

SUSTAINABILITY ANALYSIS AT SIDOMULYO SMALLHOLDER COFFEE AGRO-INDUSTRY

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Abstract

Sustainability of Sidomulyo smallholder coffee agro industry as a part of Jember coffee agribusiness should be attempted by improving their high quality of coffee bean. Development of sustainability assessment indicators is needed to determine the factors that are feasible to support coffee agro industry. Case studies conducted in smallholder coffee plantation at Jember District, East Java. Through Rap-Coffee simulation, sustainability status is moderate (58.94%). Improving the status can be achieved based on the key attributes of sustainability framework. Supports from stakeholders such as government, research institute and banking with incentives, credit, maintaining equipment and quality standards assistance would increase productivity and quality while improving smallholder coffee prices.

Key words: coffee, sustainability, Jember, Indonesia, Rap-Coffee, smallholder coffee plantation, agro industry

Introduction

Coffee is one of the Indonesian commodities which contributes as source of income of farmers, job creations and regional development. Indonesia also including one of the world's largest exporter of robusta coffee after Vietnam. Nearly 90% of coffee, grown and produced by farmers which has many limitations. Fluctuating coffee prices and export markets dependency heavily influence the farmer decisions getting improved technology adoption for better quality of coffee products. Environmental awareness, health and life styles issues, as well as ICO (International Coffee Organization) agreement prohibiting to export low quality of coffee bean become a challenge and an opportunity for smallholder coffee plantations sustainability.

Sustainability development concept was popularized by The World Commission on Environment and Development (WCED) in 1987, meaning development that meets the needs of today's society without compromising the ability of future generations to meet their needs [1]. Sustainable development paradigm is based on three pillars of economic, environmental and social that widely applied at various sectors, so that the operational

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definition of sustainability have multiple dimensions [2]. As one sub-system of coffee agribusiness, coffee agro-industrial development is an important step to support the sustainability. There are three characteristics of sustainable coffee agro-industry; (1) productivity and profits can be maintained in such long time to meet human needs in the present and future, (2) smallholder coffee agricultural resources or natural resources of smallholder coffee plantations should be improved and maintained because the sustainability depends on the raw material availability, and (3) negative impact of coffee agro-industrial activities should be minimized [3]. Sustainability assessment will be needed to know sustainability status as well as the factors influencing policies and viable alternatives can be developed at smallholder coffee production. There are indicators refer to sustainability status, changing conditions as well as evaluates of policy performance quantitatively [4]; [5].

Smallholder coffee development which focus on quality must be attempted to raise farmer incomes and meet the needs of export market in sustainable way. Case study was done at Smallholder Coffee Plantation Area (SCPA) at Sidomulyo Village, Silo District, Jember Regency. The aim of this study was to develop a framework assessing sustainability based on improvement indicators and to examine the current Sidomulyo SCPA sustainability in order to maximize its sustainability.

Methodology

The study conducted for 7 months at Sidomulyo SCPA, Silo District, Jember Regency. Research was done by survey method, discussion and depth interview with respondents. There were 3 phases in data collection and asses sustainability of SCPA. First, initial survey and discussion with stakeholders was conducted to get more detailed information as supported material to create the framework. Second, consultation and depth interview with stakeholder. Third, SCPA sustainability assessment based on the sustainability framework with Rap-Coffee. Measurement of smallholder coffee agro-industry sustainability developed based on the dimensions of Munasinghe triangle of sustainability (1993) with the addition of institutional dimension [6]. These studies use the indicators from Committee on Sustainability Assessment (COSA) in [7], and develop it.

Several stages of data analysis are as follows: (1) creating the score in each of sustainability attributes by using the values that consistent measures the bad (score 0) to the good (score 3) of sustainability condition. Scored data must be standardized before

simulation through data normalization; (2) sustainability assessment continues with Rap-Coffee (modified attributes from Rapfish), (3) statistical test in Rap-Coffee using two following analysis techniques; MDS (multi dimensional scaling), leverage analysis to determine the effect of sustainability [8]. Monte Carlo analysis was done automatically to determine the degree of error data used.

Results and Discussion

A. Sustainability Assessment Framework

Sustainability assessment framework is based on sustainable development paradigm in Earth Summit 1992 at Rio de Janeiro that leading to adoption of Agenda 21. Agenda 21 is wide-ranging blueprint for action to achieve sustainable development worldwide. Several methodological frameworks have been identified to measure the agriculture sustainability and the community to district level. Referring to [9]; [10] and [11], main functions of indicators of framework are as follows: (a) to assess conditions and changes, (b) to compare between the places and situations, (c) to assess conditions and trends related to the goals and objectives, (d) to provide initial information, and (e) to anticipate the alteration conditions and trends in the future. This is important to define the boundaries of indicators to demonstrate the tendency of environmental system that could change from one country to another [12] ; [13]. Based on these restrictions, it can be made score for each indicator.

Become one of the agricultural products traded largely in the world, coffee produced by small and big scale farmers. According to [7] the concept of sustainability on coffee production should include a holistic approach for production, distribution, use of natural resource and final product, the service that can maximize the benefits from raw materials and energy utilization, minimize the consumption of raw materials and non renewable energy, and avoid waste production and pollutants to the environment [14]; [8]. By means of this approach, it is designed indicator assessment in four dimensions of sustainability (Table 1.).

Table 1. Sustainability Indicator of Smallholder Coffee Agroindustry

No	Dimension	Indicators
A	Economic	Revenue Production and marketing cost Credit loan allowance Farming management Production quality Market access and opportunities Profit
B	Environmental	Energy management Water management Land use management Biodiversity management Pollution Prevention Reuse and recycle Carbon sequestration
C	Social	Health and safety Working hours and wages Basic human rights Social relation Perception and satisfaction
D	Institutional	Integrated decision making Capacity building Science and technology improvement Social awareness and information International cooperation and agreement Role of civil society Institutional framework and rules Disaster preparedness

B. Economic Sustainability Dimension of Smallholder Coffee Agroindustry

Economic sustainability is one of the requirements from the continuity of production activities. Economic sustainability of coffee agro industry is not only an effort to maintain the production activity but an attempt to maintain the livelihood, social and environmental needs of rural communities. Sidomulyo SCPA scores for each indicators in economic dimension (Table 2).

Table 2. Indicators of Economic Dimension of Sidomulyo SCPA

No	Economic Indicators	Score	Good	Bad	Explanation
1	Revenue	2	3	0	(0)Small (<RMW); (1) Revenue = RMW; (2)Fair > RMW (3) High, more than RMW (regional minimum wage)
2	Production & marketing cost	2	0	3	(0)Very high (1) High; (2) Fairly enough ;(3) Small
3	Credit loan allowance	1	3	0	(0)No access to credit loan (1) There is access but do not use credit loan allowances; (2) There is access but only use credit loan once; (3) There are access & credit loan allowance.
4	Farming management	3	3	0	(0)Subsistence (1) Semi commercial; (2) commercial; (3) Industrial farming
5	Quality of production	1	3	0	(0) No quality concern and not understand the quality concept (1) Not fully concern on quality; (2) Have concern on quality; (3) Have effort to increase the quality continuously.
6	Market access and opportunities	2	3	0	(0)Do not have market access(1) Limited access to market; (2) There is market with limited opportunities; (3) High access & opportunities.
7	Profit	2	3	0	(0)No profit (1) Small profit; (2) Fairly enough profit; (3) High profit

Agricultural management attributes have the highest score (3) compared with six other attributes. Support for coffee agriculture came mainly from the desire of each farmer in farmer groups to become industrial cultured farmers. Civilized agriculture industry is a

farming system that was built through the use of engineering, science and technology in order to increase added value from products as high as possible [15]. Implementation of cultured agriculture industry is expected to be increased in Sidomulyo SCPA to support their sustainability.

Based on the Rap-Coffee analysis, value of economic sustainability is enough for 62.54% (Fig.1). Leverage analysis showed the range of economic leverage factors are between 1% and 8%. There are no dominant factors in economic sustainability, if the values between 2 % and 8% distributable [16] (Fig.2). There are two more main leverage factors that can increase the sustainability status; production cost, and production quality.



Figure 1. Rap-Coffee results of Economic Dimension

Fluctuated world coffee prices are influenced by supply, weather, and economic conditions which affect the production qualities [7]. When the coffee price is high, the farmers do not hesitate to take action in operational production that can improve the quality of coffee beans. This effort will directly affect production costs because of transferred method from dry to wet method that has great input production. On the other hand, when the coffee prices are lower, the farmers tend to choose the dry which is cheaper and simpler although it produces lower quality. Therefore, continuously efforts in production quality improvement and cost stability are expected to increase sustainability status at Sidomulyo SCPA. Market opportunities are difficult variable to measure, but they show a link between producers and sustainability efforts in industrial structure. There are determined from the existence of fixed exporters, certification and quality of market information that can be accepted by the producers. Market opportunities are difficult variable to measure, but they show a link between producers and sustainability efforts in industrial structure. The market opportunities are determined from the existence of fixed

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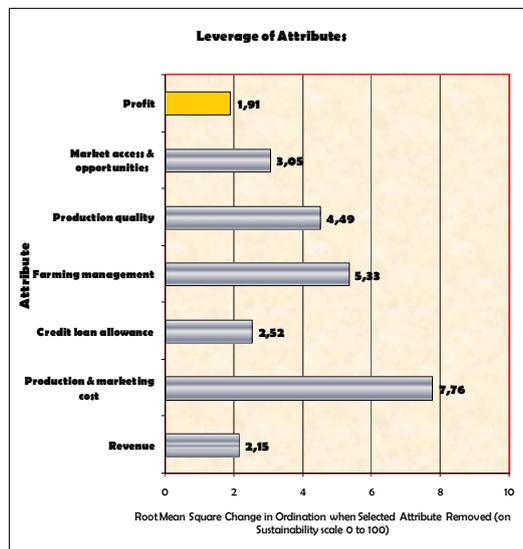


Figure 2. Leverage Analysis of Economic Dimension

C. Environmental Sustainability of Smallholder Coffee Agroindustry.

The growth of global coffee processing industry raises environmental concerns both locally and internationally. Land resources management has the highest score compared with the other indicators of environment dimension (Table 3). The farmers realize that their land productivity is determined by land management efforts. That efforts were also made to maintain the organic coffee certification (Utz certified). In organic farming practices, there is a system approach to balance and optimize the plantations which economic standards [17].

The coffee plantation system with shading plants and cover crops shows more stable nitrogen recycle than plantation without shading or cover crops [7]. They also can reduce erosion levels even though most of plantation is cultivated in flat ground area. Solid waste utilization as organic fertilizer is also one way to maintain nutrient cycle at coffee plantation.

Table 3. Indicators of Environmental Dimension of Sidomulyo SCPA

No	Environmental Indicators	Score	Good	Bad	Explanation
1	Energy management	2	3	0	(0) Depending on 1 type of energy sources (1) Using 2 types, still depend on unrenueable energy; (2) Using 2 types & not depend on unrenueable energy (3) There have been efforts to diversify the use & use more than 2 sources.
No	Environmental Indicators	Score	Good	Bad	Explanation
2	Water management	2	3	0	(0)There is no conservation efforts while using well & surface water (1) Using groundwater without conservation efforts (2) Using water & ever make conservation efforts (3) Using water & always do the conservation efforts
3	Land conservation management	3	3	0	(0)There is no erosion prevention effort; (1) Start to do the conservation with a minimum effort (2) Do with a guidance ; (3) Do independently & continuously the activities.
4	Biodiversity management	2	3	0	(0)Monoculture coffee plants (1) Coffee plants with cover crops & shade trees; (2) Coffee plants with various cover crops & shade trees. (3)Coffee plants with industrial (commercial) trees as cover crops & shade trees.
5	Pollution prevention (reduce pollution)	2	3	0	(0)There is no pollution prevention efforts & pollution has a great impact on environment (1) No effort to reduce but the pollution has little impact on environment; (2) There

					has been a concern to reduce pollution; (3)There is a continue effort to do a pollution prevention.
6	Reuse and recycle	2	3	0	(0)Do not understand & there has been no effort to R2 the waste produced (1) It has been realized but has not been attempted yet to do the R2 of waste produced; (2) Rarely make effort to R2 the waste produced (3) Understood & capable to R2 the waste produced economically.
No	Environmental Indicators	Score	Good	Bad	Explanation
7	Carbon sequestration	2	3	0	(0)Plant density & qualities are low (1) Sufficient density with low plant quality; (2) Sufficient density with adequate quality; (3) Great potential of plant density & plant quality.

The results of Rap-Coffee analysis on environmental dimension (**Fig. 3**) show a fairly continuous status (59.15%). Coffee plantations ability to produce high quality products in forest areas encourages a coffee agribusiness as attractive as carbon storages from climate change perspective. Pollution prevention efforts related with the assessment of pollution levels of coffee processing units at Sidomulyo SCPA. The existences of coffee processing industries which start to apply wet methods potentially can cause pollution to environmental and will threaten Sidomulyo SCPA sustainability. So that, it required sufficient technology to control the pollutant, to reduce the amount of water processing and wastewater treatment before discharged into the water body. Therefore, pollution reduction of coffee processing, reuse and recycle of products must be attained..



Figure 3. Rap-Coffee Results of Environmental Dimension

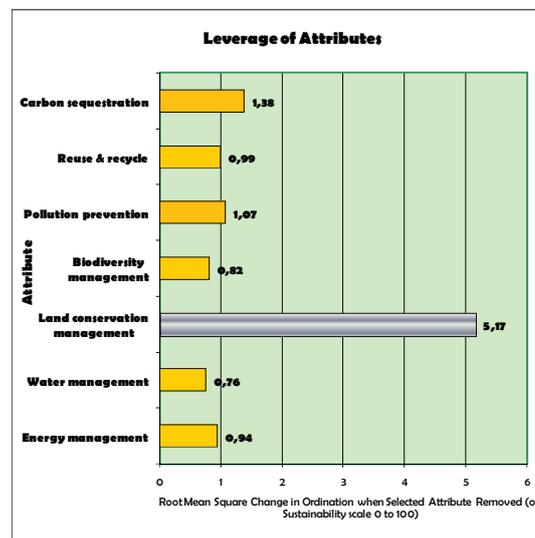


Figure 4. Leverage Analysis of Environmental Dimension

The existences of coffee processing industries which start to apply wet/wash methods potentially can cause pollution to environmental and will threaten Sidomulyo SCPA sustainability. Pollution from wet coffee processing such as pulp and wastewater can cause environmental problems especially if they discharged into water body. Ecological impacts due to high organic content can take large amount of oxygen needed by aquatic life. So that, it required sufficient technology to control the pollutant, to reduce the amount of water processing and wastewater treatment before discharged into the water body. The implementation of solid waste utilization for fertilizer or methane gas production can be carried out with support from relevant stakeholders. According to Reed (1997) in [6], the environmental system sustainability means: (a) the stability of industrial based resources, (b) to prevent the excessive exploitation of renewable resources, (c) to

reduce unrennewable resources if there are substitute resources. Therefore, pollution reduction of coffee processing, reuse and recycle of products must be attained. A better understanding of community can be developed through using community institutions at Sidomulyo SCPA.

Energy management includes the number and types of energy used by community at Sidomulyo. More various sources of energy used, especially from renewable fuels will assign high value. Most people in Sidomulyo still use firewood from non productive trees. They use diesel fuel for coffee processing. Benefit by biogas fuel from wastewater digester must be pursued to increase smallholder coffee sustainability.

Biodiversity indicators assessment based on the several natural vegetation both quantity and quality as key indicators. More specific, variation of cover crops and shading trees. For conservation, high scores mean high performance of biodiversity. Generally, coffee trees at Sidomulyo integrated with other agricultural commodities that enhance their biodiversity. From biodiversity view, coffee plantation integrated shading trees and cover crops have a high benefit in tropical forest ecosystem. Because of greenhouse gas minimization, this system can be as an alternative to deforestation that contributes to global warming. Emission from diesel fuel used at coffee processing can be minimized with its rich biodiversity in coffee plantation. Moreover, traditional coffee plantation that integrated with forest is able to protect at least 180 species of birds [7].

D. Social Sustainability of Smallholder Coffee Agroindustry.

Social sustainability primarily based on farmer tendency to accept the coffee processing unit that could increase their incomes by improving coffee quality. Those, the economic dimension at least has influenced on the social sustainability. So that, it is important for smallholder farmers becomes united in such organized cooperation such as “Koperasi”. It will be discussed further at institutional dimension. Referring to social indicators which were formulated by COSA, social dimension attributes can be developed into 5 attributes presented in Table 4.

Table 4. Indicators of Social Dimension at Sidomulyo SCPA

No	Social indicators	Score	Good	Bad	Explanation
1	Health service and sense of security (safeness)	3	3	0	(0)There is no access for health service & sense of security for rural community (1) There is no access or conversely, have health service access but have no safeness for rural community; (2)There has been minimum health service & safeness; (3) There has been easier & guaranteed health care service and safeness.
2	Working hours and wages	2	3	0	(0)Indecent paid wages & working hours; (1) Indecent paid even though working hours has been done based on the rules; (2) Decent paid & working hours according to minimum living cost ; (3) Paid wages more than minimum living cost.
3	Basic rights	2	3	0	(0) Unfulfilled basic rights of labours and communities; (1) Basic rights compliance still lack; (2) Basic rights compliance has met the rules; (3) Guarantee for basic rights compliance
4	Social relationship	2	3	0	The connection & community involvement with coffee plantation & processing (0) are weak; (1) (1) are strong enough; (2) are very strong; (3) There is not only connection but effort to build their relationship with other stakeholders.

No	Social indicators	Score	Good	Bad	Explanation
5	Farmer perception and satisfaction	2	3	0	(0) Negative, unsatisfied; (1) Negative, less satisfied; (2) Positive, satisfied; (3) Positive, very satisfied.

Sidomulyo SCPA is relatively clean and free from pollutants even though not too far from capital city of Jember district. The existence of free water sources used by community and sense of community security also supports high assessment from respondents. Rap-coffee results and leverage analysis can be seen at **Fig.5** and **Fig.6**.

The farmers manage their own plantation with helps from their relatives in their environment, except in peak season, they receives workers from other village. Labor who works in the farm or at processing plant receives their wages in profit sharing form of money based on daily average. Factory labors also receives overtime payment if they must, especially during peak season. Those rules are generally accepted and have become a habit without written rules.

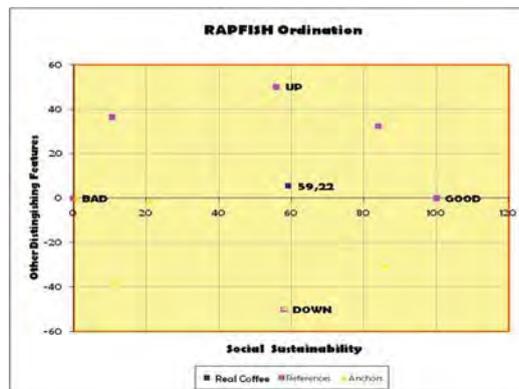


Figure 5. Rap-Coffee Results of Social Dimension

Links between communities at Sidomulyo SCPA are quite good, especially in group of farmers or Koperasi which involve in wet method of coffee processing. Eventhough, there are still several members who not participate in its new method because of limited capacity at peak season. They choose dry method as usual to avoid rotting of coffee berry after harvest. As result, the impacts from improving coffee quality with wet

method are still not strong enough at Sidomulyo SCPA. Based on these conditions, an increasing coffee capacity is expected, next years.

Farmer perception and satisfaction is the second leverage factor in social dimension. This indicator will be related to other indicators fulfillment. So, it is quite complicated to make judgement in this indicator. According to COSA in [7], its assessment is based on farmers' expectation and satisfaction level on social relationship between farmers, relationship between management and members of Koperasi, managerial ability of Koperasi management, farmers' income from coffee bean and the last, health service access and safeness in community

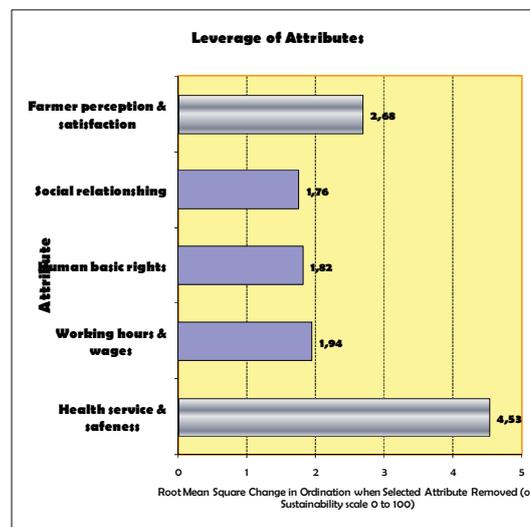


Figure 6. Leverage Analysis of Social Dimension

E. Institutional sustainability of smallholder coffee agroindustry

Institutional plays an important role, as well as the existence of natural resources, capital, technology and human resources in Indonesia agricultural development. Just because associated with the development of coffee producers, institutional becomes an important role in sustainability assessment. Without good institutional application, the availability of coffee production factors would be difficult to support the SCPA sustainability.

Integrated decision making has high score mainly based on the assessment that reasonability decision within organization should be approving by all members (Table 5.). Sidomulyo SCPA has routine activities participated by members to improve the organization such as; farmers group discussion, agriculture communication and counselling

forum, meeting forum with other stakeholders, study tours, social activities and other supporting activities. Official role from Jember Agricultural Office, cooperation with ICCRI, Jember University and Jember Polytechnic University supports Sidomulyo SCPA institutional development.

Table 5. Indicators of Institutional Dimension of Sidomulyo SCPA

No	Institutional indicators	Score	Good	Bad	Explanation
1	Integrated decision making	3	3	0	(0)Never done (1) Done limited within management; (2) Occasionally done between management & members; (3) Always done between management & the members, also invite other stakeholder.
2	Capacity building (Capability improvement)	2	3	0	(0)Never done (1) Done with stakeholder supporting; (2) Done with self supporting, rarely; (3) Done continuously.
3	Science and technology improvement	2	3	0	(1)Never done (1) Done with stakeholder supporting; (2) Done with self supporting, rarely; (3) Done continuously.
4	Social and information awareness	2	3	0	(0)Have not aware yet (1) Have aware with limited action only at management level; (2) Have aware for all members of Koperasi; (3) Becomes their needs.
5	International rules and collaboration	2	3	0	(0)Never knows (1) Understand but have no pretension to apply; (2) Apply with limited action; (3) Aware & apply supporting by other stakeholder.

No	Institutional indicators	Score	Good	Bad	Explanation
6	Civil society roles (unwritten rules) existences	2	3	0	(0)Have no consideration; (1) Have an awareness individually; (2) Have a consideration restrictively at management level; (3) Consideration with clearly & comprehensively understanding.
7	Institutional frameworks and rules	2	3	0	(0)Do not have concept yet (1) Limited only organization rules (2) Already have institutional frameworks & rules; (3) There has been guaranteed in applying it.
8	Disaster mitigation and adaptation	1	3	0	(0)Have no idea about disaster risk (1) Have an idea but still have not prepare yet; (2) Have awareness & starts to coordinate with other stakeholder; (3) Have considered the action with stakeholder coordination.
9	Public participation in community	2	3	0	1) Have not known yet (1) Have known but there have not been public participation; (2) Understanding the concept & sometimes had community get involved; (3) Always consider public participation in institutional improvement.

Institutional farmers at Sidomulyo SCPA become important, especially this organization do controlling and regulating the interdependence between economic agents and the resources. The farmers who have only 2 ha land of coffee plantation on average will be more efficient, productive and sustain if they put best foot forward in farmer

groups. Through organized farmer groups “Koperasi”, they will be stronger from institutional and capital terms.



Fig 7. Rap-Coffee Results of Institutional Dimension

Coffee certification from Utz certified is one of international rules application at Sidomulyo SCPA. They have done with exporter sponsored (Indocom) and Koperasi capability. Although, the international rules and collaboration do not include the key components in leverage analysis, but these formal certification recommended coffee exporter helps the smallholder farmer sustainability. Farther, COSA in [8], has put certification in high priority. Certification assessment process ideally involves organization transparency, information and market expansion system, commercial activities, health, education and social assistance and also price risk product management.

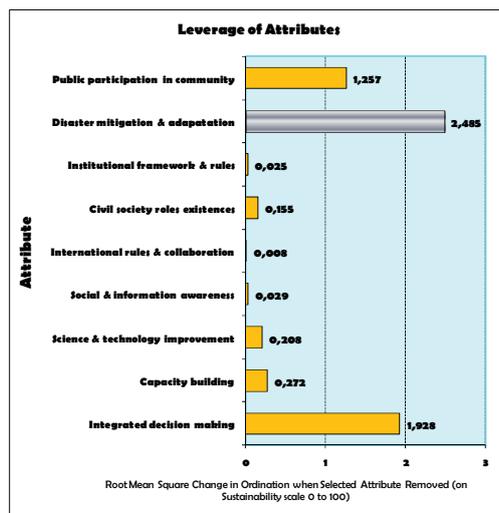


Fig 8. Leverage Analysis of Institutional Dimension

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Coffee bean quality and coffee productivities at Sidomulyo SCPA showed a well improvement after farmers group more organized in Koperasi [18]. Linkage between group members, management and relevant stakeholders within institutional development supports organizational advancement. Based on Sidomulyo SCPA assessment and condition, the farmer groups (Koperasi Ketakasi) expected to be a strong and independent organization. So, they could increase their incomes, market access and finance as sustainability improvement.

Climate change adaptation specifically characterized by adaptation to economic, environment and social system, preventive action of widespread impacts and ability to take advantage of new opportunities. [19] defines three (3) types of adaptation; (1) reduce the sensitivity of affected system, such as improving reservoir capacity, planting perennial trees which can withstand the climate change and managing the land to detain the flood, (2) change the exposure sources which is predicted can cause disaster by making early warning system or risk preparation such as climate forecasting and other anticipated actions, (3) increase the social and ecological system resiliencies that can be achieved by resources conservation, and also specific measurement on population ability to make improvement of loss. A public policy is necessary for public education related to climate change impacts.

F. Sustainability Dimension

Detailed division of sustainability dimension is detailed illustration to know how far the implementation of sustainability indicators for each dimension. Although between those dimensions cannot be separated practically. Therefore, sustainability assessment of activities must be based on the balance between dimensions. The value of sustainability for each dimension showed sustainable enough at **Table 6**.

Table 6. Sustainability Index of Sidomulyo SCPA

No	Dimension	Indeks value (%)
1	Economic	62.54
2	Environmental	59.15
3	Social	59.22
4	Institutional	54.87
	Composite between 4 dimensions	58.94

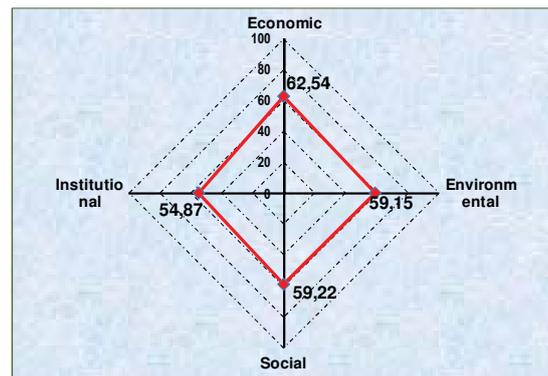


Figure 9. Sustainability Index of Sidomulyo SCPA

Rap-coffee simulation results for 4 dimensions showed sustainable enough (58.94%). Relationship between dimensions schematically can be seen at **Fig.9**. Determination coefficient (R^2) as validated Rap-coffee simulation for each dimension showed high value, 0.94 – 0.95. S-stress value as goodness of fit showed 0.13 lower than 0.25 represented good model of Rap-coffee [8].

Monte Carlo analysis at 95% confidence level is 0.19 – 0.2 lower than 1.0 showed that multidimensional scalling (MDS) computation has high precision [20] (**Fig.10**). Sustainability improvement activities within 4 dimensions must be applied together, because each key factor has a link with others. Farming management in economy dimension, land and water management in environment dimension, farmer perceptions and satisfaction in social dimencion and integrated decision making in institutional dimension are four examples of key factors which can be supported factors to improve coffee quality. By strengthening farmers institutional in “Koperasi”, participation and supports from stakeholders through provided incentives for coffee with good quality, good water management or good energy management can solve the problems of production cost which one of key factors.

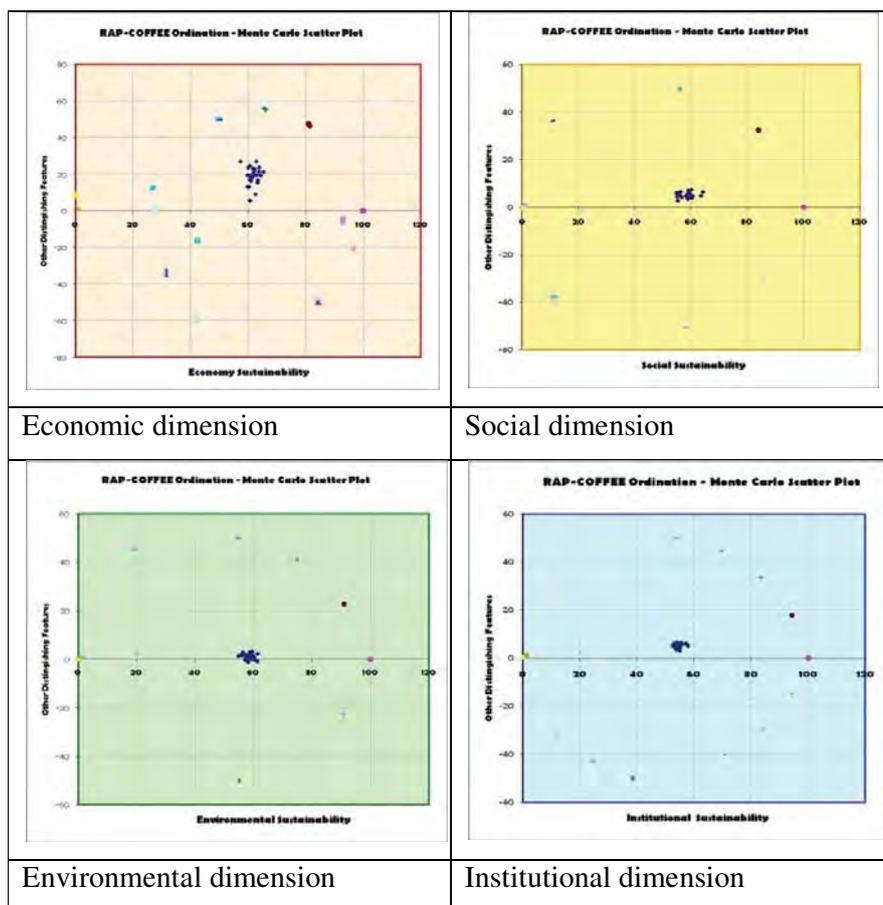


Figure 10. Monte Carlo Analysis of Sustainability Dimension

Conclusion

Sustainability assessment framework of smallholder coffee agroindustry will be needed to determine the sustainability status of coffee agroindustry. The frameworks are group of indicators which indicate the level of sustainability extended from “Munasinghe triangle” of sustainable development and COSA’s indicators of coffee sustainability [7]. The sustainability status of Sidomulyo SCPA at Jember district is fairly enough. Increasing smallholder coffee quality and coffee production at Sidomulyo coffee agroindustry must be based on activities improvement within leverage factors in each dimensions as key factors to raise sustainability index.

According to the strategic plan of plantation development 2010-2014 from Agricultural Ministry of Indonesia to be the one of best coffee producer in the world at 2025, one applied policy is increasing coffee export and smallholder coffee bean quality as well as to increase added value of coffee products which has competitiveness at international market. So that, sustainability improvement at Sidomulyo SCPA should be

directed to fulfil these plan based on 4 dimensions. Leverage factors in each dimension becoming supported factors to reach those goals. Hopefully, production factors improvement within coffee agroindustry based on leverage factors will give positive impacts for coffee farmers as well as increasing sustainability value.

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