DETERMINANT SKILLS INFLUENCING THE READINESS OF VEGETABLE FARMERS IN PENINSULAR MALAYSIA TO FACE CHALLENGES DURING CATASTROPHE

By

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Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

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DEDICATION

"To plant a seed is to believe in tomorrow."

I dedicate this thesis to my late father, Mohd Pakri bin Musa (18.8.1947 – 25.2.2018),
whose unwavering support and passion for agriculture inspired my own journey.
As both a farmer and my personal mentor, he instilled in me a deep love for the land.
I will forever carry his lessons in my heart. May Allah grant him eternal peace in Jannah.

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

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Chairman : Jasmin binti Arif Shah, PhD
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Farmers face immense challenges during catastrophic events, as these disruptions significantly affect farming operations, supply chains, and access to essential resources. The COVID-19 pandemic, which began in 2020, further exacerbated these challenges in Malaysia due to the enforcement of the Movement Control Order (MCO). These restrictions disrupted logistics, limited farmers' access to technical support, and hindered input assistance from extension agents, thereby critically impacting agricultural productivity. Despite these adversities, some farmers adapted through strategies like shifting to digital marketing and direct sales, highlighting the need for resilience and readiness to sustain agricultural activities during crises. As of 2024, the relevance of studying the pandemic's impacts on Malaysia's agricultural sector endures, given its implications for future disruptions. Studies on the agri-food supply chain post-COVID-19 provide valuable insights into adaptive mechanisms, reinforcing the importance of developing robust strategies to enhance farmers' readiness.

This research investigates the readiness of farmers to face catastrophe challenges, focusing on skills such as technology, implementation, leadership, and decision-making. Using theoretical frameworks like the Iceberg Model, the Community Readiness Model (CRM), and the Technology Readiness Index 2.0 (TRI 2.0), the study aims to: (i) determine the levels of these skills and their relationship with readiness; (ii) explore the correlations between these skills and farmers' readiness; and (iii) identify the most significant predictors of readiness during catastrophic events.

The study surveyed 503 vegetable farmers across Peninsular Malaysia, representing a target population of 35,780. Data were collected using a six-part structured questionnaire administered both online and face-to-face through simple random sampling. Analytical methods, including descriptive statistics, correlation analysis, multiple regression, and Structural Equation Modelling (SEM), were employed to evaluate the data. Descriptive findings revealed the skill levels and readiness of farmers, while correlation analysis identified positive relationships between these skills and readiness. Regression and SEM analyses highlighted decision-making skills as the most significant predictor, explaining 48.7% of the variance in readiness ($R^2 = 0.487$) alongside leadership skills. Decision-making skills demonstrated the highest correlation with readiness ($r = 0.751$), with other skills like technology, implementation, and leadership also positively correlated.

The findings emphasize the critical role of decision-making skills in preparing farmers for crises. Policymakers are urged to integrate these skills into national agricultural

resilience strategies to bolster the sector's ability to withstand future disruptions. Training programs focusing on scenario-based learning and capacity-building initiatives are recommended to enhance decision-making and leadership capabilities. These interventions will empower farmers to make informed decisions independently during crises, ensuring continuity in food production and contributing to Malaysia's food security.

This study concludes that decision-making skills are the strongest predictor of farmer readiness. Enhancing these through targeted interventions will not only improve individual farmer preparedness but also enable agricultural extension services to adopt innovative approaches tailored to crises. Future research should explore additional factors, such as technology adoption and risk perception, to gain a comprehensive understanding of farmers' resilience during catastrophic events. Policymakers and extension agents must prioritize skill development, creating a more adaptive and resilient agricultural sector capable of facing future challenges with confidence.

Keywords: Farmer readiness, catastrophe, decision-making skills, agricultural extension services, food security

SDG: GOAL 8: Decent Work and Economic Growth, GOAL 12: Responsible Consumption and Production, GOAL 13: Climate Action.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

KEMAHIRAN PENENTU YANG MEMPENGARUHI KESEDIAAN PETANI SAYUR DI SEMENANJUNG MALAYSIA UNTUK MENGHADAPI CABARAN SEMASA BENCANA

Oleh

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Petani menghadapi cabaran besar semasa bencana yang mengganggu aktiviti pertanian, logistik, dan perkhidmatan asas. Pandemik COVID-19 yang bermula pada tahun 2020 telah memperburuk cabaran ini dengan pelaksanaan Perintah Kawalan Pergerakan (PKP), yang menyekat pergerakan dan menghalang petani daripada mendapatkan sokongan teknikal serta bantuan input daripada ejen pengembangan. Kesan ini telah menjejaskan perkhidmatan nasihat serta menurunkan produktiviti pertanian. Sehingga 2024, kajian empirikal mengenai impak pandemik terhadap sektor pertanian di Malaysia masih relevan. Kajian mengenai rantaian bekalan agri-makanan pasca-COVID-19 menunjukkan bagaimana petani menyesuaikan diri dengan beralih kepada pemasaran digital dan jualan langsung, yang menonjolkan pentingnya daya tahan dan kesediaan dalam memastikan kesinambungan aktiviti pertanian. Konteks ini mengukuhkan keperluan untuk penyelidikan lanjut mengenai kesediaan petani serta menekankan pentingnya strategi untuk mengurus cabaran pada masa hadapan.

Kajian ini berasaskan kepada beberapa kerangka teori utama, termasuk Model Iceberg, Model Kesediaan Komuniti (CRM), dan Indeks Kesediaan Teknologi 2.0 (TRI 2.0), yang memberi pandangan tentang bagaimana kemahiran seperti teknologi, pelaksanaan, kepimpinan dan kemahiran membuat keputusan mempengaruhi kesediaan petani untuk menghadapi cabaran semasa bencana. Objektif utama kajian ini adalah untuk menilai kemahiran yang mempengaruhi kesediaan petani dalam menghadapi cabaran bencana. Objektif khusus kajian ini adalah: (i) untuk menentukan tahap kemahiran teknologi, pelaksanaan, kepimpinan, kemahiran membuat keputusan dan kesediaan petani untuk menghadapi cabaran; (ii) untuk menentukan hubungan antara kemahiran ini dengan kesediaan petani; dan (iii) untuk mengenal pasti kemahiran utama yang mempengaruhi kesediaan petani semasa bencana.

Kajian ini melibatkan tinjauan terhadap 503 petani sayur dari populasi sasaran seramai 35,780 di seluruh Semenanjung Malaysia menggunakan soal selidik yang dijalankan dalam talian dan secara bersemuka. Data dikumpulkan melalui pengambilan sampel rawak dan dianalisis menggunakan statistik deskriptif, regresi berganda, dan analisis korelasi. Statistik deskriptif memberi gambaran mengenai profil petani dan tahap kemahiran mereka, manakala analisis korelasi mengkaji hubungan antara kemahiran dan kesediaan petani. Analisis regresi dan Pemodelan Persamaan Struktur (SEM) mendapati bahawa kemahiran membuat keputusan adalah peramal yang paling signifikan bagi kesediaan petani, dengan nilai R^2 sebanyak 0.487 yang menunjukkan bahawa kemahiran membuat keputusan dan kepimpinan bersama-sama menerangkan 48.7% daripada varians dalam kesediaan petani. Kemahiran membuat keputusan menunjukkan korelasi tertinggi ($r = 0.751$), manakala kemahiran pelaksanaan, kepimpinan, dan teknologi juga menunjukkan korelasi positif dengan kesediaan.

Kajian ini menekankan keperluan bagi pembuat dasar untuk mengintegrasikan kemahiran membuat keputusan dalam strategi pembangunan ketahanan sektor pertanian, supaya petani lebih bersedia menghadapi bencana. Program latihan yang memberi tumpuan kepada kemahiran ini akan meningkatkan kemandirian dan ketahanan sektor pertanian. Kajian ini mencadangkan agar pembuat dasar dan ejen pengembangan pertanian mengutamakan peningkatan kapasiti petani dalam kemahiran ini melalui program yang disasarkan. Kajian ini juga mencadangkan beberapa langkah lanjut, termasuk penyelidikan lanjut untuk meneliti faktor lain seperti penerimaan teknologi dan persepsi risiko, untuk memberi gambaran yang lebih komprehensif mengenai faktor yang menyumbang kepada ketahanan petani semasa bencana.

Kata Kunci: Kesediaan petani, bencana, Kemahiran membuat keputusan, ejen pengembangan, keselamatan makanan.

SDG: MATLAMAT 8: Pekerjaan Sesuai dan Pembangunan Ekonomi, MATLAMAT 12: Penggunaan dan Pengeluaran Bertanggungjawab, MATLAMAT 13: Tindakan Iklim.

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee were as follows:

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

AVE	Average Variance Extracted
CR	Composite Reliability
CRM	Community Readiness Model
CSAI	Climate Smart Agricultural Initiative
DOA	Department of Agriculture
DOSM	Department of Statistics Malaysia
EDA	Exploratory Data Analysis
EFA	Exploratory Factor Analysis
FAO	Food and Agriculture Organization
GAP	Good Agricultural Practices
KMO	Kaiser-Meyer-Olkin
MAFS	Ministry of Agriculture and Food Security
MCO	Movement Control Order
MyGAP	Malaysian Good Agricultural Practices
OECD	Organisation for Economic Co-operation and Development
PCC	Per Capita Consumption
PHL	Post Harvest Losses
PLS	Partial Least Square
PLS-SEM	Partial Least Square - Structural Equation Modelling
SD	Standard Deviation
SEM	Structural Equation Modelling
SOP	Standard of Procedure

SPSS	Statistical Package for Social Science
TRI	Technology Readiness Index
TRI 2.0	Technology Readiness Index 2.0

CHAPTER 1

INTRODUCTION

1.1 Background of Study

A catastrophe is an event, often a natural disaster or a large-scale human-made disaster, with significant and widespread consequences. These consequences can include damage to infrastructure, loss of life, disruption of essential services and economic impacts. A catastrophe is defined as an incident that directly or indirectly impacts an entire country, necessitates a national or worldwide reaction, and endangers the lives of many people over a protracted period of time (Bissel, 2013). Catastrophes, including natural disasters and pandemics, pose significant challenges to society, with long-lasting effects that require recovery and rebuilding efforts (Cutter et al., 2013). The COVID-19 pandemic has had a substantial macroeconomic impact, leading to a significant loss in industrial production and service sector employment (Ludvigson et al., 2020). The welfare of substantial number of people is indeed threatened in catastrophes, making it crucial to mobilize resources and coordinate responses at a larger scale than the routine emergencies.

Among the various types of catastrophes, the COVID-19 pandemic stands out as a contemporary global crisis with far-reaching impacts. Officially recognized as a catastrophic event, COVID-19 has been described by the Pennsylvania court as a "natural disaster" under the Emergency Code, given its severe implications, including hardship, suffering, and potential loss of life (Nussbaum & Mason, 2020). The pandemic, caused by the novel coronavirus SARS-CoV-2, has had a profound effect on nearly every country, requiring extensive national and international responses and significantly threatening public welfare.

COVID-19 raised lots of issues relevant to the readiness and the capacity of self-sufficiency during lockdown conditions that caused negative economic effects due to the unfunctional agriculture systems responsible for food supply (Buheji et al., 2020; Paganini et al., 2020; Siche, 2020; Timilsina et al., 2020). The COVID-19 pandemic has led to considerable macroeconomic impacts, including a drastic reduction in industrial production and employment in the service sector (Ludvigson et al., 2020). Its impact on the agricultural sector has been particularly severe, highlighting vulnerabilities in food supply chains and agricultural systems (Tan et al., 2023). The pandemic has disrupted every stage of the food supply chain, from farm production to consumer delivery, resulting in decreased production, higher prices, and challenges in accessing essential resources such as seeds, fertilizers, and insecticides (Gregorioa & Ancog, 2020; Naresh et al., 2021). Smallholder and marginal farmers have been disproportionately affected, struggling with labor constraints and logistical issues that have led to decreased demand for their produce and significant financial losses (Naresh et al., 2021; Brewin, 2020; Ceballos et al., 2020; Cranfield, 2020; Poudel & Subedi, 2020).

In Malaysia, the COVID-19 pandemic, which began in January 2020, had a profound and multifaceted impact on the agricultural sector. The Malaysian government's implementation of the Movement Control Order (MCO) to contain the spread of the virus imposed strict limitations on people's movements and enforced social distancing measures. While these public health interventions were crucial to reducing the spread of the virus, they simultaneously disrupted various sectors of the economy, particularly agriculture. Farmers, rural communities, and the agricultural supply chain faced significant challenges during this period, especially in terms of labor shortages, supply-demand imbalances, and difficulties with postharvest processes due to social isolation measures (Consultancy Asia, 2020; Insights, 2020; Vergnano, 2023).

Agriculture, as an essential sector, encountered immense strain during the early stages of the pandemic. Labor scarcity, for example, became a pressing issue due to the nationwide lockdown. Many farms, especially those dependent on seasonal or migrant labor, struggled to harvest crops, leading to substantial losses. Additionally, the MCO limited the availability of key inputs such as fertilizers and seeds, further compounding productivity losses (Gregorioa & Ancog, 2020). These challenges, combined with logistical disruptions such as transportation constraints, severely affected the agricultural output, leaving farmers vulnerable to financial and operational instability. The pandemic's restrictions on movement and border closures not only impeded domestic market access but also disrupted international food supply chains, highlighting the vulnerabilities within Malaysia's agricultural system as well as the global agri-food sector.

A significant consequence of the pandemic for the agricultural sector was the profound disruption to the agri-food system, particularly for perishable crops. Farmers who produced vegetables and fruits, which have short shelf lives, were among the hardest hit. Studies conducted in other regions, such as Sri Lanka, confirmed the severe effects on farmers growing perishable crops (Alam & Khatun, 2021; Gu & Wang, 2020). In Malaysia, similar patterns emerged as farmers were unable to transport their produce to markets, leading to widespread food wastage and income losses (Bright et al., 2021;

Zhang, 2020). This disruption resulted in decreased profitability for many farmers and a general decline in farm productivity. Furthermore, the closure of hospitality, leisure, and tourism industries, which are key consumers of agricultural products, exacerbated the problem, particularly in regions like Cameron Highlands, where both agriculture and tourism are critical to the local economy (Ishak, 2021).

From a broader perspective, the COVID-19 pandemic exposed significant structural weaknesses within the agricultural sector, particularly in terms of its ability to withstand external shocks. The pandemic's ripple effects, including disruptions in transportation and the availability of agricultural inputs, illuminated the sector's reliance on functioning supply chains and market access. For instance, farmers in countries like Zimbabwe faced severe food security challenges due to the compounded effects of the pandemic, which threatened the livelihoods of smallholder farmers and exacerbated pre-existing vulnerabilities (Rukasha et al., 2021). This situation is mirrored in Malaysia, where the availability of agricultural inputs and the increased cost of essentials like seeds and fertilizers led to reduced production capacities (Aromolaran & Muyanga, 2020). These challenges highlighted the need for targeted interventions to safeguard the resilience of agricultural systems during crises.

The need for improving farmers' resilience and readiness to face future challenges has become more urgent than ever. In addition to logistical and financial disruptions, farmers must also contend with the long-term implications of the pandemic, which have underscored the importance of adaptive capacity. The pandemic highlighted that beyond technical skills and farm management, farmers must be equipped with critical decision-making and leadership abilities. These skills are pivotal in responding to crises, navigating uncertainty, and maintaining productivity in adverse conditions. Furthermore, the importance of adopting innovative technologies in agriculture has been thrust into the spotlight. Technologies such as remote crop and livestock monitoring, digital platforms for market access, and the use of information technology tools for farm management can mitigate the negative impacts of crises like the COVID-19 pandemic (Damba et al., 2020; Khan et al., 2020).

In the context of agricultural extension services, the pandemic has shifted the traditional focus from simply disseminating technical knowledge to equipping farmers with the skills needed to build resilience. Agricultural extension programs now face the challenge of preparing farmers not just for increased yields or improved farm practices but for the ability to cope with future uncertainties and disruptions. This shift includes fostering leadership, decision-making, and technological adoption, which are key components of farmer readiness. Farmers who can make informed decisions under pressure, lead their teams effectively, and adopt technological innovations are more likely to maintain or restore productivity during crises. This not only improves their individual resilience but also contributes to the overall stability and sustainability of the agricultural sector.

Farmer readiness, therefore, has broader implications for the agricultural system's ability to withstand shocks. Farmers who possess essential leadership and decision-making skills can quickly adjust their strategies to address challenges, ensuring the continuity of their operations. For example, during the pandemic, farmers with a higher level of readiness were able to pivot their business models to engage directly with consumers through digital platforms, avoiding the breakdown in traditional supply chains (Munguia et al., 2021; Saengavut & Jirasatthumb, 2021). Additionally, integrating digital technologies into farming practices, such as precision agriculture, can further enhance productivity and resilience, allowing farmers to respond more effectively to both short-term disruptions and long-term changes in the agricultural landscape.

In conclusion, the COVID-19 pandemic has served as a critical stress test for the agricultural sector, exposing vulnerabilities while also underscoring the need for enhancing farmer readiness. The ability to lead, make informed decisions, and adopt new technologies is now a crucial aspect of ensuring agricultural productivity and resilience in the face of challenges. Agricultural extension services must evolve to support these needs, focusing not just on technical assistance but also on building the soft skills that enable farmers to navigate crises. By fostering these capacities, farmers will be better prepared to maintain their productivity, contribute to food security, and ensure the overall resilience of their communities and the agricultural sector as a whole.

1.2 Catastrophe Phenomenon

A catastrophe typically refers to an event or situation characterized by its extreme and often devastating nature. Catastrophes, defined as extreme and devastating events, can result from a variety of causes, including natural disasters, human-made disasters and rare occurrences (Drake et al., 2022). These events often overwhelm local resources, requiring external assistance (Antosia, 2006). They have a significant impact on public health, causing injuries, deaths, and disruptions to health facilities and systems. The COVID-19 pandemic is a prime example of a global catastrophe, affecting public health, economies and daily life on a massive scale (Drake et al., 2022).

Catastrophe phenomena require extensive preparedness, response and recovery efforts to mitigate their effects and assist affected communities (McNutt & Leshner, 2013). Often, these events lead to the mobilization of local, national and international resources to manage the crisis and provide support to those affected. For example, it is possible to enhance a country's readiness and reduce the impact of potentially destructive earthquakes in the future by (1) directing focused post-event emergency interventions, (2) enhancing emergency teams' and the public's readiness and response capacity through preparatory training activities and (3) facilitating decision-making during the recovery phase (Hugelius et al., 2020; Poggi et al., 2021).

1.2.1 COVID-19 in Malaysia

The COVID-19 pandemic, caused by the SARS-CoV-2 virus, has had a significant impact on global health, economies and mental health (Anis et al., 2021; Rudrapal et al., 2020; David & Dabire, 2020; Amsalem et al., 2020). In Malaysia, like many other countries, implemented various measures to control the spread of the virus, including lockdowns, movement control orders and social distancing (Malaysian Prime Minister's Office, 2020). These efforts are crucial in reducing the impact of the pandemic, which has caused severe respiratory complications and a high death rate (Rudrapal et al., 2020). The pandemic has also led to widespread mental health issues, including fear and stigma (Amsalem et al., 2020). The global response to the pandemic has been challenging, with the development of effective treatments and vaccines being a priority (Rudrapal et al., 2020). These initiatives are critical in reducing and controlling the COVID-19 outbreak. This epidemic has impacted many sectors of the economy, including agriculture.

The coronavirus attack caused most of the world's sectors to collapse when the pandemic catastrophe began. Every mortal thing on the planet needs food, meaning we depend on agriculture directly or indirectly (Ibn-Mohammed et al., 2020). Because of the lockdown, every country's farming community has been hit hard, especially in areas where crops are nearing to harvest (Cheng, 2023; Narayan and Saha, 2020; Timilsina et al., 2020; Laborde et al., 2020). Farmers suffered significant losses when their harvested crops failed to reach the market due to the lack of workers/laborers and logistics. Over 570 million farms and farmlands are currently under cultivation worldwide, with family members managing more than 75% of them (Laborde et al., 2020).

1.3 Farmers' Readiness to Face Challenges

There are two types of readiness - the willingness to do something directly after seeing something and deciding whether to go after a complete preparation (Fairuz et al., 2018; Oetting et al., 2014; Stanley et al., 2014). Farmers often need to make quick decisions and take immediate action when they observe something that requires attention, such as pest infestations, signs of disease in crops or adverse weather conditions. This readiness can be influenced by factors such as attitude, knowledge and availability of resources (Malik et al., 2023). The readiness to act promptly is also crucial in agriculture to address issues as they rise and prevent potential damage or loss. On the other hand, not all situations in farming allow for immediate action.

In some cases, farmers must take the time to gather information, plan and make decisions after thorough preparation. This could involve assessing market conditions, choosing the right crop varieties or planning long-term strategies for sustainable agriculture. Stanley et al. (2014) suggested the importance of weighing decisions carefully, especially when significant resources and long-term outcomes are at stake.

Farmers' readiness varies significantly among countries based on government regulations, local infrastructure, agricultural practices, and the region's frequency and intensity of catastrophic occurrences. Farmers cannot control risks or obstacles in agriculture, so they must devise strategies with flexible and adaptable decision-making to mitigate negative disturbances and to overcome and manage them (Kahan, 2008; Papa et al., 2020). Farmers should find solutions to overcome threats and safeguard themselves from future uncertainty by facilitating the achievement of future goals and changing existing circumstances (Bukchin & Kerret, 2020; Bakar & Sum, 2020). If these risks are not effectively identified and managed, they will harm their agricultural productivity and revenue. The ability of farmers to effectively handle agricultural issues is a determining factor in their capability to predict, prevent, and react to future dangers and unexpected events.

Farmers are confronted with risk and their attitudes must be understood by researchers and policymakers who can access correct information on sophisticated risk management tools and hazards to ensure the supply of advanced extension services and agricultural finance (Ahmad et al., 2020; Ullah et al., 2015). A variety of determinants impact farmers' adoption of these practices, including social capital, education, labour supply, agricultural extension services, farming experience, and soil conditions, as well as risk mitigation attitudes (Nguyen & Drakou, 2021; Zeweld et al., 2020)., The emergence of COVID-19 caused several challenges in agricultural techniques for most farmers, especially in logistics, markets and agricultural services, which were all disrupted due to the pandemic (Minten, Mohammed & Tamru, 2020; Veeck et al., 2020). For example, vegetable growers in Ethiopia adjusted their behavior at the start of the COVID-19 pandemic, becoming more aware of the challenges that may occur due to the pandemic and preparing themselves to deal with the problem correctly (Minten, Mohammed & Tamru, 2020).

The COVID-19 pandemic has underscored the vulnerability of the agriculture sector and the need for farmers to enhance their resilience (Lioutas & Charatsari, 2021). Farmers must overcome all restraints that may lead them to be unable to function regularly without the assistance of extension agents during the pandemic's movement restrictions. Farmers must begin to empower themselves to grow the agriculture sector at this stage so they can no longer rely solely on extension agents. Therefore, even if communication or travelling is restricted, farmers can continue to operate their farms normally and with minimal hassle. Consequently, agricultural activities will run more smoothly when farmers are prepared to handle problems during and after a catastrophe.

1.4 Farmers and Vegetable Industry during Catastrophe in Malaysia

COVID-19 has an indirect influence on agricultural revenue and productivity. Farmers have found it difficult to sell their commodities or acquire inputs due to a lack of agricultural services, resulting in lower productivity and revenue and an increase in postharvest loss and food waste. Conversely, consumers have had difficulty acquiring enough food to satisfy their daily nutritional demands (Aday & Aday, 2020). The emergence of COVID-19 is a tragic yet "natural experiment" that gives a chance to look for evidence of resistance among smallholder farmers (Love et al., 2023; Sabin et al., 2022). According to the news in Gua Musang, 200 farmers were unable to sell their produce, resulting in a daily loss of RM400,000 (Adam et al., 2023; Manikam & Saad, 2021). The pandemic has impacted many facets of daily life, including social and economic sectors. Many people have been affected by uncertain financial conditions since the outbreak, particularly those in the agriculture and food industries.

One of the challenges farmers faces in sending the produce to consumers is the lack of market information. For instance, a lack of market knowledge prevents farmers from choosing the best marketing channels (Iba & Lilavanichakul, 2020; Nahar et al., 2020). Farmers must have access to market information because it helps them to choose the best market and time to sell their products. Farmers need comprehensive market information to decide how many products to market and how much to charge for those produces (Nwafor et al., 2020; Kyaw et al., 2018). The marketing channel includes several market intermediaries, resulting in significant marketing expenditures. Due to the lack of information flows, farmers were “isolated” from the “market centres” and effective farm extension services, including market information, could benefit farmers during the crisis (Deka et al., 2020; Nandi et al., 2021; Man et al., 2009).

Limited market access for rural farmers, particularly in developing countries, is a significant challenge that hinders their ability to engage successfully in agriculture (Mohlaphuli, 2023; Zezza et al., 2011). This is primarily due to the lack of agricultural market information, which affects their bargaining power and leads to uncompetitive marketplaces (Mawazo et al., 2014). The COVID-19 pandemic has further exacerbated these issues, disrupted market relations and highlighting the vulnerability of small farmers (Stojcheska et al., 2021). The lack of market information is a key issue in developing countries, often controlled by a small group of stakeholders, leading to an inefficient agricultural market and negative socio-economic impacts (Nugroho, 2021).

Transportation and logistics represent the second major challenge encountered by farmers. Farmers often cultivate their produce in remote locations with limited access to large vehicles. Research indicated that transportation availability and vehicle ownership influence farmers' marketing channel decisions. Perishable agricultural goods necessitate rapid, direct distribution channels. Transportation is a critical factor in shaping smallholder farmers' marketing channel selections, as they aim to avoid losses from deterioration during transit (Fernando et al., 2018; Nahar et al., 2020; Volpe et al., 2013). Additional transportation processes, like field-to-packaging facilities and wholesale-to-retail, help preserve the quality (Jouzdani & Govindan, 2021; Rossi et al., 2020). While short- and long-distance shipments follow similar standards, handling methods receive less care for short distance shipments (Shewfelt & Prusia, 2022).

However, the COVID-19 pandemic and MCO caught the farmers off guard. Farmers needed to decide whether to dispose or donate the harvested crops. These restrictions impacted farmers who had limited time to adapt the harvesting and marketing approaches for perishable produce. With the abrupt MCO implementation, farmers struggled to follow proper harvesting protocols or find companies to purchase their crops (Man, 2020). Moreover, border closures enacted internationally to limit viral transmission resulted in agricultural input shortages in Malaysia, including seeds, agrochemicals and fertilizers (OECD, 2020). Compounding these input shortages, border restrictions also reduced the agricultural labor force, as migrant workers could not enter the country (OECD, 2020). These input and labor shortages increased farmers' susceptibility to the economic impacts of COVID-19 (Laborde et al., 2020).

This research focused on six vegetable crops - mustard, spinach, water spinach, okra, long beans and eggplant - selected for their perishable nature and short shelf lives. Perishable commodities with abbreviated shelf lives are susceptible to spoilage and deterioration without proper handling and storage (Shewfelt, 2009; Yousuf et al., 2018). These crops were chosen based on 2021 data from the Department of Statistics Malaysia indicating their high per capita consumption in Malaysia (Figure 1.1). The selected crops comprise two categories - leafy vegetables (mustard, spinach and water spinach) and fruit vegetables (okra, long beans and eggplant). Their perishability necessitates research on maintaining quality and freshness, which is critical for farmers and the agricultural sector. The high per capita consumption of these vegetables demonstrates substantial consumer demand in Malaysia.

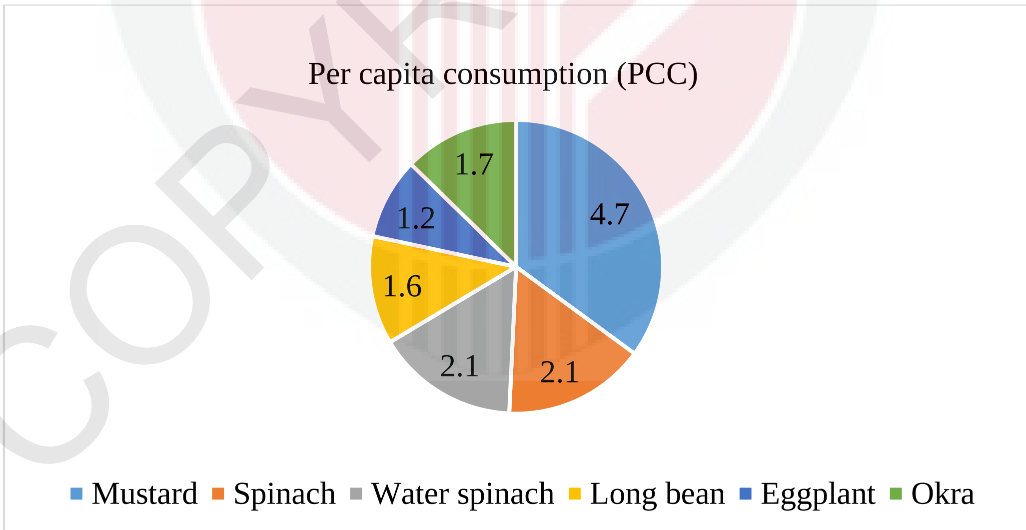

Figure 1.1: Selected Crops Per Capita Consumption in 2021 (kg/year/person)
(Source: Supply and Utilization Accounts Selected Agricultural Commodities Report, Malaysia 2017-2021)

1.5 Factors Influencing Farmers' Readiness to Face Challenges

Farmers' readiness is related to their degree of knowledge, with greater knowledge levels resulting in higher level of readiness (Fairuz et al., 2018). Farmers' readiness to face challenges such as the COVID-19 pandemic is indeed influenced by their degree of knowledge and preparedness. Knowledge plays a critical role in enabling farmers to adapt to changing circumstances and effectively respond to various challenges. Their readiness is enhanced by their ability to access and utilize information, adapt farming practices, manage finances, and connect with resources and networks that can help them navigate these unprecedented circumstances (Ahmed et al., 2021; Asfaw et al., 2019). Knowledge, combined with proactive measures and a willingness to learn and adapt, is a critical asset for farmers in facing the challenges of the pandemic and other unforeseen events.

Farmers with greater knowledge are more likely to stay informed about the latest developments related to COVID-19 and its impact on agriculture. Smallholder farmers, in particular, are vulnerable to the impacts of COVID-19 on their livelihoods and agriculture practices (Middendorf et al., 2021). Access to technology and multi-layered diversification are key factors in the farmers' ability to adapt to the pandemic (Marsden et al., 2023). By having these factors, the farmers can access information about safety measures, government guidelines, market conditions and support services more effectively, which is crucial for making informed decisions. Several elements, such as expertise, information, financial resources, infrastructure, technology, diversity, market access, community support, governmental regulations, subsidies, environmental considerations and risk management techniques, affect how prepared farmers are to meet difficulties (Ahmed et al., 2021; Phiri et al., 2020). This awareness is essential for making informed decisions, particularly in the face of challenges such as the pandemic (Balogun, 2020).

With the evolving agricultural conditions, farmers need various skills to mitigate risks and thrive in a dynamic environment. Essential skills such as adaptability, financial management, risk assessment and management, technical farming, crop and livestock health management, mechanical and equipment skills, record keeping, marketing and sales, environmental stewardship, communication, problem-solving, time management, negotiation and contracting, digital literacy, crisis management, and leadership and team management are necessary for the farmers (Bahinipati et al., 2021; Tindiwensi et al., 2020). These skills are essential for farmers' readiness and farmers can enhance and refine these abilities through ongoing education, training initiatives and exposure to exemplary methods. Furthermore, local agricultural extension services and farmer associations frequently offer valuable assistance in enhancing skills and exchanging knowledge within the farming communities.

Farmers' skills encompass a specialized set of knowledge, competencies, and proficiencies necessary for the effective management and success of farming operations. These skills include problem-solving, interpersonal communication, farm management, and organizational abilities, which are essential for carrying out day-to-day tasks with efficacy and ensuring long-term agricultural productivity. However, in the face of unprecedented challenges such as disasters, the focus shifts to a specific set of core competencies that are critical for farmers to not only survive but thrive in difficult circumstances. This research highlights the importance of four key skills—technology, implementation, leadership, and decision-making skills—each of which plays a pivotal role in determining farmers' readiness to confront and overcome catastrophic events. By exploring these determinants, the study aims to develop insights that could inform future policy, extension services, and capacity-building programs designed to enhance resilience in the agricultural sector.

In modern agriculture, technological proficiency is no longer optional—it is a fundamental requirement for navigating the complexities of contemporary farming, particularly when facing challenges such as epidemics, climate change, and market disruptions. Technological skills empower farmers to adopt innovations that significantly improve productivity and operational efficiency. For instance, the integration of digital tools such as artificial intelligence (AI), machine learning (ML), and drone technology enables farmers to monitor crops, conduct soil analysis, and manage resources remotely (Rose & Chilvers, 2018). These innovations not only optimize farm management but also provide crucial insights into market trends and environmental conditions, allowing farmers to make informed decisions.

The transformative potential of technology in agriculture is particularly evident in precision farming, which leverages advanced tools to enhance the accuracy of planting, irrigation, and harvesting processes (Rijk et al., 2023). This approach has proven to be especially effective in increasing crop yields and reducing resource waste, thereby directly addressing the pressing global issue of food insecurity. Moreover, emerging studies emphasize that during catastrophes, farmers who possess technological skills are better equipped to continue their operations with minimal external guidance. For example, during the COVID-19 pandemic, many farmers had to rely on self-learning and the use of digital platforms to maintain their activities due to limited access to extension services (Abdullah & Samah, 2013; Suhaimi et al., 2023). This highlights the necessity for farmers to possess not only basic agricultural knowledge but also the technological competencies needed to adapt to rapidly changing circumstances.

Furthermore, research shows that farmers who lack confidence in using emerging technologies tend to fall back on traditional methods that they find more familiar and controllable (Chi, 2008; Raman, Mohamed & Muniady, 2023). This reluctance to adopt new technologies underscores the importance of providing targeted training and support to encourage technological adoption. As a result, fostering technological skills among farmers becomes critical for ensuring that they are adequately prepared to face future challenges, especially in the context of disasters or other disruptions.

The ability to implement new strategies and technologies effectively is another key determinant of farmers' readiness to face challenges. Implementation skills refer to the capacity to translate knowledge into action, encompassing the processes involved in adopting, adapting, and sustaining agricultural innovations. As defined by Damshroder et al. (2009), effective implementation involves a deliberate and structured approach to integrating evidence-based practices into agricultural operations. This is particularly relevant in the context of new technologies, where successful adoption requires not only an understanding of the tools themselves but also the capacity to manage the operational changes that accompany their use.

Farmers equipped with strong implementation skills are better positioned to improve their farming outcomes. By applying precision agriculture methods, such as AI-driven analytics and sensor-based systems, farmers can optimize resource use, minimize environmental impact, and increase crop yields (Shamshiri et al., 2018). These advanced techniques allow for a more efficient allocation of inputs, such as water and fertilizers, which leads to sustainable farming practices that are both economically viable and environmentally responsible.

However, the challenge lies not only in acquiring the knowledge but also in executing it effectively. Research indicates that the failure to implement technologies properly can result in missed opportunities and even reduced productivity (Mondal, Haitook & Simaraks, 2014). Farmers must, therefore, develop robust implementation strategies that ensure the consistent application of best practices across their operations. This is particularly critical in times of disaster when disruptions to supply chains, labor, and market access can complicate the execution of farming activities. By enhancing their implementation skills, farmers can better navigate these obstacles and ensure the continuity of their operations.

Leadership is a vital component of successful farming, particularly in environments characterized by uncertainty and rapid change. Farmers who exhibit strong leadership skills are able to foster innovation, build networks, and coordinate the diverse resources required for agricultural development (McFadden & Gorman, 2021). In the context of disasters, leadership becomes even more critical as farmers must navigate complex challenges that require adaptive thinking, collaboration, and the ability to inspire others to take action. While studies like McFadden & Gorman (2021) focus on leadership as a driver of farm success, less attention has been given to how leadership and decision-making function during catastrophic events. This study extends the literature by exploring how farmers' leadership and decision-making skills directly influence their ability to navigate crises such as the COVID-19 pandemic or natural disasters, adding a new dimension to existing knowledge.

Effective leadership in farming is not limited to the management of personnel or resources but also encompasses the capacity to drive strategic change within the agricultural sector. Farmers who are capable leaders can influence the adoption of new technologies, promote sustainable practices, and build social capital through engagement with stakeholders, including extension agents, researchers, and policymakers (Ulvenblad & Björklund, 2018). Leadership also plays a crucial role in knowledge dissemination, as farmer-leaders often act as early adopters and champions of new practices, thereby facilitating broader community uptake. During crises, such as the COVID-19 pandemic, the importance of leadership skills was highlighted as farmers needed to make swift decisions regarding crop management, labor allocation, and market access (Vardiashvili, 2022). Those who demonstrated strong leadership were able to adapt quickly, mobilize resources, and guide their operations through the uncertainty. This underscores the need for leadership development as a key focus of agricultural training programs, particularly in preparing farmers to manage the increasing risks posed by climate change, market volatility, and other disruptive factors.

Decision-making is at the heart of farming, as it influences every aspect of the agricultural process—from crop selection and planting schedules to resource allocation and risk management. Farmers with strong decision-making skills are better able to analyze complex information, weigh potential outcomes, and choose the most effective courses of action. This ability is particularly important in times of crisis when quick, informed decisions can mean the difference between the success or failure of an entire farming season (Kahan, 2008).

Research has shown that decision-making is a key factor in determining farmers' adaptive capacity, especially in response to environmental and economic challenges (Martin-Clouaire, 2017). Farmers must be able to assess the risks associated with different farming strategies, taking into account factors such as weather patterns, market fluctuations, and resource availability. Moreover, decision-making skills are closely tied to knowledge management, as farmers rely on information from extension agents, researchers, and other experts to make informed choices (Demiryurek et al., 2008). In the context of catastrophe, decision-making becomes even more critical as farmers must often make rapid adjustments to their operations with limited information and support. For example, during extreme weather events, farmers may need to quickly alter their crop management practices to mitigate damage and ensure continued production (Selvaraju et al., 2006). By developing strong decision-making skills, farmers can enhance their resilience and improve their ability to navigate the uncertainties inherent in agricultural production.

The four determinants explored in this study—technological skills, implementation skills, leadership, and decision-making—are essential for enhancing farmers' readiness to face challenges. Each of these skills contributes uniquely to the overall resilience of the agricultural sector, enabling farmers to adapt to changing conditions, implement innovations effectively, and lead their communities through periods of uncertainty. Understanding the interplay between these skills and their impact on farmers' readiness will provide valuable insights for policymakers, extension services, and agricultural organizations seeking to build a more resilient and sustainable agricultural system. By focusing on these core competencies, this study aims to contribute to the development of targeted interventions that support farmers in overcoming the challenges posed by disasters. Collaborating with local agricultural authorities and farmer groups will ensure that the findings of this research are grounded in the realities of farming communities and can be translated into practical strategies for enhancing agricultural resilience.

1.6 Problem Statement

The agricultural sector faces unprecedented challenges due to disruptions in operations, logistics, and services caused by catastrophic events like the COVID-19 pandemic. Farmers' readiness to confront these challenges, especially during lockdowns and social distancing mandates, raises critical questions about their capacity to maintain production and supply chain resilience (Buheji et al., 2020). This study investigates how farmers' knowledge, skills, and attributes can ensure continuity during such crises. Specifically, it examines the role of familiarity with agricultural technology, on-farm technology implementation, leadership, and context-based decision-making in enhancing farmer readiness and sustaining operations post-catastrophe.

While technology adoption and leadership in agricultural settings are well-documented areas of study (Rose & Chilvers, 2018), there is a significant gap in understanding how these factors, along with implementation skills and decision-making abilities, jointly influence farmers' readiness for catastrophes. Most existing research addresses these aspects in isolation, without examining how they interact under crisis conditions. This study seeks to fill this theoretical gap by presenting an integrated framework that considers the synergy between these four determinants—technology, implementation, leadership, and decision-making skills—particularly in the context of agriculture during emergencies.

Previous studies have predominantly focused on farmers' readiness in regular, stable conditions, with limited attention paid to their readiness for catastrophic events. Research on how farmers' technological skills and leadership adapt to emergency situations, such as pandemics, remains sparse. Furthermore, there is little insight into how these determinants may vary in significance between normal and crisis periods. This study addresses this research gap by investigating the differences in the determinants of farmer readiness between regular farming conditions and emergencies, providing a nuanced understanding of how skills are applied in both contexts.

In practice, many farmers rely on external support, such as extension services, to enhance productivity. However, during crises, access to such support is often restricted, forcing farmers to become more self-reliant in managing their farms. The gap in extension services tailored to emergency readiness is evident, as these services typically focus on productivity enhancement rather than disaster resilience. This study contributes to closing this practice gap by offering insights into how farmers can utilize technology, implementation, leadership, and decision-making skills to maintain operations during crises. The findings will help inform policies and training programs aimed at equipping farmers with the tools they need to manage emergencies effectively.

The COVID-19 pandemic revealed critical weaknesses in the agriculture sector, particularly during the early phases of the MCO in Malaysia, which severely impacted food chain activities and agricultural supply chains (Gregorioa & Ancog, 2020). The poor response in certain regions can be attributed to a lack of disaster readiness, inadequate rescue and relief infrastructure, and insufficient early warning systems, exacerbated by policy and implementation errors (Chapagain & Raizada, 2017). These challenges highlight the need to explore the factors that determine farmers' readiness during crises, especially regarding their ability to lead and make decisions under pressure.

A key question addressed by this research is whether the determinants that influence farmer readiness—technology, implementation, leadership, and decision-making skills—differ between regular and crisis periods. During normal times, these skills are primarily directed toward enhancing productivity and farm management. However, during emergencies, these same skills are tested in new ways as farmers must navigate disrupted supply chains, reduced access to resources, and limited extension support. This study investigates how farmers adjust these critical skills to manage the unique challenges posed by catastrophic events, offering valuable insights into the adaptability of agricultural systems during crises.

The COVID-19 pandemic brought significant disruptions to the agriculture industry and rural communities. Movement restrictions, limited access to agricultural inputs, and reduced technical support from extension agents impeded farmers' ability to continue operations. In particular, the supply chain for essential farm inputs like seeds, fertilizers, and equipment was disrupted, leaving farmers to rely on their leadership and decision-making skills to maintain productivity. The pandemic also revealed a disconnect between the level of support farmers need during a crisis and the services provided by extension agents. Typically, extension programs focus on increasing farm productivity and profitability, with little attention paid to catastrophe readiness. This gap underscores the need for more comprehensive extension services that equip farmers with the skills necessary to manage crises autonomously. This study addresses this issue by examining how farmers' ability to implement technology, make decisions, and demonstrate leadership in emergency situations affects their capacity to sustain farm operations without external assistance.

Previous studies on agricultural resilience have primarily focused on long-term strategies for economic or social disruptions, often overlooking immediate responses to sudden catastrophes like COVID-19. While technology adoption and leadership skills are frequently examined separately, few studies integrate these factors to assess their collective impact on farmer readiness in crisis situations. This study addresses these gaps by specifically investigating how Malaysian farmers navigated the pandemic's challenges, highlighting the immediate need for an integrated approach to technology, implementation, leadership, and decision-making skills. By focusing on the short-term, practical responses and local context, this research provides new insights into enhancing agricultural resilience and readiness for future catastrophe.

The disruptions caused by the pandemic extended beyond farm operations, severely affecting food security. Perishable goods, such as vegetables, experienced significant post-harvest losses due to logistical challenges, market closures, and labor shortages. These issues were particularly pronounced for crops requiring intensive labor, where supply chain bottlenecks prevented regular marketing and distribution (Surendran, 2020). This situation exposed the vulnerabilities in agricultural systems and highlighted the importance of enhancing farmer readiness to withstand shocks and sustain operations during periods of disruption.

Research on post-catastrophe farmer readiness is scarce, particularly regarding how farmers can leverage technology, implementation, leadership, and decision-making skills to respond to future catastrophic events. The ability to predict, mitigate, and respond to crises is crucial for maintaining food security and minimizing losses. This study contributes to the literature by exploring how farmers can better prepare for future disruptions, offering practical recommendations for enhancing resilience through targeted training and support. While this study is contextualized within the COVID-19 pandemic, its relevance extends to other catastrophic events, including environmental disasters and economic crises. The agricultural sector is highly vulnerable to such occurrences, and understanding how farmers can enhance their readiness is crucial for building resilient and sustainable food systems. By positioning itself at the intersection of agricultural technology, leadership, and decision-making, this research offers new insights into how farmers can better prepare for future crises.

Moreover, this study acknowledges that agricultural resilience extends beyond individual skills. It requires coordinated efforts at the policy and institutional levels to ensure that farmers have access to the necessary tools and knowledge. By filling the theoretical, research, and practice gaps identified, this research provides a foundation for developing policies and programs that strengthen the agricultural sector’s ability to withstand future disruptions. While there is extensive research on technological adoption and leadership in agriculture, this study addresses the significant gap in understanding how these factors, along with implementation and decision-making skills, influence farmers' readiness to face catastrophic events.

By presenting an integrated perspective on these critical determinants, this research contributes to a more comprehensive understanding of how farmers can enhance their resilience. The findings have practical implications for policymakers, extension services, and training programs, offering a framework for equipping farmers with the skills they need to manage future crises effectively.

1.7 Research Objective

This research aimed to determine the skills influencing farmers’ readiness to face catastrophic challenges in peninsular Malaysia. The specific objectives of this study are as follows:

1. To determine the level of technology skill, implementation skill, leadership skill, decision-making skill and farmers’ readiness to face catastrophic challenges.
2. To determine the relationship between technology, implementation, leadership, decision-making skills and farmers’ readiness to face catastrophic challenges.
3. To determine the significant skills influencing farmers’ readiness to face catastrophic challenges.

1.8 Research Questions

1. What is the level of technology skill, implementation skill, leadership skill, decision-making skill and farmers’ readiness to face catastrophic challenges?

2. What is the relationship between technology, implementation, leadership, decision-making skills and farmers' readiness to face catastrophic challenges?

3. What is/are the significant skills influencing farmers' readiness to face the catastrophic challenges?

These research questions helped to shape the research work. It acts as a sharpener of the original idea to remain relevant in the study, making the researcher's efforts more practical. For instance, the first research question in the study is, "What is the level of technology skill, implementation skill, leadership skill, decision-making skill and farmers' readiness to face the catastrophic challenges?". This research question gives insight into directing what to do in the research. Thus, the process or the investigation will lead to knowing the level of farmers' readiness on the skills level investigated. By breaking down the investigation into specific skills, this study could examine different aspects of farmers' readiness in the context of catastrophic challenges. By systematically investigating each component of the research questions, the result can be well-equipped to provide a comprehensive assessment of farmers' readiness and identify areas where interventions or support may be needed to enhance their readiness for catastrophic challenges.

1.9 Research Hypotheses

The following are the hypotheses related to the specific objectives of the study:

- H_a1: Technology skill is significantly related to farmers' readiness to face catastrophic challenges.
- H_a2: Implementation skill is significantly related to farmers' readiness to face catastrophic challenges.

- H_a3: Leadership skill is significantly related to farmers' readiness to face catastrophic challenges.
- H_a4: Decision-making skill is significantly related to farmers' readiness to face catastrophic challenges.
- H_a5: Technology skill significantly contributes to farmers' readiness to face catastrophic challenges.
- H_a6: Implementation skill significantly contributes to farmers' readiness to face catastrophic challenges.
- H_a7**:** Leadership skill significantly contributes to farmers' readiness to face catastrophic challenges.
- H_a8**:** Decision-making skill significantly contributes to farmers' readiness to face catastrophic challenges.

1.10 Significance of the Study

This study is significant as it addresses a critical gap in understanding the readiness of farmers to face catastrophic challenges. One of the central objectives is to explore how the application of knowledge and skills—particularly in technology, implementation, leadership, and decision-making—plays a pivotal role in preparing farmers for such crises. The research highlights how these competencies can bring about desired changes in farm practices, even during disasters, and is valuable for practitioners, such as agricultural extension agents, who support farmers in adopting innovative practices. From a theoretical perspective, this study makes broad contributions by enhancing our understanding of resource-based theory, particularly emphasizing the superiority of intangible resources, like knowledge and skills, over tangible assets. Additionally, it extends the technological readiness framework by focusing on the importance of farmers' experience and expertise—an area often overlooked in previous studies that primarily emphasize formal education and training.

The study also sheds light on the role of agricultural extension services in enhancing farmers' readiness. By identifying the skills necessary for farmers' readiness, it supports the development of targeted training and capacity-building initiatives. This will not only help improve farm productivity, but also empower farmers to make better decisions, ultimately improving their quality of life. Additionally, the findings offer policy insights, aiding agencies like Malaysia's Department of Agriculture in shaping programs and policies that support sustainable agricultural practices in times of crisis.

This research introduces several novel elements that distinguish it from prior studies. Firstly, it focuses specifically on vegetable farmers' readiness to face catastrophic events, offering a fresh perspective on an often-overlooked group of agricultural stakeholders. While much of the existing literature examines economic disruptions and socio-economic impacts, this study centers on how vegetable farmers can effectively manage and adapt to crises. A key feature of this study is its detailed exploration of four critical skills: technology adoption, crisis management, leadership, and decision-making. By delving into these areas, the study offers actionable insights for farmers, providing them with practical tools to navigate and mitigate the impacts of catastrophic events.

The multi-theory approach further enhances the study's novelty. By integrating theoretical frameworks such as the Iceberg Model, Community Readiness Model (CRM), and Technology Readiness Index 2.0 (TRI 2.0), the research presents a comprehensive and nuanced analysis of the factors influencing farmers' readiness. This approach not only deepens the theoretical understanding of the subject but also provides a holistic analysis of the skills and strategies necessary for resilience.

Practically, the study's findings have important implications for policy and practice. It informs the design of interventions and training programs aimed at enhancing farmers' crisis readiness. Additionally, the identification of key skills can guide the development of policies and extension services to support farmers in building resilience, thus contributing to improved catastrophe readiness and response strategies. Ultimately, this research fills a notable gap in the literature by focusing on farmers' readiness to face catastrophic events, offering a foundation for future studies that could expand upon these insights and contribute to the development of more effective agricultural resilience strategies.

1.11 Scope of the Study

The scope of this study is meticulously crafted to assess the readiness of vegetable farmers in Peninsular Malaysia to effectively confront catastrophic events. It specifically focuses on the technology, implementation, leadership, and decision-making skills. This study addresses a critical gap in the existing body of research, which has predominantly concentrated on farmers' readiness in broader contexts such as climate change and general skill competencies. By homing in on the challenges posed by the COVID-19 pandemic, this research offers a nuanced and specific understanding of how these competencies impact farmers' readiness in the context of a global health crisis.

Existing literature has extensively explored the effects of climatic changes and general skill levels on agricultural readiness. However, there is a notable deficiency in research that examines the immediate impacts of pandemics or other specific catastrophic events on agricultural practices. The COVID-19 pandemic presented unprecedented challenges including significant disruptions in supply chains, restricted access to extension services, and altered market conditions. These factors substantially impacted agricultural operations, making it imperative to investigate how farmers' readiness to adopt new technologies, implement effective strategies, and exercise leadership and decision-making skills influence their ability to navigate such crises. This study aims to bridge this gap by providing an in-depth analysis of these four key competencies and their role in enhancing farmers' readiness.

The choice of Peninsular Malaysia as the geographic focus of this study is strategically significant. The region's unique socio-economic and agricultural landscape provides a rich context for examining regional responses and adaptations during the pandemic. By concentrating on Peninsular Malaysia, this study can generate findings that are not only relevant to the local context but also have implications for national agricultural policies and practices. The selection of this region allows for a more targeted investigation into how specific challenges faced by farmers in this area can inform broader strategies and interventions.

The study's focus on technology skill, implementation skill, leadership skill, and decision-making skill, aims to elucidate the collective impact of these competencies on farmers' readiness. By addressing both immediate and long-term challenges, the research seeks to provide actionable insights that can inform the development of enhanced farmer training programs, policy interventions, and support mechanisms. The findings are expected to contribute significantly to the resilience of the agricultural sector, offering practical recommendations for strengthening agricultural practices and improving overall readiness for future crises.

In summary, this study not only fills a crucial gap in the literature by focusing on the impact of the COVID-19 pandemic on agricultural readiness but also provides valuable insights that can inform the development of targeted strategies for improving agricultural resilience. The comprehensive analysis of technology, implementation, leadership, and decision-making skills in the context of a global pandemic positions this research as a significant contribution to the broader field of agricultural studies, with implications for both local and international agricultural policy and practice.

1.12 Assumption of the Study

The ability of an agricultural system to modify and adapt to survive across time is referred to as resilience (Walker et al., 2004; Darnhofer, 2014). It is to develop their ability to deal with change and uncertainty, and developing resilience requires synthesizing several types of information (Folke et al., 2003). Darnhofer et al. (2016) highlighted the relevance of networking and experiential learning in promoting resilience to boost farmer readiness among the many information sources and learning methods that farmers use.

The study of readiness is crucial for farmers to adjust to any catastrophic event. Determining the precise factors influencing the improvement of resilience and reducing the vulnerability of rural farmers by enhancing resilience to the adverse effects of climate change and drought, for example, can be one of the unique responsibilities of management and agricultural development planning (Field et al., 2014). Farmers must develop techniques to go around and handle hazards and impediments because they have no control over them (Kahan, 2008). Farmers should find ways to overcome obstacles and protect themselves from unforeseen future risks (Bakar & Sum, 2020). If improperly identified and managed, these hazards can negatively impact agricultural productivity and farmers' income.

The readiness of farmers to manage agricultural challenges determines their capacity to anticipate, avert and react to potential threats and shocks. Therefore, this study intends to address the fundamental question of what influences farmers' readiness for catastrophe and its status among samples from the study area and which aspects are of high priority. This is why the study of readiness is essential for farmers to adapt when a catastrophe phenomenon occurs. This study has broad implications because farmers' primary goal is to be prepared to meet a catastrophe by using their knowledge, skills and capacities.

The findings of this study will, in general, contribute to our knowledge of the skills required by farmers and other correlated readiness, and will provide insight into the beneficial effects of performance of vegetable growers. This understanding will improve their capacity to overcome obstacles they might face in the agricultural industry. As a result, farmer readiness is essential because it sheds light on how skills are related to extension agents' and farmers' preparation. A higher level of readiness would lead to more effective implementation and decision-making, raising farmer production, income and quality of life. Decision-makers in Malaysia would benefit from adopting clear policies and plans that would boost efficiency in the agricultural sector.

1.13 Limitations of the Study

Given that the study exclusively examines a particular subgroup of farmers in Peninsular Malaysia, the conclusions may possess limited applicability to alternative areas such as Sabah and Sarawak, different crops, or diverse agricultural methods. The readiness and expertise of vegetable farmers may differ from those of farmers engaged in other forms of agriculture, such as aquaculture and livestock farming. Furthermore, the choice of vegetable growers is restricted to those with the highest per capita consumption. The study may introduce a sample bias by exclusively picking vegetable producers with the highest consumption per capita. These farmers may not accurately reflect the overall population of vegetable growers, and their attributes and abilities may vary from those who have lower levels of consumption.

Due to the COVID-19 pandemic, researchers had restricted mobility, which hindered their ability to perform the survey in person. Performing a face-to-face survey during a pandemic with a large number of COVID-19 cases could present substantial hazards to the well-being and security of both surveyors and respondents. Therefore, the online survey was employed as the principal means of gathering data amidst the COVID-19 pandemic for the population in Malaysia that consumes a significant number of vegetables. This study exclusively examines technological, implementation, leadership, and decision-making skills, as these variables are both strong and indispensable for evaluating farmers' readiness. Furthermore, the study could be enhanced by taking into account other dimensions of the agricultural ecosystem, including market dynamics, resource accessibility, and environmental sustainability, all of which can potentially influence farmers' readiness and achievements.

1.14 Conceptual and Operational Definition of Terms

Farmer’s readiness:

Conceptual: Farmers’ readiness is the willingness to do something directly after seeing something or need decision-making on whether to go after a complete preparation has been done (Stanley et al., 2014).

Operational: Readiness of farmers in terms of knowledge and skills to face challenges and manage the risks at their level.

Catastrophe:

Conceptual: A catastrophe is an event that directly or indirectly affects an entire country, requires national or international response, and threatens the welfare of a substantial number of people for an extended period of time (Bissel, 2013)

Operational: Huge incidents that destroy the dimensions in people's lives, such as income, economy, work and the environment, especially due to COVID-19 cases.

Technology skill:

Conceptual: Technology skills are the combined skills that contain the knowledge and skills needed to accomplish the targeted work to achieve the target (Damooei, Maxey, and Watkins, 2008).

Operational: The ability of farmers to understand and apply the technology in agricultural equipment to boost their production and productivity.

Implementation skill:

Conceptual: Implementation is the process of carrying out or putting into practice a task-related plan, technique, model, specification, standard or policy.

Operational: The ability of farmers to carry out tasks in preparation for problem-solving.

Leadership skill:

Conceptual: Leadership is the ability to affect people through the activities of an organized group in efforts toward objective setting and achievement (Asogwa & Okwoche, 2012).

Operational: The ability of farmers to lead the vision, focus and identify goals for better farm productivity.

Decision-making skill:

Conceptual: Decision-making is classifying and choosing an alternative way for one potential possibility among others appropriate to the situation's demand (Miller & Byrnes, 2001; Rehman & Khan, 2015).

Operational: The ability of farmers to think objectively and confidently to make the right decision to achieve better performance.

1.15 Organization of the Thesis

The thesis is organized through five (5) chapters. Chapter 1 discusses the general background of the study, which includes the catastrophe phenomenon based on COVID-19, the relationship between COVID-19 and the vegetable industry in Malaysia, and farmers' readiness to face the challenges. The study objectives and problem statements are explained in detailed in this chapter. Chapter 2 reviews previous studies on farmers' skills to overcome challenges. The terms used in this study are also discussed in this particular chapter. The referred models are also shown in this chapter. Chapter 3 explains the theoretical and conceptual framework, data collection, procedures, and analytical and estimation tools of the study. This study uses four types of skills listed, which are (1) technology skill, (2) implementation skill, (3) leadership skill and (4) decision-making skill as independent variables. Meanwhile, the readiness of farmers is viewed based on these skills and become dependent variables of this study. Chapter 4 discusses the descriptive, correlation, multiple regression and structural equation modelling to achieve the objective of this study. Chapter 5 includes the summary of major findings, conclusion, recommendation for future research and the limitations that occurred during the study.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter explores the relevant literature on past studies. This review includes related studies that cover the study topics, which are the catastrophic phenomenon, the COVID-19 pandemic, the Movement Control Order (MCO), the Department of Agriculture, agricultural extension, the Iceberg Model, Community Readiness Model, Technology Readiness Index, technology skill, implementation skill, leadership skill, decision-making skill and farmers' readiness to face catastrophe challenges. At the end of this chapter, a review on the theoretical framework and summary of the literature are given.

2.2 Catastrophe Phenomenon

There are several sizes of emergencies (Figure 2.1), with most minor emergencies typically considered dangers or incidents, and all local responses are expected to be handled. A moderate-sized disaster will cause a sizable loss of life or property damage. According to Quarantelli and Dynes (1977), a disaster is an occurrence that leads to societal unrest. The highest level of emergency is described by terms such as major catastrophes, catastrophic disasters and extreme events. Catastrophic disasters are significant, unusual, extraordinary, horrible or have widespread consequences (Bier et al., 1999). Whether the "triggering event" is natural or manmade, it usually has an impact on the natural, social and human systems all at the same time (Bowsher, 1993; Hu et al., 2023).

Figure 2.1:Continuum of magnitude (Bissel, 2013)

A catastrophe is defined as an incident that directly or indirectly affects a whole country, necessitates a national or worldwide reaction, and poses a long-term threat to the welfare of a large number of people (Bissel, 2013). Even though they are in the same category as other emergencies and have some things in common, catastrophic events stand out in four crucial aspects due to their scale, impact and unique characteristics (Figure 2.2).

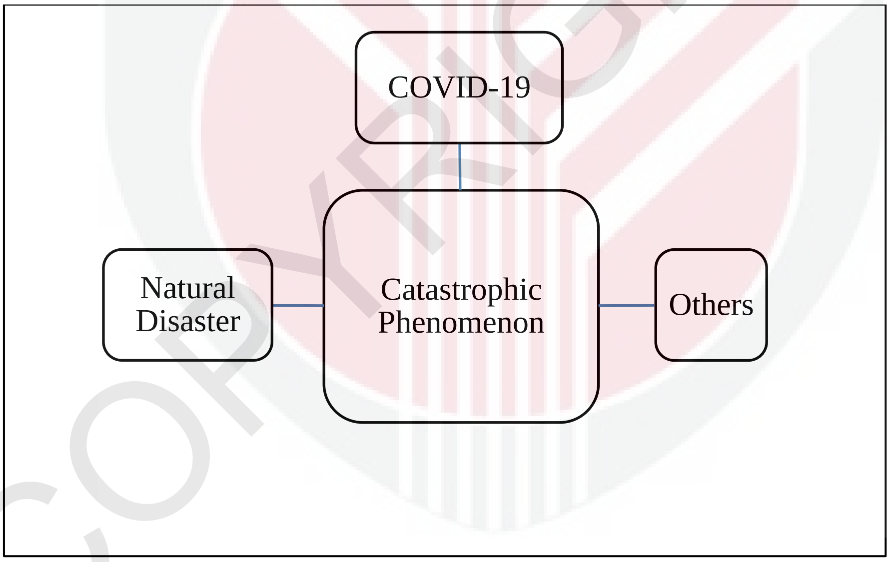

Figure 2.2: Catastrophic phenomenon categories

First and foremost, the inherent unpredictability of catastrophic events starkly contrasts with the more manageable nature of routine emergencies, which are typically anticipated and addressed through established bureaucratic procedures designed to enhance efficiency and cost-effectiveness. In contrast, the unprecedented scope and unique specifics of catastrophic occurrences often require significant deviations from conventional emergency management strategies. This divergence highlights a crucial gap in existing agricultural extension frameworks and technological approaches. Decision-makers have frequently adhered to pre-pandemic assumptions and standard policies, thereby missing critical opportunities to adapt and enhance their responses to rapidly evolving challenges (Gerrand et al., 2023; Marsden & Docherty, 2021). The standard protocols for agricultural extension and technology must therefore be re-evaluated to better address the complexities and specificities introduced by such unprecedented events, ensuring a more agile and effective response in future crises.

Secondly, the impact of catastrophic events on decision-making processes is profound. The scale and distinctiveness of these events necessitate a re-evaluation of decision-making frameworks, as they introduce unique hazards and exceptional needs that standard protocols may not adequately address (McKinsey, 2002; Reale et al., 2023; Ricci, 2020). Research by Yang et al. (2020) reveals that incidental fear associated with such crises can trigger unconscious risk-averse behavior, thereby influencing decision-making processes related to high-risk outcomes. This insight underscores the necessity for agricultural systems to incorporate adaptive decision-making strategies that account for the psychological and emotional aspects of risk, particularly during times of crisis. Integrating these considerations into agricultural extension and technology strategies can enhance the sector's ability to make informed and effective decisions under duress.

Finally, the severe disruptions caused by catastrophic events often lead to significant challenges in communication and coordination among various organizations. The complexity of managing collaborative efforts is exacerbated during extreme events, as coordination may become either nonexistent or overwhelmed. This situation is particularly challenging when many partners are unfamiliar with each other or have doubts about each other's capabilities and motives (Acar-Burkay et al., 2020; Kapucu, 2008). In the context of agricultural extension, effective coordination is crucial for managing crises and ensuring continuity in food supply. Therefore, it is essential to develop robust mechanisms for building and maintaining effective partnerships, even in chaotic situations, to enhance the sector's resilience and response capacity.

The COVID-19 pandemic has accentuated these challenges by introducing a novel and unprecedented threat to global food security. Agriculture, which is essential for sustaining over 2.5 billion people, faces heightened vulnerabilities due to its reliance on environmental factors and natural resources (FAO, 2021). The pandemic, combined with accelerating climate change and the increasing frequency of extreme weather events, has underscored the sector's susceptibility to disruptions. The agricultural sector continues to experience disproportionate impacts from such catastrophes, emphasizing the urgent need for more resilient and adaptable agricultural systems (Mthembu et al., 2022; Tansuchat et al., 2022).

Addressing these vulnerabilities requires a comprehensive re-evaluation of current agricultural extension practices and technological innovations to improve readiness and response strategies. This re-evaluation should focus on enhancing the sector's capacity to withstand future crises, ensuring the sustainability and security of global food systems (Habanyati et al., 2022; Raptou et al., 2022).

2.2.1 Impact of Pandemics and Other Catastrophes on Agriculture

Understanding the impact of catastrophes on agriculture necessitates a broader examination of various types of catastrophic events beyond the COVID-19 pandemic. While the COVID-19 pandemic, which emerged in December 2019 in China (Singhal, 2020), provides a contemporary case study, it is essential to place this event within a wider context to fully grasp the complexities of agricultural resilience and technological adaptation. The COVID-19 pandemic, characterized by its rapid global transmission via respiratory droplets (Wang et al., 2020a), presented unique challenges to global health systems and economies. The disease, manifesting through symptoms such as fever, sore throat, headaches, and lethargy, quickly escalated to a global crisis. In Malaysia, the virus was introduced in January 2020, with local transmission becoming evident by March of the same year. This escalation was significantly influenced by a large religious gathering in Kuala Lumpur, which facilitated widespread regional transmission (Sundarasen et al., 2020; Barker, 2020; Yasmin, 2020). The pandemic prompted extensive public health measures, including lockdowns, travel restrictions, testing, contact tracing, and vaccination campaigns to mitigate its impact (World Health Organisation, 2020).

However, to comprehensively address the implications of catastrophes on agricultural systems, it is crucial to consider a broader spectrum of events. Catastrophes can be categorized into several types: natural disasters, technological failures, and pandemics. Each type presents distinct challenges to agricultural resilience and requires different response strategies. Natural disasters such as hurricanes, floods, earthquakes, and wildfires pose severe threats to agricultural systems by directly damaging crops, livestock, and infrastructure. For example, hurricanes can devastate farmland, disrupt irrigation systems, and lead to soil erosion. Floods can cause extensive waterlogging, while earthquakes can damage infrastructure essential for farming activities. The recovery from such events often involves rebuilding infrastructure, restoring soil health, and ensuring food security through emergency relief efforts.

Technological failures, including power grid outages, industrial accidents, and cyber-attacks, also have significant implications for agriculture. Power grid failures can disrupt irrigation systems and cold storage facilities, affecting both crop production and food preservation. Industrial accidents, such as chemical spills, can lead to soil and water contamination, impacting crop safety and productivity. Cyber-attacks on agricultural technologies can compromise data integrity and operational efficiency. Addressing these issues requires robust contingency planning, system redundancy, and enhanced security measures.

The COVID-19 pandemic, while distinct in its global reach and impact, shares similarities with other catastrophes in terms of disrupting supply chains and affecting food systems. The pandemic highlighted vulnerabilities in global supply chains, restricted access to extension services, and altered market conditions, exacerbating challenges faced by farmers (Mthembu et al., 2022; Tansuchat et al., 2022). It also emphasized the need for more resilient agricultural systems capable of adapting to both sudden and prolonged disruptions.

Examining the broader context of various types of catastrophes enriches our understanding of how agricultural systems can be fortified against diverse threats. By integrating insights from different types of catastrophes, this study aims to provide a comprehensive framework for enhancing agricultural resilience. Such a framework will inform the development of targeted strategies, policies, and technologies to improve farmers' readiness and adaptability in the face of a range of potential disruptions, ultimately contributing to global food security and sustainable agricultural practices.

2.3 Insight from Movement Control Order (MCO)

The implementation of the Movement Control Order (MCO) by the Malaysian government on March 18, 2020, was a pivotal response to the escalating COVID-19 crisis. This measure aimed to curb the transmission of the virus by enforcing travel restrictions, limiting social interactions, and closing various government, commercial, and educational facilities (Prime Minister's Office, 2020). These stringent public health measures were instrumental in reducing the spread of the virus and mitigating immediate health risks, but they also precipitated significant disruptions across multiple sectors, including agriculture (Sundarasen et al., 2020).

The adverse effects of the MCO on the agricultural sector were profound and multifaceted. The lockdowns and restrictions imposed during the pandemic severely disrupted agricultural operations. According to Man (2020), the pandemic highlighted the agricultural sector's vulnerability to large-scale crises, revealing a significant gap in the sector’s readiness for such unprecedented events. The disruptions were particularly evident in the interruption of supply chains and the severance of connections between agricultural producers and consumers (Poudel et al., 2020). Mobility restrictions led to substantial delays and occasional halts in logistics services and transportation of agricultural goods, which in turn impacted food distribution and production capacity (Klinsrisuk & Pechdin, 2022; Kirsten, 2022; Vaghefi, 2020).

However, the context of catastrophe extends beyond the COVID-19 pandemic and encompasses a wide array of disruptive events, such as natural disasters, economic crises, and geopolitical conflicts. Historically, events like floods, droughts, and earthquakes have similarly disrupted agricultural activities, impacting planting, harvesting, and transportation. These catastrophes often lead to systemic failures in food supply chains due to labor shortages, infrastructure damage, and logistical inefficiencies.

For instance, floods can inundate farmland, leading to crop losses and delayed planting schedules. Droughts reduce water availability, affecting crop yields and livestock health. Earthquakes can damage infrastructure, including roads and storage facilities, further disrupting the flow of agricultural products. These disruptions emphasize the need for resilient agricultural systems capable of withstanding various types of catastrophes. The role of government agencies, such as the Department of Agriculture (DOA), becomes crucial in these contexts. The DOA is responsible for overseeing agricultural activities, providing support to affected farmers, and coordinating recovery efforts during crises. Effective disaster response strategies and readiness plans are essential to mitigate the impacts of such events and ensure the continuity of agricultural operations.

While the COVID-19 pandemic has brought to light specific challenges faced by the agricultural sector, it is crucial to consider these challenges within the broader context of various catastrophic events. Understanding the impact of different types of crises on agriculture helps in developing more robust and adaptive agricultural systems. By integrating insights from past and present disruptions, policymakers and agricultural stakeholders can better prepare for future crises, enhancing the sector's resilience and ensuring food security in the face of diverse threats.

2.4 Department of Agriculture Malaysia (DOA)

The Department of Agriculture (DOA) in Malaysia is a key institution responsible for promoting agricultural development and improving the livelihoods of farmers by providing essential agricultural knowledge and extension services (Hassan et al., 2010). As one of the primary government bodies in the agricultural sector, the DOA's core mission is to ensure the growth and sustainability of the agricultural community through strategic interventions that include increasing farm productivity, supporting entrepreneurial initiatives in agriculture, and equipping the workforce with relevant skills tailored to the evolving needs of the sector. Its objectives align closely with national goals of food security, economic development, and rural prosperity.

DOA's role in providing agricultural extension services is a cornerstone of its mandate. These services are designed to facilitate the transfer of knowledge, new technologies, and best practices to farmers, thereby empowering them to adopt more efficient and sustainable farming methods. According to Samsudin (2010), the department's extension services are characterized by their high level of professionalism and technical reliability. These services include advisory programs aimed at enhancing agricultural output and educating farmers on new techniques and technologies. The extension officers, often referred to as exchange agents, play an instrumental role in connecting farmers to new agricultural knowledge and practices, providing training, technical support, and acting as problem solvers (Shah et al., 2013).

Agricultural extension officers are not only critical in times of normal agricultural operations but are also essential during periods of crisis or catastrophe. The COVID-19 pandemic, for example, brought significant challenges to global food systems, and Malaysia was no exception. The DOA's role became especially prominent during the Movement Control Order (MCO) in 2020, which was enacted to limit the spread of the virus (Prime Minister's Office, 2020). The lockdown and movement restrictions severely disrupted agricultural operations, particularly in terms of labor availability, logistics, and the transportation of agricultural goods (Klinsrisuk & Pechdin, 2022; Kirsten, 2022). The DOA was at the forefront of responding to these challenges, disseminating vital information to farmers on safety protocols, adjusting policies to maintain food production, and providing guidance on how to operate under the new restrictions.

The MCO's impact on agriculture revealed critical vulnerabilities in Malaysia's agricultural system, particularly the dependency on physical labor and in-person transactions for the distribution of goods. The supply chain disruptions underscored the importance of adopting technological innovations in agriculture, such as digital platforms for market access and precision farming tools, to ensure continuity in agricultural operations during crises. The role of agricultural extension services in this context is critical, as extension agents must now equip farmers not only with traditional knowledge but also with skills related to disaster readiness, climate resilience, and technological adaptation.

Globally, agricultural extension services have been recognized as an indispensable component of agricultural development and disaster management, particularly in developing countries where smallholder farmers are vulnerable to both economic shocks and environmental hazards. In countries like Malaysia, where agriculture is a vital part of the economy, extension services help build the resilience of farmers by introducing them to innovative practices and technologies that improve productivity and mitigate risks. As Antwi-Agyei and Stringer (2021) and Singh and Mehta (2022) argue, the role of extension agents must evolve to include a stronger focus on climate-smart agricultural practices and the integration of information and communication technologies (ICT) to better equip farmers to handle both routine challenges and catastrophic events such as pandemics or extreme weather events.

DOA's proactive response to the COVID-19 pandemic demonstrated the need for agricultural policies and support systems that can adapt to emergencies. The pandemic has highlighted the necessity of building a more resilient agricultural sector by investing in technology, improving communication channels between farmers and extension agents, and creating flexible policies that can support the rapid adaptation of agricultural systems in times of crisis. The integration of digital tools, for instance, could facilitate more efficient supply chain management, remote advisory services, and better market access for farmers during lockdowns or other disruptions.

Additionally, agricultural extension services can contribute to strengthening farmers' readiness to face future challenges by promoting adaptive strategies and innovative technologies. This includes fostering a greater understanding of climate-resilient farming practices, such as agroecology, precision agriculture, and the use of droughtresistant crops. By equipping farmers with the knowledge and tools to withstand both economic and environmental shocks, agricultural extension agents can help ensure the long-term sustainability of the agricultural sector.

In conclusion, the Department of Agriculture in Malaysia plays an integral role in enhancing the country's agricultural development, especially through its extension services. The COVID-19 pandemic, while devastating, underscored the importance of these services in maintaining agricultural productivity and resilience. Moving forward, the DOA must continue to adapt its strategies to meet the evolving challenges posed by global crises, environmental changes, and the growing need for technological innovation in agriculture. The enhancement of farmers' readiness to face such challenges will be crucial for ensuring the continued sustainability of Malaysia's agricultural sector and its contribution to national food security.

2.5 Role of Agricultural Extension in Catastrophe

Agricultural extension services are indispensable, especially during times of crisis, as they provide farmers with the knowledge, guidance, and support needed to adapt to challenging circumstances and sustain agricultural activities. Their role is crucial in ensuring food security and the resilience of farming communities, particularly during emergencies. Agricultural extension services serve as a vital channel for disseminating critical information to farmers, including updates on government regulations, safety guidelines, and best practices for managing farms while adhering to health protocols. During the MCO in Malaysia, these services played a pivotal role by providing updates on operational procedures and connecting farmers with alternative markets, including online platforms, to ensure the continued sale of their products despite traditional market disruptions. Additionally, agricultural extension agents provided guidance on packaging, labeling, and marketing strategies tailored to pandemic-induced circumstances.

The significance of agricultural extension services extends beyond crisis management. According to Oakley and Garforth (1985), agricultural extension is a learning process that educates farmers on how to enhance their farm output and develop the skills necessary to manage agricultural activities more effectively. It is an ongoing process that not only disseminates pertinent information but also equips farmers with the knowledge, skills, and attitudes required to implement agricultural technologies, which ultimately leads to increased productivity (Rahim, 2008; 2010). The lack of access to such services, particularly among smallholder farmers, has a direct impact on their yields and income. Research indicates that farmer-to-farmer extension strategies, in which experienced farmers share knowledge with their peers, can help mitigate this gap (Gebresilasse, 2023; Tamsah & Yusriadi, 2022). However, the variability of advice between farmers and extension agents highlights the necessity of pluralistic extension strategies to ensure farmers receive comprehensive and reliable information (Kassem et al., 2022; Kwapong et al., 2020; Maulana & Antriyandarti, 2022; Yusuf et al., 2022).

In the Malaysian context, agricultural extension services are provided by both the government and the commercial sector, with the Department of Agriculture (DOA) playing a central role. According to Ali et al. (2018), extension agents from the DOA offer specialized knowledge, practical guidance, and access to innovative technologies that are crucial for advancing agricultural practices. The importance of these services in fostering the adoption of new agricultural technologies has been consistently verified (Ayantunde et al., 2020; Ali et al., 2018). The support provided by extension agents is particularly valued in agricultural communities, where farmers rely heavily on their expertise for various agricultural activities. In this regard, the availability and effectiveness of extension services are critical factors influencing the adoption of agricultural intensification strategies.

The global advancement of agricultural technology has further increased the need for extension services to be well-equipped to meet contemporary challenges. Mapiye et al. (2020) suggest that integrating mobile phone-based innovations with traditional extension services could significantly enhance information-sharing among farmers and improve their ability to provide feedback to extension agents. This integration could bridge the gap between scientific advancements and their practical implementation on farms, a challenge that has long plagued the agricultural sector. By facilitating the transfer of technology and knowledge, extension agents play a key role in promoting sustainable farming practices, increasing productivity, and helping farmers adopt best practices in agriculture.

Moreover, agricultural extension services are not uniform across regions, as their structure and organization vary depending on local needs and circumstances. However, the ultimate objective remains the same—to promote the development of rural areas and enhance agricultural productivity. Extension programs typically encompass a wide range of topics, including pest management, soil fertility, crop diversification, and market access strategies (Oakley & Garforth, 1985). These programs gain their practical significance through the dissemination of research findings and data that inform farmers' decision-making processes. Effective extension agents are expected to fulfill their responsibilities in alignment with organizational goals and field protocols, ensuring that farmers receive the necessary tools and knowledge to improve their agricultural practices and boost productivity (Gebresilasse, 2023; Tamsah & Yusriadi, 2022; Toborn & Harvesting, 2011).

In the context of Malaysia's agricultural sector, particularly in light of recent crises like the COVID-19 pandemic, it is evident that extension services must adapt to the evolving challenges faced by farmers. The MCO demonstrated that traditional extension methods, reliant on face-to-face interactions, need to be complemented by innovative approaches that leverage technology for information dissemination. For instance, using digital platforms to connect farmers with markets, provide real-time updates, and facilitate training has become increasingly essential. Extension agents must also receive specialized training on a broad spectrum of initiatives related to catastrophic events, enabling them to better assist farmers in crisis readiness and response (Kella et al., 2022; Olorunfemi et al., 2020).

Globally, agricultural extension services are transitioning to incorporate more advanced technologies, such as precision agriculture, digital tools for market access, and climate-resilient farming practices. These shifts are essential for enhancing the readiness of farmers to confront emerging challenges, including those related to climate change, economic disruptions, and public health crises. Extension services must evolve from simply providing technical advice to fostering a more comprehensive approach to disaster risk management and resilience building. This transformation is particularly relevant in Malaysia, where smallholder farmers face numerous vulnerabilities, including dependency on physical labor, limited access to technology, and insufficient market linkages during emergencies.

Agricultural extension services are critical to the continued sustainability and resilience of farming communities, both in Malaysia and globally. The ability of extension agents to provide timely and relevant guidance during crises, such as the COVID-19 pandemic, underscores the importance of evolving these services to meet contemporary agricultural challenges. By integrating new technologies, adapting to emergencies, and promoting sustainable practices, agricultural extension services can play a vital role in enhancing farmers' readiness and resilience. As the agricultural landscape continues to change, extension services must remain agile, ensuring that farmers are equipped with the knowledge and tools needed to thrive in an increasingly uncertain world.

2.6 Theories and Model

The theory is essential to research because it provides a framework for understanding the topic under investigation. Additionally, because it is one of the main pillars of research, theory is important (Ngulube, 2020). The use of theory facilitates the generation of transformative knowledge while also aiding in the understanding of study variables (Ngulube, 2020). This study encompasses three theories: the Iceberg Model, the Community Readiness Model (CRM), and the Technology Readiness Index (TRI). These theories facilitate the connection between the study and the selected hypotheses. The Iceberg model serves as the basis for this study. This model explains the relationship between farmers' knowledge and skills (Spencer & Spencer, 1993).

The researcher utilized theory to link: (1) the theoretical and the empirical, (2) thought claims and observed statements and (3) the abstract and the concrete (Carpiano & Daley, 2006; Madara et al., 2016). This study implements three different theories to support the research and discussion. Their intertwining can identify the relationship between research and theory in the process of obtaining findings or answers to a specific issue logically and scientifically to offer a solution to such a problem (Yahaya et al., 2019). The method of employing more than one theory in a study is commonly referred to as theory triangulation, by most authors. Theory triangulation uses various theories to understand data sets (Flick, 2002) or multiple perspectives to evaluate a single set of facts (Guion, Diehl, and McDonald, 2011). More than one theory can be utilized in a study because theory selection is governed by the amount of evidence available (Ma and Norwich, 2007). In some studies, authors employ more than one theory, either theoretically or conceptually. Most of the time, they refer to it as a theoretical framework, as opposed to triangulation, which can improve the research by providing a variety of data sets to explain various elements of an interesting phenomenon (Noble and Heale, 2019).

2.6.1 Iceberg Model Theory

In this study, the Iceberg model was used as a guide. This model explains the relationship between farmers' knowledge and skills (Spencer & Spencer, 1993) by supporting the study's primary objective: the farmers' capacity to overcome obstacles after MCO. Figure 2.3 illustrates the two components of the Iceberg model: the visible (knowledge and skill) and the hidden (other components) (social role, self-image, personality traits and motive).

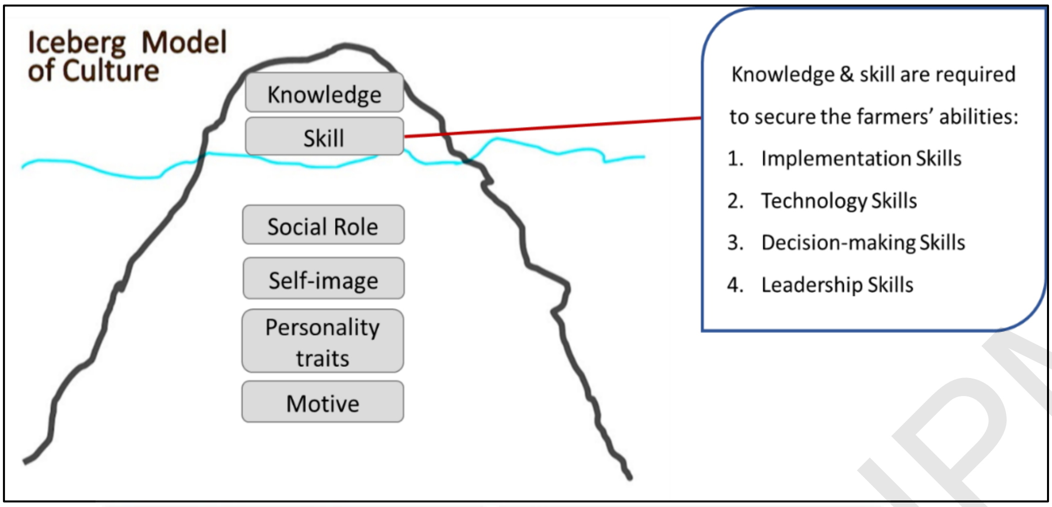

Figure 2.3: Iceberg Model

In today's agriculture, technology plays a pivotal role. Farmers need to be familiar with modern farming equipment, software applications and digital tools for data management, precision agriculture and market analysis. By embracing technology, farmers can enhance their efficiency and yield. Knowing is one thing, but being able to implement it effectively on the farm is equally crucial. Farmers should possess hands-on skills related to planting, cultivation, pest management, irrigation and postharvest practices. Practical know-how ensures that theoretical knowledge translates into tangible results. Farmers' talents will demonstrate their readiness in the visible portion. Thus, knowledge and skill are essential to improve the farmers' capacity to carry out agricultural tasks and boost productivity.

A well-rounded knowledge and skill set, encompassing technology adoption, implementation abilities, leadership and decision-making skills, is essential for farmers to thrive in modern agriculture. Access to education and training programs is instrumental in empowering farmers to acquire and apply this knowledge effectively, leading to increased agricultural productivity and overall sustainability (Caputo et al., 2023; Grigoryeva et al., 2022).

This study only emphasizes what can be seen, such as farmers' knowledge and problem-solving abilities. While skill is the capacity to carry out a task, knowledge is the information included in the study of a person. Technology, implementation, leadership and decision-making skills are part of this knowledge and skill set (Shah et al., 2022; Tingey-Holyoak et al., 2023). According to Spencer and Spencer (1993), developing knowledge and skills is possible. Moreover, training and education programs can help people build their knowledge and skills (Horváth, 2022; Khan & Abdullah, 2019; Kirillova et al., 2022).

The use of the Iceberg Model as a guideline for the independent variables in this study was based on the knowledge and skill that help to explain their relationship to each other. Technology, tools, techniques and processes are the visible components of the Iceberg Model, according to Damrath (2012), and they are extensively discussed in the literature. However, the most crucial components, such as strategic alignment, leadership and conduct and engagement, were situated below the surface and must be taken into account before applying lean tools and approaches. Utilizing the Iceberg Model further links knowledge and abilities to the practice of the farmers' regular farm tasks. In terms of a farmer's preparation, their knowledge and skills are essential because their practical knowledge is based on their exposure to the required technology on their farm.

To run their farms properly and efficiently, farmers must increase their knowledge and skills. To overcome the challenges they face, farmers need to equip themselves with the necessary knowledge, abilities and information. Farmers must adopt coping strategies in response to agricultural changes, but gaps in knowledge between scientists and farmers underscore the need for a more effective information exchange and regulatory incentives (Ansah et al., 2020; Bahta, 2022; Masingo, 2023; Peltonen-Sainio et al., 2020). In order for farmers to effectively engage in agricultural interventions, their capacities must be improved. The ability of farmers to use information, knowledge and decision-making abilities is crucial for agricultural activities (Adnan et al., 2017; Gaikwad et al., 2022; Rochlitz, 2023; Tingey-Holyoak et al., 2023). Therefore, highly educated farmers will use their information and knowledge to their advantage in agricultural pursuits to increase agricultural productivity (Sharma & Singh, 2023; Wang et al., 2018).

2.6.2 Community Readiness Model (CRM)

The Community Readiness Model (CRM) is a valuable tool for determining if a community is prepared to deal with a variety of issues (Figure 2.4). In this study, readiness is the dependent variable that is trying to understand and measure within the context of farmers' readiness to face challenges, such as catastrophes in agriculture. This model was created to assist communities in assessing their capacity to address specific problems and in designing actions accordingly. The CRM provides a structured framework to assess this readiness, taking into account factors such as farmers' knowledge, leadership support, the availability of resources and technology knowledge and skills.

CRM evaluates a community's readiness by looking at three important factors: resources (such as funding and facilities), capacity (such as knowledge, skills and leadership) and attitudes (such as beliefs, perceptions and motivation). Communities can learn about their strengths and shortcomings in relation to a certain issue by looking at these variables. It enables communities to comprehend their capabilities, attitudes and resources in relation to a particular situation and gives them the power to customize actions accordingly.

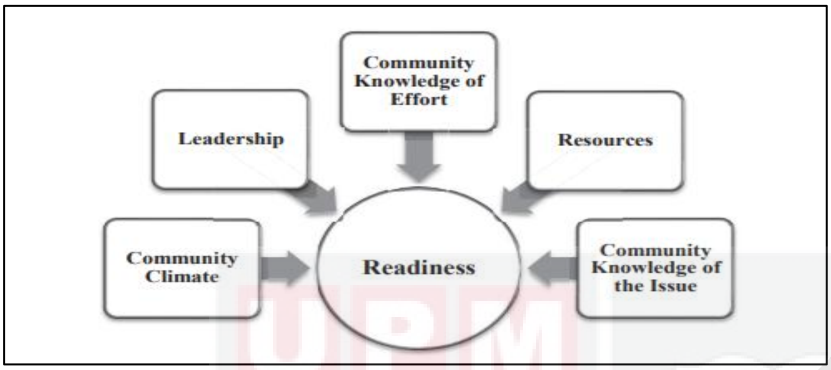

Figure 2.4: The Community Readiness Model (CRM)

The CRM is important because it demonstrates to communities how they can logically go through its sequential phase. The intervention's approach can be adjusted by evaluating the level of readiness in a community and implementing appropriate measures appropriately (Jumper-Thurman et al., 2003). CRM has been utilised to evaluate various issues that impact communities, including the assessment of communities' suitability for participation in research on obesity and breast health interventions and evaluations (Sliwa et al., 2011; Borrayo, 2007; Jarpe Ratner et al., 2013), the examination of sexual violence (Banyard, Plante & Moynihan, 2004), and the development of policies (York & Hahn, 2007).

Meanwhile, in focusing on this study's subject matter, the components within CRM, such as leadership, knowledge and resources, can be considered independent variables in this study as these factors influence and shape the readiness of the community or farmers to address challenges. First, CRM assesses leadership as one of its components, specifically looking at how local leaders feel about addressing the issue and their engagement and support. In this study, the presence of supportive and engaged local leaders influences the readiness of farmers to tackle challenges. This could involve studying their roles in mobilizing resources, advocating for necessary technologies and facilitating knowledge sharing among farmers.

Second, CRM acknowledges the importance of community members' knowledge and awareness about the issue at hand. In this research, the level of knowledge can be explored among farmers regarding potential catastrophes and adaptive strategies that affect their readiness. This could involve assessing their access to information, training programs and their understanding of best practices. Third, CRM considers resources, technology knowledge and skills as key elements in readiness assessment. In this study, the availability of resources (financial, material and technological) and the farmers' skills can be examined by using relevant technologies to examine their readiness to face challenges. This might involve evaluating their access to tools, training and support systems.

By incorporating these components from CRM into this study, a comprehensive framework is created for assessing the readiness of farmers to address agricultural challenges. This structured approach helps in gathering data, analyzing relationships and drawing meaningful conclusions about the factors influencing readiness and preparedness within the farming community. The Community Knowledge of Issue dimension, which reflects how much the agricultural community is aware of the situation, then determines the level of information surrounding farm challenges. Farmers were questioned regarding the aspects of catastrophe intensity that have been considered by local authorities and incorporated them into their farming practices.

Farmers were also asked if the government has made any plans to aid in the execution of the problem in terms of financial and support. Additional resources like training and volunteers show a proactive approach to fostering community resilience (Rozaki et al., 2024). It suggests that this study would not only assess knowledge and awareness but also the practical capacity to respond to and mitigate the impacts of natural catastrophes. This holistic approach is essential for comprehensive catastrophe readiness and response within the farming community.

2.6.3 Technology Readiness Index 2.0 (TRI 2.0)

The Technology Readiness Index 2.0 (TRI 2.0) is the third theoretical framework employed in this study, as depicted in Figure 2.5. Given that the technology component is the independent variable and readiness is the dependent variable in this study, this theory was selected based on these specific factors. Punctuality, trust, knowledge and usability are the components of TRI 2.0. The elements of TRI 2.0 are also inextricably linked to the study's variables.

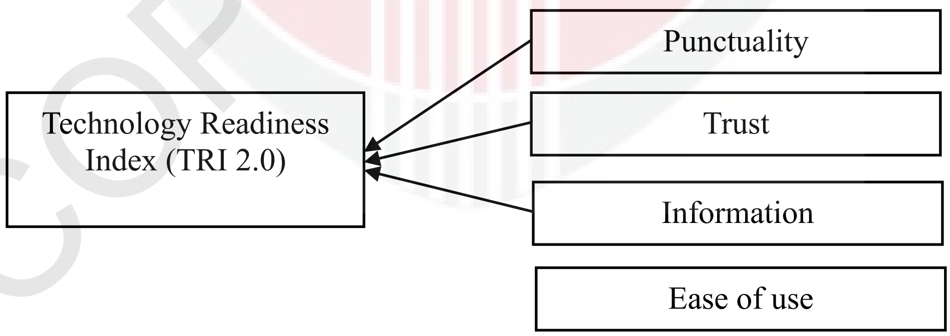

Figure 2.5: Technology Readiness Index 2.0 (TRI 2.0)

In order to comprehend people's willingness to adopt and use new technologies to fulfill their goals, whether at home or in their employment, Parasuraman and Colby's (2001) definition of "technology readiness" is crucial. The TRI, created by

Parasuraman, is a tool for assessing people's attitudes towards technology, including their level of comfort, optimism and propensity to adopt new technical advancements. Incorporating these elements from TRI 2.0 into this study allows to assess the compatibility between farmers' technological needs for catastrophic readiness and the characteristics of the technology they receive. It helps to understand how the factors of punctuality, trust, information and simplicity of use influence farmers' willingness to embrace technology for addressing agricultural challenges. By aligning the technological readiness of farmers with these key components, the interventions, technology adoption strategies and support systems can be tailored to enhance farmers' resilience and readiness in the face of natural catastrophes in their farming practices.

The TRI 2.0 model is a valuable foundation for this study's examination of farmers' capacity to deal with disaster concerns: 1) On-time availability and deployment of appropriate technical solutions depending on farmers' readiness to utilize technology in the case of a catastrophe. Being punctual in introducing and implementing technology is critical to addressing emerging challenges promptly. 2) Trust: Trust in technology is essential for farmers to have confidence in relying on it as a tool to mitigate the impacts of catastrophes. Increased adoption rates among farmers may result from cultivating their faith in digital solutions. 3) Access to timely, accurate information is essential for farmers to use technology for catastrophe readiness and to make informed decisions. To improve their readiness, knowledge of the most recent technical developments and best practices is helpful. 4) Ease of Use: Technology needs to be simple to use in order for farmers to adopt it quickly. Complicated or burdensome technologies may hinder adoption. Technology integration into agricultural practices can be made more accessible by user interface and design simplicity.

Additionally, a person's capacity to use and adapt new technology is indicated by their level of technological readiness (Hamid, 2022; Parasuraman, 2000; Saeed et al., 2023). Technological readiness is a variable that represents an individual differences and captures people's overall acceptance of new technology (Blut et al., 2016; Rahayu et al., 2022; Rahim, 2022). On the other hand, this study included theory into situations and show how people would act or react to new technology and whether to adopt it. The hypothesis also aids in this study's connection of catastrophic phenomenon and how farmers are ready to adopt technology during a crisis.

Parasuraman and Colby (2001) define technology readiness as a metric for evaluating a person's attitude or level of understanding about technology, as opposed to their technical skill or aptitude. Depending on their technological readiness score, users are categorized into five groups: explorers, pioneers, skeptics, paranoids and laggards. Understanding these user categories based on technological readiness can help assess how different groups of farmers respond to and accept technology for addressing catastrophic challenges in agriculture. It can also guide the approach to designing interventions and support systems that cater to the varying attitudes and comfort levels of farmers toward technology adoption. By recognizing the different user types, the strategies can be tailored to engage and empower farmers effectively in adopting technology solutions that can enhance their catastrophe readiness and resilience.

The use of the Iceberg Model, CRM, and TRI can provide a comprehensive understanding of farmers' readiness to face challenges caused by catastrophic events. By using the Iceberg Model, there are multiple layers of farmers' readiness and areas can be identified where interventions or support may be needed. For example, if farmers lack knowledge of catastrophe readiness, it might be necessary to provide training programs. The CRM assesses the readiness of a community to address specific issues, in this case, the readiness to face catastrophic challenges. It categorizes readiness into stages from "no awareness" to "high level of community ownership." By applying TRI, the technological interventions to the specific readiness levels of farmers can be tailored. For instance, farmers with high levels of innovativeness may be more open to using advanced weather forecasting applications. In contrast, those with higher discomfort may require user-friendly and simple technology tools.

Combining these models can provide a nuanced understanding of farmers' readiness to face catastrophic challenges, from the tangible aspects of resources and technology adoption to the deeper layers of psychological and cultural factors influencing their readiness. This knowledge can be used for more effective and targeted strategies for disaster management and support for farming communities.

2.7 Technology skill

Farmers' prior knowledge of technology skills is crucial for overcoming challenges during a catastrophe. The primary factors contributing to the limited awareness and adoption of improved agricultural technologies among farmers were the high prevalence of poverty, low soil fertility, farmers' incapability to make informed decisions, unreliable weather forecasts in rainfed farming systems, insufficient government support, and information asymmetry in input markets (Adhikari et al., 2023; Arslan et al., 2022; Ullah et al., 2022). According to a case study, both farmers and researchers must adopt new responsibilities, with farmers being required to commit their time and money in order to produce valuable data and knowledge (Aare et al., 2021; Senft et al., 2022). There is still a variety of projects that are not well distributed to rural farmers despite the fact that extension agents are active in the transmission of some technology (Kella et al., 2022; Olorunfemi et al., 2020).

In addition, challenges in catastrophic phenomena require farmers to stay within their confined area, which poses another challenge to using the existing input and resources available. The use of technology by farmers could increase output and farm productivity. Thus, this study focuses on farmers' readiness in terms of their technology skills to evaluate their readiness in terms of their knowledge and skills of technology.

Technology skills in agriculture are essential for farmers to effectively utilize and harness the potentials of modern agricultural equipment and techniques. These skills encompass a range of abilities and knowledge in areas that empower farmers to make informed decisions, troubleshoot problems and optimize their agricultural practices (Elbeheiry & Balog, 2023; Nasirahmadi & Hensel, 2022). Through greater awareness, training and skill-building initiatives, strategies to integrate modern technology in communal areas should address the concerns of enhancing the farmers and all stakeholders' knowledge. Because of their lack of confidence, technical difficulties, social and economic barriers, or lack of knowledge regarding how to manage crop production without technology, farmers without technical skills may, however, prefer to use conventional farming techniques (Aare et al., 2021; Balogh et al., 2021; Chi, 2008; Drewry et al., 2022).

Farmers may think that their age, education and farm size make it difficult for them to understand and use new technologies and methods and that their lack of market access, inadequate knowledge and resource capacity prevents them from adopting better agricultural technologies and practices (Haris et al., 2018; Kumar et al., 2020; Marescotti et al., 2021). However, by learning and using technology-related skills, farmers may improve the productivity and efficiency of their operations, as well as minimize dangers and resource waste (Ali et al., 2023; Nasirahmadi & Hensel, 2022; Phasinam et al., 2022). Additionally, adopting technology can aid farmers in responding to shifting market needs and environmental conditions, enhancing agriculture's long-term sustainability (Hatzenbuehler & Peña-Lévano, 2022; Thilakarathne et al., 2023; Wu, 2022).

Furthermore, research has shown that technology proficiency enhances readiness and performance, which means that farmers who use technology are exposed to readiness (Olagunju et al., 2019; Omar et al., 2022). The use of technology in agriculture has the potential to increase output and farm productivity significantly, including helping farmers to overcome obstacles (Kahan, 2008). Catastrophic events in agriculture, especially COVID-19, can indeed disrupt normal farming operations. During such times, farmers often need to rely on their resilience, knowledge and resources to continue farming activities with minimal guidance from extension agents or external support. By including farmers and other actors in the development of new farming technology, technology developers are able to utilize a variety of knowledge and expertise fully; therefore, farmers must try to learn how to use new technologies and increase their level of understanding about farming (Abdullah & Samah, 2013; Kenny et al., 2021).

Additionally, farmers need to be informed of fast, accurate and new knowledge and information regarding farm-related tasks such as harvesting, water management, crop rotation and land preparation (Abdul & Md, 2013; Acharya et a., 2023). It is vital to update the technological recommendations for variety, fertilizer and others so that they are more appropriate for regional conditions. Better awareness of catastrophes and the maintenance of agricultural production can be achieved with more precise information and aggressive dissemination (Apriyana et al., 2021; Raihan & Himu, 2023). Extension agents are essential in educating farmers about the most recent agricultural innovations and technical know-how. They fill the gap between the theoretical application of science to farming and its actual implementation. For farmers to increase production, adjust to changing conditions and manage their farms sustainably, they must practice continuous learning and put new information into practice.

In summary, technology skills are increasingly important for farmers' readiness to face catastrophe challenges. They enhance their ability to access information, make data-driven decisions and respond effectively to catastrophes. As technology continues to advance, agricultural extension services and support organizations need to provide training and resources that help farmers develop and utilize these skills to protect their livelihoods and ensure food security during catastrophes.

2.8 Implementation skill

The second focus is on farmers' readiness for implementation skills. Implementation skill is critical because even the most well-thought-out solutions are ineffective if they are not executed properly. Successful problem-solving often hinges on the ability to translate plans into action effectively and efficiently, making implementation skills a valuable asset in various professional and personal contexts. Implementation, according to Damshroder et al. (2009), is the deliberate process of acquiring evidence-based programs or well-known dimensional practices and putting them into use. To accomplish strategic aims and goals, one must have the ability to put plans into action.

Farmers who want to manage effective farming methods need to be able to put those methods into practice. By employing a better implementation strategy and management, farmers can increase their income and reduce agricultural produce losses. In cases where skills and knowledge improve the community's farming practices and increase crop output, high levels of understanding are required to sustain implementation abilities for ethical farming practices (Caputo et al., 2023; Mondal, Haitook & Simaraks, 2014; Teane, 2020). Additionally, the ability to effectively communicate, assimilate, interpret and implement information into knowledge depends on the receiving farmer's faith in the process (Dilleen et al., 2023; Izuchukwu et al., 2023; Fisher, 2013). The ability of smallholder farmers to understand and trust visual predictions, analyze data and make decisions is improved through capacity building and regular encounters, such as those at farming schools (Kumar et al., 2021; Marsden et al., 2023).

For farmers to maximize their agricultural operations, effective implementation of sound farming techniques and management practices is crucial. Increasing yields, lowering losses and enhancing overall farm sustainability can increase revenue. Additionally, for farmers to achieve their strategic aims and objectives, they must be prepared to put this skill into practice. Farmers must possess implementation abilities if they want to manage practical farming practices. Technology expertise is relevant to implementation as well. Farmers cannot use technology if the skill has not been well practiced. The findings of Baqutayan et al. (2017) and Tiwari (2023) offered significant evidence that adopting technology on their farms after acquiring knowledge and skills through program enrollment and boosting their agricultural output attests to this conclusion.

The role of the farmer was also examined, with a focus on how to apply newly learned skills to increase profitability. This is the rationale behind the selection of implementation skills as the elements that may affect farmers' capacity for problem-solving (Cawley et al., 2018). Additionally, the catastrophe puts farmers' ability to use technology to good use. Without direct access to extension agents or outside assistance, farmers may be forced to rely significantly on their own technological expertise and problem-solving skills during such emergencies.

By enhancing employees' views of important work qualities such as the workplace, projects and daily activities, implementation is a fundamental component that considerably influences how successfully a job is done in a variety of circumstances (Sulong, 2016; Rietze & Zacher, 2022). Plans, strategies and tasks must be implemented effectively to be carried out successfully. Having readily available knowledge helps decision-makers to make more rational, efficient and effective decisions and the implementation stage takes place after the knowledge has been learned and accepted as helpful by the farmer (Farshidi et al., 2021; Ketterings, 2014).

In essence, strong implementation skills are a foundational aspect of farmers' readiness to face catastrophic challenges. It allows them to translate their knowledge, plans and resources into effective actions that can protect their livelihoods, the well-being of their communities and contribute to overall resilience during and after a crisis.

2.9 Leadership skill

Assessing and evaluating farmers' leadership skills and readiness is a valuable endeavor, especially in the context of agriculture, where effective leadership can significantly influence a community's ability to face and overcome challenges. Leadership skills are indeed essential for farmers, especially during and after catastrophic events, where their ability to lead and make decisions can significantly impact their own and their community's resilience and recovery (Prayag et al., 2023; Waldner, 2023). Managing huge personnel teams, navigating intricate production and distribution marketplaces, and coping with constant pressure to innovate and adapt to new technologies are all the skills that farmers need (Sørensen et al., 2021; Ulvenblad & Björklund, 2018). Farmers with leadership qualities will adhere to the needs of planning and arranging farming management.

Depending on the global issues, firm development features and entrepreneurial attitudes, and it is crucial to concentrate on leadership development for agricultural entrepreneurs. Farmers require leadership abilities that promote innovation and industry networking in the agricultural sector, as innovation is strengthening the adaptability of agribusiness champions, farmers and supply chain actors while also lowering training costs (Carter, 2001; Osumba et al., 2021; Ulvenblad et al., 2012; Yu et al., 2023). The ability to communicate a vision and set goals that people strive for is said to increase output, effectiveness and impact (Hughes, 2007; Olugbo et al., 2023). A person's self-confidence is subsequently increased, which motivates them to set challenging goals and foster the growth of their self-leadership skills (Abid et al., 2021). Leadership development can help entrepreneurs articulate and execute their vision effectively. Thus, leaders in agriculture need to have a clear and sustainable long-term vision for their businesses.

The capacity to focus on setting goals for increased agricultural productivity and efficiency is referred to as leadership talent (d'Arros, 2007; Jankelová et al., 2020). Farmers with leadership qualities will adhere to the needs of planning and arranging farming management to be more discipline. A leadership education program that increases farmers' leadership knowledge and abilities can help them enhance their leadership capabilities (Martens & McLean, 2002; Masta & Janjhua, 2023; Ordaz et al., 2021), thereby benefiting their agricultural enterprises and the broader agricultural community. Such programs empower farmers with the knowledge, skills and confidence needed to lead effectively in a rapidly evolving and challenging agricultural landscape.

However, the reliance of farmers with moderate leadership levels to manage their farms can be a significant observation in the context of agricultural practices (Ishak & Manaf, 2020). Farmers cannot motivate themselves to run their operations with mediocre knowledge and abilities. Efforts to empower farmers with improved leadership skills and knowledge can help reduce their dependency towards the middlemen. Farmers may be able to manage their farms more successfully with the help of leadership development programs, agricultural extension services and informational resources.

The sustainable growth of agriculture ultimately depends on finding a balance between utilizing middlemen's assistance and developing independent leadership skills. Furthermore, Isah’s (2018) research showed how essential leadership abilities are to performance potential. It is backed up by studies from Olagunju et al. (2019) and Isah et al. (2019), who found that leadership abilities are essential and beneficial for work performance. An individual's capacity to perform at their job and positively impact their organization can be significantly impacted by effective leadership.

The ability to inspire, mentor and empower others shapes a person's capacity to lead and this capacity, in turn, influences work performance, job satisfaction and organizational success. Leadership is not limited to managerial positions; it can be cultivated and exhibited at all levels of an organization, benefiting individuals and teams throughout the workforce. This study can guide targeted interventions and capacity-building efforts to empower farmers to face better challenges, foster resilience and promote sustainable agricultural practices within their communities.

Leadership skills among farmers play a crucial role in their readiness to face catastrophic challenges. These skills not only help farmers make informed decisions but also enable them to inspire and guide their communities during difficult times. Farmers who possess these skills can foster a sense of community, resilience and readiness, making it more likely that the community can effectively respond to disasters or catastrophes, protect livelihoods and ensure the well-being of its members.

2.10 Decision-making Skills

It would be easier to explain specific subpar performances and make predictions about how agricultural management practices might alter as external conditions change with a more excellent grasp of decision-making systems. Making decisions is a crucial managerial responsibility and farmers need to have all the information they need to make an informed decision, especially when it comes to the threats that a catastrophe poses to agriculture (Fronda, 2023; Giraldo et al., 2023; Kahan, 2008; Ng'ombe et al., 2020).

Farmers with good decision-making skills can exercise critical thinking and choose the best course of action with the knowledge that their performance will increase. They can use it to make decisions that improve the performance and sustainability of their agricultural operations by managing risks, maximizing resource utilization and adapting to changing environmental circumstances. Given the complex and dynamic nature of agriculture, farmers who can think critically and make informed decisions are better positioned to thrive in this industry.

The ability of farmers to make good decisions in the face of economic, social and environmental constraints is one of the most important factors (Akimowicz et al., 2021; Ali et al., 2018). The time lag between an agricultural operation's execution and its effects, the difficulty in obtaining current information about the biophysical system, and the multiple, non-deterministic, and difficult-to-reverse effects of most agricultural operations are among the most ignored factors (Martin-Clouaire, 2017). One of the significant issues impeding smallholder farmers' attempts to raise their output is the distribution and access to timely, pertinent and adequately packaged agricultural information and knowledge (Hua et al., 2023; Magesa et al., 2020; Ndimbwa et al., 2020).

One of the many economic aspects that farmers consider while making decisions is long-term security (Ketteler, 2018). Well-informed farmers will prevent poor decisions, while farmers who are good at making decisions might use their expertise to verify the results of their choices. Contrarily, farmers with poor time management tend to take longer to complete tasks like gathering information and making judgments, which delays their final course of action (Ali et al., 2018; Gorokhova, 2020). The decision-making process potential to elicit proactive, goal-driven behavior as well as reactive behavior in response to unforeseen circumstances must be taken into account (Engler et al., 2021; Martin-Clouaire, 2017).

Demiryurek et al. (2008) claimed that understanding agriculture enhances farmers' ability to make decisions based on the knowledge and information provided by extension agents, researchers and other people. The study emphasized how important agricultural information is in enabling farmers to run their businesses efficiently and make wise decisions. Besides helping individual farmers, this knowledge enhances the agriculture industry's overall sustainability and productivity. It highlights the importance of extension services, research institutions and educational programs in providing farmers with the information and expertise they need to succeed in their farming endeavors.

In summary, decision-making skills are fundamental to farmers' readiness to face catastrophe challenges effectively. In the face of catastrophes, quick and informed decision-making is essential to ensure the safety of lives, preserve crops and livestock, and minimize economic losses. This skill empowers farmers to assess risks, make informed plans, adapt to evolving situations and effectively respond to catastrophes while safeguarding their livelihoods and the well-being of their communities.

All those four skills are related to each other, as the central core here is the knowledge of the technology itself. But what about farmers' technological skills? How can they implement the technology? Do farmers have the leadership skills to implement the technology? Can farmers decide on catastrophic phenomena and how to implement their current knowledge and skills on the technology to be used on their farm? These questions are about the situation that will influence farmers' readiness to face challenges in catastrophic phenomena. Understanding the interplay between these factors can provide insights into their ability to adapt to and mitigate the impact of catastrophic events in agriculture. Additionally, offering training and support in technology adoption and leadership development can enhance farmers' readiness for challenges in the agricultural sector. Thus, these factors are chosen in this study as these four skills will influence farmers' readiness to face catastrophic challenges.

2.11 Farmers' Readiness to Face Catastrophic Challenges

There are two classifications of readiness: (1) the willingness to act immediately after perceiving something and (2) the necessity to choose whether to proceed after thorough planning (Stanley et al., 2014). Both immediate and deliberative readiness have their place in agriculture. The key is to strike a balance between these two approaches depending on the specific situation. For example, immediate readiness may be crucial when responding to sudden crop diseases or weather emergencies. In contrast, deliberative readiness is valuable for long-term farm planning, technology adoption and risk management strategies (Chavas & Nauges, 2020; Du et al., 2020; Lioutas & Charatsari, 2021). Successful farmers often possess the ability to switch between these readiness modes as circumstances dictate, ensuring effective decision-making and preparedness in a dynamic agricultural environment.

The crucial component is a person’s physiological state of readiness, which influences whether they believe a change will be for the better or is necessary to light their overall desire and mental preparations. Agriculture presents dangers and challenges that farmers must conquer and manage, but the impacts largely depend on how well farmers are able to manage risk or how well they can reduce the susceptibility that risk causes in them (Kahan, 2008; Wang & He, 2020). Farmers should learn risk management strategies and build barriers against future uncertainty (Bakar & Sum, 2020; Lopez-Ridaura et al., 2021). If these hazards are misdiagnosed and improperly managed, agricultural production will suffer and the farmers' income will decrease. Farmers who are equipped to handle agricultural challenges are better able to anticipate, avoid and react to imminent threats and shocks.

The relationship between farmers' knowledge and their readiness to effectively manage agricultural activities is a critical aspect of modern agriculture. Fairuz et al. (2018) and Demiryurek et al. (2008) emphasized the importance of knowledge in agricultural management. When farmers possess a high level of knowledge, they are more ready for decision-making. They can assess various options, consider potential outcomes and choose the most suitable course of action based on their understanding of agricultural practices. This readiness is crucial in agriculture, where decisions about planting, harvesting, pest control and resource allocation must be made at the right time for optimal results.

A common and important feature of agricultural systems in many nations is the reliance of farmers on government assistance, notably agricultural extension agents. Many agricultural difficulties can be addressed by using the resources, knowledge and experience that agricultural extension services offer. In order to help farmers manage their farms, educate them on problem-solving techniques, implement sound agricultural practices and disseminate useful information, extension agents are essential (Shah et al., 2013; Tamsah & Yusriadi, 2022). This is because high-quality agricultural extension agents will support rural farmers' problem-solving abilities.

Agricultural extension agents serve as valuable sources of knowledge and expertise, providing guidance and support to farmers. But in order for the agricultural industry to prosper and for farmers to achieve long-term sustainability, it is essential for them to actively empower themselves and put the knowledge they learn to use. Agriculture extension agents play a crucial role in supplying farmers with experience and knowledge. However, farmers who actively empower themselves, take ownership of the knowledge given and apply it to their farming situations are the ones who experience actual agricultural success. This strategy not only improves the performance of individual farms and preparing farmers to be ready to face any challenges but also helps to sustain and expand the agricultural industry as a whole.

2.12 Theoretical framework

A well-developed theoretical framework offers significant advantages in guiding and shaping research endeavors. According to Grant and Osanloo (2014), it establishes a structured approach for academics to conceptualize their research, addressing philosophical, epistemological, methodological, and analytical considerations.

Ravitch and Carl (2016) highlight that a solid theoretical framework helps researchers contextualize formal ideas within their studies. In the case of agricultural research, particularly in assessing farmers' readiness to confront challenges, the framework plays an essential role in connecting theoretical insights to real-world applications. This is particularly relevant in the context of agricultural extension services, where theory guides the understanding of how knowledge transfer, technology adoption, and capacity building can be enhanced to improve farmer resilience and productivity.

This study incorporates three interrelated models (Figure 2.6), the Farmers' Community Readiness Model (CRM), the Iceberg Model, and the Technology Readiness Index (TRI), forming a triangulated framework that enriches the research through diverse perspectives on farmer readiness. Theory triangulation, as Noble and Heale (2019) suggest, allows researchers to approach a complex phenomenon from multiple angles, providing a more nuanced understanding of the factors at play. The use of these models enables the study to contribute to the existing body of knowledge by clarifying the competencies and skills required for farmers to navigate challenges, particularly in the realm of agricultural extension and technology readiness. The findings build on these theoretical foundations to offer a comprehensive framework for evaluating the determinants of readiness among farmers, which has significant implications for policy and practice.

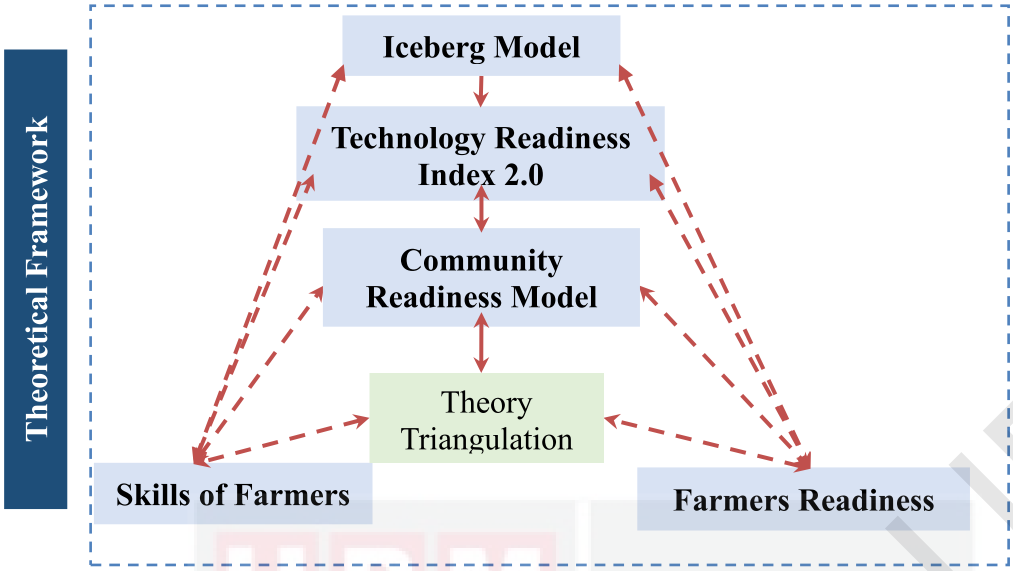

Figure 2.6: Theoretical framework

Agricultural extension services play a crucial role in equipping farmers with the knowledge and skills necessary to respond to challenges, including the adoption of new technologies. Extension services act as a bridge between scientific advancements and their practical application in farming. As Oakley and Garforth (1985) point out, agricultural extension is an ongoing educational process that equips farmers with the information, tools, and competencies they need to improve productivity. In the Malaysian context, extension services provided by both the government and private sectors play an instrumental role in disseminating technological innovations and best practices (Ali et al., 2018). By integrating technological readiness into the theoretical framework, this study not only addresses farmers' ability to adopt innovations but also contextualizes this readiness within the broader scope of agricultural development and extension services.

Farmers' readiness to embrace technology is shaped by a variety of factors, including the effectiveness of agricultural extension services, which provide crucial support during crises. In recent years, the agricultural sector has faced a range of catastrophes, from climate-related disruptions to economic shocks, which have highlighted the need for adaptive strategies and technologies. The extension agents, often serving as intermediaries, play a vital role in introducing these strategies and technologies to farmers (Ayantunde et al., 2020; Kathula, 2023). Through the lens of the Technology Readiness Index (Blut & Wang, 2019), the study examines how farmers perceive, accept, and implement new agricultural technologies, especially in the context of increasing challenges.

The incorporation of technology in agriculture has become more pronounced with advancements in digital tools, precision agriculture, and mobile-based innovations that allow for real-time decision-making (Mapiye et al., 2020). These developments in agricultural technology are essential for improving efficiency, reducing risks, and increasing yields. However, farmers' readiness to adopt these innovations depends on several factors, including access to extension services and their ability to integrate new knowledge into their existing practices. Extension services must evolve to accommodate this shift toward technology-driven farming practices, ensuring that farmers receive adequate training and support to adopt and sustain new technologies. In this study, the TRI provides a theoretical lens through which this readiness is assessed, focusing on how well-equipped farmers are to integrate "vegetable technology" and other innovations into their agricultural practices.

The study builds on a broader understanding of catastrophes by considering the diverse challenges that farmers face globally. For example, climate change has significantly altered weather patterns, increasing the frequency and intensity of droughts, floods, and storms, which directly impact agricultural productivity. Farmers must be prepared not only to respond to these immediate crises but also to adopt long-term strategies for resilience. The CRM, initially developed to assess community readiness for various social and health issues (Plested et al., 1998), is particularly well-suited to evaluating readiness in the agricultural sector. By integrating leadership and resource availability as key components, the CRM assesses farmers' capacity to take action in the face of these diverse challenges. In the agricultural context, this model helps to gauge how prepared farmers are to implement sustainable practices and adopt innovative technologies to mitigate the effects of climate-related catastrophes.

Similarly, the Iceberg Model, which links visible behaviors and outcomes to deeper layers of skills, competencies, and values (Spencer & Spencer, 1993), supports the exploration of the competencies required for farmers to navigate crises. This model provides a theoretical basis for understanding how underlying skills, such as decision-making, leadership, and technological competence, influence farmers' readiness to adapt to catastrophes beyond COVID-19. The theoretical framework guides the research in exploring how these competencies are cultivated through extension services and how they contribute to the overall readiness of agricultural communities.

The theoretical framework in this study plays a crucial role in shaping the research methodology and outcomes. As Lester (2005) points out, a robust theoretical foundation informs key methodological decisions, guiding researchers in selecting appropriate strategies, techniques, and procedures. In this study, the triangulated theoretical framework provides a comprehensive lens through which to examine the complex factors influencing farmer readiness. By incorporating the CRM, Iceberg Model, and TRI, the framework supports the research's focus on how farmers acquire, develop, and apply new skills in response to external challenges.

Furthermore, the theoretical grounding enhances the practical relevance of the study. In the context of agricultural extension services, the findings can inform the design of training programs and interventions aimed at improving farmers' readiness. For instance, extension agents can be trained to focus not only on the dissemination of technical knowledge but also on fostering leadership and decision-making skills, which are critical for resilience in the face of catastrophes. Additionally, by applying the Technology Readiness Index, the study highlights the importance of equipping farmers with the tools and knowledge they need to adopt new technologies, particularly in times of crisis.

This study's theoretical framework, which integrates the Farmers' Community Readiness Model, Iceberg Model, and Technology Readiness Index, offers a comprehensive approach to examining farmer readiness in the face of catastrophic challenges. By extending the scope beyond COVID-19, the research situates agricultural readiness within a broader global context, addressing a range of potential crises that farmers may encounter. The framework not only enriches the academic discourse on agricultural readiness but also provides practical insights for policymakers and extension agents aiming to enhance the resilience and productivity of farmers in Malaysia and beyond.

2.13 Summary of Literature Review

A review of the concept of agricultural extension, technology, implementation, leadership and decision-making skills has revealed that extension services go beyond transferring technologies to the farmers. Also, an overview of the Iceberg Model (1993), Community Readiness Model (2018), and Technology Readiness Index 2.0 (2015) was also provided to support the research framework of this study. How prepared and capable our farmers are of making the appropriate choices that will enhance their farming operations is the challenge. The provision of leadership development and assistance in decision-making for farmers is one of the main responsibilities of extension agents. This study focuses on how farmers' readiness to deal with catastrophe difficulties is influenced by technological level, implementation, leadership, and decision-making skills. This is because past research has found that a number of nontechnical or process skills have a significant impact on how prepared farmers are to deal with difficulties.

Furthermore, studies about the core and specialized skills of extension professionals and agricultural extension agents in Malaysia on the transfer of technology and human resource development are lacking, especially on how they cooperate with farmers in the current situation. This review seeks to explore theories on core skills and competency studies to determine their association with farmers' readiness. It proposes skills that agricultural extension services in Malaysia, mainly DOA, may find helpful to accomplish the goal of agricultural extension organizations. Therefore, extension agents must possess specific skills to perform technology transfer and human resources among vegetable farmers.

Last but not least, as the main player in agriculture industry, farmers must be skillful in technical areas of vegetable technology to develop their capacity and potential to adopt and practice the technology disseminated to them, especially during hard times (Nhuong and Truong, 2024). A review of the literature on the technology, implementation leadership and decision-making skills specified in this study revealed the importance of these skills for the farmers and their relationship to their readiness to face catastrophe challenges. This study attempts to verify further the contribution of these skills for farmers to be fully ready to overcome any future circumstances.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter presented the methodology used to achieve the objectives of the study. This chapter begins with discussions of research design, location of the study, population and sampling size, source of information, the instrument of the survey, collections of data, and techniques of data analysis. This study's primary source of information was scaled, which was employed in structured questionnaires and secondary data from published and unpublished journals and other relevant reading materials. The Statistical Package for Social Sciences (SPSS) version 26.0 and Smart-PLS software was used to analyze the results. Data analysis techniques employed in this study included descriptive, inferential, regression, correlation coefficient, and structural equation modeling.

3.2 Research Design

The research design outlines the methodological approach employed to address the research objectives, encompassing both the conceptual framework and the specific procedures for data collection and analysis. A well-articulated research design provides a structured blueprint that ensures all elements of the study are coherently organized to effectively address the research problem (Bryman, 2008). This study adopts a quantitative research design, characterized by its emphasis on objective measurement and statistical analysis. Quantitative research is particularly adept at examining relationships between variables through the generation and rigorous analysis of numerical data, thus allowing for hypothesis testing and the derivation of statistically significant insights (Babbie, 2015).

Specifically, the study employs a descriptive correlational design. This methodological approach integrates elements of both descriptive and correlational research to quantitatively describe data, establish relationships among variables, and predict potential future outcomes based on current findings (Stangor, 2011). Descriptive correlational research is particularly useful for investigating the interplay between multiple variables and identifying associations that may suggest causal relationships (Gogtay & Thatte, 2017).

In this study, the dependent variable is defined as farmers' readiness to face challenges arising from catastrophes. The independent variables include technological skills, implementation skills, leadership skills, and decision-making skills. To capture these variables, the study employs surveys as the primary data collection tool. Surveys provide a structured means of obtaining numerical data on farmers' attitudes, opinions, and trends through well-designed questionnaires or interviews (Babbie, 1990). This method enables the extrapolation of findings to a broader population, supported by existing research that validates the effectiveness of this approach in similar contexts (Mazlan, 2021; Abdul Halim, 2021; Olagunju, 2019; Ramle, 2012). As noted by Babbie (2015), correlational designs are particularly suited for quantifying the impact of independent variables on dependent variables.

The descriptive correlational design is employed to systematically characterize significant quantitative data, establish correlations between variables, and project future trends based on the current data (Stangor, 2011). Hopkins (2000) emphasizes that quantitative research designs effectively link independent and dependent variables within the study population, facilitating a comprehensive understanding of their relationships. Accordingly, this study utilizes a descriptive correlational approach to elucidate the quantitative relationships between farmers' readiness and their technological, implementation, leadership, and decision-making skills. This design aligns closely with the research objectives, offering a nuanced understanding of how these variables interact and contribute to agricultural resilience in the face of catastrophic events.

3.3 Conceptual Framework

A conceptual framework is a structured representation, either visual or verbal, that outlines the key components, variables, and relationships to be examined in a study (Miles & Huberman, 1994). It provides a clear depiction of how various variables are interconnected and serves as a "map" for the researcher to navigate the inquiry (Regoniel, 2015). In the context of this research, the dependent variable is farmers' readiness to face catastrophe challenges, while four main independent variables—technology skill, implementation skill, leadership skill, and decision-making skill—are hypothesized to influence this readiness.

The conceptual framework in this study demonstrates the relationships between the farmers' readiness and these key skills. Based on existing literature, farmers' readiness is significantly influenced by their knowledge and expertise in several areas: technology (Maciejczak & Faltmann, 2018), implementation (Leitão, Colombo & Karnouskos, 2016), decision-making (Ketteler, 2018), and leadership (Ulvenblad &

Bjorklund, 2018). Each of these factors is expected to contribute to farmers' ability to respond effectively to catastrophic events, such as natural disasters or market disruptions.

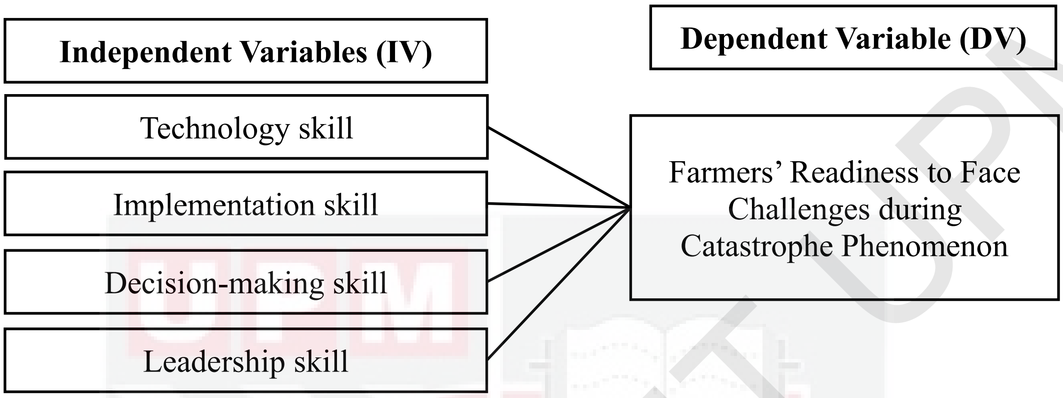

Figure 3.1: Conceptual framework showing the relationship between the skills of farmers and farmers' readiness

By visually mapping these relationships, the conceptual framework serves as a guide for examining how these independent variables—technology, implementation, leadership, and decision-making skills—affect the farmers' readiness to face challenges. This framework not only highlights the factors that will be explored but also provides a foundation for testing hypotheses and understanding the broader dynamics at play in agricultural resilience. Through this structured approach, the study aims to investigate how these skills interact and collectively influence the readiness of farmers, offering insights for enhancing their capacity to navigate future challenges.

3.4 Population

The target population for this study comprised vegetable farmers in Peninsular Malaysia who cultivated specific high-value crops. As noted by the Department of Statistics Malaysia (2020), mustard, spinach, water spinach, okra, long beans, and eggplant represent agricultural products with high per capita consumption in Malaysia. Leafy vegetables examined included mustard, spinach, and water spinach. The fruiting vegetables examined were okra, long beans, and eggplant. Focusing on farmers who cultivate these six perishables, short shelf-life vegetable crops aligns with the research aims. The target states and districts where these farmers operate are delineated in Table 3.1.

Table 3.1: Total Population of Selected Vegetable Farmers in Peninsular Malaysia

State	Number of farmers (Population)	Sample (n)
Johor	10,380	110
Melaka	658	7
Negeri Sembilan	1,229	13
Selangor	1,635	17
Perak	5,029	54
Kedah	1087	12
Pulau Pinang	569	6
Perlis	186	2
Pahang	11,166	119
Terengganu	686	7
Kelantan	3,155	34
Total	**35,780**	**381**

Source: Plant Statistics Booklet, Department of Agriculture (2021)

3.5 Sampling Size

Malaysian vegetable output increased by 0.9 % in 2020, with Pahang continuing to be the leading producer, accounting for 35.1 % of total production, followed by Johor (20.2%) and Kelantan (12.5%) (Department of Agriculture, 2021). According to Table 3.2, the planted areas of fruit vegetables are greater than those of leafy vegetables.

Based on the facts, it is possible to assume that fruit vegetable producers outnumber leafy vegetable growers in Malaysia. There is no data available on the organization of vegetable growers who cultivate green or fruity vegetables independently. The DOA states that farmers will likely plant both vegetables since they do not rely on a single crop type. The leafy vegetables in this study include mustard, spinach, and water spinach, while fruit veggies include okra, long beans, and eggplant.

Table 3.2: Production of leafy and fruity vegetables

Leafy vegetable	Production (mt)	Fruity vegetable	Production (mt)
Spinach	80,404.37	Okra	63,062.42
Sweet shoot	6,396.23	Chili	28,740.38
Spring Onion	6,661.48	Hot chilli	2,677.88
Celery	3,443.54	French bean	10,449.90
Chinese Kale	14,612.53	Long bean	60,158.13
Water spinach	42,822.22	Four-angle bean	5,144.89
Cabbage	91,389.07	Wax gourd	1,786.04
Chinese chives	3,071.61	Bottle gourd	5,325.97
Chinese cabbage	8,767.56	Pumpkin	21,759.34
Lettuce	75,546.04	Carrot	1,367.86
Brassica	153,270.82	Radish	4,552.40
		Bitter gourd	15,111.03
		Dwarf bitter gourd	4,689.24
		Angled loofah	17,165.95
		Snake gourd	2,598.34
		Brinjal	42,731.60
		Cucumber	96,353.06
		Tomato	186,662.63
Total (mt)	**333,114.65**	**Total (mt)**	**570,337.06**

Source: Plant Statistics Booklet, Department of Agriculture (2021)

The sample for this study was drawn from the target population of vegetable farmers using a simple random sampling method. Sampling involves selecting a representative subset from a larger population to gather data and draw inferences about the broader group (Lance & Hattori, 2016). The sampling frame refers to the group of individuals eligible for selection based on the study's criteria. Given that the sampling method directly impacts sample size estimates and overall accuracy, it is essential to determine the appropriate sampling strategy before data collection (Martínez-Mesa et al., 2016; Krause et al., 2011).

In this study, a simple random sampling approach was employed. This technique ensures that every individual in the target population has an equal probability of being selected, thus eliminating selection bias and enhancing the representativeness of the sample (Babbie, 2015). Simple random sampling was chosen to ensure each farmer in the population had an equal chance of inclusion, aligning with the study's objective of obtaining a representative sample. The criteria for selecting respondents in this study were: a) Vegetable farmers cultivating spinach, mustard, water spinach, okra, beans, or eggplant, b) Farmers utilizing the WhatsApp application for communication.

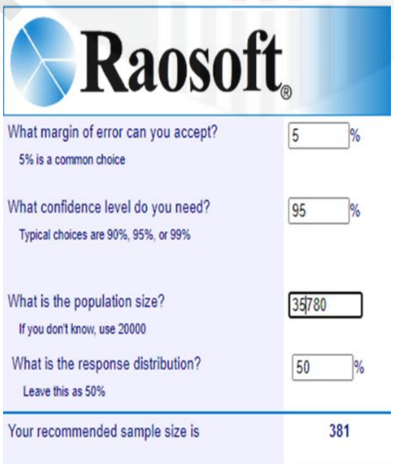

Figure 3.2: Sample size computation based on Raosoft Calculator Software
(Source: Adapted from raosoft.com – sample size calculator)

According to the Department of Agriculture (DOA) and the Ministry of Agriculture and Food Industries (MAFI), the target population meeting these criteria totaled 35,780 farmers. Raosoft's online sample size calculator recommended a minimum sample size of 381 to achieve adequate representation (Figure 3.2). The survey questionnaire was distributed to the entire target population via WhatsApp, with a link to a Google Form. To ensure a comprehensive and representative sample, the final sample size was increased to 503, surpassing the minimum requirement by approximately 32%. This enlargement of the sample size was strategic, enhancing the study's reliability, accuracy, and depth of analysis. By increasing the sample size, the study aimed to better capture the complexity and variability within the agricultural sector, providing richer insights into farmers' readiness and resilience. This approach supports the development of more effective policies and action plans, contributing to a deeper understanding of the sector's ability to adapt to challenges, including those beyond the COVID-19 pandemic.

3.6 Source of Information

3.6.1 Primary Data

Primary data for this study was collected directly from respondents using a structured questionnaire administered through an online and face-to-face survey. The questionnaire was distributed to a broad group of vegetable farmers and following the Exploratory Data Analysis (EDA) and Exploratory Factor Analysis (EFA) statistical processes, the total number of final responses was 503. This adjustment in the sample size ensures a comprehensive analysis that is more reflective of the agricultural sector's diverse perspectives, contributing to the robustness and relevance of the findings.

3.6.2 Secondary Data

The Department of Agriculture provided secondary data on vegetable farmer statistics. Additional secondary data on relevant concepts, models, and theories was gathered through the review of scholarly journals, articles, conference papers, and published research. Multiple information sources were leveraged, including online databases and library catalogues. This secondary data provided background context and supplemented the primary data collected through the farmer surveys.

3.7 Instrumentation

In this study, the questionnaire was utilized as the primary instrument for data collection, meticulously designed by adapting the questionnaire developed by Motolani et al. (2017) and Yusuf et al. (2017). These existing instruments provided a solid foundation, but significant modifications were made to tailor the questionnaire to the specific context of vegetable farmers, particularly considering the unprecedented challenges posed by the COVID-19 pandemic. The development of the questionnaire followed a structured process aimed at systematically capturing quantitative data, with each item carefully crafted to ensure clarity, relevance, and comprehensiveness in addressing the research questions.

To capture a wide spectrum of perceptions and attitudes, a six-point Likert scale was employed, ranging from "strongly disagree" to "strongly agree," thus allowing for a nuanced understanding of the respondents' views. The choice of a six-point scale was intentional, aimed at avoiding central tendency bias and encouraging respondents to take a definitive stance on each item.

The questionnaire’s validation process was rigorous, involving multiple stages to ensure the reliability and validity of the instrument. Initially, exploratory data analysis (EDA) was conducted to assess the distribution and patterns in the data, followed by exploratory factor analysis (EFA) to identify underlying dimensions and ensure the constructs measured were robust. Feedback from a pilot test was incorporated to refine the items further, and expert consultations provided additional insights to enhance content validity. This comprehensive validation process ensured that the instrument not only captured the essence of the challenges faced by farmers during the pandemic but also aligned closely with the study's theoretical framework and research objectives.

Surveys, as Kothari (2004) observes, are an effective tool for collecting data in a standardized manner, allowing for the quantitative measurement of complex constructs across a large sample. In this research, the survey methodology enabled the systematic collection of data from Malaysian vegetable farmers, providing a representative understanding of their catastrophe readiness. The questionnaire was rigorously reviewed by experts in agricultural extension, catastrophe readiness, and survey design, ensuring that it was methodologically sound and capable of yielding meaningful insights into the specific factors influencing farmers' resilience and readiness in the face of crises.

This process not only ensured the instrument’s accuracy in measuring the constructs of interest but also enhanced its applicability to the broader context of agricultural extension and technology adoption, particularly under the stressors of global challenges like pandemics and natural disasters. By incorporating expert feedback and pilot test results, the final version of the questionnaire was a finely tuned tool capable of generating valuable data on the readiness of farmers to cope with catastrophic events, thereby contributing to both academic understanding and practical implications for policy and extension services.

3.7.1 Questionnaire Design

The information required to accomplish the study's objectives was used in constructing the empirical research instrument. Closed-ended, six-point scale-based questions were the norm. The survey aims and research questions are used to build the questionnaire's items. The questionnaire's questions were all created in Malay. In addition, there were six sections in the questionnaire. Additional details on the developed instrument are disclosed as follows:

1) The first part of the questionnaire collects data on the respondents' demographic and farm profiles. Farmers' profiles contain six (6) items: location of the project, phone number, age, gender, race, and level of education. While the farm profile contains four (4) items on crop information, they include type of vegetables, My GAP certificates, type of guidance, type of extension services, and estimated income loss.

2) The second part of the study measures technical skills, represented by Section B, which contains seven questions. This section includes questions about vegetable production schedules, fertilizer application, disease and weed control, and phone and online marketing knowledge.

3) The third section is implementation skills. This section includes questions about vegetable planting, fertilizer application, plant disease, plant pest management, weed control management, and phone and web marketing skills. Seven questions on implementation skills are included in Section C.

4) The fourth part is leadership skills. There are seven questions in Section D about leadership ability. During the disaster, this section includes questions on planting schedules, fertilizer schedules, disease control, insect control, harvesting schedules, production schedules, and SOP.

5) The fifth part of the study is about decision-making skills. Plant production, plant disease management, weed control management, fertilizer management, and online marketing are all covered in this area. There are seven questions in Section E about decision-making ability.

6) The respondents' perceptions of the statements given in the questionnaire are measured using a six-point scale option (1=strongly disagree to agree 6=strongly). The sixth part of the questionnaire is about farmers' readiness. The questionnaire's last part, Section F, assesses farmers' readiness for catastrophe challenges and includes seven questions about project planning, implementation, and evaluation, becoming independent farmers, online communication in catastrophic events, and internet marketing in a catastrophic situation.

Table 3.3: Questionnaire Design

	Topics	Type of Questions	Descriptions	No. Question
A	Project Region	Closed-end	1. Project state 2. Project district	2
A1	Respondent Details	Open-ended & Closed-end	1. Respondent's phone number 2. Respondents' gender 3. Respondent's age 4. Academic qualification 5. Race	5
A2	Planting Details	Open-ended & Closed-end	1. Type of plants 2. MyGAP certification 3. Year of MyGAP certification 4. Type of guidance from DOA 5. Type of extension services from DOA	5
B	Technology	6-point scale	To measure the level of farmers' technology skills	7
C	Implementation	6-point scale	To measure the level of farmers' implementation skills	7
D	Leadership	6-point scale	To measure the level of farmers' leadership skills	7
E	Decision-making	6-point scale	To measure the level of farmers' decision-making skills	7
F	Farmers' Readiness	6-point scale	To measure the level of farmers' readiness to face catastrophe challenges	7

3.7.2 Response scale

A 6-point scale was utilized to measure the constructs in this study. Several justifications support the use of a 6-point scale. First, eliminating a neutral midpoint reduces respondent decision-making anomalies and demonstrates higher reliability compared to 5 or 7-point scales (Chomeya, 2010; Shia et al., 2016). Second, a scale without a midpoint suits the multidimensional variables examined and avoids overburdening respondents to answer the questionnaire. Prior empirical evaluations indicate that 6-point scales exhibit optimal tendencies for discrimination and reliability (Chomeya, 2010; Shia et al., 2016). Additionally, 6 and 11-point scales better approximate a normal distribution than 4- or 5-point scales, suggesting proximity to normality improves scale performance (Leung, 2011). Six-point scales also provide interpretable response options, transparent reporting of ambiguity, and understandable outputs for academic and business applications (Hewitt, 2014).

3.7.3 Validity of Instrument

To ensure the survey instrument accurately measures the intended constructs in this study, both face and content validity were rigorously evaluated. The questionnaire was reviewed by a panel of experts in agricultural extension and a representative from the Department of Agriculture to assess face validity through structured feedback templates. This provided qualitative input on how understandable, relevant, and representative the instrument items were for measuring the constructs of interest. To evaluate content validity, the survey was systematically examined to determine if the items sufficiently represented the content domains of each variable being measured based on the literature. As Elangovan and Sundaravel (2021) note, these validation processes are crucial in research to improve instrument quality.

For this study specifically, instrument validation enables accurate measurement of the relationships between farmers' catastrophe readiness skill (the dependent variable) and the corresponding independent variables of technology skill, implementation skill, leadership skill, and decision-making skill. As this research aims to understand how this particular skills influence farmer readiness to face catastrophe, robust instrumentation is key to precisely evaluating the connections between the variables within the context of Malaysian vegetable farmers. The in-depth validation processes helped optimize the questionnaire to fulfill the objectives of this research.

3.7.3.1 Face Validity

Face validity is a form of validity that evaluates whether an assessment tool or instrument seems, at first glance, to measure what it is meant to measure. The method commences with deliberations to elucidate the notion under examination and establish congruence with the selected construct. With guidance from the supervisor or expert, the researcher develops a questionnaire or survey designed to measure the intended topic. Feedback from the supervisor or expert is sought to ensure the questions are clear, relevant, and effectively capture the construct under investigation.

Based on this feedback, revisions are made to refine the instrument, such as adjusting wording or modifying question selection. Pilot testing with a small group of participants allows for further refinement and validation of the instrument. Throughout the process, the supervisor or expert provides guidance and oversight to ensure the instrument's face validity. Once finalized, the instrument is presented for final approval, with clear documentation maintained to track the evolution of the instrument and the collaborative process. By adopting a collaborative approach, the measurement instrument is able to precisely represent the intended construct, hence enhancing the validity and reliability of the research findings.

3.7.3.2 Content Validity

Content validity for the farmer readiness questionnaire was established through expert assessment of how adequately the instrument represented the catastrophe readiness construct and its sub-domains. As Almanasreh et al. (2019) note, content validation is crucial for instrument quality by verifying the appropriate coverage of the concept measured. Whereas face validity evaluates superficial appearance, content validity involves a deeper analysis of the relevance and representativeness of each item.

For this study, agricultural extension experts thoroughly reviewed the questionnaire content on technological, implementation, leadership, and decision-making skills pertaining to farmer readiness. Their feedback helped ensure a complete representation of the key catastrophe readiness elements, including capacity building, resource allocation, technology readiness, and social capital. Additionally, consultation with a subject matter expert from the Department of Agriculture supplemented this process.

Engaging content experts familiar with the complexities of the agricultural context enhanced the instrument's validity and relevance for the target population, as suggested by Schilling et al. (2007). Through collaborative development and expert validation, the questionnaire could effectively capture nuances specific to Malaysian vegetable farmers' catastrophe readiness. This rigorous approach to content validation strengthened the overall research quality and reliability of findings on how farmers' skills relate to their readiness. The involvement of extensionists from the Agriculture Extension Division, Department of Agriculture and experts from the Faculty of Agriculture, Universiti Putra Malaysia, provided multidimensional insights, contributing to robust instrumentation and study outcomes (Table 3.4).

Table 3.4: Content Validity

Construct	Comments and Recommendations
Construct 1	Extensionists from the Agriculture Extension Division suggested rephrasing questions for clarity. The expert from the Faculty of Agriculture, UPM, recommended adding a question on recent innovations.
Construct 2	Extensionists highlighted the need for more specific examples, such as specific guidance/services from extension agents to farmers.
Construct 3	Extensionists Agriculture Extension Division recommended simplifying language for farmers' understanding. The expert from the Faculty of Agriculture, UPM, advised adding a subsection for additional comments.
Construct 4	Extensionists proposed including questions on farmers' losses during MCO to specify the effect of the lockdown scenario. The expert from the Faculty of Agriculture, UPM, recommended validating the construct through focus groups for pilot testing.

3.7.4 Exploratory Data Analysis (EDA)

In addition to assessing the validity of the measurement instruments, exploratory data analysis (EDA) techniques were implemented to understand the characteristics of the dataset. Conducting EDA provided a comprehensive overview of the data prior to modeling, including checking the distributions of key variables, identifying outliers, and visualizing relationships. Specific EDA methods utilized included summary statistics of all variables, visualization of distributions through histograms and box plots, and generation of scatter plots to view bivariate relationships between variables. The EDA enhanced understanding of the data patterns, variability, and limitations.

The outcome of the thorough EDA was a deep familiarity with the quirks and nuances of the data. This guided the selection of appropriate analytical techniques for modeling by highlighting potential issues such as highly skewed distributions, outliers, and nonlinear relationships. The EDA also aided the interpretation of results by contextualizing findings within the data characteristics (Table 3.5). Overall, implementing exploratory data analysis was a vital precursor step to ensure effective modeling and valid conclusions.

Table 3.5: Exploratory Data Analysis

Outcome	Description
Data Summary	Total number of observations: 503
Missing Values	Identified missing values in variables: Correction on the double key in the value.
Correlation Matrix	Positive correlation between variable
Outlier Detection	Identified outliers in the Age variable using box plot and Tukey's method. Repair the cases as the is a mistake while key-in the data.
Assumption Testing	Tested normality assumption for variables using the Shapiro-Wilk test (p-value > 0.05), indicating normal distribution.

This table provides a concise overview of the key outcomes of the EDA conducted on the research data, including data summary, missing values, correlation matrix, outlier detection and assumption testing. It helps researchers to understand the characteristics of the dataset and make informed decisions for further analysis.

3.9.2 Exploratory Factor Analysis (EFA)

Exploratory factor analysis (EFA) was utilized as a multivariate statistical technique to identify underlying catastrophe readiness constructs measured by the questionnaire. As Haig (2014) notes, EFA isolates the minimum number of hypothetical factors that explain the covariation between observed variables. Originally developed by Spearman (1904), EFA is now widely adopted to validate instruments and evaluate theoretical structures, as evidenced by its use in key works by Henson and Roberts (2006) and Izquierdo et al. (2014).

For this study, EFA enabled the examination of the factor structure of farmers' readiness to determine the shared latent elements that account for the arrangement of observed catastrophe readiness variables. Specifically, it provided insight into the covariance between indicators of technological skill, implementation skill, leadership skill, and decision-making skill in relation to overall catastrophe readiness. Using EFA aligned with best practices for instrument validation and understanding the relationships between variables is crucial for evaluating the study's theoretical framework. It also supplemented the content and face validity processes in comprehensively assessing the measurement model prior to evaluating the structural relationships between farmer skills and readiness.

Before conducting exploratory factor analysis (EFA) to evaluate the factor structure of the catastrophe readiness questionnaire, the Kaiser-Meyer-Olkin (KMO) test for sampling adequacy and Bartlett's test of sphericity were performed. The results presented in Table 3.6 showed that the Kaiser-Meyer-Olkin (KMO) value was 0.954 ($p<0.001$), indicating high suitability of the data for exploratory factor analysis (EFA).

Additionally, Bartlett's test was statistically significant ($p<0.001$), further supporting the suitability of the data for EFA (Hair et al., 2010).

Table 3.6: Kaiser-Meyer-Olkin (KMO) and Bartlett's Test of Farmers' Readiness Constructs

Kaiser-Meyer-Olkin (KMO)	Bartlett's Test of Sphericity Approx. Chi-Square	df	Sign (p<.001)
.954	19979.787	595	.000

Next, an exploratory factor analysis of the items in the farmer's readiness instrument study was done to identify how the developed items are classified according to the structure of certain factors (Hair et al., 2010). In this study, the researchers maintained five factors for further action for the actual study sample. In this study, loading factors above .50 are considered significant for interpretation purposes and items with loading factors less than (<.50) are dropped from the study. Meanwhile, the communalities value for each item shows that each value is above .04, which is in accordance with the items in its components. The rotated Component Matrix for the study instrument can be referred to in Table 3.7.

Table 3.7: Rotated Component Matrix for Farmers' Readiness Instrument

Item	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Communalities
B1	.575					.500
B2	.778					.698
B3	.753					.685
B4	.809					.729
B5	.721					.639
B6	.786					.792
B7	.859					.806
C1		.787				.691

Table 3.7: Continued

C2	.828				.759
C3	.814				.773
C4	.817				.728
C5	.712				.667
C6	.809				.832
C7	.910				.873
D1		.583			.714
D2		.654			.798
D3		.699			.788
D4		.677			.743
D5		.582			.770
D6		.512			.630
D7		.467			.482
E1			.481		.483
E2			.678		.742
E3			.690		.728
E4			.674		.718
E5			.672		.676
E6			.700		.718
E7			.842		.798
F1				.817	.831
F2				.860	.889
F3				.845	.875
F4				.844	.862
F5				.840	.832
F6				.526	.594
F7				.795	.743

3.7.6 Pilot Test

Instrument reliability refers to its stability, internal consistency, and equivalence over time (Christodoulou et al., 2015). The reliability of the farmer readiness questionnaire was assessed through a pilot study with a small sample of the target population. As suggested by best practices, pilot testing allows preliminary evaluation of an instrument's appropriateness before broader implementation. Cronbach's alpha was calculated to examine the internal consistency reliability of the instrument by determining how closely the items relate as a group. Values of 0.7 or greater are considered acceptable (Gliem & Gliem, 2003). This pilot testing provided confidence in the reliability of the questionnaire for consistently measuring disaster readiness and associated skills. The high Cronbach's alpha across instrument subsections further validated its ability to measure the multiple constructs of interest reliably.

Table 3.8: Rule of Thumb to Interpret Cronbach's Alpha

Value of Cronbach's Alpha	Reliability
$\alpha > 0.9$	Excellent
$\alpha > 0.8$	Good
$\alpha > 0.7$	Acceptable
$\alpha > 0.6$	Questionable
$\alpha > 0.5$	Poor
$\alpha < 0.5$	Unacceptable

(Source: George and Mallery, 2003

A pilot study was conducted prior to full-scale data collection to pilot the catastrophe readiness questionnaire with a small sample representing the target population. The pilot sample consisted of 30 vegetable farmers in Peninsular Malaysia who completed the questionnaire in August 2020. Cronbach's alpha values were calculated and referred for each instrument subsection to assess internal consistency reliability (Table 3.8). The strong reliability evidenced by Cronbach's alpha values greater than 0.7 supported the appropriateness of the questionnaire for evaluating the relationships between these variables in the full study sample. Overall, thorough pilot testing procedures involving reliability analysis and a representative sample from the target population helped optimize the instrument prior to broader implementation (Table 3.9).

Table 3.9: Reliability Test of Instruments

Questions	Number of Items	Cronbach's Alpha	
		Pilot (n=30)	Actual study (n=503)
Independent Variables			
Part B Technology skill	7	0.756	0.918
Part C Implementation skill	7	0.670	0.911
Part D Leadership skill	7	0.931	0.920
Part E Decision-making skill	7	0.785	0.908
Dependent Variable			
Part F Farmers' Readiness to Face Catastrophe Challenges	7	0.907	0.940

3.8 Data Collection

Data collection for the study was methodically planned using a hybrid technique that skillfully incorporated the benefits of both online and in-person methodologies. This strategy strictly adhered to Kabir's (2016) that stated principles and processes, ensuring that the research technique was both robust and satisfied high academic rigour requirements. The hybrid method was chosen strategically, with the goal of increasing response rates while meeting the target population's different perspectives and accessibility difficulties. To supplement the online responses, physical print questionnaires were also administered directly by the research team. This component involved researchers, students and extension agents distributing surveys and collecting completed responses in-person during the visit to some farms. For respondents requiring assistance, team members provided explanations and guidance as needed to support completion.

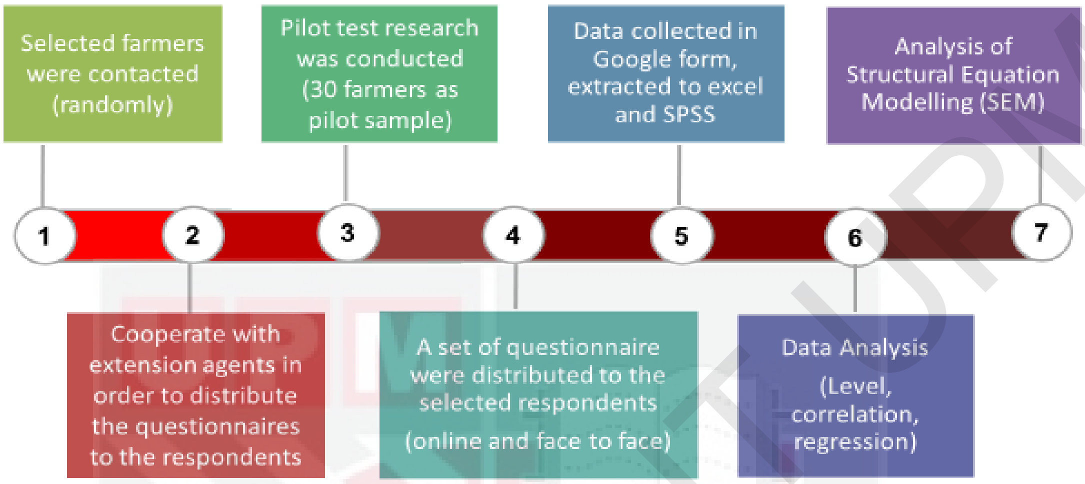

Figure 3.3: Data Collection Process

By integrating electronic and print modalities, this methodology enabled extensive sampling and participation across the target population. The online survey provided wide reach and accessibility, while the in-person administration ensured the inclusion of respondents with limited technical access or literacy. Blending these approaches allowed comprehensive data capture that was reflective of the diverse study community. The multi-faceted collection methodology was designed to obtain robust input and insights from respondents through their preferred or most accessible means.

The data collected for this study offers several strengths, including the comprehensive hybrid approach that combined online and in-person surveys, ensuring broad and diverse representation from the target population. The large sample size of 503 respondents surpassed the minimum requirement, enhancing the reliability and generalizability of the findings. Additionally, the data captured a wide range of variables, including technology, implementation, leadership, and decision-making skills, providing a holistic view of the factors influencing farmers' readiness to face catastrophe challenges. The data collection instruments underwent rigorous testing, ensuring their validity and reliability.

However, there are also some limitations to the data. The reliance on self-reported information could introduce biases, such as recall or social desirability bias, which may affect the accuracy of the responses. Furthermore, the study's cross-sectional design limits the ability to track changes in farmers' skills and readiness over time. Geographic constraints and potential response bias, particularly in the online survey, may have also led to underrepresentation of certain regions or farmers with limited technological access. These weaknesses highlight the challenges of obtaining fully representative and unbiased data in a study of this scope.

3.9 Data Analysis

SPSS software was selected due to its extensive capabilities for statistical procedures and hypothesis testing, making it well-suited for comprehensive analysis of survey data (Pallant, 2020). Specific techniques utilized included descriptive statistics for preliminary data review, correlation analysis to assess bivariate relationships, and multiple regression to evaluate predictive relationships between variables. SPSS software enables both basic and advanced analytical functions, providing the tools to investigate the research questions thoroughly from multiple angles. Key features, including data validation, graphical visualization, complex modeling functions, and flexible output reporting, facilitated a thorough examination of the data. The combination of reliability, flexibility, and sophisticated analytics available in SPSS was ideal for meeting the data analysis objectives of this study.

3.9.1 Descriptive Analysis

Descriptive statistical analysis was utilized to concisely summarize the survey data and provide an overview of the respondents (Trochim & Donnelly, 2008). Frequencies and percentages summarized categorical variables, while means and standard deviations described continuous variables. This preliminary analysis characterized the sample across key demographic factors and study constructs. Descriptive statistics enabled a quantitative profile of the respondents in terms of level of education, age, experience, and other relevant attributes. They also allowed assessment of the central tendency and variability of the main variables: technology skills, implementation skills, leadership skills, decision-making skills, and readiness. To further facilitate interpretation, the continuous measures were categorized into levels of "low," "moderate," and "high" based on calculated score ranges. This provided a snapshot of where respondents fell across these skill and readiness dimensions. The formula is written as follows:

$$\text{Level} = (\text{Max-Min}) / \text{Number of groups}$$
$$\text{Level} = (6 - 1)/3$$
$$= 1.67$$

The difference level value, according to the computation above, is 1.67. In light of this, the minimum and maximum mean scores at the low level are 1 and (1 + 1.67 = 2.67), respectively. The moderate level starts at 2.68 and goes up to 4.35 when 1.67 is added. Table 3.10 below displays the mean score value for each level.

Table 3.10: Level of skills

Mean score	Interpretation
1.00 – 2.67	Low level
2.68 – 4.35	Moderate level
4.36 – 6.00	High level

3.9.2 Correlation Coefficient Analysis

Correlation analysis was utilized to address the second research objective of examining the relationships between the key study variables. As a widely used technique, correlation coefficients quantify the statistical associations between two continuous variables (Schober et al., 2018). Specifically, Pearson's correlation coefficient (r) was calculated between each of the four skill variables (technology, implementation, leadership, decision-making) and the outcome of readiness. This assessed the direction and strength of the bivariate relationships. Pearson's r value ranges from -1 to +1, with larger absolute values indicating stronger correlations. A positive coefficient signifies the variables move in the same direction, while a negative value means they vary inversely. A correlation of zero means no linear relationship exists.

This benchmark helped assess the meaningful relationships between skills and readiness. Correlation analysis also provided fundamental insights into the paired relationships between variables as a precursor to multivariate regression modeling. Determining the correlation coefficients and their relative strengths established an initial evidentiary base for the impact of skills on readiness. Table 3.11 shows the size of the coefficients was categorized based on Guilford's rule of thumb for correlational strength (Guilford, 1956).

Table 3.11: Guilford Rule of Thumb

Size of Correlation	Interpretation	Strength
.91 to 1.00 (-.91 to -1.00)	Very high positive (negative) correlation	Very strong
.71 to .90 (-.71 to -.90)	High positive (negative) correlation	Strong
.51 to .70 (-.51 to -.70)	Moderate positive (negative) correlation	Moderate
.31 to .50 (.31 to 0.50)	Low positive (negative) correlation	Weak
.00 to .30 (-.00 to -.30)	Negligible correlation	Very weak

(Source: Hinkle, Wiersma & Jurs, 2003)

3.9.3 Regression Analysis

To a significant extent, regression analysis is utilized to forecast and predict. This was used to establish the study's third objective. It is done using regression analysis to understand which independent variables are thought to have anticipated or contributed to the dependent variable and the relationships between them. Multiple regression is used to estimate the coefficients of the linear equation when more than one independent variable best predicts the value of the dependent variable (Uyanik & Güler, 2013).

A linear regression analysis is carried out (dependent variable) to determine whether technical skills, implementation skill, leadership skill, and decision-making skill (independent variables) contribute the most to the farmers' readiness to deal with catastrophe challenges. Multiple regression is used in this research since there are more than two independent variables. Consequently, the relationship between independent and dependent variables is modelled using multiple regression (R=explained variance), a fundamental linear regression extension, to show the ability that contributes most to this relationship.

The regression equation may be completed after the beta coefficient has been determined. The ability of farmers to overcome difficulties following catastrophe problems is referred to as the dependent variable or Y. The independent variable, on the other hand, is X. The independent factors in this study include technology, implementation, leadership, and decision-making skills. The following are the formulas for multiple regression analysis models:

$y = b_0 + b_1X_1 + \dots + b_nX_n + \varepsilon_i$

y = dependent variable

b_0 = constant

X_n = independent variables

b_1 = regression coefficient

ε_i= error term

Multiple regressions analyze connections and forecast changes in the research variables in this manner. Multiple regression analysis was done to determine the relationship between the dependent variable and the independent variables mentioned below, generating the following equation:

$$Y = b_0 + b_1(X_1) + b_2(X_2) + b_3(X_3) + b_4(X_4) + \varepsilon_i$$

Where;

Y = Farmers Readiness

X_1=Technology Skill;

X_2=Implementation Skill,

X_3=Leadership Skill;

X_4=Decision Making

ε_i = Error term

3.10 Structural Equation Modelling (SEM) using Smart-PLS

Smart-PLS (PLS-SEM) software is one of the well-known programs for partial least squares structural equation modeling. This program was created by Ringle, Wende, and Will (2005). Structural equation modeling (SEM), a statistical technique, analyses structural models using latent variables (Meyers, Gamst & Guarino, 2016). SEM may be used to evaluate both structural and measurement models. The measuring model evaluates how well the relationships between the observed and expected variables match.

3.10.1 Construction Path Diagram Scheme

Structural Equation Modelling (SEM) was used to analyze the relationships between technology, implementation, leadership, decision-making skills and the readiness of farmers to face challenges. SEM integrates factor analysis and regression to examine connections between observed indicator variables and latent constructs.

The partial least squares (PLS) approach was utilized to estimate the parameters of the measurement and structural models. A visual path diagram was generated depicting hypothesized directional effects among the latent variables. Bootstrapping procedures were applied to derive standard errors and evaluate the statistical significance of the path coefficients. In this study, a bootstrap resampling routine was conducted. The no-sign changes option was selected, which provides a more conservative test of significance by not making distributional assumptions. The 95% bias-corrected bootstrap confidence intervals were examined to evaluate the significance of path coefficients at the $p<0.05$ level. Coefficients with confidence intervals not including zero were deemed statistically significant. The results revealed decision-making skill and leadership skill were significant positive predictors of farmers' readiness, as demonstrated by their path coefficients.

3.10.2 External Model

Convergent validity was initially examined when examining the measuring model for the latent dimensions of technological competence, implementation skill, leadership skill, decision-making skill, and farmers' readiness. The outer loadings of all indicator variables onto their respective latent factors were examined, with values exceeding the 0.70 threshold, indicating the observed survey items effectively measured the intended skills and readiness constructs.

Discriminant validity was then confirmed through the Fornell-Larcker criterion and cross-loadings analysis. The results demonstrated the distinct nature of the five latent variables related to farmers' skills and readiness in the model specification. Internal consistency reliability was quantified via composite reliability coefficients and Cronbach's alpha values. The calculated scores above 0.70 provided evidence of acceptable reliability across the constructs based on the observed items.

For every predictor variable in the regression model, Variance Inflation Factors (VIF) were computed in order to evaluate multicollinearity among the predictor variables. The Variance Inflation Factor (VIF) is a metric that quantifies the extent of multicollinearity by measuring the increase in the variance of an estimated regression coefficient caused by correlations with other predictors. A threshold value of 5 was used to identify predictor variables with high multicollinearity. VIF values exceeding this threshold were considered indicative of multicollinearity. Finally, average variance extracted (AVE) values exceeding the 0.50 guideline were obtained, confirming each latent variable accounted for a majority of the variance in its respective indicators versus measurement error. Satisfying these assessments of convergent validity, discriminant validity, reliability, and AVE supported the validity of the specified outer measurement model, aligning it with the theoretical framework regarding factors influencing farmers' readiness to face catastrophic challenges. This paved the way for robust analysis of the inner structural relationships**.**

3.10.2.1 Factor Loadings

The structured questionnaire was carefully designed to measure the latent factors related to technology skill, implementation skill, leadership skill, decision-making skill, and farmers' readiness. Data was collected from a sample of 503 vegetable farmers in Peninsular Malaysia, capturing their responses on a 6-point scale. During the SEM analysis, the measurement model specification linked the observed questionnaire items to their corresponding latent constructs. The SEM software computed factor loadings, which indicate the correlations between each item and its corresponding latent variable. In order to determine convergent validity, the factor loadings were assessed in relation to the suggested criterion of 0.7 or above. High loadings suggest that the observable variables are efficiently converging to measure the anticipated hidden factors. Items with low factor loadings may have been eliminated from the questionnaire to enhance convergent validity and improve the overall fit of the model. The provided factor loading scores were used to illustrate the validity and reliability of the assessment model. These robust factor loadings provide evidence that the structured questionnaire items are valid indicators of the theoretical skills and readiness constructs central to the study's model and hypotheses. This supports the rigor of subsequent SEM analysis examining the structural relationships between farmers' skills and their readiness to face challenges.

3.10.5 Composite Reliability (CR)

To assess the internal consistency reliability of the latent constructs, composite reliability coefficients were calculated using the formula:

Composite Reliability = (Sum of Squared Factor Loadings) /

(Sum of Squared Factor Loadings + Error Variance)

This provides a measure of how consistently the observed questionnaire items represent their respective latent factors, including technology skill, implementation skill, leadership skill, decision-making skill, and farmers' readiness to face challenges. Scores range from 0 to 1, with values closer to 1 indicating greater reliability. Thresholds of 0.70-0.80 are commonly used guidelines for acceptable composite reliability. Unlike Cronbach's alpha, composite reliability explicitly models measurement error and is, therefore, the preferred metric in SEM analysis. The composite reliability values obtained demonstrate the internal consistency and reliability of the latent variable measurement models based on their factor loadings and error variance. High composite reliability coefficients across the skills and readiness constructs provide evidence that the observed variables are quality indicators consistently representing their corresponding latent factors in this study.

3.10.6 Inner Model (Structural Model)

The inner structural model examined the hypothesized causal effects between the latent variables. Path coefficients quantified the relationships, while statistical significance testing evaluated the proposed causal links. The analysis focused on identifying the skills most influential in predicting farmers' readiness during catastrophes. The R^2 value indicated the amount of variance in readiness explained by the skills factors. The predictive relevance of the structural model was also assessed via Q^2.

3.11 Rationale Complementary Use of Ordinary Least Squares (OLS) and Maximum Likelihood Estimation (MLE) Regression Methods

Ordinary Least Squares (OLS) regression is widely regarded as a reliable estimation technique for linear regression analysis, primarily due to its capacity to minimize the sum of squared residuals, thereby producing a fit that aligns closely with the observed data. This technique is particularly advantageous for its interpretability and simplicity, offering coefficients that clearly illustrate the expected change in the dependent variable given a one-unit change in each predictor variable. This transparency is especially valuable for practical application, enabling clear communication of findings to a range of audiences, including those involved in agricultural extension and policymaking. Additionally, under standard regression assumptions—such as linearity, independence, homoscedasticity, and normality—OLS provides unbiased and consistent estimates, ensuring robust and reliable findings. Given the study's focus on assessing farmer readiness within a specific demographic, OLS's suitability for small to moderately sized datasets further support its use here, as agricultural research often encounters limitations in data availability.

On the other hand, Maximum Likelihood Estimation (MLE) regression offers a complementary set of strengths, particularly in more complex or non-linear modeling scenarios. The maximum likelihood estimation (MLE) of the ML method is efficient and has a less contrasting property, as well as a very important characteristic of stability and consistency (Bleed & Abdelali, 2018). In larger sample sizes, MLE becomes even more efficient, providing estimates with lower variance, which is advantageous when seeking to detect subtler relationships between variables, such as the nuanced impacts of leadership and decision-making skills on farmer readiness. Furthermore, MLE is widely used in structural equation modeling (SEM) due to its ability to handle latent variables and estimate multiple equations concurrently. Although the current study does not involve path analysis, the MLE approach provides a valuable robustness check to confirm that observed relationships, particularly those regarding decision-making significance, remain consistent when analyzed through an alternative computational approach.

In summary, employing both OLS and MLE in this study enriches the analysis by allowing for complementary insights. OLS serves as the primary analytical method, leveraging its interpretability and suitability for smaller datasets, while MLE functions as a robust check that validates the reliability of the findings under different estimation assumptions. This combined approach not only strengthens the study’s methodological rigor but also enhances the robustness of conclusions drawn about factors influencing farmer readiness, particularly in the context of developing skills relevant to agricultural resilience and extension programs.

3.12 Summary

This chapter thoroughly explained the data analysis methods utilized in this study and the methodology followed. Regression analysis, correlation coefficient, and descriptive techniques were utilized to achieve the study's objectives.

Table 3.12: Summary of the objectives and statistical tools employed

Objectives	Statistical tools used
i) Determine the level of technology skills, implementation skills, leadership skills, decision-making skills, and farmers' readiness to face challenges during the catastrophe phenomenon.	Descriptive Analysis. This involves measuring, describing, tabulating, ordering, and census the relevant data on farmers' readiness, technology, implementation, leadership, and decision-making skills using mean and standard deviation.
ii) Determine the relationship between technology, implementation, leadership, decision-making skills, and farmers' readiness to face challenges during the catastrophe.	This involves using Correlation analysis with the aid of Bivariate and Pearson's two-tailed significance tests.
iii) Determine the most important skills influencing farmers' readiness to face challenges during the catastrophe.	It involves using Multiple Regression Analysis and Structural Equation Modelling (SEM-PLS).

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter displays the findings' interpretation from the survey conducted. Four parts of the results are explained in this chapter; the first part will clarify the results for the demographic characteristics of the respondents. The findings of the population's descriptive analysis, which include the population's degree of technological skill, implementation skill, leadership skill, decision-making skill and farmers' readiness to cope with catastrophic difficulties, are explained in the second half. The results of regression and correlation between technological skill, implementation skill, leadership skill and decision-making skill concerning farmers' readiness to face difficulties in any catastrophe events were then presented. Last but not the least, the outcomes of structural equation modeling were shown.

4.2 Demographic Profile of Respondents

It is well known that demographic factors influence the farmers' readiness. The results were described based on gender, age, race, educational level and project location by state.

4.2.1 Gender, Age, Race and Educational Level

The gender composition of the respondents was 88.1% male and 11.9% female. It can be said that males dominate the agricultural industry. Commonly, farmers in Malaysia are mostly male because of their energy and responsibility to work. Besides, farmers' age distribution shows that the highest percentage are those between the age of 41 and 50 years old (25.4%). Farmers within this age range commonly has more experience than the younger ones who tend to do other jobs. Compared to their younger counterparts, older adults have more favorable attitudes toward their jobs, feel less unpleasant emotions and perceive their work environments more favorably (Kim & Kang, 2017; Luchman, Kaplan, & Dalal, 2012; O'Brien, 2022). Additionally, older workers perform better than younger workers; employment quality is higher for workers in nations with more centralized and coordinated wage-bargaining systems and stricter employment protection laws for regular workers. These institutions also tend to favor older workers' over those of younger workers (Arranz et al., 2019). Next, Table 4.1 also indicates that 69.6% of the respondents were Malay, 23.1% were Chinese, 3.2% were Indian and 4.2% belonged to other races. Most of the farmers were Malay compared to other groups.

Table 4.1: Gender, Age, Race and Educational Level

Variables	**Frequency**	**Percentage (%)**
Gender		
Male	443	88.1
Female	60	11.9
Age		
≤30	80	15.9
31-40	122	24.3
41-50	128	25.4
51-60	102	20.3
≥ 61	71	14.1
Race		
Malay	350	69.6
Chinese	116	23.1
India	16	3.2
Others	21	4.2

Table 4.1: Continued

Educational Level		
Primary school	78	15.5
Secondary school	237	47.1
Institute certificate	42	8.3
Diploma	67	13.3
Degree	79	15.7

Regarding the educational background of the respondents, Table 4.1 also indicates that 47.1% had completed secondary school. Approximately 37% of farmers have completed at least an institute-level of education. This shows that farmers, whose educational backgrounds are satisfying, could comprehend technology on a literate level. Farmers' opinions and educational levels in relation to technology adoption are influenced by various variables, including extension workers' expertise, the administration of the extension program and the physical surroundings of the area (Abdullah and Samah, 2013).

4.2.2 Respondents Project Location by States

The result indicates that the highest percentage of farmers comes from Pahang (25.25%) and Johor (23.06 %). Perlis has the lowest percentage of farmers (0.6%). The considerable difference in percentages between the highest and lowest states highlights regional disparities in the distribution of farmers. This could be due to various factors, such as land suitability for agriculture, economic opportunities and agricultural policies. Malaysia's vegetable production experienced a modest 0.9% growth. Among the states, Pahang emerged as the leading producer with a 35.1% increase, followed by Johor at 20.2% and Kelantan at 12.5%. The fruit-producing state in Malaysia, Johor, accounted for 36.0% of the total, with Pahang and Sarawak following suit at 13.1%

and 12.0%, respectively (Department of Statistics Malaysia (DOSM), 2021a).

Table 4.2 shows the respondents among the farmers under DOA's authority. The contribution of farmers is based on the number of total farmers by state location.

Table 4.2: Respondents Location by States

Variables	Frequency	Percentage (%)
Pahang	127	25.25
Johor	116	23.06
Perak	54	10.74
Kelantan	52	10.34
Selangor	42	8.35
Pulau Pinang	39	7.75
Melaka	21	4.17
Terengganu	21	4.17
Negeri Sembilan	15	2.98
Kedah	13	2.58
Perlis	3	0.60

4.2.3 Farm Profiles

Mustard, spinach, water spinach, okra, long beans and eggplant are Malaysia's selected agricultural commodities which have high value per capita consumption. Vegetable intake per capita is higher; as a result, these vegetables are in high demand in the market because customers favor them. Eggplant showed the highest percentage at 26.1%, followed by okra at 21.5%.

Table 4.3 also shows the year of respondents who owned their MyGAP certificate. The highest rate was from 2016 to 2019 (57.8%) and the lowest frequency was from 2005 to 2008, at only 8.6%. MyGAP was initiated in Malaysia in the year 2003. Thus, few farmers try to get the certificate during the early phase. However, as food safety becomes a tool to increase product quality and compliance with the legislation issue (Karaman et al., 2012), farmers need to practice MyGAP as a food safety control. Therefore, there were increasing numbers of farmers who applied for the certificate.

Table 4.3: Farm Profiles

Variables	Frequency	Percentage (%)
Type of Plant		
Eggplant	285	26.1
Okra	235	21.5
Long Beans	198	18.1
Water Spinach	138	12.6
Mustard	122	11.2
Spinach	115	10.5
MyGAP Certificates		
Yes	121	24.1
No	374	74.4
MyGAP Certified		
2005-2008	10	8.6
2012-2015	19	16.4
2016-2019	67	57.8
2020	20	17.2

The Malaysian Good Agricultural Practices (MyGAP) certification is essential to increase the value of the vegetables and the farm. In the respondent's status of MyGAP certificates, the majority of farmers do not have the MyGAP certificate. While for those with the certificate, the percentage is low, consisting of only 24.1%. MyGAP certification from DOA is necessary as the farm will comply with the pesticide and chemical residue procedure as set by the DOA. According to a study by Fam et al. (2019), to be certified with MyGAP, a farm must operate in an ecologically friendly and sustainably way, and provide high-quality and safe goods, according to the three critical characteristics of the MyGAP Farm Accreditation Scheme.

4.2.4 Types of Guidance from DOA

The highest type of guidance was fertilizer application, with a frequency of 303, representing 18.3% of total advice. The second highest was disease control, with a frequency of 281 and a percentage of 17.0%. Some farmers claimed that they do not receive any guidance from extension agents. Therefore, expanding access to extension officers could improve farmers' capacity for adaptation and ensure the efficacy of implemented practices (Agbenyo et al., 2022; Rahim, 2008). As a result, the responsibility of extension officers in transferring technology and technical ability to farmers to raise their production is critical to the success of extension services. They must thus provide various forms of assistance to improve farmers' capacity for farm work. For instance, agricultural extension agents in Ghana require capacity building in technical and communication skills, climate innovative agricultural interventions and information communication technologies to support smallholder farmers in managing climate risks and impacts effectively. Assessments of their capacity-building needs should be made regularly (Antwi-Agyei and Stringer, 2021).

Table 4.4: Types of Guidance from DOA

Type of Guidance from DOA	Frequency	Percentage (%)
Planting Schedule	154	9.3
Fertilization	303	18.3
Pest Control	235	14.2
Disease Control	281	17.0
Weed Control	221	13.4
Harvesting	180	10.9
Marketing	155	9.4
Others	125	7.6

4.2.5 Types of Extension Services from DOA

Fertilizer services received a significant proportion of extension services, with 306 farmers representing 36.2% of all respondents. According to the data summary, the proportion of fertilizer services is pretty significant compared to the other services. It is consistent with the prior data set's recommendations for fertilizer application. Farmers require technical assistance and agricultural incentive aids to expand their agricultural activities, and it is vital to provide technical training and assistance to farmers in upgrading their farm operations (Baqutayan et al., 2017; Xiang et al., 2020). Small farmers might benefit from receiving high-quality technical support if they can better match their production methods with regional possibilities, boost household income and livelihoods, and alleviate pressure on deforestation (Stabile et al., 2020). For example, Mwambi et al. (2020) and Hoffmann et al. (2019) agreed that a lack of knowledge and insufficient incentives are significant obstacles to enhancing food safety in developing countries. Therefore, extension agents must also emphasize the other services to farmers.

Table 4.5: Type of Extension Services from DOA

Type of Extension Services from DOA	Frequency	Percentage (%)
Fertilizer	306	36.2
Irrigation System	145	17.1
Land Preparation	114	13.5
No Assistance	114	13.5
Drainage	105	12.4
Fences	62	7.3

4.2.6 Estimated Profit Loss During MCO

During occasions such as MCO, logistical service disruptions and movement limits may have ripple effects on the agricultural supply chain, affecting farmers, customers, pricing and food security. Understanding these processes is essential to developing sensible solutions and more durable agricultural systems. Due to the interruption of logistical services and mobility restrictions during MCO, the link between agricultural produce and the ultimate consumer has been severed (Poudel et al., 2020). The expected profit loss suffered by farmers during MCO is shown in Table 4.6, with 173 respondents or 34.4% of the total, lost RM 5001 or more, representing the majority of respondents. According to Table 4.6, Peninsular Malaysia's vegetable farmers lost more than RM 5000 in revenue.

Table 4.6: Estimated Profit Loss During MCO

Estimated Profit Loss During MCO	Frequency	Percentage (%)
RM0 – RM1000	82	16.3
RM1001 – RM2000	76	15.1
RM2001 – RM3000	54	10.7
RM3001 – RM4000	70	13.9
RM4001 – RM5000	48	9.5
RM5001 and more	173	34.4

The findings showed that the COVID-19 pandemic impacts smallholder farmers' income and agricultural activities. Farmers express adverse effects on output, sales, pricing and incomes, according to Tamru et al. (2020), and most farmers claimed revenue losses and productivity reductions due to overstocked goods (Harris et al., 2020). Less income results from a scarcity of critical inputs as well. The majority of a farmer's revenue is reliant on their profit. MCO has impacted their income, which has impacted their everyday expenditures. COVID-19 endangers the financial security of both individuals and organizations (Sneader & Singhal, 2020). The pandemic threatens the global financial system and impacts health worldwide. Because of this, some economies are slowing down (OECD, 2020).

4.3 Level of Technology Skill, Implementation Skill, Leadership Skill, Decision-making Skill and Farmers' Readiness to Face Catastrophic Challenges

Farmers' readiness to tackle catastrophic challenges is influenced by their skill set. The premise is that farmers with the necessary skills are more likely to be prepared for and able to navigate such challenges than those lacking. Having the required skills is a crucial factor in determining readiness. This implies that farmers with the skills to handle various catastrophic challenges are better equipped to respond effectively. This study tested four variables: technology, implementation, leadership and decision-making skills. These variables represent dimensions that impact farmers' readiness to face catastrophic challenges.

This research examined the influence of these four variables (technology, implementation, leadership and decision-making skills) on farmers' readiness to handle catastrophic challenges. This study contributes to understanding how different skills relate to farmers' readiness. The findings could have practical implications for agricultural extension programs, policy-making and interventions to enhance farmers' abilities to face catastrophic situations. By testing the influence of technology, implementation, leadership and decision-making skills, this study aims to uncover which specific skills significantly impact farmers' readiness. This can guide strategies and efforts to empower farmers with the skills necessary to address and manage catastrophic challenges effectively.

4.3.1 Technology Skill

Table 4.7 indicates the frequencies, percentages, mean and standard deviations for all seven measurement items of the construct “technology skill” towards the readiness of vegetable farmers. Based on the table, half of the vegetable farmers (58.8%) have agreed and strongly agreed that “My knowledge level to use a phone for communication” (Mean = 4.52, SD = 1.31). It is indicated that the farmers know to use phones for communication. This also means farmers can communicate with extension agents via phone during pandemic or MCO. Thus, in any case of emergency or any problem, farmers can contact extension agents to ask for information or any term on the technical area of farming.

Additionally, a majority of the vegetable farmers (81.7%) have agreed (quite agree, agree and strongly agree) that “My knowledge level to determine the correct rate of vegetable fertilizer” (Mean = 4.43, SD = 1.069). This result showed that farmers understand how to apply fertilizer at the proper rate for various vegetables. In other words, farmers know the rate and quantity that plants require to grow faster and to their fullest potential. For example, the plant clinics in Rwanda are helpful to farmers as they increase their awareness and knowledge of identifying and handling their plants (Tesfaye et al., 2022). Small-scale farmers must understand the significance of technology usage of their plants for agricultural production as this can lead to higher yields compared to non-users and users (Silvestri et al., 2019; Sawe et al., 2020).

The lowest contributed item to measure technology skill towards vegetable farmers' readiness is “My knowledge level to market the products online” (Mean = 3.17, SD = 1.62). Despite this, some farmers (19.7%) agree that they are ready to market their products online. However, some farmers (24.3%) strongly disagree about their knowledge to market their products online. This result showed that even farmers with access to the internet and a phone do not always know how to advertise their goods online. Additionally, farmers with limited access to internet resources will find it even harder to advertise their goods online. Furthermore, age and reading level may have an impact on this knowledge. Age and education of farmers contribute to their lack of knowledge and resource capacity, which limits their adoption of newer agricultural technology and practices (Kumar et al., 2020; Michels et al., 2019; Serebrennikov et al., 2020; Yap et al., 2023).

Table 4.7: Distribution of readiness of vegetable farmers by technology (n=503)

Items	**Frequencies (%)**						**Mean**	**SD**
	1	**2**	**3**	**4**	**5**	**6**		
1. My knowledge level of using phones for communication	17 (3.4)	28 (5.6)	54 (10.7)	108 (21.5)	168 (33.4)	128 (25.4)	4.52	1.31
2. My knowledge level to determine the correct rate of vegetable fertilizer	7 (1.4)	11 (2.2)	74 (14.7)	153 (30.4)	182 (36.2)	76 (15.1)	4.43	1.069
3. My knowledge level of preparing the correct vegetable fertilization schedule	11 (2.2)	15 (3.0)	73 (14.5)	165 (32.8)	171 (34.0)	68 (13.5)	4.34	1.109

Table 4.7: Continued

My knowledge level to prepare a proper schedule for vegetable disease control	10 (2.0)	22 (4.4)	82 (16.3)	174 (34.6)	156 (31.0)	59 (11.7)	4.23	1.115
My knowledge level in preparing a schedule for weed control	13 (2.6)	30 (6.0)	93 (18.5)	135 (26.8)	161 (32.0)	71 (14.1)	4.22	1.223
6. My knowledge level in preparing vegetable production schedules according to the demand	29 (5.8)	23 (4.6)	100 (19.9)	178 (35.4)	116 (23.1)	57 (11.3)	3.99	1.26
7. My knowledge level of marketing products through online	122 (24.3)	59 (11.7)	98 (19.5)	99 (19.7)	88 (17.5)	37 (7.4)	3.17	1.62
Overall							4.13	0.936

Note. 1 = Strongly Disagree, 2 = Disagree, 3 = Not Agree, 4 = Quite Agree, 5 = Agree, 6 = Strongly Agree. SD = Standard Deviation.

From this research, the results show an acceptable level of farmers' perception regarding the contribution dimension of technology skills applied by farmers on the farm that will reflect their readiness to face catastrophic challenges. Table 4.8 indicates the detailed measurement items for technological skills.

As shown in Table 4.8, about 40.8% of the farmers reported the technology skill level as high. However, about 53.5% of the farmers reported the technology skill level as moderate. Nonetheless, the overall mean value of 4.13 (SD = .936) manifested that most farmers have knowledge and technology skills regardless of their readiness to face catastrophic challenges. In conclusion, the findings indicate that vegetable farmers are only somewhat prepared in terms of their understanding of the day-to-day operations of their farms. Some of the understanding, nevertheless, required more instruction and knowledge.

Farmers, particularly the younger generation, are interested in learning new technologies online because of today's modern technology. However, elderly farmers continue to rely on their wisdom and are helped by extension workers. Furthermore, farmers must first understand the technology skills they learned before any catastrophe. It is crucial to consider knowledge dissemination among farmers who have already accepted the new agricultural technology extension mode when directing farmers to use it and communicating this information to elderly and small-scale farmers (Alam et al., 2023; Gao et al., 2020; Landini, 2016).

Table 4.8: Distribution of readiness of vegetable farmers by technology (n=503)

Level of Technology skill	Frequency	Percentage (%)
Low (1.00 – 2.66)	29	5.8
Moderate (2.67 – 4.33)	269	53.5
High (4.33 – 6.00)	205	40.8
Mean = 4.13		
SD = 0.936		

4.3.2 Implementation Skill

Table 4.9 indicates the frequencies, percentage, mean and standard deviation for all seven measurement items of the construct "implementation skill" towards the readiness of vegetable farmers. Based on the table, half of the vegetable farmers (48.7%) agreed and strongly agreed that "My skill level of planting vegetables the right way" (Mean = 4.43, SD = 1.06). This indicated that farmers know how to plant and implement their skills by planting the vegetables correctly.

Additionally, a majority (83.7%) of the vegetable farmers have agreed (quite agree, agree and strongly agree) that "My skill level of applying vegetable fertilizer correctly" (Mean = 4.43, SD = 1.04). This result showed that the farmers were prepared to choose the best fertilizer for a particular crop. Typically, fertilizer packaging comes with usage instructions. Therefore, while applying fertilizer to their vegetables, farmers may turn to this resource. Instead of using time-consuming, conventional ways, farmers may select which crops are profitable and how much fertilizer to use accordingly, and it improves their knowledge and abilities while utilizing the input (Daadi and Latacz-Lohmann, 2021; Spandana and Pabboju, 2019).

The lowest contributed item to measure implementation skill towards vegetable farmers' readiness is "My skill level of marketing the products online" (Mean = 3.18, SD = 1.651). Despite this, some farmers (25.9%) agree that they have the skill to market their products online. However, some farmers (25.0%) strongly disagree about the skill level to market their products online. This result showed that not all farmers who have access to the internet are knowledgeable about how to advertise their products online or about the platforms they might use to do so. Most farmers and customers believe an online platform can make their operation even more accessible, so farmers should be trained to use the Internet for productive purposes. This will help more farmers, especially those with low skills and educational attainment, to use the Internet and positively promote their products.

Table 4.9: Distribution of readiness of vegetable farmers by implementation (n=503)

Items	Frequencies (%)						Mean	SD
	1	2	3	4	5	6		
1. My skill level in planting vegetables in the right way	9 (1.8)	9 (1.8)	64 (12.7)	170 (33.8)	175 (34.8)	75 (14.9)	4.43	1.06
2. My skill level in applying vegetable fertilizer correctly	7 (1.4)	9 (1.8)	66 (13.1)	177 (35.2)	169 (33.6)	75 (14.9)	4.43	1.04
3. My skill level in using a phone to communicate	21 (4.2)	32 (6.4)	66 (13.1)	121 (24.1)	157 (31.2)	106 (21.1)	4.35	1.341
4. My skill level in controlling weed	11 (2.2)	13 (2.6)	90 (17.9)	175 (34.8)	148 (29.4)	66 (13.1)	4.26	1.11
5. My skill level in identifying vegetable pests	12 (2.4)	24 (4.8)	95 (18.9)	171 (34.0)	144 (28.6)	57 (11.3)	4.16	1.145
6. My skill level in identifying vegetable diseases	21 (4.2)	13 (2.6)	99 (19.7)	163 (32.4)	151 (30.0)	56 (11.1)	4.15	1.184
7. My skill level in marketing the products online	126 (25.0)	58 (11.5)	86 (17.1)	103 (20.5)	90 (17.9)	40 (8.0)	3.18	1.651
Overall							4.14	0.905

Note. 1 = Strongly Disagree, 2 = Disagree, 3 = Not Agree, 4 = Quite Agree, 5 = Agree, 6 = Strongly Agree. SD = Standard Deviation.

From this research, the results mean that there is an acceptable level of farmers' perception regarding the contribution dimension of implementation skill applied by farmers in producing the vegetables from their farm that will reflect their readiness to face catastrophic challenges. Table 4.9 indicates the detailed measurement items for implementation skill.

Table 4.10 showed almost half (53.7%) of the farmers reported their implementation skill level as moderate. However, almost half (42.1%) of the farmers also reported the level of implementation skill as high. Nonetheless, the overall mean value of 4.14 (SD = .905) manifested that almost all the farmers are restrained by implementing their farming activities regardless of their readiness to face the catastrophic challenges. The results also showed that vegetable producers made every effort to carry out their daily routine during a challenging period to ensure their product could be grown and sold in a catastrophic scenario. Policies must force farmers to make their own risk management decisions and have access to a variety of tools and methods since smallholder farmers' susceptibility is sensitive to the minimal income needed to maintain daily living (Addala et al., 2022; Neisi et al., 2020; Zeleke et al., 2021).

Table 4.10: Distribution of readiness of vegetable farmers by implementation skill (n=503)

Level of Implementation skill	Frequency	Percentage (%)
Low (1.00 – 2.66)	21	4.2
Moderate (2.67 – 4.33)	270	53.7
High (4.33 – 6.00)	212	42.1
Mean = 4.14		
SD = 0.905		

4.3.3 Leadership Skill

Table 4.11 indicates the frequencies, percentages, mean and standard deviations for all seven measurement items of the construct "leadership skill" towards the readiness of vegetable farmers. Based on the table, in the third quarter, the vegetable farmers

(72.5%) agreed and strongly agreed that “My compliance level to follow the standard of procedure provided by the government during catastrophe situation” (Mean = 4.92, SD = 0.98). Farmers' understanding of catastrophe practices, such as pandemics, vulnerability and adaptation practices, could be improved by involving in various organizations, such as farmer associations and climate field schools (Hasan and Kumar, 2016; Vaishnavi et al., 2023).

Additionally, a majority (87.5%) of the vegetable farmers have agreed (quite agree, agree and strongly agree) that “My compliance level to harvest the produces according to the specified time” (Mean = 4.60, SD = 1.03). This finding demonstrated that the farmers are confident in deciding when to harvest their vegetables, even under challenging situations. The lowest contributed item to measure implementation skill towards vegetable farmers' readiness is “My compliance level to follow the vegetable crop schedule provided” (Mean = 4.25, SD = 1.185). Despite this, some farmers (31.6%) agree that they are ready to follow the vegetable crop schedule provided. In addition, only 4.2% of farmers strongly disagree about their compliance level with following the vegetable crop schedule provided. This finding indicated that most farmers comply with the vegetable crop schedule provided. From this research, the results mean that there is an acceptable level of farmers' perception regarding the contribution dimension of leadership skills applied by farmers that will reflect their readiness to face catastrophe challenges. Table 4.11 indicates the detailed measurement items for leadership skill.

Table 4.11: Distribution of readiness of vegetable farmers by leadership (n=503)

Items	Frequencies (%)						Mean	SD
	1	2	3	4	5	6		
1. My compliance level to follow the SOP provided by the government during MCO	2 (0.4)	7 (1.4)	36 (7.2)	93 (18.5)	212 (42.1)	153 (30.4)	4.92	0.98
2. My compliance level with harvesting the products according to the specified time	8 (1.6)	5 (1.0)	50 (9.9)	146 (29.0)	201 (40.0)	93 (18.5)	4.60	1.03
3. My compliance level to supply the products according to the schedule specified by the customer	9 (1.8)	13 (2.6)	69 (13.7)	150 (29.8)	180 (35.8)	82 (16.3)	4.44	1.104
4. My compliance level to follow the fertilization schedule provided	9 (1.8)	13 (2.6)	65 (12.9)	154 (30.6)	191 (38.0)	71 (14.1)	4.43	1.076
5. My compliance level to control weeds in the vegetable project area	11 (2.2)	9 (1.8)	80 (15.9)	163 (32.4)	179 (35.6)	61 (12.1)	4.34	1.075
6. My compliance level to control vegetable diseases	12 (2.4)	13 (2.6)	73 (14.5)	176 (35.0)	164 (32.6)	65 (12.9)	4.32	1.099
7. My compliance level to follow the vegetable crop schedule provided	21 (4.2)	16 (3.2)	72 (14.3)	159 (31.6)	176 (35.0)	59 (11.7)	4.25	1.185
Overall							4.47	0.903

Note. 1 = Strongly Disagree, 2 = Disagree, 3 = Not Agree, 4 = Quite Agree, 5 = Agree, 6 = Strongly Agree. SD = Standard Deviation.

As shown in Table 4.12, more than half (58.1%) of farmers reported the leadership skill level as high. In addition, about 38.8% of farmers reported their leadership skill level as moderate. Nonetheless, the overall mean value of 4.47 (SD = 0.903) manifested that almost all the farmers are developing their leadership and readiness to face the catastrophe challenges. To sum up, the analysis shows that the vegetable farmers are pretty ready in terms of leadership for almost all the activities in their farms.

Table 4.12: Distribution of readiness of vegetable farmers by leadership skill (n=503)

Level of Leadership skill	Frequency	Percentage (%)
Low (1.00 – 2.66)	16	3.2
Moderate (2.67 – 4.33)	195	38.8
High (4.33 – 6.00)	292	58.1
Mean = 4.47		
SD = 0.903		

4.3.4 Decision-Making Skill

Table 4.13 indicates the frequencies, percentage, mean and standard deviation for all seven measurement items of the construct "decision-making" towards the readiness of vegetable farmers. Based on the table, half of the vegetable farmers (58.3%) have agreed and strongly agreed that "My confidence level of deciding to choose the right type of fertilizer for vegetables" (Mean = 4.63, SD = 1.050). It is indicated that the farmers were ready to choose the right vegetable fertilizer. This also indicates that farmers know which fertilizers are best for different kinds of vegetables, influencing their decision-making when selecting fertilizers. This is why, given that farmers acquire pertinent technical training in advancing technologies with their farms as their sources of information (internal and external) may be considered throughout the whole decision-making process (Gonzalvo et al., 2020; Krah et al., 2019; Singh & Shrivastav, 2022).

Additionally, a majority (87.1%) of the vegetable farmers have agreed (quite agree, agree and strongly agree) that “My confidence level to determine the appropriate fertilizer rate for vegetables” (Mean = 4.54, SD = 1.042). This finding significantly demonstrated that the farmers are confident in applying the correct fertilizer rate that must be used according to the type of vegetables. This means farmers understand the fertilizer rate and usage that plants need to grow faster and, at best, in size. According to Ali et al. (2018), farmers who can make decisions effectively will inhibit wrong decisions. In addition, farmers must know the consequences of their decisions to avoid any problems. The lowest contributed item to measure decision-making towards vegetable farmers' readiness is “My confidence level of deciding to market the product online” (Mean = 3.39, SD = 1.651). Despite this, some farmers (22.1%) agree that they are ready to market their products online.

However, some farmers (21.5%) strongly disagree about their confidence in deciding to market their products online. This finding indicated that some of the farmers who have access to the internet were ready to market their products online; however, the farmers who have limited internet access will have difficulties marketing their products online. From this research, the results mean that there is an acceptable level of farmers' perception regarding the contribution dimension of decision-making skill applied by farmers in producing the best result from decisions made that will reflect their readiness to face catastrophe challenges. Table 4.13 indicates the detailed measurement items for decision-making.

Table 4.13: Distribution of readiness of vegetable farmers by decision-making (n=503)

Items	Frequencies (%)						Mean	SD
	1	2	3	4	5	6		
1. My confidence level in deciding to choose the right type of fertilizer for vegetables	7 (1.4)	6 (1.2)	51 (10.1)	146 (29.0)	186 (37.0)	107 (21.3)	4.63	1.050
2. My confidence level in determining the appropriate fertilizer rate for vegetables	8 (1.6)	8 (1.6)	49 (9.7)	164 (32.6)	185 (36.8)	89 (17.7)	4.54	1.042
3. My confidence level in deciding to continue vegetable production during a catastrophe	12 (2.4)	19 (3.8)	66 (13.1)	136 (27.0)	163 (32.4)	107 (21.3)	4.47	1.205
4. My confidence level in deciding to choose the right type of herbicide according to the type of vegetable diseases	9 (1.8)	16 (3.2)	59 (11.7)	164 (32.6)	168 (33.4)	87 (17.3)	4.45	1.112
5. My confidence level in deciding to choose the right type of weedicide according to the weeds	12 (2.4)	14 (2.8)	65 (12.9)	173 (34.4)	157 (31.2)	82 (16.3)	4.38	1.130
6. My confidence level in deciding to identify vegetable diseases	16 (3.2)	15 (3.0)	74 (14.7)	159 (31.6)	161 (32.0)	78 (15.5)	4.33	1.178
7. My confidence level in deciding to market the product online	108 (21.5)	47 (9.3)	91 (18.1)	111 (22.1)	92 (18.3)	54 (10.7)	3.39	1.651
Overall							4.31	0.945

Note. 1 = Strongly Disagree, 2 = Disagree, 3 = Not Agree, 4 = Quite Agree, 5 = Agree, 6 = Strongly Agree. SD = Standard Deviation

As shown in Table 4.14, almost half (48.5%) of the farmers reported the decision-making level as moderate. However, almost half (48.3%) of the farmers also reported the decision-making level as high. Nonetheless, the overall mean value of 4.31 (SD = .945) manifested that almost all the farmers are restrained by making decisions regardless of their readiness to face the catastrophe challenges. The findings also indicated that vegetable farmers are trying their best to make decisions in difficult times to ensure their products can be marketed offline and online to survive in a catastrophic situation. Farmers must first understand the technical skills they learned from extension agents before the catastrophe to make the best decision. Agricultural training and the growth of agricultural extension services will assist farmers in acquiring new technologies, improving their decision-making capacities in farm production and improving resource use efficiency (Karimov, 2014; Mappa et al., 2023).

Table 4.14: Distribution of readiness of vegetable farmers by decision-making (n=503)

Level of Decision-making	Frequency	Percentage (%)
Low (1.00 – 2.66)	16	3.2
Moderate (2.67 – 4.33)	244	48.5
High (4.33 – 6.00)	243	48.3
Mean = 4.31		
SD = 0.945		

In addition, enhancing the design of extension tools to provide information about the level of risk associated with anticipated results, as well as offering the ability to easily switch between low-risk and high-risk recommendations, will assist farmers in making more informed choices. This will lead to increased adoption of extension advice and greater efficiency in extension programmes (Antwi-Agyei, and Stringer, 2021; Nolte et al., 2022; Oyinbo, 2019).

4.3.5 Farmers' Readiness to Face Catastrophe Challenges

Table 4.15 indicates the frequencies, percentage, mean and standard deviation for all seven measurement items of the construct farmers' readiness to face catastrophe challenges. Based on the table, half of the vegetable farmers (58.3%) have agreed and strongly agreed that "My readiness level to lead myself after catastrophe phenomenon" (Mean = 4.51, SD = 1.179) is the highest. This indicates that the farmers' perception of themselves was ready to lead them to face catastrophe challenges.

Additionally, a majority (83.1%) of the vegetable farmers have agreed (quite agree, agree and strongly agree) that "My readiness level to be independent after catastrophe phenomenon" (Mean = 4.49, SD = 1.16) is the second highest mean. This finding significantly demonstrated that the farmers were confident they would be ready after the catastrophe. That is to say, the farmers understand the consequences and are ready to face them.

The lowest contributed item to measure farmers' readiness to face catastrophe challenges is "My readiness level to market the products online after catastrophe phenomenon" (Mean = 3.54, SD = 1.649). Despite this, some farmers (23.1%) agree they are ready to market their products online. However, some farmers (19.1%) strongly disagree about their readiness to market their products online. Additionally, those who have higher education levels, pursue skill development, run new agricultural operation entities (such as family farms and professional cooperatives) and practice agricultural entrepreneurship see a more significant impact of online purchases and sales on their participation in the digital financial market (Jie et al., 2022; Liu et al., 2021; Su et al., 2021). This emphasizes the need for specialized assistance and interventions to ensure that more farmers can use digital technologies in the agriculture industry.

From this research, the results mean that there is an acceptable level of farmers' perception regarding the contribution dimension of skills that farmers apply in producing the best result from decision-making that will reflect their readiness to face catastrophe challenges. Table 4.15 indicates the detailed measurement items for readiness to face catastrophe challenges.

Table 4.15: Distribution of readiness of vegetable farmers (n=503)

Items	Frequencies (%)						Mean	SD
	1	2	3	4	5	6		
1. My readiness level to lead myself after a catastrophe phenomenon	16 (3.2)	6 (1.2)	65 (12.9)	139 (27.6)	170 (33.8)	107 (21.3)	4.51	1.179
2. My readiness level to be independent after a catastrophe phenomenon	13 (2.6)	11 (2.2)	61 (12.1)	152 (30.2)	163 (32.4)	103 (20.5)	4.49	1.16
3. My readiness level to monitor vegetable projects personally after a catastrophe phenomenon	17 (3.4)	8 (1.6)	63 (12.5)	150 (29.8)	172 (34.2)	93 (18.5)	4.45	1.171

Table 4.15: Continued

4. My readiness level to implement the vegetable project by myself after the catastrophe phenomenon	15 (3.0)	15 (3.0)	65 (12.9)	148 (29.4)	170 (33.8)	90 (17.9)	4.42	1.183
5. My readiness level to plan my vegetable project after the catastrophe phenomenon	20 (4.0)	17 (3.4)	62 (12.3)	149 (29.6)	174 (34.6)	81 (16.1)	4.36	1.217
6. My readiness level to communicate online after a catastrophe phenomenon	49 (9.7)	34 (6.8)	74 (14.7)	118 (23.5)	141 (28.0)	87 (17.3)	4.05	1.506
7. My readiness level to market the products online after the catastrophe phenomenon	96 (19.1)	43 (8.5)	85 (16.9)	116 (23.1)	100 (19.9)	63 (12.5)	3.54	1.649
Overall							4.26	1.067

Note. 1 = Strongly Disagree, 2 = Disagree, 3 = Not Agree, 4 = Quite Agree, 5 = Agree, 6 = Strongly Agree. SD = Standard Deviation.

As shown in Table 4.16, almost half (48.3%) of the farmers reported the readiness level as high. Almost half (45.9%) of the farmers also reported the readiness level as moderate. Nonetheless, the overall mean value of 4.26 (SD = 1.067) showed that almost all the farmers are ready to face the catastrophe challenges. The data reveals that vegetable farmers' skill levels and characteristics, such as education, non-farm jobs and farming experience, considerably impact their adaptive ability.

Thus, school attainment, non-farm work and farming experience are key inducements to improve smallholder farmers' adaptive ability through various adaptation strategies (Marsden et al., 2023; Thinda et al., 2020). This indicates that measures to increase knowledge, boost non-farm income alternatives and encourage farming expertise will help smallholder vegetable producers adapt to environmental difficulties more effectively. Adopting diverse adaptation strategies is also considered a technique for increasing their resilience (Gemeda et al., 2023).

Table 4.16: Distribution of readiness of vegetable farmers (n=503)

Level of Farmers' Readiness	Frequency	Percentage (%)
Low (1.00 – 2.66)	29	5.8
Moderate (2.67 – 4.33)	231	45.9
High (4.33 – 6.00)	243	48.3
Mean = 4.26		
SD = 1.067		

4.3.6 Summary of Mean, Standard Deviation and Level between Technology, Implementation, Leadership and Decision-Making skills and Farmers Readiness

This study's first objective was to determine the level of technology, implementation, leadership, decision-making and farmers' readiness to face challenges and catastrophes. The overall mean of the farmers was categorized into three levels (low, moderate, and high). The ratings in Table 4.17 categorize farmers' readiness into three levels: low (1-2.699), moderate (2.670-4.339), and high (4.340-6.000). According to this scale, respondents' perceptions of readiness, technology adoption, and implementation skills fall within the moderate range, while leadership and decision-making skills are rated higher, nearing the high range. This suggests that farmers' preparation in terms of leadership and decision-making is relatively stronger, while readiness, technology, and implementation skills are still developing.

Table 4.17: Summary of Mean, Standard Deviation and Level between Technology, Implementation, Leadership and Decision-Making skills and Farmers Readiness

Skills	**Mean**	**Standard Deviation**	**Level**
Independent Variables			
Technology Skill	4.13	0.936	Moderate
Implementation Skill	4.14	0.905	Moderate
Leadership Skill	4.47	0.903	High
Decision-making Skill	4.34	0.945	High
Dependent Variable			
Farmers’ Readiness to Face Catastrophe Challenges	4.26	1.067	Moderate

***Level range: Low (1.00 – 2.669); Moderate (2.68 – 4.339); High (4.34 – 6.00)**

The mean scores across all variables are somewhat close to one another, indicating uniformity in the respondents' perceptions. This can be explained by the unit of analysis in this exploratory research, which focuses on vegetable farmers. The similarity in scores reflects a collective understanding of readiness within the context of vegetable farming. Farmers tend to share common experiences and challenges in the agricultural sector, which likely contributes to the homogeneity of their responses.

This uniformity suggests that farmers have a relatively consistent perception of readiness across various dimensions, including leadership and decision-making. These findings highlight the need for targeted interventions to further enhance readiness, particularly in technology adoption and implementation skills. By examining these perceptions, this study provides valuable insights into the patterns of readiness among vegetable farmers, which can inform both future research and practical applications.

4.4 The correlation between technology skills, implementation skills, decision-making skills, leadership skills and farmers' readiness to face challenges during a catastrophe phenomenon.

A Pearson product-moment correlation was conducted to assess the relationship between technological skills, implementation skills, decision-making skills, leadership skills, and farmers' readiness to face challenges during a catastrophe. The results, as shown in Table 4.18, indicate positive correlations between all the variables, with decision-making skills ($r = 0.751$) showing the strongest correlation, followed by implementation ($r = 0.668$), leadership ($r = 0.646$), and technology skills ($r = 0.633$).

This analysis is crucial as it reveals both the strength and direction of the relationships between independent variables (IVs) and the dependent variable (DV), helping to identify key factors that influence farmers' readiness. While these correlations provide insights into how various skills may relate to readiness, it is important to note that correlation does not imply causation. The findings serve as a baseline for further exploration, highlighting which variables may play a significant role in enhancing readiness, but without establishing direct cause-and-effect relationships.

Table 4.18: Correlation test of technology skills, implementation skills, leadership skills, and decision-making skills toward farmers' readiness (n=503)

Factors	Farmers' Readiness	
	Correlation Coefficient (r)	Sig. Value (p)
Technology Skill	0.633**	0.000
Implementation Skill	0.668**	0.000
Leadership Skill	0.646**	0.000
Decision-making Skill	0.751**	0.000

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

4.4.1 Technology skill

H1: There is a significant relationship between technology skills and farmers' readiness to face challenges during a catastrophe phenomenon.

Table 4.18 shows a statistically significant relationship between technology skills and farmers' readiness (r=0.633, p=0.001<0.025). The significant correlation was moderate and positive. Therefore, the research hypothesis H1 is accepted. Technology in agricultural practices has many advantages, as it helps smoothen agricultural management and practices. Technology can increase farm yields and make agricultural inputs more cost-effective. Technology can aid in developing agricultural automation for small-field farming, allowing for cheap cost, high efficiency and high precision (Prabha & Pathak, 2023; Tian et al., 2020; Zhou et al., 2021). Advances in agricultural automation, such as sensors, Internet-of-Things cameras, mobile applications and big data analytics, can result in the most efficient use of energy and the least amount of agricultural waste conceivable (Alam et al., 2023; Phasinam et al., 2022; Tiwari, 2022). As a result, all agricultural communities, particularly farmers, require advanced technological capabilities to improve farm management and increase output.

The literature highlights that technology plays a critical role in enhancing agricultural productivity and sustainability, particularly during crises such as the COVID-19 pandemic (Balogun, 2020; Bhuvanasri et al., 2022; Lioutas & Charatsari, 2020; Hashem et al., 2021). Previous studies emphasize the potential of innovative methods, including social media and mobile applications, to provide farmers with timely access to vital information and resources, while smart farming technology can help mitigate external shocks (Balogun, 2020; Lioutas & Charatsari, 2020). However, this research builds on those findings by addressing the effectiveness of these technologies among different groups of farmers, acknowledging that knowledge diffusion, particularly for elderly and small-scale farmers, may vary (Gao et al., 2020; Krithika & Karthikeyan, 2023).

In revisiting the literature, the study reaffirms the importance of involving farmers in the development of new agricultural technologies to fully leverage their expertise and meet diverse needs (Kahan, 2008; Kenny et al., 2021). This research adds to the discourse by exploring how technological skills influence farmers' readiness to face challenges, further contributing to policy recommendations aimed at inclusive technology adoption. By integrating insights from the literature, the findings underscore the need for targeted interventions that support knowledge diffusion and technological implementation across all farmer demographics.

The COVID-19 pandemic has underscored the need for agricultural resilience and the potential of smart farming technology to mitigate crises (Ghosh-Jerath et al., 2022; Lioutas & Charatsari, 2020). Farmers' readiness to adapt to change is crucial, and their ability to do so has been demonstrated during the pandemic (Darnhofer, 2020; Ebel et al., 2022; Safitri et al., 2022). However, the pandemic has also highlighted the need for a shift in agricultural strategies, emphasizing the importance of relations and processes in the system (Darnhofer, 2021; Nolte et al., 2022). Digital transformation, including precision agriculture and Agriculture 4.0, is a key component of this shift, offering solutions to global agricultural challenges (Alam et al., 2023; Dayioğlu & Türker, 2021; Sekabira et al., 2023). The results highlight the need for extension agents to be equipped with essential skills to enhance farmers' capabilities, consistent with Langemeier's (2018) assertion that maximizing input efficiency, adopting advanced technologies, and benchmarking production efficiency are critical steps in preparing farmers to face catastrophic events. This aligns with the study's findings that extension workers play a pivotal role in disseminating technology innovations, as emphasized during the COVID-19 pandemic (Abdullah et al., 2021; Jamil et al., 2023).

Farmers can adapt to a catastrophe by sharing skills and knowledge, technology and innovations, input supply, technical guidance and liaison roles with existing local institutions (Asare-Nuamah et al., 2019; Ebel et al., 2022; Safitri et al., 2022). Scaling up the technology will considerably contribute to farmers' resilience to the adverse effects of catastrophe by increasing household income and food security (Fentie and Beyene, 2019; Merchant et al., 2022). It is critical to increase farmers' knowledge and technological know-how about catastrophes and their effects, as well as to create effective adaptation and mitigation strategies and to build climate-resilient infrastructure in the agricultural sector (Bochtis et al., 2020; Lopez-Ridaura et al., 2022; Sekaranom et al., 2021). This will assist farmers in improving their ability to implement more catastrophe adaptation techniques, hence increasing farm productivity (Danso-Abbeam et al., 2021).

4.4.2 Implementation skill

H2: There is a significant relationship between implementation skills and farmers' readiness to face challenges during a catastrophe phenomenon.

There was a moderate, positive correlation between implementation skills and farmers' readiness (Table 4.18), which was statistically significant ($r = 0.668$, $p=0.001<0.025$). The research hypothesis (H2) of this study is accepted.

Farmers must have implementation skills to practice good farming management and practices. Maintaining implementation skills towards appropriate agricultural practices requires a high level of understanding. Farmers can reduce agricultural losses and boost revenue with a better implementation plan and management. Farmers can enhance crop productivity using tools and better irrigation infrastructure. At the same time, income and overall well-being can be increased through better ties to markets and new information sources made possible by agricultural innovation platforms (Chilundo et al., 2020; Shah, 2021). As a result, cooperatives should examine farmers' characteristics, implementation conditions and the effects of control measures when developing a long-term management strategy for improving food quality and safety and increasing market competitiveness (Zhou et al., 2019).

The study by Baqutayan et al. (2017) found that farmers who participated in programs designed to enhance agricultural production were more inclined to adopt technology on their farms. This suggests that education and training significantly improve technology adoption by equipping farmers with the necessary knowledge and skills. The findings underscore that successful farm operations and readiness are built upon a foundation of practical knowledge and its application. This is consistent with the research of Darnhofer (2021) and Bochtis et al. (2020), which highlights that knowledge enables farmers to adapt practices to their specific conditions, optimize resource use, and make informed decisions. Effective resource management and the application of best practices are crucial for enhancing resilience, particularly in the face of unforeseen challenges such as extreme weather events (Danso-Abbeam et al., 2021). These insights support the study's conclusion that informed implementation strategies are vital for improving readiness for catastrophes, thereby reinforcing the importance of education and practical training in agricultural technology adoption.

The basis for successful implementation is knowledge. Farmers must be aware of both the theoretical and practical details to ensure proper use of farming practices. Farmers can adapt their practices to local conditions and make educated judgments with knowledge. Farming operations can be made more efficient by using a well-organized implementation strategy and efficient management techniques. It supports optimal resource allocation, time management and input optimization for farmers. Effective implementation and management also help to reduce risk; therefore, farmers are better equipped to tackle unforeseen obstacles, such as extreme weather occurrences, when they adhere to best practices and efficiently manage their resources.

4.4.3 Leadership skill

H3: There is a significant relationship between leadership skills and farmers' readiness to face challenges during a catastrophe phenomenon.

The correlation between leadership skills and farmers' readiness was statistically significant (r=0.646, p=0.001<0.025) (Table 4.18). The significant correlation was moderate and positive. Therefore, the research hypothesis H3 is accepted.

Farmers with leadership abilities will adhere to the needs of planning and organizing a production farm and must manage themselves without outside assistance or instructions. They should organize all the work on their farm and be the primary mover without any guidance from outsiders. When developing future catastrophe policies for the agricultural sector, farmers' opinions must be considered to ensure the effectiveness of farm-scale implementation. Farmers' adoption of adaption measures is also probably influenced by succession planning and environmental values (Ivanov, 2021; Ruoso et al., 2019; Safitri et al., 2022).

The reviewed literature provides a foundation for understanding the critical role of leadership in enhancing agricultural performance and resilience. Isah's (2018) study highlights the significant impact of leadership abilities on performance potential, a finding further supported by Olagunju et al. (2019) and Isah et al. (2019), who demonstrate that effective leadership positively influences job performance. This is especially pertinent for farmers managing their farms and workforce during crises, where management attitudes and decisions critically affect welfare outcomes (Munoz et al., 2019). The success of farmer-producer organizations is also closely tied to leadership, emphasizing its role in organizational efficacy (Kumari et al., 2021). Additionally, the development of interpersonal leadership skills that foster trust is crucial for effectiveness (Englefield et al., 2021; Nadifa et al., 2023), while non-cognitive abilities, such as innovativeness, facilitate the adoption of climate change mitigation strategies (Kreft et al., 2021; Nezlek & Cypryańska, 2023).

Leadership not only drives self-improvement among farmers but also encourages the pursuit of new information, the use of advanced methods, and ongoing enhancement of practices. By integrating leadership qualities into farming, farmers can achieve better self-control, motivation, and management, which in turn positively impacts the broader agricultural sector. This review of the literature positions the current study within the context of existing research, underscoring the significance of leadership in optimizing agricultural practices and performance, and contributing to sustainable and profitable farming methods.

4.4.4 Decision-making skill

H4: There is a significant relationship between decision-making skills and farmers' readiness to face challenges during a catastrophe phenomenon.

There was a high, positive correlation between decision-making skills and farmers' readiness (Table 4.18), which was statistically significant ($r = 0.751$ $p=0.001<0.025$). The significant correlation was high and positive. Therefore, the research hypothesis (H4) of this study is accepted. Farmers skilled in decision-making can think critically and take the best course of action with the assurance of improving readiness. To make the best decisions to solve issues, farmers need more information and experience operating a farm and dealing with challenges in agriculture. For the distribution of benefits from the three study crops to reach smallholder farmers and better support their growth, such reforms must give them greater recognition and engagement in decision-making (Sakai et al., 2020). Understanding the justification and addressing the difficulties faced by agricultural producers will be beneficial in designing and formulating sustainable agriculture policies (Kasu et al., 2019).

Demiryurek et al. (2008) emphasize the pivotal role of agricultural knowledge in enhancing farm management. Access to information from extension agents, researchers, and other sources equips farmers to make well-informed decisions. To bolster farms' resilience to unforeseen events, it is crucial to develop training and advisory programs that reflect a nuanced understanding of farmers' attitudes and needs (Perrin et al., 2020). Furthermore, Motolani et al. (2017) highlight the significance of decision-making skills for human resource development, noting that such skills are essential for improving production and farm performance. Capacity-building initiatives and frequent interactions at farmer field schools can enhance smallholder farmers' ability to interpret visual forecasts, analyze data, and make informed decisions (Amarathunga et al., 2023; Kumar et al., 2021).

However, Rashidi et al. (2021) reveal that decision-making processes have been adversely affected by restrictions imposed during Movement Control Orders (MCOs), which have hindered effective communication and timely decision-making. The perishable nature of agricultural products exacerbates these challenges, particularly concerning logistics, marketing, and distribution. Thus, decision-making skills are cultivated through continuous knowledge acquisition about crops, market trends, and weather patterns. Education, practical experience, and critical thinking are fundamental to developing these skills, enabling farmers to improve their agricultural practices and address emerging challenges effectively. Langemeier (2018) further supports the need for extension agents to possess the competencies required to foster farmers' capabilities, including implementing efficient technologies, engaging consultants for complex issues, and monitoring production efficiency metrics. The COVID-19 pandemic has underscored the importance of enhancing extension workers' skills in technology dissemination, requiring heightened expertise, communication, and support (Abdullah et al., 2021; Jamil et al., 2023).

The study also draws attention to the need for a shift toward digital transformation in agriculture, echoing the arguments of Alam et al. (2023) and Dayioğlu & Türker (2021), who underscore the importance of precision agriculture and Agriculture 4.0 in addressing global agricultural challenges. By integrating technological innovations such as these, farmers can enhance their resilience, improve household income, and ensure food security, as supported by Fentie and Beyene (2019). The study's findings reinforce the idea that scaling up technology and fostering knowledge-sharing between farmers and local institutions significantly contributes to strengthening their capacity to withstand the adverse effects of catastrophes (Asare-Nuamah et al., 2019; Lopez-Ridaura et al., 2022).

Farmers must apply coping strategies in response to agricultural changes, but gaps in farmers' understanding and scientific understanding underscore the need for more effective knowledge-sharing and policy incentives (Peltonen-Sainio et al., 2020). It can provide practical support in management measures without rash judgments because it is possible to incorporate the expertise and experience of farmers with their fields (Vallentin et al., 2019). In order to increase smallholder farmers' ability to change through the adoption of various adaptation measures, school attainment, non-farm work and farming experience are significant incentives (Thinda et al., 2020). Farmers' knowledge and experience are valuable assets and involving them in decision-making processes can lead to more practical and successful solutions. Additionally, education, non-farm employment and farming experience are identified as key factors that enhance smallholder farmers' adaptive capacity in the face of changing agricultural conditions and challenges.

4.5 The Contribution Technology, Implementation, Leadership and Decision-Making skills towards Farmers Readiness

Farmers' capacity to respond to catastrophe challenges is the most critical factor affecting the dependent variable, which has been the regression study's focus. The third and final study goal was to find the finest skills that indicate farmers' readiness to deal with catastrophic issues. Four-dimensional skills were predicted for the multi-linear regression model to explain the variation in farmers' readiness to understand better on the factors that influence farmers' readiness. Technology skill (X1), implementation skill (X2), leadership skill (X3) and decision-making skill (X4) were the four skills. Consequently, the following is the first prediction equation used in this study:

$$Y = b_0 + b_1(X_1) + b_2(X_2) + b_3(X_3) + b_4(X_4) + \varepsilon_i$$

Where: Y = Farmers' Readiness

b_0 = Constant

b_1 = Estimates (Regression coefficients)

X_1 = Technology skill

X_2 = Implementation skill

X_3 = Leadership skill

X_4 = Decision-making skill

ε_i = Error

In order to examine the degree to which the data sustain the model, the enter regression method was used. Based on this method, only one variable factor was significant in explaining farmers' readiness to face catastrophe challenges, which was decision-making skill ($t=9.797$, $p=0.000$). As revealed in the coefficient (Table 4.19), the model coefficients estimated for b0 (0.404) and b4 (0.662). Thus, the estimated coefficients in the equation are given below:

$$Y = 0.404 + 0.662(X_4) + \varepsilon_i$$

By comparing the strength of one coefficient variable to another variable, the Beta value under standardized coefficients is used to compare the various strengths of each variable in the model. Beta values are measured in standard deviation and not in units of the variables. This means that when the result and variables are transferred to standard scores or z-scores before running the regression analysis, a beta value is to be obtained. The decision-making skill has the highest Beta coefficient, which is 0.586, as shown in Table 4.19. This demonstrates that the ability to make decisions is the most crucial talent that affects how prepared farmers are. When the estimate coefficients model is tweaked, however, the variation explained by the other skills is reduced. This demonstrates that improvements in decision-making ability led to increases in readiness of 0.586 standard deviations.

The estimated coefficient for the farmers' readiness model is shown in Table 4.19. Decision-making is important with farmers' readiness to confront problems during catastrophe phenomena; as shown in Table 4.19, the p-value obtained was 0.000, which was less than 0.05. Compared to other skills, decision-making has the highest Beta value of 0.586. As a result of the research, farmers' decision-making influences their readiness to handle issues in catastrophe challenges. Aside from that, farmers' readiness to tackle catastrophe difficulties was unaffected by technological skill, implementation skill or leadership skill, as the p-values for these three skills are more than 0.05, which is not significant. As a result, it does not contribute to farmers' readiness to address catastrophe challenges.

Table 4.19: Regression Analysis for Farmers' Readiness to Face Catastrophe Challenges

	Unstandardized Coefficients		Standardized Coefficients		
Model	**B**	**Std. Error**	**Beta**	**t**	**Sig.**
(Constant)	0.404	0.162		2.489	0.013
Technology	0.068	0.069	0.059	0.986	0.325
Implementation	0.126	0.079	0.107	1.584	0.114
Leadership	0.045	0.064	0.038	0.708	0.479
Decision-making	0.662	0.068	0.586	9.797	0.000

R= 0.758, R^2 = 0.574, Adjusted R^2 = 0.571, Std. Error of Estimate= 0.699

Considering the regression analysis results (Table 4.19) which demonstrate that three of the four skills did not significantly impact farmer readiness, it is crucial to emphasize that the lack of statistical significance does not negate the potential importance or contribution of these variables.

The inclusion of these variables was grounded in a thorough review of relevant literature and well-established theoretical frameworks, confirming their relevance in the field. While they did not achieve statistical significance in this study, several factors may explain this outcome. Firstly, the significance of variables is often influenced by contextual factors. For instance, the characteristics of the respondents, the specific sampling methods employed, and the timing of data collection can all play a role. It is possible that, during a period of stability in agricultural practices, variables such as technological skills and implementation skills did not emerge as significant because these factors may not have been immediately pertinent to farmers' current operational challenges.

Additionally, the temporal and situational dynamics of agricultural practices should be considered. The relevance of certain skills may change over time, particularly as the agricultural landscape evolves. Technological advancements, shifts in farming practices, or new challenges may increase the importance of skills such as technology adoption and implementation in future studies. Thus, the current study's findings are temporally and contextually specific, and these variables may become more significant under different circumstances.

Furthermore, the findings are context-specific, reflecting the unique conditions at the time of data collection. In other contexts, such as periods of rapid technological change or heightened agricultural uncertainty, these same variables may exhibit a stronger influence on farmer readiness. Therefore, their lack of significance in this study should not be interpreted as an indication of their irrelevance, but rather as a reflection of the specific context in which the research was conducted.

In conclusion, while the regression analysis indicates that three skills did not significantly affect farmer readiness in this study, their theoretical relevance and potential impact remain significant. The importance of these variables may vary depending on the context, timing, and methodological factors. Future research conducted in different settings or under evolving agricultural conditions may reveal different patterns of significance, underscoring the relevance of these variables in shaping farmer readiness in various scenarios.

Strategic decision-making is a crucial ability for farmers, particularly in the adoption of sustainable practices (Ali et al., 2018; Coteur et al., 2020). This process involves various steps, including assessment, interpretation, development of improvement strategies, implementation and results monitoring (Coteur et al., 2020). Factors such as personal knowledge, experience and management routines also influence farmers' decision-making (Morton, 2011). The increasing complexity of the agricultural sector has led to the development of new tools and the role of strategic advisers in supporting farmers (Krassadaki & Matsatsinis, 2016). The COVID-19 pandemic has further highlighted the need for effective decision-making in farming, as it has disrupted supply chains and market dynamics.

The proportion of the variance in farmers' readiness that the decision-making skill variable can explain is shown by the adjusted R^2 value of 0.571. In this instance, farmers' ability to make decisions accounts for about 57.1% of the variation in their readiness. The R^2 value (adjusted or not) gauges how well the regression model fits the data. It shows the extent to which the independent variable(s), in this case, decision-making ability, can account for the variation in the dependent variable (farmers' readiness). The decision-making skill may have a moderate impact on explaining the variable in readiness, according to an R^2 of 0.571.

The decision-making skill variable in this model does not account for the remaining 42.9% of the variance in farmers' readiness. This indicates that other factors at play contribute to farmers' readiness but were not included in this study. The unexplained factors could include various aspects such as socioeconomic conditions, external support systems, local climate conditions, access to resources, personal motivations and more. These unexamined factors might have substantial effects on farmers' readiness.

Additionally, the high R-squared value observed in the study indicates that a significant proportion of the variance in farmer readiness is explained by the predictor variables. However, the potential issue of multicollinearity is highlighted by the strong correlation between leadership and decision-making abilities ($r = 0.81$) and other high correlation values among predictor variables. To address these concerns, several diagnostic tests were conducted. Firstly, a normality test confirmed that the data follows a normal distribution, which supports the appropriate specification of the regression model and minimizes the likelihood of multicollinearity. Additionally, Variance Inflation Factor (VIF) analysis was performed to assess multicollinearity among the predictor variables. The VIF values, though approaching 3.5 to 4, remain within acceptable ranges, indicating that multicollinearity is not severe. Therefore, despite the high R-squared value reflecting robust explanatory power, the analyses affirm that multicollinearity is not a significant issue, thereby ensuring the validity and reliability of the regression results.

Recognizing the existence of unexplained variance underscores the need for future research to explore these additional factors. Understanding the holistic picture of farmers' readiness might require considering a broader range of variables in subsequent studies. In summary, this analysis provides important insights into the contribution of decision-making skills to farmers' readiness. However, the presence of unexplained variance highlights the complexity of the subject and suggests that other factors play a significant role in determining farmers' readiness to face catastrophe challenges. This acknowledgment opens avenues for further research and exploration in this area.

4.6 The Assessment of Outer Model and Inner Model

The association between farmers’ skills and readiness was examined using the partial least squares (PLS) methodology. PLS analysis’ measurement model (or outer model) step determines whether the theoretically stated construct is valid. The measurement model is validated to ensure that the instrument is valid and that the survey questionnaire defines the variables to be measured accurately. This method investigates factor loadings, composite reliability (CR) and Average Variance Extracted (AVE).

Construct Validity.

The construct validity of specific indicators can be verified by assessing the appropriate cross-loadings and factor loadings; loadings greater than 0.50 on two or more factors have been proposed to be significant (Hair et al., 2011). The fact that all indicators assessing a given construct in Table 4.20 have loadings greater than 0.50 on that construct and less than 0.50 on the others, supports construct validity. A previous study has suggested that the factor loading cut-off values should be more than 0.60 (Chin et al., 1997; Hair et al., 2011). The factor loadings for the 26 observed variables ranged from 0.772 to 0.937, with all values being positive and more than the specified value, according to an evaluation of the factor loadings for each item.

Convergent Validity (CR).

Convergent validity refers to the degree of agreement between many questions assessing the same idea. Factor loadings, the CR and the AVE can be used to determine convergence validity (Hair et al., 2011). At first, items were taken out to boost CR. These items included two indicators from the category of technology skill (B6 and B7), two indicators from the category of implementation (C6 and C7), one indicator from the category of leadership (D7), two indicators from the category of decision-making (E1 and E7) and two indicators from the category of farmers' readiness (F6 and F7). This technique was developed following the criteria stated by Hair et al. (2011). The author also proposed deleting items with loadings ranging from 0.40 to 0.70 from the measure if doing so can improve the overall reliability of the scales.

As a result of the deletion, all factor loading, CR and AVE values were more significant than the suggested cut-off values, demonstrating the convergence validity of the measurement model. CR is a measure used to assess the reliability or internal consistency of latent variables in a structural equation model (SEM). It helps determine how well the observed variables (indicators) that make up a latent variable are consistent in measuring that latent construct. Factor loadings represent the strength of the relationships between observed variables and their underlying latent constructs in the SEM. The trustworthiness of each composite dependability rating is evaluated based on its magnitude. According to the results, these ratings range from 0.775 to 0.958. These values exceed the permissible limit of 0.70, as suggested by Hair et al. (2011), which is a standard criterion for acceptable reliability.

Table 4.20: Outer Loadings

	Technology skill	Implementation skill	Leadership skill	Decision-making skill	Farmers' Readiness
B1	**0.772**	0.619	0.620	0.569	0.472
B2	**0.870**	0.747	0.680	0.687	0.501
B3	**0.843**	0.743	0.663	0.686	0.484
B4	**0.861**	0.768	0.708	0.700	0.487
B5	**0.838**	0.732	0.667	0.681	0.540
B6	0.577	0.488	0.326	0.361	0.348
B7	0.575	0.467	0.335	0.388	0.429
C1	0.713	**0.846**	0.702	0.678	0.489
C2	0.754	**0.878**	0.722	0.704	0.492
C3	0.743	**0.889**	0.712	0.756	0.561
C4	0.702	**0.870**	0.694	0.735	0.470
C5	0.682	**0.837**	0.716	0.737	0.577
C6	0.497	0.520	0.336	0.354	0.399
C7	0.496	0.478	0.318	0.375	0.418
D1	0.686	0.675	**0.838**	0.659	0.493
D2	0.714	0.719	**0.901**	0.728	0.539
D3	0.700	0.765	**0.892**	0.787	0.593
D4	0.701	0.767	**0.876**	0.759	0.586
D5	0.620	0.675	**0.881**	0.710	0.528
D6	0.592	0.606	**0.819**	0.656	0.570
D7	0.418	0.437	0.634	0.529	0.535
E1	0.465	0.475	0.562	0.694	0.588
E2	0.690	0.752	0.750	**0.895**	0.674
E3	0.664	0.743	0.743	**0.915**	0.636
E4	0.670	0.739	0.743	**0.888**	0.650
E5	0.651	0.700	0.723	**0.867**	0.552
E6	0.696	0.741	0.744	**0.883**	0.599
E7	0.542	0.503	0.410	0.508	0.490
F1	0.556	0.571	0.605	0.684	**0.922**
F2	0.552	0.582	0.613	0.692	**0.937**
F3	0.555	0.591	0.630	0.697	**0.929**
F4	0.547	0.577	0.631	0.685	**0.929**
F5	0.523	0.538	0.598	0.658	**0.917**
F6	0.457	0.487	0.409	0.493	0.663
F7	0.425	0.422	0.357	0.409	0.551

*** Loadings that are above the value of 0.70 are in bold.**

The fact that all the composite dependability ratings are above 0.70, indicates that the observed variables reliably measure their respective latent constructs. This strengthens the internal consistency of the measurement model and suggests that the indicators are consistent and dependable in representing the underlying latent constructs.

Table 4.21: Measurement Model

Construct	**Indicators**	**Outer Loadings**	**Cronbach > 0.708**	**Rho-a >0.708**	**CR[b] >0.708**	**AVE[a] >0.501**
Technology skill	B1	0.775				
	B2	0.898				
	B3	0.864	0.912	0.915	0.935	0.741
	B4	0.896				
	B5	0.867				
Implementation skill	C1	0.885				
	C2	0.904				
	C3	0.911	0.936	0.940	0.951	0.796
	C4	0.899				
	C5	0.862				
Leadership skill	D1	0.858				
	D2	0.911				
	D3	0.906	0.940	0.944	0.953	0.770
	D4	0.892				
	D5	0.879				
	D6	0.817				
Decision-making skill	E2	0.904				
	E3	0.937				
	E4	0.909	0.948	0.951	0.960	0.828
	E5	0.888				
	E6	0.910				
Farmers' Readiness	F1	0.931				
	F2	0.958				
	F3	0.952	0.970	0.970	0.976	0.892
	F4	0.947				
	F5	0.933				

[a] Average variance extracted (AVE) = (summation of the square of the factor loadings)/
{(summation of the square of factor loadings) + (summation of the error variances)}.

[b] Composite reliability (CR) = (square of the summation of the factor loadings)/{(square of the summation of the factor loadings) + (square of the summation of the error variances)}.

When measurement error is considered, the AVE is the final measurement to be studied since it tells how much of the variance in the observed variable is explained by the latent variable (Ramayah et al., 2013). According to Table 4.21, the AVE range for all constructions is greater than the minimum needed value of 0.50, ranging from 0.741 to 0.892 (Barclay et al., 1995).

Figure 4.1 depicts the findings of the measuring model.

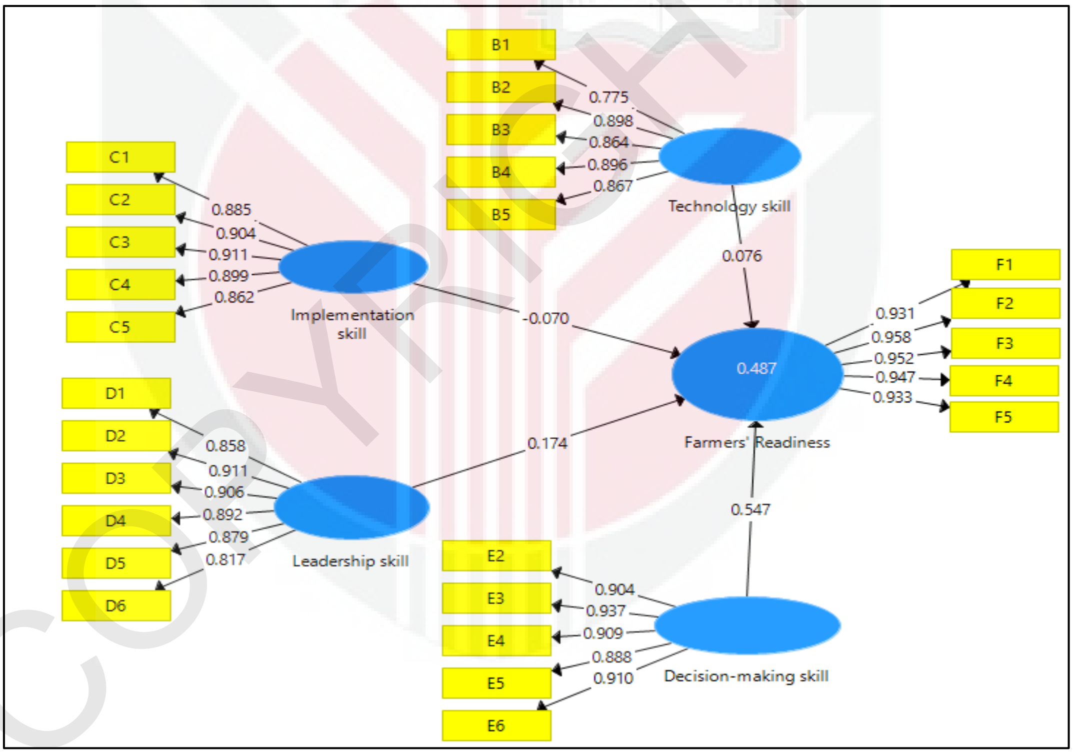

Figure 4.1: Outer model assessment

The data shows that all five constructs—technology, implementation, leadership, decision-making and farmers' readiness—are legitimate measures of their respective dimensions and are statistically significant at p<0.05.

Discriminant Validity.

The next stage in determining discriminant validity, or "the extent to which items differentiate across constructs or measure distinct concepts," is to compute and examine links between potentially overlapping variables' measurements (Al-rahmi et al., 2019; Ramayah et al., 2011). As a result, discriminant validity can be examined by comparing assessments of hypothetical overlapped constructs. Any construct's AVE must be larger than the sum of the squares of all connections to other constructs (Christmas, 2005). The proposed model has strong discriminant validity when the correlation between the components is less than the squares of the AVE (Fornell & Larcker, 1981).

In Table 4.22, the AVE square roots are compared with the correlations between the constructs. The statement asserts that all of the AVE square roots are greater than the correlations in the corresponding columns and rows. This finding suggests that each construct shares more variance with its indicators than with other constructs, indicating appropriate discriminant validity.

Table 4.22: Discriminant Validity

	Technology skill	**Implementation skill**	**Leadership skill**	**Decision-making skill**
Technology skill	**0.845**			
Implementation skill	0.772	**0.792**		
Leadership skill	0.756	0.768	**0.831**	
Decision-making skill	0.719	0.739	0.806	**0.863**

Note: The off-diagonals depict the variable correlations; meanwhile, the diagonals represent the square root of the AVE.

The results presented in Table 4.22 indicate that the measuring model has appropriate discriminant validity, as evidenced by the AVE square roots being greater than the correlations between constructs. This finding enhances confidence in the distinctiveness of latent constructs in the SEM.

Collinearity Statistics (VIF)

Table 4.23 provides insights into the presence of multicollinearity among predictor variables in the dataset, as indicated by their Variance Inflation Factors (VIF).

Table 4.23: Collinearity Statistics (VIF)

Variables	VIF
B1	2.023
B2	3.428
B3	2.998
B4	3.293
B5	2.693
B6	1.465
B7	1.470
C1	2.239
C4	2.559
C5	2.383
C6	1.384
C7	1.324
D1	2.560
D3	3.713
D4	3.497
D5	3.149
D6	2.361
D7	1.442
E1	1.470
E2	2.802
E4	2.645

VIF values exceeding a certain threshold, often set at 5 or 10, are indicative of multicollinearity. The identification of predictor variables with elevated VIF values, namely B2, B4, D3, D4 and D5, implies that these variables are highly correlated with other predictors in the model. High VIF values indicate that the variance of the estimated coefficients for these variables is inflated due to multicollinearity, which can lead to unstable parameter estimates and reduced predictive accuracy. Conversely, predictor variables with low VIF values, such as B6, B7, C6, C7, D7 and E1, exhibit minimal multicollinearity concerns. These variables are less correlated with other predictors in the model, resulting in more stable coefficient estimates and enhanced interpretability of their effects on the outcome variable.

Assessment of Inner Model

The next stage examines the structural model (inner model) by looking at the projected relationships between components of farmers' readiness (Figure 4.3).

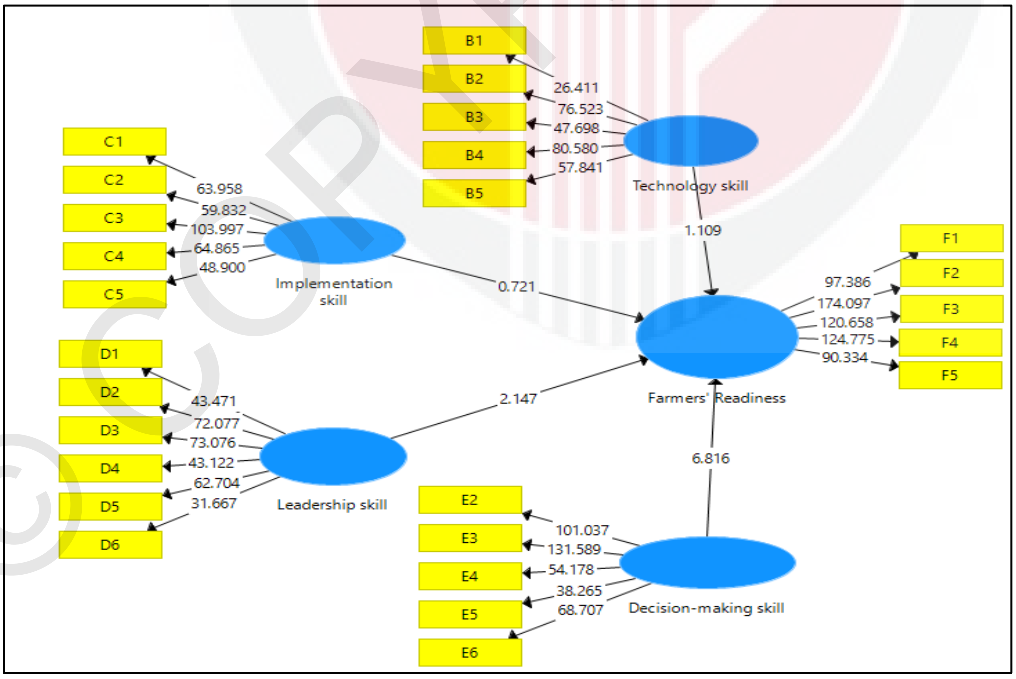

Figure 4.2: The inner model's graphic representation follows the bootstrapping process.

The coefficient of determination, or R2, for dependent variables, is also calculated to determine the degree of variation. Effect size (f^2) and predictive relevance (Q^2) were also evaluated. First, the weights or path coefficients of the associations were analyzed and evaluated for significance using t-values produced from the bootstrapping method.

Table 4.24: Structural model

Structural Construct	f^2	R^2	Q^2
Decision-making skill	0.147		
Leadership skill	0.016		
Farmers Readiness		0.487	0.431

The endogenous R^2 of 0.487 (Table 4.24) indicates leadership and decision-making skills account for 48.7% of the variance in farmers' readiness to face challenges. To assess effect size (f^2), the guidelines propose values of 0.02 as small, 0.15 as medium and 0.35 as large practical effects (Cohen, 1988). The results demonstrate a medium effect size for decision-making skill (f^2 = 0.147) and its moderate association with farmers' readiness. Leadership skill exhibited a small-to-medium effect size (f^2 = 0.016) and modest correlation with the outcome variable.

Predictive relevance was evaluated via Stone-Geisser's Q^2 statistic using blindfolding procedures (Vinzi, 2010; Hair et al., 2011). Q^2 values greater than zero signify the path model has predictive relevance (Stone, 1974; Hair et al., 2014). The Q^2 value of 0.431 for this model can be regarded as a significant level of out-of-sample predictive power. Overall, the explained variance, effect sizes and Q^2 value provide evidence of the structural model's substantial predictive validity and the key factors influencing farmers' readiness to confront challenges during catastrophic events.

Hypothesis Testing

Table 4.25 presents the path coefficients (β) and their corresponding significance values. The results show that two pathways were significant, while two were not. The relationship between leadership skill and farmers' readiness ($\beta = 0.081$, $t = 2.147$, $p = 0.032$) was significant, as was the relationship between decision-making skill and farmers' readiness ($\beta = 0.080$, $t = 6.816$, $p < 0.001$), supporting both hypotheses. However, the pathways from technology skill to farmers' readiness ($\beta = 0.068$, $t = 1.109$, $p = 0.268$) and implementation skill to farmers' readiness ($\beta = 0.097$, $t = 0.721$, $p = 0.471$) were not significant, indicating that these relationships were not supported.

Table 4.25: Construct hypotheses

Hypothesis	**Std. Deviation**	**T Statistics**	**p-values**	Decision
Technology skill -> Farmers' Readiness	0.068	1.109	0.268	Not supported
Implementation skill -> Farmers' Readiness	0.097	0.721	0.471	Not supported
Leadership skill -> Farmers' Readiness	0.081	2.147	**0.032**	Supported
Decision-making skill -> Farmers' Readiness	0.080	6.816	**0.000**	Supported

Table 4.26 also displays the hypothesis's strength and decision. The result showed that decision-making toward farmers' readiness was strong, with 70.0% of the relationship. At the same time, leadership skills showed a weak relationship with only 33.3% towards farmers' readiness. However, both constructs are accepted as they were significant ($p<0.05$) towards farmers' readiness.

Table 4.26: Strength and decision on hypotheses

Hypothesis	Construct	P<0.050	Relationship	Strength	Decision
There is a positive relationship between decision-making skills and farmers' readiness.	Decision-making skill -> Farmers' Readiness	0.000	70.0%	Strong	Accepted
There is a positive relationship between leadership skills and farmers' readiness.	Leadership skill -> Farmers' Readiness	0.032	33.3%	Weak	Accepted

The primary analysis of this study was conducted using SPSS to perform regression analysis and address objective 3, which sought to determine the significant contributors to farmers' readiness. OLS regression revealed that decision-making skills were a significant contributor, highlighting their role in preparing farmers to confront challenges in the agricultural sector. However, to strengthen the analysis and gain deeper insights, Structural Equation Modeling (SEM) using PLS was applied. MLE allows for the evaluation of more complex relationships between variables and provides additional rigor, especially in cases where latent variables are involved.

The use of MLE method analysis reinforced the significance of decision-making skills, aligning with the results from OLS regression. However, MLE also revealed a significant relationship between leadership skills and farmers' readiness, which was not evident in the OLS regression. This discrepancy between the two methods likely stems from MLE's capacity to account for underlying structures and relationships that traditional regression may not fully capture. As a result, MLE helped identify leadership skills as a critical factor in farmers' readiness, even though it did not appear significant in the OLS analysis.

The findings of this study highlight the critical role of decision-making skills as a consistent and significant predictor of farmer readiness in the face of catastrophic events, verified through both Ordinary Least Squares (OLS) and Maximum Likelihood Estimation (MLE) regressions. This outcome emphasizes that decision-making skills are crucial for farmers' preparedness, as they enable rapid and effective responses to complex challenges in farming (Ali et al., 2018). Ali et al. (2018) similarly underscores the importance of decision-making in allowing farmers to make well-informed choices that minimize adverse impacts on farm management, which is particularly important in crisis situations where swift adaptation is essential. Additionally, Demiryurek et al. (2008) found that farmers with strong decision-making capabilities are better equipped to identify and capitalize on emerging opportunities, navigate unforeseen circumstances, and address the intricacies of modern agriculture, reinforcing the conclusions of this study.

While decision-making skill was significant across both methods, leadership skill showed significance only in MLE regression and not in OLS. This discrepancy led to the rejection of the leadership skill hypothesis due to the inconsistency in verification, though the MLE result does suggest a potential relationship. Previous studies also support the potential impact of leadership on farmer readiness. For example, Ulvenblad et al. (2018) discuss how leadership development in agriculture is instrumental in motivating entrepreneurs, enabling them to enhance their skillsets and navigate broader societal and market demands. Leadership skills aid farmers not only in managing daily operations but also in fostering innovation, establishing industry networks, and addressing challenges (Ulvenblad et al., 2012; Milone & Ventura, 2019). This study supports previous literature by suggesting that while leadership skills may influence farmer readiness, decision-making skills demonstrate a stronger and more consistent impact.

Expanding on the importance of decision-making, studies such as Carter (2001) have highlighted the value of strategic decision-making in promoting creativity, fostering adaptability, and establishing strategic networks. This skill set allows farmers to implement informed decisions that contribute to the long-term sustainability of their farms, supporting strategic adaptation to market changes, and ensuring resilience. As Demiryurek et al. (2008) noted, effective decision-making enables farmers to respond to crises proactively, identify potential risks, and enhance the efficiency of farm operations. This aligns with our study's findings that decision-making is foundational to farmers' readiness, underscoring the importance of empowering farmers with tools that support timely and well-considered decision-making in challenging scenarios.

The theoretical frameworks used in this study—namely, the Iceberg Model, Community Readiness Model (CRM), and Technology Readiness Index 2.0 (TRI 2.0)—further elucidate the relationship between decision-making and leadership skills in fostering farmer readiness. The Iceberg Model, which posits that both visible and hidden factors influence outcomes, is particularly relevant here. While technology and resources represent tangible factors, it is the less visible aspects—such as decision-making and leadership—that play a more crucial role in preparing farmers to face catastrophic events. The model reinforces the idea that foundational elements like strategic alignment and effective decision-making are essential for resilient farm management, especially in crises.

The Community Readiness Model (CRM) complements this perspective by stressing the importance of leadership, knowledge, and resources in assessing readiness. Studies by Ivanov (2021) and Safitri et al. (2022) highlight that proactive leadership within agricultural communities fosters resource mobilization and guides community members through agricultural challenges. This model emphasizes that leadership plays a critical role in guiding farmers to access essential information and resources, thereby enhancing their capacity to handle adversity. While leadership did not show consistent statistical significance in this study, CRM supports its potential relevance in building community resilience and preparing farmers for future challenges.

Technology also plays a supporting role in farmer readiness, as illustrated by the Technology Readiness Index 2.0 (TRI 2.0), which examines factors such as trust, accessibility, and ease of use. Although decision-making and leadership emerged as more prominent determinants of readiness, technology adoption remains essential for long-term resilience. Studies by Sekabira et al. (2023) and Alam et al. (2023) emphasize that farmers' willingness to adopt technology is influenced by its usability and the degree of trust they place in it. This framework suggests that while decision-making is immediately crucial for facing catastrophic events, technology adoption is key to building sustainable farming practices that improve readiness over time.

Comparing these findings to prior research, this study reveals that leadership, and decision-making skills may take precedence over technology adoption in preparing farmers for immediate crises. Studies such as Langemeier (2018) and Abdullah et al. (2021) previously emphasized technology as a primary driver of readiness; however, our study suggests that in the context of smallholder farming during catastrophes, decision-making and leadership skills may play a more direct role. This divergence from previous literature suggests the need for context-specific research, as determinants of readiness can vary based on agricultural, cultural, or regional differences.

From a practical standpoint, the study's results underscore the importance of agricultural extension services in enhancing farmers' decision-making skills. Agricultural extension programs play a crucial role in equipping farmers with strategic skills that improve resilience. By providing farmers with targeted training that focuses on decision-making skills, extension services can enhance their capacity to manage their operations independently and make informed choices during crises. This aligns with research by Langemeier (2018) and Abdullah et al. (2021), which emphasizes that extension agents should go beyond technical support and focus on enhancing farmers' managerial and strategic skills.

In addition, agricultural extension must adapt to the specific contexts of various farming communities, as differences in crop types, farming practices, and regional conditions affect farmers' needs. Extension services tailored to the unique challenges faced by vegetable farmers, for example, can help address skill gaps and foster resilience. This study suggests that extension agents should actively work with farmers to identify their specific needs and provide contextually relevant support, as recommended by Darnhofer (2021) and Alam et al. (2023), who stress the importance of flexible and context-specific agricultural extension programs.

Furthermore, while technology adoption was not consistently significant in predicting readiness in this study, it remains essential for long-term resilience, as emphasized by Fernandez-Cornejo et al. (2007) and Bock (2004). Their research indicates that digital agriculture and precision farming offer valuable tools for optimizing productivity and mitigating risks. As farmers continue to adapt to evolving market conditions, extension services can play an instrumental role in providing technology training that aligns with farmers' decision-making capabilities, thereby enhancing readiness through a combination of immediate and long-term strategies.

The integration of both short-term and long-term strategies in agricultural extension programs is essential for promoting effective farm management and resilience. Studies such as Ruoso et al. (2019) and Jamil et al. (2023) underscore the benefits of a balanced approach, where farmers are equipped not only with immediate decision-making tools but also with technological resources to adapt over time. Our study supports this view, suggesting that comprehensive extension services focused on both decision-making and technology are necessary to prepare farmers for current and future challenges.

In conclusion, this study contributes to the academic discourse on agricultural readiness by demonstrating that decision-making skills have a more immediate impact on farmer readiness. By drawing on theoretical frameworks such as the Iceberg Model, CRM, and TRI 2.0, this study offers a holistic perspective on how the factors interact to enhance farmer readiness. These findings carry significant implications for agricultural extension, training programs, and policymaking, calling for interventions that prioritize decision-making skillstraining, as well as technology literacy. Future research should continue exploring the complex interplay between these skills across different agricultural contexts to advance our understanding of farmer readiness and resilience in the face of catastrophes.

The study offers critical and novel insights into agricultural readiness by demonstrating that while technology adoption plays a significant role in ensuring long-term resilience, decision-making skills have a more immediate and substantial impact, especially during crises. The findings highlight that decision-making skills are a consistent and significant predictor of farmer readiness, underscoring their critical role in navigating urgent challenges. This nuanced understanding challenges previous research that has predominantly emphasized technology as the primary driver of agricultural readiness, suggesting that while technology is essential for long-term sustainability, the ability to make timely, informed decisions is crucial in crisis situations.

Interestingly, leadership skills showed a potential relationship with readiness in some contexts but did not emerge as a consistent predictor across both regression methods, which indicates that leadership's impact may be more context-dependent and less robust compared to decision-making skills. This highlights that while leadership is important, its influence on immediate crisis readiness may not be as straightforward or universally applicable as decision-making.

Farmers' resilience and proactive adaptation are central themes in the study. The evidence reveals that farmers are not only aware of the importance of acquiring skills and knowledge but are actively seeking additional training and diversifying their marketing strategies to ensure the survival and success of their agricultural operations. This proactive approach underscores their strategic thinking and awareness of the dynamic nature of agricultural challenges. By diversifying marketing strategies through both offline and online channels, farmers exhibit adaptability to shifting market conditions and changing consumer behaviors. This flexibility is crucial in mitigating risks associated with market disruptions and ensuring continuous product availability—particularly vital during crisis situations when traditional markets may be disrupted.

4.7 Summary

Theoretically, there is a limited body of research on the readiness of farmers to face the challenges of catastrophe, particularly in the context of agricultural extension, both in Malaysia and globally. This study addresses that gap by offering new insights into how different skills contribute to farmers' readiness for crises. By applying the research framework to examine the interplay between technology adoption, implementation strategies, leadership, and decision-making skills, the study provides valuable lessons for both practitioners and academics. The findings underscore the importance of decision-making skills as a significant predictor of farmer readiness, highlighting their role in navigating immediate challenges. While leadership was found to have some potential impact, it was not as consistently predictive as decision-making, indicating that its influence may be more context dependent.

This research not only fills an important gap in the existing literature but also provides a comprehensive understanding of how various skills contribute to farmers' readiness for catastrophic events. The study's findings have significant implications for both practitioners working directly with farmers and researchers aiming to deepen their understanding of the factors influencing agricultural resilience. The study centers on four key areas: technology skills, implementation strategies, leadership qualities, and decision-making abilities, and aims to determine their correlation with farmers' preparedness for catastrophes. The research employed descriptive, correlation, regression, and structural equation modeling analyses to successfully achieve the study's goals.

This chapter focused on explaining the outcomes of the research, with an emphasis on the key discoveries. The overarching goal was to determine how various factors—such as technology adoption, leadership, decision-making, and implementation strategies—relate to and contribute to farmers' preparedness for catastrophic challenges. The chapter likely elaborated on the results of the quantitative analysis, utilizing statistical techniques, data visualization, and interpretation to demonstrate how these factors interact and ultimately influence the readiness of farmers to face crises.

CHAPTER 5

CONCLUSION, IMPLICATION AND RECOMMENDATION

5.1 Introduction

This chapter summarizes the study, which involves an overview of the research problems, objectives, design, methodology and major findings. The conclusions drawn based on the study's findings, along with theoretical and practical implications, have been highlighted. In addition, based on the findings, recommendations, including those of further research, were presented.

5.2 Summary

Farmers' readiness to face the catastrophe phenomenon causes new challenges for the agricultural community due to a slowdown in agricultural activities, logistics, and services. For example, post-COVID-19 raised many issues relevant to the status, readiness, and capacity of the different communities and countries' self-sufficiency during lockdown conditions and social distancing requirements (Buheji et al., 2020). Through the pandemic, this study concerns the farmers' self-development, such as knowledge of agriculture technology, implementation of the technology on the farm, self-leadership, and decision-making depending on the current situation. These aspects primarily concern the readiness of farmers to continue their farming activities during the catastrophe challenges.

Several issues arose as a result of the MCO, such as limited technical support from extension agents, a lack of information and knowledge across the agriculture supply chain, changes in marketing channels, disconnection of the agriculture supply chain, and limited availability of fertilizers, pesticides, seeds, machinery spare parts, and farm equipment. COVID-19 restrictions significantly influenced the agricultural sector, as there was limited movement and technical assistance from extension workers to farmers. Extension agents are essential in providing farmers with technical advice, information, and assistance. The constraints enforced under the MCO most certainly limited extension agents' capacity to physically engage with farmers, limiting their access to professional support.

Aside from that, agricultural services lagged owing to a lack of information and expertise throughout the agriculture supply chain, resulting in a disruption in the supply chain. Farmers, for example, had to change their marketing strategies and channels due to the COVID-19 outbreak since they couldn't manage their farms or sell their products as usual. Farmers are unable to manage their businesses, resulting in huge product and income losses due to vegetable dumping, as purchasers no longer purchase their products during MCO.

As a result, this research is needed to identify farmers’ readiness to be exposed to the problems of the catastrophe challenges and based on the latest catastrophe phenomenon, the COVID-19 epidemic, one of the agricultural community’s new challenges due to the slowdown of farm activities, logistics, and services. Furthermore, extension agents, who play an essential part in the development process and problem-solving, could not meet with farmers as often as they would have liked to provide advice due to movement restrictions.

5.2.1 Level of Technology, Implementation, Leadership and Decision-making Skills Towards Readiness to Face Catastrophe Phenomenon

This study's first objective was to determine the level of technology skill, implementation skill, leadership skill, decision-making skill, and farmers' readiness to face catastrophe challenges. The overall mean of the farmers was categorized into three levels (low, moderate, and high). Farmers' scores on leadership and decision-making skills showed a high skill level. Otherwise, the readiness, technology, and implementation levels were medium. The findings provide insights into areas of strength and potential areas for improvement, guiding potential interventions and strategies to enhance overall readiness in the agricultural sector.

5.2.2 Relationship between Technology, Implementation, Leadership and Decision-making Skills Towards Readiness to Face Catastrophe Phenomenon

According to thi study, technology, implementation, leadership, and decision-making abilities influence farmers' readiness to tackle catastrophe issues. In this study, all four skills are independent variables, and all four skills are necessary for farmers to become successful, productive, and more open to the technology learning process. The results showed that technological skill ($r = 0.633$), implementation skill ($r = 0.668$), and leadership skill ($r = 0.646$) have a moderate and positive correlation. In contrast, decision-making skill ($r = 0.751$) has a strong and positive correlation.

5.2.3 The Most Important Skills That Influence Farmers' Readiness to Face Challenges During The Catastrophe Phenomenon

Accordingly, the hypothesized contribution of technology skills to farmers' readiness was not supported (β=.068, p=.325). The analysis of the regression model indicated that the standardized coefficients are inconsistent with the hypothesis that technological skill contributes to farmers' readiness among vegetable farmers in Malaysia. In addition, we hypothesized that the contribution of implementation skills (β=.126, p=.114) and leadership skills (β=.045, p=.0.479) was inconsistent with the hypothesis that technology skill contributes to farmers' readiness. However, only decision-making skill (β=.662, p=.000) was supported and consistent with the findings of this study as depicted by the coefficients and p-value. However, using SEM, the findings showed that the two hypotheses, decision-making and leadership skills, were significant toward vegetable farmers' readiness.

The finding revealed that decision-making skills were a significant predictor of vegetable farmers' readiness to face catastrophic events, with a consistent relationship identified across both OLS and MLE regressions. In contrast, while leadership skills showed some significance in MLE regression, it did not achieve consistent results across both methods, leading to the rejection of the hypothesis regarding leadership's direct impact on readiness. These findings suggest that decision-making skills play a critical role in enhancing farmers' ability to navigate challenges, while the influence of leadership skills may be more context-dependent or less immediately impactful.

The study contributes to the body of agricultural research by highlighting the importance of decision-making skills in boosting farmer readiness. This understanding can inform practical strategies aimed at improving the preparedness of farmers for crises, particularly by focusing on strengthening their decision-making abilities. Furthermore, the findings emphasize the need for agricultural extension services to prioritize training programs that enhance decision-making skills among farmers. While leadership skills are still important, the study suggests that decision-making should be the primary focus for immediate improvements in farmer readiness. Extension agents can play a key role in fostering these skills, helping farmers not only adapt to challenges but also thrive in the face of adversity.

This study also reinforces the importance of ensuring that agricultural inputs, food processing, and distribution systems remain operational during times of crisis, such as through exemption from lockdown restrictions. The movement of food from farm to plate should be prioritized, and additional support for logistics, particularly for underprivileged groups and those in need, is essential. Governments and industry partners must collaborate to keep agricultural input markets running smoothly, ensuring access to necessary resources such as seeds, fertilizers, labor, and credit, which are crucial for planting and harvesting cycles.

5.3 Conclusion

This study assessed the readiness of vegetable farmers to confront catastrophic challenges, such as the COVID-19 pandemic, with a focus on the role of various skills, including decision-making, leadership, technology, and implementation. The findings revealed that farmers demonstrated a notable level of readiness, particularly in terms of their decision-making and leadership skills. However, while their decision-making abilities consistently predicted their readiness, the role of leadership skills showed mixed results across different regression methods.

Specifically, decision-making skills were found to be a significant predictor of farmer readiness in both Ordinary Least Squares (OLS) and Maximum Likelihood Estimation (MLE) regressions. This consistent outcome across both methods confirms the critical importance of decision-making in preparing farmers for catastrophic events. Farmers who excel in making well-informed, timely decisions are better equipped to handle the challenges posed by such crises, making decision-making a crucial factor in enhancing their overall preparedness.

In contrast, leadership skills showed significance only in the MLE regression, but did not reach significance in the OLS regression. This inconsistency between the two methods led to the rejection of the hypothesis that leadership skills are a strong and consistent predictor of readiness. While MLE suggests a potential relationship between leadership and readiness, the results were not conclusive enough to fully support the hypothesis across both regression methods. This indicates that while leadership may contribute to readiness, its influence may not be as straightforward or immediate as that of decision-making skills.

Furthermore, while farmers showed a reasonable level of technology adoption and implementation skills, these factors alone were not sufficient to overcome the disruptions caused by the pandemic. Supply chain challenges and the limited adoption of conventional farming methods highlighted the importance of not only having technological tools but also being able to effectively apply them in times of crisis. This finding underscores the need for continued investment in training farmers to utilize technology effectively, ensuring they are prepared to implement new methods under adverse conditions.

Structural Equation Modeling (SEM) reinforced the importance of decision-making and leadership skills in enhancing farmer readiness. Farmers who demonstrated strong decision-making and leadership capabilities were better positioned to confront adversities, showcasing their ability to navigate complex situations and manage resources effectively during crises. However, the inconsistent findings for leadership skills suggest that while leadership is important, its impact may vary depending on other contextual factors.

In conclusion, this study highlights the central role of decision-making skills in preparing farmers to face catastrophic events. Decision-making emerged as a consistent and significant predictor of readiness, while leadership, although potentially influential, did not show the same level of consistency. To enhance farmers' readiness, agricultural extension services should prioritize strengthening decision-making skills, while also considering targeted strategies to develop leadership skills. A comprehensive approach that integrates strong decision-making with technological proficiency and leadership will provide the most effective foundation for improving farmer resilience in the face of future crises.

5.4 Implications of the Study

The current study's findings give vital information to farmers, extension advisory services, and farmer preparation via skills to increase extension agents' and clients' abilities and potential. These are critical components in assuring ready-to-meet catastrophe issues. The following are the study's theoretical, practical, and policy implications.

5.4.1 Theoretical Implications

This study has significant theoretical implications as it pertains to farmers' objective of effectively addressing catastrophic challenges by leveraging their knowledge, skills, and capabilities. This study has contributed to the existing information on resource-based theory by highlighting the importance of intangible resources, such as knowledge and skills, in predicting farmers' readiness, as opposed to tangible resources like physical assets. The study further supported the technological readiness hypothesis by highlighting the importance of farmers' experience and knowledge, which had previously been overlooked in studies that primarily focused on education and training to improve performance and productivity. The project will additionally establish a robust foundation for existing research models and expand the existing knowledge by equipping farmers with the necessary skills to tackle forthcoming difficulties effectively.

The utilization of three different theories in this study, as demonstrated by Noble and Heale (2019), exemplifies how theory triangulation can enhance research by providing a diverse array of data sets to elucidate certain aspects of a phenomenon under investigation. This study made significant contributions to the Iceberg Model, Farmers' Community Readiness Model, and Technology Readiness Index by assessing the respective strengths of each theory. The study would provide a solid foundation for previous study models and contribute to the existing knowledge by equipping farmers with skills that enhance their readiness to address difficulties effectively through comprehensive knowledge.

5.4.1.1 Iceberg Model

The Iceberg Model helps visualize the underlying causes of an event beyond the immediately visible. In the context of this study, it underscores the deeper, often overlooked factors affecting farmers' readiness to face challenges during catastrophes. By examining not just the observable behaviors or outcomes (the "tip of the iceberg") but also delving into the farmers' attitudes, values, and the systemic structures that influence these behaviors, the study enriches our understanding of farmers' readiness. It reveals how embedded cultural norms, beliefs, and institutional practices shape farmers' ability to adapt to difficulties, emphasizing the need to address these foundational aspects to enhance farmers' resilience and readiness effectively.

5.4.1.2 Farmers' Community Readiness Model

The Farmers' Community Readiness Model is pivotal for understanding how prepared a community is to take action on an issue. This study's focus on assessing skills influencing farmers' readiness contributes to this model by identifying specific areas where the community's capacity can be enhanced. It extends the model's application by offering empirical evidence on the determinants of readiness within the agricultural sector during crises, such as technological, leadership, and decision-making skills. The findings offer actionable insights for targeted interventions to improve community readiness, demonstrating the model's relevance in strategizing responses to agricultural challenges posed by catastrophic events.

5.4.1.3 Technology Readiness Index

The Technology Readiness Index measures individuals' propensity to embrace and use new technologies for accomplishing goals in home life and at work. This study's evaluation of technological skills among farmers and their impact on readiness to face challenges enriches the index's applicability in the agricultural context. By identifying the technology-related factors that either facilitate or hinder farmers' readiness, the study contributes to refining the index for better assessing technological readiness in sectors traditionally viewed as less technology-driven. It underscores the critical role of technological adoption in enhancing farmers' capabilities to manage adversities, providing a nuanced understanding of technology's place in fostering agricultural resilience.

Each of these theories benefits from the study's insights into the complex interplay between skills, readiness, and the ability to navigate difficulties in agriculture. By grounding its findings in these theoretical frameworks, the study not only extends their applicability but also provides a richer, more comprehensive understanding of the factors that enable farmers to effectively confront challenges during catastrophic phenomena.

Moreover, the technology skill, in essence, pertains to the technical proficiency of farmers in effectively implementing technologies under the guidance of specialists, resulting in tangible improvements in agricultural practices. According to the viewpoints of resource-based theory, it is feasible to acquire knowledge and skills (Spencer and Spencer, 1993). The utilization of information, expertise, and decision-making skills by farmers is imperative for agricultural endeavors (Adnan et al., 2017).

The data regarding the readiness of farmers has contributed to the academic requirements in the field, and the results can aid extension agencies and agents in defining the necessary skills, such as technological proficiency and implementation abilities. Additionally, they can be arranged in their appropriate ratio to accomplish goals and improve individual readiness.

Furthermore, the study investigated the farmers' readiness to confront the challenges posed by catastrophes by assessing their proficiency in four key areas: technology, implementation, leadership, and decision-making. The findings contribute to the existing literature on farmers' readiness, providing a valuable reference for other researchers in the field. One important theoretical implication of this study is that when people are invested, their productivity increases. Investing in the education and training of farmers and extension agents can enhance their readiness level, particularly in dealing with catastrophic issues.

The present study confirmed that decision-making skills is essential aspects of human resource development. It also emphasized the importance of education and training for extension agents to equip them with the necessary abilities to address challenges faced by vegetable farmers in Malaysia effectively. Overall, this study has the capacity to provide a beneficial influence by offering pragmatic observations, directing policies and initiatives, enhancing extension methodologies, and adding to the progression of agricultural knowledge in Malaysia. This resource can be highly beneficial for extension staff, researchers, policymakers, and stakeholders who are interested in enhancing the resilience of farmers in response to various challenges.

5.4.2 Implications for Practice

Furthermore, in practical terms, the results of this study will enhance our understanding of the skills necessary for farmers and other factors associated with readiness. They will offer valuable insights into the advantageous impacts of readiness on vegetable cultivators. Enhancing their knowledge will enhance their ability to overcome challenges in the agricultural sector. Hence, the readiness of farmers is crucial as it illuminates the correlation between skills and the readiness of both extension agents and farmers. Enhanced readiness would result in improved execution and decision-making, hence increasing agricultural productivity, revenue, and overall standard of living for farmers.

Farmers will acquire the necessary skills to confront difficulties posed by catastrophic phenomena effectively. This study aims to raise awareness and provide education to individuals, particularly farmers and agricultural professionals, such as extension agents, regarding the elements that impact farmers' readiness to address the challenges posed by catastrophic events and their significance. Farmer readiness-enhancing skills can be integrated into DOA extension and technology transfer operations. Consequently, the extension agents will have the opportunity to gain the necessary skills for their future performance. Moreover, the identification of essential skills can be employed to train extension agents and guarantee that the utilization of these skills would enhance their performance and foster strong working relationships with vegetable growers, which could be significant in evaluating their state of readiness.

Technological skill will enable farmers to enhance their quality of life and agricultural productivity. Research is crucial for extension agents as it focuses on skills that they need to master in order to provide their clients with any technology efficiently. Alternatively, the results and findings of this study would serve as a basis for involving extension agents in becoming effective catalysts for change. Agricultural researchers, government organizations, commercial vendors, and the development sector have aimed to address agricultural issues by prioritizing the dissemination of technological breakthroughs to overcome many challenges that humanity faces. These interventions typically modify farming practices by adopting technologies (Moerkerken et al., 2019; Ison and Russell, 2000).

However, it is crucial to assess the readiness of farmers in order to determine the extent to which agricultural organizations, particularly the Department of Agriculture (DOA), are accomplishing their goals. The findings will help identify areas for organizational enhancement. Consequently, this study is crucial for enhancing the efficacy of DOA extension services. Additionally, it is crucial as it will offer valuable input to DOA extension officials and farmers in times of catastrophic issues, enabling them to collaborate in implementing technologies that would enhance the overall understanding of extension activities. Moreover, this study enhances the methodology for assessing farmer readiness. It will enhance their abilities and maximize their efficiency by utilizing appropriate techniques and skills for the existing technology, especially in anticipation of future situations or obstacles.

5.4.3 Implication for Policy

The Ministry of Agriculture and Food Security (MAFS) and Department of Agriculture in Malaysia plays an instrumental role in formulating and executing agricultural policies aimed at enhancing catastrophic readiness and resilience within the sector. This study underscores the imperative for MAFS to harness research insights for crafting strategic programs that bolster farmers' readiness against catastrophic events. Specifically, the findings advocate for the implementation of policies aligned with "New Norms," reflecting adaptive strategies that address the evolving challenges posed by pandemics and other disasters. These policies could encompass the promotion of digital agriculture, facilitation of remote crop monitoring, and the establishment of online marketplaces to ensure the continuity of agricultural operations amidst disruptions.

Further, the research highlights the criticality of equipping extension agents with modern agricultural technologies, disaster risk management, and adaptive practices. In response, MAFS could prioritize the professional development of these agents, thereby enhancing the effectiveness of extension services. The establishment of plant clinics emerges as a pivotal strategy, proposed to elevate agricultural productivity and resilience. Through these clinics, farmers would gain access to expert advice on a spectrum of concerns, from pest management to crop health, thereby fortifying their ability to withstand shocks.

Moreover, the participatory involvement of farmers in the planning and decision-making processes is identified as a crucial factor for cultivating resilient agricultural communities. MAFS's promotion of farmer-led initiatives and their active participation in policy dialogues ensures that strategies are both pragmatic and reflective of the farmers' real-world experiences and needs. Capacity building and training constitute another significant recommendation, emphasizing the need for comprehensive programs that cover a broad spectrum of competencies, including modern farming techniques, sustainable practices, and effective communication strategies. Such initiatives aim to create an informed and adept agricultural community poised to navigate the myriad challenges endemic to the sector.

Lastly, the study suggests that MAFS foster collaborations with technology companies, research institutions, and international bodies to facilitate the dissemination of innovative farming tools and practices among vegetable producers. This strategic partnership is anticipated to enhance productivity and resilience, positioning Malaysian agriculture for sustainable growth and robustness in the face of adversity. In summary, integrating these recommended strategies into MAFS's policy and programmatic framework is crucial for advancing the agricultural sector's readiness and response to catastrophic challenges. The development of skilled extension agents, informed by the study's findings, is essential for translating policy objectives into tangible outcomes, thereby ensuring the agricultural sector's sustainability and efficiency in Malaysia.

5.5 Recommendations

The study's findings might help public or private enterprises to realize the full potential of all farmers better. It will help related organizations, notably the DOA, present ideas on issues that farmers face when difficult situations arise and comprehend farmers' concerns about problem-solving approaches. Agriculture extension organizations would strive to improve farmers' ability to handle risk in the future by developing a program that aims to provide resilient farmers with the capacities that are required. It is vital to develop significantly trained farmers' attitudes to tackle challenges from catastrophes without any complex complications.

5.5.1 Recommendations for Practice

The Ministry of Agriculture and Food Security (MAFS), in collaboration with the Department of Agriculture (DOA) and other relevant extension organizations, should spearhead the design and implementation of agricultural technology programs aimed at enhancing farmers' technological proficiency. These programs must be tailored to meet the specific challenges faced by the agricultural sector, particularly in the context of increasing environmental volatility and catastrophic events such as floods or droughts. The focus should be on providing farmers with hands-on experience in utilizing modern agricultural technologies, such as precision farming tools, climate-smart agriculture techniques, and data-driven decision-making platforms. By engaging farmers directly in the adoption and application of these technologies, such programs will ensure that they are better equipped to manage the uncertainties of future climatic and market challenges.

DOA should ensure that agricultural educational programs are meticulously designed to address the unique needs, skill levels, and challenges of different farmer demographics. This requires a comprehensive approach that integrates theoretical knowledge with practical, field-based applications, enabling farmers to directly apply what they have learned in real-world contexts. The practical component of these training programs should emphasize the implementation of emerging technologies, such as automated irrigation systems, pest-resistant crop varieties, and digital farm management tools. This will empower farmers to effectively incorporate these technologies into their daily operations, improving productivity and resilience to catastrophic events. Furthermore, periodic evaluations and follow-up workshops can be incorporated to ensure that the training outcomes are sustained over time.

Leadership training should be embedded as a core component of agricultural educational curricula, focusing on the development of critical soft skills such as communication, team management, and strategic decision-making. Programs should be designed to cultivate a sense of responsibility and accountability among farmers, encouraging them to take leadership roles in their communities and within the agricultural sector. Through hands-on workshops and mentorship by seasoned agricultural extension agents, farmers can be trained in effective management principles, such as labor organization, resource allocation, and regulatory compliance. This training will not only improve farmers' ability to make informed decisions regarding farm operations but also foster a culture of compliance with best practices and regulatory standards. By building these leadership competencies, farmers will be better positioned to take proactive roles in responding to agricultural challenges, ensuring that they can guide their communities through periods of uncertainty and change.

To ensure the successful implementation and sustainability of the learned skills and technologies, a structured tracking and monitoring program should be established, facilitated by agricultural extension agents under the guidance of MAFS and DOA. This program would involve regular follow-ups with farmers to assess their progress in adopting new technologies and implementing the practices learned during training. Data collected through this initiative would provide valuable insights into the effectiveness of the educational programs and inform future policy adjustments. Additionally, this monitoring program would serve as a feedback mechanism, allowing extension agents to provide ongoing support and guidance, ensuring that farmers remain aligned with their initial objectives and continue to develop the skills necessary for long-term resilience. This continuous engagement will foster a learning culture, encouraging farmers to refine their strategies, share knowledge with peers, and stay updated on the latest technological innovations.

5.5.2 Recommendations for Policy

The COVID-19 pandemic revealed weaknesses in global food security, highlighting the need for stronger policies to help farmers and the agricultural sector cope with future crises. The following recommendations focus on improving agricultural resilience through technology adoption, financial systems, catastrophe readiness, and farmer empowerment. Governments should create policies that encourage farmers to adopt modern agricultural technologies, such as precision farming tools, weather prediction systems, and digital pest management. These tools can help farmers adapt to challenges like climate change and market fluctuations. Providing incentives such as subsidies, grants, or tax breaks can make these technologies more accessible to small-scale farmers. Public investment in digital infrastructure, especially in rural areas, is also important to ensure farmers have the connectivity they need to use these tools effectively. These measures will help farmers make informed decisions and boost productivity.

Financial protection policies, such as crop insurance and weather-based insurance, are essential to protect farmers from losses due to disasters or market disruptions. Insurance schemes based on environmental conditions, such as rainfall or drought, can help stabilize farmers' incomes during uncertain times (Mohamad Basir et al., 2024). Governments should also support the creation of cooperatives, credit unions, and microfinance institutions that can offer affordable credit and loans to farmers. These financial systems would help farmers invest in new technologies and improve their farming practices.

Policies should promote sustainable farming practices, including the use of organic fertilizers and the recycling of agricultural waste. Governments can offer incentives for practices that enhance soil health and reduce environmental damage. Improving storage facilities and supply chains is also essential. During crises, when transportation and market access may be disrupted, having adequate storage can prevent food losses and ensure a steady supply of agricultural products. Public investment in modern storage systems would help stabilize food availability and protect farmers' incomes.

Agricultural extension services play a critical role in helping farmers improve their skills and knowledge. Policies should focus on providing more training for extension agents, with an emphasis on catastrophe readiness, modern farming techniques, and the use of new technologies. Governments should also support the development of digital platforms that allow extension agents to offer real-time advice and information to farmers, particularly those in remote areas. These services can include weather updates, pest alerts, and market trends, helping farmers make timely, informed decisions. Governments should encourage the formation of farmer cooperatives and networks, which allow farmers to share resources, access markets, and buy inputs at lower costs. Cooperatives increase farmers' bargaining power and help them adopt new technologies and sustainable practices. Policies should provide financial and technical support to these cooperatives, helping farmers work together more efficiently and improve their resilience to disruptions.

Government policies should promote digital marketing platforms and mobile apps that allow farmers to reach wider markets, even during crises. By cutting out middlemen, these platforms can increase farmers' profits and expand their market reach. Supporting digital tools that connect farmers directly with consumers and markets helps improve access to real-time information about prices and demand. These systems allow farmers to better plan their production and respond to changing market conditions, strengthening food security and protecting their livelihoods. Governments must prioritize catastrophe readiness in agriculture by providing tools and training to help farmers cope with extreme weather and other crises. Catastrophe insurance schemes, crop insurance, and weather-indexed insurance policies can offer financial protection during disasters. Additionally, governments should establish programs, such as "catastrophe field schools," to teach farmers about disaster risks and adaptation strategies. These programs will equip farmers with the skills needed to reduce their vulnerability and better manage the impacts of disasters.

5.5.3 Recommendations for Knowledge

A foundational recommendation is the need for farmers to gain a robust, comprehensive understanding of the latest agricultural technologies. Educational programs developed by MAFS and DOA should not only focus on technical training but also ensure that farmers comprehend the broader implications of technology adoption, particularly in mitigating the impacts of catastrophic events such as extreme weather or pest infestations. These programs should incorporate case studies, simulations, and expert-led sessions that explore the role of digital platforms, precision agriculture, and sustainable farming practices in modern agriculture. By integrating theoretical insights with practical examples, farmers will be better equipped to make informed decisions about which technologies to adopt, based on their specific farm conditions and market needs. This approach will also ensure that farmers are prepared to continuously update their knowledge as new technologies emerge, promoting an adaptive and future-oriented mindset.

In addition to technical proficiency, farmers should develop strong leadership and managerial skills to effectively guide their farming operations and contribute to community-wide agricultural resilience. The integration of leadership training into the agricultural curriculum, as proposed, should emphasize both individual and collective leadership development. This involves cultivating decision-making skills, problem-solving abilities, and communication techniques that enable farmers to take on leadership roles within their communities and beyond. Such training should also incorporate elements of behavioral change, encouraging farmers to adopt a proactive approach to farm management, regulatory compliance, and sustainable agricultural practices. By promoting leadership at all levels of the agricultural hierarchy, these programs will empower farmers to drive innovation, manage risks, and collaborate effectively with stakeholders such as government agencies, non-governmental organizations, and fellow farmers.

An essential component of preparing farmers for future challenges is equipping them with the knowledge and skills to make informed decisions under pressure. Programs developed by MAFS, DOA, and agricultural extension organizations should emphasize strategic decision-making, focusing on scenario planning, risk assessment, and adaptive management. These programs should include modules on how to respond to unexpected challenges such as crop failures, market fluctuations, and climate-related disasters. By honing farmers' decision-making skills, the programs will enable them to navigate uncertainties more effectively and implement adaptive strategies that ensure the long-term viability of their farms. Furthermore, promoting peer-to-peer learning and the sharing of best practices will help disseminate this decision-making knowledge throughout farming communities, enhancing collective resilience.

The success of these educational initiatives relies not only on individual farmer engagement but also on the broader dissemination of knowledge within agricultural communities. To foster a culture of continuous learning and collaboration, farmers who participate in these programs should be encouraged to share their knowledge and experiences with their peers. This can be achieved through formal knowledge-sharing platforms, such as farmer cooperatives, community forums, and digital knowledge hubs, where farmers can exchange ideas, discuss challenges, and collaborate on solutions. By promoting such knowledge dissemination mechanisms, MAFS and DOA can ensure that the benefits of training and technological advancement reach a wider audience, thereby strengthening the overall resilience of the agricultural sector. Additionally, engaging community leaders, extension agents, and other stakeholders in these knowledge-sharing activities will create a support network that reinforces the adoption of best practices and the continuous development of skills across the farming population.

5.5.4 Recommendations for Future Research

This research highlights four key skills contributing to farmers' readiness to face catastrophes. However, it is essential to recognize that several other factors influence farmers' ability to confront these challenges. Future studies should explore a broader range of elements that impact readiness, such as resources, tools, logistics, compensation and benefits, education, training, and experience. Expanding research beyond the current scope will provide a more comprehensive understanding of farmers' readiness, incorporating variables like community awareness, which is central to the Community Readiness Model. This model helps gauge how aware agricultural communities are of farm challenges, suggesting that future research should delve into additional factors needed for a complete readiness index.

Future studies should investigate the impact of various external factors on farmers' readiness. These could include access to financial resources, availability of advanced tools, and the quality of logistics that enable farmers to adapt to adverse situations. Additionally, examining the role of compensation and benefits offered to farmers during crises, along with education and training opportunities, will help paint a fuller picture of their readiness. These elements can significantly affect farmers' capacity to handle catastrophes, and a more holistic readiness index incorporating these factors would be beneficial.

One of the key areas for future research involves exploring the implementation of technology transferred to vegetable farmers and understanding their role in adopting these technologies. By conducting surveys of both farmers and extension agents, researchers can assess the challenges hindering successful technology adoption. Key questions to consider include: How do farmers contribute to the acceptance of new technologies? What are the obstacles preventing them from fully implementing the technology? Identifying these challenges will provide insights into the support mechanisms required, such as incentives or rewards, to ensure the successful adoption of advanced agricultural technologies.

Further studies should focus on assessing farmers' technical skills, attitudes toward technology, and usage patterns. It is essential to evaluate how proficient farmers are in using modern technologies and whether these technologies offer long-term viability in terms of economic, social, and environmental impacts. By examining these aspects, future research can provide valuable insights into the broader consequences of technology adoption, helping policymakers and extension agents design more effective programs to improve farmers' catastrophe readiness.

To validate and expand upon this study's findings, future research should be replicated with different crops, regions, and farmer groups. Comparing results across various agricultural contexts will help determine whether the readiness skills identified in this study apply more broadly. Conducting similar research with other farming communities or different geographic areas can help assess the generalizability of the findings and refine recommendations for strengthening farmers' readiness to face catastrophes.

A mixed-methods approach, combining quantitative and qualitative research, would enhance future studies. Surveys can be used to gather quantifiable data on farmers' technology adoption, decision-making processes, and perceived readiness levels. Qualitative methods, such as interviews and focus group discussions, can provide deeper insights into farmers' experiences and leadership skills. These qualitative insights would offer a nuanced understanding of how farmers navigate challenges, make decisions, and implement new technologies. Incorporating in-depth interviews and focus groups will help researchers gain more complete data, offering a richer understanding of the dynamics involved in farmers' readiness.

Future studies could also benefit from using case studies to examine the experiences of farmers who have faced catastrophic events. By studying how these farmers prepared, responded, and adapted to crises, researchers can gain a deeper understanding of their readiness levels. These case studies would also help identify best practices for catastrophe management and readiness within agricultural settings.

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APPENDICES

APPENDICES

BORANG SOAL-SELIDIK KAJIAN

BORANG INI UNTUK DIISI OLEH PETANI YANG TELAH DIPILIH SEBAGAI RESPONDEN KAJIAN

* Required

KAJIAN SECARA USAHA SAMA ANTARA UPM DENGAN JABATAN PERTANIAN

TAJUK: KESEDIAAN PETANI MENGURUSKAN PROJEK TANAMAN SAYUR PASCA PKP
RESPONDEN: PENGUSAHA SAYUR TERPILIH, BIMBINGAN JABATAN PERTANIAN
ARAHAN:

1. JAWAB SEMUA SOALAN MENGENAI DIRI ANDA.
2. TIADA JAWAPAN YANG BETUL ATAU SALAH
3. IDENTITI ANDA TIDAK AKAN DIKENALI.
4. KEJUJURAN ANDA SANGAT DIHARGAI.

SILA PILIH LOKASI PROJEK ANDA MENGIKUT ZON

A. LOKASI PROJEK

1. A.1 Nama Zon *
   - Zon Utara (Perlis, Kedah, P.Pinang)
   - Zon Tengah (Perak, Selangor)
   - Zon Selatan (N.Sembilan, Melaka, Johor)
   - Zon Timur (Pahang, Terengganu, Kelantan)
2. A.1 Nama negeri *

3. A.2 Nama daerah *

A1. MAKLUMAT PETANI

Pilih maklumat yang berkaitan dengan diri anda.

4. A1.1 No Telefon Bimbit *

5. A1.2 Jantina *

- [ ] Lelaki
- [ ] Perempuan

6. A1.3 Umur *

7. A1.4 Tahap pendidikan tertinggi

** Mark only one oval.*

- Tamat sekolah rendah
- Tamat sekolah menengah
- Sijil institut
- Diploma
- Ijazah

8. A1.5 Bangsa

**Mark only one oval.*

- Melayu
- Cina
- India
- Lain-lain

Pilih maklumat tanaman sayur yang anda usahakan.

A2. MAKLUMAT TANAMAN

9. A2.1 Jenis tanaman (boleh tanda lebih dari satu)

	Tandakan		Tandakan
Sawi	☐	Bendi	☐
Kangkung	☐	Terung	☐
Bayam	☐	Kacang Panjang	☐

10. A2.2 Sijil My GAP

( ) Ada, jawab soalan A2.2.1

( ) Tiada

11. A2.2.1 Tahun diperolehi sijil MyGAP

____

12. A2.3 Jenis bimbingan dari Jabatan Pertanian (boleh tanda lebih dari satu)

	Tandakan
Jadual tanaman	☐
Pembajaan	☐
Kawalan musuh	☐
Kawalan penyakit	☐
Kawalan rumpai	☐
Penuaian hasil	☐
Pemasaran	☐
Tiada Bimbingan	☐

13. A2.4 Jenis bantuan dari Jabatan Pertanian (boleh tanda lebih dari satu)

- Penyediaan kawasan
- Perparitan
- Pagar
- Sistem pengairan
- Baja
- Tiada Bantuan

14. A2.5 Anggaran kerugian sewaktu PKP *

- RM0-1000
- RM1001-2000
- RM2001-3000
- RM3001-4000
- RM4001-5000
- RM5001 dan lebih

B. TEKNOLOGI TANAMAN

SILA PILIH TAHAP PENGETAHUAN ANDA MENGIKUT AKTIVITI YANG DINYATAKAN

15. B1. Tahap PENGETAHUAN saya menyediakan jadual pengeluaran sayur mengikut permintaan *

	1	2	3	4	5	6	
Sangat rendah							Sangat tinggi

16. B2. Tahap PENGETAHUAN saya menyediakan jadual pembajaan sayur yang betul *

	1	2	3	4	5	6	
Sangat rendah							Sangat tinggi

17. B3. Tahap PENGETAHUAN saya menentukan kadar baja sayur yang betul *

	1	2	3	4	5	6

Sangat rendah	◯	◯	◯	◯	◯	◯	Sangat tinggi

18. B4.Tahap PENGETAHUAN saya menyediakan jadual kawalan penyakit sayur yang betul *

	1	2	3	4	5	6	
Sangat rendah	◯	◯	◯	◯	◯	◯	Sangat tinggi

19. B5. Tahap PENGETAHUAN saya menyediakan jadual kawalan rumpai *

	1	2	3	4	5	6	
Sangat rendah	◯	◯	◯	◯	◯	◯	Sangat tinggi

20. B6. Tahap PENGETAHUAN saya menggunakan telefon untuk berkomunikasi *

	1	2	3	4	5	6	
Sangat rendah	◯	◯	◯	◯	◯	◯	Sangat tinggi

21. B7. Tahap PENGETAHUAN saya memasarkan hasil dalam talian (online) *

	1	2	3	4	5	6	
Sangat rendah	◯	◯	◯	◯	◯	◯	Sangat tinggi

C. PELAKSANAAN

SILA PILIH TAHAP KEMAHIRAN ANDA MELAKSANAKAN AKTIVITI YANG DINYATAKAN

22. C1. Tahap KEMAHIRAN saya menanam sayur dengan cara yang betul *

	1	2	3	4	5	6	
Sangat rendah	◯	◯	◯	◯	◯	◯	Sangat tinggi

23. C2. Tahap KEMAHIRAN saya membaja sayur yang betul *

	1	2	3	4	5	6	
Sangat rendah	◯	◯	◯	◯	◯	◯	Sangat tinggi

24. C3. Tahap KEMAHIRAN saya mengenal pasti penyakit sayur *

	1	2	3	4	5	6	
Sangat rendah	◯	◯	◯	◯	◯	◯	Sangat tinggi

25. C4. Tahap KEMAHIRAN saya mengenal pasti perosak sayur *

	1	2	3	4	5	6	
Sangat rendah	◯	◯	◯	◯	◯	◯	Sangat tinggi

26. C5. Tahap KEMAHIRAN saya mengawal rumpai *

	1	2	3	4	5	6	
Sangat rendah	◯	◯	◯	◯	◯	◯	Sangat tinggi

27. C6. Tahap KEMAHIRAN menggunakan telefon untuk berkomunikasi *

	1	2	3	4	5	6	
Sangat rendah	◯	◯	◯	◯	◯	◯	Sangat tinggi

28. C7. Tahap KEMAHIRAN saya memasarkan hasil secara dalam talian *

	1	2	3	4	5	6	
Sangat rendah	◯	◯	◯	◯	◯	◯	Sangat tinggi

D. KEPIMPINAN

SILA PILIH TAHAP PEMATUHAN ANDA TERHADAP AKTIVITI YANG DINYATAKAN

29. D1. Tahap PEMATUHAN saya mengikut jadual tanaman sayur yang disediakan *

	1	2	3	4	5	6	
Sangat rendah	◯	◯	◯	◯	◯	◯	Sangat tinggi

30. D2. Tahap PEMATUHAN saya mengikuti jadual pembajaan yang disediakan *

	1	2	3	4	5	6	
Sangat rendah	◯	◯	◯	◯	◯	◯	Sangat tinggi

31. D3. Tahap PEMATUHAN saya mengawal penyakit sayur *

	1	2	3	4	5	6	
Sangat rendah	◯	◯	◯	◯	◯	◯	Sangat tinggi

32. D4. Tahap PEMATUHAN saya mengawal rumpai di kawasan projek sayur *

	1	2	3	4	5	6	
Sangat rendah	○	○	○	○	○	○	Sangat tinggi

33. D5. Tahap PEMATUHAN saya memetik hasil mengikut masa yang ditentukan *

	1	2	3	4	5	6	
Sangat rendah	○	○	○	○	○	○	Sangat tinggi

34. D6. Tahap PEMATUHAN saya membekalkan hasil mengikut jadual yang ditentukan oleh pelanggan *

	1	2	3	4	5	6	
Sangat rendah	○	○	○	○	○	○	Sangat tinggi

35. D7. Tahap PEMATUHAN saya mengikuti SOP yang disediakan oleh kerajaan sewaktu PKP *

	1	2	3	4	5	6	
Sangat rendah	○	○	○	○	○	○	Sangat tinggi

E. MEMBUAT KEPUTUSAN

SILA PILIH TAHAP KEYAKINAN ANDA MEMBUAT KEPUTUSAN MENGIKUT AKTIVITI YANG DINYATAKAN

36. E1. Tahap KEYAKINAN saya membuat keputusan untuk meneruskan pengeluaran sayur sewaktu PKP

	1	2	3	4	5	6	
Sangat rendah	○	○	○	○	○	○	Sangat tinggi

37. E2. Tahap KEYAKINAN saya membuat keputusan mengenal pasti penyakit sayur *

	1	2	3	4	5	6	
Sangat rendah	○	○	○	○	○	○	Sangat tinggi

38. E3. Tahap KEYAKINAN saya membuat keputusan memilih jenis racun yang sesuai mengikut jenis penyakit sayur

	1	2	3	4	5	6	
Sangat rendah	◯	◯	◯	◯	◯	◯	Sangat tinggi

39. E4. Tahap KEYAKINAN saya membuat keputusan memilih jenis racun yang sesuai mengikut rumpai.

	1	2	3	4	5	6	
Sangat rendah	◯	◯	◯	◯	◯	◯	Sangat tinggi

40. E5. Tahap KEYAKINAN saya membuat keputusan memilih jenis baja yang sesuai untuk sayur *

	1	2	3	4	5	6	
Sangat rendah	◯	◯	◯	◯	◯	◯	Sangat tinggi

41. E6. Tahap KEYAKINAN saya membuat keputusan menentukan kadar baja yang sesuai untuk sayur

	1	2	3	4	5	6	
Sangat rendah	◯	◯	◯	◯	◯	◯	Sangat tinggi

42. E7. Tahap KEYAKINAN saya membuat keputusan memasarkan hasil secara dalam talian *

	1	2	3	4	5	6	
Sangat rendah	◯	◯	◯	◯	◯	◯	Sangat tinggi

F. KESEDIAAN PASCA PKP

SILA PILIH TAHAP KESEDIAAN ANDA MENGIKUT AKTIVITI YANG DINYATAKAN PASCA PKP.

43. F1. Tahap KESEDIAAN saya merancang sendiri projek sayur pasca PKP *

	1	2	3	4	5	6	
Sangat rendah	◯	◯	◯	◯	◯	◯	Sangat tinggi

44. F2. Tahap KESEDIAAN saya melaksanakan sendiri projek sayur pasca PKP *

	1	2	3	4	5	6	
Sangat rendah							Sangat tinggi

45. F3. Tahap KESEDIAAN saya memantau sendiri projek sayur pasca PKP *

	1	2	3	4	5	6	
Sangat rendah							Sangat tinggi

46. F4. Tahap KESEDIAAN saya memimpin diri sendiri pasca PKP *

	1	2	3	4	5	6	
Sangat rendah							Sangat tinggi

47. F5. Tahap KESEDIAAN saya untuk berdikari pasca PKP *

	1	2	3	4	5	6	
Sangat rendah							Sangat tinggi

48. F6. Tahap KESEDIAAN saya untuk berkomunikasi secara dalam talian pasca PKP *

	1	2	3	4	5	6	
Sangat rendah							Sangat tinggi

49. F7. Tahap KESEDIAAN saya untuk memasarkan hasil secara dalam talian pasca PKP *

	1	2	3	4	5	6	
Sangat rendah							Sangat tinggi

ETHICS COMMITTEE FOR RESEARCH INVOLVING HUMAN SUBJECTS (JKEUPM)

UNIVERSITI PUTRA MALAYSIA

Research title	**:**	**Determinants of Skills Influencing Vegetable Farmers' Readiness to Face Challenges During the Catastrophe Phenomenon in Peninsular Malaysia.**
Study Site	**:**	**Malaysia.**
JKEUPM Ref No.	**:**	**JKEUPM-2023-708**
Principal Investigator	**:**	**Dr. Jasmin Binti Arif Shah**
Co-investigator	**:**	**Dr. Nur Bahiah Binti Mohamed Haris, Assoc. Prof. Dr. Norida Binti Mazlan, Murni Azureen Binti Mohd Pakri (Student).**

Documents received and reviewed with reference to the above study:

1. Ethics Application Form, Version 1 dated 17/07/2023
2. Respondent's Information Sheet / Consent (English), Version 1 dated 17/07/2023
3. Respondent's Information Sheet / Consent (Malay), Version 1 dated 17/07/2023
4. Respondent's Information Sheet / Guardian's/Parent's Consent (Malay), Version 1 dated 17/07/2023
5. Proposal (English), Version 1 dated 17/07/2023
6. Questionnaire / Interviews (Malay), Version 1 dated 17/07/2023
7. Curriculum Vitae of:
    a. Dr. Jasmin Binti Arif Shah
    b. Dr. Nur Bahiah Binti Mohamed Haris
    c. Assoc. Prof. Dr. Norida Binti Mazlan
    d. Murni Azureen Binti Mohd Pakri

The University Research Ethics Committee, Universiti Putra Malaysia (JKEUPM) operates in accordance to the ICH-GCP Guidelines.
Decision by JKEUPM:

[X] Approved

[X] **Permission MUST BE OBTAINED from the respective hospitals/ institutions before conducting the research**

[ ] Disapproved

Please note that the approval is **VALID UNTIL 04 OCTOBER 2024**

Researchers should comply with the following:

I. Complete a Study Final Report upon study completion (Form 3.2).

II. Ethical approval is required in the case of amendments/ changes to the study documents/ study sites/ study team.

BIODATA OF STUDENT

Murni Azureen Mohd Pakri was born on 7th December 1994 in Baling, Kedah, Malaysia. She completed her primary education at Sekolah Kebangsaan Siong, Baling, Kedah (2006), followed by her secondary education at Kubang Pasu Integrated Boarding School, Bukit Kayu Hitam, Kedah (2011). She then pursued the Foundation of Agricultural Science at Universiti Putra Malaysia (UPM), completing it in 2012. She continued her studies at UPM, earning a Bachelor's degree in Agricultural Science in 2017. In 2021, she obtained a Master's Degree in Agricultural Extension from the Faculty of Agriculture.

She has worked as a Research Officer at the Malaysian Agricultural Research and Development Institute (MARDI), specifically at the Socio-Economic, Market Intelligence & Agribusiness Research Centre in Serdang. In early 2022, she began her postgraduate studies in Agricultural Extension at UPM. Currently, she is a Research Management Assistant in the Monitoring, Evaluation, and Learning (MEL) department at WorldFish, Penang.

In addition to her work and studies, she actively engages in agricultural practices, dedicating time to farming on her family’s farm in her hometown of Baling, Kedah. Despite her busy schedule, she ensures that she stays connected to the land, applying both the practical and theoretical knowledge she has gained throughout her academic and professional journey. Her strong determination and passion for agriculture drive her commitment to contributing to the field, not just through research, but through hands-on experience. This balance of practical farming and academic expertise exemplifies her deep-rooted dedication to agricultural development.

LIST OF PUBLICATIONS

Mohd Pakri, M. A., Arif Shah, J. ., Mohamed Haris, N. B. ., & Mazlan, N. (2022). Factors Influencing Farmers' Readiness to Face Covid-19 Post-Movement Control Order Challenges in Peninsular Malaysia. *Journal of Tropical Resources and Sustainable Science (JTRSS)*, *10*(2), 50–57. https://doi.org/10.47253/jtrss.v10i2.1008

Mohd Pakri, M. A., Arif Shah, J. ., Mohamed Haris, N. B. ., & Mazlan, N. (2024). The Perspective of Vegetable Farmers in Readiness to Face the Post Covid-19 Pandemic: A Cross-Tabulation Analysis. *Advances in Agricultural and Food Research Journal*, *5*(1). https://doi.org/10.36877/aafrj.a0000502

Mohd Pakri, M. A., Shah, J. A., Haris, N. B. M., & Mazlan, N. (2025). Empowering Vegetable Farmers through Skill Development to Tackle Post-COVID-19 Challenges: Insights from Partial Least Squares Modelling. International Journal of Academic Research in Progressive Education and Development, 14(1), 254–272. http://dx.doi.org/10.6007/IJARPED/v14-i1/24274

Mohd Pakri, M. A., Arif Shah, J. ., Mohamed Haris, N. B. ., & Mazlan, N. The Perspective of Vegetable Farmers in Readiness to Face the Post Covid-19 Pandmic: A Cross Tabulation Analysis. Poster presenter in National Agricultural and Food Engineering Convention (NAFEC), 2023. (Silver medal).