

IMPACT OF COMMUNITY BIODIVERSITY MANAGEMENT AS A CONCEPT OF MODERN AGRICULTURE TOWARDS DIVERSITY OF TROPICAL FRUIT TREE, ECOSYSTEM SUSTAINABILITY AND COMMUNITY INCOME IN INDONESIAN SUPPORTING AEC

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INTRODUCTION

The ASEAN Economic Community (AEC) is a big challenge and opportunity for Indonesia to encourage the economic growth. The AEC is the realization of the end goal of economic integration, based on a convergence of interests of ASEAN Member Countries to deepen and broaden economic integration through existing and new initiatives with clear timelines. The AEC will establish ASEAN as a single market and production base making ASEAN more dynamic and competitive with new mechanisms and measures to strengthen the implementation of its existing economic initiatives; accelerating regional integration in the priority sectors (ASEAN Secretariat, 2008).

The high level of competitiveness is an important key for Indonesia to conquer the global competition. One of most valuable assets owned by Indonesian is specific genetic resources. It is related with Indonesia as a mega biodiversity countries and an archipelagic country, with its thousands of islands scattered between two continents (Asia and Australia) and two oceans (Pacific and Indian). Indonesia is endowed with very rich and unique biological resources. More than 329 native and introduced fruit species have been documented and described in Indonesia as potential sources of food, nutrition and medicine (Uji, 2007). The Indonesian Ministry of Agriculture (2010) has prioritized mango and *Citrus* commodities and has targeted production of some 2.5 million tons of mango and 2.3 million tons of *Citrus*. However, the programs are threatened by farm land conversions. The rate of farm land conversions in Indonesia is around 100.000 hectares per year and caused by the rapid population growth in the last 15 years that increased around 1,49% per year (Indonesian Statistic Agency, 2014).

Diversifying the agricultural sector has become now an important strategic interest for the Indonesian Government, which requires also a conservation strategy to maintain a viable population of species and the intra-specific diversity within species as the fundamental source for improved planting material. To diversify and improve the agricultural sector, the conservation of fruit trees is urgently needed by the Indonesian government (Hanani *et al.*, 2009), especially for fruit trees which have recalcitrant seeds and cannot be conserved in cold storage. The prevention of erosion of native fruit genetic resources should be highlighted as a national priority. Loosing plant genetic resources means that Indonesia will lose national assets to develop new products or compete in the global market, whereas the competitiveness level of Indonesian fruits in Asia is already low.

On-farm conservation entails the active participation of local communities in the documentation, multiplication, utilization and safeguarding of unique species and varieties found on their farms. *In-situ* and *on-farm* conservation is ineffective without local community

participation (Isager *et al.*, 2001). Community-based Biodiversity Management (CBM), is an example of a conservation approach that empowers the community through participation so that their access to and control over genetic resources are secured (Rechlin *et al.*, 2008). Sthapit *et al.*, (2008) described CBM method entails several steps and type of interventions. Firstly, sites and communities are selected with high level of unique inter or intra-specific diversity, followed by full understanding of the local context to determine if *on-farm* conservation is appropriate and feasible. The next steps are: raising awareness, set-up institutional modalities, strengthen capacities and skills, development and implementation of action plans for utilization and conservation, mobilize CBM funds, and facilitating social learning in which local stakeholders lead and drive the CBM process (Sthapit *et al.*, 2008).

On-farm conservation activities and interventions include the organization of diversity fairs, the documentation and description of local species and varieties in a catalogue or register, establishment of nurseries for multiplication and distribution of unique plant or seed material, the promotion of nutritional values and traditional recipes, the development of enterprises and market linkages for the sales of products or services based on local unique crop diversity and the protection/conservation of most important source trees or seed material (Arsanti, 2013). Thus, CBM approaches can be classified as a new concept of modern agriculture system since the community participations have been placed as an important part and the project also osculate the upstream and downstream aspects of conservation, so that the community can generate the economic welfare.

METHODOLOGY

As an impact assessment, this studies were focused on the benefit of the diversity project's activities in enhancing the number of tropical fruit tree diversity, ecosystem sustainability, and community income. The methodology used in this study are survey and literature review. The study had been held in 2014 at two sub district in South Kalimantan (Telaga Langsat for mango, Cerbon for *Citrus*) and two sub district in East Java Province (Tiron for mango and Bibis for *Citrus*). The locations were selected out have been part of the UNEP/GEF funded project namely "Sustainable use of wild and cultivated tropical fruit tree diversity, improving livelihoods, ecosystem services and food security". The project used the CBM approach to strengthen local *on-farm* conservation practices for mango and *Citrus* species and varieties in selected villages. Data was collected by enumerators using pen and paper questionnaire including multiple choice questions and few open questions regarding their participation of project interventions. Respondents were selected by purposive random sampling, selecting 383 people from six locations. Interviews were conducted at the end of the UNEP/GEF project for on-farm conservation after completion of all field activities. The variables used in this study are community participation in the conservation of tropical fruit trees, the number of tropical fruit tree ownership, and income of community related to their conservation activities.

RESULTS AND DISCUSSION

Characteristic of Respondents

The study shows that the average age of respondents was 48.5 years old. It reflected that most of farmers respondents are in productive age. They actively worked in their farm to cultivate paddy, vegetable, fruit, and also raised cattle. They also still involved in the farmers group activities. By interacting with the other farmers they benefitted from the information related to their mango and *Citrus* farming.

The 62% respondents are male and 38% are women. It showed that the project has prioritized the involvement of woman farmers in the project. Gender is an important issue and involving woman farmers in conservation programs is necessary as they have significant knowledge on conservation issues and hence should have the same right as men to be

involved in any decision making process regarding *on-farm* conservation activities (Kurniasih, 2007). The woman farmers were also actively involved in the farmer group activities, conservation activities and the training workshops provided by government agencies or Non-Government Organizations (NGOs). Woman also got involved through a woman farmer group that established a business unit for the processing of mango and *Citrus* fruits.

Most of the respondents did not have high level education such as pursuing a bachelor or master's degree. About 62% of the respondents were formally educated (under 9 years), meaning they just finished a primary or secondary school. Others respondents or 38% are well educated as they finished a high school or bachelor degree. Education strengthens capacities and gives knowledge and ideas to the participants to access more information and technologies that are useful to improve their farming system.

Community Participation

This study conducted in the final phase of a community-based *on-farm* conservation project showed that farmers' participation in project activities had a major positive effect on their perceptions about *on-farm* conservation, and thus increased the likelihood that practices are adopted and continued within their farming system. In the diversity fair activity the study showed that 27% respondents attended the diversity fair, 14% respondents stated that they actively participated in the diversity fair as a guide and promoted the CBM activities to the visitors. They visitors stated that diversity fair is new method of dissemination since they can get a lot of information about the richness of genetic resources and CBM activities.

In this study, 40% of farmers indicated that they participated actively in community nursery. They produce the mango and *Citrus* planting materials in community nursery that were established by the project. Unfortunately, community nurseries have not been able to fulfill the planting materials demand because of its limitation of rootstocks. This issue should be taken by the government and it should develop faculties so that the access to seedlings of species/varieties by farmers is improved. This may be done through establishing nurseries by formal sector or by promoting community nurseries.

The result also showed that 15% respondents stated that they involve to build the diversity block. They conserved the wild relatives of mango and *Citrus* trees in some place and they use it to serve the material planting in grafting activities. To increase the farmers capabilities in nursery, the project also give assistant for the farmers in grafting or seedling technologies.

The existing conservation activities that are part of the CBM approach, such as biodiversity block or garden, community biodiversity register or fruit catalogue, community nursery, diversity fair, processing product of mango and *Citrus*, and marketing training, are effective to encourage farmers' participation and perception on conservation of mango and *Citrus*. Therefore, these activities should be continued to get increased participation not only in the project location but also in the other places in Indonesia.

Fruit Trees Diversity

At the beginning of the project, it had been identified that in six project sites have a richness of genetic resources of mango and *Citrus*. The four locations represented a center of mango and *Citrus* diversity in Indonesia. The baseline survey had been done in 2013 by Winarno et.al. (2013) reported that Tiron Kediri has different species and 24 varieties of *M. indica* are known within the community. Indigenous varieties such as Jaran, Lanang, Santok Kapur, Santok Buto Bader, Jempol, Dodonilo, Beruk, Pakel, Empok, Ireng, Dasamuko, Cantek, Lulang, Cantrik, are combined with commercial varieties like Podang Urang, Podang Lumut, Golek, Gadung, Madu, and Manalagi.

After the project intervention, the mango trees maintained by community in Tiron had been increasing by 14,1% (Table 1).

Table 1. Distribution of Mango Tree Diversity in Tiron Before and After The Project

| No | Varieties | Before | | After | | | |
|----|--------------|-------------------|-----------------|-------------------|--------|-----------------|-------|
| | | Number of farmers | Number of Trees | Number of farmers | % | Number of Trees | % |
| 1 | Podang Urang | 52 | 1233 | 55 | 5,77 | 1270 | 3,0 |
| 2 | Podang Lumut | 6 | 42 | 7 | 16,67 | 104 | 147,6 |
| 3 | Golek | 18 | 47 | 19 | 5,56 | 50 | 6,4 |
| 4 | Gadung | 29 | 291 | 30 | 3,45 | 302 | 3,8 |
| 5 | Jaran | 2 | 2 | 3 | 50,00 | 10 | 400,0 |
| 6 | Madu | 15 | 28 | 16 | 6,67 | 56 | 100,0 |
| 7 | Santok Buto | 7 | 8 | 8 | 14,29 | 30 | 275,0 |
| 8 | Kopyor | 13 | 20 | 15 | 15,38 | 45 | 125,0 |
| 9 | Manalagi | 6 | 15 | 10 | 66,67 | 17 | 13,3 |
| 10 | Dodonilo | 1 | 1 | 5 | 400,00 | 6 | 500,0 |
| 11 | Arumanis | 4 | 17 | 10 | 150,00 | 55 | 223,5 |
| | Total | 153 | 1704 | 178 | 16,34 | 1945 | 14,1 |

In Bibis Magetan at the beginning of the project has been identified 6 different species (*C. grandis*, *C. sinensis*, *C. hystrix*, *C. reticulata*, *C. aurantifolia*, *C. limon*), 3 varieties of *C. reticulata*, and 9 varieties of *C. grandis* are known within the community. Almost all indigenous varieties of *C. grandis* such as Adas, Adas Duku, Nambangan, Sri Nyonya, Pamelo Magetan, Jeruk Gulung, and Jeruk Jowo, are commercial varieties.

After the project, the study identified that the number of Citrus trees in Bibis had increase by 15,79% that shows at Table 2.

Table 2. Distribution of Citrus Tree Diversity in Bibis Before and After The Project

| No | Varieties | Before | | After | | | |
|----|-------------------|-------------------|-----------------|-------------------|--------|-----------------|--------|
| | | Number of farmers | Number of Trees | Number of farmers | % | Number of Trees | % |
| 1 | Adas Duku | 51 | 2891 | 53 | 7,84 | 2892 | 21,07 |
| 2 | Nambangan | 36 | 2827 | 37 | 94,44 | 2828 | 1,80 |
| 3 | Sri Nyonya | 51 | 476 | 53 | 13,73 | 480 | 34,24 |
| 4 | Bali Merah | 28 | 452 | 29 | 3,57 | 453 | 34,96 |
| 5 | Pamelo Magetan | 9 | 150 | 9 | 0,00 | 150 | 18,67 |
| 6 | Sunkis | 6 | 20 | 6 | 0,00 | 22 | 75,00 |
| 7 | Jeruk nipis | 2 | 2 | 3 | 50,00 | 3 | 200,00 |
| 8 | Keprok Manis | 10 | 72 | 13 | 30,00 | 73 | 43,06 |
| 9 | Jeruk Gulung | 1 | 3 | 4 | 100,00 | 4 | 233,33 |
| 10 | Jeruk Jowo | 17 | 172 | 19 | 11,76 | 175 | 15,12 |
| 11 | Jeruk Pecel | 1 | 14 | 2 | 0,00 | 15 | 128,57 |
| 12 | Jeruk Purut | 1 | 2 | 1 | 0,00 | 2 | 400,00 |
| | Total | 213 | 7081 | 229 | 24,88 | 7097 | 15,79 |

In Telaga Langsat, identified 11 different species of mango : *Mangifera indica* (local name : hampalam nagara, mangga golek, mangga gadung, hampalam hambuku, hampalam biasa and apel), *M. foetida* (local name of varieties : hambawang biasa, hambawang kalambuai, and hambawang tapah), *M. odorata* (local name of variety : kuini), *M. torquenda* (local name : hambawang pulasan), *M. griffithii* (local name of varieties : rawa-rawa humbut and rawa-rawa biasa), *M. casturi* (local name : kasturi), *M. havilandii* (local name : hampalam damar), *M. applanata* (local name of varieties : palipisan sak hirang and palipisan sak hijau), *M. rufocostata* (local name : tandui), *M. caesi* (local name of varieties : binjai manis and binjai asam), and *M. pentandra* (local name : asam pauh).

After the project intervened the community, the number of mango trees diversity had been increasing by 17%. The enhancement of mango trees in Telaga Langsat is shown in Table 3.

Table 3. Distribution of Mango Tree Diversity in Telaga Langsat Before and After The Project

| No | Varieties | Before | | | After | | |
|----|---------------|-------------------------|--------------------|----------------------|--------|--------------------|--------|
| | | Number of farmers | Number of Trees | Number of farmers | % | Number of Trees | % |
| 1 | Kasturi | 8 | 12 | 13 | 62,50 | 13 | 8,33 |
| 2 | Mangga gadung | 2 | 3 | 5 | 150,00 | 4 | 33,33 |
| 3 | Binjai | 2 | 4 | 2 | 0,00 | 4 | 0,00 |
| 4 | Hambawang | 4 | 6 | 5 | 25,00 | 7 | 16,67 |
| 5 | Hampalam | 10 | 14 | 11 | 10,00 | 15 | 7,14 |
| 6 | Kuini | 2 | 3 | 3 | 50,00 | 3 | 0,00 |
| 7 | Mangga Golek | 6 | 7 | 8 | 33,33 | 8 | 14,29 |
| 8 | Mangga Apel | 2 | 3 | 3 | 50,00 | 6 | 100,00 |
| 9 | Mangga Madu | 1 | 1 | 1 | 0,00 | 2 | 100,00 |
| | Total | 37 | 53 | 51 | 37,84 | 62 | 16,98 |

In Cerbon site, the number of citrus tree conserved by the community is also raising about 13,56%. At the beginning of the project, there were 47 varieties are maintained per household and in total 7 different species; 2 varieties of *C. reticulata*; 3 varieties of *C. sinensis*; and 2 varieties of *C. grandis* are known within the community. Commercial Indigenous varieties such as Limau Sambal, Limau Bali, Limau Purut, and Limau Nipis. The number of farmers and Citrus tree enhancement after the project intervention in Cerbon site can be seen in Table 4.

Table 4. Distribution of Citrus Tree Diversity in Cerbon Before and After The Project

| No | Varieties | Before | | After | | | |
|----|--------------|-------------------|-----------------|-------------------|-------|-----------------|--------|
| | | Number of farmers | Number of Trees | Number of farmers | % | Number of Trees | % |
| 1 | Podang Urang | 52 | 1233 | 55 | 5,77 | 1378 | 11,76 |
| 2 | Podang Lumut | 6 | 42 | 8 | 33,33 | 49 | 16,67 |
| 3 | Golek | 18 | 47 | 23 | 27,78 | 52 | 10,64 |
| 4 | Gadung | 29 | 291 | 32 | 10,34 | 312 | 7,22 |
| 5 | Jaran | 2 | 2 | 3 | 50,00 | 5 | 150,00 |
| 6 | Madu | 15 | 28 | 18 | 20,00 | 35 | 25,00 |
| 7 | Santok Buto | 7 | 8 | 11 | 57,14 | 9 | 12,50 |
| 8 | Kopyor | 13 | 20 | 23 | 76,92 | 38 | 90,00 |
| 9 | Manalagi | 6 | 15 | 11 | 83,33 | 17 | 13,33 |
| 10 | Dodonilo | 1 | 1 | 1 | 0,00 | 8 | 700,00 |
| 11 | Arumanis | 4 | 17 | 5 | 25,00 | 32 | 88,24 |
| | Total | 153 | 1704 | 190 | 24,18 | 1935 | 13,56 |

In average, the number of fruit trees in 4 project sites was raising about 15% after 6 years CBM intervention. This study identified that this condition was caused by : (1) the project gave sapling and training for the community; (2) farmers' knowledge were raising since the interventions; (3) community nurseries were developed properly, so that the farmers' can access the seed easily; and (4) the added value of fruit trees product was increasing since the farmers got several training on processing fruit.

Community Income

Based on the analysis of the base line data, it was observed that mango contributes just 1,3% in South Kalimantan, and 13.9 percent in Tiron, Kediri, East Java. After the intervention of the project, the house hold income were raising about 10% in Telaga Langsat and 20,6% in Tiron (Table 5).

Table 5. House Hold Income and Contribution of Mango Before and After the Project

| Particulars | Before | | After | |
|------------------------------------|------------------|--------------------|------------------|--------------------|
| | Tiron, EJ | Telaga Langsat, SK | Tiron, EJ | Telaga Langsat, SK |
| HH Net income (Rp) | 11.122.870 | 10.757.192 | 14.459.731 | 12.908.630 |
| Contribution/Share of Mango (Rp/%) | 1.549.978 (13,9) | 144.175 (1,3) | 2.991.946 (20,6) | 1.075.719 (10) |

Meanwhile for Citrus, the study identified that based on baseline survey, the intervention also raised the community income. In Bibis site the house hold income were raising about

15% and in Cerbon site the project can lead the community to raise the income from Citrus until

Table 5. House Hold Income and Contribution of *Citrus* Before and After the Project

| Particulars | Before | | After | |
|-------------------------------------|----------------------|----------------------|-------------------|----------------------|
| | Bibis, EJ | Cerbon, SK | Bibis, EJ | Cerbon, SK |
| HH Net income (Rp) | 22.329.566 | 9.021.422 | 24.795.479 | 12.908.630 |
| Contribution/Share of Citrus (Rp/%) | 9.016.006 (40,44) | 4.961.782 (55,47) | 12.877.288 (51,9) | 6.745.178 (52,23) |

The raising of community income was led by the processing was led by several factor such i.e. : (1) The ownership of fruit trees were raising and the community can generate more money by selling the fresh fruit; (2) The development of processing product by woman farmers group, so they can earn more income by adding the value of the fruit; (3) the community nurseries were develop properly, so the community can generate the income by selling the planting material.

Conclusion

The community biodiversity management approach and its activities, as used in the project, seems an appropriate approach to influence farmers' perceptions related to conservation activities, especially when incentives and needs of farmers are recognized and addressed. Creating access to planting material of unique fruit species and varieties, the provision of additional agronomic and technical support and the creation of benefits through income generation seem all important aspects for a community-based biodiversity management approach.

With efficient and effective government assistance, farming communities in high diversity areas may be able to position themselves as agent of change to ensure the sustainable utilization and conservation of fruit tree diversity. Maintaining the diversity is a must since the genetic resources of tropical fruit tree are comparative advantages for Indonesia to win the global economic competition especially to face the AEC.

Some outcome that emerge from this study that can be implemented by stakeholders are:

1. The importance of identifying and working through custodian households within the community as entry point for interventions and agents of change to document and spread knowledge, practices and saplings across the community.
2. The importance of having a long timeframe of 5-8 years of *on-farm* conservation projects to understand the context, identify key stakeholders, plan interventions to be able to influence and change perceptions and behaviors regarding the utilization and safeguarding of local fruit tree species.
3. The existing conservation activities that are part of the CBM approach, such as biodiversity block or garden, community biodiversity register or fruit catalogue, community nursery, diversity fair, processing product of mango and *Citrus*, and marketing training, are effective to encourage farmers' participation and perception on conservation of mango and *Citrus*. Therefore, these activities should be continued to get increased participation not only in the project location but also in the other places in Indonesia.

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