assess the calibre and applicability of secondary data before utilising it in their work. It is important to take into account variables like sample representativeness, data restrictions, and the reliability of the data source. Additionally, biases or inconsistencies in the secondary data that can undermine the reliability of the findings should be considered by researchers(Canals, 2017).

In conclusion, secondary data refers to previously obtained information that may be utilised in fresh research investigations despite having been collected for a different reason. Secondary data may be a useful tool for analysis and the investigation of research issues in quantitative research. To get insights and reach conclusions, researchers might analyse secondary data using statistical techniques. But it's crucial to evaluate the value and applicability of secondary data and be conscious of any biases that could exist.

3.7 Research Strategy

The purpose of research strategy is to provide insight into how research questions can be answered and how research objectives can be met (Saunders Mark et al., 2019). In this study, a survey or questionnaire is used to collect data in order to conduct a comprehensive analysis of the adoption of agrotechnology instruments by agricultural groups in Malaysia.

Referring to the research framework, the survey is divided into four sections in order to collect information from respondents. These sections are demography, independent variables comprising respondents' adoption of agrotechnology tools, and the dependent variable, which relates to the impact of food security. Most of the queries or statements would be closed-ended.

For research on the dependent and independent variable, a five-point Likert scale is utilised in the development of the survey. Likert scale, which was created by Rensis Likert, is not only convenient for obtaining specific opinions, but also for creating the scale itself. the survey's responses (Joshi et al., 2015). The five-point Likert scale would range from 1 (strongly disagree) to 5 (strongly concur) for negative and positive dimensions, respectively.

3.7 Questionnaire Design

Technically, the questionnaire consists of four sections, the first of which, Section A, centres on the respondents' demographic information, including their gender, age, level of education, occupation in agriculture, and frequency of agrotechnology instrument use. This section seeks to collect respondents' general demographic background information.

The second section, Section B, C, D focuses primarily on the research's independent variables. The variables consist of perceived simplicity of use, perceived utility, social influence, and facilitating conditions, each of which is comprised of four to five questions. This section identifies the most influential factor on agrotechnology instruments, whereas Section E focuses on the dependent variable, which is the impact of technology on food security. The results from all of these sections are used to determine whether there is a correlation between each of the measured constructs.

On a five-point Likert scale, 1 corresponds to'strongly disagree,' 2 corresponds to 'disagree,' 3 corresponds to 'neutral,' 4 corresponds to 'agree,' and 5 corresponds to ‘strongly agree.' The degree of agreement and disagreement on each of the statements in Sections B, C, D and E is measured using this scale.

The survey is generated using Google Form and distributed entirely digitally to the intended respondents. The adoption of online questionnaire distribution is more cost-effective, flexible, and time-efficient than the traditional method of questionnaire distribution. In fact, rapid, accurate data and results from the distributed questionnaire can be obtained in a brief amount of time(Narayan ka ,2022) .

3.8 Sampling Design

Sampling design in research refers to the methodical selection of a subset of individuals, entities, or observations from a larger population to represent that population in an investigation. It plays a crucial role in quantitative research, which is aligned with positivism and seeks to generalise findings from a sample to the entire population. The sampling plan ensures that the selected sample is representative and permits researchers to draw valid conclusions about the target population. (Moser & Kalton, 2017)Quantitative research employs various sampling techniques, including probability sampling and non-probability sampling. Probability sampling techniques, such as simple random sampling, stratified sampling, and cluster sampling, involve a random selection of individuals from the population, ensuring that each member has an equal chance of being included. These techniques offer a solid basis for generalizability and statistical inference.

Non-probability sampling methods, on the other hand, do not rely on a random selection and instead utilise either purposeful or convenience sampling. These methods are frequently employed when probability sampling is impractical or inappropriate. Convenience sampling entails selecting individuals who are easily accessible and frequently available, whereas purposeful sampling entails selecting individuals who meet specific criteria pertinent to the research query(Subu et al., 2022). Non-probability sampling may limit the generalizability of results to the entire population. However, in certain research contexts, it can still provide significant insights.

Researchers must consider the research query, available resources, and the target population when selecting the most appropriate sampling design. In addition, they must consider the potential biases and limitations of various sampling methods, as well as the need for a representative and diverse sample(Moser & Kalton, 2017). In addition, researchers should disclose and justify their sampling design selections in order to increase the research's transparency and reliability.

In conclusion, sampling design is an essential component of quantitative research, as it facilitates the generalizability of findings from a sample to the entire population. Probability sampling techniques, such as simple random sampling, assure equal selection probabilities and facilitate statistical inference. Non-probability sampling techniques, such as convenience and purposeful sampling, provide insights in particular contexts, but may limit generalizability. Researchers must carefully consider the research question and context in order to choose an appropriate sampling design that correlates with their research objectives and available resources.

3.8.1 Population and Sampling Frame

In quantitative research, the population refers to the entire group of individuals or objects being studied, while the sampling frame is a subset of the population from which a sample is drawn. Sampling is necessary because it is often impractical or impossible to study the entire population. Various sampling techniques, such as random sampling, stratified sampling, and cluster sampling, are used to select a representative sample. These techniques ensure that the sample is a practical and accessible representation of the larger population, allowing researchers to gather data efficiently while still making valid inferences about the entire population. For this research, the suitable population would be the agricultural sector in Malaysia, which includes farmers, agricultural workers, and relevant stakeholders involved in food production. In 2022, there were approximately 1.86 million people employed in the agriculture industry in Malaysia. This population is directly related to the topic at hand, as agrotechnology primarily affects those involved in the agricultural industry and their subsequent impact on food security.

To establish a sampling frame, it is important to identify a comprehensive list of all individuals or elements that make up the target population. In this case, the sampling frame could include databases from governmental agencies responsible for agriculture, such as the Ministry of Agriculture and Agro-Based Industry in Malaysia. These databases may contain information about registered farmers, agricultural organizations, and other key stakeholders in the agricultural sector.

3.8.2 Sampling Strategy

Sampling strategy in research is the methodological approach used to select a subset of individuals or units from a larger population to participate in a study. It is supported by the positivist approach and aims to make generalizations about a population based on a sample. One common sampling strategy is probability sampling, which involves randomly selecting participants from the target population. Non-probability sampling methods include purposive sampling, snowball sampling, and quota sampling. It is important to consider the strengths and limitations of each sampling strategy and make informed decisions to ensure the validity and generalizability of their findings. By carefully selecting an appropriate sampling strategy, researchers can enhance the validity and reliability of their findings.

3.8.3 Sample Size

The sample size will be determination using Krejcie and Morgan Table. The ever-increasing need for a representative statistical sample in empirical research has created the demand for an effective method of determining sample size. To address the existing gap, Krejcie & Morgan (1970) came up with a table for determining sample size for a given population for easy reference. For this research, the suitable population would be the agricultural sector in Malaysia, which includes farmers, agricultural workers, and relevant stakeholders involved in food production will be in 1.86 million people employed. So that, the research sample size will in 384 respondents.

N	*S*	*N*	*S*	*N*	*S*
10	10	220	140	1200	291
15	14	230	144	1300	297
20	19	240	148	1400	302
25	24	250	152	1500	306
30	28	260	155	1600	310
35	32	270	159	1700	313
40	36	280	162	1800	317
45	40	290	165	1900	320
50	44	300	169	2000	322
55	48	320	175	2200	327
60	52	340	181	2400	331
65	56	360	186	2600	335
70	59	380	191	2800	338
75	63	400	196	3000	341
80	66	420	201	3500	346
85	70	440	205	4000	351
90	73	460	210	4500	354
95	76	480	214	5000	357
100	80	500	217	6000	361
110	86	550	226	7000	364
120	92	600	234	8000	367
130	97	650	242	9000	368
140	103	700	248	10000	370
150	108	750	254	15000	375
160	113	800	260	20000	377
170	118	850	265	30000	379
180	123	900	269	40000	380
190	127	950	274	50000	381
200	132	1000	278	75000	382
210	136	1100	285	1000000	384

Note.—*N* is population size. *S* is sample size.

Source: Krejcie & Morgan, 1970

Table3.1 show the Krejcie and Morgan Table

3.9 Pilot Test

A pilot test is a preliminary stage of data collection conducted before the main research study to assess and refine the research instruments and procedures. It is commonly employed in quantitative research and aims to gather objective and measurable data. During a pilot test, researchers administer the research instruments, such as surveys or experimental protocols, to a small subset of participants like the intended study population. This allows researchers to observe how participants respond to the instruments, identify any confusing or ambiguous questions, and assess the feasibility and practicality of the data collection procedures.

A pilot test is a preliminary stage of data collection conducted before the main research study to assess and refine the research instruments and procedures. It helps researchers identify and rectify any flaws or weaknesses in the research instruments and procedures, reducing the likelihood of errors or biases in the data. Through this preliminary evaluation, researchers can enhance the quality and rigor of the data collected, contributing to the overall strength of the research study. The pilot test serves as a valuable opportunity to detect and address potential issues in the data collection process, ultimately improving the quality and validity of the data collected in the main research study(Sürücü & Maşlakcı, 2020a).

3.10 Time Horizon

In research, "time horizon" means the length of time over which data is collected and the study is done. It shows how long the study project will take, including how long it will take to collect data, analyse it, and come to a decision. Time span is especially important in quantitative research, which often tries to collect data at certain times or over a certain amount of time to look for patterns and trends.

A cross-sectional study, for example, has a short time range because it takes data at a single point in time or over a short period. It gives a picture of the important factors at a certain point in time. A longitudinal study, on the other hand, has a longer time frame because it watches people or things over a longer length of time. Researchers can then look at changes, trends, and connections over time. There can also be different time frames within a study. For example, some factors can be looked at in a cross-sectional way, while others can be followed over time.

The decision of time horizon is based on the study question, the nature of the thing being studied, and the tools that are available. Cross-sectional studies can be used to get a snapshot of a community or to find out how two factors are related at a certain time. Longitudinal studies, on the other hand, let researchers watch and analyse changes over time, figure out what causes what, and look into how things develop. Choosing the right time frame is important to make sure that the research plan fits with the study's goals and research questions.

In research, the time frame is the length of time over which data is collected and the study is done. In quantitative research, the time frame shows whether the study is focused on a single point in time (cross-sectional) or if it looks at a longer period of time (longitudinal). The choice of time horizon is based on the goals and questions of the study as well as the type of the thing being studied.

3.11 Data Analysis

Data analysis is a key part of the research process. It includes looking at, organising, and figuring out what the collected data means in order to come to useful conclusions and answer research questions. In quantitative research, data analysis methods are used to look at numbers that were collected in an organised way(Sürücü & Maşlakcı, 2020b). This fits with the scientific approach that quantitative research is based on. Researchers can find patterns, connections, and trends in the data and make statistical inferences and generalisations by analysing the data. The collected information will be put into a table, graph, or chart, and secondary data will be used to back up the main data received through surveys. In this research, descriptive analysis and Inferential Analysis are used while reliability and validity of the data will be evaluated.

Quantitative data analysis methods usually involve statistical techniques that let researchers explore and summarise the data, test theories, and draw conclusions about the community from which the sample was taken. Some of these methods are descriptive statistics, such as measures of central tendency (like mean and median) and measures of variability (like standard deviation and range), which show how the data is spread out and what its main features are. Inferential statistics, like hypothesis testing and regression analysis, are used to figure out how factors relate to each other and to make generalisations about the whole community(Heale & Twycross, 2015a).

It's important to remember that quantitative data analysis should be done carefully and openly, following set statistical processes and reporting rules. Researchers should also think about any problems or biases that might be in the data and take steps to fix them(Sadan, 2017). Also, it's important to be careful when interpreting numeric data, since statistical relationships don't always mean that one thing caused another.

In conclusion, data analysis is an important part of quantitative research because it lets researchers look at numbers and draw conclusions from them. Quantitative data analysis methods, such as descriptive and inferential statistics, are used to look for patterns, connections, and trends in the data and to make statistical inferences and generalisations. Researchers should be careful when analysing data, taking into account any possible limits and reading the results with care.

3.12 Descriptive Analysis

Descriptive analysis is a crucial method used in research to transform collected data into a more manageable form that is simpler to understand and interpret. It involves describing what the data reveals, allowing researchers to gain insights into the characteristics and patterns within the dataset. To conduct a comprehensive descriptive analysis, it is essential to consider the variables associated with the data, as they provide key information for understanding the research objectives.

Variables play a significant role in descriptive analysis as they provide the basis for measurement and analysis. In the context of this research on the impact of agrotechnology on food security in Malaysia, there may be various variables of interest, such as crop yield, income level, adoption of agrotechnology practices, and food security indicators. These variables help to capture the essential dimensions of the research topic and provide insights into the relationships and patterns within the data.

Central tendency and dispersion are two important aspects of descriptive analysis that provide valuable information about the dataset. Central tendency measures focus on summarizing the typical or average value of a variable, while dispersion measures describe how the values of the data are distributed around this central tendency.

There are three common methods for measuring central tendency that is mean, mode, and median. The mean is calculated by summing all the values of a variable and dividing by the number of observations, providing an average value. The mode represents the most frequently occurring value in the dataset, while the median is the middle value when the observations are arranged in ascending or descending order. These measures of central tendency help researchers understand the typical values and tendencies within the dataset.

Dispersion, on the other hand, provides insights into the spread or variability of the data. Two well-known measures of dispersion are the standard deviation and variance. The standard deviation quantifies the average amount by which values deviate from the mean, offering a measure of how much the data points vary from the average(Chapman, 2017). Variance is the square of the standard deviation and provides a measure of the average squared deviation from the mean.

In this research, the respondent's demographic information can be presented using frequencies and percentages, enabling researchers to understand the distribution of characteristics such as age, gender, education level, and occupation within the sample. Additionally, all variables, whether independent or dependent, can be described using measures of central tendency (mean, mode, median) and measures of dispersion (standard deviation, variance). These statistical measures provide a comprehensive understanding of the dataset and enable comparisons and interpretations of the findings.

3.13 Inferential analysis

Inferential analysis is a key part of scientific research because it lets researchers go beyond the data they have collected and make decisions and draw conclusions that make sense based on the data they have collected. Researchers can extrapolate their results to the larger group from which the sample was taken by using inferential analysis. This gives them valuable insights and implications for the research question at hand.

Inferential analysis involves the utilization of statistical methods and techniques to analyse the collected data and make inferences about the population parameters. These statistical tools enable researchers to quantify the relationships, patterns, and trends observed in the sample and make reasonable estimations about the corresponding population characteristics. There are a few key steps in the process of inferential research. First, the collected data is carefully looked at and put through a number of statistical tests to find out how the factors are related to each other. This preliminary study will be used as a basis for later inferential steps.

After the initial analysis is done, researchers do inferential tests like hypothesis testing or estimating confidence intervals. These tests give you a way to figure out what the features of the community are based on the sample data. Hypothesis testing includes coming up with null and alternative hypotheses, choosing the right statistical test, figuring out the test statistic, and figuring out what the results mean. Confidence interval estimating, on the other hand, involves making intervals around the sample values to give a range where the true population parameter is likely to fall.

In this research, the inferential analysis is important because the inferential Analysis is the extension beyond the data collected, it can be the judgements. or conclusions made based on the data obtained.

3.14 Reliability

In the context of research, reliability refers to the consistency, stability, and dependability of the measurements or instruments employed in data collection. It is a crucial concept, especially in quantitative research methods supported by positivism, because it ensures the collected data are accurate and reliable. Reliability is the degree to which a measurement or instrument yields consistent results when utilised repeatedly under similar conditions(Sürücü & Maşlakcı, 2020a).

When assessing the reliability of their measures, researchers consider various categories of reliability. Test-retest reliability, which examines the consistency of measurements over time, is a prevalent variety(Heale & Twycross, 2015b). This entails administering the same test twice to the same group of participants and analysing the correlation between the scores obtained. A strong test-retest reliability is indicated by a high correlation.

Inter-rater reliability, which evaluates the consistency of measurements taken by various observers or ratters, is another type of reliability. This is especially essential for studies involving observations or behavioural coding. Multiple ratters can independently observe the same events and then calculate the agreement or correlation between their ratings to determine inter-rater reliability. Another type of reliability that evaluates the consistency of measurements within a specific measurement instrument or scale is internal consistency reliability(Boakye et al., 2015). It examines whether the items on a scale or questionnaire consistently measure the same construct. This can be determined using statistical methods such as Cronbach's alpha, which assesses the degree of correlation between the items. A high Cronbach's alpha indicates a reliable internal consistency.

In conclusion, reliability is a crucial concept in positivist-supported quantitative research methods, guaranteeing the consistency and dependability of measurements or instruments. Internal consistency reliability evaluates the consistency of a measurement instrument. These types of reliability give researchers confidence in the precision and consistency of the collected data, thereby bolstering the validity and generalizability of their findings.

3.15 Validity

Validity in research is the degree to which a study measures or evaluates what it intends to measure accurately. It is a crucial component of quantitative research that conforms to the positivist philosophy. Validity guarantees that the findings and conclusions derived from the collected data are meaningful, trustworthy, and generalizable to the target population(Heale & Twycross, 2015c). To establish validity and ensure that their study produces trustworthy and credible results, researchers employ a variety of techniques.

Internal validity is a form of validity in quantitative research that refers to the extent to which a study demonstrates a causal relationship between variables. Researchers endeavour to establish internal validity by meticulously regulating extraneous variables, employing an appropriate research design, and utilising techniques such as random assignment or experimental manipulation(Heale & Twycross, 2015c).

The external validity of research findings refers to their applicability to other populations, contexts, or settings. External validity is enhanced by selecting representative samples and assuring that the study conditions are representative of the actual world. This allows researchers to draw conclusions and generalise their findings beyond the sample and research context.

In quantitative research, construct validity is another crucial aspect of validity. It refers to the extent to which a study's measures effectively assess the theoretical constructs they were designed to measure. Utilising established measurement instruments, conducting pilot studies, and ensuring that the measures correlate with the underlying theory or concept, researchers establish construct validity(Sürücü & Maşlakcı, 2020b).

Validity is a crucial aspect of quantitative research employing the positivist methodology. Researchers attempt to establish internal validity to demonstrate causal relationships between variables, external validity to generalise findings to broader populations or contexts, and construct validity to guarantee accurate measurement of theoretical constructs. By resolving these various forms of validity, researchers increase the credibility and reliability of their research results.

3.16 Conclusion

In overall, chapter three had discussed into the data collection method used, questionnaire design, Sampling Design, variables and measurement and data analysis technique of this study.

CHAPTER 4

DATA ANALYSIS AND RESULT

4.0 Introduction

Results and data analysis from the results are presented in this chapter. 386 individuals provided responses for the quantitative research that produced the data. To determine if the hypothesis is accepted, the primary goal of the data analysis process is hypothesis testing. Data was gathered using Google Forms to send the questionnaire to the target respondents, who are individuals working at an upper level in Malaysia's agriculture industry. Section A consists of 6 questions designed to gather basic demographic information from the respondents and 2 questions designed to gauge their familiarity with agrotechnology and usage. For Section B, C, D there are 12 questions in total that related to the independent variables while another 3 questions in Section E are questions related to the dependent variable. Prior to distributing the questionnaire to the 384 respondents based on the sample size, the researcher conducts a pilot test to ensure the questionnaire's reliability. This chapter covers data analysis using descriptive statistics, multiple regression analysis, reliability analysis, and Pearson correlation analysis. The researcher utilised SPSS Statistics 23 as the programme for data analysis.

4.1 Pilot Test

The pilot test was a reliability test for this study, which was carried out to ensure that the questionnaire's questions were clear and concise enough to entice responders to read the questions carefully. The pilot test also helped identify the possible issue that might arise. The validity and reliability of the data gathered may therefore be guaranteed following the pilot test. 30 people in all responded to the Google Form-prepared questionnaire. This questionnaire takes three to five minutes to complete on average. Following SPSS analysis, the pilot test results are displayed in the table below:

Table 4.1 Results of Pilot Test

Variables	Cronbach's Alpha	Number of Items
Independent Variables 1. agricultural practices	0.914	4
2.farmer profiles	0.748	4
3. institutional and market factors	0.896	4
Dependent Variables 1. food security in Malaysia	0.932	3
Overall	0.948	15

As shown in the table above, the pilot test conducted with the SPSS software was reliable. Each of the variables exhibited a Cronbach's Alpha value greater than 0.70. Variables with values exceeding 0.70 are deemed to have an acceptable level of reliability, while values surpassing 0.80 indicate an exceptionally high level in the Pilot Test. While variables exceeding 0.70 are deemed permissible, certain modifications will be implemented for those variables falling between 0.70 and 0.80.

In the case of variables exceeding 0.80, the questions may be continued, as this indicates that the respondents have comprehended the questions adequately while providing their responses to the questionnaire.

Values exceeding 0.70 are deemed to be legitimate and acceptable. The findings indicate that all independent and dependent variables exceed the threshold of 0.70. Furthermore, the Cronbach's Alpha value for the entire 15-item questionnaire is 0.948, suggesting that all items are valid and reliable. Consequently, following revisions to the questions pertaining to variables with values below 0.80 and above 0.70, the Google Form was utilised to disseminate the questionnaire to the 384 respondents.

4.2 Respondent Rate

The respondent rate is a key metric used in this research report to assess how well the data collection process worked. The careful method used to determine the sample size is reflected in the target number of replies for this study, which was 384. Using the popular Google Forms platform, the questionnaire was distributed to potential volunteers, and an impressive 389 replies were obtained. The little overabundance of responses received not only surpassed the initial goals but also strengthened the data's robustness, demonstrating the validity of the conclusions. Thus, response rates show how well the research team communicated with the intended audience, guaranteeing that the data set is complete and representative for insightful analysis. Based on all the data collected through Google Form, the table below will show and summarize the rate of response.

Table 4.2: Rate of Total and Target Responses

	Number of Responses	Percentage (%)
Total Target Responses	384	100
Total Responses Over Target	5	1.3
Total	389	101.3

4.3 Descriptive Statistic Analysis

Descriptive statistical analysis is an essential instrument utilised in this research to convert the unprocessed data collected into a structured and understandable format (Trochim, 2020). Consistent with this tenet, the subsequent segment is committed to clarifying and presenting the demographic particulars of the participants. This encompasses critical variables such as the participants' age, gender, educational attainment, and other relevant information that enhances the comprehension of the individuals involved in the research. In addition, this segment explores the experiences of the participants in regard to their knowledge of agrotechnology and its application. Through the provision of a comprehensive outline of these critical variables, the study endeavours to furnish valuable insights into the attributes of the surveyed populace. This establishes the foundation for a subsequent, more profound examination of their viewpoints and reactions during the research.

4.3.1 Demographic Profile

The demographic profile of each respondent was collected by requiring respondents to answer the Section A of the questionnaire. The demographic details collected from respondents included gender, age group, educational level, type of enterprise, main sector of activity, and area of activity of agriculture.

Table 4.3 Demographic Profile of Respondents

Variable	Description	Number	Percentage (%)
Gender	Male	255	65.6
	Female	134	34.4
Age Group	Below 16	0	0
	16-26	3	0.8
	27-36	55	14.1
	37-46	269	69.2
	47-56	59	15.2
	55-66	3	0.8
	More than 66	0	0
Educational Level	Degree	47	12.1
	Diploma	56	14.4
	Primary school	25	6.4
	Secondly school	261	67.1
Type of enterprise	Family farm	190	48.8
	Large enterprise	18	4.6
	others	2	.5

	Small-medium enterprise	179	46.0
The sector of agricultural activity	Animal breeding, livestock management	98	25.2
	Commerce	8	2.1
	Horticulture	1	.3
	Machinery	2	.5
	Other	1	.3
	Plant production	227	58.4
	Plant production, Animal breeding, livestock management	47	12.1
	Plant production, Commerce	1	.3
	Plant production, Horticulture	4	1.0
Area of Agricultural Activity	Johor	25	6.4
	Kedah	51	13.1
	Kelantan	23	5.9
	Malacca	26	6.7
	Negeri Sembilan	17	4.4
	Pahang	51	13.1
	Penang	47	12.1
	Perak	52	13.4
	Perak, Selangor	6	1.5
	Perak, Selangor, Negeri Sembilan	5	1.3
	Perlis	18	4.6
	Sabah	4	1.0
	Sarawak	5	1.3
	Selangor	32	8.2
	Terengganu	27	6.9

4.3.2 Age Group

Table 4.4: Descriptive Statistics (Age group)

(Source: SPSS Output)

Age

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	16-26	3	.8	.8	.8
	27-36	55	14.1	14.1	14.9
	37-46	269	69.2	69.2	84.1
	47-56	59	15.2	15.2	99.2
	57-66	3	.8	.8	100.0
	Total	389	100.0	100.0	

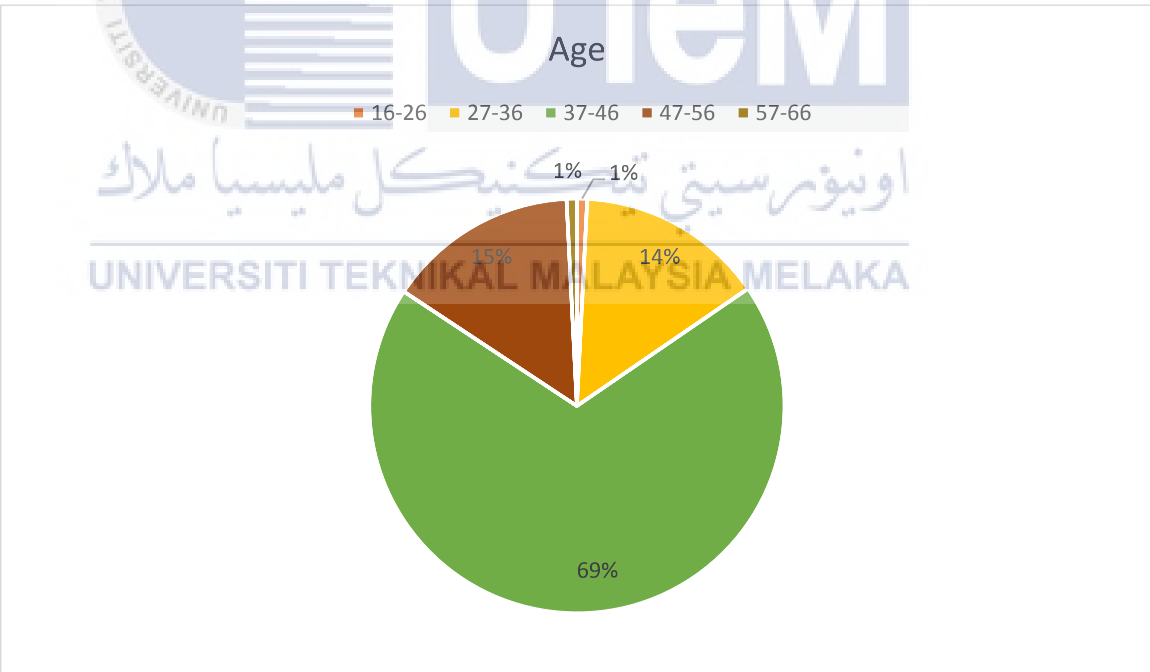

Figure 4.1 Age Group of Respondents

The table and figure above had illustrated the age group of the 389 respondents. Majority of the respondents which include 269 (69.2%) of the respondents are 37-46 years old. Next, 59 respondents which is 15.2% of the total respondents are in the age of 47-56. Another 14.1 % of the respondents, which is 55 of them are 27-36 years old while 0.8 %, 3 of the 389 respondents are in the age of 16 -26. Another 0.8% of the respondents, which is 3 of them are 57-66 years old None of the respondent is 61 years old and above. Majority of the respondents are in 37-46 age group.

4.3.2 Gender

Table 4.5: Descriptive Statistics (Gender)

(Source: SPSS Output)

Gender:

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Female	134	34.4	34.4	34.4
	Male	255	65.6	65.6	100.0
	Total	389	100.0	100.0	

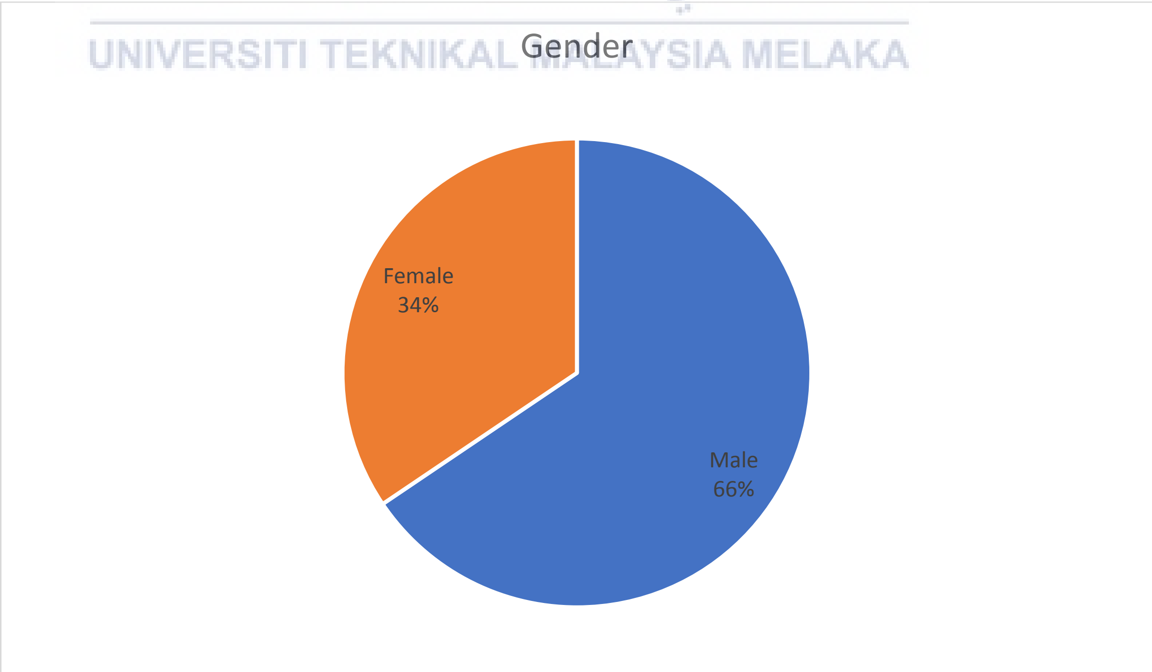

Figure 4.2 Gender of Respondents

Table and Figure above show the percentage of gender that answered the questionnaire through Google Form distributed. 66% which is 225 of the respondents are male while 34% which means 134 of the 389 respondents that answered the questionnaire are male.

4.3.3 Educational Level

Table 4.6: Descriptive Statistics (Educational Level)

(Source: SPSS Output)

Education level

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Degree	47	12.1	12.1	12.1
	Diploma	56	14.4	14.4	26.5
	Primary school	25	6.4	6.4	32.9
	Secondly school	261	67.1	67.1	100.0
	Total	389	100.0	100.0	

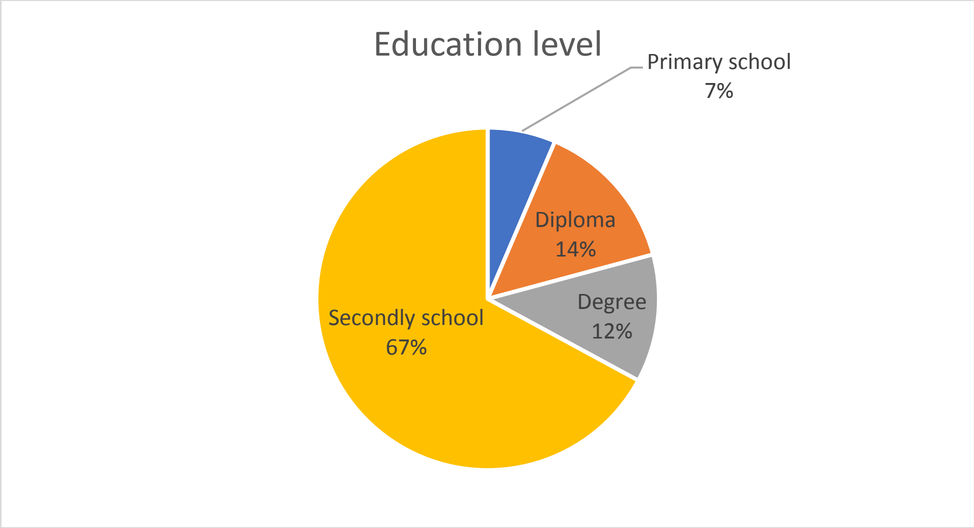

Figure 4.3 Educational Level of Respondents

The percentage of educational level of respondents is shown in the figure and table above. 261 (67 %) of the respondents stated educational level as secondly school while 56 (14 %) of the total respondents had marked their educational level as Diploma. On the other hand, 12 % which is 47 of the 386 respondents had stated Degree as their educational level. 7 %. More respondents' educational level is Secondly school. This may be due to the questionnaire is college at the agricultural wholesale market at the city.

4.3.4 Type of enterprise

Table 4.7: Descriptive Statistics (Type of enterprise)

(Source: SPSS Output)

Type of enterprise

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Family farm	190	48.8	48.8	48.8
	Large enterprise	18	4.6	4.6	53.5
	others	2	.5	.5	54.0
	Small-medium enterprise	179	46.0	46.0	100.0
	Total	389	100.0	100.0	

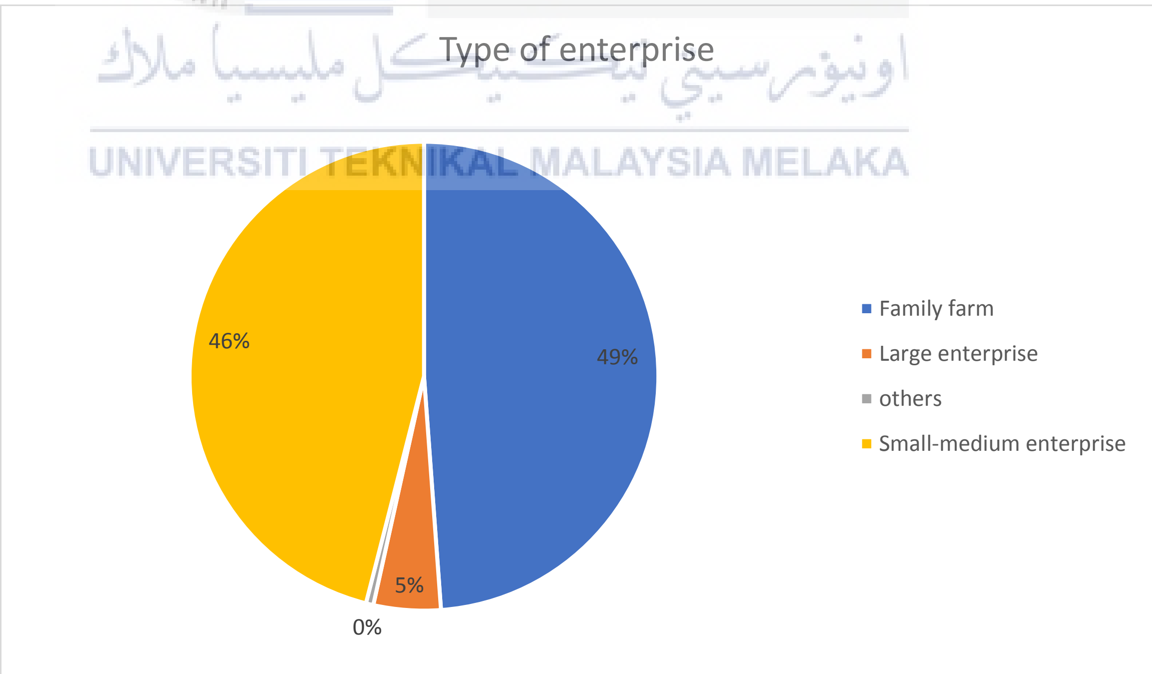

Figure 4.4 Type of enterprise of Respondents

The dataset on the type of enterprise reveals a diverse distribution among the 389 respondents. Family farms emerge as the predominant category, with 190 responses, constituting 48.8% of the total. This indicates a substantial representation of individuals associated with or operating within the framework of family farming. Conversely, large enterprises account for 18 responses, reflecting 4.6% of the total, suggesting a smaller but noteworthy presence in the surveyed population. Small to medium-sized enterprises (SMEs) make a significant impact, with 179 responses, contributing to 46% of the total. This highlights a considerable proportion of individuals engaged in smaller-scale business operations. The "others" category encompasses two responses, equivalent to 0.5% of the total, reflecting unique or varied enterprise types not explicitly categorized as family farms, large enterprises, or SMEs. In summary, the descriptive statistics underscore the diversity in the distribution of enterprise types, shedding light on the predominant role of family farms and the varied landscape of entrepreneurial ventures among the respondents.

4.3.5 The sector of agricultural activity

Table 4.8: Descriptive Statistics (The main sector of agricultural activity)

(Source: SPSS Output)

The main sector of agricultural activity

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Animal breeding, livestock management	98	25.2	25.2	25.2
	Commerce	8	2.1	2.1	27.2
	Horticulture	1	.3	.3	27.5

	Machinery	2	.5	.5	28.0
	Other	1	.3	.3	28.3
	Plant production	227	58.4	58.4	86.6
	Plant production, Animal breeding, livestock management	47	12.1	12.1	98.7
	Plant production, Commerce	1	.3	.3	99.0
	Plant production, Horticulture	4	1.0	1.0	100.0
	Total	389	100.0	100.0	

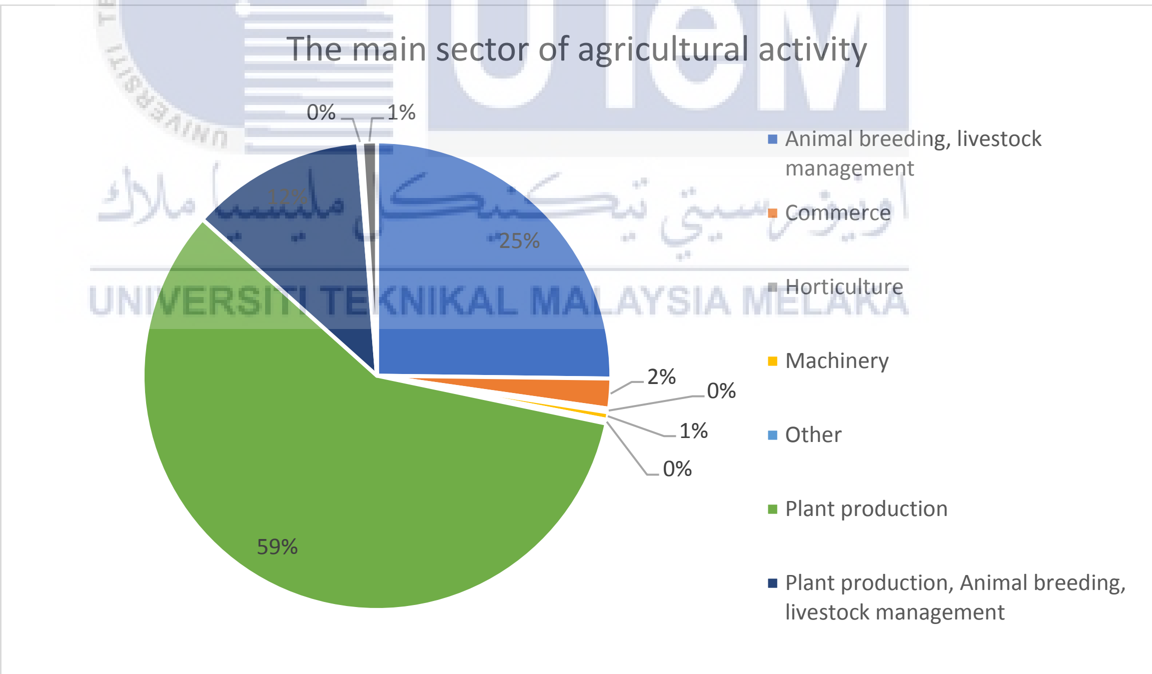

Figure 4.5 The sector agricultural include of the respondents.

In the data set of the main sectors of agricultural activity, most respondents are engaged in plant production, accounting for 227 or 58.4%. This was followed by animal breeding and livestock management with 98 responses, accounting for 25.2%.

Business represented a smaller proportion, with 8 responses, equivalent to 2.1% of the total. Gardening and machinery each accounted for the smallest share, accounting for 1 response each, at 0.3% and 0.5% respectively. Additionally, there was a category labeled "Other" with 1 response, also 0.3% of the total. Notably, some respondents were involved in multiple sectors, such as plant production combined with animal breeding and livestock management, accounting for 47 responses or 12.1% of the total. There were also respondents involved in plant production and commerce (1 response or 0.3%) and plant production and horticulture (4 responses or 1.0%). These findings indicate a diverse distribution of agricultural activities among respondents, with an emphasis on plant production.

4.3.6 Area of Agricultural Activity

Table 4.9: Descriptive Statistics (The Area of Agricultural Activity)

(Source: SPSS Output)

Area of Area of Agricultural Activity

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Johor	25	6.4	6.4	6.4
	Kedah	51	13.1	13.1	19.5
	Kelantan	23	5.9	5.9	25.4
	Malacca	26	6.7	6.7	32.1
	Negeri Sembilan	17	4.4	4.4	36.5
	Pahang	51	13.1	13.1	49.6
	Penang	47	12.1	12.1	61.7
	Perak	52	13.4	13.4	75.1
	Perak, Selangor	6	1.5	1.5	76.6
	Perak, Selangor, Negeri Sembilan	5	1.3	1.3	77.9
	Perlis	18	4.6	4.6	82.5
	Sabah	4	1.0	1.0	83.5

	Sarawak	5	1.3	1.3	84.8
	Selangor	32	8.2	8.2	93.1
	Terengganu	27	6.9	6.9	100.0
	Total	389	100.0	100.0	

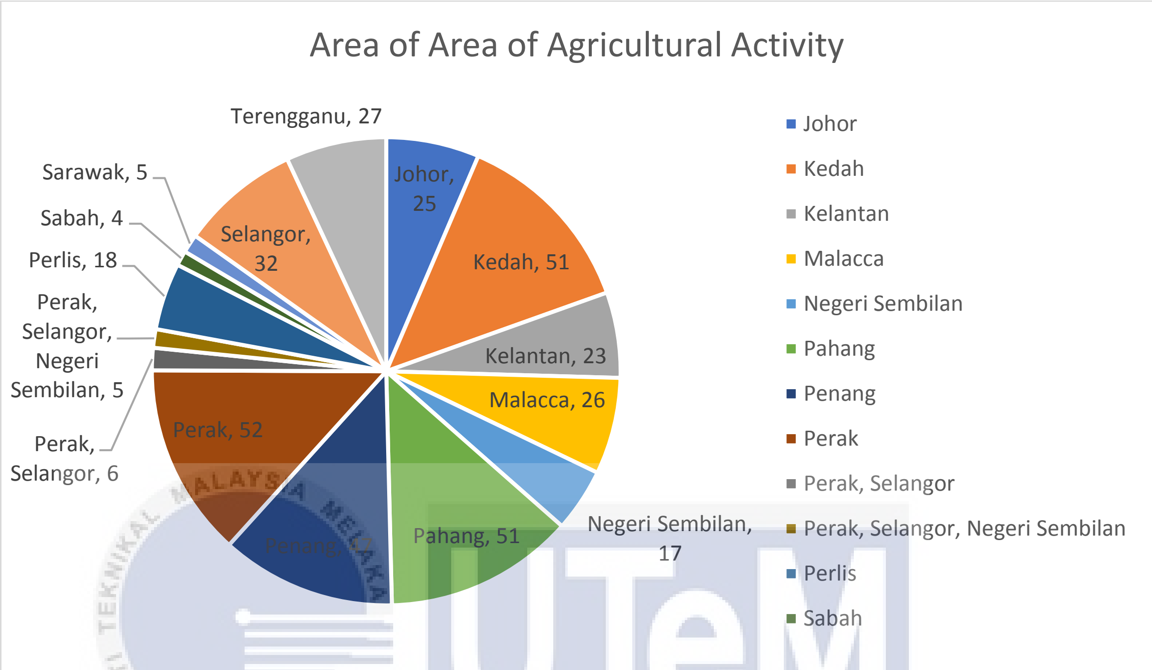

Figure 4.6 The Area of Area of Agricultural Activity

Questionnaire data provide insights into the distribution of respondents according to agricultural activity areas. Perak appeared most frequently with 52 respondents, accounting for 13.4% of the total sample. This was followed by Kedah and Pahang with 51 respondents each, accounting for 13.1% of respondents each. Selangor and Penang also had a high proportion of respondents, with 32 and 47 respondents respectively, accounting for 8.2% and 12.1% of the total. Johor, Malacca, Terengganu and Kelantan regions had a moderate frequency of respondents ranging from 23 to 27 respondents, representing 5.9% to 6.9% each. Notably, some respondents indicated involvement in agricultural activities in multiple regions, with six respondents from Perak and Selangor and five respondents from Perak, Selangor and Negeri Sembilan. Meanwhile, states such as Sabah and Sarawak were interviewed less frequently, with 4 and 5 respondents respectively, accounting for 1.0% and 1.3% of the total. Overall, the data provides a comprehensive overview of the geographical distribution of respondents engaged in agricultural activities in Malaysia.

4.3.7 The familiarity of respondents with the term "agrotechnology"

Table 4.10: Descriptive Statistics (The familiarity of respondents with the term "agrotechnology")

(Source: SPSS Output)

Familiarity of respondents with the term "agrotechnology"

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	78	20.1	20.1	20.1
	Yes	311	79.9	79.9	100.0
	Total	389	100.0	100.0	

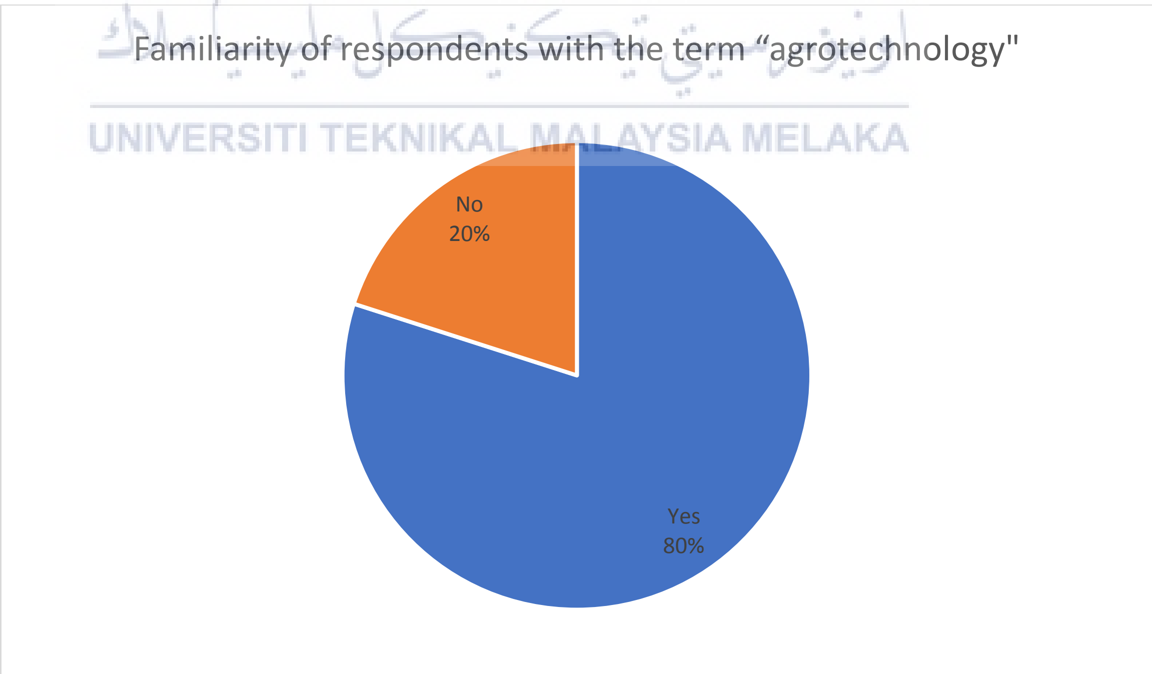

Figure 4.7 The familiarity of respondents with the term "agrotechnology"

Following of the data on respondents' familiarity with the term "agricultural technology", the majority of respondents (79.9% of the sample) answered in the affirmative, indicating that they are familiar with the term. In contrast, a small number of respondents (20.1% of the total) reported being unfamiliar with the term. This distribution indicates that respondents have a relatively high level of awareness and recognition of agricultural technology concepts. The findings indicate that a large proportion of respondents possess some level of knowledge or exposure to agricultural technology practices, while a smaller proportion may require further education or awareness-building activities to enhance their understanding of this agricultural technology-related term.

4.3.8 Usage of Agrotechnology

Table 4.11: Descriptive Statistics (The Usage of Agrotechnology)

(Source: SPSS Output)

Usage of Agrotechnology

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	178	45.8	45.8	45.8
	Yes	211	54.2	54.2	100.0
	Total	389	100.0	100.0	

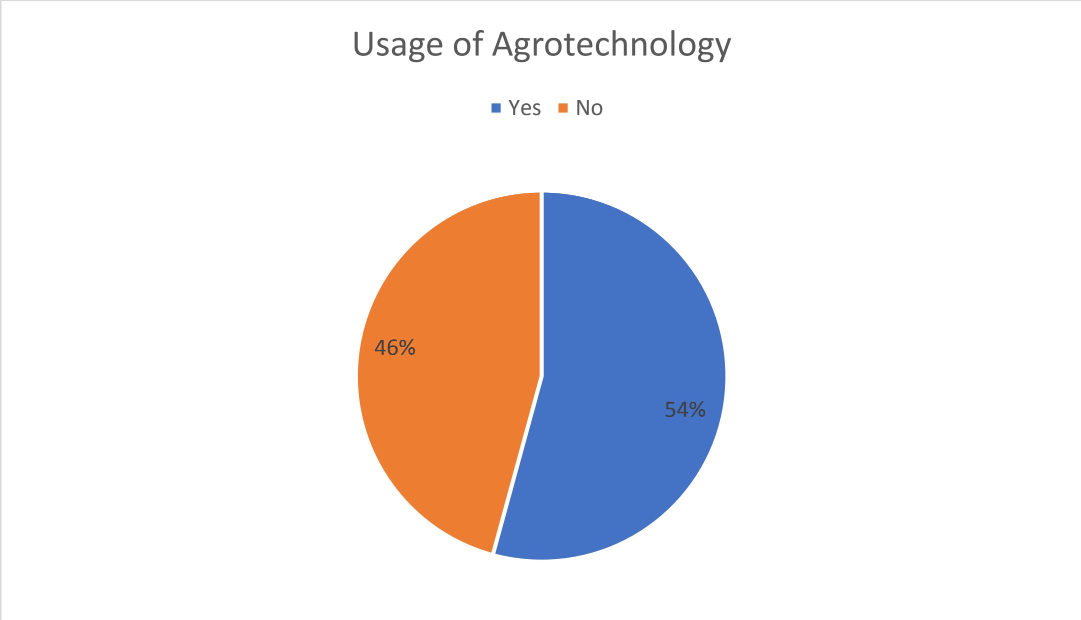

Figure 4.8 The Usage of Agrotechnology

The survey results show that the majority of the respondents (211 of the total, or 54.2%) answered in the affirmative, indicating that they use agricultural technology in agricultural practices. On the other hand, 178 (45.8%) respondents reported no use of agricultural technology. This indicates a relatively balanced distribution of responses, with a slight majority indicating active involvement in agricultural technology. These findings provide insight into current agricultural technology adoption rates among the surveyed population, highlighting noteworthy levels of utilization, but also indicate that a large proportion of respondents have not yet incorporated such technologies into their farming activities.

4.4 Research Validity

To determine whether an instrument is measuring what it claims to (Phelan & Wren, 2005), research validity must be conducted. Therefore, this study employs Pearson Correlation to establish research validity, as it is critical to verify the association between the variables under investigation.

4.4.1 Pearson Correlation

To determine the degree of linear significance or implication between two variables, one must utilise Pearson Correlation (Magiya, 2019). Therefore, in order to establish the relationship between food security and the agricultural practices, farmer profiles and institutional and market factors, this study employs Pearson Correlation. The Pearson Correlation Coefficient is a metric that ranges from -1 to 1. A positive relationship is indicated by a R value closer to 1; a negative relationship is indicated by a R value closer to -1; and a value of 0 indicates the absence of any relationship.

Table 4.12 Relationship interpreted through R value.

R value	Relationship
0.70 or higher	Very Strong Positive Relationship
+0.40 to +0.69	Strong Positive Relationship
+0.30 to +0.39	Moderate Positive Relationship
+0.20 to +0.29	Weak Positive Relationship
+0.01 to +0.19	No or Negligible Relationship
0	No Relationship
-0.01 to -0.19	No or Negligible Relationship
-0.20 to -0.29	Weak Negative Relationship
-.030 to -0.39	Moderate Negative Relationship
-0.40 to -0.69	Strong Negative Relationship
-0.70 or higher	Very Strong Negative Relationship

Table 4.13 Pearson Correlation Results between Variables

(Source: SPSS Output)

Correlations

		IV1	IV2	IV3	DV
IV1	Pearson Correlation	1	.927**	.889**	.991**
	Sig. (2-tailed)		.000	.000	.000
	N	389	389	389	389
IV2	Pearson Correlation	.927**	1	.940**	.907**
	Sig. (2-tailed)	.000		.000	.000
	N	389	389	389	389
IV3	Pearson Correlation	.889**	.940**	1	.854**
	Sig. (2-tailed)	.000	.000		.000
	N	389	389	389	389
DV	Pearson Correlation	.991**	.907**	.854**	1
	Sig. (2-tailed)	.000	.000	.000	
	N	389	389	389	389

**. Correlation is significant at the 0.01 level (2-tailed).

Table 4.13 shows the results of Pearson correlation analysed using SPSS. According to the above table, there is a significant relationship between all variables including dependent and independent variables as the significant output between variables is 0.000. This is because a p-value can be considered statistically significant when it is 0.05 and below (Jaadi, 2019). For the independent variables including agricultural practices, farmer profiles and institutional and market factors and the dependent variable (food security in Malaysia), the Pearson correlation analysis conducted through SPSS showed 0.991, 0.907 and 0.854 respectively. According to

Table 4.12, R values between 0.70 and above indicate a very strong positive relationship between the dependent and independent variables. Therefore, agricultural practices, farmer profile, institutional and market factors can be concluded to have a very strong positive significant relationship with food security in Malaysia as the R value is between 0.70 to above and Sig. The (2-tailed) between these variables is 0.000.

4.5 Research Reliability Test

To analyse the reliability of this research, the questionnaire was required to gain response from 389 respondents. There are 12 questions for independent variables which are agricultural practices, farmer profiles and institutional and market factors and 3 questions for dependent variable which is food security in Malaysia. The degree of reliability of this research is consider according to the Cronbach's Alpha level of consistency as shown below:

Table 4.14: Cronbach's Alpha Level Consistency

Cronbach's Alpha	Internal Consistency
$0.5 > \alpha$	Unacceptable
$0.6 > \alpha \geq 0.5$	Poor
$0.7 > \alpha \geq 0.6$	Questionable
$0.8 > \alpha \geq 0.7$	Acceptable
$0.9 > \alpha \geq 0.8$	Good
$\alpha \geq 0.9$	Excellent

The table below shows the results of Cronbach’s Alpha:

Table 4.15 Reliability Statistics

(Source: SPSS Output)

Variables	Cronbach’s Alpha	Number of Items
Independent Variables		
1. agricultural practices	0.866	4
2. farmer profiles	0.736	4
3. institutional and market factors	0.826	4
Dependent Variables		
1. Food security in Malaysia	0.837	3
Overall	0.957	15

Table 4.16 Overall Cronbach’s Alpha

(Source: SPSS Output)

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.957	0.948	15

Table 4.16 above shown the results of reliability test after analysed by using SPSS. The value of Cronbach’s Alpha achieved are considered as valid when it exceeds 0.70. The reliability test for agricultural practices had come out with Cronbach’s Alpha value of 0.866 which is at the range of Good according to the Cronbach’s Alpha Level Consistency. For institutional and market factors, it scored

0.826 of Cronbach's Alpha value which is also consider as Good. On the other hand, the Cronbach's Alpha values of farmer profiles are 0.736 respectively which means farmer profiles is in the Acceptable range . For dependent variable which is Food security in Malaysia obtained 0.837 Cronbach's Alpha value and make it to be in the range of Good as well. In short, the reliability test of all variables are acceptable since all of it obtained more than 0.70. For the overall Reliability test, this research had obtained 0.957which means it internal consistency is Excellent according to the Cronbach's Alpha Level Consistency table as shown in Table 4.14. Hence, this research can be concluded as highly reliable based on this reliability test done.

4.6 Multiple Regression Analysis

Multiple Regression Analysis is done by doing Multiple Linear Regression in this research in order to figure out the linear connection between the dependent variables and independent variables (Kenton, 2020).

Table 4.17 Multiple Linear Regression

(Source: SPSS Output)

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.993[a]	.986	.986	.08102

a. Predictors: (Constant), IV3, IV1, IV2

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	173.394	3	57.798	8805.924	.000[b]
	Residual	2.527	385	.007		
	Total	175.921	388			

a. Dependent Variable: DV

b. Predictors: (Constant), IV3, IV1, IV2

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-.131	.040		-3.294	.001
	IV1	1.215	.018	1.092	66.254	.000
	IV2	.045	.031	.032	1.442	.150
	IV3	-.207	.025	-.147	-8.127	.000

a. Dependent Variable: DV

According to the Model Summary, the Coefficient for Multiple Determination R Square is 0.986. This had indicated the dependent variable, Food security in

Malaysia were 98.6% influenced by the independent variables included agricultural practices, farmer profiles and institutional and market factors. Another 1.4% (100%-98.6%= 1.4%) of Food security in Malaysia is going to be influenced by other factors that are still yet to discover.

The F value is 88.059and the significance value according to the Anova Table is 0.000. All results will be significant when the F value is large, the significance value is small (Glen, 2020). Since the significance value is less than alpha level of 0.05 as well, it can be concluded that there is statistically significant relationship occur between the independent variables which are agricultural practices, farmer profiles and institutional and market factors with the dependent variable, Food security in Malaysia. The following shows the standard Multiple Linear Regression Equation: $\hat{y}$ = b0 + b1x1 + b2x2 + … + bp-1xp-1 + bpxp

By implementing the equation above, the linear equation below was developed based on the Beta coefficients in Table 4.19:

Food security in Malaysia

=

-0.131+1.215AR+0.045FP-0.207IMF

The equation above had shown that the relationship between independent variables which are agricultural practices, farmer profiles on the dependent variable, Food security in Malaysia are positive. while the institutional and market factors are negative show that the institutional and market factors on the dependent variable, Food security in Malaysia are negative.

Based on the coefficient Beta, the agricultural practices have higher contribution towards Food security in Malaysia than the other independent variables. This is because the contribution of the independent variable is larger when the value of the coefficient is larger.

4.7 Hypothesis Testing

Table 4.18 Multiple Linear Regression (Coefficient)

(Source: SPSS Output)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-.131	.040		-3.294	.001
	IV1	1.215	.018	1.092	66.254	.000
	IV2	.045	.031	.032	1.442	.150
	IV3	-.207	.025	-.147	-8.127	.000

a. Dependent Variable: DV

Hypothesis Testing for this research are done by referring the p-value (significance value) in the Table 4.20. When p-value is larger than 0.05, the null hypothesis will be accepted. Oppositely, the null hypothesis will be rejected when the p-value is less than 0.05. In short,

When

$p < 0.05$, accept alternative hypothesis.

$p > 0.05$, reject alternative hypothesis.

1. Agricultural practices: P-value =0.000

H0: There is not significant relationship between agricultural practices and food security in Malaysia.

H1: There is a significant relationship between agricultural practices and food security in Malaysia.

Based on the p-value of perceived usefulness in the Table 4.18, the p-value is 0.000 which means it is less than 0.05. This had shown that there is significant relationship between the agricultural practices and food security in Malaysia. Therefore, the alternative hypothesis, H1 is accepted while the null hypothesis (H0) is rejected.

2. Farmers profile: P-value =0.150

H0: There is not significant relationship between Farmers profile and food security in Malaysia.

H1: There is a significant relationship between Farmers profile and food security in Malaysia.

According to the p-value of social influence in the Table 4.18, the p-value is 0.150 which means it is more than 0.05. This had indicated that there is no significance relationship between Farmers profile and food security in Malaysia. Since the p-value is more than 0.05, the alternative hypothesis, H1 is rejected while the null hypothesis (H0) is accepted.

3.0 Institutional and market factors: P-value =0.000

H0: There is not significant relationship between Institutional and market factors which food security in Malaysia.

H1: There is a significant relationship between Institutional and market factors which food Security in Malaysia.

Based on the p-value of perceived usefulness in the Table 4.18, the p-value is 0.000 which means it is less than 0.05. This had shown that there is significant relationship between Institutional and market factors which food Security in Malaysia. Therefore, the alternative hypothesis, H1 is accepted while the null hypothesis (H0) is rejected.

4.8 Conclusion

Every analysis performed in this chapter was examined utilising SPSS Statistics 23.

Initially, a Pilot Test was conducted to ascertain the questionnaire's reliability. The chapter then provided a discussion, analysis, and conclusion regarding the data gathered from 389 respondents. This chapter presents the outcomes of four distinct types of analyses performed in the research: descriptive statistics analysis, Pearson correlation, reliability test, and multiple regression analysis.

Following the analysis of the data, hypothesis testing was also conducted. Both H1 and H3 were deemed acceptable due to their p-values being below 0.05. Nevertheless, the p-value associated with H2 exceeded 0.05, leading to the rejection of the hypothesis.

CHAPTER 5

DISCUSSION, IMPLICATION AND CONCLUSION

5.0 Introduction

This chapter will provide a more comprehensive analysis of the findings and results that were examined in Chapter 4. The discourse commences with a concise overview of the data and outcomes that were examined via Descriptive Statistical Analysis. The subsequent section pertains to scale measurement, which is succeeded by an analysis of the objectives and hypotheses. The implications of this research are also elaborated upon in this chapter, along with suggestions for further investigations. The research's conclusion is presented in the final section of this chapter.

5.1 Descriptive Statistic Analysis Summary

The Descriptive Statistic Analysis is done by analysing the data collected from respondents in Section A . There are 389 responses in total that are completed by 389 respondents in Malaysia. There were 255 of the respondents are male which are 65.6% of the total respondents and 134 or 34.4% of the respondents are female. Then, out of 389 respondents, 269 (69.2%) of them are 37-46 years' old, 59 (15.2%) of them are from the age group of 47-56 , another 55 or 14.1% of the respondents are in the age group of 27-36 while 3 or 0.8% of the respondents are in the age group of 57-66. another 3 or 0.8% of the respondents are in the age group of 16-26. None of the respondents are from the age group of 66 and above.

Besides that, there are 261 (67.1%) of the total respondents' educational level are secondly school, 56 (14.4%) are Diploma, 47 (12.1%) are degree and 25 (6.4%) are primary school. That are no respondents are having Master as educational . For type of enterprise 190 or 48.8% respondent is working or business at the family farm, another 179 or 46% of the respondents are working or business at the Small-medium enterprise while 18 or 4.6 % of the respondents are working or business at the large enterprise. The dataset on enterprise types showcases a diverse distribution among the 389 respondents, revealing distinct patterns within the surveyed population. Family farms emerge as the dominant category, comprising 48.8% of the total with 190 responses, emphasizing a significant presence of individuals associated with or operating within the family farming framework. In contrast, large enterprises constitute a smaller but noteworthy fraction, accounting for 4.6% with 18 responses. The substantial impact of small to medium-sized enterprises (SMEs) is evident, contributing 46% (179 responses) to the overall distribution, underscoring the prevalence of smaller-scale business operations. The "others" category, encompassing unique or varied enterprise types, represents 0.5% of the total with two responses.

The dataset on the main sectors of agricultural activity reveals a predominant focus on plant production, encompassing 58.4% of the respondents, while animal breeding and livestock management trail behind at 25.2%. Business activities constitute a smaller fraction at 2.1%, with gardening and machinery representing the least common sectors at 0.3% and 0.5%, respectively. Noteworthy is the presence of respondents engaged in multiple sectors, such as the combination of plant production and animal breeding, accounting for 12.1% of the total. Additionally, there are instances of overlap between plant production and commerce (0.3%) and plant production and horticulture (1.0%). These diverse patterns underscore the varied distribution of agricultural activities among respondents, emphasizing the significance of plant production within the surveyed population.

The questionnaire data reveals insightful patterns in the distribution of respondents based on their agricultural activity areas in Malaysia. Perak emerges as the most prominent region, with 52 respondents comprising 13.4% of the total sample, followed closely by Kedah and Pahang, each contributing 13.1%. Selangor and Penang also exhibit substantial representation, constituting 8.2% and 12.1% of the respondents, respectively. Johor, Malacca, Terengganu, and Kelantan show moderate frequencies, ranging from 5.9% to 6.9%. Noteworthy is the occurrence of respondents engaged in multiple regions, such as six respondents from Perak and Selangor, and five from Perak, Selangor, and Negeri Sembilan. In contrast, Sabah and Sarawak have fewer interviews, comprising 1.0% and 1.3% of the total, providing an encompassing overview of the geographical distribution of agricultural activities in Malaysia.

5.2 Scale of Measurement

5.2.1 Research Validity

The research validity for this research is done by using Pearson Correlation. Hence, it is done to find out the validity between the relationship of independent variables which are agricultural practices, farmer profiles and institutional and market factors, with the dependent variables which is food security in Malaysia. The agricultural practices had scored 0.991 which is the highest Pearson Correlation in compare with other independent variables. On the other hand, the farmer profiles and institutional and market factors had shown Pearson Correlation of 0.907, and 0.854 respectively. Therefore, agricultural practices, farmer profiles and institutional and market factors are having the strong positive relationship with the dependent variable according to the Table 4.14. Since the significant output between agricultural practices, farmer profiles and institutional and market factors are 0.000 which is less than 0.05, it can be concluded that there is significant relationship.

5.2.2 Research Reliability

The reliability test was first done during pilot test to figure out the reliability of the questionnaire. After that, the reliability test was also done on the data collected from the 389 respondents to find out the reliability of this research. The Cronbach's Alpha Value for agricultural practices, farmer profiles and institutional and market factors are 0.866, 0736, and 0.826 respectively. The Cronbach's Alpha Value for overall output is 0.957. Since the Cronbach's Alpha value is higher than 0.80, the research can be concluded as highly reliable.

5.3 Discussion

5.3.1 General Objective 1.To examine the relationship between agricultural practices with food security in Malaysia.

This research had clarified that the agricultural practices is positively affecting the food security in Malaysia which also proved that there is relationship between these two variables. This had been figured out by referring to the Multiple Regression Analysis as the p-value of perceived usefulness 0.000 which is less than 0.05 and this prove that there is positive relationship between agricultural practices with food security in Malaysia. A study done by (Chuang et al., 2020.)also found out the positive relationship of agricultural practices with the food security.

Agricultural practices enhance resilience to environmental changes and reduces the risks associated with the dependence on a single crop. This approach can contribute to maintaining a stable and diverse food supply, thus positively impacting food security. Malaysia’s agriculture is susceptible to climate variations. Climate-resilient agricultural practices, including the adoption of drought-resistant crops and water management strategies, can mitigate the impact of climate change on crop yields and ensure a more consistent food supply. Hence, it can be concluded that there is relationship between perceived usefulness and consumer buying behaviour towards online grocery shopping.

5.3.2 General Objective 2. To examine the relationship between farmers profile with food security in Malaysia.

Another factor that proposed in this research is farmer’s profile. However, it is found that there is no positive relationship between farmers profile and food security in Malaysia. The p-value of farmers profile is 0.150 according to the results gained in thorough Multiple Regression Analysis. Since the 0.150 is more than 0.05, the researcher had to reject the alternative hypothesis and accept the null hypothesis. a study by (Mahmudul Alam &Chamhuri,2010.) had gained similar results with this research that the farmer’s profile. is not going to be affected by food security.

The lack of a positive relationship between farmers' profiles (education level, social status, income, gender, and demographics) and food security in Malaysia may stem from the intricate nature of factors influencing food security. Unequal access to resources, market dynamics, government policies, climate change, and social and cultural factors can overshadow the impact of individual farmer characteristics. Additionally, the effectiveness of policies, data limitations, and the influence of broader economic and environmental conditions contribute to the complexity of the relationship. A comprehensive understanding of these interconnected factors is crucial for devising effective strategies to improve food security in the Malaysian agricultural sector.

5.3.3 General Objective 3. To examine the relationship between institution and market factor with food security in Malaysia.

This research had clarified that the institution and market factor is positively affecting the food security in Malaysia which also proved that there is relationship between these two variables. This had been figured out by referring to the Multiple Regression Analysis as the p-value of perceived usefulness 0.000 which is less than 0.05 and this prove that there is positive relationship between institution and market factor with food security in Malaysia. A study done by (Daniel and Mulugeta,2020) also found out the positive relationship of institution and market factor with the food security.

The relationship between institutions and market factors significantly influences food security for farmers in Malaysia. Government policies and regulations, such as subsidies and trade practices, directly impact farmers' income and practices. Access to resources and services, including seeds and credit facilities, influences productivity and efficiency. Investment in agriculture, both public and private, supports modernization and technology adoption. Price stability is crucial for farmers' income security. When institutions foster policies that ensure access, investment, and stable prices, they create an environment conducive to increased agricultural productivity and income, contributing to overall food security for farmers in Malaysia.

5.4 Implication of research

The thorough examination of "Investigating the Impact of Agrotechnology on Food Security in Malaysia" within the agricultural wholesale market in Perak has far-reaching consequences that resonate with stakeholders in numerous fields. Primarily, the research sheds light on the present state of agrotechnology implementation in the agricultural industry of Malaysia. Utilising these insights, policymakers can enhance current strategies and policies that seek to promote technological progress in the agricultural sector, thereby guaranteeing the continued expansion of the industry.

Furthermore, the research results make a substantial contribution to our understanding of the critical function that agrotechnology fulfils in enhancing food security. As a result of these revelations, policymakers can now customise interventions to resolve the challenges and leverage the benefits associated with agrotechnology adoption. These specific initiatives possess the capacity to strengthen the food security infrastructure of the nation. In addition to its relevance to policymaking, the study provides farmers and agribusinesses with invaluable insights that serve as a guide to the potential advantages and challenges associated with the incorporation of agrotechnology into agricultural operations. Equipped with this information, stakeholders are empowered to make well-informed decisions that maximise the utilisation of agrotechnology in order to increase productivity and resilience.

Moreover, the ramifications of this investigation transcend the scholarly domain, laying a solid groundwork for subsequent Research. Scholars have the opportunity to utilise these results as a foundation for further investigation into particular aspects of agrotechnology and food security, including socioeconomic ramifications and scalability assessments in various regions of Malaysia.

Fundamentally, the study surpasses its short-term goals by providing an abundance of ramifications that strike a chord with policymakers, agricultural practitioners, commercial enterprises, and scholars equally.

5.5 Limitation of Research

As the progress made in "Investigating the Impact of Agrotechnology on Food Security in Malaysia" at the agricultural wholesale market in Perak is acknowledged, it is necessary to further examine the inherent constraints that invariably accompanies research endeavours of this magnitude. An essential aspect that necessitates meticulous examination pertains to the possibility of response bias that is intrinsic in research methodologies based on questionnaires. The utilisation of self-reported data presents a nuanced yet substantial concern: participants might be tempted to provide responses that are socially acceptable or unintentionally distort their agricultural practices. This adds an additional level of intricacy that undermines the precision and dependability of the research's depiction of the complex realities within the agricultural domain.

Furthermore, the research's focus on the agricultural wholesale market in Perak, which is limited to a specific geographical area, induces careful consideration concerning the applicability of its results. Perak's distinctive agroecological conditions, fluctuating levels of infrastructure development, and socioeconomic dynamics may generate a microcosm that is specific to its context and may not easily extrapolate to the agricultural landscape of Malaysia as a whole. As a result, inquiries emerge regarding the generalizability of the study's findings to other geographical areas within the nation. Potentially more robust and representative of agricultural markets and regions, a broader and more heterogeneous sample could bolster the external validity of the study.

Moreover, the inherent limitations of establishing definitive causal relationships between agrotechnology adoption and food security outcomes are attributed to the cross-sectional design of the study. Although the study offers significant insights into the current state of affairs, the temporal dimension continues to present a difficulty. Longitudinal studies, which encompass significant durations, would play a crucial role in documenting the ever-changing progression of agrotechnology implementation and the subsequent effects it has on food security. By adopting this methodology, the intricate temporal dynamics in operation could be revealed, facilitating a more holistic comprehension of the cause-and-effect connections.

The study was susceptible to resource limitations, including budgetary and temporal restrictions, which could have had an impact on critical components such as sample sizes and methods of data acquisition. Although these limitations are rational in light of the pragmatic aspects of research, they inevitably give rise to possible consequences. The aforementioned consequences may materialise as constraints on the statistical power of the study and the overall strength of its findings. It is crucial that forthcoming research endeavours navigate these resource limitations with care, pursuing novel approaches to optimise the process of data collection and analysis despite the constraints.

Notwithstanding these complexities, it is imperative to emphasise the study's importance as a significant contribution to the discipline, establishing a robust foundation for subsequent inquiries. Recognising these constraints does not undermine the value of the research; rather, it is a crucial stride in the process of honing and progressing the methodologies utilised in future scientific pursuits. In order to enhance the calibre and influence of forthcoming investigations, it is critical to methodically acknowledge, confront, and manoeuvre around these constraints while maintaining a steadfast dedication to ongoing refinement and scholarly distinction.

5.6 Recommendations for Future Research

Building upon the findings of the present investigation, potential directions for further research become apparent, offering the chance to enhance our comprehension of the complex interplay between agrotechnology and food security in Malaysia. Longitudinal studies are an essential subsequent measure that enable the documentation of the ever-changing progression of agrotechnology implementation and its subsequent influence on food security over prolonged durations.

In order to address the inherent response bias that may arise in questionnaire-based research, it is advisable to employ a mixed-methods approach. By augmenting surveys with comprehensive interviews or focus group discussions, a more nuanced viewpoint can be obtained, one that delves into the complexities of farmers' practices and experiences in the context of agrotechnology. Moreover, it is recommended that forthcoming investigations focus on the unique obstacles and prospects encountered by discrete subindustries operating within the agricultural wholesale sector in Perak. By customising interventions to suit the distinct requirements of various stakeholders, the beneficial effects of agrotechnology on food security can be maximised.

To attain a holistic comprehension, it is imperative to broaden the scope of inquiry to include comparative analyses conducted in various regions of Malaysia. By adopting such a methodology, it is possible to uncover regional disparities in the adoption of agrotechnology and gain insight into the contextual elements that impact the effectiveness of agrotechnology endeavours. Further research endeavours should explore the socio-economic ramifications of agrotechnology adoption, surpassing a focus on technical aspects. It is crucial to evaluate the impacts of agricultural development on rural areas, employment trends, and income distribution in order to formulate policies that promote sustainable and inclusive development.

In summary, it is recommended that forthcoming investigations be carefully planned to rectify the identified constraints, thereby expanding the scope of investigation to provide a more comprehensive and nuanced comprehension of the complex correlation between agrotechnology and food security in Malaysia.

5.7 Conclusion

Chapter 5 provides an extensive and in-depth analysis of the research results on the impact of agricultural technology on food security in Malaysia. This section begins with an overview of the data and results explored in Chapter 4, beginning with a comprehensive descriptive statistical analysis. The analysis is based on responses from 389 participants in Malaysia and covers aspects such as demographics, education levels, business types, agricultural activities and regional distribution.

In the descriptive statistical analysis, detailed breakdown of participant demographics revealed distributions by gender, age group, education level, and business type. It is worth noting that family farms have become the dominant enterprise type, accounting for 48.8% of the total, followed by small and medium-sized enterprises (46%) and large enterprises (4.6%). The main sectors of agricultural activity, mainly focused on plant production, are also clarified. Geographically, Perak is the most prominent region, with Kedah, Pahang, Selangor and Penang accounting for a large proportion.

Turning to measurement scales, this section focuses on the validity and reliability of the study. Pearson correlation coefficient was used to establish the validity of the relationship between the independent variables (agricultural practices, farmer profiles, institutional and market factors) and the dependent variable (food security). Notably, agricultural practices showed the highest Pearson correlation (0.991), indicating a strong positive relationship. The subsequent discussion on the reliability of the study was assessed through Cronbach's Alpha which strengthened the reliability of the study with a value exceeding 0.80.

The following sections (5.3 and 5.4) delve into the core of the study, discussing the relationship between agricultural practices, farmer profiles, institutional and market factors, and food security. Research has found that agricultural practices have a positive impact on food security, increasing resilience to environmental change and contributing to a stable and diversified food supply. In contrast, there is no significant positive relationship between farmer profile and food security. The complex interplay between factors such as unequal access to resources, market dynamics, government policies, and social and cultural influences are highlighted as potential explanations for this lack of correlation. On the other hand, there is a positive relationship between institutional and market factors and food security, emphasizing the role of government policy, investment and price stability.

The significance of the study section highlights the practical implications of the study for policymakers, agribusiness and academics. It highlights the potential of improved strategies to promote technological advancement in the agricultural sector, ultimately contributing to the growth of the industry. The research has implications beyond academia, providing stakeholders with valuable insights to make informed decisions about the adoption of agricultural technologies.

However, this section also acknowledges the limitations of the study. Possible response bias due to self-reported data, regional specificity associated with focusing on Perak, and the inability of the cross-sectional design to establish clear causal relationships were considered limitations. Resource constraints, including budget and time constraints, were also acknowledged, giving rise to considerations of sample size and data collection methods.

Recommendations for future research provide a roadmap based on current research. Longitudinal studies, mixed methods, regional comparative analysis, and a focus on socioeconomic impacts are recommended to address identified limitations and enhance the robustness and applicability of the study.

In summary, Chapter 5 provides a thorough exploration of the research findings, providing valuable insights into the complex relationships between agricultural technology, farmer profiles, institutional and market factors, and food security in Malaysia. Despite its limitations, this study makes a significant contribution to the field, providing practical implications for various stakeholders and guiding future research efforts. The nuanced understanding gained from this chapter has the potential to influence policy and practice to promote sustainable development of Malaysian agriculture.

References

Adams, A., & Jumpah, E. T. (2021). Agricultural technologies adoption and smallholder farmers' welfare: Evidence from Northern Ghana. *Http://Www.Editorialmanager.Com/Cogentecon*, *9*(1). https://doi.org/10.1080/23322039.2021.2006905

Adelaja, A., & George, J. (2021). Food and Agricultural Security: An Introduction to the Special Issue. *Sustainability 2021*, *Vol. 13*, *Page 12129*, *13*(21), 12129. https://doi.org/10.3390/SU132112129

Adopt advanced technology, AI to boost farm yields and ensure food security: Expert. (2023, September 5). www.thesundaily.my. *https://www.thesundaily.my/local/adopt-advanced-technology-ai-to-boost-farm-yields-and-ensure-food-security-expert-LM10949299*

Agriculture Overview: Development news, research, data | World Bank. (2023, Mar 31). Retrieved June 7, 2023, from https://www.worldbank.org/en/topic/agriculture/overview

Agriculture's connected future: How technology can yield new growth. (2020, October 9). McKinsey & Company. *https://www.mckinsey.com/industries/agriculture/our-insights/agricultures-connected-future-how-technology-can-yield-new-growth*

Ahmed, F., Al-Amin, A. Q., Mohamad, Z. F., & Chenayah, S. (2016). Agriculture and food security challenge of climate change: a dynamic analysis for policy selection. *Scientia Agricola*, *73*(4), 311–321. https://doi.org/10.1590/0103-9016-2015-0141

Ali Zainuddin, A., Nazri Jai, A., Husna Zainudeen, A., Baharudin, A., Mahadir Naidu, B., Ying Ying, C., Siew Man, C., Zhuo Lin, C., Paiwai, F., Nordin, F., Leng Huat, F., Jan Jan Mohamed, H. B., Akmal Abd Hamid, H., Ismail, H., Mat Hassan, H., Mutalip, H., Abu Saad, H., Tee Guat Hiong, H., Sulaiman, J., …

Kaur, J. (2014). VOLUME II SURVEY FINDINGS. *NATIONAL HEALTH AND MORBIDITY SURVEY*.

Anitei, M., Veres, C., & Pisla, A. (2021). *Research on Challenges and Prospects of Digital Agriculture*. 67. https://doi.org/10.3390/PROCEEDINGS2020063067

Arslan, A., McCarthy, N., Lipper, L., Asfaw, S., & Cattaneo, A. (2014). Adoption and intensity of adoption of conservation farming practices in Zambia. *Agriculture, Ecosystems & Environment*, *187*, 72–86. https://doi.org/10.1016/J.AGEE.2013.08.017

Balafoutis, A., Beck, B., Fountas, S., Vangeyte, J., Van Der Wal, T., Soto, I., Gómez-Barbero, M., Barnes, A., & Eory, V. (2017). Precision Agriculture Technologies Positively Contributing to GHG Emissions Mitigation, Farm Productivity and Economics. *Sustainability 2017, Vol. 9, Page 1339*, *9*(8), 1339. https://doi.org/10.3390/SU9081339

Ball, B. C., Hargreaves, P. R., & Watson, C. A. (2018). A framework of connections between soil and people can help improve sustainability of the food system and soil functions. *Ambio*, *47*(3), 269. https://doi.org/10.1007/S13280-017-0965-Z

Baryshnikova, N., Altukhov, P., Naidenova, N., & Shkryabina, A. (2022, February 1). Ensuring Global Food Security: Transforming Approaches in the Context of Agriculture 5.0 - IOPscience. Ensuring Global Food Security: Transforming Approaches in the Context of Agriculture 5.0 - IOPscience. https://doi.org/10.1088/1755-1315/988/3/032024

Bhabra, M., & Sparks, F. (2022). Exploring research impact; Why it matters? *Current Opinion in Otolaryngology and Head and Neck Surgery*, *30*(3), 188–193. https://doi.org/10.1097/MOO.0000000000000801

Bhoi, P. R., Ouedraogo, A. S., Soloiu, V., & Quirino, R. (2020). Recent advances on catalysts for improving hydrocarbon compounds in bio-oil of biomass catalytic pyrolysis. *Renewable and Sustainable Energy Reviews*, *121*, 109676. https://doi.org/10.1016/j.rser.2019.109676

Blok, V., & Gremmen, B. (2018). Agricultural technologies as living machines: Toward a biomimetic conceptualization of smart farming technologies. *Ethics*, *Policy and Environment*, *21*(2), 246–263. https://doi.org/10.1080/21550085.2018.1509491

Boakye, M., Harkema, S., Ellaway, P. H., & Skelly, A. C. (2012). Quantitative testing in spinal cord injury: overview of reliability and predictive validity. *Journal of Neurosurgery. Spine*, *17*(1 Suppl), 141–150. https://doi.org/10.3171/2012.5.aospine1296

Borchers, M. R., & Bewley, J. M. (2015). An assessment of producer precision dairy farming technology use, prepurchase considerations, and usefulness. *Journal of Dairy Science*, *98*(6), 4198–4205. https://doi.org/10.3168/JDS.2014-8963

Bravo-Ureta, B. E., Jara-Rojas, R., Lachaud, M. A., & Moreira, V. H. (2017). *A META ANALYSIS OF FARM EFFICIENCY: EVIDENCE FROM THE PRODUCTION FRONTIER LITERATURE*.

Cadieux, K. V., & Blumberg, R. (2019). Food Security in Systemic Context. *Encyclopedia of Food and Agricultural Ethics*, 1264–1272. https://doi.org/10.1007/978-94-024-1179-9_11

Canals, L. (2017). *Instruments for gathering data*. https://doi.org/10.14705/rpnet.2017.emmd2016.637

Cecchini, M., Bedini, R., Mosetti, D., Marino, S., & Stasi, S. (2018). Safety Knowledge and Changing Behavior in Agricultural Workers: an Assessment Model Applied in Central Italy. *Safety and Health at Work*, *9*(2), 164–171. https://doi.org/10.1016/J.SHAW.2017.07.009

Chandio, A. A., Jiang, Y., Rehman, A., Twumasi, M. A., Pathan, A. G., & Mohsin, M. (2021). Determinants of demand for credit by smallholder farmers': a farm level analysis based on survey in Sindh, Pakistan. *Journal of Asian Business and Economic Studies*, *28*(3), 225–240. https://doi.org/10.1108/JABES-01-2020-0004/FULL/PDF

Chandra Karmokar, B., Samawat Ullah, M., Siddiquee, K., & Alam, K. M. R. (2015). Tea Leaf Diseases Recognition using Neural Network Ensemble. *International Journal of Computer Applications*, *114*(17), 975–8887.

Chapman, S. J. (2017). Review of Discovering Statistics Using IBM SPSS Statistics, 4th Edition. *Https://Doi.Org/10.1080/15512169.2017.1366328*, *14*(1), 145–147. https://doi.org/10.1080/15512169.2017.1366328

Chen, Y., Michalak, M., & Agellon, L. B. (2018). Focus: Nutrition and Food Science: Importance of Nutrients and Nutrient Metabolism on Human Health. *The Yale Journal of Biology and Medicine*, *91*(2), 95. /pmc/articles/PMC6020734/

Chouayet, W., & Rezitis, A. (2016). Price Transmission along the European Food Supply Chain in Selected Northern-Southern Countries. *International Journal of Food and Beverage Manufacturing and Business Models*, *1*(2), 31–48. https://doi.org/10.4018/IJFBMBM.2016070103

Climate-Smart Agriculture. (2021, April 5.). Retrieved May 31, 2023, from https://www.worldbank.org/en/topic/climate-smart-agriculture

Crotty, M. (1998). The Foundations of Social Research BT - Introduction: The Research Process. *Introduction: The Research Process*, 1–17. http://books.google.com/books?id=Op_SDKrf1ZQC&printsec=frontcover&dq=inauthor:crotty+(1998+book)&hl=&cd=1&source=gbs_api

Daniel, E. (2016). *Journal of Education and Practice www.iiste.org ISSN*. *7*(15). www.iiste.org

Dawadi, S., Shrestha, S., & Giri, R. A. (2021). Mixed-Methods Research: A Discussion on its Types, Challenges, and Criticisms. *Journal of Practical Studies in Education*, *2*(2), 25–36. https://doi.org/10.46809/JPSE.V2I2.20

Dawson, T. P., Perryman, A. H., & Osborne, T. M. (2016). Modelling impacts of climate change on global food security. *Climatic Change*, *134*(3), 429–440. https://doi.org/10.1007/S10584-014-1277-Y

De Baerdemaeker, J., Munack, A., Ramon, H., & Speckmann, H. (2001). Mechatronic systems, communication, and control in precision agriculture. *IEEE Control Systems Magazine*, *21*(5), 48–70. https://doi.org/10.1109/37.954519 de Pinto, A., Cenacchi, N., Kwon, H. Y., Koo, J., & Dunston, S. (2020). Climate smart agriculture and global food-crop production. *PLOS ONE*, *15*(4), e0231764. https://doi.org/10.1371/JOURNAL.PONE.0231764

De Pintoid, A., Cenacchi, N., Kwonid, H.-Y., Koo, J., & Dunston, S. (2020). *Climate smart agriculture and global food-crop production*. https://doi.org/10.1371/journal.pone.0231764

Dessart, F. J., Barreiro-Hurlé, J., & Van Bavel, R. (2019). Behavioural factors affecting the adoption of sustainable farming practices: a policy-oriented review. *European Review of Agricultural Economics*, *46*(3), 417–471. https://doi.org/10.1093/erae/jbz019

Dhanaraju, M., Chenniappan, P., Ramalingam, K., Pazhanivelan, S., & Kaliaperumal, R. (2022). Smart Farming: Internet of Things (IoT)-Based Sustainable Agriculture. *Agriculture 2022, Vol. 12, Page 1745*, *12*(10), 1745. https://doi.org/10.3390/AGRICULTURE12101745

Dossou-Yovo, E. R., & Saito, K. (2021). Impact of management practices on weed infestation, water productivity, rice yield and grain quality in irrigated systems in Côte d'Ivoire. *Field Crops Research*, *270*, 108209. https://doi.org/10.1016/J.FCR.2021.108209

Ecarnot, F., Lombion, S., Pourrez, A., Laurent, A., Fournier, A., Lheureux, F., Loiseau, M., Rigaud, J. P., Binquet, C., Meunier-Beillard, N., & Quenot, J. P. (2022). A qualitative study of the perceptions and experiences of healthcare providers caring for critically ill patients during the first wave of the COVID-19 pandemic: A PsyCOVID-ICU substudy. *PLoS ONE*, *17*(9). https://doi.org/10.1371/JOURNAL.PONE.0274326

FAO Food Price Index | World Food Situation | Food and Agriculture Organization of the United Nations. (2023, 7 April). Retrieved June 2, 2023, from https://www.fao.org/worldfoodsituation/foodpricesindex/en/

Farmer Education. (2020 April 8.). Retrieved May 31, 2023, from https://www.nifa.usda.gov/topics/farmer-education

Fausti, S., & Wang, T. (2018). Cost of crop production. *Practical Mathematics for Precision Farming*, 191–199. https://doi.org/10.2134/PRACTICALMATH2017.0032

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS Transforming the livestock sector through the Sustainable Development Goals WORLD LIVESTOCK. (2018). https://doi.org/10.4060/ca1201en

Food security and nutrition and sustainable agriculture | Department of Economic and Social Affairs. (2021, August 3). Food Security and Nutrition and Sustainable Agriculture | Department of Economic and Social Affairs. https://sdgs.un.org/topics/food-security-and-nutrition-and-sustainable-agriculture

Fraser, E. D. G., & Campbell, M. (2019). Agriculture 5.0: Reconciling Production with Planetary Health. *One Earth*, *1*(3), 278–280. https://doi.org/10.1016/J.ONEEAR.2019.10.022

Gaffney, J., Bing, J., Byrne, P. F., Cassman, K. G., Ciampitti, I., Delmer, D., Habben, J., Lafitte, H. R., Lidstrom, U. E., Porter, D. O., Sawyer, J. E., Schussler, J., Setter, T., Sharp, R. E., Vyn, T. J., & Warner, D. (2019). Science-based intensive agriculture: Sustainability, food security, and the role of technology. *Global Food Security*, *23*, 236–244. https://doi.org/10.1016/J.GFS.2019.08.003

Gebreegziabher, Y., Girma, E., & Tesfaye, M. (2019). Help-seeking behavior of Jimma university students with common mental disorders: A cross-sectional study. *PLoS ONE*, *14*(2). https://doi.org/10.1371/JOURNAL.PONE.0212657

Girdziute, L., Besuspariene, E., Nausediene, A., Novikova, A., Leppala, J., & Jakob, M. (2022). Youth's (Un)willingness to work in agriculture sector. *Frontiers in Public Health*, *10*. https://doi.org/10.3389/FPUBH.2022.937657

Hall, C., Dawson, T. P., Macdiarmid, J. I., Matthews, R. B., & Smith, P. (2017). The impact of population growth and climate change on food security in Africa: looking ahead to 2050. *International Journal of Agricultural Sustainability*, *15*(2), 124–135. https://doi.org/10.1080/14735903.2017.1293929

Heale, R., & Twycross, A. (2015). Validity and reliability in quantitative studies. *Evidence-Based Nursing*, *18*(3), 66–67. https://doi.org/10.1136/EB-2015-102129

Hejvani, F., & Vasheghani Farahani, M. (2018). An Investigation into Inductive and Deductive Methods in Teaching Grammar to German EFL Learners: A Comparative Study. *Global Journal of Foreign Language Teaching*, *8*(2), 76–91. https://doi.org/10.18844/GJFLT.V8I2.3202

Hermans, T. D. G., Smith, H. E., Whitfield, S., Sallu, S. M., Recha, J., Dougill, A. J., Thierfelder, C., Gama, M., Bunderson, W. T., Museka, R., Doggart, N., & Meshack, C. (2023). Role of the interaction space in shaping innovation for sustainable agriculture: Empirical insights from African case studies. *Journal of Rural Studies*, *100*. https://doi.org/10.1016/j.jrurstud.2023.103012

Herrera, J. P., Rabezara, J. Y., Ravelomanantsoa, N. A. F., Metz, M., France, C., Owens, A., Pender, M., Nunn, C. L., & Kramer, R. A. (2021). Food insecurity related to agricultural practices and household characteristics in rural communities of northeast Madagascar. *Food Security*, *13*(6), 1393. https://doi.org/10.1007/S12571-021-01179-3

Hunziker, S., & Blankenagel, M. (2021). Research Design in Business and Management. *Research Design in Business and Management*. https://doi.org/10.1007/978-3-658-34357-6

Increasing agricultural productivity & enhancing food security in Africa | IFPRI : International Food Policy Research Institute. (2020, March 15). Retrieved June 13, 2023, from https://www.ifpri.org/publication/increasing-agricultural-productivity-enhancing-food-security-africa

Jaeger, W., & Humphreys, C. (1988). The Effect of Policy Reforms on Agricultural Incentives in Sub-Saharan Africa. *American Journal of Agricultural Economics*, *70*(5), 1036–1043. https://doi.org/10.2307/1241732

Janssen, S. J. C., Porter, C. H., Moore, A. D., Athanasiadis, I. N., Foster, I., Jones, J. W., & Antle, J. M. (2017). Towards a new generation of agricultural system data, models and knowledge products: Information and communication technology. *Agricultural Systems*, *155*, 200–212. https://doi.org/10.1016/J.AGSY.2016.09.017

Jayne, T. S., Chamberlin, J., & Headey, D. D. (2014). Land pressures, the evolution of farming systems, and development strategies in Africa: A synthesis. *Food Policy*, *48*, 1–17. https://doi.org/10.1016/J.FOODPOL.2014.05.014

Jiren, T. S., Riechers, M., Bergsten, A., & Fischer, J. (2021). A leverage points perspective on institutions for food security in a smallholder-dominated landscape in southwestern Ethiopia. *Sustainability Science, 16*(3), 767–779. https://doi.org/10.1007/S11625-021-00936-9/TABLES/2

JOHNSON, BURKE, R., & CHRISTENSEN, L. (2014). *EDUCATIONAL RESEARCH QUANTITATIVE, QUALITATIVE, AND MIXED APPROACHES*. 977. https://www.researchgate.net/publication/264274753_Educational_Research_Quantitative_Qualitative_and_Mixed_Approaches_Fifth_Edition

Jones, A. D., Ngure, F. M., Pelto, G., & Young, S. L. (2013). What are we assessing when we measure food security? A compendium and review of current metrics. *Advances in Nutrition (Bethesda, Md.)*, *4*(5), 481–505. https://doi.org/10.3945/AN.113.004119

Joshi, A., Kale, S., Chandel, S., & Pal, D. (2015). Likert Scale: Explored and Explained. *British Journal of Applied Science & Technology*, *7*(4), 396–403. https://doi.org/10.9734/BJAST/2015/14975

Kiptot, E., Franzel, S., & Degrande, A. (2014). Gender, agroforestry and food security in Africa. *Current Opinion in Environmental Sustainability*, *6*(1), 104–109. https://doi.org/10.1016/J.COSUST.2013.10.019

Kivuva, E. M. (2017). *An Assessment of Integrated Water Resource Management (Iwrm) Approach for Reducing Food Insecurity in Drylands: a Case of Kikuu River Sub-sub-catchment, Makueni County, Kenya*. http://erepository.uonbi.ac.ke/handle/11295/101415

Lambrecht, I., Vanlauwe, B., Merckx, R., & Maertens, M. (2014). Understanding the process of agricultural technology adoption: Mineral fertilizer in Eastern DR

Congo. *World Development*, *59*, 132–146. https://doi.org/10.1016/j.worlddev.2014.01.024

Legal, F., & Office, E. (2016). *The Case of the Food and Agriculture Organization of the United Nations (FAO)*.

Lenore Newman. (2021). *Agriculture 2.0: Three technologies that can change how food is grown*. https://scroll.in/article/987379/agriculture-2-0-three-technologies-that-can-change-how-food-is-grown

Lewis, J., & Rudnick, J. (2019). The Policy Enabling Environment for Climate Smart Agriculture: A Case Study of California. *Frontiers in Sustainable Food Systems*, *3*, 31. https://doi.org/10.3389/FSUFS.2019.00031/BIBTEX

Lipper, L., Thornton, P., Campbell, B. M., Baedeker, T., Braimoh, A., Bwalya, M., Caron, P., Cattaneo, A., Garrity, D., Henry, K., Hottle, R., Jackson, L., Jarvis, A., Kossam, F., Mann, W., McCarthy, N., Meybeck, A., Neufeldt, H., Remington, T., … Torquebiau, E. F. (2014). Climate-smart agriculture for food security. *Nature Climate Change*, *4*(12), 1068–1072. https://doi.org/10.1038/NCLIMATE2437

London, T. M. (1998). *An Essay on the Principle of Population*. http://www.esp.org

Lowder, S. K., Sánchez, M. V., & Bertini, R. (2021). Which farms feed the world and has farmland become more concentrated? *World Development*, *142*. https://doi.org/10.1016/J.WORLDDEV.2021.105455

Malaysia - Global Hunger Index (GHI) - peer-reviewed annual publication designed to comprehensively measure and track hunger at the global, regional, and country levels. (2022, April 28). Retrieved May 19, 2023, from https://www.globalhungerindex.org/malaysia.html

Malaysia - Rice Production, Rubber, Palm Oil, Forest Plantation Scheme | Britannica. (2022, March 7.). Retrieved May 19, 2023, from https://www.britannica.com/place/Malaysia/Agriculture-forestry-and-fishing

Minot, N. (2014). Food price volatility in sub-Saharan Africa: Has it really increased? *Food Policy*, *45*, 45–56. https://doi.org/10.1016/J.FOODPOL.2013.12.008

Molotoks, A., Smith, P., & Dawson, T. P. (2021). Impacts of land use, population, and climate change on global food security. *Food and Energy Security*, *10*(1), e261. https://doi.org/10.1002/FES3.261

Moser, C. A., & Kalton, G. (2017). Survey Methods in Social Investigation. *Survey Methods in Social Investigation*. https://doi.org/10.4324/9781315241999

MOVING FORWARD ON FOOD LOSS AND WASTE REDUCTION FOOD AND AGRICULTURE. (2019). www.fao.org/publications

Mozaffarian, D., Angell, S. Y., Lang, T., & Rivera, J. A. (2018). Role of government policy in nutrition—barriers to and opportunities for healthier eating. *BMJ*, *361*. https://doi.org/10.1136/BMJ.K2426

OECD FAO Guidance for Responsible Agricultural Supply Chains. (2020.). https://doi.org/10.1787/9789264251052-en

Pawlak, K., & Kołodziejczak, M. (2020). The Role of Agriculture in Ensuring Food Security in Developing Countries: Considerations in the Context of the Problem of Sustainable Food Production. *Sustainability 2020, Vol. 12, Page 5488*, *12*(13), 5488. https://doi.org/10.3390/SU12135488

(PDF) Strengths and Weakness of Online Surveys. (2019.). Retrieved June 12, 2023, from https://www.researchgate.net/publication/333207786_Strengths_and_Weakness_of_Online_Surveys

Pouwels, J. L., Lansu, T. A. M., & Cillessen, A. H. N. (2017). Adolescents' explicit and implicit evaluations of hypothetical and actual peers with different bullying participant roles. *Journal of Experimental Child Psychology*, *159*, 219–241. https://doi.org/10.1016/J.JECP.2017.02.008

Precision farming - Publications Office of the EU. (n.d.). Retrieved May 31, 2023, from https://op.europa.eu/en/publication-detail/-/publication/711eac1b-a331-11e7-8e7b-01aa75ed71a1/language-en

Rajpurohit, D. S., Arvadia, L. K., & Jangir, R. (2017). Growth and Yield of Summer Sesamum (Sesamum indicum L.), Dry Weight of Weeds and Weed Control Efficiency Influence by Different Row Spacing and Weed Management under

South Gujarat Condition. *International Journal of Current Microbiology and Applied Sciences*, *6*(8), 2493–2501. https://www.academia.edu/55545457/Growth_and_Yield_of_Summer_Sesamum_Sesamum_indicum_L_Dry_Weight_of_Weeds_and_Weed_Control_Efficiency_Influence_by_Different_Row_Spacing_and_Weed_Management_under_South_Gujarat_Condition

Ramin Shamshiri, R., Kalantari, F., Ting, K. C., Thorp, K. R., Hameed, I. A., Weltzien, C., Ahmad, D., & Mojgan Shad, Z. (2018). Advances in greenhouse automation and controlled environment agriculture: A transition to plant factories and urban agriculture. *International Journal of Agricultural and Biological Engineering*, *11*(1), 1–22. https://doi.org/10.25165/IJABE.V11I1.3210

Rasanjali, W. M. C., Wimalachandra, R. D. M. K. K., Sivashankar, P., & Malkanthi, S. H. P. (2021). Impact of Agricultural Training on Farmers' Technological Knowledge and Crop Production in Bandarawela Agricultural Zone. *Applied Economics & Business*, *5*(1), 37. https://doi.org/10.4038/AEB.V5I1.27

Rehman, A., Farooq, M., Lee, D.-J., & Siddique, K. H. M. (2022). Sustainable agricultural practices for food security and ecosystem services. *Environmental Science and Pollution Research 2022 29:56*, *29*(56), 84076–84095. https://doi.org/10.1007/S11356-022-23635-Z

Reilly, C., Stevenson, K., Warner, W., Park, T., Knollenberg, W., Lawson, D., Brune, S., & Barbieri, C. (2022). Agricultural and environmental education: a call for meaningful collaboration in a U.S. context. *Https://Doi.Org/10.1080/13504622.2022.2040431*, *28*(9), 1410–1422. https://doi.org/10.1080/13504622.2022.2040431

Remans, R., Villani, C., Jones, S., Smith, A., Laporte, M.-A., Carmona, N. E., Arnaud, E., Dulloo, E., & China, R. (2019). Measuring Agricultural Biodiversity for Sustainable Food Systems. *Biodiversity Information Science and Standards 3: E46785*, *3*, e46785-. https://doi.org/10.3897/BISS.3.46785

Roberts, D. P., Short, N. M., Sill, J., Lakshman, D. K., Hu, X., & Buser, M. (2021). Precision agriculture and geospatial techniques for sustainable disease control.

Indian Phytopathology 2021 74:2, *74*(2), 287–305. https://doi.org/10.1007/S42360-021-00334-2

Sadan, V. (2017). *Data collection methods in quantitative research*.

Saunders Mark, Lewis Philip, & Adrian Thornhill. (2019). Research Methods for Business Students. *Research Methods for Business Students*, 125–171.

Scopus preview - Scopus - Document details - Agriculture 4.0: Broadening Responsible Innovation in an Era of Smart Farming. (2018, December 3). Retrieved May 20, 2023, from https://www.scopus.com/record/display.uri?eid=2-s2.0-85077622477&origin=inward&txGid=92b1c2f0a83c812f6c719d659f0d1a96

Seelan, S. K., Laguette, S., Casady, G. M., & Seielstad, G. A. (2003). Remote sensing applications for precision agriculture: A learning community approach. *Remote Sensing of Environment*, *88*(1–2), 157–169. https://doi.org/10.1016/J.RSE.2003.04.007

Shepherd, M., Turner, J. A., Small, B., & Wheeler, D. (2020a). Priorities for science to overcome hurdles thwarting the full promise of the 'digital agriculture' revolution. *Journal of the Science of Food and Agriculture*, *100*(14), 5083–5092. https://doi.org/10.1002/JSFA.9346

Sihite, N. W. (2022). LITERATURE REVIEW: RELATIONSHIP BETWEEN FOOD SECURITY AND STUNTING AMONG TODDLERS. *GEMA KESEHATAN*, *14*(1), 1–10. https://doi.org/10.47539/GK.V14I1.294

Slijper, T., Urquhart, J., Poortvliet, P. M., Soriano, B., & Meuwissen, M. P. M. (2022). Exploring how social capital and learning are related to the resilience of Dutch arable farmers. *Agricultural Systems*, *198*, 103385. https://doi.org/10.1016/J.AGSY.2022.103385

Smith, H., & Jones, H. (2018). TEACHING FOR SOCIAL JUSTICE: Creating equity for pupils living in poverty and those from black and minority ethnic backgrounds. *Learning to Teach in the Primary School, Fourth Edition*, 337–347. https://doi.org/10.4324/9781315453736-31/TEACHING-SOCIAL-JUSTICE-HANNEKE-JONES-HEATHER-SMITH

Smith, M. J., & Smith, M. J. (2018). Getting value from artificial intelligence in agriculture. *Animal Production Science, 60*(1), 46–54. https://doi.org/10.1071/AN18522

Soma, T., & Nuckchady, B. (2021). Communicating the Benefits and Risks of Digital Agriculture Technologies: Perspectives on the Future of Digital Agricultural Education and Training. *Frontiers in Communication*, *6*, 259. https://doi.org/10.3389/FCOMM.2021.762201/BIBTEX

Sonka, S. T. (2016). Big data: Fueling the next evolution of agricultural innovation. *Journal of Innovation Management*, *4*(1), 114–136. https://doi.org/10.24840/2183-0606_004.001_0008

Subramaniam, Y., Masron, T. A., & Subramaniam, T. (2020). INSTITUTIONAL QUALITY AND FOOD SECURITY. *Https://Doi.Org/10.1142/S0217590820500046*, *67*(6), 2099–2127. https://doi.org/10.1142/S0217590820500046

Subu, M. A., Holmes, D., Arumugam, A., Al-Yateem, N., Maria Dias, J., Rahman, S. A., Waluyo, I., Ahmed, F. R., & Abraham, M. S. (2022). Traditional, religious, and cultural perspectives on mental illness: a qualitative study on causal beliefs and treatment use. *International Journal of Qualitative Studies on Health and Well-Being*, *17*(1), 2123090. https://doi.org/10.1080/17482631.2022.2123090

Suffian, F., & Suffian, F. (2023). Policy Analysis : Food Security in Malaysia. *Journal of Administrative Science ICOPS*, *20*, 91–111.

Sürücü, L., & Maşlakcı, A. (2020). VALIDITY AND RELIABILITY IN QUANTITATIVE RESEARCH. *Business And Management Studies: An International Journal*, *8*(3), 2694–2726. https://doi.org/10.15295/BMIJ.V8I3.1540

Tabe-Ojong, M. P. Jr., Aihounton, G. B. D., & Lokossou, J. C. (2023). “Climate-smart agriculture and food security: Cross-country evidence from West Africa.” *Global Environmental Change*, *81*, 102697. https://doi.org/10.1016/J.GLOENVCHA.2023.102697

Tadesse, S. T., Oenema, O., van Beek, C., & Ocho, F. L. (2018). Diversity and nutrient balances of urban and peri-urban farms in Ethiopia. *Nutrient Cycling in Agroecosystems*, *111*(1), 1–18. https://doi.org/10.1007/S10705-018-9911-0

The State of Food and Agriculture 2019. (2019). *The State of Food and Agriculture 2019*. https://doi.org/10.4060/CA6030EN

The State of Food Security and Nutrition in the World 2021. (2021). *The State of Food Security and Nutrition in the World 2021*. https://doi.org/10.4060/CB4474EN

Thilsted, S. H., Thorne-Lyman, A., Webb, P., Bogard, J. R., Subasinghe, R., Phillips, M. J., & Allison, E. H. (2016). Sustaining healthy diets: The role of capture fisheries and aquaculture for improving nutrition in the post-2015 era. *Food Policy*, *61*, 126–131. https://doi.org/10.1016/J.FOODPOL.2016.02.005

Torero, M. (2016). Alternative mechanisms to reduce food price volatility and price spikes: Policy responses at the global level. *Food Price Volatility and Its Implications for Food Security and Policy*, 115–138. https://doi.org/10.1007/978-3-319-28201-5_6/FIGURES/3

Yao, H., Alhussam, M. I., Risha, O. A., & Memon, B. A. (2020). Analyzing the Relationship between Agricultural FDI and Food Security: Evidence from Belt and Road Countries. *Sustainability 2020, Vol. 12, Page 2906*, *12*(7), 2906. https://doi.org/10.3390/SU12072906

Yoo, J. J., Lee, S. W., & Lee, S. H. (2010). Rawls scheduler: Load considered proportional share scheduling for high performance multimedia systems. *Parallel and Distributed Computing, Applications and Technologies, PDCAT Proceedings*, 34–41. https://doi.org/10.1109/PDCAT.2010.82

Zhang, L., Li, R., Li, Z., Meng, Y., Liang, J., Fu, L., Jin, X., & Li, S. (2021). *A Quadratic Traversal Algorithm of Shortest Weeding Path Planning for Agricultural Mobile Robots in Cornfield*. https://doi.org/10.1155/2021/6633139

APPENDICES 1

Investigating the impact of agrotechnology on the Food Security in Malaysia

Dear Farmer!

I am student of Bachelor of technology management (technology innovation) with honors from University Teknikal Malaysia Melaka. I would like to ask for your help and assistance in my final year project survey about the impact of agrotechnology on the Food Security in Malaysia. This study aims to investigate the impact of agrotechnology on food security in Malaysia by examining three key factors: agriculture practices, farmers' profile, and institution and market factors. Agrotechnology refers to the application of modern agricultural techniques, such as precision farming, biotechnology, and smart farming, to enhance productivity and efficiency in the agricultural sector

QUESTIONNAIRE

Part A

1 Age:

- Below 16
- 16-26
- 27-36
- 37-46
- 47-56

- 57-66
- More than 66

2 Gender:

- Male
- Female

3 Education level:

- Primary school
- Secondly school
- Diploma
- Degree
- Master

4 Type of enterprise:

- Small-medium enterprise
- Large enterprise
- Family farm
- Non-profit organization
- Other:

7 What is the main sector of activity? (Multiple answer is possible.)

- Plant production
- Animal breeding, livestock management
- Horticulture
- Machinery
- Commerce
- Other:

In case of multiple question please write which one is dominant: ……………..

8 Area of Agricultural Activity

- Perlis
- Kedah
- Penang
- Perak
- Selangor

- Negeri Sembilan
- Malacca
- Johore
- Kelantan
- Terengganu
- Pahang
- Sabah
- Sarawak

9 Are you familiar with the term "agrotechnology"?

- Yes
- No

9 Usage of Agrotechnology:

Have you adopted any agrotechnology practices in your agricultural activities?

- Yes
- No

Part B

(5. Strongly Agree, 4. Agree, 3. Neutral, 2. Disagree, 1. Strongly Disagree)

AGRICULTURE PRACTICES	5	4	3	2	1
Do you agree the agricultural robots on your farm will affected your crop yield and efficiency					
Are you agree the utilizing precision agriculture techniques will contributed to resource optimization and increased productivity on your farm.					
Do you agree using artificial intelligence in your agricultural operations will make in decision-making and enhancing crop management.					

Do you agree the practicing climate-smart agriculture are influenced your farm's resilience to changing weather patterns and climate conditions.					

Part C

(5. Strongly Agree, 4. Agree, 3. Neutral, 2. Disagree, 1. Strongly Disagree)

FARMERS PROFILE					
Do you agree the education level influenced your adoption of agrotechnology and modern farming practices.					
Do you agree the social factors affect your willingness to adopt new agricultural technologies.					
Do you agree the implementation of agrotechnology impacted your farm's income and profitability.					
Do you agree if using new technology on agriculture industry can attract the new generation and female come over this industry.					

Part D

(5. Strongly Agree, 4. Agree, 3. Neutral, 2. Disagree, 1. Strongly Disagree)

INSTITUTION AND MARKET FACTOR					
Are the government policies and regulations affect your access to and adoption of agrotechnology.					

Do you agree in Malaysia can able to easily access necessary resources and services to adopt and implement agrotechnology					
Do you agree if received any investments or funding to support the implementation of agrotechnology on your farm will increase you farm income.					
Do you agree the price stability in the agricultural market impact your decisions to invest in agrotechnology.					

Part E

(5. Strongly Agree, 4. Agree, 3. Neutral, 2. Disagree, 1. Strongly Disagree)

FOOD SECURITY					
Do you agree agrotechnology can helped you manage seasonal variations and potential disruptions to the stability of your food supply.					
Are you agree the adoption of agrotechnology improved access to food for local communities.					
Are you agree implementation of agrotechnology impacted the dietary diversity of the local population.					