A systematic review of the role of integrated farming and the participation of universities in ensuring food security: Malaysia's effort

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Key words: famines, food security, integrated farming, agricultural universities, Malaysia.

Contributions: MTHS, conceptualized the idea, wrote the original draft, and acquired the funding; FSS, wrote the initial draft, visualization, reviewed and edited the article; MIMZ, IK, acquired the funding, and reviewed and edited the article. All authors have accepted responsibility for the entire content of this article and approved its submission.

Conflict of interest: the authors declare no other conflict of interest.

Ethics approval and consent to participate: not applicable.

Funding: the Ministry of Higher Education funded this research through the PENJANA KPT-CAP (Career Advancement Programme).

Availability of data and materials: data sharing does not apply to this article as no new data were created or analyzed in this study.

Acknowledgments: the authors would like to thank the Department of Aerospace Engineering, Faculty of Engineering, Universiti Putra Malaysia, and Laboratory of Biocomposite Technology, Institute of Tropical Forestry and Forest Product, Universiti Putra Malaysia, for the close collaboration in this research.

Received: 21 September 2023.
Accepted: 9 February 2024.
Early access: 29 March 2024.

Italian Journal of Food Safety 2024; 13:11854
doi:10.4081/ijfs.2024.11854

Abstract

Food security is critical for promoting health and well-being and achieving sustainable development, especially in developing countries. Despite the recent efforts to improve it, food security is still a concern due to the rapid increase in populations, conflicts, and natural disasters worldwide. Universities, particularly agricultural universities, play an essential role in addressing food security issues by researching, developing new technologies, and providing education and training to farmers and other stakeholders. The main objective of this review is to discuss the role of universities and integrated farming in ensuring food security, specifically in Malaysia. It includes a brief overview of the different types of integrated farming methods that can be used to improve food security and finally discusses the Student Farmer Entrepreneur program, which can be crucial for promoting food security by increasing agricultural productivity, promoting local food production, encouraging sustainable agriculture practices, and supporting rural development. This review also considers the significant impact of the Malaysian government and universities on food security. With integrated farming and the Student Farmer Entrepreneur program, food security can be further improved.

Introduction

Food is one of a human's five primary necessities to survive. It contains necessary nutrients, aiding growth, repair, body tissue maintenance, and regulating vital anatomy processes. Due to its extreme importance for human development and civilization, most countries in the world have constitutional guarantees on food. Thus, in 1948, the Universal Declaration of Human Rights recognized the right to food as a vital core for an adequate standard of living (Office of the United Nations High Commissioner for Human Rights, 2010).

In 1996, the first World Food Summit defined food security as a state where all individuals within a given population have access to safe and nutritious food at all times, ensuring they can maintain a healthy and active life (Peng and Berry, 2018). It is well known that food security heavily depends on agriculture. Since ancient times, famines have occurred everywhere around the world. It was in the early 1970s that the severe scarcity of food in the world market, which caused soaring prices and famines worldwide, created food security awareness among people (Zhou and Wan, 2017). Governments worldwide have started developing and implementing policies and rights to protect food security and prevent famines from occurring once more.

Famine is defined as an extreme scarcity of food, and it could stem from a combination of conflict, economic policies, chronic poverty, natural disasters, or climate change (USA for UNHCR, 2022). Table 1 summarizes the greatest famines in history (Smil, 1999; Grove, 2007; Majd, 2013; Song, 2019; Baek *et al*., 2020; Gao *et al*., 2021; Mishra and Aadhar, 2021; Kuzovova, 2022).

History has proven that many lives will be lost if measures are not taken. The effort to enhance food security has become more prevalent in recent years. Although food security has improved recently, 828 million people still experience hunger (WHO/UN, 2019). Due to the COVID-19 pandemic, world hunger has started to rise once more. More than 30 million children still suffer from severe acute malnutrition (WHO, 2023), and 45% die from starvation (UN WFP, 2022). Due to the increasing awareness of food security, governments and non-government bodies in countries worldwide have started taking up the responsibility to ensure food security by developing several policies and proposals, giving donations, and much more to combat the food crisis.

In Malaysia specifically, the focus is on integrated farming, by involving the participation of local universities. Integrated farming can be defined as a whole farm management system that combines modern tools and technologies with traditional practices. It is used based on a given site and situation, often employing many cultivation techniques in a small growing area. It aims to manage all resources available with continuous improvement while being bound to sustainable development. Integrated farming is based on three dimensions: economic development, social development, and environmental protection. The system must be profitable to be sustainable and can be designed using various practices and techniques, including crop-livestock integration and whole-system cycling. Integrated farming reduces input-driven agriculture and encourages the use of natural resources and communities (Behera and France, 2023).

Integrated farming plays a role in food security by addressing several challenges small farms face in highly populated regions or countries. Integrated farming incorporates intercropping, within-field strip rotation, soil munching, and many more to increase food production (Chai *et al.*, 2021). Furthermore, sustainable practices such as recycling nutrients, water conservation, and reducing synthetic fertilizer and pesticide usage help maintain the health of the soil and the environment, ensuring long-term food production (Chai *et al.*, 2021). Integrated farming can also enhance climate resilience by adapting to changing weather conditions and reducing climate change's impact on food production (Paramesh *et al.*, 2022). Finally, integrated farming can help countries achieve food sovereignty by developing local food production capabilities and reducing dependence on external inputs and resources (Ansar and Fathurrahman, 2018). To efficiently deploy integrated farming in the community, it is vital to have the participation of universities.

Universities can establish research platforms with highly qualified talent pools of researchers and staff in collaboration with local, regional, national, and international partners to find solutions to alleviate persistent food insecurity through integrated farming (University of Malaysia Terengganu, 2022). Appropriate technologies are needed to develop an integrated farming system, and universities can provide these necessary technologies for sustainable farming and food security (Ansar and Fathurrahman, 2018). Additionally, universities can integrate agriculture and agronomic models with social and demographic modeling approaches to increase agricultural sustainability.

University participation is vital in ensuring food security because college students are a group that is highly impacted by food insecurity, with prevalence estimates on Malaysian campuses ranging between 22% and 69.4% (Razak *et al.*, 2014; Abu Bakar *et al.*, 2019; Izwan Syafiq *et al.*, 2019; Rajikan *et al.*, 2019; Jamil *et al.*, 2020). Food insecurity among university students can negatively impact their academic performance, physical and mental health, and food choices. Thus, getting them involved in ensuring food security through integrated farming will be very beneficial not only to them but also to the community as a whole. Involving students in integrated farming provides them with hands-on learning experiences related to food production, agriculture, and nutrition. This practical engagement enhances their understanding of where food comes from and how it fuels their bodies. Educating students about integrated farming systems and their role in food security can help promote sustainable agricultural practices from a young age. This knowledge equips them to contribute to sustainable food production and environmental conservation in the future. Student participation in integrated farming fosters community involvement and awareness about the importance of local food production. It can also encourage the integration of agriculture, food production, and nutrition education into the regular curriculum, promoting a holistic approach to learning. Therefore, this review aims to further discuss the role of universities and integrated farming in ensuring food security.

Table 1. Greatest famines in history.

Year	Event	Country	Cause	Death toll (estimated)	References
1315-1317	Great Famine of 1315	Europe	Overpopulation, climate change	7,500,000	(Baek *et al*., 2020)
1630-1632	Deccan Famine	India	Three consecutive crop failure	7,400,000	(Mishra and Aadhar, 2021)
1783-1784	Chalisa Famine (Gao et al., 2021)	India	Prolonged droughts	11,000,000	
1789-1793	Skull Famine (Grove, 2007)	India	Prolonged droughts	11,000,000	
1810, 1811, 1846, 1849	Four Famines	China	Droughts	45,000,000	(Song, 2019)
1917-1919	Persian Famine (Majd, 2013)	Iran	War, droughts	10,000,000	
1932-1933	Holodomor	Soviet Union	Economic policies	8,000,000	(Kuzovova, 2022)
1959-1961	The Great Chinese Famine	China	Economic policies	30,000,000	(Smil, 1999)

Food security

Despite the recent effort to improve it, food security is still a concern due to the rapid increase in populations, conflicts, and natural disasters worldwide. Food security is only ensured when it fully encompasses the four key dimensions (Food and Agriculture Organization, 2006): availability, access, utilization, and stability.

Food availability refers to the food supply within a region, including food quantity, quality, and diversity (Swaminathan and Bhavani, 2013). This criterion is achieved when the amount of food is sufficient and consistently available to every citizen in the country. Access refers to the ability of individuals to obtain food, which can be affected by factors such as income, geography, and social status (Gebremariam *et al.*, 2017). Utilization refers to the ability of individuals to utilize the food they consume to meet their nutritional needs (Akem, 2022). Finally, stability refers to the ability of a population to maintain access to food over time, regardless of factors such as climate change, political instability, or economic shocks (García-Díez *et al*., 2021). Food security is critical for promoting health and well-being, reducing poverty, and achieving sustainable development, especially in developing countries.

According to the data provided by the Food and Agriculture Organization of the United Nations, the prevalence of undernourishment has been increasing since 2012, as shown in Figure 1 (Food and Agriculture Organization, 2023). It can be seen that the prevalence of undernourishment has significantly increased post-COVID-19. Thus, due to the worrying increase in undernourishment, there has been a significant increase in food security research conducted worldwide.

Currently, an increase in food security research is being conducted to solve the current issues with food supply. A search was conducted in the SCOPUS library to find the number of journals published from 2013 until 2023. The keyword used was "food security". The results have led to a total of 53,868 journals that have been published with food security as the main subject of the research. Figure 2 shows that there has been an increment of research worldwide conducted from 2013 until 2023 aiming to enhance food security, and Malaysia has also taken part in this effort. By searching through the SCOPUS library with "food security" as the keyword and limited to the country "Malaysia" ranging between 2013 and 2023, the result shows that 1051 journals were published. It can be seen that an increasing amount of research was being conducted between 2013 and 2023. Similar to the trend shown by the prevalence of undernourishment, the amount of research increased significantly post-COVID-19, as shown in Figure 3.

Food security issues in Malaysia

Based on the Global Food Security Index 2022, Malaysia is ranked 41st among 113 countries (Ministry of Agriculture and Food Security, 2023). Although Malaysia has made significant progress in food security in recent years, challenges remain. The country has a well-developed agricultural sector, which accounts for 8% of the gross domestic product and provides employment for 16% of the workforce (International Trade Administration, 2023). One major problem with Malaysia's food security is its lack of self-sufficiency in essential food items (Arshad *et al.*, 2011). The country relies heavily on food imports to meet domestic demand, particularly for certain products such as rice, wheat, and meat. When the COVID-19 pandemic hit Malaysia, a supply chain disruption affected food security within the country (OECD, 2020).

One of the primary causes of low food security in Malaysia is the ineffective policy of placing price ceilings on staples to improve nutritional value. This policy did not make any substantial changes and instead lowered the food supplies for staple foods (Ikram, 2023). Many of the strategic plans suggested were either not implemented or ineffective in ensuring food security. Meanwhile, there is still a need to clarify the budget to address issues such as malnutrition. Thus, this leads to slow progress on

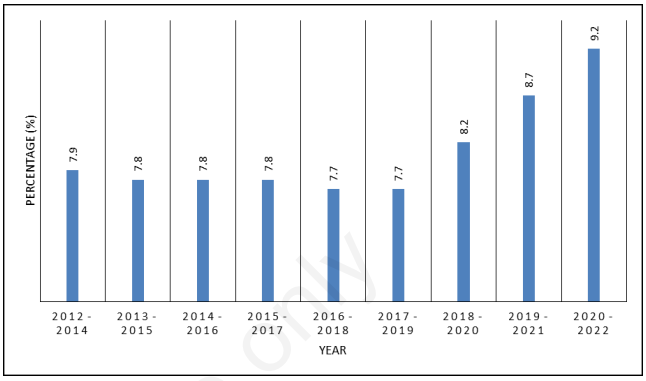

Figure 1. Prevalence of undernourishment for three-year average from 2012 to 2022.

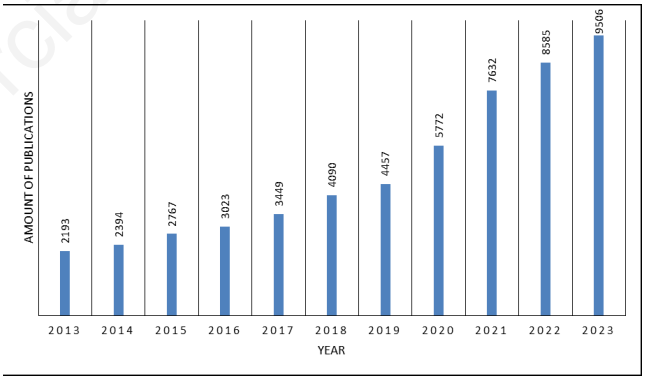

Figure 2. Food security study worldwide from 2013 to 2023.

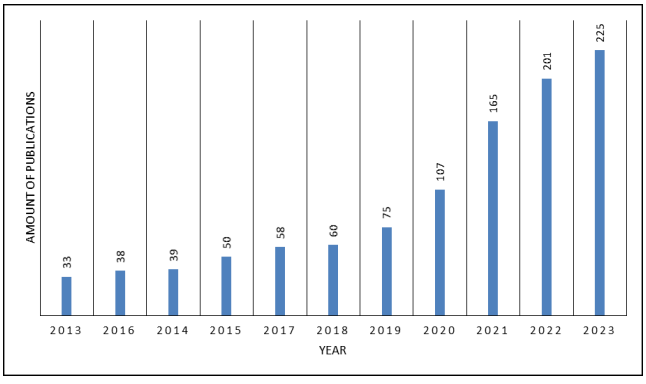

Figure 3. Food security journals affiliated with Malaysia published from 2013 to 2023.

policy implementation and low nutritional value as the year progresses.

Another problem with food security in Malaysia is that there is no collaboration between government bodies to drive the national agenda. The Ministry of Agriculture focuses solely on agricultural aspects and neglects other aspects that relate to them. The ministry cannot see the bigger picture; thus, there is no coordinated farm-to-fork approach, which could also address the food waste issue (PEMANDU, 2009).

Securing essential food items is also an issue in Malaysia, a country that lacks clarity on the list of focused food items (Wong *et al*., 2022). Thus, ensuring the right amount of food needed for a particular essential item is harder. If the list of priorities for the critical food item could be identified, then the local production of that specific item could be increased instead of procuring it through imports.

In Malaysia, the cultivated food crops are much lower than industrial crops. This is because the financial yield of industrial crops is much higher than food crops, attracting more growers. In return, the production of industrial crops will increase, thus creating a vicious cycle of industrial crop production. Most of the farming areas will be dedicated to industrial crops, decreasing the area that could be used for food crops to ensure food security (International Trade Administration, 2023).

Another critical challenge to food security in Malaysia is the unequal distribution of wealth, which can limit access to food for some population segments (Alam *et al*., 2016). Poverty and food insecurity remain an issue in certain parts of the country, particularly among marginalized communities such as indigenous people and migrant workers.

Climate change has also affected Malaysia's weather, leading to more frequent and severe droughts, floods, and other extreme weather events (Mahmood *et al*., 2022). These climate-related challenges can affect food production and availability, particularly in rural areas.

In addition, one of the main challenges in the agricultural sector is attracting young people's interest in being agricultural entrepreneurs. Agriculture is still considered unprofitable, but it can be turned into a business that can generate a high income. More young people involved in the agricultural sector will indirectly increase agricultural production. At the same time, to increase productivity, Malaysia should switch to smart farming. The country must use technological developments that can dynamically develop the agricultural sector.

Despite these challenges, the Malaysian government has improved food security by investing in agricultural research and development (Flaherty and Dardak, 2013), promoting sustainable farming practices (Khorramnia *et al*., 2014; Rahman and Dardak, 2021), and implementing food safety regulations (Philip, 2015). Additionally, Malaysia has established strategic partnerships with other countries to secure food supplies and reduce reliance on imports. Overall, while there are challenges, Malaysia has made significant strides toward achieving food security and continues to work toward improving the situation for all its citizens.

Initiatives by the Malaysian government

Many governments worldwide have implemented several policies and programs to address food security issues in their countries, including Malaysia. The Malaysian government has launched the National Food Security Policy to ensure the availability, accessibility, and affordability of safe and nutritious food for all Malaysians (Sani *et al.*, 2022). The policy outlines strategies for enhancing domestic food production, reducing reliance on food imports, and promoting sustainable farming practices.

In 2019, the government launched the National Agrofood Policy to strengthen the agro-food sector and enhance food security (Ministry of Agriculture and Food Security, 2021). The policy aims to increase food production, promote innovation and technology adoption, and improve market access for farmers.

The government also provides various agricultural subsidies and incentives to support farmers and encourage agricultural production (Bernama, 2023). For example, the government offers subsidies for fertilizers, seeds, and other inputs and assistance for crop insurance and marketing. The government has established the Food Price Stabilization Scheme to stabilize the prices of essential food items and ensure they remain affordable for all Malaysians (Bala, 2022). Under this scheme, the government purchases and sells essential food items at fixed prices to prevent fluctuations. The government has implemented strict food safety regulations to ensure that all food produced and consumed in the country meets the highest safety and quality standards. The Ministry of Health and the Ministry of Agriculture and Agro-based Industry enforce these regulations. The government promotes sustainable farming practices to improve productivity, reduce environmental impacts, and enhance food security (Khorramnia *et al*., 2014). For example, the government provides training and technical assistance to farmers on sustainable agriculture practices such as organic farming and conservation agriculture.

In the latest policy, the government has drawn up the National Food Security Policy Action Plan 2021-2025 (DSMN Action Plan) to increase the food system's resilience. This plan has five strategies, namely, expanding technological adaptation in the food system as a pragmatic step to increase the efficiency and productivity of the system based on the economic scale and sustainable agriculture, empowering research and development based on food security towards increasing food production capacity and agricultural inputs such as fodder, breeds and quality seeds domestically, empowering the availability of food security data to identify and monitor the level of food security of the Malaysian population based on locality, translate food security aspirations as a shared responsibility by focusing efforts to expand strategic collaboration based on food security between ministries, state governments, and the private sector and strengthen cross-departmental governance and agency to bridge gaps in the food system to improve the efficiency of national food security monitoring.

In the recent 2023 budget, the agricultural sector received the government's primary attention. In this regard, as much as RM 5.32 billion has been allocated to strengthen the agricultural sector and national food security further. Overall, the Malaysian government has taken several steps to address food security issues in the country, including increasing domestic food production, promoting sustainable agriculture, and ensuring the safety and affordability of food for all Malaysians. However, even with these initiatives given by the government, their complete implementation could not be realized entirely without the help of local universities.

The role of universities in food security

Universities, particularly agricultural universities, play an essential role in addressing food security issues by researching, developing new technologies, and providing education and training to farmers and other stakeholders. Universities play an indispensable role in producing a knowledgeable and highly skilled

workforce in the agricultural sector and providing solutions by conducting research and innovation.

One of the efforts made by universities to ensure food security is through research and development (Ezanee, 2022). Agricultural universities research new crop varieties (Glenn *et al.*, 2017; Kanwal *et al*., 2022; Gros-Balthazard *et al*., 2023), innovative farming techniques (Depenbusch *et al*., 2021; Liu *et al*., 2021; Montes de Oca Munguia *et al*., 2021), and sustainable agricultural practices to improve productivity (Piñeiro *et al*., 2020; Muhie, 2022; Boufous *et al*., 2023) and efficiency in food production (Bin Rahman and Zhang, 2022; Jiang *et al.*, 2022). They also research climate change impacts on food production and develop strategies to adapt to changing conditions (Gedik and Günel, 2021; Filho *et al*., 2022).

Agricultural universities provide training and education to farmers and other stakeholders on sustainable agriculture practices, agricultural entrepreneurship, and food safety (Raof *et al*., 2020). Training and education help farmers improve their skills, knowledge, and capacities to produce food sustainably and efficiently.

Another way that the university could play a role in ensuring food security is through community outreach (Alam *et al*., 2016; Doustmohammadian *et al.*, 2022). Agricultural universities often engage with local communities to promote food security and raise awareness of food-related issues. They collaborate with local farmers, non-governmental organizations, and other stakeholders to develop solutions to food security challenges, such as improving market access and increasing crop diversity.

Technology transfer is another way universities could help ensure food security (Hassan, 2023). Agricultural universities work to transfer technology to farmers, such as using precision agriculture tools and crop management software, to help farmers increase crop yields and reduce waste. They also develop and promote the use of renewable energy sources in agriculture, such as solar panels and biogas systems.

As for policy development, agricultural universities provide evidence-based research to help in policy development related to food security. University researchers work with governments and international organizations to develop policies and strategies that support sustainable agriculture, promote food safety, and enhance food security.

Finally, universities can provide vacant areas for agricultural farming. Utilizing this area will not waste the vacant space and could lead to more production within the country. In addition, this space can be used for agro-tourism and increase awareness of food security among students and nearby residents.

Universities play a vital role in ensuring food security in the country. Being the center of learning and knowledge sharing, universities could become a bridge for spreading awareness of food security among citizens. Furthermore, with the vacant spaces available in the universities, small farms and integrated farming can be used to create an area suitable for learning and community engagement in order to spread awareness of food security among the students and local community.

Utilizing vacant spaces in universities

The vacant spaces on the university's grounds can be thoroughly utilized and contribute to increasing food security among students and the surrounding community. The vacant space can be utilized by turning it into community gardens, campus farms, aquaponics, rooftop gardens, vertical farming, and food forests. By utilizing vacant campus areas for food production, universities can contribute to food security, promote sustainable agriculture practices, and provide opportunities for education and community engagement.

Community gardens

Universities can create community gardens where students, staff, and local community members can grow food (Carney *et al*., 2012; Rezai *et al*., 2016; Kusumanagari and Ellisa, 2021; Hassan, 2023). These gardens will produce fresh fruits and vegetables and serve as an educational ground for teaching sustainable agriculture practices.

Community gardens are plots of land that are collectively gardened and cared for by a group of individuals within a community. The location of gardens could be in urban or rural areas. The garden serves as a source of fresh produce for the community and a gathering place for individuals to share their gardening knowledge and build relationships.

Community gardens can have numerous benefits, which are: i) improved access to fresh produce – community gardens can provide individuals access to fresh, locally-grown produce that may not be readily available. The access can help improve the overall health of community members by increasing their consumption of fruits and vegetables; ii) education and skill-building – community gardens can teach individuals about sustainable agriculture practices, food production, and gardening skills. Education and skill-building can be precious for children and young adults who may have yet to be exposed to these topics in their regular education; iii) community building – community gardens can bring people together from diverse backgrounds and help build relationships within a community. Gardeners can share their knowledge and experiences, and gardening can create a sense of shared responsibility and connection to the land; iv) environmental benefits – community gardens can help reduce the carbon footprint of food production by reducing the distance that food needs to travel from farm to table. Gardens can also help improve soil health and biodiversity and reduce the need for chemical fertilizers and pesticides; v) economic benefits – community gardens can help reduce household food expenses by providing access to fresh produce at a lower cost. They can also offer opportunities for individuals to sell their excess produce at local farmers' markets, generating income for themselves and their community.

Community gardens can be a valuable tool for promoting food security and building strong, resilient communities. They provide a space for individuals to connect with the land and each other while also promoting sustainable agriculture practices and improving access to fresh produce.

Campus farms

Universities can also establish small-scale on-campus farms to produce crops for consumption or sale to local markets (Galloway, 2021). These farms can utilize sustainable agriculture practices and provide opportunities for students to gain hands-on experience in farming. A campus farm is an agricultural system on a university or college campus. Campus farms can be used for various purposes, such as teaching and research, food production, and community outreach. These farms can range in size from small plots of land to larger-scale operations that produce a significant amount of food for the campus and surrounding community.

Campus farms can have numerous benefits for universities, including: i) education and research – campus farms can provide

students with hands-on experience in sustainable agriculture practices, food production, and research. Education and research can be precious for agricultural or environmental science students; ii) food security – campus farms can provide a source of fresh, locally-grown produce for the campus community, reducing the carbon footprint of food production and improving food security; iii) community outreach – campus farms can promote community engagement and outreach, providing opportunities for residents to learn about sustainable agriculture practices and engage with the university; iv) economic benefits – campus farms can provide opportunities for students and staff to sell their excess produce at local farmers' markets, generating income for the campus and the surrounding community; v) environmental benefits – campus farms can help promote biodiversity and improve soil health, reducing the need for chemical fertilizers and pesticides and promoting sustainable land use practices.

Campus farms can be established in various ways, depending on the needs and resources of the university. Students may run some campus farms, while a dedicated team of staff and faculty may run others. Some universities may partner with local farms or community organizations to establish a campus farm, while others may have access to their own land or green spaces.

Overall, campus farms can be a valuable tool for promoting sustainable agriculture practices, improving food security, and building strong, resilient communities. They provide a space for individuals to connect with the land and each other while promoting education, research, and community outreach.

Aquaponics systems

Another way is by setting up aquaponics systems. Universities can set up aquaponics systems, which combine aquaculture (raising fish) and hydroponics (growing plants in water) (K. *et al.*, 2016). These systems can be used to grow fish and vegetables in a closed-loop system, using nutrient-rich water from the fish to fertilize the plants. In an aquaponics system, fish are raised in tanks, and their waste is used as a nutrient-rich fertilizer for plants grown in water. Aquaponics systems can be set up in various ways, depending on the size and needs of the operation. Some systems may use a recirculating system, where water is continuously cycled through the fish tanks and the plant beds. Other systems may use a vertical design, where the plants are grown in vertical towers fed by water pumped from the fish tanks.

The benefits of aquaponics systems include: i) efficient use of resources – aquaponics systems use significantly less water than traditional agriculture, as the water is recirculated through the system. Additionally, because the fish and plants are grown in the same system, there is no need for additional fertilizer or chemicals; ii) high yield – aquaponics systems can produce a high yield of fish and vegetables, making them an efficient use of space and resources; iii) sustainable – aquaponics systems are a sustainable way to produce food, which uses minimal resources and creates minimal waste; iv) versatile – aquaponics systems can be set up in various locations, including urban areas or areas with poor soil quality, making them a versatile option for sustainable agriculture; v) educational – aquaponics systems can be used as an educational tool for teaching about sustainable agriculture, biology, and chemistry.

Aquaponics systems can be valuable for promoting sustainable agriculture practices and improving food security. They provide a way to produce high yields of fish and vegetables using minimal resources, making them an efficient and sustainable option for food production.

Rooftop gardens

The vacant space on the university's rooftop can be turned into a rooftop garden, which can be used to grow crops and provide insulation. Rooftop gardens can also help reduce heat island effects in urban areas. Rooftop gardens are a type of urban agriculture that involves the cultivation of plants on the roof of a building (Gupta and Mehta, 2017). These gardens can range in size from small rooftop plots to larger-scale operations that cover the entire rooftop of a building. Rooftop gardens can grow various plants, including fruits, vegetables, herbs, and flowers.

The benefits of rooftop gardens include the following: i) efficient use of space – rooftop gardens provide a way to use the otherwise unused space on the roof of a building for food production, making them a valuable tool for urban agriculture; ii) improved air quality – rooftop gardens can help improve air quality by absorbing carbon dioxide and other pollutants; iii) reduced urban heat island effect – rooftop gardens can help reduce the urban heat island effect, where urban areas are significantly warmer than surrounding rural areas, by providing a natural cooling effect; iv) improved energy efficiency – rooftop gardens can help improve the energy efficiency of buildings by providing insulation and reducing the need for air conditioning; v) community building – rooftop gardens can unite communities around food production and sustainable agriculture practices.

Establishing a rooftop garden requires careful planning and consideration of weight limitations, water supply, and sunlight exposure. Rooftop gardens may require special equipment such as raised beds, irrigation systems, and protective coverings to protect the building from water damage.

Overall, rooftop gardens can be a valuable tool for promoting sustainable agriculture practices and improving food security in urban areas. They provide a way to use otherwise unused space for food production efficiency and numerous environmental and social benefits for the surrounding community.

Vertical farming

Universities can also use vertical farming techniques in small spaces to grow crops, such as on walls or stacked layers (Oh and Lu, 2023). Vertical farming can be a particularly effective way to utilize the limited space on campus. Vertical farming is a method of growing crops in vertically stacked layers or shelves, using artificial lighting and a controlled environment. In a vertical farm, plants are grown in trays or containers stacked on each other, allowing for a high density of crops in a small area.

The benefits of vertical farming include the following: i) efficient use of space – vertical farming allows for the efficient use of space, as crops can be grown in a much smaller area than traditional farming methods; ii) reduced water usage – vertical farming can use up to 70% less water than traditional farming methods, as water can be recycled and reused; iii) year-round harvest – vertical farming allows for year-round harvesting, as the crops are grown indoors in a controlled environment, unaffected by weather conditions or seasonality; iv) controlled environment – vertical farming allows for precise control over environmental factors such as temperature, humidity, and lighting, leading to more consistent and predictable crop yields; v) reduced environmental impact – vertical farming can reduce the environmental impact of agriculture by minimizing the use of pesticides and herbicides, reducing carbon emissions associated with transportation, and reducing the amount of land required for farming.

Vertical farming requires specialized equipment such as grow lights, climate control systems, and hydroponic systems for grow-

ing crops. It also requires a significant initial investment and ongoing operating costs. Overall, vertical farming can be a valuable tool for promoting sustainable agriculture practices and improving food security, particularly in urban areas where space is limited and traditional farming methods are not feasible. It provides a way to efficiently grow crops with minimal environmental impact and consistent yields, allowing for year-round food production.

Food forests

Finally, universities can create food forests that are designed to mimic natural ecosystems and provide a diverse range of fruits, nuts, and other edible plants (Albrecht and Wiek, 2021). These forests can produce food, provide habitats for wildlife, and enhance the ecological health of the campus (Olesen *et al*., 2022). A food forest, also known as a forest garden or edible forest garden, is a type of agroforestry system that mimics a natural forest ecosystem but incorporates edible trees, shrubs, and plants. In a food forest, plants are arranged in layers, similar to the layers of a natural forest, with tall trees providing shade and structure, understory trees and shrubs providing additional shade and habitat, and groundcover plants filling in the gaps.

The benefits of food forests include: i) biodiversity – food forests promote biodiversity by creating a diverse ecosystem that provides a habitat for various species, including birds, insects, and other wildlife; ii) sustainable agriculture – food forests are a form of sustainable agriculture that uses ecological principles to produce food while minimizing external inputs such as pesticides and fertilizers; iii) food security – food forests can improve food security by providing a reliable source of nutritious food, particularly in areas where traditional agriculture is not feasible; iv) soil health – food forests improve soil health by increasing organic matter, reducing erosion, and promoting beneficial microorganisms; v) community building – food forests can unite communities around food production and sustainable agriculture practices. Establishing a food forest requires careful planning and consideration of factors such as soil type, climate, and plant selection. Food forests may require ongoing maintenance, such as pruning, mulching, and irrigation. Food forests can also be valuable for promoting sustainable agriculture practices and improving food security. They provide a way to efficiently use the land for food production while promoting biodiversity, soil health, and community building.

Impact of university participation in ensuring food security

Impact on academia and government

University participation plays a significant role in ensuring food security, and its impact on the government can be seen through research, education, and community engagement. Several studies have highlighted the prevalence of food insecurity among university students in Malaysia, emphasizing the need for interventions and policies to address this issue. Universities, such as Universiti Malaysia Kelantan (2024) and Taylor's University (2024), have established impact labs and research initiatives focused on food security and nutrition, aiming to contribute to national and global efforts in this area. By conducting research, promoting sustainable agricultural practices, and providing education on food security, universities can inform evidence-based policies and empower communities to achieve food security. Additionally, understanding the factors contributing to food insecurity among university students is essential for developing targeted interventions and support systems. Therefore, university participation addresses food security challenges and promotes the population's well-being. The impact of university participation in ensuring food security for the government is evident through the establishment of specialized labs and research initiatives, as well as the recognition of food insecurity among university students, emphasizing the need for targeted interventions and support systems (Ahmad *et al.*, 2021).

Impact on the economy and society

Food insecurity among college students negatively impacts their health, stress levels, academic performance, and overall well-being. Access to healthy food is crucial for college students to avoid additional stressors that affect their mental and physical health. Studies have shown that food insecurity is associated with poorer diet quality, and food-insecure students often have to choose cheaper and less healthy alternatives (Celik *et al.*, 2023). Food insecurity also affects society as a whole, impacting the future workforce and the availability of qualified talent. Therefore, addressing food insecurity among college students should be a priority for college administrators to meet the needs of their students, maintain their reputations, and meet missions of excellence (Loofbourrow and Scherr, 2023).

University participation in ensuring food security could also impact the economy. Research from Australian universities indicates a high prevalence of food insecurity among college students, ranging from 38% to 48% (Loofbourrow and Scherr, 2023). This can affect students' finances, academic performance, and physical and mental health, ultimately influencing their future economic contributions. Additionally, programs such as the Double Up Food Bucks initiative have been shown to benefit the local economy by supporting local farmers and keeping more food dollars within the community (Colorado State University, 2024). University participation can contribute to the overall economic well-being of society by fostering a healthier and more productive future workforce.

Impact on the environment

The university's research can lead to the development of sustainable agricultural practices that reduce the environmental impact of food production. Additionally, universities can promote local and organic food, reducing the carbon footprint associated with food transportation (Columbia University, 2024). Overall, universities need to prioritize sustainable and environmentally friendly practices in their efforts to ensure food security.

Integrated farming

Integrated farming can increase food security by producing more food with a smaller environmental footprint. Universities can play a role in developing sustainable integrated farming systems through research and education. For example, the University of Putra Malaysia (UPM), which focuses on agriculture, forestry, and veterinary medicine, has a strong background in research on integrated farming practices in the country. Farm Fresh @ UPM is an example of a Malaysian university effort to ensure food security through integrated farming and sustainable practices (Farm Fresh, 2024), as shown in Figure 4. It is a collaboration between UPM and Farm Fresh, a local milk brand. These demonstrate the ongoing interest and research in integrated farming in Malaysia, particularly in smallholder agriculture and sustainable livelihoods.

Universities can also educate farmers on sustainable farming practices and provide training on implementing integrated farming systems. Integrated farming is a sustainable agricultural system that combines different farming activities, such as crop cultivation, livestock rearing, and aquaculture, in a mutually beneficial manner (Mukhlis *et al.*, 2018). It aims to optimize the use of natural resources, minimize waste and environmental pollution, and increase the productivity and profitability of the farming enterprise. By maximizing the potential of integrated farming, food security could be improved.

In integrated farming, different system components are carefully planned and managed to complement each other. For example, animal waste can be used as fertilizer for crops, while crops can be used as feed for livestock (Raghuram, 2022). Aquaculture can be integrated into the system by using the nutrient-rich water from fish ponds to irrigate crops and using the crop residues as feed for fish (Raghuram, 2022).

Integrated farming also promotes biodiversity by maintaining a variety of crops and animals on the farm, which helps to enhance soil health and reduce the risk of pest and disease outbreaks (Hird, 2017). Additionally, integrated farming can provide a more stable source of income for farmers by diversifying their sources of revenue. Integrated farming is a holistic approach to agriculture that seeks to optimize the use of resources, improve productivity, and promote environmental sustainability.

The literature search in the SCOPUS library using "integrated farming" as the keyword, ranging between 2013 and 2023, shows that 7072 documents were published worldwide. From the trend shown in Figure 5, it can be seen that there has been a significant increase in research conducted, with the highest number of publications occurring in 2021, with a total of 1010 publications. This shows an increasing interest in this subject area. Furthermore, the pandemic significantly affected the agricultural sector, causing world hunger to increase significantly post-COVID. Thus, research related to food security and integrated farming is heavily emphasized throughout the world. The literature search found that several types of integrated farming have been identified, which will be further discussed in the following sub-sections.

Crop-livestock integrated farming

Crop-livestock integrated farming is a type of integrated farming system where crop cultivation and livestock rearing are combined in a mutually beneficial way (Hird, 2017). This system is based on the principle that crops and animals are interdependent and can enhance each other's productivity and sustainability.

In crop-livestock integrated farming, animal manure is used as crop fertilizer, while crop residues are used as feed for livestock. This helps reduce dependence on synthetic fertilizers and animal feed, which can be expensive and have negative environmental impacts.

In this system, the crops and animals are carefully managed to complement each other. For example, the crops may be rotated to provide a variety of animal feed. In contrast, the animals may be grazing on the crop residues after harvest, which helps maximize resource use and minimize waste.

An example of this integration was a study conducted by Bansal *et al*. (2022). The research discusses the influence of crop diversification and grazing animals on soil aggregation and associated carbon, nitrogen, and phospholipid fatty acids. The study emphasizes the improved physicochemical and microbial properties resulting from integrating livestock into a crop production system, which can enhance farm profitability, reduce weed and pest pressure, and improve nutrient cycling. The study provides valuable insights into the potential benefits of integrated crop-livestock systems, particularly in terms of soil health and overall farm profitability. The findings underscore the importance of diversification and grazing management in agricultural practices, highlighting the potential for enhanced soil quality and agricultural productivity through integrated crop-livestock systems.

Crop-livestock integrated farming has many benefits, including: i) improving soil fertility – animal manure is a rich source of nutrients that can help to improve soil fertility and reduce the need for synthetic fertilizers; ii) diversifying income – farmers can generate revenue from crop production and livestock rearing, which can help stabilize their income and reduce risk; iii) reducing environmental impact – using animal manure as fertilizer can help reduce the ecological impact of synthetic fertilizers. In contrast, integrating crops and animals can help reduce waste and improve sustainability. Overall, crop-livestock integrated farming is a sustainable agricultural system that can help to improve productivity, profitability, and environmental sustainability.

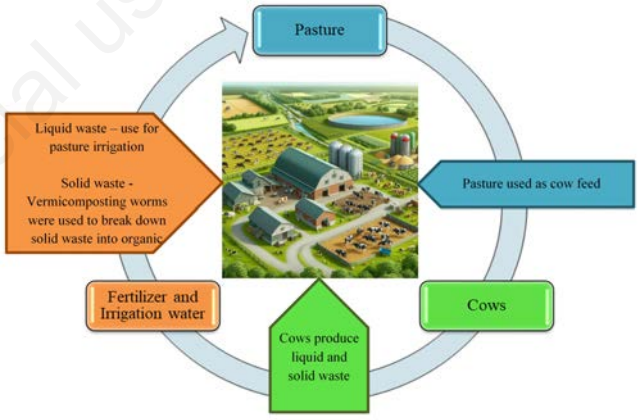

Figure 4. Integrated farming and sustainable practices on Farm Fresh @ University of Putra Malaysia.

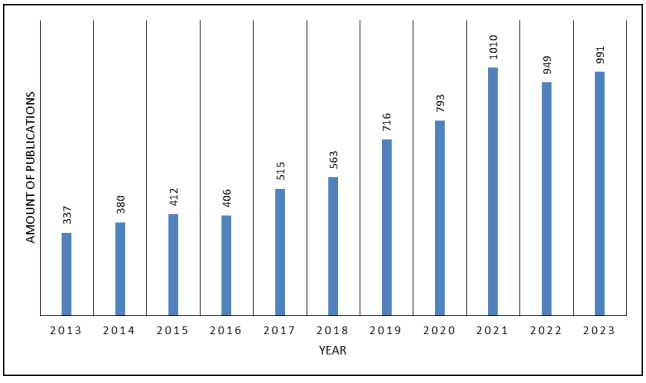

Figure 5. Research publications related to integrated farming between 2013 and 2023.

Agroforestry

Agroforestry is a system that combines tree crops with other crops, such as vegetables or fruits (Vijayanathan *et al*., 2022). The trees provide shade and wind protection for the other crops, while their leaves and branches can be used as mulch or for animal feed.

Agroforestry is a land use management system integrating trees, crops, or livestock on the same land. It is a sustainable agricultural approach that seeks to optimize land, water, and other resource uses while promoting biodiversity and environmental conservation.

In agroforestry, trees are planted in a way that complements other crops or livestock on the farm. For example, trees can be planted on the edges of fields to provide shade and wind protection for crops. Alternatively, trees can be grown in rows between crops, allowing them to share nutrients and water.

Research conducted by Rathore *et al*. (2022) discusses the positive impact of agroforestry systems on soil carbon storage, water productivity, and economic returns in semi-arid regions. The study hypothesized that integrating perennial fruit trees with seasonal crops could enhance farm productivity, economic returns, and environmental sustainability. The research found that agroforestry systems have a remarkable carbon sequestration potential, contributing to multiple crucial roles in restoring ecosystem services. Additionally, agroforestry reduces runoff, intercepts rainfall, and binds soil particles together, thus helping in erosion control, and ultimately contributing to soil health improvement and maintenance. The study concludes that agroforestry systems positively impact soil carbon dynamics, soil health, and profitability in semi-arid regions.

Agroforestry has many benefits, including: i) improved soil fertility – trees help to improve soil fertility by fixing nitrogen and other nutrients from the air and depositing them in the soil; ii) biodiversity conservation – agroforestry systems provide habitat for various wildlife and promote biodiversity; iii) climate change mitigation – trees in agroforestry systems absorb carbon dioxide from the atmosphere, helping to mitigate climate change; iv) increased productivity – trees can help improve crop yields by providing shade, reducing wind erosion, and serving as a source of income by selling timber and other products.

Depending on the local ecological and socioeconomic conditions, agroforestry can take many forms. Standard agroforestry systems include alley cropping, forest farming, and silvopastoral systems.

Aquaculture-agriculture integrated farming

Aquaculture-agriculture integrated farming is a type of integrated farming system that combines fish farming (aquaculture) with crop cultivation (agriculture) (Ibrahim *et al*., 2023). This system uses nutrient-rich water from fish ponds to irrigate crops, while the crop residues can be used as feed for the fish.

In this system, fish ponds are often constructed in or near agricultural fields, allowing for water use for irrigation. The water from the fish ponds is rich in nutrients, such as nitrogen and phosphorus, which can help fertilize crops and improve soil fertility. The crops, in turn, can help filter the water and remove excess nutrients and sediments, thus improving the water quality for the fish.

One example of aquaculture-agriculture integrated farming is a study by Wei *et al.* (2023). The research focuses on the emergence and expansion of a new crop-aquaculture system in China that combines rice production with crawfish breeding (Wei *et al.*, 2023). The study finds that China's rice-crawfish farming system has rapidly expanded due to high demand and profits. It was reported that the total area of rice-crawfish farming in five provinces of China increased significantly from 0.11 Mha in 2013 to 0.70 Mha in 2019. This indicates a growing trend toward integrating aquaculture with traditional rice farming.

Aquaculture-agriculture integrated farming has many benefits, including: i) increased productivity – using nutrient-rich water can help improve crop yields, while the crop residues can be used as feed for the fish, thus increasing overall productivity; ii) reduced waste – the integration of crops and fish can help to reduce waste, as the nutrients from one component are used to support the other; iii) diversified income – farmers can generate revenue from fish production and crop cultivation, thus reducing their reliance on a single source of income; iv) improved environmental sustainability – using nutrient-rich water can help reduce the need for synthetic fertilizers. In contrast, the crops can help improve the fish's water quality.

Aquaculture-agriculture integrated farming can take many forms, depending on the local ecological and socioeconomic conditions. Some standard aquaculture-agriculture integrated farming systems include rice-fish farming, shrimp-vegetable farming, and fish-vegetable farming.

Horticulture-livestock integrated farming

Horticulture-livestock integrated farming is a type of integrated farming system that combines horticulture (the cultivation of fruits, vegetables, and ornamental plants) with livestock rearing (Dawson, 2016). In this system, livestock is raised alongside horticultural crops to maximize the use of resources and minimize waste.

In horticulture-livestock integrated farming, animal manure is used as fertilizer for the horticultural crops, while the crop residues are used as feed for the livestock. This helps reduce dependence on synthetic fertilizers and animal feed, which can be expensive and have negative environmental impacts.

The livestock in this system can provide additional benefits, such as pest control, soil aeration, and weed control. The study conducted by Garcia *et al.* (2023) investigated the impact of pasture-raised poultry on arthropod communities in a mixed-cover crop system. The research found that pasture-raised poultry could have profound and complex net effects on arthropod communities due to their high density per area, broad omnivory, and high manure deposition. The study examined the impact of different poultry densities on ground and vegetation-dwelling arthropods and found that the presence of poultry could have both positive and negative effects on different arthropod groups. The integration of pasture-raised poultry into agroecosystems was shown to have significant implications for arthropod communities, with potential impact pathways including direct and indirect effects such as predation and nutrient deposition.

Horticulture-livestock integrated farming has many benefits, including: i) improved soil fertility – animal manure is a rich source of nutrients that can help to improve soil fertility and reduce the need for synthetic fertilizers; ii) diversified income – farmers can generate revenue from horticultural crop production and livestock rearing, which can help stabilize their income and reduce risk; iii) reduced waste – the integration of horticulture and livestock can help to reduce waste, as the nutrients from one component are used to support the other; iv) improved environmental sustainability – using animal manure as fertilizer can help reduce synthetic fertilizers' ecological impact. In contrast, integrating crops and animals can help reduce waste and improve sustainability.

Overall, horticulture-livestock integrated farming is a sustainable agricultural system that can help improve productivity, profitability, and environmental sustainability.

Silvopastoral systems

Silvopastoral systems are a type of agroforestry system that combines the cultivation of trees with livestock grazing (Hoque *et al*., 2022). In this system, trees are planted in pastures or rangelands to provide shade and shelter for livestock and other benefits such as improving soil fertility and carbon sequestration. The trees in silvopastoral systems can be managed for multiple purposes, such as timber production, fruit production, or forage production. The livestock can graze beneath the trees, providing natural fertilization and weed control, and the tree foliage and fruits can be used as supplementary feed.

The study conducted by Assani Seidou *et al.* (2023) used native trees and shrubs as fodder in the silvopastoral system. These were used to evaluate the effects of different small-scale agroforestry systems on milk production and dairy cows' reproductive performance in Benin's drylands. It was found that the silvopastoral system increased milk production and improved the demographic traits of dairy cows. It also contributed to the adaptation of livestock smallholder farmers to climate change. The study emphasized the importance of promoting traditional and technical innovations, delineating animal corridors, rehabilitating good management practices for silvopastoral resources, and valorizing indigenous knowledge to support the adaptation of smallholder livestock farmers to climate change.

Silvopastoral systems have many benefits, including: i) improved livestock productivity – the shade and shelter provided by the trees can help to reduce heat stress in livestock, leading to improved productivity and reduced mortality rates; ii) improved soil fertility – the trees in silvopastoral systems can help improve soil fertility by fixing nitrogen and other nutrients and reducing soil erosion; iii) climate change mitigation – the trees in silvopastoral systems can help to sequester carbon, thereby mitigating climate change; iv) biodiversity conservation – silvopastoral systems can provide a habitat for wildlife, including birds, insects, and mammals; v) diversified income – farmers can generate revenue from tree production and livestock rearing, which can help stabilize their income and reduce risk.

Silvopastoral systems can take many forms, depending on the local ecological and socioeconomic conditions. Some common silvopastoral systems include savannah woodlands, parklands, and agroforestry-pastoral systems.

Impacts of integrated farming

The impacts of integrated farming on various sectors such as academia, government, society, the economy, and the environment have been explored in recent research. However, not all aspects are equally covered in the available literature. Integrated farming has gained considerable attention in modern agriculture due to its potential to promote sustainable practices and improve the quality of life for resource-poor farmers. It involves integrating multiple agricultural activities, such as crop cultivation, livestock rearing, aquaculture, and agroforestry, within a single cohesive system. This approach has multiple objectives: sustainability, food security, farmers' security, and poverty reduction.

Academia and government

Academic researchers working among farmers in developing countries are in a privileged position to understand what farmers are doing and observe their practices. This allows for the development of new ideas and methods for better farming, which brings together individual farmers, organizations, environmental groups, agriculture administrators, university educators, and policymakers. Integrated farming practices can help quantify the carbon benefits of sustainable farming practices, ensuring that farmers are rewarded for their efforts in reducing their carbon footprint. This can lead to further research and development in the field of sustainable agriculture. In addition, research conducted by Chai *et al*. (2021) shows that integrated farming with intercropping has increased food production by 20%. This research contributes to the development of more sustainable and efficient farming practices. Furthermore, with the government's support, adopting integrated farming could promote research by providing incentives and implementing policies encouraging farmers to adopt these systems. This can lead to a more sustainable and resilient agricultural system, as well as improved livelihoods for farmers.

For example, the Standards and Industrial Research Institute of Malaysia collaborates with local industries and academic institutions to facilitate technology transfer and commercialization (Business Today Editorial, 2023). This collaboration ensures that industries have access to advanced research infrastructure and expertise and promotes the development of a skilled workforce.

Society and economy

Integrated farming in Malaysia has significant impacts on both society and the economy. The agricultural sector in Malaysia has been essential in contributing to the country's economy, providing employment and food supplies. The involvement of farmers in the agriculture sector has increased over the years, and agriculture has become a critical sector in the Malaysian economy. The sustainable transformation of the agriculture sector is seen as crucial for the sustainable reduction of poverty and the transition to a higher economic status in the country. Integrated farming offers opportunities for smallholder farmers and can contribute to increased productivity and crop diversification, thus enhancing food security and farmers' incomes. Therefore, integrated farming is vital to Malaysia's economic development and social well-being.

One example of integrated farming in Malaysia that affects society and the economy is the Integrated Agricultural Development Project in Sarawak, which has raised farmers' incomes by creating a large-scale fruit producer (Idris *et al.*, 2012). Additionally, FGV Holdings Berhad's integrated farming business contributes to Malaysia's food security goals and provides opportunities for more locals to venture into agriculture (FGV Holdings, 2023). The modernization and diversification of Malaysia's agro-food sector and better integration with its "farm-to-fork" food economy could help advance other national priorities and achieve higher levels of inclusion and resilience (World Bank, 2020).

Environment

Integrated farming has a positive impact on the environment in several ways. By integrating crops, livestock, agroforestry, and aquaculture, integrated farming helps reduce the environmental impact of agriculture by minimizing greenhouse gas emissions, water pollution, and soil erosion. This approach also improves soil health by reducing synthetic fertilizers and pesticides, leading to healthier and more productive crops. Furthermore, integrated farming can contribute to the sustainable intensification of agricul-

ture by offering opportunities for intensified cycling of nutrients, water, and energy on farms, thereby reducing inputs, pollution, and waste. Additionally, integrated farming provides a stable and sustainable production system, which helps minimize risk and increase resilience to climate change (Fatima *et al.*, 2023). Therefore, integrated farming is considered an eco-friendly and sustainable approach to agricultural development.

In Malaysia, the integration of cattle and oil palm production is a strategy to increase Malaysian beef self-sufficiency and palm oil sustainability. This integration helps mitigate environmental impacts and increase resource use efficiency. It helps reduce herbicide use for weeding control, improve nutrient cycling, water retention, and biological function, and increase soil organic carbon (Grinnell *et al.*, 2022).

The role of the student farmer entrepreneur in food security

Integrated farming is a sustainable agricultural production system that aims to maintain farm incomes, achieve nutritional improvement, and safeguard the environment. The role of student farmer entrepreneurs is essential in integrated farming because they can bring innovative ideas and technologies to the farming system, leading to increased productivity and profitability. Student farmer entrepreneurs can also help to diversify crops, reduce their vulnerability to pests and diseases, and improve soil health. Furthermore, adopting an integrated farming system can provide better business opportunities for graduates and employment for the rural population.

The Student Farmer Entrepreneur program encourages young people, particularly students, to venture into agriculture and farming businesses (Bakar *et al*., 2022). The program aims to promote entrepreneurship and innovation in agriculture by providing students with the necessary knowledge, skills, and resources to start and manage successful agricultural enterprises.

The program typically involves theoretical and practical training, including farm management, crop production, livestock management, and agricultural marketing courses. Participants may also receive mentoring and coaching from experienced farmers and business experts to help them develop their entrepreneurial skills and grow their businesses.

The program aims to create a new generation of agricultural entrepreneurs who can drive innovation and growth in the agricultural sector while contributing to food security and economic development in their communities.

The program plays a vital role in food security in several ways: i) increasing agricultural productivity – by promoting entrepreneurship and innovation in agriculture, the program can help increase agricultural productivity, producing more food to meet the needs of a growing population; ii) promoting local food production – Student Farmer Entrepreneur programs typically encourage participants to start agricultural enterprises in their local communities. This can help promote local food production, increasing availability and reducing dependence on imported food; iii) encouraging sustainable agriculture – Student Farmer Entrepreneur programs often emphasize the importance of sustainable agriculture practices, such as conservation farming, which can help conserve natural resources and protect the environment while ensuring long-term food security; iv) supporting rural development – many student farmer entrepreneurship programs focus on supporting rural development by promoting entrepreneurship and creating new economic opportunities in rural areas. This can help to reduce poverty and promote economic growth in rural communities. It can be concluded that the Student Farmer Entrepreneur program can be crucial in promoting food security by increasing agricultural productivity, promoting local food production, encouraging sustainable agriculture practices, and supporting rural development.

Conclusions

Food security is essential to fighting against famines and ensuring positive country development. Food insecurity and hunger have been global issues for centuries. Although there has been a decline in world hunger in recent years, the problem persists and cannot be eradicated. Due to the COVID-19 pandemic, the amount of hunger slightly rises because of the inability to continue with food imports and exports and restraints on normal farming activities. Governments worldwide have been stepping up their efforts to ensure food security. Similarly, universities have been working with the government by proposing new policies, new farming methods, training and educating farmer students, and several more. Universities and governments need to work together so that future problems with food shortages will not happen.

Food insecurity has increased significantly after the COVID-19 pandemic due to the cut-off of the supply chain during the quarantine period. To regain the food security performance shown during pre-COVID, many researchers started to focus on enhancing food security. Thus, there was an increase in research publications on food security that were published post-COVID. This trend also includes Malaysia, where a visible increase in publications affiliated with Malaysia was published. In these published papers, a compilation of food security issues in Malaysia and the initiatives taken by the government were discussed. It was discovered that the main issue with food security in Malaysia is due to the lack of proper planning and collaboration of the government with different agencies and non-governmental bodies. In addition, the lack of food crops compared to industrial crops also severely affected the self-sufficiency of food distribution. However, there are some initiatives that the government has taken to mitigate these issues. Many policies and collaborations have been developed recently to help boost food security in Malaysia.

One of the most conspicuous actions taken by the Malaysian government is its collaboration with local universities. The universities play a significant role in implementing most of the initiatives developed by the government. Universities are an excellent medium for disseminating information clearly and could become a bridge to reach the surrounding communities with the students' help. In addition, universities could assist the local farmers through consultation from university researchers or experts, as well as *via* a funded research and development program that connects the community and the university. Furthermore, vacant spaces in the university can also be turned into a learning and community engagement area to develop better information circulation and networking. The students could work with the surrounding community and develop valuable skills and experiences that cannot be obtained through indoor learning.

The most significant method that the universities use to enhance food security while also developing future agricultural experts is integrated farming. From the review, it can be concluded that there are many types of integrated farming. Furthermore, with the universities playing a role in implementing this system, there is a visible increase in food security within Malaysia. Implementing

integrated farming in university study programs helps develop students' skills and experience at an early stage. It not only positively impacts the students' development but also helps increase food production within the country. Thus, student farmer entrepreneurship programs were highly recommended, and the collaboration between the government and universities has heavily emphasized this type of program in recent years.

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