

The Analysis of Integration Sustainability of Coffee Plantation and Goat Husbandry (a Case Study in Ampelgading subdistrict, Malang Regency, East Java, Indonesia)

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Abstract

Ampelgading sub-district is one of the coffee production center in Malang who perform the integration system combined with the goats husbandry. To determine the achievement level of the integration sustainability of the coffee plantations and goat husbandry, it is needed the systems approach and an assessment of the sustainability criteria. This study aims to determine the status of sustainability and attributes that influence in determining the status of sustainability it self. To get sample was by stratified random sampling. Interviews, observation and documentation are use for getting data. The analytical method used is Multi Dimensional Scaling (MDS), laverage and monte carlo contained in the program RAPKOKA which is the result of modified Rapprofish program. The results showed that status of multidimensional sustainability is 77, 32% (sustainable) which the each status for dimension of ecology 81.66% (sustainable), the dimension of economy 52.14% (fairly sustainable), the dimension of social 85.06% (sustainable), the dimensions of technology 69.15% (fairly sustainable) and the dimension of institution 78.30 % (sustainable). The 13 of 54 attributes that were analyzed are sensitive to the status of sustainability so that it is necessary the efforts to increase it.

Keywords: coffee plantations, goat, sustainability status

1. Introduction

Coffee is one of the commodities that have an important role in the national economy. To avoid environmental damage while still fulfilling the needs of coffee, coffee cultivation needs to be done based on the principle of sustainability. According to Bayer et al.(1992), sustainability is the ability to keep productive while maintaining the resource base. Sustainability should include some basic aspects that are ecologically stable, economically able to continue, equitable, humanist and flexible. Integration of coffee plantations and goats husbandry is one of implementation of sustainable farming systems. Physiologically, coffee is in classification of plants C3 that cannot withstand full sun light (Abdoellah, 2013). There is connection between coffee plants that need the shade plants and the farmers efforts to increase their income from the coffee plantations, thus it will form a simple agroforestry system up to complex system which is integrated with goat husbandry, then it will form agrosilvopasture system.

In the sustainable agriculture system, a farming system is viewed holistically as the system which is economically profitable, environmentally friendly, socially acceptable and it guarantees social justice and has harmony with the local culture (Budiasa, 2011). In the integration system of coffee plantations and goat husbandry, to know the level of sustainable achievement, it is needed system approach and assessment or testing to the fulfillment of sustainable criteria. Now, the approach of sustainable agricultural development is so various and depend on the condition variety of each region. System approach in sustainable agricultural is developed from the three basic pillars; they are ecological, economic and social dimensions. Several approaches related to sustainable development, such as through an ecological, economic, social, cultural, ethical, institutional, political and security approach (Dalay-Clayton and Bass, 2002), also technological and infrastructural approach (Hidayanto et al, 2009). Therefore, to know the status and determine a strategy to improve the integration of sustainability status of coffee plantations and goats husbandry in the Ampelgading sub-district, it is needed to analyze the sustainability based on the ecological, economic, social, technological and institutional dimension.

The purpose of this study is to a) assess the sustainability index and status of the integration of coffee plantations and goats husbandry in the Ampelgading sub-district, b) identify sensitive attributes which affect the sustainability.

2. Research Methods

2.1 Time and Place

The research was conducted in January - March 2015 at the Ampelgading sub-district, Malang regency, East Java Province, Indonesia.

2.2 Types of Data and Data Collection Methods

The type of data used are primary data and secondary data. Methods of data collection that is a) an interview by using interview guides that have been prepared, b) observation and c) documentation of the journal, a report of activities and a variety of resources from related institutions.

2.3 Population and Sample

The population in this study were farmers who undertake the integration of the coffee plantations and goats husbandry as well as being members of farmer groups. Sampling was done by stratified random sampling based on the criteria of land area. Samples were taken from seven villages by considering the major agricultural commodities are plants of coffee. Total samples taken are 54 farmers from 14 farmer groups.

2.4 Method of Analysis

Analysis method of Integration sustainability of coffee plantations and goats husbandry is by the approach of Multi-Dimensional Scaling (MDS) with RAPKOKA program (Rapid Appraisal Integration of coffee plantations and goat husbandry), which is modified from RAPFISH program (Rapid Assessment Techniques for Fisheries) developed by Fisheries Center, University of British Columbia (Kavanag, 2001; Fauzi and Anna, 2002). MDS is a method of computer-based statistical analysis techniques using the software, which performs the transformation of any dimension and multidimension of Integration sustainability of coffee plantations and goat husbandry towards the sustainable agriculture in Ampelgading sub-district.

Data analysis by MDS includes sustainable aspects of the ecological, economic, social, technological and institutional dimensions. Then, it is conducted the multidimensional analysis by combining all the attributes of the five sustainable dimensions above. Data analysis with MDS is implemented through several stages. First, review the attributes of each dimension of sustainability and define the attributes through field observations, as well as a literature review. Overall, there are 54 attributes were analyzed, consist of 15 attributes of ecological dimension, 9 attributes of economic dimension, 9 attributes of social dimension, 12 attributes of technological dimension, and 9 attributes of institutional dimension. Second, scoring based on the results of field observations, interviews and expert opinion in accordance with the determined requirements. Scores range depends on the condition of each attribute. Third, the results of scoring is analyzed, by using the MDS program, to determine the position of integration sustainability status of coffee plantations and goats husbandry in each dimension and multidimensional stated in the sustainability index scale. The sustainability index scale is in around 0-100% and it can be seen in Table 1.

Monte carlo analysis is used to predict the effect of tools in the process of analysis conducted, at the 95 percent confidence interval. Results of analysis expressed in terms of index values monte carlo, which further distinguished by an index value of MDS analysis results. If the difference between the two values of the index is small, it indicates that: (a) the errors in making scores of each attribute is relatively small, (b) the scoring variation as a result of difference opinion is also relatively small, (c) the analysis process

Table 1. Categories of Index and Sustainability Status

Index Scale	Category
00,00–25,00	Poor (unsustainable)
25,01–50,00	Less (less sustainable)
50,01–75,00	Quite (fairly sustainable)
75,01–100,00	Good (sustainable)

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Leverage analysis in MDS was conducted to determine the attributes that are sensitive and interventions that need to be done. Attribute of sensitive was gotten based on the leverage analysis result that was seemed at changes in Root Mean Square ordination on the x axis. The greater the change, the more sensitive the attribute

role to the increase of sustainability.

3. Results and Discussion

Based on the results of the RAPKOKA analysis showed that the sustainability index of ecological dimensions is sustainable (81.66%), the sustainable sufficient economic dimension (52.14%), the sustainable social dimension (85.06%), sustainable sufficient technological dimensions (69.15%) and sustainable institutional dimension (78.30). The index of each sustainability dimension in the form of kite diagram is presented in Figure 1. The sustainability status of each dimension cannot describe the status of the integration sustainability of coffee plantations and goats husbandry overall. Therefore, it was implemented the multidimensional analysis by using RAPKOKA and sustainability index value was 77.32% and it was in good status/ sustainable. The index of multidimensional sustainability status can be seen in Figure 2.

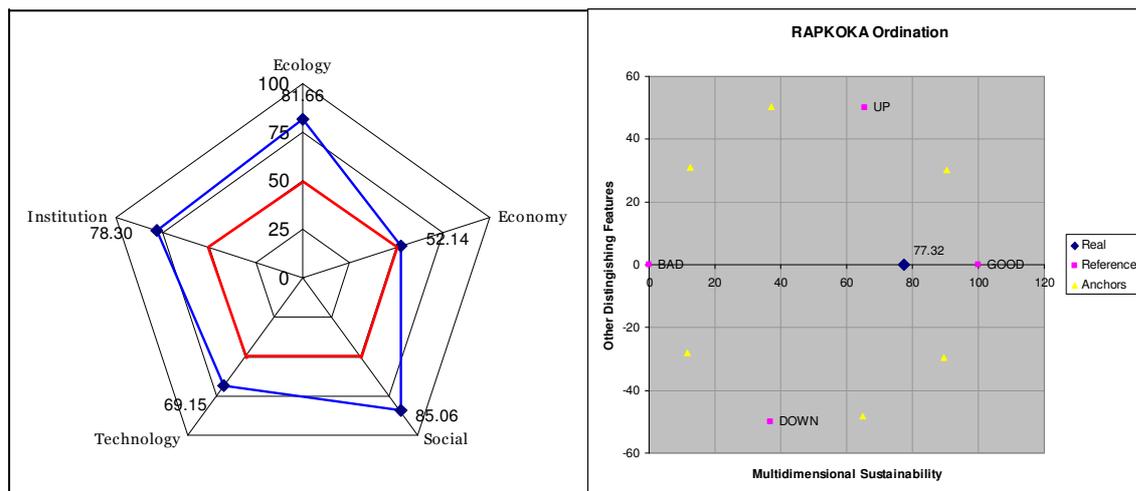


Figure 1. Overpass Diagram of sustainability index of each dimension

Figure 2. Multidimensional sustainability index

The difference between montecarlo analysis results and the value of MDS sustainability index is less than 1, it indicates that there is no significant error in analyzing and scoring of each attribute. Variations of the scoring caused by different opinion is relatively small and the data analysis process conducted repeatedly is stable, and there is no error in inputting and the data is not lost. The difference value between sustainability index of MDS and Monte Carlo analysis are presented in Table 2.

RAPKOKA analysis results showed that all of the attributes that assessed to the status of the integration sustainability of coffee plantation with goats husbandry, is sufficiently accurate and reliable. It seems from the stress of only about 0.13 and 0.14 and the value of the determinant coefficient obtained by the range of 0.94 and 0.96 (close to 1). This is suitable with Kavanagh opinion (2001), who states that the results of the analysis is sufficient if the stress value is smaller than the value of 0.25 and the value of the determinant coefficient (R^2) approaches a value of 1.

Table 2. Difference between Sustainability Index Value, Stress Value and Determinant Coefficient (R^2)

Sustainability dimensional	MDS	Monte Carlo	Differences	Stess	R^2
Ecology	81.66	80.88	0.76	0.13	0.96
Economy	52.14	52.20	0.06	0.14	0.95
Social	85.06	84.54	0.52	0.13	0.95
Technology	69.15	68.37	0.78	0.13	0.95
Institutional	78.30	77.31	0.99	0.13	0.95
Multidimensional	77.32	76.65	0.67	0.14	0.94

Source: Primary Data Analysis.

3.1 Sustainability of Ecological Dimension

Ecological dimension consists of 15 attributes that have effect on sustainability. The attributes are 1) the suitability of land for coffee plants, 2) the altitude of land, 3) the implementation of conservation, 4) the suitability of shade plants, 5) Sanitation of coffee plantation, 6) Health corral, 7) Layout of corral, 8) the use of inorganic pesticides, 9) the use of fertilizer, 10) the coffee waste for feed / fertilizer, 11) the goat waste as fertilizer, 12) the use of clipping shade, 13) the risk of fire, 14) carrying the feed, 15) the occurrence of drought. The results of the analysis indicate that sustainability index is 81.66% (good / sustainable).

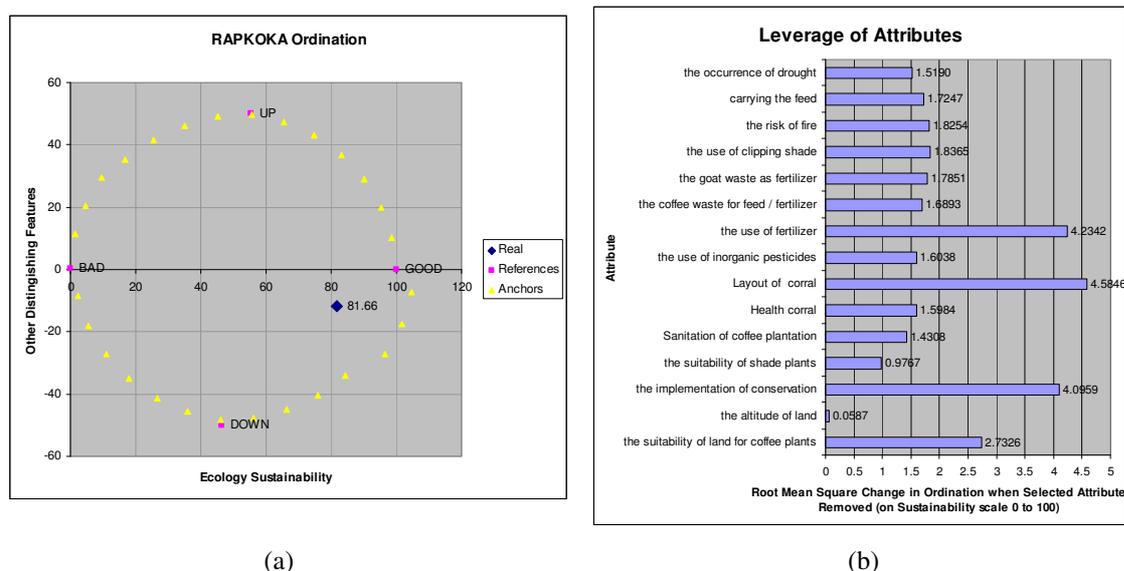


Figure 3. The sustainability index of ecological dimension (a) and sensitive attributes of ecological dimension (b)

Leverage analysis results indicate that in the ecological dimension, the main supported factors are: 1) location of the goat corral, 2) the use of fertilizer, and 3) the implementation of conservation. Index of sustainability and analysis result of Leverage of ecological dimension can be seen in Figure 3. Location of goat corral affects the level of nutrient cycling in the overlay and free costs. The corral in the coffee plantations will facilitate the transportation of feed and compost. Based on the survey results, there is 20% of location of corral are in coffee plantation, 70% is near the house with a distance of 100 m and 10% is in neighborhood (no spacing). The goat corrals which are located very close to the house will cause pollution if there is no attention of sanitation. Considering of safety factors and facilitating in monitoring will also affect to the farmers to make a cage near their house. In order to enhance the sustainability status of repairs that need to be done on this attribute is to implement the good management of corral and always maintain the cleanliness of the corral. To save costs, the farmers go to their coffee plantation while transporting the compost.

The use of fertilizer is second sensitive attributes in the ecological dimension. Based on the interview, 98% of farmers use a combination of organic and inorganic fertilizers and only 2% of farmers use organic fertilizers. In order to improve the status of sustainability, it should reduce the use of inorganic fertilizers gradually so that it can to press the external inputs. Integrated plant nutrition management on the coffee plantations is an effort to optimize the nutrient cycle in a single stretch optimally. According to Abdoelah (2013), the system include; the use of shade from the type of legume, the use of rootstock which is resistant to the low soil fertility, the system follows the contour planting, producing terrace and rorak, the use of organic fertilizers since the nursery to the field, the use of inorganic fertilizers according to the characteristics of soil and crop development stage, the use of ground cover from the legume type, utilization of trimmings result as mulch, returns the fruit peel and integration with livestock.

Implementing conservation becomes the sensitive attributes that affect to the sustainability of ecological dimension. Mechanical conservation such as terrace form and contour planting has been done. Vegetative conservation which is implemented by the farmers are the shade to strengthen the terrace and fence and to defend the litter. It should be maintained and enhanced by making rorak to collect rain water and soil solution and the nutrient elements to absorb around the roots of coffee. In addition it also serves as an accommodating rorak organic material, conserves soil moisture and protects it from erosion.

3.2. Sustainability of the Economic Dimension

In the economic dimension, the factors that are predicted to affect the status of sustainability consists of 9 attributes, they are 1) the appropriateness of coffee and goats integration, 2) Production of coffee, 3) Culving interval, 4) The result of the integration for the necessities of life, 5) recording and analysis of farming , 6) coffee marketing, 7) availability of capital, 8) the status of land ownership and 9) the use of The results of the appropriateness analysis shows that all the decent integration patterns are applied to cultivated with Benefit Cost Rasio (BCR) value is > 1 . The pattern of multistory shade coffee and goats (multistory coffee system and cattle) has the highest BCR value, that is 1.26. The combination pattern of perennials and goats (Mixtures of plantation crops and cattle) with the BCR 1.19 and the lowest is a combination pattern between perennials and annual crops (Plantation crop combination and cattle) with the BCR value is 1.05. The average income that is received by farmers is greater than the regional minimum wage in Malang Regency in 2015. Leverage analysis results indicate that the attributes which are sensitive to the sustainability index are 1) the recording and analysis of farming and 2) Results of integration for subsistence. The results of Leverage analysis of the economic dimension presented in Figure 4b.

Based on the farming analysis, the integration of the coffee plantation and goat husbandry is profitable and it is worth to be implemented, but farmers have not ability to analyze his farm and it has not conducted the activities and financial records. To improve the sustainability status of the economic dimension, the farmer's skill to do the recording and analysis of farming must be enhanced. Coaching and mentoring from the extension is needed to raise awareness of farmers. By mastering the recording and analysis of good, farming, the farmers will be easier in making decision and business planning. Based on available resources (capital / assets, labor, land and technology package) and the results of the analysis, the farmer will make an exact plan and it will be more profitable. In the integration of coffee plantation and goat husbandry, the decisions made is related to the use of combinations of inputs (use of fertilizer and labor) and also related to the choice of shade plants that has a high economic value without disregarding its function as a shade. Determining the system of rearing goats is including system of maintenance, the amount of livestock and the timing of sales. If the activity of recording and analysis can be done well, the status of sustainability of economic dimension will increase.

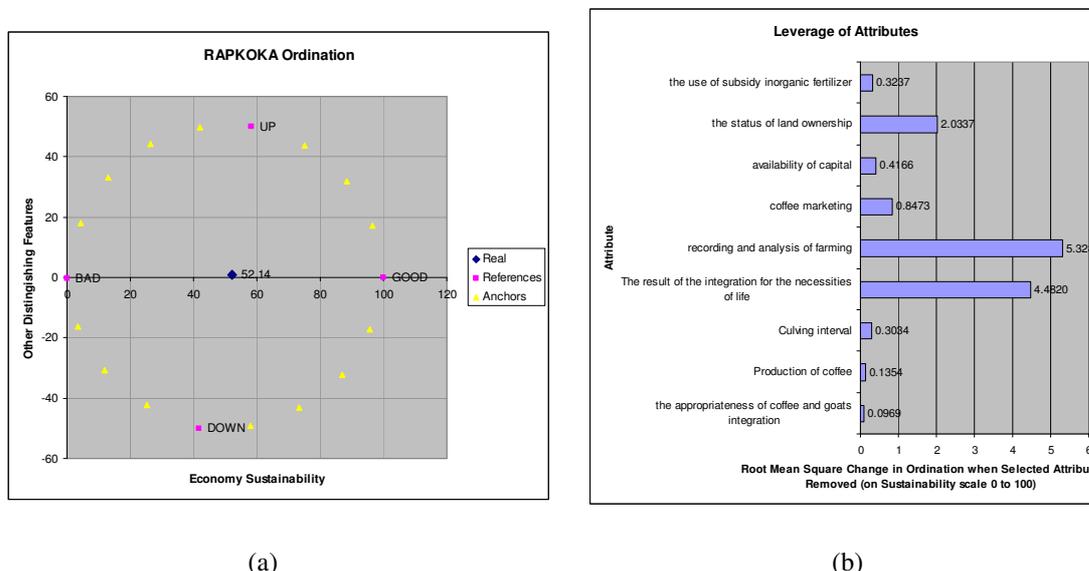


Figure 4. Index of sustainability (a) and sensitive attributes of Economic Dimensions (b).

Based on interviews, the results of the integration effort of coffee plantations and goats husbandry are able to fulfill more than 75% of farmer's subsistence. It shows that the integration can be the main income for the farmers. The disadvantages in the integration efforts influence farmers' income and ability fulfill their subsistence. In order to improve the status of sustainability, the management and maintenance of coffee plantations and goats husbandry must be run well. Horizontal diversification in coffee plantations by considering the economic value can be a source of monthly income before coffee producing.

The status of land ownership of all farmer respondents is their own land. The status will determine the income and business management by farmers. The farmers who work on their own land, will do plantation management well because there are no worries of other people who will take advantages. To increase the status of

sustainability of economic dimension, then the status of farmer's land ownership must be kept as their land ownership rights.

3.3 Sustainability of Social Dimension

In the social dimension, the factors that are predicted effecting the sustainability index and status consists of 9 attributes, they are ; 1) the availability of family food in one year, 2) the status of human development index, 3) Frequency in following the training and extension program, 4) the appropriateness of home, 5) home sanitation, 6) participation of family members in the farming, 7) allocation of time in the farming, 8) the intensity of the conflict, 9) coffee plantation worker's age. The analysis showed that the score of sustainability index is 85,06% (good / sustainable). Although it based on the analysis of the social dimension is already sustainable, but based on the analysis of leverage, there are most sensitive attribute to the sustainability index, such as frequency of following training and the status of human development index. In detail, the index of sustainability and result of leverage analysis of social dimensions can be seen in Figure 5.

The average of extension frequency followed by farmers are still low, that is once a year. In order to increase the sustainability status, the frequency of extension should be increased. Extension is as a media of learning for the farmers where it is about cultivation technology and farm management or other material based on the needs of farmers. While the training is only attended by the representatives of farmer groups. Representatives of groups are expected to deliver their knowledge gotten in the training to all group members. Frequency of following training is very difficult to be increased and followed by all farmers because it depends on the organizers and the programs.

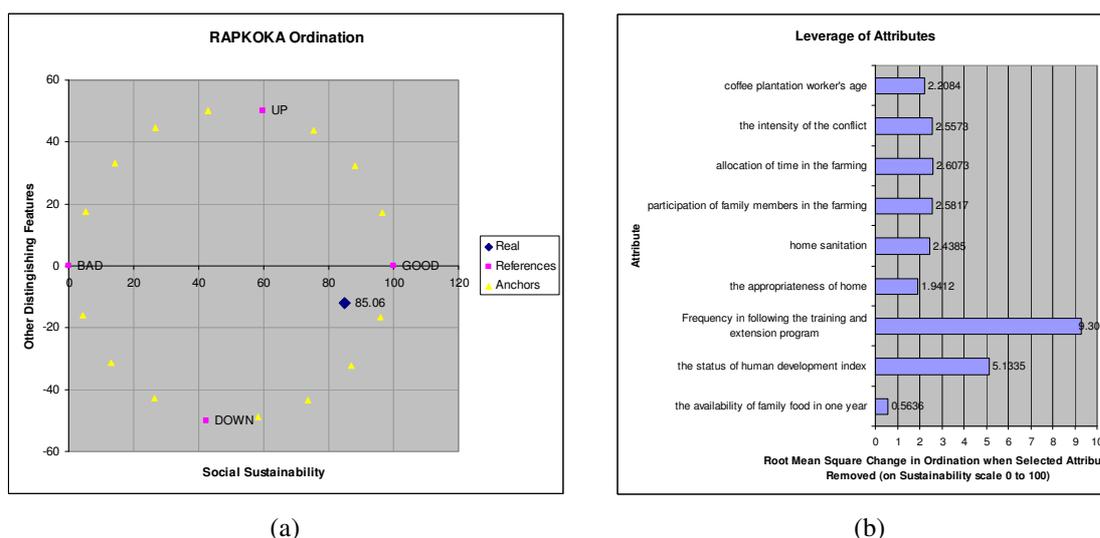


Figure 5. Sustainability index (a) and sensitive attributes of the social dimension (b)

The status of human development index in Ampelgading sub-district is 76.69 with the upper middle category. In order to increase the value of the sustainability status of social dimension, then the Human Development Index (HDI) should be increased to a maximum value of 100. The aspects that should be a concern to increase the HDI are age of life, knowledge and a decent standard of living.

3.4 Sustainability Status of Technological Dimension

In the technological dimension, the factors that are predicted effecting the sustainability index and status consists of 12 attributes: 1). coffee clones selection, 2) the frequency of fertilization, 3) pruning of coffee, 4) pruning of shade plants, 5) pest and disease control, 6) harvesting coffee, 7) hulling of coffee, 8) sorting, 9) livestock waste treatment, 10) types of fodder, 11) ease to access technology and information, 12) ease of transportation. Based on the results of the MDS analysis, it can be known that the sustainability status of technological dimension is 73.79 with the sufficient sustainability category.

Leverage analysis results indicate that the attributes that are sensitive to sustainability index of the technological dimension are sorting coffee, livestock waste treatment and pest and disease control. Sustainability index and leverage analysis results in detail can be seen in Figure 6.

The efforts to improve the status of sustainability are a simple sorting, cooperating with wholesalers and marketing by group, so that the profit margin can be gotten by the farmers. Sorting can be done by manual or mechanical sieve so that the coffee can be graded by size and separated from disabilities coffee or other seeds. Manual sieve with a diameter of 6.5 mm and a diameter of 3.5 mm can be used to separate the coffee based on quality standards.

The Farmers awareness to undertake the processing of animal waste by composting is still low. The use of dried livestock waste will lead to shrinkage of chemical elements and cause environmental pollution. According Soetanto (2002), the use of fresh manure directly into the plant is not always beneficial and it causes the problems for the content, weeds, organisms causing disease and toxic compounds that are contained will make the plant to experience excretion. The use of fresh manure may generate heat during decomposition so that the plants will lack of certain nutrients. To reduce the negative impact, it is necessary to do the process of composting goat waste before being used as fertilizer. The usage of local microorganism with the natural materials can be made as a source of decomposers to save the material costs.

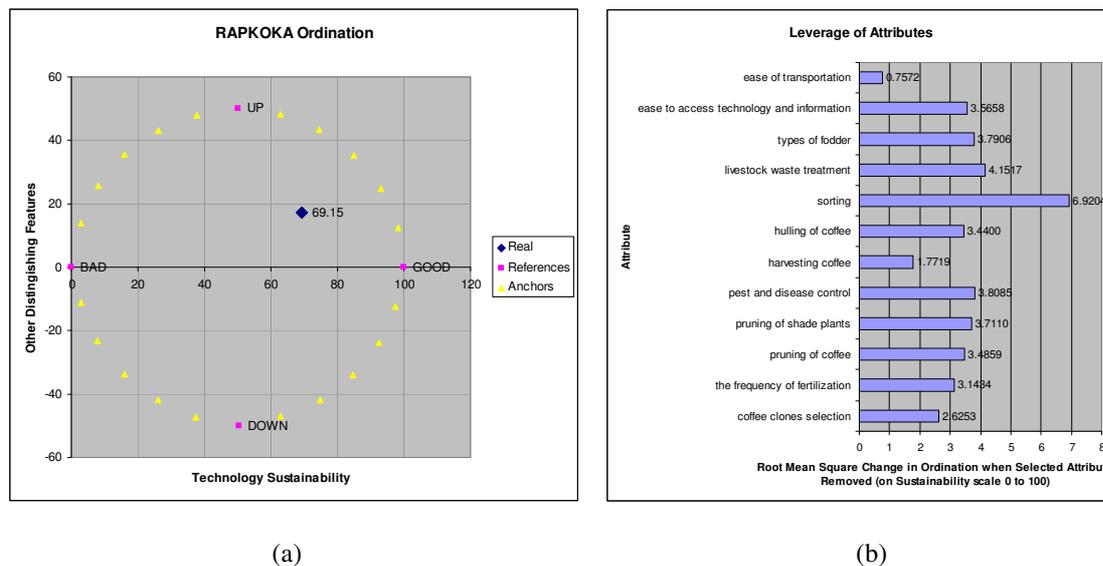


Figure 6. Sustainability index (a) and sensitive attributes of technological dimension (b)

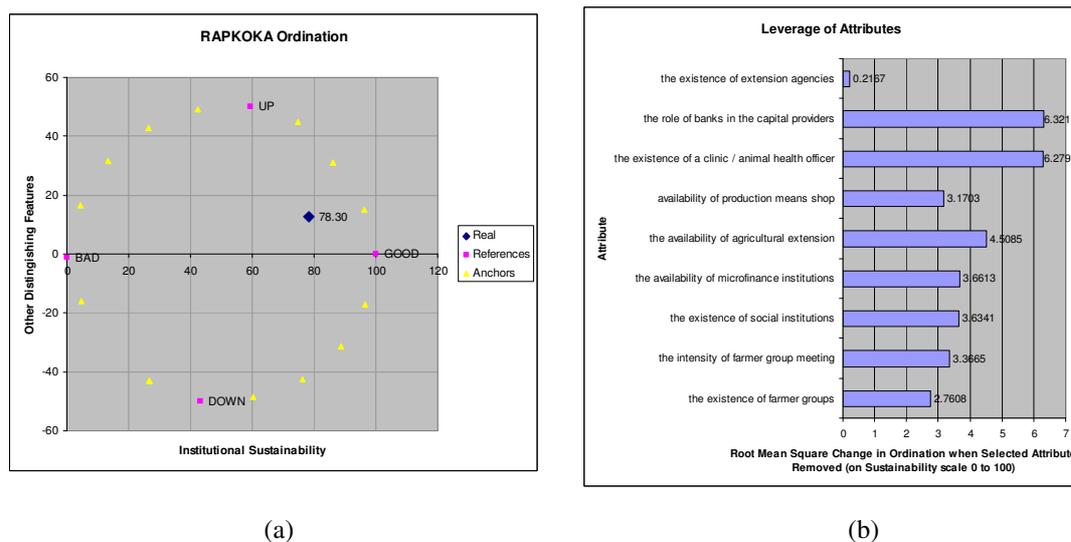


Figure 7. Sustainability index (a) and Sensitive attributes of institutional dimension (b)

The use of pesticides and fungicides is still very low, but the farmers' knowledge about pest control system of coffee should be improved in an integrated manner. Utilization of local resources as materials for plant-based pesticides is not

optimal. Lack of knowledge of farmers on pest and disease control in coffee plants should be concern to increase the status of sustainability. The integrated pest management should be implemented by concerning the principle of healthy plants cultivation, preservation of natural enemies, periodic/ weekly observation and IPM expert farmer. To increase the sustainability status of technological dimension, the ability and farmer's awareness to be able to perform integrated pest management should be improved.

3.5 Sustainability of Institutional Dimensions

The attributes which form the institutional dimensions are :1) the existence of farmer groups, 2) the intensity of farmer group meeting, 3) the existence of social institutions, 4) the availability of micro-finance institutions, 5) the availability of agricultural extension, 6) availability of production means shop, 7) the existence of a clinic / animal health officer, 8) the role of banks in the capital providers, 9) the existence of extension agencies. The analysis showed that the sustainability index is 78.30% (good/ sustainable) and contained sensitive attributes of institutional dimension that is the role of banks in the capital provider, the existence of a clinic / animal health officers and the availability of agricultural extension. The results are showed in Figure 7.

In order to increase the status of sustainability, the farmer's ability to access capital from the banks should be increased primarily through government programs such as KKPE with very low interest. In addition, farming that is done must be oriented to the agribusiness, having a properly market and accurate planning. Selection of the type of business should be adjusted to the period of the loan and ability to repay the loan from business profits. The availability of livestock health workers who have not been able to reach throughout the region should be attention. The efforts that might be done is by constructing the service of husbandry based society. This services is including the empowerment of local communities to be more self-sufficient and capable of holding greater responsibility in fulfilling the services they need. In general, the extension activeness is good enough, but their role in providing assistance and guidance to farmers should be improved. Some extension and coaching needs that need to be presented in correlation with the sustainability integration of coffee and goat are: a) the ability of farmers in undertaking management, recording and analyzing the farming, b) the ability of farmers to take advantage of market information, c) increasing the awareness and skills of farmers for composting waste livestock, d) increasing farmer's awareness to do coffee cultivation conservatively and e) holding the integrated pest management of coffee.

4. Conclusions

Sustainability status of multidimensional integration of coffee plantation and goat husbandry in Ampegading sub-district is 77.32 % (sustainable). The sustainability status of integration of coffee plantations and goats husbandry on the ecological dimensions is 81.66 % (sustainable), the economic dimension is 52.14 % (fairly sustainable), the social dimension is 85.06 percent (sustainable), technology dimension is 69.15 % (fairly sustainable), the institutional dimensions is 78.30 % (sustainable).

There are 13 sensitive attributes that influence in improving the sustainability index. They are 3 attributes of ecological dimension, 2 attributes of economic dimension, 2 attributes of social dimension, 3 attributes of the institutional dimension and 3 attributes of technological dimension.

5. Suggestions

Government and relevant agencies are necessary to facilitate the farmers to be able to access capital, to get assistance and extension on farm management, pest management and integrated plant nutrient management on coffee, to improve the ability of farmers in accessing markets and conducting post-harvest until the stage of sorting. In order to improve the bargaining position of farmers, it should be done in groups of marketing management through farmer groups and improve coffee quality by handling harvest and post-harvest in the right way and handling sorting and grading. The farmers should hold composting of goat waste before use it as fertilizer. The implementation of conservation techniques should be adapted to the characteristics of the land, plant age and by combining mechanical and vegetation conservation.

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