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A Comparison of Strawberry Cultivation: Case Study of Selected Farms in Malaysia and Japan

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Abstract

Strawberries are non-climate crops that can be planted both in temperate and seasonal climate regions and are popular among consumers worldwide. The variety cultivated depends on the region of planting as the effects of temperature, photoperiod and humidity are the main requirements for strawberry growth. Japan is among the top producers of strawberries with noticeable quality. Malaysia plants strawberries in the highland regions but only for local consumption. Thus, the intended study was done to compare the cultivation and post-harvest practice of strawberries between selected farms in Cameron Highlands, Malaysia and Nagano, Japan. A case study approach was used in this study through questionnaires and informal interviews to obtain the required information on demographics, cultivation practices and technology used by farmers of the selected farms. Based on the obtained information, all four farms in Nagano cultivated strawberries in greenhouses with elevated bed system and irrigation techniques, whereas three of the farms from Cameron Highlands cultivated strawberries by planting in an open area covered with rain shelters. The market value of strawberries from Nagano was also higher compared to Cameron Highlands, despite the minimal differences in farm areas.

Keywords: Strawberry, Cameron Highlands, Nagano, Cultivation, Farm Management.

Introduction

Strawberry or scientifically known as *Fragaria x ananassa* Duch belongs to the Rosaceae family which can be planted in subtropical, temperate and tropical regions (usually at higher altitude areas where the temperature is much cooler) (Al-madhagi, Hasan, Ahmad, Zain, & Yusoff, 2012). Strawberry plantation requires between 20 °C to 28 °C and between 12 °C to 18 °C of day

and night time temperatures respectively (Ashraf, Abidin, Ahmad, Sya, & Pahang, 2018). After pollination, it takes 20 to 40 days for fruit-bearing (Palencia, Martínez, Medina, & López-Medina, 2013). Strawberries are popular among consumers due to their attractive appearance, pleasant taste and high nutritional benefits. High in vitamin C and rich in bioactive compounds (such as anthocyanins, polyphenols, tannins and flavonoids) are the driven factors for high demands of strawberries worldwide (Bhat, Geppert, Funken, & Stamminger, 2015). Despite the worldwide demands of strawberries, the production of the commodities faces difficulties to maintain the freshness as strawberries are well known for their highly perishable properties (Andrade et al., 2017). The qualities of strawberries depend on the environment of the cultivation area and are directly affected by altitude, latitude, soil characteristic, cultivation system, the length and temperature(Soria, López-Aranda, Medina, Miranda, & Domínguez, 2009).

Strawberries in Malaysia are planted in Cameron Highlands or also known as Hill Station as it is located 1,500 metres above the sea level in the Titiwangsa Range (Rosemary, Ariffin, Zainol, Binti Sabran, & Hua, 2016). Cameron Highlands is denoted as an agritourism city where it is popular among local visitors and has gained much popularity by foreign tourists for short visits due to its agricultural attraction places such as tea plantation, orchid, honey production and strawberry farms (Barrow, Weng, & Masron, 2009). Cameron Highlands having a cool temperature ranging from 12 to 25 °C which suitable for strawberries cultivation (Eisakhani & Malakahmad, 2009). Varieties of strawberry planted in Cameron Highlands includes Camariosa, Camarosa, Camaroga, Festival, Sweet sensation, Winter star, and Albion (Al-madhagi et al., 2012).The market of strawberries in Malaysia is limited for the local consumption due to the low yield and highly perishable nature of strawberries.

In the meanwhile, strawberries cultivation and plantation in Japan are localised in the Pacific coast islands of Japan which are Honshu and Kyushu islands as the mild weather condition is more favourable for strawberries (Petlock & Sugimoto, 2013). Varieties of strawberries planted in Japan differ according to the season and cultivation area. Sagahonoka, Amaou, and Benihope are popular winter variety cultivated in Saga, Fukuoka, and Shizuoka prefecture respectively (Petlock & Sugimoto, 2013). In addition, Summer princess, Summer Engel, Flamenco are example of strawberries cultivated during summer-autumn season (Masaki, 2010). Strawberries are placed third as valuable production crops in Japan after rice and tomatoes which shows a significant contribution to Japan's agricultural commercial value (Ishikawa et al., 2018). The consumption of strawberries in Japan accounts for 3% of fresh consumption and the demands for strawberry-based products increasing each year (Petlock & Sugimoto, 2013).

Strawberries cultivated in Japan widely known of its sweet taste and soft texture with higher commercial values compared to strawberry cultivated in Malaysia (Yoshida, 2013). Hence, the marketability of Japan's strawberry is higher compared to Malaysia as the strawberries produce not only for local distribution but also for export to other countries. Such deviation believed due to the cultivation practices between Japan and Malaysia. Cultivation practices directly affect the strawberry plant morphology which will later affect the quality of strawberries (Correia et al., 2011). Different cultivation systems used are responsible for the different qualities of strawberries produced (Andrade, Miguel, Spricigo, Dias, & Jacomino, 2017). Higher yield and quality of strawberries will lead to higher commercial values. Some of

the limitations in strawberry production during pre and post-harvest include overripe strawberries, contamination of pathogen, and physical damage during harvesting and short shelf life(Bhat & Stamminger, 2015). Besides, the efficiency of strawberry production depends on the variety planted and implementation of crop systems (Soria et al., 2009).

Up to date there are non-available literatures found comparing the different in techniques and practices of strawberries cultivation between Malaysia and Japan. Thus, this intended comparison between cultivation practices among selected farms from Cameron Highlands and Nagano was done to give a brief overview of farm management used by farmers of two different regions with different climates, and the impact to farmers and the market with the utilization of the fresh commodities. Through this study, the farmers and strawberry's producer in Cameron Highlands may adapt the techniques used by the Japan's cultivators to increase the yield as well as quality of strawberries produced.

Materials and methods

Study Area

In this study, four farms each from Japan and Malaysia were selected to compare the effects of different cultivation practices and climate on the overall yield of strawberries of the selected areas. Strawberries in Malaysia are commercially planted in the highland region of Cameron Highlands. Cameron Highlands has an approximate area of 715 km² with daily minimum and maximum temperatures of 14.8 °C and 21.2 °C respectively, making it suitable for the plantation of temperate crops (Barrow et al., 2009). Meanwhile, Nagano in Japan located in Honshu Island with an altitude of 371.4 metres was chosen as a study area for strawberry plantation in Japan. The study was done from May to June 2019 in which during the time of the study, Nagano was experiencing the end of spring approaching the summer weather with an average temperature of 25 °C (Anon, 2019; Kai, Rahman, 2018; Ogbiji, 2018); thus, the strawberries cultivated were the summer variety of strawberries.

2.2 Design of the study

This study was done through a case study approach. According to Gabel et al. (2018), a case study is denoted as empirical and evaluates a phenomenon in the real-life context in which the main objective is to extract comparable and contrasting reasons or sequences of a specific idea. The study was conducted through a questionnaire, farm visits and informal interview sessions which covered the demographical information of strawberry farms, cultivation practices, strawberry varieties and product utilization, post-harvest handling and the total yield obtained in a year. Questionnaire of the current research combined both 'open-ended' and 'close-ended' questions. Respondents were given a few answer selections in close-ended questions, while the open-ended option was available for respondents with a different answer the ones provided and for further comments (Rosemary et al., 2016; Tzotzou, 2016). The demographic questionnaire was done to compare several aspects regarding the farms including farm size, type of technology or practices used in the farm, number of employee and plantation aids obtained. Cultivation process questions given to the farmers included the method of planting and seedling, water source, variety of strawberries, cultivation cycle, soil, fertilizer and pesticide used as well as methods of harvesting. The post-harvest aspects included in the case study were grading and sanitization methods of fresh strawberries and strawberry products utilization. Eight farms participated in this study in which four of the farms were from Japan and

the other four were from Malaysia, thus the data obtained from eight respondents could be used for the comparative studies. Literature was also added to support the findings of this research study. The farmers were chosen randomly from the targeted areas of strawberries plantation in both countries.

Results and Discussion

Demographic information on selected farms

Table 1 shows the demographic information of the farms studied. The farms from Cameron Highlands, Malaysia and Nagano, Japan were selected randomly and located closer to each other in the same region. Farm's establishment years varied from 1999 to 2012 for the four farms located in Cameron Highlands, Malaysia, whereas in Nagano strawberry farm's establishment years for four farms ranged from the oldest farm established in 1998 to the recently established farm in 2019. The number of workers correlated to the farm size, as the bigger the farm size, the manpower required to manage the farm becomes more on-demand. The trend of increasing manpower as the size of cultivation gets bigger can be seen in both Cameron Highlands and Nagano. In Cameron Highlands, the farms with the largest cultivation area of strawberries were approximately 8094 m^2 and required 10 and 25 employees for Farm 1 and Farm 2 respectively. Meanwhile, the largest farm area of the selected farm in Japan was 9000 m^2 which required 30 employees to manage the farm operation. Based on Table 1, only one worker is needed in managing Farm 5. This farm establishment was for research purposes.

The similarity that can be found for strawberry cultivation in both countries was that all the farms involved in this study obtained aids from the government. For strawberry farmers in Cameron Highlands, they use their expenditure to make up for the shortage of production cost obtained from the government as they claimed that it is difficult to obtain sponsorships or aids from private bodies. Such limitation becomes one of the main reasons for the lack of current technology used by the farmers as external aids are limited while the production costs keep increasing each year due to market uncertainties, bad weather, diseases and pest attack (Barrow et al., 2009).

In Cameron Highlands, strawberries are cultivated in an open area using fertigation techniques and protected with rain shelters to protect the crop from rainy weather. Plastic rain shelter is the commonly used shelter in Cameron Highlands to minimize the damage of crops due to rain and sunlight which enables crop diversification and eases pest management in the cultivation area (Barrow et al., 2009). In contrast, a greenhouse is the most common practice done for strawberry cultivation in Nagano, Japan. Since Japan has a seasonal climate, cultivation in open areas will affect the strawberry fruits quality. According to (Petlock & Sugimoto, 2013), starting from 2013, almost all Japan's strawberry cultivation farms shifted their cultivation practice from open-field farming to greenhouse production to ease the control of temperature, water, pests, disease and pollination to produce premium quality strawberries. Miyoshi et al. (2013) added that greenhouse promotes the constant soil temperature layer as an effect of air circulation inside the greenhouse and heat exchange between the soil layer and surrounding temperature. The application of greenhouse technique has been successful in producing consistency in terms of quality and higher production yield of strawberries in the selected farms in Nagano as they were able to commercialize their commodities not only locally but also for overseas market.

The oldest and biggest farm among the four farms in Nagano has a broader market compared to the other farms as they managed to market their strawberries not only to other Japanese regions such as Osaka and Kyoto but also to Hong Kong, Thailand and Mongolia with an annual production yield of 90 tones. Meanwhile, Farm 8 established in 2012 with 20 tons of yield annually also exported their strawberries to Thailand. Based on a market report done by USDA Foreign Agricultural Service on Japan's strawberry market, in 2014, 205 metric tons of strawberries were exported to Hong Kong, Taiwan, Singapore and Thailand (Petlock & Sugimoto, 2013). Meanwhile, selected farmers from Cameron Highlands were only able to promote and sell their commodities locally around their farm area despite the annual yield that was not much different from Nagano's strawberry farms. Farm 3 managed to produce 36 tons of strawberries per year. Farm 1 and Farm 2 stated that they obtained RM300,000 and RM50,000 per year on average which accounted to approximately 12 and 2 tons annually. Despite the larger cultivation farm areas compared to the other farms studied in Cameron Highlands, Farm 2 was unable to compete in mass production.

The divergence in the market capability of Cameron Highlands and Nagano may be due to the different varieties of strawberries planted, cultivation practices and climate conditions in which the mentioned factors correlated to the quality of strawberries produced.

Table 1: Overview of farm details

Country		**Malaysia**				**Japan**			
Farm		Farm 1	Farm 2	Farm 3	Farm 4	Farm 5	Farm 6	Farm 7	Farm 8
Establishment year		2011	2005	1999	2005	2018	2019	1998	2012
Number of employees		10	25	15	2	1	6	30	10
Farm area (m^2)		8094	8094	4047	1012	1200	2000	9000	4500
Aids	Government	√	√	√	√	√	√	√	√
	Private	√		√	√		√		√
	Own money	√	√	√	√		√		
Market	Domestic	√	√	√	√		√	√	√
	Oversea							√	√
Technology and practices in farm	Greenhouse	√				√	√	√	√
	Fertigation		√	√	√				
	Rain shelter			√	√				
	Others								
Production yield annually		RM300,000	RM50,000	36 Tonnes (RM900,000)	24 Tonnes (RM600,000)			90 Tonnes	20 Tonnes

Cultivation techniques and methods of strawberries

Comparisons of cultivation techniques and practices of the studied strawberry farms between Cameron Highlands and Nagano are tabulated in Table 2. All farms studied use the same method of planting which is from the plant.

Water is the main necessity in every crop plantation. Based on the questionnaire answered, Farm 1 and Farm 2 obtained their water source outside the farm which was from mountain water. Meanwhile, Farm 7 and Farm 8 received their water source from underground, whereas Farm 6 mentioned that they recycled their water to reduce the cost. FDA (2019) stated that the water sources for irrigation of strawberry plants vary through planting regions and resources available nearby include underground wells and surface water. The common technique to water strawberry plants is through the drip irrigation system which is practised by all farms involved in this study. Irrigation process is usually done depending on the rate of water evaporated, temperature, and the flow rate of drip tube and plant development (Ramachandran, Ishak, & Ibrahim, 2015). According to (Fang et al., 2012), the commercial standard of strawberry cultivation has grown on drip irrigation bed sized 1.2m wide, 8.0 m long and located 0.3 m above ground and covered with black plastics with spacing between the plants at about 0.3 m. The benefit of drip irrigation is that it minimizes the contact of fruit with water as the tube used is directly fixed to water the soil. Contact of water with fruits is not desirable in strawberry planting as it could be the medium of pathogen transmitter both from plant or soil and human, causing mildew and premature softening of fruits (FDA, 2019). Strawberries require more water during the fruit setting and fruit sizing stages to ensure they receive optimum nutrients and proper environment.

Farm 1 and Farm 4 stated that their cultivation cycle was four cycles per year and fruit-bearing all year around. Farms 3 and 4 had eight cultivation cycles which were a result of different varieties planted. All farmers from Nagano did not state their cultivation cycle but mentioned that their cultivation cycle depended on summer and winter. The production of winter type strawberries in Japan starts from November to May every year (Masaki, 2010).

The selection of suitable variety or cultivar of strawberry depends on the climate and location the strawberries are intended to be planted. The varying cultivars may relatively have different fruit ripening, resistance towards disease, weather condition tolerance and different characteristic of fruits (shape, size, color and firmness) (FDA, 2019). For tropical countries, varieties of 'Festival', 'Chandler', 'Winter Dawn', 'Selva', 'Diamante', 'Albion', and 'Sweet Charlie' are among the commonly cultivated cultivars (Murthy & Pramanick, 2014). Based on Table 2, the 'Festival' variety of strawberry is planted in all four farms in Cameron Highlands. Farm 2 and Farm 3 planted several varieties of strawberries in their farms such as 'Montery', 'Beauty', 'Fortuna', 'Camarosa' and 'Camaroga'. According to Ahmed et al. (2017), the 'Camarosa' variety is better in vitamin C content, has higher fruit dry matter and fruit organic matter compared to the 'Camaroga' variety but less sweet as the total soluble solid content is lower. However, the 'Camarosa' cultivar, which is denoted as a short-day variety, is likely to experience crown and root diseases with lower production yield which requires proper handling of soil fumigation process (Fang et al., 2012). In contrast, the 'Festival' cultivar shows better resistance towards *F. oxysporum*, *P. exigua*, *G. fructicola, P. exigua*, and *P. ultimum* pathogens, which initiate the crown disease in strawberries (Fang et al., 2012).

Strawberry varieties cultivated in Nagano are selected based on weather condition, which is characterized as summer and winter varieties. Based on Table 2, during summer, the strawberry hybrid Shindai BS8-9 is planted by the farmers in Farm 1 and Farm 2, while Farm 5 cultivates different varieties, namely 'Kaori Noh', 'Suzu Akane' and 'Karuizawa'. The summer variety is cultivated and harvested in summer whereas the winter variety is available during the winter season(Petlock & Sugimoto, 2013). 'Bennehoppe' and 'Tochiotome' are among the popular varieties of strawberry planted in Japan. 'Tochiotome' claimed to have good shelf life while 'Bennehoppe' is popular due to its attractive appearance of the bright red color of the flesh. Among the four farms from Nagano, only Farm 8 cultivated a white color variety of strawberries. White strawberries are considered a premium product in Japan. Petlock & Sugimoto (2013)added that premium strawberries are higher in market price and popular as a gift.

Coco-peat is the commonly used medium for strawberry cultivation due to its proven suitability. Coco-peat is waste from coco fibers which is a valuable raw material for most plants as substrates (Mallen, 2016). Coco-peat is best to be used for strawberry cultivation due to its aerial porosity which enhances the watering process, promotes good soil ventilation and allows the root of the plant to move easily within the soil (Ahmadizadeh, Ebrahimi, Souri, & Ebrahimi, 2012). Only Farm 5 used a mixture of rockwool and coco-peat for their strawberry plantation. The mixture of rockwool in the growth media of strawberry enhances the irrigation process with constant and controllable water distribution on plant roots (Depardieu, Prémont, Boily, & Caron, 2016).

All four farms in Nagano cultivate their strawberries inside a greenhouse. Such methods are able to avoid the effect of climate and soil conditions on strawberry yield as the environment can be controlled (Kawabe, 2018). This is further supported by Miyoshi et al. (2013) who mentioned that the temperature inside the greenhouse is monitored to be around 8°C using the heater as the temperature is denoted as a desirable temperature for strawberry growth during the night time, especially during wintertime. Since Nagano experiences the summer and winter climates, greenhouse cultivation will give a more stable environment for strawberry growth. Summer may be over humid while during winter, the environment may become dry where the strawberries may grow without the proper dormant period, thus contributing to the development of fungal diseases (Murthy & Pramanick, 2014). Based on the farm visit to the Nagano farms, the strawberries inside the greenhouse were cultivated in an elevated bench system as shown in Figure 1. The benches were positioned at several heights from the floor level to ease the harvesting process. Planting of strawberry in the elevated bed system allowed ease of picking which was done manually. According to Petlock & Sugimoto (2013), lower bed strawberry bench is often set around 40 to 50 cm high from the ground while a higher bench is set approximately 70 to 90 cm from the ground.

Figure 1: Elevated bench system cultivation

Cameron Highlands is located in a tropical climate where the long day photoperiod is difficult to obtain, in addition to the weather condition that is often cloudy (Hasan, Al-madhagi, Ahmad, & Yusoff, 2011). Temperature and photoperiod are the two crucial aspects during the bearing of a flower for strawberries (Pratumjon, Machikowa, & Wonprasaid, 2016). The tropical climate of Malaysia require higher costing if greenhouse plantations are to be implemented as the environment inside the greenhouse needs to be maintained at around 20 °C with humidity of around 70% in order to obtain good strawberry quality of size diameter, color and taste (Ramachandran et al., 2015; Zainol Abidin, Ahmad, Suraidi, & Pahang, 2018). According to (Ramachandran et al. (2015), greenhouse cultivation techniques are not popular or less applicable in Cameron Highlands due to the naturally geographic conditions of the mountains and hills that act as the cooling system. Thus, only rain shelters are used to cover the cultivation area the fertigation system is used for rainy weather. Fertigation system is done using drip-irrigation which promotes effective water management and fertilizer application (Depardieu et al., 2016).

Table 2: Results of cultivation practices

Country		Malaysia				Japan			
Farm		Farm 1	Farm 2	Farm 3	Farm 4	Farm 5	Farm 6	Farm 7	Farm 8
Method of planting	Plant	√	√	√	√	√	√	√	√
	Seedling							√	
Water source	Within farm			√	√	√	√		
	Outside farm	√	√					√	√
Cultivation cycle		4 cycle per year/fruit bearing All year	5-8 cycle per year/fruit bearing All year	8 cycle per year/fruit bearing All year	4 cycle per year/fruit bearing All year				
Variety of strawberry		• Festival	• Festival • Montery • Beauty • Fortuna	• Festival • Camarosa • Camaroga	• Festival	• [a]Shindai BS8-9	• [a]Shindai BS8-9	• [b]Akiheme • [b]Tochiotome • [b]Beni-hoppe	• [b]Shinku no misuza, • [b]Beni-hoppe • [a]Kaori Noh • [a] Suzu akane • [a]Karuizawa
Colour of strawberry	Red	√	√	√	√		√	√	√
	Dark red		√			√			
	Light red								
	White								√
	Others:								
Cultivation	Hill								

technique	system								
	Matted row system								
	Vertical		√						
	Plastic tunnels								
	Greenhouse	√				√	√	√	√
	Others:			Fertigation	Fertigation				
Seedling technique	Pot	√		√	√	√	√	√	√
	Ground								
	Hydroponic		√						
	Others:								
Soil/media used	Clay								
	Coco-peat	√	√	√	√	√	√	√	√
	Organic soil								
	Sandy loam								
	Others:					Rockwool			
Fertilizer used	Chemical	√	√	√	√	√	√	√	
	Organic				√	√			√
Pesticide used	Chemical	√	√	√	√	√	√	√	
	Organic		√			√			√

Uppercase a, and b are winter and summer variety respectively.

Meanwhile, Farm 1 stated that they were using hydroponic methods in strawberry cultivation. Hydroponic method of plantation does not use soil for the growing of crops or plant in which the roots of the plant are immersed in nutrient-rich water solution which is often practised by small-scale farmers for in-place plant growing (Gashgari, Alharbi, Mughrbil, Jan, & Glolam, 2018). The advantages of the hydroponic system of strawberry planting includes environmental control and easy to control the nutrition intake by the plant (through the addition of nutrient solution) (Ahmadizadeh et al., 2012). Caso, Chang, & Rodríguez-Delfín (2009) added that the soilless method promotes more efficient water and fertiliser used and the fruits produced are better in quality (shape and weight) with fewer diseases. The hydroponic methods are usually done in the greenhouse for ease of control in which among the four farms from Cameron Highlands, only Farm 1 cultivated strawberries under a greenhouse with the use of the hydroponic technique.

Based on the interview session with the farmers from Farm 5, they were using stolon from the matured plants, which were later arranged in a bed about 10 cm spaced between each plant. Stolons are used in growing strawberries due to the shallow root systems of strawberries (Palencia, Martínez, Medina, & López-Medina, 2013). Healthy and free from disease runners are crucial in strawberry cultivation to prevent from crown and root diseases (Fang et al., 2012). The common practice used in growing strawberries is from plantlets obtained through the runner nodes of the parental plant or adult plants (Hasan et al., 2011). The runner and plantlet of the 'Camaroga' variety are better than 'Camarosa' as both varieties are composed of different genetics and their responses towards the photoperiod during growth depend on the environmental control. Seedling in the higher land area is claimed to generate better runner plants as the temperature is lower as compared to the landside area (Pratumjon et al., 2016). A study by Pratumjon et al., (2016) resulted in strawberries of the 'Prarachatan' variety that were better cultivated in a greenhouse under controlled temperature and longer supply of light, which enhanced the photoperiod effect.

Seedling of strawberries was obtained through potting techniques for all studied farms on this study, except Farm 2 in which seedling was done through hydroponic methods. According to Masaki (2010), almost all strawberry farmers in Nagano practice seedling using the pot method in which the runners are planted into pots at the end of August to the middle of September near to the end of the harvesting season, since potted seedling grows much faster than ground seedling.

Four farmers from Cameron Highlands used chemical fertilizer and pesticides, whereas Farm 5 from Nagano stated that they used a mixture of 50% chemical and 50% organic fertilizer and pesticides. Farm 8 practiced the use of fully organic fertilizer and pesticide during cultivation to produce premium quality of strawberries. The use of pesticides is unavoidable as strawberries are easily affected by crown and root diseases. The pesticide is used to kill soil microorganisms which may cause fruit decay and affect the growth of strawberry plants (FDA, 2019). According to(Murthy & Pramanick (2014), the fungal pathogens that are commonly associated with crown and root diseases especially in mild tropical climate include *Botrytis cinera*, *Colletotrichum acutatum*, *Phytophthora cactorum*, *Phytophthora fragariae*, *Verticillium dahlia*, and *Sphaerotheca macularis*. Similarity on the use of pesticide during cultivation by both Cameron Highlands and Nagano farmers showed that plant disease is one of the main concerns in strawberry plantation which directly affects the production yield.

Meanwhile, fertilizer is used to enhance the growth and provide nutrients for the strawberries. Fertilizer may be added through soil injection or mixed inside the irrigation system (known as the chemigation system) (FDA, 2019). All four farmers from Nagano used the chemigation practice in which the fertilizer was mixed beforehand in the water and later irrigated to the plants. Farm 6 stated that during the growing of strawberry plants, the number of leaves on a plant plays a crucial role in the strawberry quality. The excess numbers of leaves were discarded to allow better nutrition absorption in the plant. The leaf removal treatment or also known as hormone treatment results in changes in internal resources allocation which helps to increase the strawberry quality produced (Correia et al., 2011).

The difference in cultivation practices by selected farms from Cameron Highlands and Nagano was mainly due to the effect of different geographical and climate conditions and available resources which relatively affected the quality of strawberries produced.

3.3 Post-harvest handling and processing of strawberries

Both farmers from Cameron Highlands and Nagano manually harvested their strawberries. Strawberries are often hand-picked to minimize losses due to improper handling and harvesting as they are highly perishable. Since the strawberries were manually picked, the grading was also made manually in both studied farm areas in Cameron Highlands and Nagano. The grading of fresh strawberries is usually done in terms of weight and shape. The shape is one of the crucial physical qualities which in strawberries can be characterized into several shapes such as reniform, conical, cordate, ovoid, cylindrical, rhomboid, obloid, globose, and wedges (Ishikawa et al., 2018). Fresh strawberries are not sanitized upon picking and directly packed for direct selling or put in a crate before distribution.

Based on Table 3, most farmers in Cameron Highlands will utilize their overproduction of fresh strawberries into other products such as dairy products, confectioneries, bakery, and beverages. Cameron Highlands is an agritourism city in which the demand of strawberries increases significantly during the holiday periods in Malaysia, while during common days, the strawberries tend to be unpicked, causing over-ripening which may lead to dumping if improper utilization of the commodities is not done. Consumption of fresh strawberries is more preferable to consumers but due to the highly perishable nature of strawberries, this limits its availability. Thus, the strawberries are processed into other products (Tadapaneni et al., 2012). Strawberry jam and juice have become the most popular products produced in Cameron Highlands. Ramachandran et al. (2015) stated that strawberries are often used in the menus by local cafes and restaurants in Cameron Highland as ingredients in pastry and bakery products such as pie cakes, ice creams, and waffles. Utilization of fresh strawberries into dry products such as jam, pickles, and biscuits is done to increase the market value of the short shelf life of strawberries. Murthy & Pramanick (2014) added that small strawberry farmers have low economic resources and cultivation is only enough for their livelihood. Thus, the utilization of strawberries not only increases the shelf life of strawberries but also contributes to economic gain for small-scale farmers and reduces the waste of unsold strawberries due to overripening.

Table 3: Results of post-harvest handling and processing

Country		Malaysia				Japan			
Farm		1	2	3	4	5	6	7	8
Harvesting tools	Manual	√	√	√	√	√	√	√	√
	Machine								
Method of grading	Manual	√	√	√	√	√	√	√	√
	Machine								
Sanitization method	Chlorine sanitizer								
	Organic sanitizer								
	Dry cleaning								
	Water								
	Not sanitized	√	√	√	√	√	√	√	√
Distribution channel	Direct selling	√	√	√	√		√	√	√
	Small retailer			√	√		√	√	√
	Large retailer			√			√	√	√
	E-commerce			√	√				
	Supermarket						√		
	Wholesaler			√			√		√
	Specialty shop								
Category of products:	Fresh strawberry	√	√	√	√	√	√	√	√
Confectionery	Chocolate								√
	Jellies		√	√	√		√		
	Candy								√
	Jam								
	Cakes		√				√		
	Biscuit		√						√
	Wafer								
Bakery	Pastry	√		√	√		√	√	
	Cookies		√						√
	Pie				√				
	Muffin								
	Bread		√		√				
Beverages	Juice		√		√				
	Soft drink								
Others:	Cordial Topping							Daifuku	Butter cream

In contrast, the utilization of strawberries into other products in the studied farms of Nagano was done as a tourist attraction and as premium products. Commonly, frozen strawberries are imported from other countries such as China, Chile, and Peru and used for jam manufacturing (Petlock & Sugimoto, 2013). The processing of fresh strawberries into products often uses lower grade strawberries as the first grade or premium grade after sorting of fresh strawberries are primarily optimized for the fresh market (Gössinger et al., 2009). The second-grade strawberries are characterized as having being misshapen, with white patches on red strawberries that exceed one-fifth of the surface area of the strawberry, bruised, and traces of soil on the surface of the strawberries (Palencia, Martínez, Medina, & López-Medina, 2013).

3.4 Production cost of strawberry cultivation

The production cost for all farms studied varied, depending on the cultivation cycle, size of farm, and number of employees. For the farms studied in Cameron Highlands, Farm 1 and Farm 2 had approximately the same farm size (as in Table 1), but Farm 2 had 25 employees as compared to Farm 1 with 10 employees in which the allocation for labor cost of Farm 2 was higher by 50% of production cost as compared to Farm 1 with only 30% allocation for labor cost. Farm 4 had the lowest allocation for a labor cost of 5% as the farm size was the smallest among the four farms studied in Cameron Highlands with only two employees. The bigger the farm area, the higher the capital cost for the cultivation of strawberries. Farm 1 allocated 30% for capital cost, whereas only 10% capital cost was needed by Farm 4. The total raw material costs accounted for fertilizers, pesticides, soils, and strawberry seeds, which varied between farms. Farm 1 and Farm 2 did not allocate any contingency or costs for other purposes.

Table 4: Results of production cost

Country	Malaysia				Japan			
Farm	Farm 1	Farm 2	Farm 3	Farm 4	Farm 5	Farm 6	Farm 7	Farm 8
Labour cost	30	50	20	5	50	20	25	37
Capital cost	30	20	20	10	10	30	20	10
Total raw material cost	30	10	30	10	3		25	10
Maintenance cost	10	20	10	10				5
Others			20	65	37	50	30	38

In contrast, Farm 5 from Nagano, Japan allocated 50% of the total production cost in labor despite having only 1 employee, whereas the capital was 10% and the total material cost was 3% for Farm 5. Farm 5 included their maintenance cost together with other costs. In addition, Farm 6 focused on the labor and capital costs as they merged the raw material and maintenance as other costs, which accounted for 50% of the total production cost. Farm 7 allocated 25%, 20%, and 25% for labor, capital, and raw material costs, respectively with 30% allocation for other costs, which included maintenance cost. Farm 8 allocated 37% of its production cost to pay for their 10 employees and put the highest allocation for contingency purposes (38%).

Based on the obtained results in Table 4, all four farmers in Nagano, Japan had some allocation for other costs, which were not included in the main production cost of raw materials, labour cost, and capital cost due to the uncertainty of weather conditions and pest attacks.

Conclusion

Based on the recent findings, cultivation techniques used by selected farms from Cameron Highlands and Nagano were not relatively different. Farmers from both studied area used cocoa-peat as the soil media with pot seedling technique, and most of them used fertilizer and pesticide from chemical based. However, the major deviation of strawberry cultivation between selected farms in Cameron Highlands and Nagano was the greenhouse cultivation technique used in Nagano. The greenhouse cultivation helps to minimise the environmental effects which promoting consistence yield and quality of strawberries produced. Through the comparison study made, cultivation of strawberries in Cameron Highlands may adapt the greenhouse cultivation technique with proper installation of temperature control and planting area. Greenhouse practice expected to help in increasing the production of strawberries in Cameron Highlands not only for local consumption but also marketed outside Cameron Highlands regions.

Conflict of interest

All authors did not have any conflict of interest.

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