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Knowledge and Acceptance Level of Vegetable Farmers on Organic Farming and Biological Control in Kampar, Perak

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Organic farming practices and biological control (biocontrol) are relatively less adopted in agriculture compared to conventional agricultural practices globally. In recent years, it is becoming more common, but in Malaysia it is still disfavored. Generally, in Malaysia, not many farmers are practicing organic farming and adopting biocontrol. This study aims to determine the level of knowledge and acceptance of vegetable farmers about organic farming practices and biocontrol in the Kampar district. Fifty farmers were selected using non-probability sampling, whereas face-to-face and telephone interviews were conducted to collect data with the aid of a questionnaire. The respondents had a good level of knowledge (mean score of 4.00) and a neutral perception on the economic benefits of organic farming (mean score of 2.65). They have a moderate level of knowledge on biocontrol (mean score of 3.24). The respondents' acceptance level for organic farming practices (mean score of 2.65) and biocontrol (mean score of 3.13) were neutral, mainly due to the low local demand for organic vegetables and the low confidence in the effectiveness of biocontrol. The respondents possess moderate knowledge of organic farming and biocontrol but conventional farming was still preferred. The acceptance level for these practices remained neutral. Participatory program such as farmer field school can be introduced to increase the adoption of these practices.

Keywords: acceptance level; biocontrol; knowledge; organic farming; vegetables farmers

I. INTRODUCTION

Before the advent of chemical fertilisers, organic farming has been practised since 13,000 BP when humankind first domesticated and cultivated wild plants (Balter, 2007; Behera *et. al.*, 2011; Tomaš-Simin & Trbić, 2016). In the 1960s, the Green Revolution tried to address increasing global food demand using improved crop varieties, and expanded use of chemical fertilisers and pesticides. It was a success in many developing countries (Andersen & Hazell, 1985; Pingali, 2012). This farming practice is known as the conventional farming method, where farmers focus on the high yield production while neglecting the possible health and environmental hazards (Chausali & Saxena, 2021). Today, the persistence and indiscriminate use of mineral fertilisers and chemical pesticides in the agriculture sector had led to serious unintended consequences on the environment (i.e., the loss of diversity, land degradation) and socio-economic (i.e., poorly developed input, credit and output market for small farmers and policies discriminated against small farmers welfare to apply information and resources effectively) (Pingali, 2012; Pisani, 2006; Kumar, 2017).

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The increasing environmental awareness has led to the sustainable farming practice which better known as organic farming. This focus on sustainable crop production through conserving a healthy agroecosystem (Chausali & Saxena, 2021). Organic farming has been proven to be more sustainable compared to conventional farming, as it better preserves biodiversity and fertile soil (Ghabbour *et. al.*, 2017; Katayama *et. al.*, 2019; Wintermantel *et. al.*, 2019; Vellenga *et al.*, 2018). There has been a rapid global rise in organic farming in the late twentieth century and this is because of the increasing demand by consumers, especially the younger generation, higher net profit per hectare of farming area, and the increase in societal pressure in environmental protection had leads to more research on these farming methods (Siegner, 2017; Tanrivermis, 2006; Watson *et al.*, 2006). Furthermore, some developed countries, such as Sweden and the US, also placed efforts in encouraging the conversion of conventional farming to organic farming by incentivising the farmers through subsidies (Lohr & Salomonsson, 2000). The number of organic producers worldwide increased by more than 55% compared to the last decades, while organic farmland increased 2.9% from 2017 to 2018, reaching a total of 71.5 million hectares (Willer *et al.*, 2020). Concomitantly, organic farming encouraged non-chemical pest control by adopting biocontrol. Biocontrol is an effort that relies on natural enemies, such as predators, parasitoids and beneficial microbes, to manage and reduce pest damages. It is divided into three approaches: conservation, classical and augmentative. Conservation biocontrol focuses on conserving natural enemies of the pest that naturally exist by improving the agroecosystem or farming practices. The classical biocontrol involved the introduction of exotic natural enemies of certain pests and this usually is done for the control of invasive pest. Lastly, augmentative biocontrol is done by periodic release of natural enemies which have low populations in nature to suppress a pest and keep it under control (Sanda & Sunusi, 2014). This is an effective and environmentally friendly approach (Holmes *et al.*, 2016). According to Lenteren (2012), biocontrol will play a key role in modern pest management because it is more sustainable and environmentally friendly. The adoption of biocontrol has grown rapidly across the globe due to the low investment cost and increasing number of organic farmers (Eggar, 2020; El-Shafie, 2019). In Southeast Asia, countries such as Cambodia and Thailand have used biocontrol effectively for pest control. For example, the huge success in the management of invasive cassava mealybug, *Phenacoccus manihoti*, using parasitoid, *Anagyrus lopezi* (Wyckhuys *et al.*, 2018) and the use of egg parasitoid *Trichogramma* spp. in the management of multiple key Lepidoptera pests (such as *Spodoptera* spp.) in maize and paddy (Babendreier *et al.*, 2019).

Unfortunately, organic farming in Malaysia is catching up relatively slower compared to other Asian nations as Malaysia has far fewer certified organic producers (Willer *et al.*, 2020). Based on the report presented by Iskandar (2018), the total number of farms with myOrganic certification in Malaysia was 211, only 54 of which are vegetable farms. Furthermore, the biocontrol is mainly used in large-scale plantations, such as the management of rhinocerous beetles in oil palm plantations using entomopathogenic fungi, *Metarhizium* spp. and Oryctes nudivirus (OrNV) (Kamarudin *et al.*, 2019), control of rodent population in plantations and paddy fields using barn owls (Wood & Fee, 2003), and management of Bakanae disease in rice using *Trichoderma* species (Wan *et al.*, 2015). In the case of Malaysian vegetable farming, the only well-known success story is the control of diamondback moth, *Plutella xylostella*, by parasitoids, *Diadegma semiclausum* and *Diadromus collaris* in highlands cabbages *(Sarfraz et al., 2005)*. Currently, there is limited documentation regarding the knowledge and level of acceptance of vegetable farmers on organic farming and biocontrol in Malaysia. Therefore, the objective of this study is to examine the level of knowledge and acceptance level of vegetable farmers in Kampar district towards organic farming and biocontrol. It is important to have this documented to more effectively communicate and promote these practices to them.

II. MATERIALS AND METHOD

A. Pre-survey

The questionnaire for this study was divided into 6 sections: (1) demographic of farmers, (2) general knowledge on organic farming, (3) perception on economic benefits of organic farming, (4) acceptance level of organic farming, (5) general knowledge of biological control, and (6) acceptance level of biological control. In section one, there were 10 questions associated with the demographic information of the respondents pertaining to gender, ethnicity, age, highest academic qualification level, farming location, farming experience, farm size, land ownership, major crops produced, and farming techniques. The questions in section two to six were designed with reference to Bader (2020), Farmer *et al.* (2014), and Fami *et al.* (2016) to measure the level of knowledge, perception and acceptance in line with the objective of the study. Knowledge, perception and acceptance levels were measured on a 5-point Likert scales ranging from 1 (strongly disagree) to 5 (strongly agree), to indicate the respondent's agreement on the statements (Preddy & Watson, 2010). The questionnaire was trilingual (English, Mandarin and Bahasa Malaysia). A pilot test was carried out in a small group of farmers in preparation for the actual study (Hassan *et. al.*, 2006; Lancaster *et al.*, 2002). Thirty vegetable farmers participated in the pilot test as a minimum of 12 respondents were recommended (Lancaster *et al.*, 2002). The questionnaire was amended to better fit the targeted population based on feedback from the pilot test respondents. The questionnaire was reviewed by the Scientific and Ethical Review Committee of Universiti Tunku Abdul Rahman (UTAR) and the ethical clearance (U/SERC/105/2020) was obtained in July 2020.

B. Study Area

This study was carried out in Kampar district which the townships include Kampar, Bandar Baru, Gopeng, Kopisan, Lawan Kuda, Kota Bahru, Jeram, Kuala Dipang, Sungai Siput Selatan, Malim Nawar, Tronoh Mines and Mambang Diawan. Kampar district was selected for its concentrated vegetable farming communities (Chai, 2020). The location was within the vicinity of the university, which allowed accessibility during the movement control order (MCO) restrictions of the COVID-19 pandemic.

C. The Study

In this study, 50 individual vegetable farmers in the Kampar district were selected. Non-probability sampling was used, because it focused on similar traits or characteristics shared among samples (Etikan *et al.*, 2016). Data collection was conducted from August 2020 to October 2020. The survey was carried out face-to-face and through telephone interviews and data was collected with the aid of structured questionnaire. Face-to-face interviews were the main mode of data collection, as it allowed extra information to be gained through verbal and non-verbal communications (Opdenakker, 2006). Non-verbal communication such as body languages, facial expression and attitude are social cues observable during face-to-face interviews. Telephone interviews were used when in-person meetings are restricted, such as accessibility to the farm, time availability of the farmers for face-to-face interview, and travel restrictions due to pandemic (Glogowska *et. al.*, 2011; Thulasingam & Cheriyath, 2008).

D. Statistical Analysis

Data collected from the surveys were analysed using Statistical Product and Service Solution (SPSS) program version 26.0. The mean and percentage of the Likert-scale were calculated for each of the questions in all sections. Knowledge level and the perception of respondents were categorised into 3 classifications: high level of knowledge or positive perception (3.51-5.00), moderate level of knowledge or neutral perception (2.51-3.50) and low level of knowledge or negative perception (1.00-2.50) (Bader, 2020; Ozturk *et al.*, 2019). The acceptance level was obtained from the mean of the Likert-scale for the questions involved. It was classified according to various level, from low (1.00-2.49), neutral (2.50-3.49), to high (3.50-5.00) (Roy *et al.*, 2017).

III. RESULT AND DISCUSSION

A. Demographic Information

The demographic information of the respondents collected in this study is shown in Table 1. A total of 50 vegetable farmers in Kampar district responded to the survey conducted. Forty-nine out of 50 (98%) respondents were male and only 1 respondent (2%) was female. According to Giuliano (2014), less females are involved in the agriculture sector due to the physical strength required in farm labour and domestic commitments. The majority of the respondents were Chinese (92%) while Indian and other ethnicities contributed 4%, respectively.

Most of the respondents (30%) were within the age group of 50 to 59, followed by the age group above 60 (28%), the age group of of 40-49 (16%), the age group of 31-39 (14%) and the age group below 30 (12%). Shaharudin and Rahim (2020) and Abdullah and Samah (2013) stated that younger generations are not passionate about working in the agriculture sector, instead preferring to work indoors, with less exposure to extreme weather and less physical exertions. Most of the survey participants (64%) possess only secondary education as their highest formal academic qualification. Typically, Malaysian agriculture labourers are low literacy as experience and physical strengths are perceived as the main requirements for this career (Shaharudin & Rahim, 2020). Furthermore, it is also perceived by majority of the society as labour-intensive career with no prospect of social mobility, reserved for the uneducated and poor (Dising & Puad, 2018; White, 2012). This could be the main factor that driving youth away from agriculture, as the efforts needed to achieve lucrative profits are not considered proportional. Most of the respondents were farmers in Malim Nawar (37.74%), followed by Gopeng and Kota Bahru. The registered farmers in Kampar district who were members of the vegetable association were primarily farmers from Malim Nawar (Chai, 2020).

In terms of the land status of the respondents, 69% of the respondents leased their land from the government and the majority had a farm more than 3 hectares. According to Chai (2020) and Chong (2020), the average rate for leasing vegetable cropland in Malim Nawar, Gopeng, Kota Bahru and Jeram per hectare was RM105 per month, while the land for oil palm plantation was rated at RM800 and above depending on the number of palms planted. The affordable leases in the area is probably a factor in the willingness of the respondents to expand their farm land. Ahmad (2020) reported that the Perak State Government also strongly encourages farmers to register and use government lands gazetted for agriculture purposes. Furthermore, approximately 34% of the respondents had less than 10 years of farming experience, followed by 21-30 years (28%). Many farmers begin farming at a later stage of life or after retirement to support their retirement living, and young people who venture into agriculture is often suffer unemployment in other sectors (Abdullah & Sulaiman, 2013; Soon, 2017). Others inherit the family profession where a child takes over the farm of his aging parents. Most of the respondents (60%) have farms larger than 3.01 hectares, followed by 11 respondents (22%) who have farms between 1.01 and 2.00 hectares. Six respondents (12%) were farming 2.01 to 3.00 hectares of land, whereas only 3 respondents had farms smaller than 1.00 hectare.

The most cultivated crops among the respondents were sweet potatoes, *Ipomoea batatas* (21%), yam bean, *Pachyrrhizus erosus* (20%) and maize, *Zea mays* (22%) (Table 1). These are also the top three major crops in Kampar district (Department of Agriculture, 2020). The land in this district is mostly comprised of sandy and sandy loam soils and they are suitable for these crops (Chai, 2020; Delp, 2018; Tong, 2017; Nedunchezhiyan *et al.*, 2012). Most of the respondents (96%) adopt conventional farming techniques on their farms, where they still heavily depended on agrochemicals in crops production (Figure 1), which corresponded with the findings of Mispan *et al.* (2015) and Shobri *et al.* (2016) that most farmers in Malaysia still heavily relied on agrochemicals in their farming practices.

Table 1. Demographic information of the respondents

Variables	**Frequency**	**Percentage (%)**
Gender		
Male	49	98.00
Female	1	2.00
Ethnicity		
Chiniese	46	92.00
Indian	2	4.00
Others	2	4.00
Age (Years)		
≤ 30	6	12.00
31-39	7	14.00
40-49	8	16.00
50-59	15	30.00
≥ 60	14	28.00
Educational Level		
No Formal Education	4	8.00
Primary Education	6	12.00
Secondary Education	32	64.00
Tertiary Education	8	16.00

Farming location		
Gopeng	8	15.09
Jeram	6	11.32
Kampar	6	11.32
Kopisan	1	1.89
Kota Bahru	7	13.21
Lawan Kuda	5	9.43
Malim Nawar	20	37.74
Farming Experience (Years)		
≤ 10	17	34.00
11 – 20	10	20.00
21 – 30	14	28.00
≥ 31	9	18.00
Land Tenure		
Leased Land	37	69.00
Owned Land	10	18.00
Temporary Occupation License (TOL) Land	7	13.00
Farm size (ha)		
≤1.0	3	6.00
1.0-2.0	11	22.00
2.1-3.0	6	12.00
≥ 3.01	30	60.00
Major vegetables cultivated		
Sweet potato	19	20.88
Yam bean	18	19.78
Maize	20	21.98
Others	34	37.36

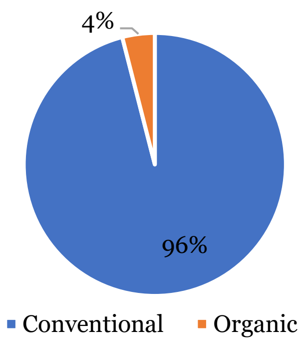

Figure 1. Farming practice of the respondents

B. Knowledge and Perception of The Respondents on Organic Farming Practices

Table 2 shows that the respondents have high level of knowledge on organic farming practices but the adoption of this practice remained low, most probably attributed to their neutral perception on the economic benefits of organic farming. Eighty percent of the respondents (mean score of 4.12) agree with Behera *et al.* (2011) that organic farming is a traditional farming practice started by farmers during ancient times using natural resources. Despite practising crop rotation, using animal manure and compost, which are generally considered as common practices in organic farming (Meena *et al.*, 2013), almost half of the respondents consider organic farming as specific to certain geographical regions. Most of the respondents deemed their current land ill-suited to organic farming, because of low soil fertility. The respondents explained that organic farming requires undisturbed environments such as newly cleared or virgin lands without conventional farms nearby, surrounded by natural forests, accessible to clean water and air, and with a buffer zone to separate from adjacent farms. However, successful conversion to organic farming has been demonstrated in the absence of said good environment (Padel, 2001). For example, the Palayamanan model where the rice farmers in the Philippines incorporate different practices, including composting, mulching and biocontrol, had created a good environment and enabled farmers to achieve higher harvest and higher income (Corales *et al.*, 2004).

About half of the respondents understood that the application of synthetic pesticides is prohibited in organic farming (mean score of 3.84). Another regulation in organic farming, the elimination of the application of mineral inputs and chemical pesticides, which was understood by half the respondents (Trewavas, 2001). The other half of the respondents were either unsure or do not know about this. This reflected the fact that there are still farmers who were unclear about organic farming practices. According to some respondents, they considered bio-pesticides a kind of chemical input, even though most bio-pesticides are derived from organic sources, including beneficial microbes namely entomophagous fungi (such as *Beauveria bassiana, Verticillium lecanii* and *Metarhizium anisopliae*) (Milner, 1997).

Most of the respondents were aware of the environmental benefits of organic farming practices, namely less soil erosion and environmental pollution, and improved soil fertility. Organic farming is perceived as a sustainable farming method because it could reduce negative externalities resulting from conventional agricultural practices (Meemken & Qaim, 2018). In addition, soil fertility and biodiversity can be improved or restored through organic farming practices due to lower dependence on chemical inputs (Pimentel *et al*., 2005). According to Novara *et al.* (2019), organic farming practices contributed to healthier soil by increasing soil organic matter and lowering bulk density. The increase in soil organic matter and soil organic carbon were found to have a positive effect on crop yield. Healthy soil results in better nutrients uptake by housing diverse microbial communities which helps the plant to better absorb available nutrients (Coyne & Mikkelsen, 2015). Eventually, such practices will lead to a comparable yield to conventional farming while preserving the environment.

Although the respondents were aware of the positive environmental impacts, they did not understand that these environmental benefits can translate into economic benefits. Our findings show that they only had a neutral perception on economic benefits (mean score of 2.65). Most of the aspects in economic benefits were perceived negatively by most of the respondents (Table 3). The majority of respondents (78%) see organic farming as more labour-intensive and time consuming compared to conventional farming. More labour inputs and time are required to operate the farm as it highly depends on manual and mechanical control (Karyani *et al*., 2019). It is reported that the labour-intensiveness of organic farming is highly dependent on farm structure and system. Therefore, a properly managed organic farm can achieve labour efficiency equivalent to conventional farms (Orsini *et al*., 2018). In addition, conventional farming is more capital intensive per hectare compared to organic farming, due to the additional agrochemicals required (Yadav & Kumari, 2020). Hence, savings from agrochemicals can be redirected to investment on labour and suitable technology for the management of an organic farm.

The respondents thought organic farming had lower crop yield. De Ponti *et al.* (2012) reported that organic farming can produce similar yield as compared with conventional farming. Badgley *et al.* (2007) also proved that crop yield by organic farmers in developing countries has shown remarkable increments after conversion from conventional farming. The respondents' believed that crop yield will decline which led to their assumption that organic farming is not profitable (Chai, 2020). The Food and Agriculture Organisation (2007) has proven that organic farming can be more profitable compared to conventional farming with proper marketing strategies. The retail price of organic products are typically higher than conventional products due to the premium charge of organic products (Seufert *et al*., 2017).

One of the farmers in this survey, Ramesh (2020) viewed organic vegetable farming as profitable as it required less input compared to conventional farming, concurring with Yadav and Kumari (2020). The economic analysis of Loncaric *et al.* (2013) found that organic farming increases farm profitability while solving manure disposal problems. Thus, this misconception about organic farming may explain the low popularity. The availability of organic farming input is not a cause for hesitation among the respondents as they think it is easily available in their respective local communities. According to Chai (2020) and Chong (2020), organic inputs such as organic fertilisers and manure are easy to obtain as each farming community has at least one supplier or agriculture shop. Furthermore, unprocessed manure can be easily acquired from the poultry industry at low prices.

Table 2. Knowledge of the respondents on organic farming practices

	Mean ± SD	Percentage of Response (%)		
		Neg.	N.	Pos.
Organic farming practice is a traditional practice that use in ancient time.	4.12 ± 1.26	14	6	80
Organic farming practices can be practised in any farm.	3.24 ± 1.60	36	12	52

Any chemical pesticides are strictly prohibited in organic farming.	3.84 ± 1.62	24	6	70
Organic farming practice is more environmental-friendly (e.g., less soil erosion, more soil microbial activity and less pollution).	4.42 ± 0.84	4	10	86
Organic farming practices will enhance soil fertility (e.g., more readily available nutrients and better nutrients retention) in long-run.	4.36 ± 1.01	8	8	84
Average	4.00 ± 0.48			

Note: Neg.: Negative; N: Neutral; Pos.: Positive.

Table 3. Respondents' perception on economic benefits of organic farming

	Mean ± SD	**Percentage of Response (%)**		
		Neg.	**N.**	**Pos.**
Practicing organic farming is less laborious and time-consuming than conventional farming.	2.12 ± 1.14	78	4	18
Crop yield can be improved through organic farming.	2.04 ± 1.32	70	16	14
Producing organic vegetables would be more profitable than conventional farming.	2.56 ± 1.36	54	20	26
Organic inputs (e.g., fertilisers) are easy to purchase from local agricultural shops.	3.88 ± 1.47	24	4	72
Average	2.65 ± 0.85			

Note: Neg.: Negative; N: Neutral; Pos.: Positive.

C. Knowledge of the Respondents on Biological Control

The respondents had a moderate level of knowledge about biocontrol with a mean score of 3.24 (Table 4). This partial understanding may be a factor in the hesitation of most of the respondents to adopt biocontrol. Only 44% of the respondents knew that biocontrol is not limited to organic farming. Baker *et al.* (2020) claimed that biocontrol can be adopted by both organic and conventional farming systems. Biocontrol is a complementary element, when integrated with conventional farming system, is known as the integrated pest management (IPM) approach (Fountain & Wratten, 2013). It combines several farming practices, focusing on biocontrol, and uses chemical control as the last resort for pest suppression (Naranjo *et al.*, 2015). A review by Samada and Tambunan (2020) explained that the development of bio-pesticides is aimed at replacing synthetic chemical pesticides, as to produce safer food with less or no pesticide residue. This proves that biocontrol is not restricted to organic practices, as bio-pesticide application involves beneficial microorganisms and bio-chemicals only to suppress pests and diseases (Kumar & Singh, 2014).

Although many researchers know that biocontrol is divided into three approaches, this information is often not known by farmers, as 52% of the respondents still think that biocontrol relies solely on introducing biological agents. Among the biocontrol approaches mentioned, only classical biocontrol requires the introduction of biological agents of an exotic origin to control invasive pests (Kenis *et. al.*, 2017; Lenteren, 2012). A success story of classical biocontrol in Malaysia was the control of diamondback moth (*Plutella xylostella*) with the introduction of exotic parasitoids, *Diadegma semiclausum* and *Diadromus collaris*. It managed to suppress the diamondback moth population invading crucifers grown in Cameron Highlands, Malaysia (Sarfraz *et al.*, 2005). The use of *Trichoderma harzianum* to control soil-dwelling pathogens, such as *Rhizoctonia solani*, *Fusarium oxysporum* and *Pythium* spp., is becoming common among more progressive farmers (Zin &

Badaluddin, 2020). They purchase *Trichoderma* inoculum and apply it directly on their farm to suppress soil pathogens (Chong, 2020). They usually only apply based on advice from friends or sales representatives without further understanding the microorganisms. Therefore, it is not surprising that most of the farmers in this survey were only familiar with classical biocontrol approaches. However, to achieve effective biocontrol, farmers do not need to introduce any of the control agents but simply conserve and provide a healthy agroecological system to allow it to happen naturally through conservation biocontrol (Graham *et al.*, 2017). Therefore, this further shows the limited understanding of the respondents about biocontrol.

Almost all respondents (88%) were aware that unlike biocontrol, synthetic pesticides are detrimental to the environment and human health. This concurred with the findings of Sulaiman *et al.* (2019), where most farm or plantation workers know the health hazard of pesticide use, but still suffer from symptoms such as vomiting, diarrhoea, skin irritation and dizziness. They may not understand the severity of this harm as most do not read the safety information and do not receive any relevant education or training (Sulaiman *et al.*, 2019). Farina *et al.* (2016) found that the agricultural soil of Cameron Highlands was contaminated with high pesticide residues due to the farmers' habit of spraying "cocktail" pesticides (a mixture of two or more pesticides). This pollution poses no immediate health risks to farm workers (Farina *et al.*, 2016), but the risks of poisoning may present in the long-term as workers were exposed to the contaminated soil during manual weeding and harvesting (El-Wakeil *et al.*, 2013). The negative impact is not limited only to farms, but pesticides also enter and pollute waterways (Agrawal *et al.*, 2010). This increases the risk of the public exposed to such toxicants with children being the most vulnerable group to the pollution (Agrawal *et. al.*, 2010; Liu & Schelar, 2007). Therefore, farmers who better understand the negative impact of pesticides are more open to adopt biocontrol (Abdollahzadeh *et al.*, 2015).

The respondents unanimously agreed that the adoption of biocontrol required considerable knowledge. According to Kumar (2016), biocontrol is considered a complex form of pest management. Education in the execution of biocontrol is necessary for success. Farmers who decided to implement biocontrol needed to fully comprehend and justify each decision during implementation (Barratt *et al.*, 2017). However, in practice, farmers can acquire necessary training through field education or farmer education, such as the farmer field school (FFS) approach (Ooi & Kenmore, 2005). In the farmer field school approach, farmers were taught about biocontrol through the insect zoo approach. They were shown the predatory behaviour of natural enemies found in the field to help them grasp the principles of biocontrol (Pontius *et al.*, 2002). Eventually, farmers would be able to differentiate "good" insects from "bad" insects. This is important because only 46% of the farmers believe that biocontrol agents protect their crops. Their doubt arises from having never observed the predatory interactions between insects, and to make assumptions based on the proximity of the insect to the crop damage. One of the common misperceptions of farmers in this study is their generalisation of coccinellids (ladybird beetles) as pests, while in truth, the majority of coccinellids are predators. This indicates the inability of the respondents to identify insects in the field, making biocontrol impractical to them at the present.

Most of the respondents (80%) realised that healthier vegetables can be produced with the aid of biocontrol. As biocontrol replaces synthetic chemical pesticides, there will be less or no chemical residues in crops (Kumar, 2016; Rebek *et al.*, 2012). Despite the promise of healthier vegetables, most respondents (68%) believe that biocontrol is challenging to implement and less efficient in managing pests. Many farmers were found to have several common key misconceptions on biocontrol, one of which is that biocontrol is unreliable and slow. This premise is founded in a minority of non-professional who implement the approach without proper research (Lenteren, 2012). In contrast, the results of chemical control are more visible and immediate, thus more convincing to farmers. However, it will lead to many negative externalities (such as pesticide resistance and environmental pollution) in the long run (Kumar, 2016; Pisani, 2006).

Table 4. Knowledge of the respondents on biological control

	Mean ± SD	Percentage of Response (%)		
		Neg.	**N.**	**Pos.**
I think biological control is not only for organic farming.	3.12 ± 1.53	38	18	44
Introduction of natural enemies is not a must to use biological control approach.	2.68 ± 1.49	52	16	32
Usage of synthetic pesticides is harmful to the environment and human health as compared to biological control.	4.24 ± 1.12	8	4	88
It requires a lot of knowledge in order to effectively use biological control (e.g., pest population monitoring, differentiating good and bad insects).	4.68 ± 0.47	0	0	100
Biological control agents will not harm my crops.	3.00 ± 1.58	42	12	46
Biological control can help in producing healthier vegetables.	3.88 ± 0.85	8	12	80
I prefer biological pest control because it is better than chemical control.	2.12 ± 1.34	68	10	22
Application of biological control is not challenging and it is easier to manage pests.	2.16 ± 1.27	68	16	16
Average	3.24 ± 0.95			

Note: Neg.: Negative; N: Neutral; Pos.: Positive.

D. Level of Acceptance on Organic Farming Practices

The respondents had a neutral acceptance level (mean score of 2.65, Table 5) towards organic farming practices, where half of them (48%) proposed the need for a support system to facilitate transitions to organic farming. The supporting resources include, technical support, relevant training, seminars and workshops, accessible information through local agriculture departments and online, and financial assistance. More than half of the respondents (56%) will consider organic farming if there is higher market demand, but two-thirds (66%) were not incentivised by the environmental benefits. Bouttes *et al.* (2018) found that farmers are willing to take short-term risks in adopting new practices if there are long term consumer demands instead of environmental and health benefits. In addition, the most common challenges faced by farmers during the transition are also related to marketing strategies, such as logistics and facilities to market the produce and profitable pricing. Negative peer pressure can also be a problem (Cranfield *et al.*, 2009). Farmers are aware of the risks and technical challenges in implementing new and unfamiliar production practices, but they were willing to endure if there are trusted consultants and experts to help them (Bouttes *et al.*, 2018). This corroborates the results of this study, suggesting that most of the respondents were willing to adopt organic farming with the necessary supports to fetch better market demands. Unfortunately, many Malaysian consumers remain resistant toward purchasing organic produces, probably due to the premium price tag (Meemken & Qaim, 2018; Seufert *et al.*, 2017).

This leads to most (70%) perceiving the conversion to organic farming is highly risky even with more secure land titles and most of them (58%) do not consider this conversion worthwhile due to limited local demand and lack of marketing channels. Although global consumer demand for organic food is increasing, it remains spotty and scarce due to its recent introduction to the supply chain (Fagan, 2017). Consumers of organic food are typically high-income, and willing to pay more for production methods that are environmentally friendly, safe to farmers, locally grown, synthetic pesticide-free and better perceived flavour or nutritional value (Thompson, 2000). The social perception of organic food as more expensive due to low yield is unfounded but remains a concern for farmers attempting to attain financial security. Thus, risk averse farmers would likely continue with their current practice (Mamuya, 2011). Nechaev *et al.* (2018) suggested that the government programmes such as social orientation of state policy (quality of life), promotion of healthy lifestyle, and awareness of environmental problems would spur an increase in demand for organic foods. Legislation and economic policies in setting standards and certification for organic production articulate farmers' eligibility for subsidies and incentives. Developing countries possessing smaller organic market potential could help farmers facilitate the export of organic produce to countries with higher demand. Government can assist farmers in overcoming technical challenges, enforce certification to maintain the standard and export value, provide necessary financial aids through subsidy and navigable land tenure policies, provide suitable platforms for farmers to market produce to suitable markets, raising public awareness on health and environmental benefits of organic products, and subsidising retail prices of organic food to make it more affordable (Archana, 2013; Lockeretz, 2007; Scialabba, 2000; Thompson, 2000).

Table 5. Level of acceptance of respondents on adoption of organic farming practices

	Mean ± SD	**Percentage of Response (%)**		
		Neg.	**N.**	**Pos.**
I will adopt organic farming practices if sufficient resources are provided (e.g., guidelines, techniques and subsidies).	2.92 ± 1.66	48	8	44
I will consider adopting since organic farming is healthier to the environment and human.	2.28 ± 1.42	66	8	26
I will consider adopting organic farming technique if such products can obtain a better demand.	3.06 ± 1.50	40	4	56
I am willing to take risk on managing organic farms.	2.16 ± 1.23	70	12	18
I am willing to take the risk from venturing into organic farming although I do not possess a permanent land title.	2.76 ± 1.67	58	6	36
Average	2.65 ± 0.40			

Note: Neg.: Negative; N: Neutral; Pos.: Positive.

E. Level of Acceptance on Adopting Biological Control

The results in Table 6 revealed that the respondents do not reject the idea of biocontrol but at this point, they are still unsure about adopting this pest management approach (mean score of 3.13). Most of the respondents (60%) showed willingness in adopting biocontrol but most of them (70%) do not want to risk adopting it. If someone they knew uses biocontrol, 86% of them will consider to adopt it. According to Moser *et al.* (2008), factors that influence the adoption of biocontrol include, positive publicity (word of mouth and advertising), personal hands-on experience and the promotion of these approaches by local research institutions, cooperatives or growers' associations. Farmers are more likely to adopt sustainable farming practices when they receive reviews from other farmers who have experienced the new practices (Dessart *et. al.*, 2019; Ghane *et al.*, 2011). Unfortunately, these are not available to farmers in the Kampar district. Thus, the farmers' lack of confidence in biocontrol approaches is due to unfamiliarity, uncertainty on the level of control, higher confidence in chemical pesticides than biocontrol agents, limited biocontrol companies and lack of promotion by local research and agriculture institutions (Cullen *et. al.*, 2008; Moser *et al.*, 2008). The lack of participation of farmers in the development of biocontrol methods led to the failure to disseminate research findings to the farmers. There is a poor communication link between researchers and farming communities which hinders the adoption of this approach (Noorhossein *et al.*, 2010).

There is comparable efficiency between biocontrol and chemical control (Adly, 2015), but biocontrol in certain scenarios, especially open fields with higher abiotic pressure on biocontrol agents, may take a longer time to establish. Most of the respondents (56%) cannot accept the longer duration needed to establish effective control, while 20% of them were unsure. This is understandable as the risk on yield loss increases their financial insecurity (Cullen *et al.*, 2008). Barratt *et al.* (2017) claimed that the implementation of biocontrol does not produce immediate impact, so farmers perceive pesticides as a more reliable and financially guaranteed option. However, Sanda and Sunusi (2014) reported that the use of entomopathogenic nematodes, namely Steinernematidae and Heterorhabditidae, to suppress insect pest populations have a positive effect on crop yield. Similarly, conservation biocontrol is also found to reduce the cost of production and increase yield (Cullen *et al.*, 2008). In a nutshell, biocontrol is effective for pest management in the production of pesticide-free crops and at the same time, conserving the agroecosystem will help generate comparable or even higher yield than conventional practices.

Although most of the respondents still prefer chemical over biocontrol, 54% of the respondents agreed that the increase in agrochemical prices is an incentive to adopt biocontrol. Hoddle (2004) found that farmers would likely adopt biocontrol to reduce production costs, which include labour and agrochemical input (Hoddle, 2004). Rengam *et al.* (2018) inferred prices and advice from licensed pesticide dealers influence farmers' choice of pesticide. In addition, pesticide resistance is becoming common with an increasing dependence on the use of chemicals for pest control. Farmers incur a higher cost by increasing the dosage or frequency of chemical pesticide applications to achieve equal efficacy. However, the recent trend of alternative approaches, such as bio-pesticides and conservation biocontrol, are proposed to replace chemical pesticides due to their lower cost of implementation (Popp *et al.*, 2013). Generally, our findings suggest that the respondents do not adopt biocontrol mainly due to lack of fundamental understanding. The lack of confidence in this approach is due to the lack of exposure and familiarity with biocontrol, leading to erroneous presumptions. In order to encourage adoption, the gaps between institutions and crop producers must be fostered through communication and interaction. These interactions can take the form of participatory training, such as farmer field school.

Table 6. Level of acceptance of respondents on adopting biological control

	Mean ± SD	**Percentage of Response (%)**		
		Neg.	**N.**	**Pos.**
I will consider practising biological control if it is suitable for any farming practices.	3.30 ± 1.66	32	8	60
I am willing to take the risk on adopting biological control.	2.38 ± 1.35	70	8	22
I will adopt biological control in my farm if farmers I know practice biological control.	4.22 ± 1.28	14	0	86
I will adopt biological control although this approach might be time-consuming.	2.52 ± 1.30	56	20	24
The rise in price of agrochemicals could be one of the factors causing me to consider adopting biological control.	3.24 ± 1.70	42	4	54
Average	3.13 ± 0.74			

Note: Neg.: Negative; N: Neutral; Pos.: Positive.

IV. CONCLUSION

The level of knowledge and acceptance of vegetable farmers in Kampar district on organic farming and biological control were surveyed. The respondents possess good level of knowledge with a mean score of 4.00 despite a neutral perception on the economic benefits of organic farming (mean score of 2.65). In general, the respondents understood the philosophy and have fundamental knowledge of organic farming practices. However, most of the respondents still do not adopt organic farming because they are not willing to compromise short term profits for the risks of transition. In addition, the respondents had moderate level of knowledge on biocontrol with a mean score of 3.24. They indicated inadequate understanding in terms of implementation and effectiveness. Without said knowledge, farmers perceive biocontrol as a risk and impractical, leading to a low adoption rate.

The respondents showed a neutral acceptance level (mean score of 2.65) towards organic farming. At this juncture, they are neither against nor in favour of organic farming practices. They were reserved due to the uncertain risks and challenges they perceived in the lack of local demand, inadequate and poor marketing strategies, and lack of support in terms of technical knowledge and government subsidies. The respondents were willing to convert to organic farming if perceived uncertainty can be overcome. Similarly, the respondents had a neutral attitude towards adopting biocontrol with a mean score of 3.13. Most of the respondents were uncertain about adopting biocontrol as part of their pest management practice due to limited awareness of success stories in farms locally and abroad. Therefore, the lack of exposure and doubt about the effectiveness of biocontrol could have led to low confidence among the respondents in the approach and consequently to low adoption. This can be overcome with farmer education program such as the farmer field school which has been proven successful in neighbouring ASEAN countries. In addition, local extension services, such as the Department of Agriculture can provide farmers with more exposure to organic farming and biocontrol through workshops and seminars, which will help to increase awareness.

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