Study on sustainable forest management to enhance carbon sinks and stabilize CO_2 by Carbonization in Sarawak, Malaysia

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1. Objectives

This study is to verify feasibility of natural forest restoration at devastated lands in tropical area by utilizing indigenous species, as well as to conduct industrial plantation of early maturing trees to produce pulps and timbers for various uses. Besides, this is also to trigger charcoal manufacture utilizing wood wastes, barks, and industrial wastes, etc., which have been generated in plantation lands and agricultural lands. Those charcoals would be used for soil improvement in order to increase land productivity, or utilized for water purification and as fuel. Thus, local industry shall be vitalized. The areas covered by this study were; coastal lowland of Sarawak State as well as Rajang district, the inland mountainous region. The counterpart of this study was the local competent company, Ta-Ann Inc., which gave us full support and cooperation.

2. Estimation of Baseline Value and Growth of Plantation Trees

Several research plots were established for a study on the logged-over forests as well as the secondary forests of slash-burnt agriculture. The aboveground biomass and the growth increment of those forests were estimated by applying allometric growth equations derived from the harvesting methods as well as existing research results. As a result, the following baseline value was calculated; 99 - 125 tons/ha as the logged-over forests, 3.05 tons/ha as current annual increment, 32 tons/ha as the 5-year-old secondary forests, 99 tons/ha as that of 32 years old, 6.0 tons/ha as current annual increment until the 12th year, 1,13 tons/ha as that of over the 13th year. The growth estimation of *Acacia mangium* plantation forests was conducted by applying a logistic growth model.

3. Carbonization Business in Sarawak State

Carbonization business has just set forth in Sarawak State. Various carbonization methods has been utilized based on its purpose or raw materials. Carbonizing rice husk briquette has the highest productivity, with 0.21 RM/kg of production cost by utilizing saw dusts of rubber trees as raw material. Due to its quality and convenience, it is expected to have higher market value than ordinary wood charcoal. As for wood charcoal production, there were several types of kiln such as honeycomb type, Siamese kiln, and instant kiln utilizing oil drum, etc. Even with a certain limitation in seeking for better profitability, the oil drum type has a value in a sense that it is practical for local habitants with only small amount of investment.

As for the remaining wood wastes caused by commercial cutting, only 60% of total wood volume would be utilized at the time of logging at the forest site, 5% of which would become a loss on the way to lumberyard. 40% of them would become wood wastes during manufacturing process at lumbermill. Therefore, it can be said that approx. 66% would become remaining wood wastes throughout the way from forests to lumbermills. This doesn't only mean that there are sufficient raw materials available for carbonization, but also implies that it is necessary to utilize them by various methods in order to consume them effectively for better resource conservation.

4. Business Profitability

Average growth volume was calculated as 20m3/ha per year based on the data of *Acacia mangium* obtained by actual measurement. Besides, entire cost related to plantation business was studied and economical precondition was established in order to test calculate and see if this business would become profitable in 36 years, which would be the end of the second 12 year cutting cycle. As the result, internal return ratio (IRR) was 9.27%, which is considered to be a marginal level for plantation business.

5. Socioeconomic Condition of Site and Peripherals

Three villages are in the proximity of Similajau district. As for Woodlay plantation plot in Rajang district, a certain study was conducted in 19 villages. All of them consist of longhouse of Ivan, and the habitants live mainly on slash-burnt agriculture. The locations of fields, cropping patterns, the usage of forestry products were investigated during the study.

6. Project Planning

Similajau-Bintulu Plantation Plot:

5,000 ha of industrial plantation shall be established in selective cutting forests of Similajau, and briquette type of charcoal for fuel use would be manufactured for exportation by utilizing enormous volume of saw dusts generated in a large scale lumbermill complex of Bintulu.

Rajang Plantation Plot:

24,000 ha of industrial plantation shall be established in selective cutting forests and a part of slash-burnt agricultural fields, 70 % of which would be forests of wood material production, whereas 30% would be for chip production. The cut off pieces, generated in forest thinning process or during cutting harvest period, would be made into charcoal.

7. Carbon Balance Resulting from Project

Multiple scenarios were made under several conditions according to the baseline value described before as well as plantation tree growth estimate, in order to test calculate carbon balance. 1) Negative factor deteriorating the balance of this project is approx. 1.8 million tons of carbon emission generated during the initial phase of this project due to the complete cutting of entire selective cutting forests and secondary forests of slash-burnt agriculture existed in plantation area. 2) As for the baseline under assumption that this plantation project is not existed, carbon absorption volume of the above mentioned forests existed in the area as they grow would be approx. 40 thousand tons per year within planting - cutting cycle. 3) Due to those two negative factors, carbon balance of planting - cutting cycle would result in emission, but not reduction, for approx. 50 years, even considering partial carbon fixation of wood materials, or spreading of slash-burnt agriculture in case this project does not exist. 4) There are various uncertainty remained, such as details of charcoal balance calculation method in plantation project which are yet to be defined, the way to reflect an activity of slash-burnt agriculture in estimation of baseline, etc. These factors affect highly on carbon balance calculation of entire project.

Compared with complicated method of baseline calculation or difficult balance evaluation method of plantation trees, charcoal production by carbonization can steadily be evaluated and firmly accumulated without fault, although the volume is yet to be increased. If it is recognized as zero emission method of plantation project or effective use of biomass, carbonization can be considered as the most reliable method.