ABSTRACT

The program “The study of pine for economic plantation and conservation at Wat Chan Royal Project” aimed to study the potential of the site as well as the pine status, i.e. productivity, increment, utilization, and timber consumption, for both indigenous and exotic pines. The study sites are located in Wat Chan Royal Project Development Center (Huai Ngoo substation), Galyani Vadhana district, Chiang Mai province, and pine genetic improvement experimental plots in Chiang Mai. The total study period is 5 years, starting from 2016 to 2020. The results below are of those studied in the 2nd year.

Pine species trials

The study of species /provenance trials was planted seedling on May. After planted 1 month seedling 5 species from 10 provenances were shown that *P. tecunumanii* from Yucul (Nicaragua) perform highest in height (21.93 cm), while *P. merkusii* from Huey Tha, Sisaket showed lowest in height (4.40 cm). *P. merkusii* from Huey Tha, Sisaket did the best in diameter at root collar (5.17 mm) and *P. kesiya* from Doi Suthep showed lowest (1.58 mm). High survival rate were found in all species and provenances.

Pine utilization

P. merkusii and *P. caribaea* gave the highest amount of oleoresin by bark chipping method but *P. merkusii* and *P. oocarpa* and gave the highest amount of oleoresin by borehole method. Comparing resin tapping method, bark chipping method gave the higher resin than borehole method. For stimulant, the proper ingredient was the mixture of sulphuric acid 40% concentration with lubricant and plant growth regulators.

The highest cellulose content were in *P. oocarpa* and *P. tecunumani* but *P. merkusii* was the lowest one. *P. merkusii* has the highest lignin and pentosan amount but *P. oocarpa* has the lowest one. *P. caribaea* and *P. oocarpa* had the highest NaOH solubles but *P. tecunumani* had the lowest NaOH solubles. The highest alcohol-benzene solubility was *P. oocarpa* but *P. tecunumani* had the

lowest one. The highest hot water solubility was *P. tecunumani* but *P. merkusii* has the lowest one. *P. merkusii* had the highest ash content but *P. tecunumani* had the lowest one.

For anatomical features, five pine species had a clear distinct growth ring boundaries. Tracheid and parenchyma were presented through the entire growth ring. Longitudinal parenchyma laid along tracheid alignment. Pit was noticeable in the tangential section. Ray had the multiple rows perpendicular to longitudinal parenchyma and tracheid. Resin canals are visible in cross section view. However, *P. merksii* and *P. kesiya* had thicker cell wall and *P. caribaea* than others. *P. caribeae*, *P. merkusii* and *P. kesiya* had the longest fiber.

For energetic properties, five pine species was no significantly different. *P. oocarpa* had the highest heating value for firewood. Charcoal from *P. merkusii*, *P. caribaea* and *P. oocarpa* was the highest group of heating values. *P. oocarpa* was highest suitability for firewood and charcoal.

Silvicultural practices for exotic pine

Yield and health of natural pine stand

The growth of *P. merkusii* was studied by using tree-ring analysis technique on 17 individual trees. Diameter of the oldest tree was 77.5 cm indicating 324 years old (from 1692 – 2015) while the youngest tree was 84 years old with the diameter of 44.7 cm.

The growth model consists of 3 periods:

1. Age between 74 - 142 years, the mean diameter was 53.43 cm. The average diameter growth increased 0.41 cm per year. The best fit model was linear; DBH = -0.0017 (year) + 0.5309 (R^2=0.181)

2. Age of 143 – 231 years, the mean diameter was 67.93 cm. The average diameter growth increased 0.23 cm per year. There best fit model was exponential; DBH = $0.447e^{(-0.005)(year)}$ (R^2=0.665).

3. Age of 232 – 324 years, the mean diameter is 75.65 cm. The growth can be divided into two periods. During the year 1-142, the average diameter growth

is increased by 0.25 cm per year. However, after 143 years growth rate increased at a gradual rate at 0.09 cm per year. There best fit model was exponential; DBH = 0.276e $^{(-0.004)(year)}$ (R^2=0.496)

The yield of *P. merkusii* calculated from average diameter and height provided the average annual increment volume of 0.032 cubic meter per tree.

According to tree health, the results from 33 inventory sample plots showed that 105 individual (20.71%) of pine were wounded from wood igniter harvesting. Wounds can be classified into two categories: 1) wound and puncture with small but long hole, 2) big wound. The numbers of wounds in one tree can be up to 6. The range of the wound per tree was between 0.03 -0.76 cubic meters. The most damaged tree was wounded about 62.62% of total tree volume. The damage more than 30 % was found in 16 trees. If the proportion of wound volume is equal, consider cutting wound type 2 because it is vulnerable to windsnap. The old and unhealthy pine should be removed out of the area for stimulating the natural regeneration.

Thinning of *P. caribaea*

Experimental site was selected for 12 years old *P. caribaea* with 20 blocks in Intakin Silvicultural Research station at Chiangmai Province. Intensities of thinning was applied for 5 levels, of which each thinning intensity comprised of 3 replicates, except control (no thinning) with has 8 replicates. Growth rate of trees left after thinning will be monitored for the rest of the project period.

Natural regeneration of pine

The trees from 3 sample plots of high density and 3 sample plots of low density were 203 and 56, respectively. High density plots showed an uneven-aged stand (J shape). As a result, reproduction of pine trees for high density area follows natural mechanisms (Sustained yield), whereas the low density plots showed irregular uneven-aged stand characteristics.

The guideline for pine management based on this 1st and 2nd year study was that old-unhealthy pine should be removed out of the area for stimulating natural regeneration. The harvesting system for these unhealthy pine trees will be divided into

2 compartments. In addition, cutting intensity should be based on basal area (10-40% of total basal area). Pine natural regeneration management should be managed to ensure the sustainable succession in the area.