Assessing Multidimensional Resilience of Smallholder Plantations in Bengkulu Province, Indonesia

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ABSTRACT

The resilience of smallholder plantations implies the ability of farmers to thrive in disturbances or disruptions on their farms. The farmers try to integrate social and economic capacities and resources to adapt, tolerate, and manage the risk, and enhance their farm resilience. There are three priority plantation commodities contributing to Indonesia's economic growth, particularly Bengkulu Province, which are oil palm, rubber, and coffee. Thus, it is important to understand the resilience of smallholder plantations in Bengkulu Province. 360 farmers have been surveyed from six villages in three districts (North Bengkulu, South Bengkulu, and Rejang Lebong). The method deployed in this study is quantitative descriptive analysis. This research developed a multidimensional resilience indicators approach based on farmers' perceptions about their capacity of adaptability, recoverability, anticipation, and innovation level. These fourth resilience indicators were assessed by 12 sub-indicators which have been arranged in a structured questionnaire. The results show that more than 50% of smallholder plantations in Bengkulu Province are classified as less resilient smallholders. The further finding also indicates that the most resilient smallholders are coffee farmers, whereas the least resilient smallholders are rubber farmers. The smallholding farmers in Bengkulu Province generally are innovative farmers and have good recoverability. However, they are quite adaptive and less anticipatory farmers.

Keywords: Smallholders' resilience, Adaptability, Recoverability, Anticipation, Innovation

1. INTRODUCTION

Indonesia is one of the top plantation producer countries in the world for oil palm, rubber, and coffee [1]. However, most of the production is generated by smallholding farmers [2]. In some regions, smallholding farmers dominate the economic contribution share, including Bengkulu province. As one of the youngest provinces in Indonesia, the region's growth is sustained by the agricultural sector. More than 70% of the population are farmers, and most of them are smallholders. Unluckily, Bengkulu province is one of the poorest provinces in Indonesia. About 15% of the population lives below the poverty line [3].

Smallholding farmers are typically complex and heterogeneous. They are generally categorized as small farm size owners, low capital producers, low productivity of labor, traditional, sensitive to price variations [4], and limited access to information, market, and services [5]. These characteristics can be the reason why plantation smallholders tend to be vulnerable to disruption and become less resilient. However, they are vital for ensuring food security in many developing countries, including Indonesia [6].

The concept of resilience was firstly originally mentioned by Holling in his paper which focused on ecological systems [7]. His paper explained the differences between a condition other than stability which features the ability of a system to absorb environmental changes. Resilience is fundamentally a system property. It refers to the magnitude of change or perturbation which a system experiences without shifting into the alternate state that has different structural and functional properties and supplies, and

different bundles of the environmental services that benefit people [8]. The farming system is different from ecological systems in their production intention and their deliberate attempts to control the environment and minimize disruption. To build resilience in the farming system, including smallholder plantation, the foremost circumstances to note are geographical conditions, climate changes, and other environmental challenges [9] [10] [11] [12].

In much previous research, a farm resilience assessment is drawn around one or a few related dimensions to provide a degree of focus. Smallholder's resilience was assessed by the adaptability capacity [13] [14] [15] [16], the recoverability [17], anticipation and preparedness [18], and farmer's adoption to innovation [19] [20]. This study proposes a comprehensive approach by utilizing the multidimensional capacities of the farming system. Smallholder resilience is conceptualized as the dynamic capacities of plantation smallholders to adapt to changes, recover from the business downturn and catastrophe, anticipate risk, and innovate new designs of farming systems [20]. The resilience of the small-scale agricultural businesses, including smallholder plantations, can be theorized as the ability of smallholders to manage challenges, disordered circumstances, or even disruptions [21]. On the small scale of farms, the resilience can be improved by diversifying crops and implementing adaptive approaches to respond to disturbances [22] [23]. Resilience is also framed as the ability of farmers to recover in the least possible time in case of a disruptive incident. In this paper, general resilience was applied to present the smallholder plantation system resilience.
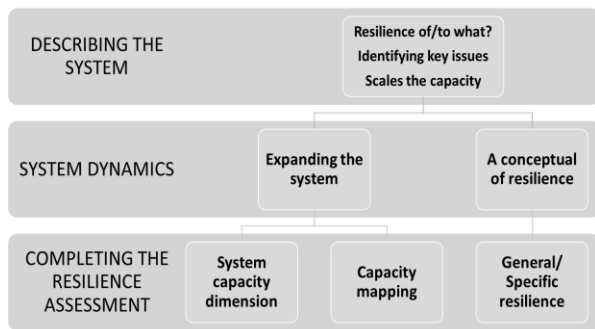

Figure 1. Resilience assessment framework
Source: Resilience Alliance [8] (modified by authors, 2021).

Based on this background, this paper aims to assess the resilience level of smallholder plantations in Bengkulu Province, Indonesia. Smallholder plantations' resilience is defined as the ability of farming systems to ensure the provision of the system functions in the face of increasingly complex and accumulating challenges, disturbances, or even disruptions. This study used a multidimensional capacities approach, such as the

capacity of adaptability, recoverability, anticipation, and farmers' innovation level.

2. METHOD

2.1. Data Collection
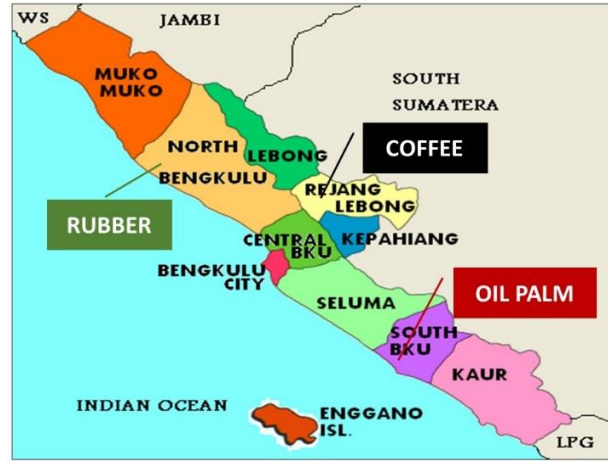
Figure 2. Research location map

Table 1. Samples distribution

District/Sub	Commodity	Villages	Samples
South Bengkulu/ Pino Raya	Oil palm	Pasar Pino	60
		Nanjungan	60
North Bengkulu/ Batik Nau	Rubber	Maninjau	60
		Samban Jaya	60
Rejang Lebong/ Sindang Dataran	Coffee	Warung Pojok	60
		Bengko	60
Total			360

This study was conducted in Bengkulu Province, Indonesia. Bengkulu is well known as one of the poorest provinces in Indonesia. More than 350 thousand households are depending on their livelihood as a farmer, and most of them are smallholding farmers [3]. Bengkulu's economic growth is sustained by the agricultural sector, and plantation commodities are the main contributor to gross domestic income. There are three priority plantation commodities in Bengkulu Province, which are (ordered by production), oil palm, rubber, and coffee [3]. Each commodity is mainly produced in a different region. Oil palms were firstly introduced and cultivated in the South Bengkulu district in the 1980s. Whereas, rubbers are mostly produced by farmers in the North Bengkulu district, and coffee crops are cultivated in the highland region, Rejang Lebong district.

This research employed cross-sectional data at the farmer level, in which 360 plantation farmers were randomly selected as the research samples. A multistage sampling technique was used to select the smallholding plantation farmers for this research. In the first stage, the districts were purposively chosen. Then, one subdistrict in each district was selected based on the largest harvest land area. In this subdistrict, two villages producing the largest oil palm, rubber, and coffee were determined. In the second stage, 60 farmers were randomly selected from each village. A total of 360 farmers were interviewed using a structured questionnaire. During the survey, respondents were asked to rate their current conditions and actions in retaining and expanding their business to indicate the resilience level.

2.2. Resilience assessing approaches

2.2.1. Resilience

The aim of this research is to assess the resilience level of smallholder plantations in Bengkulu Province by adopting a multidimensional capacity approach. A list of 38 items representing four dimensions of smallholder's resilience (adaptability, recoverability, anticipation, and innovation) was created based on a comprehensive review of the literature [8] [20] [24] [25]. The dimensions were indicated by 12 indicators (Figure 3). The indicators were gathered from different sources of literature and explained separately. The statements written for each of these indicators to which participants responded were on a 5-point Likert-type-scale (1-strongly disagree; 2-disagree; 3-neutral; 4-agree; and 5-strongly agree).

By adopting resilience measurement from Levine [26], smallholder resilience is classified by two groups of farmers. Levine expressed in his book that resilience can be measured by the probability approach. Since it certainly makes sense to describe the system as being *more* or *less* resilient. To measure smallholder resilience, this study used an original multidimensional approach, and the math formulation used is:

$$AR_n = \sum_{i=1}^{I} ACap_n \qquad (1)$$

Where AR_n is the resilience of smallholder plantations of respondent n, $ACap_n$ represents the total average score of each capacity dimension of respondent n (min. 4 points, and max. 20 points), i indicates the number of dimension capacity (4): capacity of adaptability, recoverability, anticipation, and innovation.

2.2.2. Adaptability

The adaptability capacity is represented by three indicators: (1) Experience towards catastrophe (EtC), (2) Diversification on farming activities (DoF), and (3) Resource adaptability (RA) [27] [28] [29] [30]. Experience towards catastrophe is explained by (i) the intensity of natural disaster experiences, (ii) the existence of prevention efforts towards natural disaster incidents, and (ii) the ability of adaptation in every natural disaster incident. Diversification in farming activities is described by (i) Conducting a multi-crops strategy, and (ii) utilizing another side-crop yield for the plantation. Whereas resources adaptability is explained by (i) preparing production inputs (seeds, fertilizers, and other inputs) independently, (ii) maximizing the utilization of family labor, (iii) using organic materials, (iv) optimizing on using existing technology, and (v) minimizing dependency on external resources. Those statements are on a 5-point Likert scale. The classification of this dimension is 1-1.8 = Not very adaptive; >1.8-2.6 = Less adaptive; >2.6-3.4 = Quite adaptive; >3.4-4.2 = Adaptive; >4.2-5 = Very adaptive.
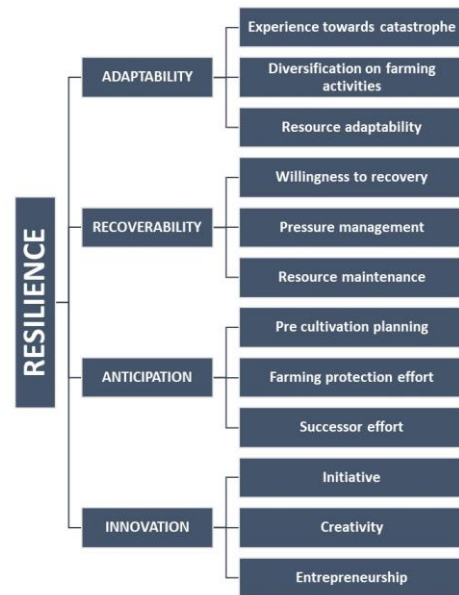

Figure 3. Agricultural resilience framework
Source: Constructed by authors, 2021.

2.2.3. Recoverability

The recoverability is represented by 3 indicators: (1) Willingness to recovery (WoR), (2) Pressure management (PR), and (3) Resource maintenance (RM) [24] [31] [32]. Willingness to recovery is indicated by (i) confidence towards the continuity of plantation business, (ii) the existence of a family strengthens to rise from hardship, and (iii) the faith of God's help makes farmers recover from failure/loss. Pressure

management is indicated by (i) ability to compromise with disasters or disturbances, (ii) ability to run plantation business in disordered circumstances, and (iii) running the plantation business as it should even in non-profitable conditions. Meanwhile, resource maintenance is indicated by (i) replacing damaged plants regularly, (ii) conducting plant maintenance intensively, and (iii) improving soil conditions after a flood, landslide, or other natural disasters. All the statements are on a 5-point Likert scale. The category of this dimension is 1-1.8 = Not very good; >1.8-2.6 = Not good; >2.6-3.4 = Quite good; >3.4-4.2 = Good; >4.2-5 = Very good.

2.2.4. Anticipation

The anticipation level of smallholder plantations is represented by 3 indicators: (i) Pre cultivation planning (PCP), (ii) Farming protection effort (FPE), and (iii) Successor effort (SE) [18]. Pre-cultivation planning is explained by (i) arranging scheduled and structured planning for farming activities, (ii) executing preparations before cultivation activities, (iii) preparing action to face the risk of disaster or disruption, and (iv) creating a backup plan to anticipate crisis or disruption. While, farming protection effort is indicated by (i) agricultural insurance, (ii) reserved fund, and (iii) prevention effort. In addition, the successor effort is indicated by (i) encouraging the children to pursue the family's business, (ii) providing the children with agricultural education background, and (iii) requesting the children to involve in farming activities. Anticipation capacity statements are on a 5-point Likert scale. Whereas the category of this dimension is 1-1.8 = Not very anticipatory; >1.8-2.6 = Less anticipatory; >2.6-3.4 = Quite anticipatory; >3.4-4.2 = Anticipatory; >4.2-5 = Very anticipatory.

2.2.5. Innovation

The smallholder's capacity for innovation is represented by 3 indicators: (i) Initiative (IN), (ii) Creativity (CR), and (iii) Entrepreneurship (EN) [19]. The initiative indicator is indicated by (i) deciding business affairs independently and quickly, and (ii) conducting actions initiatively, not by others' orders. Creativity indicator is explained by (i) finding a new way to overcome the farm problem, and (ii) finding new ideas to run plantation businesses. Then, entrepreneurship is indicated by (i) having goals and confidence, (ii) leadership, (iii) expanding business, and (iv) taking risks. The innovation capacity statements are on a 5-point Likert scale. Whereas the category of this dimension is 1-1.8 = Not very innovative; >1.8-2.6 = Less innovative; >2.6-3.4 = Quite innovative; >3.4-4.2 = Innovative; >4.2-5 = Very innovative.

3 RESULTS AND DISCUSSION

3.1 Smallholders' resilience level

Smallholder plantations' resilience in Bengkulu province is indicated by dimensions of adaptability, recoverability, anticipation, and capacity of innovation. The results show that more than 50% of smallholder plantations' resilience scores are less than the average score (Table 2). The largest score of resilience dimension is recoverability capacity, with an average score of 3.97 (good recoverability). It is described by the willingness of smallholders to recovery, pressure management, and resource maintenance capacity. Overall, pressure management has the highest indicator value (4.51 of 5). The farmers confessed that they are able to compromise with disasters or disturbances and to run plantation businesses in disordered circumstances. They also confirmed that they perform the business as it should even in non-profitable conditions. Willingness to recovery is the second valuable indicator in this dimension. It reflected farmers' faith in the ministrations of God, family support during the harmful conditions, and their ability to carry out the business at a good level. It means that the influence of significant others around farmers is important to their farm sustainability. FAO highlights that under threatening circumstances farmers must be able to shortly recover to prevent disaster and food crisis [24].

The last indicator with the lowest value is resource maintenance. However, this indicator is still at a good level. The farmers explained that they replaced damaged plants in a particular situation of finance. Less than 80% of them conducted plant maintenance intensively, and only 67.5% of farmers conducted improving soil conditions after flood, landslide, or other natural disasters. Among the three groups of farmers, the highest score of recoverability capacity is coffee farmers (very good). Whereas the oil palm farmers are at a good level, and rubber farmers are at a quite good level (Figure 4).

Table 2 shows that the smallholders in Bengkulu province are categorized as innovative farmers. Innovation level is drawn by initiative, creativity, and entrepreneurship. Generally, the plantation farmers in Bengkulu province have a very good capacity for entrepreneurship. The finding reveals that 99% of farmers have goal and confidence running their plantation and will expand it. They stated that they have good leadership capacity. 99% of farmers confessed that they have the mentality of risk-taker. The further result confirms that the initiation level of plantation farmers in the research location is categorized as good. The farmers have made decisions of their business affairs independently and quickly. 98% of them also explained that they conducted an action initiatively, not by others' orders. Moreover, the smallholding farmers are

classified as creative farmers. 83% of them always find a new way to overcome the farm problem, and 76% of the farmers can find new ideas to conduct their plantation business. Overall, the coffee smallholders are the most innovative farmers (very innovative), while the lowest score is rubber farmers (quite innovative) (Figure 4).
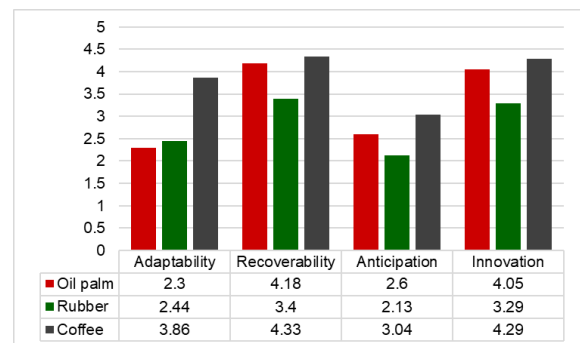
All farmers in research locations have experienced natural disaster incidents, particularly earthquakes, but only 54% of farmers perform preventive actions. Experience towards catastrophe is explained by the intensity of natural disaster experiences, the existence of prevention efforts towards natural disaster incidents, and the ability of adaptation in every natural disaster incident. The further findings also reveal that only 53% of farmers confessed that they have no diversification farming activities besides main plantation crops. Diversification of farming activities is described by conducting a multi-crops strategy and utilizing another side-crop yield for the plantation. Whereas resources adaptability is explained by preparing production inputs independently, maximizing the utilization of family labor, using organic materials, optimizing using existing technology, and minimizing dependency on external resources. More than 60% of farmers confess that they did not prepare seeds, fertilizers, and other inputs independently. About 83% of the smallholders are agreed that they have used family members maximally in farming activities, and only 10% of farmers are categorized as dependent farmers on external resources. They also confirmed that plants maintenance is conducted by existing technology. In general, the most adaptive smallholders are coffee farmers (3.86 of 5). On the contrary, rubber farmers and oil palm farmers are categorized as less adaptive farmers. Overall, the smallholder plantations in Bengkulu province are classified as quite adaptive farmers.

Table 2. Smallholder plantations' resilience

Indicators	Mean	Std. dev	Category
Adaptability	*2.86*	*0.98*	Quite adaptive
Experience towards catastrophe	2.73	1.36	
Diversification on farming activities	2.78	1.57	
Resource adaptability	3.09	0.92	
Recoverability	*3.97*	*0.61*	Good recoverability
Willingness to recovery	4.05	0.59	
Pressure management	4.51	0.50	
Resource maintenance	3.35	1.30	
Anticipation	*2.60*	*0.68*	Less anticipatory
Pre cultivation planning	3.38	0.90	
Farming protection effort	2.12	0.92	
Successor effort	2.33	0.95	

Innovation	*3.88*	*0.74*	Innovative
Initiative	3.65	1.33	
Creativity	3.45	1.22	
Entrepreneurship	4.52	0.48	
Resilience score	13.32		
Less resilient	52.22%		
More resilient	47.78%		

Plantation smallholders in Bengkulu province are classified as less anticipatory farmers (2.60/5). More than 24% of farmers have no pre cultivation preparation, and 15% of farmers never arrange schedule and cultivation planning. Pre cultivation planning is explained by arranging scheduled and structured planning for farming activities, executing preparations before cultivation activities, preparing action to face the risk of disaster or disruption, and creating a backup plan to anticipate crisis or disruption. Meanwhile, in the farming protection effort, the indicators representing smallholding farmers' capacity are the availability of agricultural insurance, reserved fund, and prevention effort. Unfortunately, the further results reveal that 100% of plantation farmers did not have agricultural protection schemes, like agricultural insurance.


Figure 4. Resilience level of smallholder plantations

	Adaptability	Recoverability	Anticipation	Innovation
Oil palm	2.3	4.18	2.6	4.05
Rubber	2.44	3.4	2.13	3.29
Coffee	3.86	4.33	3.04	4.29

The availability of agricultural insurance in developing countries is still considered rare. In Indonesia, there are various barriers to the implementation of agricultural insurance [33]. A study in Nepal reveals that farmers who have agricultural insurance are categorized as anticipated farmers towards natural disasters [18]. Nevertheless, more than 55% of farmers have provided reserved funds to anticipate unpredicted farm costs. Furthermore, in terms of succession their plantation, farmers are in the category of less anticipatory smallholders. Only 44% of farmers encourage their children to pursue the family's business. Then, less than 40% of the smallholders provide their children with an agricultural education background. However, almost 60% of the farmers ask their children to involve in farming activities. The main reason for this statement is the respondents explained that the plantation is a family business, thus all family members have a responsibility in running the farm. The most anticipated smallholders are coffee farmers, whereas the least anticipated smallholders are rubber farmers.

3.2. Adaptability

Figure 5 describes the adaptability capacity of smallholder plantations in Bengkulu province. This capacity is indicated by three main indicators, which are experience to catastrophe (EtC), diversification on farming activities (DoF), and resources management (RM). Based on the field survey, this study found that coffee farmers are categorized as the most experienced farmers in facing catastrophes in research locations. This indicator is indicated by the intensity of occurrence, prevention effort towards catastrophe, and ability to adapt to various natural disaster incidents. The most catastrophic incident that occurred in Bengkulu province is the earthquake. All farmers explained that they have experienced it. However, coffee farmers have preventive actions better than oil palm and rubber farmers. The average score of coffee smallholders' in this sub-indicator is 3.90, while the rubber farmers are 2.38, and oil palm is only 1.90. In diversification on farming activities, coffee farmers have the highest average score (3.90), whereas rubber farmers' score is 2.48. Oil palm farmers have the least score (1.70) of diversification strategy. There are only less than 10% of oil palm farmers cultivated multiple crops on their plantation area. However, oil palm plantation smallholders are classified as quite adaptive farmers in resources management. Their average score (3.51) is better than rubber farmers' score (2.83) in preparing production inputs and maximizing the involvement of productive family members in farming activities.
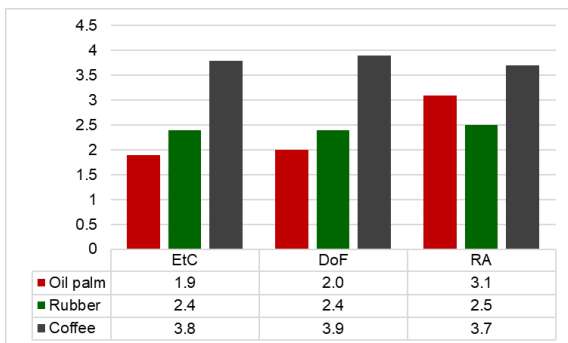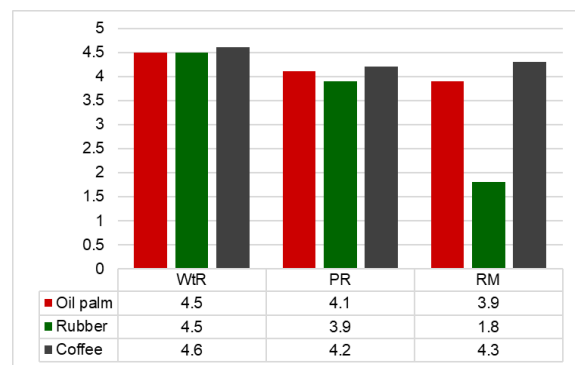

Figure 5. Adaptability of smallholder plantations

3.3. Recoverability

Plantation smallholders' recoverability is the ability of farmers to recover from the business downturn. It is approached by the willingness to recovery (WtR), pressure management (PR), and resource maintenance (RM). The result reveals that all groups of smallholder plantations in Bengkulu province are classified in the very good capacity level of willingness to recovery (Figure 6). The farmers confessed that their faith in the ministrations of God, the existence of family support during harmful conditions, and their ability to carry out

farm business in disordered circumstances helps them to recover from downturn situations and catastrophe. Additionally, further finding shows that the plantation farmers have a good capacity for pressure management. This indicator is reflected by their capacity for problem-solving and facing business disruption. Pressure management is also described by the ability of farmers in running their farms even in unprofitable conditions. Nevertheless, in resource maintenance, rubber farmers are categorized as less recoverable smallholders. Only 30% of rubber farmers declared that they replaced damaged plants regularly. The result also confirmed that the farmers who conducted plant maintenance intensively are less than 35%. Moreover, only 12% of farmers conducted improving soil conditions after natural disaster incidents.


Figure 6. Recoverability of smallholder plantations

3.4. Anticipation level

Farmers' anticipation capacity assists farmers to prevent and protect their farms from any disturbances or disordered circumstances. This ability is indicated by pre cultivation planning (PCP), farming protection effort (FPE), and successor effort (SE). This study reveals that coffee farmers are at the highest score of pre cultivation planning (4.10) and are categorized as smallholders with a good level of anticipation (Figure 7). Meanwhile, oil palm and rubber farmers are classed in quite anticipatory smallholders. This indicator is reflected by the existence of arranging scheduled and structured planning for farming activities, executing preparations before cultivation activities, preparing action to face the risk of disaster or disruption, and creating a backup plan to anticipate crisis or disruption. Based on the field survey investigation, only 55% of rubber smallholders arranged cultivation planning, while there are more than 80% of oil palm and coffee farmers conducted this action.

The second indicator is farming protection effort. The research result uncovers that coffee farmers have the highest score (2.80) among other groups of plantation smallholders. The FPE is reflected by the accessibility of farmers to farm protection schemes

(agricultural insurance), the availability of reserved funds, and the prevention effort. More than 85% of coffee farmers provided reserved funds to anticipate emergency conditions as their finance anticipation strategy. Meanwhile, less than 65% of oil palm farmers and only 19% of rubber farmers executed this unpredictable cost preparation. Furthermore, in the indicator of successor effort, the oil palm farmers are classified as the most anticipatory smallholders (Figure 7). 71% of oil palm farmers involved their family members in farming activities, while 60% of coffee farmers acted this strategy, and less than 50% of rubber farmers performed this action. Succession effort strategy is portrayed by encouraging the children to engage in the family's business, providing the children agricultural education background, and requesting them to participate in farming activities.

	PCP	FPE	SE
Oil palm	3.2	2.0	2.8
Rubber	2.9	1.6	1.9
Coffee	4.1	2.8	2.3
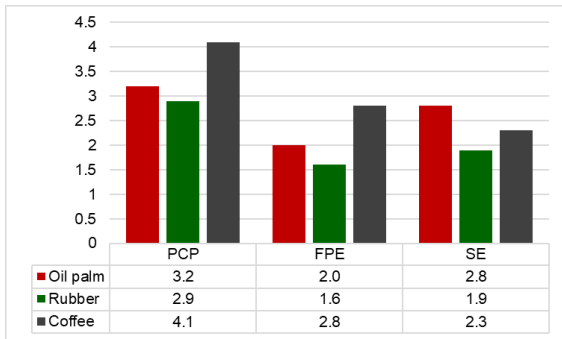
Figure 7. Anticipation level of smallholder plantations

3.5. Innovation level

Figure 8 features the innovation level of smallholding plantation farmers in Bengkulu province. This dimension is described by initiative capacity (IT), creativity (CR), and entrepreneurship (EN). The highest score of the initiative indicator is oil palm smallholders (4.20) and categorized as creative farmers. Whereas the lowest score is rubber farmers, with an average score of 3.80, and at the same level of initiative capacity. The initiative indicator is indicated by deciding business affairs independently and quickly and conducting actions initiatively, not by others' orders.

	IT	CR	EN
Oil palm	4.2	3.5	4.5
Rubber	3.6	2.7	4.5
Coffee	4.1	4.2	4.5
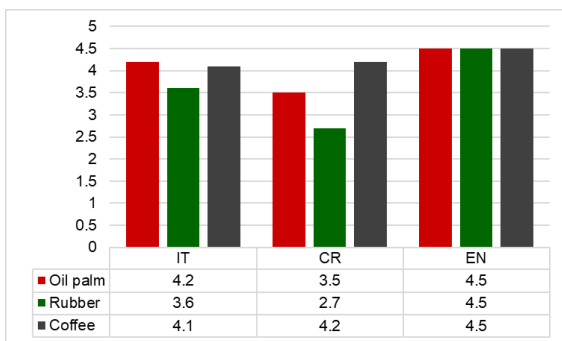
Figure 8. Innovation level of smallholder plantations

Creativity indicator is explained by finding a new way or new idea to overcome the farm problem and to run the plantation business. The most creative smallholders are coffee farmers. 99% of farmers explained that they run the plantation by their own idea. Only rubber farmers were identified as quite creative smallholders (2.70) in this indicator. Less than 60% of farmers executed these strategies to overcome problems regarding how to run a plantation business. Moreover, entrepreneurship is indicated by having goals and confidence, leadership, expanding business, and taking a risk. The final result shows that all groups of smallholders (oil palm, rubber, and coffee farmers) have very good capacity in entrepreneurship. They are capable of formulating business goals and having a very good capacity for leadership. They also confessed that they have the potential planning to expand their plantation (99.72% of farmers).

4. CONCLUSIONS AND IMPLICATIONS

The resilience of smallholding plantation farmers is conceptualized as the ability of farmers to ensure their provision to cope with the complexity of challenges or disruptions by delivering their capacity of adaptability, recoverability, anticipation, and innovation. The research result concludes that the plantation smallholders in Bengkulu Province were categorized as less anticipatory farmers. They confessed that they have less protection on farming activities and succession efforts. The further finding also reveals that the smallholders were classified as quite adaptive farmers. Most oil palm and rubber farmers explained that they did not conduct any diversification strategy in their farming activities. However, the farmers in the research location were found to have a good recoverability level and were also categorized as innovative farmers.

From the conclusion above, some policies related to the problem can be suggested to enhance the resilience level of smallholder plantations. Firstly, for the farming protection effort, the government should provide *easy to access* agricultural protection scheme. *Easy to access* means that farmers are able to easily participate and meet financial or requirement systems. Secondly, the extension program should be executed intensively. It is extremely important to improve the capacity of adaptation of smallholding farmers, particularly oil palm and rubber farmers, and the anticipation level of rubber farmers.

AUTHORS' CONTRIBUTIONS

Apri Andani: Conceived and designed the experiments; Performed the experiments; Analysed and interpreted the data; Contributed reagents, materials, analysis tool or data; Wrote the paper.

Irham: Conceived and designed the experiments; Analysed and interpreted the data; Wrote the paper.

Jamhari and Any Suryantini: Conceived and designed the experiments; Analysed and interpreted the data, Wrote the paper.

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