Pelita Perkebunan 36 (3) 2020, 249–263
DOI: 10.22302/iccri.jur.pelitaperkebunan.v36i3.453
ISSN: 0215-0212 / e-ISSN: 2406-9574

Knowledge Level of Farmers and the Importance of Coffee Seedling Attributes and Accessibilities in Bandung Regency, West Java, Indonesia

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Received : 5 August 2020 / Accepted : 10 September 2020

Abstract

Bandung Regency is one of the main Arabica coffee plant development centers in West Java, especially in Pangalengan District. The problem of Arabica coffee farming is that the seedlings used not from recommended seed gardens, which may affect coffee productivity in the future. There are several factors that influence farmers in the selection of coffee seedlings, including the knowledge of farmers on the attributes of coffee seedlings, and the importance of the attributes. The purpose of this study were 1) analyzing farmers'perception on the importance of different coffee seedlings attributes; 2) analyzing farmers' knowledge of the seedlings attributes in each coffee variety; 3) analyzing the level of suitability and gap of the attributes of Arabica coffee seedling and the position of various categories of attributes and seedling accessibility in the concept of priority. The research method used quantitative approach from 77 coffee farmers. The data was analysed using descriptive analysis, Importance Performance Analysis and Cartesian diagrams. The results show that in general all the coffee attributes and seedlings accessibility evaluated had a positive score and very important for farmers. Furthermore, the farmers' knowledge on the attributes and seedlings accessibility was variaed. Farmers have good knowledge on seedlings size, productive age, productivity, fertilizer use efficiency, seedling price, and ease of obtaining seedling attributes. There is an unsuitability and gap between the important and knowledge level of farmers about coffee attributes and seedlings accessibility.

Keywords: Coffee seedling, importance level, knowledge level, Cartesian diagram

INTRODUCTION

Coffee is a plantation commodity that plays an important role for the Indonesian economy, as a source of foreign exchange, employment, maintaining environmental conservation, raw materials for the food and beverage industry and farmers' income (Ditjenbun, 2016). This commodity is estimated to be one of the major revenue sources for about 1.84 million coffee farmers, who mostly inhabit rural and remote areas (Ditjenbun, 2014). The coffee plantation areas in Indonesia reach 1.24 million hectares, consist of 96% smallholder plantations, 2% large state-owned plantations and 2% large privately-owned plantations (Ditjenbun, 2018).

Coffee has a high economic value, in some regions with appropriate agro-climates it is used as a superior commodity. Furthermore, in line with regional development, the determination of coffee as a superior commodity is expected to be able to support a community economy growth. The problems faced so far are low production, crop productivity, yield quality and weak bargaining position for determining prices. Some farmers have not properly used cultivation technologies such as selection of appropriate planting material or superior seedlings, and have poor post-harvest handling. Therefore, coffee produced by farmers in general has a low quality (Listyati *et al*., 2017).

West Java coffee has penetrated the international market. Data from BPS Jawa Barat (2018) show that based on the amount of Arabica coffee production, there are five regencies which are coffee production centers in West Java Province, namely Bandung, Bogor, Garut, West Bandung, and Sumedang.

Bandung Regency is the largest Arabica coffee center in West Java, with 10,730 ha area and 5,277 tons of production in 2017 (Disbun Jawa Barat, 2016). The Pangalengan is one of the Districts in Bandung Regency that is a coffee producer, especially Arabica coffee. Land and agro-climate conditions in Pangalengan District support the development of Arabica coffee farming. One of the villages in the Pangalengan District which is the center of Arabica coffee production is Pulosari Village. Pulosari village has the largest area of Arabica coffee in the Pangalengan District.

Since 2000, the people in Pulosari Village have been actively cultivating Arabica coffee. Based on interviews with the Chairperson of the Kubangsari Forest Village Community Institute (LMDH) in Pulosari Village, the awareness of coffee farmers of Pulosari Village in using superior seedlings is still not optimal (Sugiman, priv. comm.). Some farmers still use local seedlings with unclear sources. This affects coffee productivity going forward. Furthermore, information from Chairperson of the Kubangsari Forest Village Community Institute states that some farmers in Pulosari Village have used superior seedlings that have been released by the Ministry of Agriculture, for example Kartika, Andungsari and Tim-Tim (Gayo 1) (Decree of The Minister of Agriculture Number: 3998/Kpts/SR.120/12/2010on Desember 29, 2010) (Sugiman, priv. comm.).

Quality of seedling is one factor that determines crop production, along with other factors such as fertilizer, water, light, and climate. Low quality seedlings, although supported by other factors of production, will produce low yields due to genetic, physiological, and physical characteristics. Genetic quality is influenced by the genetic identity of the parent plant, while physiological quality is the ability of a seed to grow successfully into a plant (viability). This includes characteristics such as generation and seed growth strength. The physical quality of the seed is the appearance of the seed, for example, homogeneous size, pithy, clean from mixtures, not susceptible to pests and diseases, and attractive packaging (Pinem & Safrida, 2018). According to Nurhakim *et al*. (2014), good seed selection is an aspect that also determines the success of coffee farming activities. When selecting seeds, important aspects are how to choose superior varieties and clones, as well as the clarity of seed sources.

Farmers have several reasons why they have not used superior coffee seeds and their decisions were influenced by many factors, both external and internal including the importance and knowledge of farmers on superior seedling. Furthermore, this is strongly related to the performance of coffee seeds that are circulating in the community, both from improved varieties that have been

released and local seed that have been widely used by farmers. The performance is inseparable from the attributes inherent in the seed, both in terms of potential production, growth capacity, resistance to pests and diseases, and ease of maintenance (Hasibuan *et al*., 2013).

The suitability level is the result of a comparison between the level of farmers' knowledge of Arabica coffee seed attributes and the level of importance they rate these attributes. The gap value indicates the gap extent between farmers' expectations and the performance of institutions related to the Arabica coffee development. The purpose of this study is to determine the suitability and gap values of coffee seedling attributes, based the level of importance and knowledge of coffee farmers on the attributes of Arabica coffee seedlings. Furthermore, the study aims to determine the priority of quality improvement through Cartesian Diagrams.

MATERIALS AND METHODS

This research used quantitative methods, in which the data collection carried out by surveys. The study was conducted in Pulosari Village, Pangalengan District, Bandung Regency, with the consideration that Pulosari Village was the largest producer of Arabica coffee in the Pangalengan District. The research was conducted from February until March 2020.

Pulosari village has the largest area of Arabica coffee production in the Pengalengan District (BPS Bandung, 2018). Pulosari Village is 2.5 km from the capital of the Pangalengan District. Geographically, Pulosari Village is at an altitude of 1,446 m asl., with topography in the form of a plateau with a slope of 32^{o}. Rainfall and average air temperatures in Pulosari Village are 2,400 mm per year and 18-24^{o}C respectively. Based on geographical location and climate, Pulosari Village is suitable for coffee plant development.

As many as 77 of 326 coffee farmers was determined as respondents based on the Slovin formula with an error margin of 10% (Murwani, 2014). Arabica coffee farmers in Pulosari Village were divided into several Forest Farmers' Groups. Sampling was carried out using a proportionate stratified random sampling technique.

Variables of attributes and coffee seedling accessibility were measured using a Likert scale (Sugiyono, 2012) with a scale range of 1-5. The level of importance farmers rated the attributes and accessibility of seedling was categorized into 5 classes; very unimportant, unimportant, quite important, important, and very important. The class intervals were as follows:

1.00 - 1.80 : Very unimportant
1.81 - 2.60 : Not important
2.61 - 3.40 : Quite important
3.41 - 4.20 : Important
4.21 - 5.00 : Very important

Likewise, the knowledge level of farmers and attributes and accessibility of seeds was also categorized into 5 classes; really do not know, do not know, know enough, know and very know. The class intervals were as follows:

1.00 - 1.80 : Really do not know
1.81 - 2.60 : Do not know
2.61 - 3.40 : Know enough
3.41 - 4.20 : Know
4.21 - 5.00 : Very know

The importance and knowledge level of seed attributes and accessibility were determined through an Importance Performance Analysis following the method of Supranto (2001). By using Importance Performance Analysis and Cartesian Diagram, it is that the level of suitability and gaps in the attributes of Arabica coffee seedlings will be known, as well as the position of the various attribute categories and their accessibility in the priority concept.The importance level is indicated by the letter Y, while the knowledge level is indicated by the letter X. Table 1 indicates the

Table 1. Likert scale measurement of importance and knowledge level

Category		Score
Importance Level	Knowledge Level	
Very important	Very know	5
Important	Know	4
Quite important	Know enough	3
Not important	Do not know	2
Very unimportant	Really do not know	1

measurement of importance and knowledge level using a Likert scale.

The Importance Performance Analysis method is carried out through the following stages:

a. Determining the importance and knowledge level of seedling attributes and accessibility

Important seed attributes and accessibility have a greater or equal value with v (Yi ^{3} v).

$$\hat{Y} = \frac{\sum_{i=1}^{n} Yi}{n} \quad \hat{Y} = \frac{\sum_{i=1}^{n} Yi}{n} \quad \ddot{X} = \frac{\sum_{i=1}^{n} Xi}{n} \quad \ddot{X} = \frac{\sum_{i=1}^{k} Xi}{k}$$

Description:

Yi = Average value of the importance level for each attribute and accessibility of seedling analyzed

$\hat{Y}$ = Average value of the importance level for all seedling attributes and accessibility analyzed

Xi = Average value of the knowledge level for each attribute and accessibility analyzed

$\ddot{X}$ = Average value of the knowledge level for all attribute and accessibility analyzed

K = Total of seedling attributes

n = Number of respondents

b. Determining the suitability and gaps level of the seedling attributes and accessibility that were considered as important

Analysis of the suitability level is the result of a comparison between the farmers' knowledge level of seed performance and the importance level of the seed attributes and accessibility. The percentage of suitability level is considered sufficient if it has a value of more than 75%. The formula used is as follows:

$$Tk_i = \frac{Xi}{Yi} \times 100\%$$

$$Ts_i = 100\% - Tk_i$$

Description:

Tk_i = Level of quality suitability

Ts_i = Level of quality gap

Xi = Farmer knowledge assessment score

Yi = Farmer importance assessment score

c. Determining the priority of quality improvement (Cartesian diagram)

In the Cartesian diagram of the Importance Performance Analysis method, the horizontal axis (X) will be filled by the knowledge level score, while the vertical axis (Y) will be filled by the importance level score. The seed attributes and accessibility in the map are in accordance to the knowledge and importance level (X, Y) (Supranto, 2001). The formula for each of these factors, is as follows:

$$X = \frac{\sum_{i=1}^{n} Xi}{n} \quad Y = \frac{\sum_{i=1}^{n} Yi}{n}$$

Description:

X = Average score of knowledge level

Y = Average score of importance level

n = Number of respondents

Therefore, the Cartesian diagram used is divided into 4 parts and limited by two lines that intersect perpendicular to the average value of the importance and satisfaction level on all quality attributes (X, Y). These points are obtained from the following formula:

$$X = \frac{\sum_{i=1}^{n} Xi}{k} \qquad Y = \frac{\sum_{i=1}^{n} Yi}{k}$$

Description :

X = Average score of knowledge level from all coffee seedling attributes

Y = Average score of importance level from all coffee seedling attributes

k = Total coffee seed attributes used

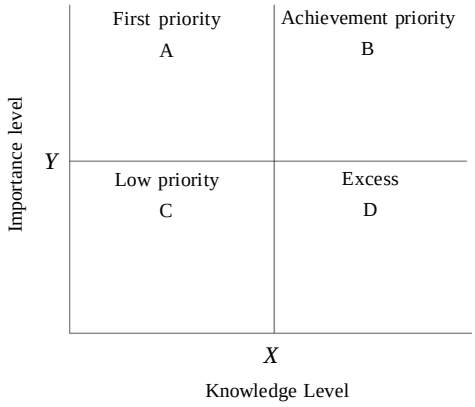

Figure 1. The Cartesian diagram

Description :

A = Shows the seedling attributes that are considered important and affect customer satisfaction, but have been unknown by farmers.
B = Shows the seedling attributes that are important for consumers and have been well known by farmers.
C = Shows the seedling attributes that are considered less important for consumers, but are known by farmers.
D = Shows the seedling attributes that according to consumers are less important, but already known by farmers.

RESULTS AND DISCUSSION

The Importance Level of Coffee Seedling Attributes

The importance level of coffee seedlings attributes rated by farmers was analyzed to find out how important coffee seedlings attributes are considered to be by the farmers (Hasibuan, 2013). Furthermore, this was also used as a strategy for developing a seeding system and assembling superior coffee varieties in the future. The importance level farmers rated the attributes and accessibility of coffee seedlings consisted of 12 variables, described in Table 2.

Table 2 shows that the assessment of farmers level of importance regarding both attributes and accessibility of seedlings were classified as very important, with the acquisition of an average score of 4.85. Additionally, the average score for the seedlings attribute variable was 4.98 and the seedlings accessibility variable was 4.68. All attributes were evaluated to have a positive score and were located in a very important category.

The coffee seedlings attributes evaluated to have the highest importance level were type of variety, pests and diseases resistance, productive age, productivity and adaptability with an average score for each variable of 4.99. These variables are still in the very important category. The variable that was evaluated to have the lowest importance level was the ease of getting seedlings, with a score of 4.66. This was still categorized as very important. This evaluation is in accordance with research of Sari & Suciati (2018), that the level of farmer evaluation of superior varieties of rice seeds

Table 2. The importance level of farmers rated seedlings attributes

	Variable	Average score	Category
Seedling attributes	Types of varieties	4.99	Very important
	Seedling size	4.95	Very important
	Harvest age	4.95	Very important
	Productive age	4.99	Very important
	Productivity	4.99	Very important
	Pests and diseases resistance	4.99	Very important
	Adaptability	4.99	Very important
	Average of seed attribute score	4.98	Very important
Seedling accessibility	Fertilizer efficiency	4.48	Very important
	Ease of maintenance	4.74	Very important
	Seedling price	4.75	Very important
	The ease of getting seedling	4.66	Very important
	Seedling availability	4.76	Very important
	Average of seed accessibility	4.68	Very important
	Average of total score	4.85	Very important

in Jember Regency shows that the attributes of productivity, weather suitability, rice quality and grain prices have the highest level of importance.

Arabica coffee seeds which have the attributes of superior varieties, standardized seed size, short harvest age, long productive age, high productivity, resistance to pests and diseases and high adaptability are characteristics of Arabica coffee seeds that are favored by the market according to the preferences of coffee farmers in Pulosari Village. The efficient use of fertilizers, ease of maintenance, affordable seed prices, easy access to seeds and sufficient seed availability are also considerations for farmers in choosing coffee seeds. According to Dzuhrinia (2017) soybean seeds which have high productivity attributes, resistant to pests and diseases and large seed sizes are characteristics of soybean seeds favored by soybean farmers in Jatiwaras Sub-District.

From the measured 12 attributes and accessibility of coffee seeds, the level of importance rated by Arabica coffee farmers was in the important and very important category with a percentage as in Table 3.

Farmers' assessment of each attribute and accessibility of the coffee seeds as illustrated in Table 3 shows that the expectation of farmers to use superior coffee seeds is very high in Arabica coffee cultivation.

Farmer Knowledge Level on Coffee Seedlings Attributes

Knowledge is the result of human sensing, or the result of individual knowledge of an object from its senses (Notoatmodjo, 2012). Opinion of Yuantari *et al*. (2013) that level of knowledge of an individual is closely related to the level of experience and formal education, the higher the experience and education, the higher the knowledge of an individual. Farmers knowledge of seed attributes is also inseparable from the results of farmers' perception of the coffee seeds. The number of farmers on the threshold level of the farmers on the attribute of the seed is analyzed to find out how the farmer understands the various attributes of the selected coffee seeds. The level of knowledge of farmers on coffee seed attributes consists of 12 variables, described in Table 4.

Table 3. The percentage of farmer importance rating of coffee seedling attributes and accessibility

Attribute and seedling accessibility	Category/farmers			
	Important		Very important	
	Σ	%	Σ	%
Types of varieties	1	1.30	76	98.70
Seedling size	4	5.19	73	94.81
Harvest age	4	5.19	73	94.81
Productive age	1	1.30	76	98.70
Productivity	1	1.30	76	98.70
Pests and diseases resistance	1	1.30	76	98.70
Adaptability	1	1.30	76	98.70
Fertilizer efficiency	40	51.95	37	48.05
Ease of maintenance	1	1.30	76	98.70
Seedling price	23	29.87	54	70.13
The ease of getting seedling	34	44.16	43	55.84
Seedling availability	17	22.08	60	77.92

Table 4 shows that the assessment level of farmers' knowledge of both the attributes and the accessibility of the seeds of each variety as a whole was classified known, with the acquisition of an average score of 3.30. Furthermore, the average score for the seedling attribute variable was 3.38 and the average score for the average seedling accessibility was 3.20. According to each variable, the coffee seed attributes that farmers had the highest level of knowledge on was fertilizer efficiency, with a score of 3.63. This was categorized in the know category.

Fertilizer efficiency has a high perceived with a score of 3.63 and is included in the known category. Farmers' knowledge of the frequency with which coffee plants are fertilized in a year, what type of fertilizer is applied (organic or non-organic), the dosage of fertilizer applied and how to fertilize coffee plants is quite good. There is no farmers in the category of un-known for this attribute. This means that coffee farmers in Pulosari Village have realized the importance of the coffee plant fertilized. Seed availability attribute has a low score of 2.01 and is in the unknown category. Farmers did not have

Table 4. Overview of farmers knowledge level on coffee seedling attributes

	Variable	Average Score	Category
Seedlings attributes	Types of varieties	3.13	Know enough
	Seedling size	3.44	Know
	Harvest age	3.36	Know enough
	Productive age	3.53	Know
	Productivity	3.49	Know
	Pests and diseases resistance	3.39	Know enough
	Adaptability	3.31	Know enough
Average score of seed attribute		3.38	Known enough
Seedlings accessibility	Fertilizer efficiency	3.63	Know
	Ease of maintenance	3.35	Know enough
	Seedling price	3.45	Know
	The ease of getting seedling	3.54	Know
	Seedling availability	2.01	Don't know
Average score of accessibility		3.20	Know enough
Average total score		3.30	Know enough

Table 5. The percentage of farmer knowledge level of coffee seedling attributes and accessibility

Attribute and seedlings accessibility	Knowledge level				
	1	2	3	4	5
Type of varieties	0	6.49	55.84	37.66	0
Seedling size	0	0	50.65	49.35	0
Harvest age	0	0	54.55	41.55	3.90
Productive age	0	1.30	24.68	54.54	19.48
Productivity	0	7.79	7.79	75.32	9.10
Pests and diseases resistance	0	36.36	5.19	45.46	12.99
Adaptability	0	0	27.27	68.83	3.90
Fertilizer efficiency	0	0	32.47	62.34	5.19
Ease of maintenance	0	3.90	51.95	44.15	0
Seedling price	0	2.60	48.05	48.05	1.30
The ease of getting seedling	0	7.79	25.97	64.94	1.30
Seedling availability	0	9.09	24.68	66.23	0

enough information about the available ready-to-plant coffee seeds. Most of the Arabica coffee farmers in Pulosari Village bought coffee seeds from local seedlings that take coffee beans to become seeds from production gardens.

The percentage level of knowledge of coffee farmers on each attribute and accessibility of coffee seedling can be seen in Table 5. Table 5 shows that the level of knowledge of Arabica coffee farmers in Pulosari Village on each attribute and accessibility of coffee seedlings varies. It is also related to the level of education and experience that farmers have in coffee farming. Measurement was based on coffee farmers' knowlegde of certain standards on a number of questions with answer choices score 1: really do not know; score 2: do not know; score 3: know enough; score 4: know and score 5: very know.

For the attribute of varieties, more than 50% of coffee farmers were categorized in the know enough category for developed Arabica coffee varieties. There are 8 varieties of Arabica coffee that are known and cultivated by Pulosari Village farmers, namely Kartika, Ateng, TimTim (Gayo 1), Ateng Super, Ateng Coklat, Lini S, Andungsari and Sigarar Utang. Almost all Arabica coffee farmers in Pulosari Village have coffee businesses that use several varieties. The widely used varieties of Arabica coffee in Pulosari Village are TimTim (Gayo 1), Ateng and Ateng Coklat.

The high standard of plant from generative coffee plant seedling is a minimum of 15 cm. From vegetative seedling (grafting), the minimum plant height is 20 cm, while for for coffee seeds from cuttings the minimum height is 15 cm (Ditjenbun, 2016). For the seed size attribute 50.65% of farmers are in the category of know enough, while 49.35% of farmers are in the category of know. The average Arabica coffee seedlings used by farmers are 30-40 cm height of. This size has exceeded the minimum standard for coffee seedling height. This means that farmers already know the size of the seedling that are suitable for planting in their farms.

Arabica coffee plants start producing fruits at the age of 1.5 years (Mawardi *et al*., 2008). Productivity starts to increase maximally after the age of more than 5 years when the plants already can be harvested. For the harvest age, 54.55% of farmers were in the know enough category. For farmers, the faster the harvest, the added value for this plant. This is because it is related to the income obtained by farmers. According to farmers, the average Arabica coffee plant begins to bear fruit at the age of 2 years. Farmers start harvesting coffee plants at the age of 3 years, although this is not optimal. Normal harvest can be done by farmers on plants aged 4 years and over where coffee production has increased and is stable.

Productive age is the time when plants produces maximum production. Hartatri & de Rosari (2011) says that the productive age of coffee plants is 15 to 55 years. The results of Fatma's (2011) showed that there was a real influence on the age of plants on the production of coffee farming. The amount of coffee production will continue to increase until it reaches the optimal plant age, with a peak at the age of 9 years. In terms of knowledge related to the age of the plant, 54.55% of farmers were know category. Coffee plants in the Pulosari Village begin to produce normally at the 4 years age. At the 4 years age, the Arabica coffee plant begins to produce a maximum until the plant is 10 to 15 years old.

High production and productivity are expected in Arabica coffee farming. Seed potential is considered by farmers before farming has started. The level of knowledge

of farmers on Arabica coffee productivity of each variety shows that 75.32% were in the know category. There is a variety of Arabica coffee production in Pulosari Village based on plant age. Andungsari and Kartika varieties above 15 years of age have an average productivity of 1.5-2 kg cherries per tree per year. Meanwhile, TimTim (Gayo 1) and Ateng varieties have an average productivity of 4-10 kg cherries per tree per year.

The level of knowledge farmers had on Arabica coffee plant resistance to pests and diseases has a fairly high perception, with a score of 3.39. This belongs to the category of know enough. Pests and diseases can interfere with the productivity of coffee plants. The results of the evaluation of the level of knowledge farmers had on resistance to pests and diseases of cultivated Arabica coffee varieties showed 45.45% were in the category of know. The pest that once attacked Arabica coffee plants in Pulosari Village is coffee berry borer (*Hypothenemus hampeii* Ferr.). Pest control by farmers is routinely carried out so that these pests rarely attack coffee plants in Pulosari village anymore.

Plant durability in different environmental conditions or extreme weather represents the adaptability of that plant. Farmer knowledge related to Arabica coffee plant adaptability shows that 68.83% were included in the category of know. Arabica coffee can grow well in areas with an altitude between 1,000-2,000 m asl. This knowledge is used by coffee farmers to cultivate arabica coffee in Pulosari Village, which is at an altitude of 1,446 m asl. A suitable geographic environment supports the adaptability of coffee plants during extreme weather conditions.

The benefits of crop fertilization include increasing production and yield quality, maintaining high production stability, improving plant condition and resistance to extreme environmental changes such as drought and over bearing (Ditjenbun, 2014). The level of farmer knowledge on fertilizer efficiency of each Arabica coffee variety had a high perception, with more than 60% of farmers including the know category. No farmer in the do not know and really do not know category about this attribute. This means that coffee farmers in Pulosari Village have realized the importance of fertilizing the coffee plant. Farmers also know the application of fertilization to Arabica coffee plants.

One form of maintenance in coffee cultivation is routine pre-harvesting pruning. The level of knowledge of farmers about this showed that 51.95% were in the know enough category. More than 50% of farmers know enough about this attribute because the purpose of pruning is to keep the plant low for easy care. Some coffee farmers do not know about pruning before harvest. This ignorance is due to a lack of information about the importance of routine pruning. Pruning is still carried out but not routinely as recommended in the Good Agriculture Practice (GAP).

Knowledge of seed prices of each Arabica coffee variety is important as one of the economic considerations before starting farming. Farmer knowledge about the suitability of seed prices with quality and expected production shows that as many as 48.05% were either in the know enough category, on the known category. Farmers' knowledge about the suitability of seedling prices with the expected quality and production is quite good. Before buying coffee seeds of one variety, farmers also need to compare the prices of other seedlings. Pulosari village farmers bought coffee seedlings between Rp.1,500-Rp.3,000 per seedling for all varieties from local coffee seedling producers. The price of seedlings purchased from local

nurseries is relatively cheaper than the price of certified seedlings.

The ease of getting seedling, especially superior seedlings, is important for good Arabica coffee farming. The level of knowledge farmers had about producers of Arabica coffee seedling in the Pulosari Village and surrounding areas showed the majority of farmers (64.94%) were in the know category. Most farmers obtained Arabica coffee seedlings from local coffee seedling producers in Pulosari Village and some farmers even planted their own seed. The majority of coffee seedling producers in Pulosari Village do not have permits. Most of the seedlings sold were not certified and labeled.

There are several coffee seed producers outside Pulosari Village, and some even have a seed production business license. The Arabica coffee seed producers that already have the license are located in Mekar Sari Village, Pasirjambu District, Bandung Regency. Outside Bandung Regency, there are also coffee seed producers, including in Sumedang and Tasikmalaya Regency. The considerations for the distance and transportation costs have made farmers prefer to buy coffee seeds around Pulosari Village.

One of the determining factors for the success of coffee development is the availability of superior and quality planting material. The level of knowledge of farmers related to the existence of Arabica coffee seed source garden in the area around Pulosari Village showed that 66.23% of farmers were in the know category. The Directorate General of Estate Crops, Ministry of Agriculture has determined that in the Pangalengan District, especially in Margamulya Village, there is an Arabica coffee seed source of the Sigarar Utang variety. Knowledge of seedling availability is related to planning of the development of Arabica coffee farms, especially farmers in Pulosari Village. Knowledge of the number of seeds available is quite good because some of the Pulosari Village coffee farmers are also seeding coffee seeds to become coffee seedlings.

Analysis of Suitability and Gap Levels

The suitability level analysis is the result of a comparison between the farmers' knowledge level of the arabica coffee seedling attributes with the importance level of coffee seedling attributes. The attributes that are assessed need to get priority attention from seed producers and from the government as policy makers. The percentage of suitability level is obtained based on the average value of knowledge compared to the average value of importance. The level is considered quite suitable if it reaches a value of ≥ 75%. The distribution results of the suitability and gap levels for each seed attribute are presented in Table 6.

Table 6 showed that of all the important coffee seedling attributes, none had a suitability value of 100%. The average suitability level was only 68.13%, less than 75%. There were only 2 seedling attributes that had a suitability value above 75%, namely the efficiency of fertilizer use (81.03%) and the ease of obtaining seedling (75.97%). Meanwhile, 10 seedling attributes had a suitability value below 75%, with the seedling availability attribute having a suitability value of only 42.23%. This means that information about the varieties of coffee seedlings has not been fully conveyed to the farmers. Counseling related to Arabica coffee farming is still rarely given to coffee farmers in Pulosari Village. This is in line with the study of Sudarko *et al*. (2020), which states that government counseling support for coffee farmers is low. In-depth interviews with coffee farmers and counselors confirm that programs related to coffee plantation counseling are still limited in terms of funding, number and competency levels of coffee counselors. Furthermore,

Table 6. Distribution of suitability and gap levels in Arabica coffee seedling attributes

Seed attributes/ accessibility	Importance level	Knowledge level	Suitability (%)	Gap(%)
Types of varieties	4.99	3.13	62.73	37.27
Seed size	4.95	3.44	69.49	30.51
Harvest age	4.95	3.36	67.88	32.12
Productive age	4.99	3.53	70.74	29.26
Productivity	4.99	3.49	69.94	30.06
Pests and diseases resistance	4.99	3.39	67.94	32.06
Adaptability	4.99	3.31	66.33	33.67
Fertilizer efficiency	4.48	3.63	81.03	18.97
Ease of maintenance	4.74	3.35	70.68	29.32
Seed price	4.75	3.45	72.63	27.37
The ease of getting seeds	4.66	3.54	75.97	24.03
Seed availability	4.76	2.01	42.23	57.77
Average	4.85	3.30	68.13	31.87

the coffee plantation locations, which are predominantly in the hills, mountains and forests, are often difficult to reach. This is a major obstacle in coordinating and implementing counseling programs.

The low level of coffee farmers' formal education and the lack of experience in coffee farming mean that knowledge levels of Arabica coffee seedling attributes are still lacking. However, the support and participation of farmer groups, LMDH village officials and local and central government through the socialization and counseling of good coffee cultivation is expected to further enhance the development of Arabica coffee in Pulosari Village.

The gap value is the result of a 100% reduction with the suitability value of each quality attribute. This value shows the extent of the gap between farmers' expectations and the performance of institutions related to coffee development. The maximum gap in this study was 25%. This means that the smaller the quality attribute gap, the more fulfilled consumer expectations are. In Table 6, it can also be seen that the average gap value was 31.87%, above 25%. Ten attributes have a high gap value of more than 25%. The highest gap was found in the attributes of seedling availability (57.77%) and variety types (37.27%), while the lowest gap was found in the aroma quality attribute (6.14%). Therefore, this shows that the performance of institutions related to the development of Arabica coffee still needs to be improved.

Quality Improvement Priority Analysis

From the data obtained based on the importance and knowledge level of 77 farmers, a diagram is needed to make it easier to determine the priority of improvement. A Cartesian diagram divided into 4 priority quadrants that can be used as a tool to arrange business priorities that improve performance quality (Pratama, 2017). A Cartesian diagram is a chart that is divided into four parts and is limited by two lines that intersect perpendicular to the points (X, Y). The X-axis represents the value of knowledge level, while the Y-axis represents the value of the importance level for the seedling attributes analyzed. Placement of the data in the Cartesian diagram is very useful to find out the position of various categories for seedling attributes and accessibility. The priorities can therefore be determined and this can be used to improve efforts related to the manufacture of Arabica coffee superior seeds. The Cartesian diagram for the research results is shown in Figure 1.

The Cartesian diagram is divided into 4 main sections, including the first priority (quadrant A), the achievement priority

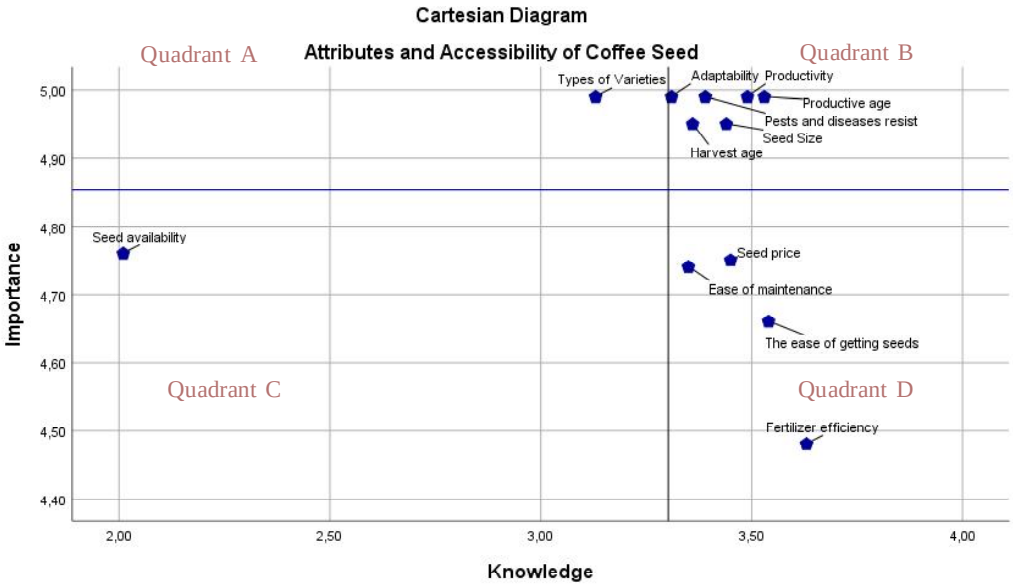

Figure 2. Cartesian diagram of coffee seedling attributes and accessibility

(quadrant B), the low priority (quadrant C), and the excess (quadrant D).

1. First Priority (Quadrant A)

Seedling attributes included in this quadrant were those that were considered important by farmers, but farmers' knowledge about these attributes is still lacking. Therefore, these attributes require the attention of relevant institutions in the form of socialization and counseling. The seedling attributes included in this quadrant were variety types.

The varieties that are widely used by Arabica coffee farmers in Pulosari Village are TimTim (Gayo 1), Ateng and Ateng Coklat. TimTim (Gayo 1) is a superior variety that has been released by the Ministry of Agriculture, while Ateng and Ateng Coklat have not been released as superior varieties. Most of the Arabica coffee farmers in Pulosari Village are independent farmers. The decision to use certain coffee varieties is partly influenced by individuals following other coffee farmers. There is a need for ongoing advice about good coffee cultivation so that Arabica coffee cultivation develops and produces maximum production in the future.

2. Achievement Priority (Quadrant B)

Quadrant B includes attributes that were considered important to farmers and ones that farmers' knowledge of is quite good. Seedling attributes included in this quadrant were seedling size, harvest age, productive age, productivity, resistance to pests and diseases and adaptability.

Farmers' knowledge about the size of the seedlings ready for planting, the age of the coffee plants can be harvested, how many years the coffee plant can produce optimally, productivity every year, pests and diseases that can attack coffee plants and how coffee plants adapt to the planting environment is considered good. Knowledge and information related to these attributes needs to be continuously updated, along with the development of science and technology that produces further innovations in the development of

Arabica coffee. Support from governments can be provided through coffee cultivation technical training programs that teach skills such as determination of planting materials and post-harvest processing.

3. Low Priority (Quadrant C)

Seedling attributes included in this quadrant are those that are less known by farmers and are also considered less important. The seed attribute included in this quadrant is seed availability. Lack of knowledge and perceived importance of farmers regarding these attributes needs to be a shared concern between farmers, seed producers and the government.

Seedling availability is related to the number of ready-to-plant Arabica coffee seedlings needed by farmers, the origin of the seedlings and the ease of obtaining these seedlings. Knowledge related to the origin of seedlings can determine whether the coffee seedlings are superior or not, which will greatly affect the quality and production of coffee plants in the future. As coffee is a perennial crop with a long investment period, the level of farmers' perceived importance and knowledge about the attributes of seedling availability, especially in regards to superior seeds, needs to be improved.

4. Excess (Quadrant D)

Seedling attributes included in this quadrant were those that were considered less important for farmers but were well known. The seedling attributes included in excess quadrant were the seedling price, ease of maintenance, ease of obtaining seedlings and fertilizer efficiency.

Farmers' knowledge of the seedling attributes of the seedling price, ease of maintenance, ease of obtaining seedlings and fertilizer efficiency is higher than the importance of these attributes. Pulosari Village coffee farmers' knowledge of seedling attributes was obtained independently. As an example, the seedling price is quite well known by farmers because most farmers in Pulosari Village obtain seedlings using their own capital. The average seedling price is the same as for different varieties. The ease of obtaining seedlings is an attribute with a high knowledge level because in obtaining Arabica coffee seedlings, Pulosari Village farmers can buy from local coffee seedling producer in the area around the village. It is hoped that the determination of priority for quality improvement through the Cartesian Diagram can become a reference for improvements related to the supply of superior Arabica coffee seedlings.

CONCLUSIONS

The importance level of seedling attributes and accessibility variables were classified as very important. All attributes evaluated, namely varieties, seedling size, age of harvest, age of production, productivity, resistance to pests and diseases, adaptability, efficiency of fertilizer use, ease of maintenance, price of seedling, ease of obtaining seedlings and availability of seedlings had positive scores. The knowledge level of the farmers regarding the seedling attribute and accessibility variables for each variety was classified in seperate categories. The seedling attributes categorized as known include seedling size, productive age, productivity, fertilizer use efficiency, seedling price, and ease of obtaining seedlings. The attributes of variety types, harvest age, resistance to pests and diseases, adaptability and ease of maintenance were all categorized in the well known category. Meanwhile, the knowledge level of farmers of the seedling availability attribute was categorized as unknown. The suitability value of all seedling attributes

was low (below 75%), while the gap value of all seedling attributes was high (above 25%). A Cartesian diagram showed the position of seedling attributes and accessibility in terms of their priority. Seedling availability by farmers in Pulosari is considered a low priority. Lack of knowledge and perceived importance of farmers regarding these attributes needs to be a shared concern between farmers, seedling producers and the government. Determination of new seed source gardens and evaluation of Arabica coffee seed source gardens that have been determined by relevant agencies in accordance with applicable regulations is one way to guarantee the availability of Arabica coffee superior seedlings. Furthermore, the government can support through programs that can improve Arabica coffee farming. These programs include training in skills such as the selection of planting materials, post-harvest processing and good marketing techniques. Farmer empowerment through intensive assistance by field counselors is therefore another method through which farmers are able to develop independently.

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