EXECUTIVE SUMMARY

Activity 1.1 To identify available suitable lands for development of energy forests in North Sumatra province

Utilization of renewable energy is a necessity to overcome the dependence on fossil energy. To support contribution of forestry sector in sustainable energy development, it is necessary to strengthen the enabling conditions, such as raw materials availability through the development of energy forests. In this case, information on trees species to be developed including the land requirements and species suitability are necessity.

The objective of this activity is to identify suitable land for energy forest and provide land suitability maps for the developed tree species i.e. Kaliandra (*Calliandra calothyrsus*), Lamtoro (*Leucaena leucocephala*) and Gamal (*Gliricidia sepium*). This study also collects growth and yield data of tree species to be developed. This information is expected to be utilized as a foundation for formulation appropriate energy plantation forest policies and strategies in North Sumatra.

The activities were conducted from January to March 2018 with the research object covering the entire Forest Management Unit in North Sumatra. Materials and tools for this study include land cover maps, land type maps, topography and annual rainfall and temperature, map of government administration; maps of watershed, plant growing requirements data and computer equipment with Arc GIS software.

Constructing the land and tree species suitability maps, especially on critical land in production forest areas is conducted by matching techniques between plant growth requirements and soil characteristics, rainfall and altitude data. This technique is developed through spatial modeling process in the form of overlay and spatial modeling of land suitability. Then, the map is used for the determination of sample location and analysis of the sampling results in the field.

In accordance the objectives, the energy forest development is expected to produce high productivity biomass, normal growth and economical cycle. The planted species should have properties (a) adaptable to various soil and climatic conditions; (b) fast growing (higher increments) and can compete with Imperata; (c) quickly sprout after pruning; (e) wood has a high heating value and (f) has other economic value.

Among the fast-growing tree species, Kaliandra, Lamtoro and Gamal trees meet the above characteristics. Although not a endemic species, these species are able to adapt to various conditions in Indonesia. However, they are not resistant to poorly drained soils and flooded regularly. As intolerant fast growing species, these trees are not able to growth well in understory with moderate to high intensity. Nevertheless, Gamal is able to grow on acid and unproductive land.

In the Lake Toba highland region, Kaliandra can grow well up to 1400 m altitude from sea level with high rainfall until long dry season up to 6 months. This species can also grow in minimum temperature of 18-22°C, different than Lantoro and Gamal which require warmer condition. Therefore Kaliandra is preferably planted at higher altitudes. The latter two species require a temperature of 25-30^{o}C for optimum growth.

Besides growing fast, these species also have a high heat. Kaliandra have stand volume increment 150 - 180 m^3/ha/year with an average calorific value of 4,700 kcal/kg. Furthermore, the increment of Lamtoro is 20-60 m^3/ha/year and an average calorific value of 4,197 kcal/kg. While, average increment Gamal tree is 32 m^3/ha/year with an average calorific value of 4,168 kcal/kg.

If development of energy forest is prioritized on production forest areas, the available land is 1.421.905 ha or 46.53% of forest area in North Sumatra. Based on the function, these forests consist of 641,769 ha of limited production forest, 704,452 ha of permanent production forest, and 75,684 ha of production forest can be converted. Furthermore, if energy forests will be built on critical land, there will be 1,254,134.46 ha of critical land that can be

developed for biomass production. This land area is 17.27% of the total of 7,262,037 ha of land available in North Sumatra. The critical land area is distribute over two areas of watershed management, which is 943,633.38 ha in BPDASHL Asahan Barumun and the remaining 310,501,08 ha in BPDASHL Wampu Ular. Potential land for planting will be more extensive if it is also considered 1,465,550 ha of potential critical lands and 2,133,820 ha quite critical lands.

Considering Kaliandra, Lamtoro and Gamal are susceptible to shade and the planting area prioritized only to production forest areas, the appropriate plantings area for these species are critical lands or open area in Production Forest Management Units. The critical land or open area in the total KPH Production in North Sumatra reached 853,143 ha.

Regarding the land suitability criteria as follows S1 (very suitable with production estimation > 75%); S2 (quite suitable with production estimation 50 - 75%); S3 (marginally suitable with an estimated production of 25-49%); and N (unsuitable), there are 270,162 ha, 298,600 ha, and 285,803 ha of production forest that very suitable (S1) for Kaliandra, Lamtoro and Gamal plantations. Furthermore, there are 327,038 ha, 270,162 ha, 277,271 ha, which is sufficient (S2) for planting of Kaliandra, Lamtoro and Gamal, respectively. The land classified as S3 (suitable marginal) consists of 255,943 ha for Kaliandra, 312,819 ha for Lamtoro, and 305,710 ha for Gamal plantation. The land suitability of these three tree species is expected to be a guide in energy forest management especially in North Sumatra. Thus the utilization of renewable energy can be implemented optimally.

Keywords: land suitability, land availability, energy forest, critical land, production forest