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Changing Farmers' Perception towards Sustainable Horticulture: A Case Study of Extension Education in Farming Community in Yogyakarta, Indonesia

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ABSTRACT

Applying sustainable horticulture as an innovation in The Special Region of Yogyakarta (DIY) Indonesia can be a commendable example in agricultural extension education. Previous research has revealed that understanding farmers' perceptions of innovation is essential for appropriate interventions to change their behavior. In DIY, the surveys were conducted in 2016 with 257 males and 93 females of farmers groups member from 21 villages in Sleman, Bantul, and Kulonprogo Regency. The objective of the survey was to determine the effects of farmer's internal factors on the perception of ecological, social economy, and ethical (ESE) urgency as a component of sustainable horticulture practices. The findings from the ecological, social, and ethical dimensions among the farming community in DIY indicated that, directly and indirectly, the farmers can acknowledge and practice sustainable horticulture. However, this was altering several factors, most notably, motivation and the prospect of increased income. The important thing in extension work was motivation, and a major motivating factor was the possibility of increased agricultural income. This study suggests that extension education of achieving horticultural sustainability in DIY should be based on the motivation of farmers and thoughtfulness of their basic needs especially needs to have higher income.

Keywords: ecological, ethical, agricultural extension education, motivation, and sustainable horticulture.

INTRODUCTION

Moderate or severe food insecurity (based on the Food Insecurity Experience Scale) has been on the rise at the global level, from 22.6 percent in 2014 to 30.4 percent in 2020, the year the COVID-19 pandemic spread across the globe (FAO, IFAD, UNICEF, WFP, & WHO, 2021). FAO finds that the COVID-19 pandemic has made it more challenging to achieve the SDGs by 2030 (Food and Agriculture Organization [FAO], 2020), especially progress was already stalled towards meeting SDG Targets 2.1 and 2.2: ending hunger and

ensuring access to safe, nutritious, and sufficient food for all people all year round; and eradicating all forms of malnutrition (FAO *et al.*, 2021).

The Special Region of Yogyakarta (DIY) has been experiencing food insecurity and lack of nutrition since 2014. It was 392 existing villages area where 16 have been observed as low food security and low nutrition villages and 26 as very low food security and very low nutrition villages (Badan Ketahanan Pangan dan Penyuluhan DIY, 2014). However, the current situation is getting better, and by 2021 there are four low food security and low nutrition villages in DIY (BAPPEDA DIY, 2021) despite the COVID-19 pandemic. It is one indicator of the success of the agricultural extension in DIY. Even though the data were collected from 2015 to 2016, it provides evidence of changed farmer perceptions due to the high effectiveness of implementing sustainable horticultural extension in DIY (Euriga, Amanah, Fatchiya, & Asngari, 2018) to alleviate food insecurity and malnutrition.

Law No.16 of 2006 on the agricultural, fishery and forestry extension systems play an essential role in balancing or integrating food safety, human needs, and environmental sustainability. Agricultural extension education is not mentioned in SDGs 2 and 4 (about lifelong education), but it has a vital role in supporting sustainable horticulture by changing farmer perceptions (Ramborun, Facknath, & Lalljee, 2020) to adopt innovations. This research can strengthen or depict the weaknesses of agricultural extension education to support sustainable agriculture. Extension and research could simultaneously identify adaptations of agricultural innovations and monitor the evolution of complex systems under diverse conditions (Davis, 2019).

However, sustainable horticulture is one of the innovations of agriculture that can achieve the stated issues because its products, primarily vegetables and fruits, are believed to improve nutrition. Horticulture as the branch of agriculture, especially fruits and vegetables, has high economic value. Horticulture was prioritized in this research because of the higher decrease in productivity than other commodities in DIY (Statistics of D.I. Yogyakarta Province, 2014). Previous research suggests focusing more on sustainable horticulture (Lal, 2008; Spina *et al.*, 2021). In 2021, the attention to increasing the availability of more nutritious foods, such as fruits and vegetables, for healthy diets.

The government has been implemented sustainable horticulture by issuing a Decree of Minister of Agriculture No. 48/Permentan/OT.140/10/2009 about Good Agricultural Practices (GAP) for Fruits and Vegetables for Prima Certification (Prima 1, Prima 2, and Prima 3). Therefore, for this study, the concept of sustainable horticulture is defined as farming practices including inputs (superior seeding, organic fertilizer), cultivation (conservation land, crop rotation, mulch, irrigation, integrated pest management, and labor), post-harvest, marketing, and partnerships, especially for vegetables and fruit.

Sustainable horticulture can be called an innovation because of the processes involved in its implementation (Spina *et al.*, 2021). However, the acceptance of any innovation depends on its perceived characteristics, and extension activities have been one of the main factors influencing farmers' perception of innovation. The extension workers influence the decision-making processes undertaken by farmers in adopting innovations (Faruque-As-

Sunny, Huang, & Karimanzira, 2018). They use appropriate extension methods to help farmers form opinions or perceptions and make correct decisions.

The formation of perception has three mechanisms "selectivity, closure, and interpretation." It illustrates how they are generated to influence individual behavior (Litterer 1975). Perception is an active, not a passive, process, resulting both from what exists in the outside world and from people's own experiences, desires, needs and wants, loves and hatreds; it is so important in interpersonal communication and influences the communication choices (DeVito, 2013). According to Bayesian theories of perception that prescribe how an agent should integrate prior knowledge and sensory information and investigate how current and future empirical data can inform and constrain computational frameworks that implement such probabilistic integration in perception (de Lange, Heilbron, & Kok, 2018). In the domain of environmental psychology, the stimulus-organism-response (SOR) model explains that various environmental aspects can act as a stimulus (S) that influences an individual's internal state (O), which subsequently derives the individual's behavioral response (R) (Zhai, Wang, & Ghani, 2020). Hence, two external factors, information and experience, have been influential in forming a perception.

According to previous research, the adoption of innovation in this context was dependent on some internal factors such as age, formal and non-formal education, land tenure (Ntshangase, Muroyiwa, & Sibanda, 2018), agricultural income (Faruque-As-Sunny *et al.*, 2018), farming experience, and motivation (Sapbamrer & Thammachai, 2021). The learning process may be applied to initiate innovation initiatives efficiently (Probst *et al.*, 2019) by changing their perception. Farmers have been observed to use their perception in accepting any innovations introduced to them, sustainable horticulture inclusive. Several studies have revealed that farmers view this from its importance economically, environmentally, and socially for a specified period (De Silva & Forbes, 2016).

Innovation in horticulture has a multidisciplinary nature and a higher complexity and suggests further investigations, especially in socio-economic aspects of innovations (*Spina et al.*, 2021). The problem is how we can change farmer perceptions about sustainable horticulture practices as innovation? The previous research emphasized the importance of understanding sustainability under the relevance of farmers' perceptions (De Olde, Oudshoorn, Sørensen, Bokkers, & De Boer, 2016). It is also essential to focus on understanding farmers and academics in agriculture on sustainability through the extensive use of factor analysis to assess farmers' perceptions of ecological, socio-economic, and ethical dimensions (Dunlap, Van Liere, Mertig, & Jones, 2002). Researchers need to see how farmers view sustainable horticulture from the three pillars of economic, environmental, and social importance over a given year (De Silva & Forbes, 2016).

The attributes such as relative advantage, suitability, complexity, and perceptions of the advantages and disadvantages of innovation affected its adoption rate (Abdollahzadeh, Sharifzadeh, & Damalas, 2015). Several other studies also agreed that farmers' perceptions of innovation affect the adoption rate (Kabir & Rainis, 2015; Ntshangase *et al.*, 2018; Tey *et al.*, 2014; Van Thanh & Yapwattanaphun, 2015). Therefore, this study aimed to analyze the

influence of internal factors on farmers' perceptions of sustainable horticulture. This research provides policy recommendations to the government, extension agents, and university-based extension services to change farmer perceptions to implement sustainable horticultural practices.

RESEARCH METHOD

Study area

The research was conducted in 2016 in Sleman Regency (13 villages), Kulonprogo Regency (7 villages), and Bantul Regency (1 village). The highest population of horticultural farmer groups was in Sleman Regency, with snake fruit as the primary commodity. The main commodity in Bantul was shallots, while in Kulonprogo were varies from chili, watermelon, and melon. Sleman Regency is in the mountainous areas, while Bantul and Kulonprogo Regency are around the coast. These topographic characteristics direct farmers to plant commodities that are following natural conditions.

Sampling procedure and data collection

The population consisted of 2621 horticulture farmers in DIY. The 350 respondents were chosen using the probability of multistage random sampling from 70 farmers' groups. It consisted of 17 farmer groups that have received PRIMA certification, 13 women farmer groups, and 40 farmer groups that have not received PRIMA. From each group, respondents were chosen that consist of two administrators and three members.

Primary data were collected using questionnaires with a Likert scale based on the research objectives. Statements and questions of each variable were based on the modification of previous studies. The variables measured were internal factors and farmers' perceptions of sustainable horticulture. Internal factors included age, formal and non-formal education, agricultural income, farming experience, land tenure, and motivation (De Silva & Forbes, 2016; Faruque-As-Sunny *et al.*, 2018; Ntshangase *et al.*, 2018; Sapbamrer & Thammachai, 2021; Tey *et al.*, 2014; Van Thanh & Yapwattanaphun, 2015).

The statements about the perception of this research were adapted from previous research, which is included the urgency of ecological, socio-economic, and ethical values (Dunlap, Beus, Howell, & Waud, 1993) with some modifications based on research location consideration (DIY) and a new ecological paradigm (Dunlap *et al.*, 2002). In this research, the perception of sustainable horticulture is defined as farmers' response to the urgency of ecological, socio-economic, and ethical practices in cultivating vegetables and fruit. It was also determined through the same process as the perception of motivation but measured by only 14 items.

The assessment was determined using the known mean ($\bar{x}$) and standard deviation (sd). It was classified as low when $x < (\bar{x} - 1sd)$, moderate if $(\bar{x} - 1sd) \leq x < (\bar{x} + 1sd)$ and high when $x \geq (\bar{x} + 1sd)$. The age variable is the respondent's age when the data is measured by one item of an open question. Formal education is the level of school activity in the number of years

measured by one open item question. Non-formal education is the complete form of organized training outside the school level that follows the respondents for the past year as a group member measured by two items of an open question. Agricultural revenue was assessed from the farming attempts as measured by one item of an open question. The duration of farming is the length of time a person has spent in the planting job based on the number of years measured by a question item. Land tenure is the ownership status, extent, and location of cultivated/agricultural land used for vegetable and fruit cultivation as measured by two items of an open question.

Sustainable horticultural motivation is the factor that encourages an individual to continuously implement environmentally-friendly practices in cultivating vegetables and fruit-based on the needs identified (Boersema & Reijnders, 2009). These involve (1) survival needs such as safety, physiological needs, and subsistence, (2) social needs such as shared feeling, affection, and participation, (3) the need for personal growth such as recognition, self-actualization, understanding, identity, and freedom. They were measured with 20 statement items using 4 Likert scales, i.e., Strongly Disagree = 1, Less Agree = 2, Agree = 3, and Strongly Agree = 4. Further, it is categorized into three parts, high category (2-3), moderate (1.1-1.99), and low (0-1), according to the quartile of mean and standard deviation score of all respondent's answers.

Analytical technique

Data obtained were analyzed through the use of descriptive and regression data analysis. The demographics (age, gender, formal education, non-formal education, land tenure, farming revenue, farming experiences) used a descriptive method including frequency, percentage, and mean. The descriptive method also applied for farmers' motivation variable and perceptions of sustainable horticulture, measured using the Likert Scale. Factors that affect the perception were analyzed with multiple linear regression. It used independent variables (age, formal education, non-formal education, farming revenue, farming experiences, land tenure, and motivation) and dependent variables (farmers' perceptions of sustainable horticulture).

RESULTS AND DISCUSSION

Characteristics of Respondents

Table 1 shows the general characteristics of the respondents. It was discovered that the majority of the horticultural farmers assessed were male under 48 years, which means they were mainly in the productive age with 7 to 12 years of formal education and no informal education.

It was also discovered that most of them started cultivating after their retirement to support their families. The survey also revealed that the farmers had followed the extension activities in different forms, including (1) Field School-Integrated Pest Management (SLPHT), (2) Field School-Good Agricultural Practices (SL-GAP) with various commodities; (3) Field

School-Good Snake Fruit Handling Practices (SLGHP), (4) Integrated Crop Management Field School (SLPTT), (5) Field School-Climate (SLI), (6) Organic Training, (7) Cultivation Training, (8) Processing Training/Post-Harvest, (9) Management Training, and (10) Marketing Training. The modified farmer field school was a promising approach to training farmers (Davis, 2019) and already applied in agricultural extension education in DIY (Euriga *et al.*, 2018). Most of the lands used are narrow in size (below 0.5 ha) and owned by the farmers. It was found that most respondents have income above IDR 2,000,000 which is classified as a high category, and most of them have been engaged with farming activities for 7 to 29 years.

TABLE 1. DISTRIBUTION OF RESPONDENT CHARACTERISTICS (N = 350)

Characteristics	Category	Freq.	(%)	*Mean*
Age	<48 years	160	45.7	48.97
	48-54 years	95	27.1	
	>55 years	95	27.1	
Gender	Male	257	73.4	-
	Female	93	26.6	
Formal Education	0-6 years	39	11.1	11.34
	7-12 years	254	72.6	
	>12 years	57	16.3	
Non-formal Education	< 1 time	152	43.4	1.62
	1-3 times	151	43.1	
	>4 times	47	13.4	
Land Tenure	Narrow	245	70.0	0.43
	Wide	82	23.4	
	Very wide	23	6.6	
	Low	94	26.9	
Farming Revenue	Moderate	124	35.4	
	High	132	37.7	1,855,110
Farming Experiences	<7 years	59	16.9	18.41
	7-29 years	224	64.0	
	>29 years	67	19.1	

The motivation of farmers in adopting sustainable horticulture

The results showed that most DIY horticulture farmers were more motivated by personal growth and social needs than survival needs (Table 2).

TABLE 2. THE DISTRIBUTION OF FARMERS' MOTIVATION TO ADOPT SUSTAINABLE HORTICULTURE (N=350)

Motivation	High (Score=2-3) (n)	Moderate (Score=1.1-1.99) (n)	Low (Score=0-1) (n)	Likert Score
Survival needs	39	269	39	1.98
Social needs	61	238	51	2.03
Personal-growth needs	64	235	51	2.04

Farmers in DIY have been adopting sustainable horticulture because they need new technology. Sustainable horticulture is a new technology, so that they want to go to training to get certification for good agricultural practices. Scientific literature pointed to the

relevance of the term technology in innovation horticulture. In contrast, high technology, digital, organizational, and product-related innovations can progressively support the multifunctionality of agricultural and food systems (Spina *et al.*, 2021). Farmers in DIY also had a high concern to protect customers by making sure of food safety and protecting the environment and agricultural ecosystem for the next generation. This motivation can result from the farmer field school. It can be inferred that extension education through farmer field school as new models of extension around evidence-informed pedagogies can promote learning and practice change (Sewell *et al.*, 2017).

Perceptions of farmers on sustainable horticulture

The results showed that farmers perceive socio-economic urgency as more important with a Likert score of 2.14 than ecological at 1.99 and ethical urgency at 1.98, as shown in Table 3. It indicates that farmers prioritize socio-economic dimensions such as the villagers' well-being (health and welfare), improved agricultural income, development of privileges, enhanced attention to the environment, and marketing in sustainable horticulture.

TABLE 3. THE DISTRIBUTION OF FARMERS' PERCEPTIONS TOWARD SUSTAINABLE HORTICULTURE (N=350)

Urgency	High (Score=2-3) (n)	Moderate (Score=1.1-1.99) (n)	Low (Score=0-1) (n)	Likert Score
Ecological	44	257	49	1.99
Social economics	80	239	31	2.14
Ethical	58	227	65	1.98

The results also revealed that the respondents' highest motivation was to earn a higher income by practicing sustainable horticulture. The motivation to reach a higher income is categorized as survival needs (Boersema & Reijnders, 2009). Our result confirmed previous findings, whereas increased revenue from the sales of crops and vegetables contributed to the greater likelihood of innovation adoption (Faruque-As-Sunny *et al.*, 2018).

Therefore, in this case, an extension worker must take a rallying point on the ecological and ethical dimensions to make the farmers cognize the prominence of all the dimensions in sustainable agriculture and instigate them in their horticultural practices. Table 4, Figures 1, 2, and 3 show in detail the urgency of each dimension. In the ecological dimension, the most important indicators were the submission that the diversity of living creatures is important for sustainability. The farmers' low score was given to energy consumption, classifying the current fuel use as usual.

In the socio-economic dimension, farmers emphasized increasing agricultural incomes but were less sure about their prerogative rights (privileges) to develop the indigenous of their village on their own. They point out that sustainable horticulture should increase agricultural income as measured from the highest score recorded after maintaining soil fertility. Farmers gave the lowest value to the statement that they will retain indigenous plants if they do not produce. Farmers tend to replace the plants with others when they are considered less productive or less profitable, not necessarily because of rotation.

TABLE 4. THE DISTRIBUTION OF FARMERS PERCEPTIONS INDICATORS TOWARD SUSTAINABLE HORTICULTURE (N=350)

No.	Dimension	Strongly Disagree		Less Agree		Agree		Strongly Agree	
		Freq.	%	Freq.	%	Freq.	%	Freq.	%
	Ecological Dimension								
1.	The use of chemicals significantly affects soil fertility	61.00	17.4	68	19.4	145	41.4	76	21.7
2.	Crop rotations shall be under the condition of the land	12.00	3.4	35	10	254	72.6	49	14
3.	Energy consumption (such as fuel, electricity) is too much	53.00	15.1	132	37.7	146	41.7	19	5.4
4.	Raw materials and agricultural equipment should utilize available resources	6.00	1.7	38	10.9	274	78.3	32	9.1
5.	The diversity of living things is essential for sustainability	1.00	0.3	8	2.3	254	72.6	87	24.9
	Socio-Economics Dimension								
6.	The health/welfare of the villagers should always be considered	1.00	0.3	4	1.1	216	61.7	129	36.9
7.	Agricultural income should be increased	2.00	0.6	1	0.3	195	55.7	152	43.4
8.	The village still has its privileges to develop	3.00	0.9	30	8.6	242	69.1	75	21.4
9.	The number of farmers who pay attention to the environment should be upgraded	2.00	0.6	7	2	218	62.3	123	35.1
10.	Marketing is very important to make things easier	1.00	0.3	6	1.7	218	62.3	125	35.7
	Ethical Dimension								
11.	Soil fertility is very important to maintain	0.00	0	2	0.6	179	51.1	169	48.3
12.	Food supplies are very important to satisfy	0.00	0	5	1.4	209	59.7	136	38.9
13.	My knowledge and skills in farming must be tailored to the available resources	0.00	0	20	5.7	256	73.1	74	21.1
14.	Indigenous plants should be maintained even if it is not yielded	28.00	8	101	28.9	172	49.1	49	14

Figures 1, 2, and 3 show that attention should be placed on the ecological dimension, especially energy use (fuel, electricity) and farmers' perception that chemicals will decrease soil fertility.

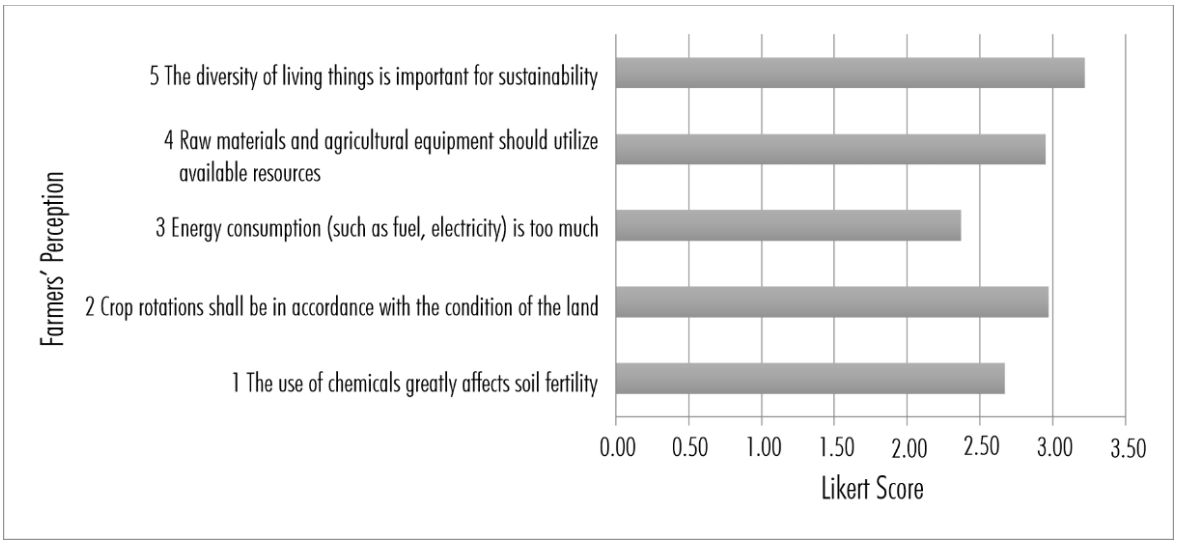

FIGURE 1. FARMERS' PERCEPTION OF ECOLOGICAL DIMENSION

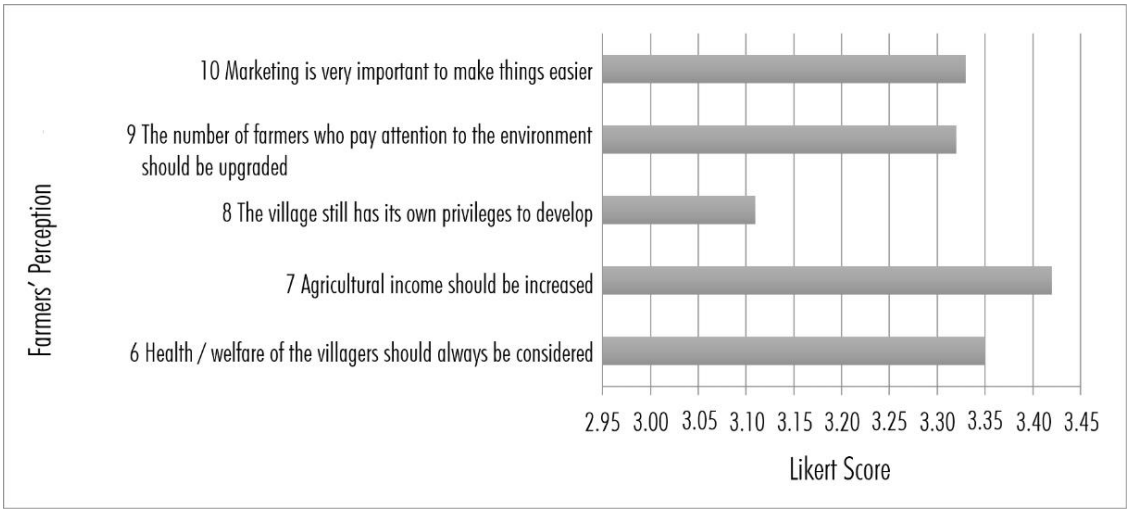

FIGURE 2. FARMERS' PERCEPTION OF SOCIO-ECONOMIC DIMENSION

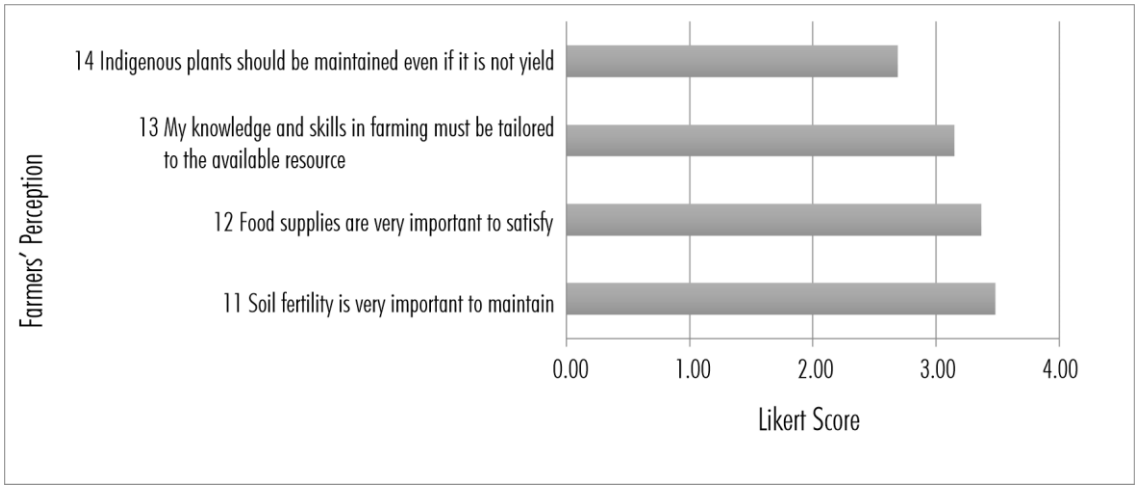

FIGURE 3. FARMERS' PERCEPTION OF ETHICAL DIMENSION

Factors Affecting Farmers' Perceptions toward Sustainable Horticulture

The factors affecting the perception of farmers to sustainable horticulture are presented in Table 5. It was discovered that age has no effect, and the inconsistency of age effect on adoption is often observed in findings of this nature (Sapbamrer & Thammachai, 2021). There were reported results indicating a negative and positive association between age and adoption (Faruque-As-Sunny *et al.*, 2018; Ntshangase *et al.*, 2018; Sapbamrer & Thammachai, 2021). It can be found that educational psychology offers andragogy and pedagogy learning methods that have implications for learning and teaching in further effective agricultural extension in the pedagogy group.

The results also revealed that formal education significantly affects the farmers' perceptions of sustainable horticulture. However, an in-depth analysis of this factor showed it only has a significant positive effect on the perception of the ethical dimension. It supports previous research that reported a positive influence of education on perception (Abdollahzadeh *et al.*, 2015; Ntshangase *et al.*, 2018). Other studies have shown that the higher

a person's education, the more they will have a heightened awareness of the environment (Theodori & Luloff, 2002; Vaske, Donnelly, Williams, & Jonker, 2001).

TABLE 5. FACTORS AFFECTING FARMERS' PERCEPTIONS TOWARDS SUSTAINABLE HORTICULTURE (*STANDARDIZED COEFFICIENT*)

Factors	Farmers' Perceptions towards Sustainable Horticulture (All Dimension)			Ecological	Socio-Economics	Ethics
	$R^2 = 29.7\%$			$R^2 = 26.9\%$	$R^2 = 25.1\%$	$R^2 = 29\ \%$
	β_1	t-Values	Sig	Sig	Sig	Sig
Age	-.010	-.161	.872	.783	.338	.689
Formal Education	.089	1.667	.096*)	.345	.189	.059*)
Non-formal education	.002	.039	.969	.449	.602	.819
Farming revenue	-.126	-2.257	.025**)	.002***)	.840	.009***)
Farming experiences	-.036	-.583	.560	.289	.974	.815
Land Tenure	.043	.786	.433	.824	.342	.176
Motivation	.263	4.952	.000***)	.001***)	.000***)	.000***)

***) significance at 1% level **) significance at 5% level *) significance at 10% level

Non-formal education was found not to affect perception. It is possible because it only involves technical knowledge without creating awareness about the importance of horticulture's ecological, socio-economic, and ethical sustainability. Previous research found that the past interventions were not coordinated and focused on technical challenges (Probst *et al.*, 2019). They suggest that the stakeholder mapping showed that dominant economic players and traditional means of communicating are essential to achieve innovation.

However, knowledge is one of the key factors driving people to conduct pro-environment behaviors (Amoah & Addoah, 2021), although it was insufficient to change behavior (Corace & Garber, 2014). People with higher education have more access to threats and environmental problems than those with low education. In addition, they have a better capacity to understand and spread environmental messages. It shows that farmers who know the environment will have an attitude to support and conduct pro-environmental behavior. Innovation consists of concepts including "knowledge," "diffusion," and "barriers," indicating that the focus of the literature is the adoption and constraints for the spread of innovation (Spina *et al.*, 2021). Spina *et al.* (2021) argued that the concept of "knowledge" is not the same as information but includes perceptions, unconscious motivations, and behavioral habits.

Agricultural revenues have a significant positive effect on farmers' perceptions of sustainable horticulture. It is in line with previous research, which shows a positive influence of income on perceptions (Abdollahzadeh *et al.*, 2015). Prosperous farmers are more environmentally friendly because they have achieved prosperity (Wilson & Hart, 2000). In contrast, organic farmers had lower incomes than conventional farmers (Fairweather & Campbell, 2003). The result also showed that farmers with high incomes in DIY have a better perception of sustainable horticulture. From an in-depth analysis, it can be discovered that income does not affect socio-economic urgency. It means that a person's income will not affect their perception of socio-economic dimension indicators.

The results also exposed that the farming experience does not affect the perceptions of sustainable horticulture. Many research evidence showed inconsistency, and it is difficult to

formulate a verifiable conclusion about farming experience's effect on adoption (Sapbamrer & Thammachai, 2021) and perception (Ntshangase *et al.*, 2018). Perception also could be linked to the success or failure experienced (Ntshangase *et al.*, 2018) and risks to adopting an innovation (Chen *et al.*, 2018), including climate change (Woods, Nielsen, Pedersen, & Kristofersson, 2017). Therefore three sectors, extension agents, farm associations, and the government, are key drivers for sustainable adoption (Sapbamrer & Thammachai, 2021). Unique extension education needs to be formulated appropriately, based on the specific characteristics of each region (Mariyono *et al.*, 2018).

Understanding land tenure, including farm ownership and farm size, and how they influence adoption is important in developing strategies for promoting an innovation (Ntshangase *et al.*, 2018) and changing farmer perceptions. Contrary, land tenure does not affect perceptions of sustainable horticulture. Land tenure in DIY is relatively small or not as extensive as in developed countries such as Australia and the United States. Therefore, it is not easy to implement mechanization. Furthermore, there is not much variation in the area of land in the region. Consequently, the farmers do not own most of the lands used for cultivation. Some considerations should be given to future land ownership.

The motivation was discovered to have a significant positive effect on perceptions of sustainable horticulture. It is in agreement with previous research that decision to apply pro-environment sustainable agriculture depends on various factors such as motivation and mental attitude (Quinn & Burbach, 2008) when it enables taking advantage of opportunities and can be made incrementally (Woods *et al.*, 2017). It was also discovered that the relevance of farmers' needs to sustainable horticulture affects their perception. It may explain why farming experiences and some other factors do not affect perceptions. These results support one societal model that indicated the determinants of behaviors (internal and external) to be Needs, Opportunities, and Abilities or NOA Model (Vlek, 2000). Therefore, motivation can also be added to the Litterer model mechanism (1975) because perception is not only influenced by experience and information but also by needs.

Previous studies (Charatsari, Lioutas, & Koutsouris, 2017) suggest that integrating social psychology into extension/education research can paint a more detailed picture of how farmers interact with extension/ education services. Agricultural extension education should consider the role of self-determined motivation in a different life domain of the farmers. It will help to increase farmers' participation in sustainable horticulture practices because it is guided by the most internal forms of human motivation (identified, integrated, and intrinsic motivation) (Charatsari *et al.*, 2017). The farmers' perception of sustainable horticulture practices was the primary motivation for its adoption. However, the other factors that acted as barriers (trialability, complexity, compatibility, and risk) should be considered (Sewell *et al.*, 2017).

Agricultural extensionists were expected to intervene after the factors influencing the perceptions have been identified. However, there are various theories of change in determining the proper intervention to be used. The need to increase behavioral changes will necessarily require the assistance of professionals in terms of quantity and skills. Following

the report of previous research works, the implementation of effective change was strongly influenced by groups (Borek & Abraham, 2018; Ding, Lin, & Zhang, 2020). It was also reported that individual choice and independent actions are shaped and limited by a group (Tennant, 2007; Wei, Zhao, & Zheng, 2019). Therefore, extension work will be best conducted through a farmer group. Their shared value, aspirations, and diversity in age, farming systems, and academic/practice focus helped the group bond. It provided stimulation that motivated regular attendance and builds group cohesion (Sewell *et al.*, 2017).

Strategy and policy instruments can also influence change by modifying certain behaviors, applying regulations, providing economic incentives, information, education, communication, and using specific scenarios (Boersema & Reijnders, 2009). Extension agents can implement it to accelerate the diffusion of innovation through non-formal education. The findings of previous research (Ntshangase *et al.*, 2018) confirm the important role of extension in promoting innovation, particularly the intensity of the extension services, for example, through training (Sapbamrer & Thammachai, 2021). Extension agents can apply Problem-based learning (PBL), a relatively novel teaching and learning process in horticulture (Abbey, Dowsett, & Sullivan, 2017). As Abbey found that production and emotional intelligence competencies are invaluable in the horticulture industry because stakeholders interact with each other and the agro-ecological system.

The findings from the ecological, social, and ethical dimensions among the farming community in DIY showed that, directly and indirectly, the farmers can accept and practice sustainable horticulture. However, this is subject to several factors, but most importantly, motivation and prospect of increased income. The critical thing in extension work was motivation, and a major motivating factor is the possibility of increased agricultural income. It means that if farmers can get increased income which will improve their livelihood, and show the way to implement sustainable horticulture, they will do it. Formal education was also essential because farmers can accept and understand the concept of sustainable horticulture better. However, it cannot be transferred through extension work, unlike informal education. Therefore, the two most important factors were motivation and the prospect of increased income with other intervening variables such as understanding of the environment.

CONCLUSION

Formation of perception was significant because of its effect in adopting an innovation. However, it was discovered that farmers' perceptions of sustainable horticulture are dependent on ecological, social, and ethical urgency. More clearly, the perceptions were influenced by internal factors such as formal education, agricultural income, and motivation. It was found that ecological and ethical dimensions were significantly positively influenced by motivation and agricultural income, while socio-economic dimension was influenced only by motivation.

The findings showed that extension education needs to be strengthened not only by providing technical knowledge but also through the communication and knowledge that can raise farmers' awareness about sustainable horticulture practices. It was also discovered that

the motivation of farmers should also be considered. Another finding was that the behavior of farmers can be modified through the provision of economic incentives that can change their perceptions because agricultural income had been observed to be their highest urgency.

The government should also make policies that support the sustainability of indigenous plants as well as village privileges. It can be implemented by supporting the establishment of agro-tourism village snake fruit based on the consideration that DIY is a province in Indonesia with the former royal realms united as a Special Region with *snake fruit* as indigenous plants. It is also following the observation that most farmers implemented sustainable horticulture for personal growth.

The initial conclusions about how extension education changes horticulture farmer perceptions can adapt in different regions, especially in Indonesia, because agricultural extension education has been coordinated under the Ministry of Agriculture of Indonesia Programs. Although this research was done in 2016, the findings are still relevant because extension education can help DIY decrease the number of low food security and low nutrition villages from 2014 until 2021. However, future studies need to be done regarding changed circumstances in the COVID 19 pandemic era.

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