Teak Studies of
RFD-JIRCAS
FY2006 – 2020
&
NAFRI-JIRCAS
FY2016-2020

OKA Hiroyasu
Modified from the presentation prepared by TAKAO Gen
Royal Forest Department (RFD), Thailand, and Japan International Research Center for Agricultural Sciences (JIRCAS), Japan, have jointly promoted research and development in forestry from 2001 until today. Special focus is placed on teak. Outcomes of the project were published as JIRCAS Working Reports.
• To achieve higher-value plantation products through developing technologies of;
  – Stand Treatment, Soil Analyses & Improvement, Efficient Monitoring, Genetics, etc.

• Partners

Royal Forest Dept. (RFD) Thailand
Forestry Research Center (FRC) NAFRI, Lao PDR
Forestry Research Inst. Malaysia (FRIM), Malaysia
Universitas Gadjah Mada (UGM), Indonesia

Teak (Tectona grandis)
Dipterocarp Sp.
RFD-JIRCAS studies were summarized in JIRCAS Working Reports

**No. 74, 2012**

*Approach to Sustainable Forestry of Indigenous Tree Species in Northeast Thailand*

Edited by Iwao Noda, Noppon Voncharangiwa, Woraphun Himmapan

March 2012

Japan International Research Center for Agricultural Sciences, Tsukuba, Ibaraki, Japan

**No. 85, 2017**

*Improvement of Utilization Techniques of Forest Resources to Promote Sustainable Forestry in Thailand*

Edited by Masazumi Kayama and Woraphun Himmapan

March 2017

Japan International Research Center for Agricultural Sciences, Tsukuba, Ibaraki, Japan
Contents of the Working Reports

No. 74, 2012

Growth performance of indigenous tree species under uneven-aged forest management in Northeast Thailand
A modeling approach to sustainable forest management: “Virtual Forest” predicts forest growth and canopy structure
A preliminary result of coppicing trials in teak plantations in Kanchanaburi, Thailand
Two-year results of a clonal test of teak (*Tectona grandis* L.f.) in the Northeast of Thailand
A preliminary result of soil improvement trial on teak in Khon Kaen, Thailand

**Improvement of soil suitability mapping for teak plantations in Northeast Thailand**
Variable density yield model for teak plantations in the Northeast of Thailand
Current situation and solution on management of Nong Bua Lam Phu Private Forest Plantation Cooperative Limited
Current functions and expected roles of Private Forest Plantation Cooperatives in Thailand
Trends of forestry and wood processing industry in Thailand: Analysis using historical forestry statistics from 1997 to 2008
The present circumstances of teak wood processing, marketing and future prospects in Northeast Thailand
Current situation of teak farm forestry after Economic Tree Plantation Promotion Project in Northeast Thailand
Financial analysis of private teak plantation investment in Thailand
Profitability of combined farm management with teak plantations in Northeast Thailand

No. 85, 2017

**Estimation of biomass and carbon stock in young teak plantations in Thailand**
Potential stereoscopic tree height measurement of teak plantations using Pléiades high-resolution satellite imagery
Effects of first thinning on growth and stem form of teak plantations in Thailand
The growth of coppiced teak in Northern Thailand
Preliminary Results of a Second Clonal Test of Teak (*Tectona grandis* L.f.) in Northeastern Thailand

**Growth characteristics of teak seedling planted on different types of sandy soil in Northeast Thailand**
Growth Performance of 6-year-old Teak Plantation under Different Soil Improvement Methods in Khon Kaen Province, Thailand
Effect of perlite for soil improvement and on growth characteristics of teak seedling planted in sandy soil in Northeast Thailand

**Improved Yield Prediction Model for Teak Plantations in Northeastern Thailand**
Effects of coppicing and seedling options on financial evaluation of teak (*Tectona grandis* L.) farm plantation management in Thailand
Case studies on enterprise types of processing and sales of planted teak timbers

Excerpts from the Working Reports

- Management of teak plantations
  1. Improved soil suitability map for teak plantations
  2. Growth characteristics of teak seedlings planted on sandy soils
  3. Second clonal test of teak in Northeast Thailand
  4. The Growth of coppiced teak in Northern Thailand
  5. Improved yield prediction model for teak plantations
  6. Effects of first thinning on growth and stem form of planted teaks
  7. Estimation of biomass and carbon stock in young teak plantations
• Socio-economic aspects of the teak industry
  8 Trends of forestry and wood processing industry in Thailand
  9 Current functions and expected roles of Private Forest Plantation Cooperatives (PFPC)
  10 Current situation and solution on management of Nong Bua Lam Phu PFPC
  11 The present circumstances of teak wood processing, marketing and future prospects
  12 Current situation of teak farm forestry after Economic Tree Plantation Promotion Project
  13 Profitability of combined farm management with teak plantations
  14 Case studies on enterprise types of processing and sales of planted teak timbers

• From fast-growing species to indigenous trees
  15 Growth performance of indigenous tree species under uneven-aged forest management
  16 “Virtual Forest” predicts forest growth and canopy structure
Objectives and methods

- To improve the soil suitability mapping for teak plantation in northeast Thailand (after Sukchan & Sakai, 2009)
- Soil classification based on the Soil Group Map (LDD, 2004)

Key Findings

- The soil suitability classes were revised from three classes to five classes
- In Udon Thani Province for example, the suited soil covers 42.3%, while the not-suited 23.6%
- Correctly classified samples accounted for 69%, which was acceptable
Fig. 2. Revised soil suitability map for teak plantation in Udon Thani Province

Objectives and methods
– To determine the factors that suppress teak growth, which occurs on sandy soil, we planted teak seedlings in sandy soil at two sites
  • One of the sites exhibited suppressed teak growth but the other did not
– We compared growth, photosynthetic rate, leaf water potential, and the concentrations of elements in plant organs between the two sites

Key Findings
– The suppressed site showed low concentrations of nutrients in the soil, especially Ca
– The low growth rates correlated with decreases photosynthetic rate and drought stress in the dry season
– the concentration of Ca in soil was important for teak growth
  • the site with low Ca showed drastic suppression of teak growth and Mg toxicity caused by Ca deficiency
Objectives and methods

- We estimated biomass and carbon stock from allometric relationships between tree size parameters and plant part biomass (leaves, stems, total root biomass) in young teak (*Tectona grandis* L.f.) plantations
  - 177 trees harvested to estimate above- and below-ground biomass

Key Findings

- Tree DBH shows high correlation with biomass
- Similar wood density of the sampled trees might have reduced site-specific differences
- Above-ground and below-ground carbon stock ranged from 1.3 to 67.7 Mg ha⁻¹ and from 0.4 to 13.7 Mg ha⁻¹, respectively.
Mean wood density of stem samples from the plots ranged from 0.49 ± 0.04 to 0.59 ± 0.05 g cm-3 for heartwood and 0.47 ± 0.05 to 0.60 ± 0.08 g cm-3 for sapwood.

Table 2. Coefficient of equations for leaves, branches, stems, and above-ground and below-ground biomass. Corrected coefficient by correction factor (CF). Stem diameter at breast height (DBH), stem diameter at the lowest branch (D₂), and tree height (H).

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Independent variable</th>
<th>n</th>
<th>a</th>
<th>b</th>
<th>R²</th>
<th>CF</th>
<th>Correcting bias using CF</th>
<th>a</th>
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<tbody>
<tr>
<td>Leaf dry biomass (kg)</td>
<td>DBH (cm)</td>
<td>100</td>
<td>0.0199</td>
<td>1.7702</td>
<td>0.50</td>
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<td>DBH²-H (cm²m)</td>
<td>100</td>
<td>0.0201</td>
<td>0.5951</td>
<td>0.44</td>
<td>1.111</td>
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<td>H (m)</td>
<td>100</td>
<td>0.0387</td>
<td>1.5726</td>
<td>0.28</td>
<td>1.146</td>
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<td>Branch dry biomass (kg)</td>
<td>DBH (cm)</td>
<td>100</td>
<td>0.0044</td>
<td>2.8904</td>
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<td>DBH²-H (cm²m)</td>
<td>100</td>
<td>0.0033</td>
<td>1.0067</td>
<td>0.89</td>
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<td>0.0048</td>
<td>2.9488</td>
<td>0.70</td>
<td>1.082</td>
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<td>Stem dry biomass (kg)</td>
<td>DBH (cm)</td>
<td>100</td>
<td>0.0446</td>
<td>2.6074</td>
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<td>1.004</td>
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<td>DBH²-H (cm²m)</td>
<td>100</td>
<td>0.0289</td>
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<td>H (m)</td>
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<td>Above-ground biomass (kg)</td>
<td>DBH (cm)</td>
<td>100</td>
<td>0.0647</td>
<td>2.5715</td>
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<td>DBH²-H (cm²m)</td>
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<td>0.9125</td>
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<td>H (m)</td>
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<td>0.0436</td>
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<td>Below-ground biomass (kg)</td>
<td>DBH (cm)</td>
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<td>0.0453</td>
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<td>D₂ (cm)</td>
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<td>DBH²-H (cm²m)</td>
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<td>0.7553</td>
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<td>2.1754</td>
<td>0.66</td>
<td>1.061</td>
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Measurement of below ground biomass and standing trees
Development of Forestry Technologies of the Indigenous Tree Plantations on the Slopes in Laos

FY 2016-2020

Conducted by Imaya and Simone
Activities and Outputs (Teak plantation)

Survey of soil distribution and their characteristics (2016-2018)

Geographic information

Site index from tree measurement

Soil map

Geographic information + Soil info

To estimate soil suitability (2017-2018)

Soil suitability map for teak plantation (growth based)

Soil suitability map for teak plantation (Integrated with soil conservation) (2019-2020)

Soil erodibility

To clarify the control factor of soil erosion (2019-2020)
A series of soil surveys at 59 forest stands (with 32 teak) along a line of 40 km in length, extending from the lowland in Luangprabang District to the mountain area in Xieng Ngeum District, Luangprabang Province.
Estimation of Site Index

Tree measurement → Plot predominant heights → Site index model

60 teak plots

Measure the height of dominant trees and their ages

Estimate the dominant tree height at a standard age of 15 years

\[ SI_{15} = \exp \left[ \ln(PHeight) - 4.46 \left( \frac{1}{15} - \frac{1}{\text{Age}} \right) \right] \]

Site index

Estimated heights (m) of dominant trees at the age of 15 years

Mean: 17.9 ± 2.45
A draft of soil physicochemical diversity map was made on the basis of 51 soil cross section survey and its physicochemical analysis by using partition tree analysis with topographical data.

A draft of soil suitability map for teak plantation was made on the basis of 60 plots tree census and analysis of relation among site index, topography and soil property.
Key Findings (Laos)

- Relations between soil chemical properties and parent material in Luang Prabang were clarified.
- A draft of soil physicochemical diversity map was made for a part of Luang Prabang Province.
- Relations between site index of teak height growth, topography and soil properties are analyzed by using partition tree method.
- Based on these findings, we made a draft of soil suitability map for teak plantation in a part of Luang Prabang.
➢ Soil suitability map for teak plantations for several provinces in Northeast Thailand.

➢ Estimation of above- and below-ground biomass of teak in Thailand.

➢ A draft of soil suitability map for teak plantation in a part of Luang Prabang, based on tree measurement, physico-chemical analysis of soils and geographical information. (Working Report coming soon)