Chapter 3

Lessons Learned from the Pilot Studies

Sustainability Assessment of Biomass Utilisation in East Asia Working Group

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3. LESSONS LEARNED FROM THE PILOT STUDIES

As summarised in the previous chapter, the field-testing of the WG methodology in selected East Asian countries (Sagisaka, 2009) revealed that the methodology could successfully quantify the sustainability of biomass utilisation projects. However, through the experience from the field-testing, the WG recognises that some minor location-specific modifications may be required, while applying the methodology to biomass utilisation projects in other East Asian countries. The WG members also feel that sharing their lessons learned from the pilot studies contributes not only to sustainability assessment of biomass energy utilisation in the East Asian region but also to other biomass sustainability frameworks developed elsewhere in the world.

The lessons learned from the pilot studies in East Asia together with the directions for minor modifications of the WG methodology are addressed in this chapter.

3.1. Lessons Learned from Each Pilot Study

3.1.1. From Andhra Pradesh, India

Some of the issues emerged and lessons learned from the results of the pilot study in Andhra Pradesh, India, are described as follows.

On a small scale, such as village or community level, some good examples of biodiesel production using tree oil are successful. However, major biodiesel producers in the state are not able to procure enough feedstock, i.e. tree borne oils or seeds for biodiesel production. They are surviving on biodiesel production using various other feedstocks such as palm stearin, animal tallow, waste oils, etc. This defeats the basic purpose of the biodiesel producers as well as government policies, which are focused on biodiesel production using tree borne oils. Jatropha curcas was initially considered a miracle plant in India that would grow on any type of soil without irrigation, fertiliser, or any other care. But the pilot study results indicate that Jatropha and other plants, such as Pongamia, need some care for their survival, particularly in the first few years after planting. Also, for a good and sustainable yield, regular irrigation and fertiliser application throughout the life span of plantation is essential. Although the Government of India policies seem to encourage production of biodiesel in the country, the ground realities are different. The targets of biodiesel production (a blending target of 20%), which were earlier set to be achieved by 2011-2012, are now being revised to 2016-2017 as per the National Policy on Biofuels of December 2009 (MNRE, 2010). Based on observations from the field survey, however, achieving the new targets too seems doubtful.

Only a limited success is demonstrated on economic, environmental and social aspects of the biodiesel production chain. Economic analysis indicates that cost incurred during the cultivation stage is much higher than the revenue generated as oil tree growing companies are making a financial loss during this stage. However, economic benefits in terms of total value added (TVA) by the biodiesel producers and foreign exchange savings for the country could be substantial, which confirms that promotion of biodiesel production would result in net economic benefits.

On the environmental front, although data are not sufficient, preliminary estimates from available data indicate a net reduction in greenhouse gas (GHG) emissions during the life cycle of the biodiesel production. Other environmental changes such as impact on local air pollution, water demand, land use change (LUC), etc., may be significant but none of the stakeholders on the sites surveyed collected data to calculate such impacts.

Probably the best performance in all stages of biodiesel chain is shown on the social front. Both during oil tree cultivation and biodiesel production phases, good employment is generated in the surrounding localities. The wages of those employed in the biodiesel production chain are about 50-60% higher than their wages in employment elsewhere. Due to increase in wages, employees are able to spend more on their food, health, education and living standards. Estimation of various social development indicators (SDIs) shows an overall improvement at village or community level. As there is a visible increase in employment and income of individuals employed in oil tree plantations as well as other stages of biodiesel production, promoting these activities would certainly have a positive effect on social development of local people and communities.

For the success of biodiesel programmes, it is necessary to encourage farmers to undertake plantations of Jatropha and other oil trees. This is only possible by ensuring financial gains to them resulting from cultivation of biodiesel crops. Special focus is needed to sustain cultivators during crop gestation period (i.e. no yield period from planting to harvesting). The study supports the idea of initiating ancillary activities such as poultry farming, intercrops, rearing milk producing animals, etc., which were found successful in the field. In addition, introduction of mass awareness and capacity building programs in rural areas, financial and technical supports such as interest free loans or soft loans, easy availability of quality seeds and other inputs, crop insurance, etc., would attract farmers towards biodiesel crops. Among various hurdles, the price of raw material (oil seeds) and final product (biodiesel) was found to be the biggest limitation for promoting tree oil based biodiesel production. It is necessary that price of both oil seeds and biodiesel are kept at such a level that could sustain the biodiesel industry. The pilot study recommended that tree oil seed price should be around 10-15 INR per kg (as against 7-8 INR per kg at present) and biodiesel purchase price should be above 35 INR per litre (as against the governments' present purchase price of 26.5 INR per litre).

The pilot study focused on a very small scale (village or community level) and the story at macro level (state or country level) may be altogether different. Thus, projection and application of the results of this micro level study at macro level would be inappropriate. Instead, it is suggested that more rigorous field work on a larger area, representing a state or the country, as the case may be, should be undertaken for a macro scale assessment. A representative sample size could be coverage of at least 10-15% of total plantation area and about 25% of biodiesel production capacity in the state or country including both small and large scale biodiesel production units.

3.1.2. From Lampung, Indonesia

3.1.2.1. Cassava for Ethanol Production

There are some issues related to production of ethanol fuel that cannot be answered merely by the sum of net profit from the main product and by-products. For example, there will be problems related to productivity of feedstock, efficiency of technology, and production capacity. There may be a question whether ethanol production is energetically favourable or not. Hence, in order to answer these and other issues, it is preferable that other economic parameters like productivity, net energy balance, change in the consumption of fossil fuels and traditional use of biomass, energy diversity, and government policy are included. Enforcement from government is really needed to utilise bioethanol as a biofuel in Indonesia.

The three factors included in the HDI calculation are life expectancy index, education index, and GDP index. The first two indices are nearly constant for a short period. The GDP index, however, is strongly determined by revenue of the farmers which is affected by fluctuation of the cassava price. Therefore, the higher the price of cassava, the better the HDI will be. However, it will be very difficult to significantly increase HDI by changing of cassava price because of logarithmic factor. Therefore, it is required to include other parameters to answer social issues related to ethanol fuel production. For example, because cassava is also used for food and feed, demand of cassava for ethanol production will affect the price and supply of food or feed. Increasing raw material will increase income and affect the allocation and rent of land for cassava production. Therefore, other social parameters like job creation, change in income, access to modern energy, price and supply of food or feed, land allocation and land tenure for bioenergy, should be considered.

3.1.2.2. Jatropha for Crude Jatropha Oil

Using Jatropha wastes such as Jatropha cake to produce biogas and Jatropha peel, wet cake, and sludge for compost will give additional benefit. For this reason, waste management is likely also important to be considered as environmental indicator. However, it is necessary to include other parameters to answer environmental-related issues. The parameters that is likely important to be considered involve soil quality, water quality, water use and efficiency, LUC related to bioenergy feedstock production, and biological diversity in the landscape. It is also imperative to consider other indicators like the change in consumption of fossil fuels and traditional use of biomass as well as energy diversity. Electricity generation using Jatropha biodiesel and biogas production from Jatropha cake will enrich energy diversity available to the people. These energy sources will eventually affect their use of fossil fuels (especially, kerosene and liquefied petroleum gas) and the use of wood energy. When the study group visited the community, it was revealed that electricity is the primary need for the people. They expected to ultimately get electricity by growing and processing Jatropha. Moreover, a unit of generator set has already been equipped in the processing unit. For this reason, ease for the people to access modern energy is an important parameter from social point of view. Global Bioenergy Partnership (GBEP) also listed this as one of the social parameters (GBEP, 2011) in relation to renewable energy development. In fact, electricity is one of the most wanted energy sources by the people.

Even though still lower than HDI of North Lampung district, the Jatropha production and processing activities helped increase HDI. This indicated that Jatropha production and biofuel production from Jatropha and their waste utilisation has positive impact to HDI. However, the people do not directly feel the real benefit of the HDI. It is, therefore, important to include other social parameters to assess sustainability of biomass utilisation.

3.1.3. From Quezon, the Philippines

3.1.3.1. Economics Aspects

The economic indicators that were taken into consideration for calculating the economic impact of the energy project are the following: 1) total net profit (TNP) accumulated from product conversion or processing; 2) wages from employment created out of the biomass industry; 3) tax revenues generated from the different entities within the industries; and 4) foreign trade impacts in terms of foreign exchange earnings and savings. The total value added (TVA) for the industry included the summation of all the value added in each enterprise, which includes personnel remuneration, taxes and duties earned by the government from the enterprises, and the entrepreneur’s net profit. On the other hand, East Asian country members will mostly likely be interested in the net foreign exchange earnings from exported products aside from the reduced importation of fossil fuel products. The other most important reason for the shift to biofuels is the concern on environment.

TVA is merely a measure of economic benefits derived from individual activity conducted, may it be in the production or processing of agricultural products. This shows the additional net profit, additional wages as a result of added employment and added tax revenue paid to the government by both the owners and labourers for the production or further processing of the agricultural products (Tallec and Bockel, 2005). If this activity is not performed, then no further economic benefits will be realized.

TVA alone gives not much meaning to the sustainability of biomass production or processing but knowing the components of the total value added will serve as indicators for the policy makers, private investors, employees/labourers and other players in the biofuel industry to continue or proceed with the program, business or any activity depending on whether it is worth continuing from the economics point of view.

An attractive net profit means good business and so the private investors will then be encouraged to continue the activity while minimal net profit or worse still, negative net profit will discourage them to continue. Substantial wages received from the management will encourage the labourers to work well resulting in better business for the employer. On the other hand, the government will be happy to support the investors due to taxes generated from the business. In the process, the business becomes sustainable. The TVA including its subcomponents namely TNP, wages from employment, and tax revenues generated from the different entities within the industries are appropriate measures to be used as indicators of biomass sustainability.

The other benefit for the economy on a national level includes the net foreign exchange earnings from exported products. Positive net foreign exchange earnings (meaning that the savings for non-importation of fossil fuel for using biodiesel and foregone revenue for non exportation of raw materials such as copra or coconut oil, the raw material for biodiesel production in the Philippine's case) are good for the economy of the country (Elauria, 2008). Other than this, it will increase the level of energy security of one's country.

3.1.3.2. Social Aspects

The Human Development Index (HDI) may provide a comprehensive assessment of the social impact of biofuels programmes but it is applicable at macro level, such as national or state/province level. At micro level, such as village or community level, it gives a very vague picture of the real social impact of the biofuels programmes. However, its three subcomponents, viz., life expectancy index, education index and GDP index, provide more meaningful assessment of the social impact of the biofuel business at community or project level. Thus, while HDI may be appropriate to show the change in the social status of each country or each state/province within a country, its three subcomponents are much more appropriate or applicable to the community level. Also, since the three subcomponents of HDI can stand alone, it is not necessary that all the impacts as measured by each subcomponent are positive.

HDI as a social indicator seems to be applicable only at the national level. Even if this social indicator takes into account the measures for life expectancy, education and GDP, these data are only available at the national level or at least in the regional level therefore HDI as measure of social development is more appropriate at the national or regional level. Another social indicator appropriate for the national level is the effect on energy security as a result of the biofuels program of the government. This is a big relief particularly to the transportation sector being heavily dependent on imported fossil fuels.

On the other hand, conflict with food security as a result of using the raw material which may be intended for food may give negative social implication and hence must also be considered.

As for the project or community levels, better and direct measures of social impact are suggested. In case of the biodiesel production from coconut in the Philippines, social impact to the community can be better measured in terms of increased income of the employee, better education for the children, improved health condition and probably improved relationship in the plant or community among others. In the case where the project or community is in a far flung area, the easier access to energy particularly clean energy may also be included.

3.1.3.3. Environmental Aspects

Life Cycle Assessment (LCA) was used in the evaluation of environmental indices. The system boundary was from the cultivation of coconut to the consumption of biodiesel including the sale of the major by-products. The emission investigated is GHGs from the four stages of biodiesel (coconut methyl ester, CME) production (plantation, copra production, oil production and CME production).

Life cycle GHG emissions expressed in terms of CO_2eq as suggested in the WG guidelines (Sagisaka, 2009) have been used. Evaluation of GHG using LCA seems to be the most appropriate approach in assessing the impact of the production of biofuels to the environment since GHG emissions have been directly attributed to the increased atmospheric concentration of GHGs which may consequently lead to change in climate.

3.1.4. From Khon Kaen, Thailand

3.1.4.1. Environmental Assessment

Life cycle assessment is a well-established, standard technique for quantifying GHG emissions. This is useful for calculating possible reductions in GHG emissions from any project as compared to a baseline. However, the issue related to allocation of emissions to co-products remains open to differences in methodological choices which can sometimes significantly affect the results. Narrowing the options for allocation may be a possible way to make the results comparable. Although GHG emissions have been evaluated in this pilot study following the guidelines produced by the WG (Sagisaka, 2009), it is however an option to also include other aspects (mid-point indicators) that might be of relevance depending on the case study assessed. In the context of this particular pilot study other environmental aspects including abiotic resources depletion (including water), eutrophication, acidification, and land use could also be included for the environmental assessment part.

3.1.4.2. Socio-Economic Assessment

Social development as characterized by HDI in this pilot study is mainly affected by the GDP index or in other words by income. However, since HDI only considers aspects of life expectancy, education and income, some other parameters for assessing social development study such as employment opportunity (for employees at the biorefinery complex) and safety of income (for farmers) are not captured by this indicator. Such aspects are important for assessing social development at a community scale. HDI by incorporating aspects of life expectancy, education and GDP indices is suitable for national scale assessment of social development and ranking purposes. However, as seen in this pilot study, it is more difficult to adapt and provides limited information at local scale to evaluate social development/benefits that may have arisen from a particular project.

For future assessments it is imperative that the aspect associated to the nature and scale of the activities assessed be carefully considered to not distort interpretation of results. Also, social and economic assessment results are to be performed in an integrated way. As observed in this pilot study, the results of social and economic assessments are interlinked since social development is influenced by the involvement of people in activities contributing to economic output and generating income. It is imperative that those aspects be recognized to not bias the sustainability results obtained from the social and economic (socio-economic) assessments of an activity.

3.2. Summary of the Lessons Learned

The lessons learned, which are worthy of noting or common to the four pilot studies for each pillar of sustainability, are summarised in this section.

3.2.1. Environmental Pillar

From the lessons learned from the four pilot studies, the WG supports that LCA is a well-established, standard technique for quantifying GHG emissions, which is one of the important role of utilising biomass energy to improve the environment.

However in the current WG methodology to evaluate GHG emissions from life cycle point of view, emissions from land use change (LUC) are not included. At present there exist very few LUC (example, IPCC) models, which poses a big challenge for countries in East Asia to obtain information/data and calculate losses of carbon stock from (any particular cases of) land clearance. However, a comprehensive comparison of data from literature indicates that GHG emissions from LUC (from land with high carbon stocks), if it occurs, can be a significant deciding factor in determining the sustainability of biomass utilisation. Therefore future considerations for such relevant environmental impacts pertaining to any losses of carbon stock from LUC, is essential to complete the sustainability assessment of biomass cultivation and utilisation.

The WG also recognises that the environmental impact caused by biomass energy utilisation is not only climate change induced by GHG emissions. The other environmental impact categories that should be included are;

- impacts on air, water and soil quality
- water use / efficiency of water use
- biodiversity
- issues associated with LUC
- net energy balance
- abiotic resources depletion
- eutrophication
- acidification

3.2.2. Economic Pillar

The economic indicators in most of the pilot studies showed positive results and it indicates that the biomass utilisation projects studied were economically sustainable. However, in order to analyse economic sustainability better, it may be necessary to understand what those economic results mean.

The three subcomponents of the total value added (TVA) are appropriate economic indicators for the business and community level. Total net profit (TNP) is more of business concern; wages derived from employment is for the labourers; while tax revenue generated is for the local and national government. A high TNP alone will not ensure the sustainability of the production nor the high wage of the employees/labourers and also of the high tax paid to the government. The sustainability of biomass utilisation like in biofuel production is anchored on the attractiveness of the business from all the three economic sub-indicators namely TNP, wages and tax generation. The positive impact of these three sub-indicators must be present.

However, the net foreign exchange earnings is only applicable or appropriate on the national level.

3.2.3. Social Pillar

As mentioned in the preceding section, there were difficulties in getting data for HDI calculation at community level. Moreover, the Indonesian pilot study on Jatropha reported a small increase in HDI. Since HDI is calculated by incorporating aspects of life expectancy, education and GDP indices, it seems more suitable for national scale assessment of social development and ranking purposes. To assess social aspect at community level, some studies suggest including more directly measurable parameters such as;

- employment opportunity (for employees at the biorefinery complex)
- safety of income (for farmers)
- income increase
- better education for the children
- improved health condition
- probably improved relationship in the plant or community among others
- energy diversity
- easier access to modern / clean energy / electricity
- employment
- food security (price of food / feed)
- land allocation and tenure
- policy enforcement
- change in the consumption of fossil fuels / traditional use of biomass

On the other hand, some other parameters that should be seen in national level are;

- energy security
- food security

3.3. Other Issues of Concern

To assess sustainability of biomass utilisation for energy, the data required to evaluate each indicator are to be collected based upon the prepared questionnaires as provided in the WG guidelines (Sagisaka, 2009). Through the lessons learned from the pilot studies, however, the WG recognises the limitations of the current methodology. The other issues of concern are summarised in this section.

3.3.1. Data Availability

It was observed in many cases that data to calculate the indicators are unavailable or difficult to collect; Data needed to calculate life cycle GHG emissions such as fuel consumption per trip, number of trips made per year, electricity consumed for the year among others was not easy to collect; Questions on economics particularly cost and revenue data are difficult to collect, for the plant owners/managers/supervisors are quite hesitant in giving pieces of information that may reveal economics or financial aspects of the operation of the plant; Data to calculate HDI such as literacy rate, life expectancy and GDP indices are not available at the community level. Since there are data that can only be collected from the plant records or the target communities to calculate the indicator for each pillar of sustainability, access to these data should be checked in advance.

3.3.2. Data Reliability

From experience, it is not enough to rely on the data given by the respondents particularly technical data such as fuel consumption, efficiency and others. It is important that these technical data collected from the plant and verified from literature.

In the case of coconut shell as fuel used in copra drying in the Philippines case, the respondents gave a very rough estimate of the amount of fuel used per batch of fresh coconut meat to be dried. When the researchers calculated the amount of coconut shell needed to dry a batch of 3,000 nuts of fresh coconut meat, the amount of coconut shell given by the respondents was very far from the calculated value. It means that the respondents gave a very vague estimate. This will not just affect the cost and return in copra processing but also the GHG emission from the burning of coconut shell.

Reliability of data obtained from the questionnaires depends on the manner the questionnaire is prepared and how the questionnaire would be used. Mere distribution and collection of the questionnaire would most likely result in incomplete and inaccurate information. Most company data from the day to day operation of the plant like fuel consumption, distance travelled of vehicle used in the plant, electricity and fuel consumption among others are most of the times not readily available and the one in charge gives estimates which are doubtful. Inaccurate information such as these will affect the calculation of the indicators.

3.3.3. Appropriateness of the Use of Questionnaire

It is important to formulate a single questionnaire for the respondents that will capture the data needed for the calculation of the economic, social and environmental indices of the project/plant. There must be separate types of questionnaires for the producers and processors of biofuels. The respective questionnaires will then be tailored to fit the target respondents so that specific information can then be collected from them. If possible, the person distributing the questionnaire should be properly trained in explaining the intention of the survey to the respondents. The interviewer can then formulate follow up questions on the spot to capture the right information.

3.4. Upgrading the WG Methodology

As described in this chapter, comprehensive lessons were learned from the pilot studies. Those were carefully discussed by the WG in order to improve and upgrade the methodology for the wider range of its application. Based on the discussion, the methodology application for biomass utilisation project at different (small and large) scales will be addressed in the next chapter.