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Refining the definition of sustainable agriculture: An inclusive perspective from Malaysian vegetable sector

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Abstract: Skepticism about the longevity of conventional agriculture has resulted in the quest for sustainable agriculture. Like many developing countries, a homogenous definition of the term ‘sustainable agriculture’ is yet to be developed in Malaysia. To fill this gap, using an inclusive perspective, this study posits a refined definition of ‘sustainable agriculture’ for Malaysia. Cognizant of relevant past studies, which were built on rather narrow viewpoints, this study integrates qualitative insights from selected up-stream stakeholders in Malaysian vegetable sector. The structured results suggest that sustainable agriculture can be defined as the process by which an integrative balanced agricultural system is realised through a dynamic set of practices that are (1) environmentally enhancing, (2) resource optimal, (3) economically viable, (4) socially justifiable and (5) functionally feasible over time. Though derived from Malaysia, this definition can be adapted to fit local nuances in other countries and sectoral emphases in agriculture. With these five inter-related operational attributes, which are capable of enhancement and/or modification periodically, this flexible definition can progressively provide potential direction towards academic understanding and development of agricultural sustainability.

Keywords: sustainable agriculture, Malaysian vegetable sector, inclusive perspective, sustainability concept

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INTRODUCTION

Improving sustainability is of paramount importance to both developed and developing countries. The term 'sustainable development' was originally defined by the Brundtland Commission as 'the development that meets the needs of the present without compromising the ability of future generations to meet their own needs' [1]. Though the initial purpose is to link poverty alleviation to environmental and natural resource management, the definition has culminated in a consensus of the need for economic growth without degrading natural endowments. This consensus has attracted the highest socio-political support at the United Nations Earth Summit in Rio de Janeiro in 1992 [2]. It has been further endorsed by the United Nations World Sustainable Development (Millennium) Summit in Johannesburg 2002 [3].

The diffusion of sustainability concepts has created a new paradigm in agricultural development. This new paradigm seriously questions the contribution of conventional agricultural practices to industry sustainability [4]. Among others, chemical inputs are widely criticised for their undesirable impacts on soil, water, biodiversity, human health, food safety and economy [5-7]. While these findings are not new, Carson [8] in her classical "Silent Spring", presented irrefutable arguments to posit that chemical pesticides cause multiple destructions in exchange for a mono-beneficial crop protection. In the long run, such externalities can potentially strike at the heart of food security and poverty.

Skepticism about the longevity of conventional agriculture has resulted in the perceived need for sustainable agriculture, which was internationally addressed in the Agenda 21 [9], the Millennium Ecosystem Assessment [10] and the International Assessment of Agricultural Science and Technology for Development [11].

Many studies [12-16] have attempted to define the term 'sustainable agriculture'. However, there is neither a definitive nor a standardised definition of 'sustainable agriculture' [17-21]. This is mainly because definitions invariably differ in individual contexts. The term 'sustainable agriculture' should therefore be refined, at least, in the local context.

Like many developing countries, 'sustainable agriculture' has not been officially defined by the Malaysian government for a specific agricultural sector. Similarly, past studies on local agricultural sustainability issues [22-25] have not attempted to define 'sustainable agriculture' in Malaysia. The definition is crucially needed in responding to the pressing issue of agricultural sustainability while, at the same time, guiding the development of the industry and its sub sectors [26-27].

To fill the aforementioned gap, this study is intended to refine the definition of 'sustainable agriculture' through the use of an inclusive perspective from farm-level. The context of Malaysian vegetable sector forms the basis of the work.

Responding to Pimbert's [28] call for inclusive research, this study departs from past studies, which have arisen from a basis of rather narrow standpoints. Ultimately, the realisation of sustainable agricultural systems for food production requires the participation and understanding of all up-stream contributors [29]. To serve this purpose, insights from selected up-stream stakeholders of the vegetable sector in Malaysia were integrated and operational attributes that can potentially serve as directional guidelines for future actions were also posited.

BACKGROUND

Early agricultural policies in Malaysia were economically orientated. The First National Agricultural Policy (1984-1991) and the Second National Agricultural Policy (1992-1997) emphasised the maximisation of farm income via efficient utilisation of local resources [26].

With emerging concerns centred on sustainability, the Third National Agricultural Policy (1998-2010) took a slightly different approach. The difference, however, arises as a consequence of a rather shallow vision of sustainable development [27]. Though the vision is to ensure that the present needs are not met at the expense of future generations [25], the overarching emphasis is still on income maximisation through responding to market information and optimal resource utilisation.

Under the Third National Agricultural Policy, the vegetable sector has undergone the holistic promotion of two prominent programmes of relevance to sustainable development. Firstly, the "Malaysia's Organic Scheme" was launched in 2001. According to the Department of Agriculture [30], the scheme asserts that organic production methods constitute one of the best means for the production of safe, quality foods. Organic production does not use chemical inputs and attempts to avoid environmental degradation. Secondly, the "Malaysia's Good Agricultural Practices" (GAPs) Scheme was introduced in 2002. This scheme focuses on integrated systems which aim to manage all farm resources in a sustainable format [31]. It is intended to increase farm productivity as well as produce safe, quality foods. At the same time, the scheme also seeks to assist the welfare, safety and health of farm workers by preserving a safer and a more natural environment.

These programmes have, so far, had only limited success. Up to the end of 2010, the number of adopters was less than 30 vegetable farmers for the Malaysia's Organic Scheme and 100 vegetable farmers for Malaysia's GAPs Scheme [32]. The number of adopters represents less than one percent of the 46,040 vegetable farmers in Malaysia [33]. Nevertheless, a starting point for sustainable agriculture has been made. This is supported by Tey et al.'s study [34] that recorded adoption rates of cover crops/mulches (35%-45%), organic fertilizers/composts (35%-45%), intercropping (35%-45%), crop rotation (30%-40%), conservation tillage (25%-35%), and integrated pest management (25%-35%).

One strategy, which conceivably would result in more successful implementation, is agreement on the definition of 'sustainable agriculture' at farm level. Without such agreement, relevant agricultural programmes end up promoting previous standard practices under a new name [13]. Any definition should include some notions of operational attributes for sustainable agriculture. This is not an easy task but we can progress our understanding by extracting and integrating multiple insights from industry contributors while, at the same time, being guided by the compass of past studies.

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LITERATURE REVIEW

There are a number of definitions from various philosophical and technical attempts in defining the term 'sustainable agriculture'. Despite these varying definitions, past studies were mostly built on the three common components of sustainable development: the environmental, the economic and social aspects.

Environmental Aspect

The concept of environmental sustainability is traditionally important in the definition of sustainable agriculture [5, 35-37]. Typically, this component addresses the conservation and management of the environment and natural resources for present and future generations [38]. Natural resources include, among others, soil, water, ecosystems and biodiversity. Conservation seeks to ensure that agricultural practices do not degrade the environment and natural resources [14]. By reducing reliance on off-farm inputs, such management promotes more efficient use of renewable and non-renewable resources through the utilisation of on-farm integrative resource systems [13].

In addition, there is an expansionary component. Beyond management and conservation, it stresses the enhancement of environmental quality and the resource base on which agricultural activities depend. This expanded component is officially adopted by the United States [39] and Canada [40], but remains largely unacknowledged in other countries. McIsaac [41] is a notable exception.

It is important to acknowledge that the expanded component is built upon the presumption of the conservation and management of the environment and natural resources [37]. However, the maintenance of natural endowments in the current form is less than optimal, if they have already been degraded. Rodale [42] asserts that sustainable agriculture should improve the status quo of soils (among many other resources). Enhancement is one of the most plausible strategies to improve the sustainability level of the environmental component.

Economic Aspect

Economic sustainability is another important component in the definition of 'sustainable agriculture' [13-14, 41, 43]. The component refers to the economic viability of carrying out sustainable agriculture over time [38]. It considers the maintenance of economy-wide factors, such as costs-benefits, inputs-outputs, and investment-returns. Not only does it deal with monetary concerns, it also weighs on farm operation and employment factors [17]. The notion of economic viability is formally accepted by the United States [39] and Canada [40]. It is also echoed by some past studies [44-47].

Because a farm enterprise cannot become sustainable overnight, the transitional stage does not offer immediate economic returns to farmers. Sustainable agriculture is, hence, impeded by economic hurdles since it offers less attractive marketing returns and diminishes economic benefit during the transitional stage.

Against the aforementioned concern, Lehman et al. [12] provide a useful perspective which can be borrowed. In their review of Canada's [40] definition of 'sustainable agriculture', they question whether ensuring economic viability is really an essential component in sustainable agriculture. For simplicity, they translate economic viability to farm profitability over time. They point out that farmers could engage in sustainable agriculture even though the recommended practices might not directly result in a profit. Among many initiatives, subsidies, tax reduction, and cuts in interest rates could indirectly improve farm profitability.

It can be readily conceived that the economic viability of sustainable agriculture is possible in one or many ways, both in the short- and long-run; the "economic" component in sustainable agriculture should not be neglected.

Social Aspect

"Social sustainability" is an imperative component in the definition of 'sustainable agriculture' [44-47]. Fundamentally, the component stresses social acceptable attainment and the continued satisfaction of present and future human need [38]. Among basic needs, food and fiber are commonly highlighted in connection with the crucial role of ensuring food security in society [48]. That means sustainable agriculture should endeavor to maintain or improve farm yield for the stability of food security.

Food and fiber must also be produced in safe ways. This concept is inclusive, stretching from production to consumption, i.e. to assure the health and safety of agricultural producers at farm level and ensure food safety for consumers at market level [13]. The United States [39] agreed that health, safety and food safety will enhance the quality of life and society as a whole.

The importance of social component is generally overlooked. As an example, the need to ensure the health and safety of farm workers is not included by the Science Council of Canada [40] and a number of past studies [5, 36]. Karami & Keshavarz [4] note that the social component has been relatively neglected by various studies [46, 49-50]. This situation arises because no operative definition of the social component has been developed [51].

METHODS

Three core components are indicated in the definition of sustainable agriculture. These components are environment, economic, and social. They can be used as a guiding framework to refine the definition of 'sustainable agriculture'. A similar framework has also been used by Norman et al. [15] for defining sustainable agriculture in the United States.

Our qualitative data collection method was inclusive [52]. The method involved seven selected up-stream stakeholders of the vegetable sector in Malaysia (May-June 2011). Focus group discussions (FGDs) were conducted individually for (1) the Department of Agriculture (DoA), (2) the Federal Agriculture Marketing Authority (FAMA), (3) the Cameron Highlands Vegetable Growers Association, and (4) the Vegetable Farmers Association of Selangor. Each FGD was made up by at least four volunteer respondents. With their consent, the 90 minute FGDs were audio and video taped. Interviews were conducted separately for K-Farm, Malaysian AgriFood Corporation (MAFC), and Centre for Environment, Technology & Development, Malaysia (CETDEM). As recording was not allowed, the 45 minute English interviews were documented using shorthand.

The qualitative information collected was transcribed and saved as raw datasets for content analysis which involves automated or manual coding, reflecting the frequency with which concepts appear in texts. This generates easily understandable categories of coded concepts [53]. This analysis has been commonly used on qualitative data in a variety of agricultural settings, such as the

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definition of agricultural literacy [54], the concept of sustainable development [55], and the public perception of sustainable agriculture [56].

From the review of past studies and the datasets, 18 concepts were identified for coding purposes. These 18 concepts are presented in Table 1. The exercise was based on keywords and the meanings of conversational content. e.g. 'environment' and 'health and safety' were coded for a conversation "…sustainable agriculture is not just to protect the environment. It is also for the health of people. It is a holistic approach that integrates (requires) your commitment…"

Table 1. Concepts for refining the definition of 'sustainable agriculture'

No.	Components	Sub-components	Concepts	Sustainability goals
1	Environment	Environmentally enhancing	Ecosystem*	Sustainable agriculture maintains and enhances local ecosystems.
2			Environment*	Sustainable agriculture does not degrade the environment.
3		Resource optimal	Renewable resources*	Sustainable agriculture optimizes the use of renewable farm resources.
4			Non-renewable resources*	Sustainable agriculture optimizes the use of non-renewable farm resources.
5	Economic	Economically viable	Cost**	Sustainable agriculture enables reduction in production cost.
6			Price**	Sustainable agriculture results in higher ex-farm prices.
7			Income*	Sustainable agriculture increases farm incomes.
8			Accessibility**	Sustainable agriculture increases accessibility / supply points to modern markets.
9			Marketability**	Sustainable agriculture increases the demand for produce.
10	Social	Socially justifiable	Food*	Sustainable agriculture satisfies human food needs.
11			Food safety*	Sustainable agriculture produces safe foods.
12			Health and safety*	Sustainable agriculture ensures the safety and does not harm the health of farm workers.
13			Life quality – consumers*	Sustainable agriculture enhances the life quality of consumers.
14			Life quality – workers*	Sustainable agriculture enhances the life quality of farm workers.
15		Functionally feasible	Compatibility**	Sustainable agriculture is compatible with local conditions.
16			Knowledge**	Knowledge of sustainable agriculture is transferrable to farm workers.
17			Technical*	Sustainable agriculture is technically appropriate for farm workers to carry out.
18			Technology**	Sustainable agriculture is assisted by technology.

(Sources: * our literature review; ** the raw datasets)

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RESULTS AND DISCUSSION

The outputs of content analysis, which showed the number of times each concept coded in texts, were summarized in Table 2. It was difficult to interpret the table meaningfully in its current form. Therefore, these coded concepts were grouped into attributes (environment, resource, economic, social, and function) according to their similarities. Following that, these attributes were categorized within their related core component of sustainable agriculture. Together, the sub-components were graphically illustrated.

Figure 1 depicts our framework of 'sustainable agriculture'. The figure illustrates, through an integrative approach, sustainable agriculture in various farms. It is a consolidated result of three balanced core components, namely of environment, economic, and social. Each of them neither is independent nor represents one third of sustainable agriculture. Instead, they are complimentarily and form the wholeness.

Though the core components are not implicitly portrayed, they are represented by their own attribute(s): (1) "environmentally enhancing" and "resource optimal" for the component of environment; (2) "economically viable" for the economic component; (3) "socially justifiable and "functionally feasible" for the social component. Each attribute is distilled from similarities shared with other concepts (Table 2).

From the above it is clear that a large part of our findings agrees with past studies [13-14, 41] and includes components of environment, economic, and social in the definition of 'sustainable agriculture'. More notably, our findings also suggest a number of refined attributes in an integrative balanced agricultural system.

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Table 2. Frequency of coded concepts

No.	Components	Sub-components	Concepts	Frequency count (number of times coded)							Total
				Official segment		Farmers segment		Private & NGO segment			
				DoA	FAMA	Cameron Highlands	Selangor	K-Farm	MAFC	CETDEM	
1	Environment	Environmentally enhancing	Ecosystem	1	3	-	-	-	-	-	4
2			Environment	4	3	1	3	2	2	1	16
3		Resource optimal	Renewable resources	1	3	2	1	1	-	3	11
4			Non-renewable resources	3	4	2	1	2	1	1	14
5	Economic	Economically viable	Cost	-	2	3	1	1	1	2	10
6			Price	-	3	4	2	1	-	-	10
7			Income	-	3	9	1	1	1	1	16
8			Accessibility	3	1	-	1	1	-	-	6
9			Marketability	-	-	2	1	-	-	-	3
10	Social	Socially justifiable	Food	-	1	-	-	-	-	1	2
11			Food safety	9	2	7	2	3	2	1	26
12			Health safety	5	-	1	2	1	-	2	11
13			Life quality – consumers	1	1	-	-	1	-	4	7
14			Life quality - farmers	1	1	-	-	1	-	3	6
15		Functionally feasible	Compatibility	-	3	7	1	2	1	-	14
16			Knowledge	4	-	3	-	5	-	-	12
17			Technical	3	1	9	2	4	1	-	20
18			Technology	5	1	-	-	-	-	-	6
Total				40	32	50	18	26	9	19	

Notes:
DoA – the Department of Agriculture; FAMA – the Federal Agriculture Marketing Authority; Cameron Highlands – the Cameron Highlands Vegetable Growers Association; Selangor – the Vegetable Farmers Association of Selangor; MAFC – Malaysian AgriFood Corporation; CETDEM – Centre for Environment, Technology & Development, Malaysia

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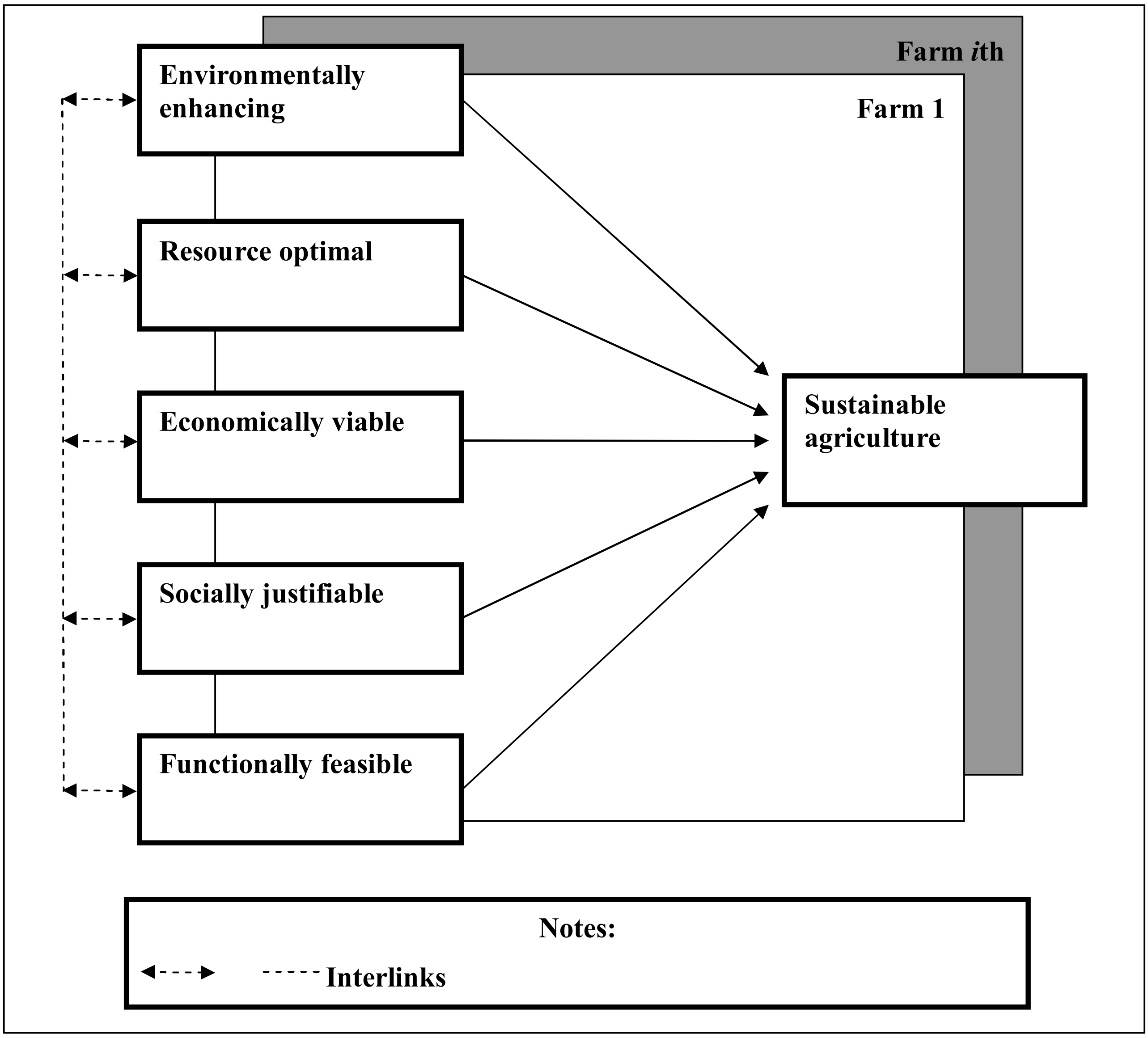

Figure 1. Definitional framework of 'sustainable agriculture'

The Refined Definition

From our structured results, 'sustainable agriculture' could be defined as *the process by which an integrative balanced agricultural system is realized through a dynamic set of practices that are environmentally enhancing, resource optimal, economically viable, socially justifiable and functionally feasible over time.*

The Integrative Balanced Agricultural System

An integrative, balanced, agricultural system is formed by three interacting and equally important components. The three components are environment, economic, and social. They operate together for the common purpose of producing sufficient food for meeting human basic need.

In understanding the core components, past studies [59-61] have characterized the economic and social components as socio-economic subsystems and the environmental component as ecological subsystems. They are inexorably integrated with the dynamic interaction processes, which result in sustainability [62]. In other words, agricultural activities depend on ecological conditions and these conditions depend upon various agricultural activities [63]. As such, the development of the sustainability in the integrative balanced agricultural system involves feedback loops, which maintain the sustainability within and between the subsystems as a whole [64].

Agriculture is a managed system [61]. Humans in socio-economic subsystems are the integral participants, who manage agricultural systems [4, 65]. These people make decisions on agricultural activities. These decisions are determined by a complex consideration of social and economic goals [63]. In return, their induced changes influence their future decisions [66]. Therefore, improvement in the sustainability of the integrative balanced agricultural system is possible with enhanced ecological and socio-economic feedback processes to the actors over time [64].

Zooming in, these subsystems are characterised by attributes [67]. Attributes are inter-related, crucially and determine the quality of the agricultural system as a whole [68]. In our interest to improve sustainability in the integrative balanced agricultural system, five identifiable attributes emerge. They are (1) environmentally enhancing, (2) resource optimal, (3) economically viable, (4) socially justifiable and (5) functionally feasible.

Environmentally Enhancing

As a key attribute of the environmental component, implicit in the attribute "environmentally enhancing" is the concept of protecting, maintaining and improving environmental quality in sustainable agriculture. This concept emphasises reparation of on- and off-farm environmental issues. Major on-farm environmental issues include soil erosion and nutrient loss, compounding of the impairment of productive capacity [69]. Beyond the farm gate, pollution of surface, ground, and downstream water resources as well as loss of biodiversity are common off-farm issues [70].

This attribute places value on the concept that environmental quality should not be placed at risk by agricultural activity [71]. An important step in realisation is the multi-functional conservation of soil resources, preservation of soil nutrients, control of water quality and the rehabilitation of biodiversity in ensuring environmental quality as a whole. In order to achieve this, damaging practices can be substituted with environmentally sound counters [14]. One should, however, bear in mind that such substitutions require serious consideration in respect to their possibly complex management techniques and long-term environmental consequences. These substitutes do not necessarily refer to either traditional or modern approaches. Hybrid approaches may integrate beneficial practices of both of the aforementioned i.e. to bring them into consonance for the reconciliation of environmental persistence. Even in the face of disturbance, the environment has the ability to produce continuous functionality for ongoing agricultural activities.

Resource Optimal

Another environmental attribute, "resource optimal" refers to the knowledge-based efficiency in the use of available resources in sustainable agriculture. The need for both resource conservation and resource improvement, simultaneously, are embedded in the notion. General resources include soil, water and biomass in the renewable segment and fossil based chemical inputs in the non-renewable segment. Optimisation promotes intelligent decision making to rationalise the need, the choice and the way to get the most out of available resources.

Contrary to the common view on resource attributes, we do not assert that sustainable agriculture must imply a net reduction in resource use. Our reasoning is based on the logic that the net reduction might cause yield loss, which in turn would necessitate the use of more land to produce food requirements. In contrast, appropriate resource use in sustainable agriculture should be rationalised in a manner which considers underlying need or unanticipated problems. Identified resources are best allocated and used on an optimal basis.

It should be cautiously noted that few farmers are well formally educated. Pretty [72] suggests that the education which they have gained, based on their practical experience, makes productive use of their knowledge and problem-solving skills. It improves their judiciousness and self-reliance by making better use of available resources. Therefore, it makes them less reliant on costly external inputs. In return, these create an accord of resource resilience. When facing some shock e.g. price hikes of chemical fertilisers, agricultural activities can continue to function in the same essential ways e.g. by substitution with cheaper, readily available organic fertilisers.

Economically Viable

"Economic viability" implies a need to ensure a farm's normal economic growth and development whilst realising sustainable agriculture objectives. Sustainable agriculture should not, jeopardise farm profits and the ability to improve profitability levels over the long-run. These goals might be realised through farm structure expansions or technological investments. In probing the meaning of "economic viability" further, Lehman et al. [12] have suggested that the notion represents a complete economic self-sufficiency: if a farmer is said to be economically self-sufficient, he does not get any direct and indirect monetary assistances from other parties.

Positive impacts due to knowledgeable use of resources are likely to spillover from production costs to farm profits. Assuming that sustainable agriculture does not compromise yield, a farmer still could increase profitability levels. This is possible through the reduced reliance on external inputs. Their reduction is replaced by efficient utilisation of available resources. Such a concept of profitability is realised when the net savings offsets the costs of production [73].

When resources are used in a knowledgeable manner, the farmer also makes gains from positive market responses. Sustainable agriculture is rewarded with greater market access since the possibility of supplying to modern marketing channels e.g. supermarkets and hypermarkets, which increasingly demand healthier products.

Additionally, when prices for product produced in an agriculturally sustainable manner are almost the same as those produced by more conventional farming enterprises, consumers would rationally prefer sustainably produced items over the conventional ones. In other words, healthier products are more in demand and consequently more sellable. As such, though the market prices might remain unchanged, farm profits are readily conceived to benefit in one or many ways from the introduction of a sustainable agricultural regime.

Socially Justifiable

The attribute of "socially justifiable" is based on the belief that the social functions of sustainable agriculture should be reasonably based and adequately grounded. Sustainable agriculture is fundamentally necessitated by the need to satisfying human food needs, which is to responsibly produce sufficient nutritious food to ensure food security. This responsibility clarifies that not only is such a basic function acceptable but its consequences, both positive and negative, might well be justified when viewed through the prism of social well-being.

Food must be produced and consumed safely. This is not limited within the confines of the common concern for food safety. Its focus is also the health of farm workers. One would argue that the reduced reliance on external (chemical) resources has already enhanced the safety levels of farm workers and consumers. The situation is unlikely to be so if their substitutes (available resources) are not used in a knowledgeable manner. For example, improper handling of composts might expose farm workers to prospective chronic diseases [74]. At consumer end, the use of unstable or immature composts might endanger food safety through their contamination by pathogens [75].

To safeguard this social function, government plays a crucial role. Some kind of government support and regulation would be required to develop some rewarding certification programmes e.g. Good Agricultural Practices Scheme or Organic Scheme. These programmes may serve as a blueprint for farm operation and act as credence for public confidence.

Altogether, sustainable agriculture should enhance the quality of life for both farmers and consumers. When society as a whole is healthy, its members are more likely to perform their social functions. Therefore, the abovementioned safety concerns are two pre-requisites to maintain quality of life. Other attributes, as they are inter-related, also play a significant role in determining a farmer's quality of life e.g. lower financial returns are likely to discount a farmer's ability to improve his current qualitys of life.

Functionally Feasible

"Functionally feasible" refers to the capability which enables the practitioner to fulfill the purpose of sustainable agriculture within their current means and conditions. It goes beyond philosophy and considers the quality of being do-able. As such, successful functionality within sustainable agriculture must account for knowledge transferability, compatibility, techniques and technologies.

At its most fundamental level, the knowledge of how to carry out recommended sustainable agricultural practices must be made available and transferrable to farm government support. Given that most farmers are not highly formally educated special considerations should be given to the implementation of education programmes and extension services. Receipt of a good education should see that a farmer would (1) have acquired the necessary skills and competencies, (2) have gained ideas to adapt these practices to the farm, (3) be equipped to share that knowledge with his farm workers and (4) find himself able to realise sustainable agriculture.

Education is meaningless if recommended sustainable agricultural practices are not compatible with a dynamic and harmonious combination. This combination may include farmer value, need and local underlying conditions. Inconsistency of a practice with any one factor in a combination will, in all probability, reduce adoption and diffusion rates.

Recommended sustainable agricultural practices should be technically appropriate for farm workers to carry out. Some of them are readily understood by farm workers; others are relatively complex. In both cases, suitability of these practices is derived from practice and familiarity. However, simpler practices are preferable than those that require new understandings and skill development.

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Technologies can ease the implementation of recommended sustainable agricultural practices with efficiency [76]. There are technologies that are ideologically grounded without causing undue damage to the environment [72]. Not only these technologies are meant to maintain environment but they also increase productivity, improve food quality and enhance environmental quality [77].

CONCLUSIONS

To make it more reasonable, acceptable, adaptable and more generally applicable at farm-level, the definition of 'sustainable agriculture' is refined using an inclusive approach. This work is based on a study of the vegetable sector in Malaysia. The refinements are built upon three components of sustainable development: environment, economic and social. These components are commonly embedded in previous research attempts to define the term. The inclusive paradigm involves qualitative data collection from seven selected up-stream stakeholders in the vegetable sector in Malaysia.

The results of content analysis are structured to shed light on a more meaningful definition of 'sustainable agriculture'. They point to a process whereby the realisation of an integrative balanced agricultural system is invariably circumscribed by a definitional framework containing five common structural elements: (1) environmentally enhancing, (2) resource optimal and (3) economically viable, (4) socially justifiable, and (5) functionally feasible. While they have individual emphases, they are nonetheless inter-related in determining the quality of sustainable agricultural systems. As a whole, they provide operational direction that is potentially useful in the planning of agricultural sustainability.

Our definition of 'sustainable agriculture' is flexible. Since it is empirically grounded on reasons and acceptance in an inclusive paradigm, it can be adapted to different agricultural sectors. Its operational attributes can be modified to accommodate varying local nuances and sectoral emphases as they are fluid. They evolve in tandem with changes both in the concept and local sustainability issues.

Future studies should look into the applicability of sustainable agricultural practices. This should also be considered by those research efforts which search for potential innovation in practice and technology. Environmental maintenance practices suitable in one area might be unsuitable in other areas whose focus is on environmental enhancement. Beyond physical suitability, practices which return marginal profits at the current time might be undesirable in future.

Under changing conditions, periodical review, modification and improvement should be made in respect to sustainable agriculture in dynamic patterns. Such complex permutations can be best done via a more inclusive research paradigm [28] i.e. to get more participatory involvement of upstream stakeholders who have practical knowledge and can contribute significantly to the research [78]. Farmers are the ones who must evaluate the suitability of recommended practices and, in consequence, make adoptive decisions.

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