ISBN : 978-979-9337-50-4

PROJECT COMPLETION REPORT

CFC/ITTO/62-PD40/00 Reev. 4(I)
UTILIZATION OF SMALL DIAMETER LOGS
FROM SUSTAINABLE SOURCE
FOR BIO-COMPOSITE PRODUCTS

Faculty of Forestry
Bogor Agricultural University
Bogor, Indonesia
2012

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PROJECT CFC/ITTO-62-PD 40/00 REV. 4(I): UTILIZATION OF SMALL DIAMETER LOGS FROM SUSTAINABLE SOURCES FOR BIO-COMPOSITE PRODUCTS

Host Government : Republic of Indonesia

Executing Agency : Faculty of Forestry, Bogor Agricultural University (IPB)

Period :

01 December 2007 – 30 November 2010
(with 13 months extension from 01 December 2010 to 15 December 2011)

Faculty of Forestry
Bogor Agricultural University
Bogor, Indonesia
2011

Project Number	:	CFC/ITTO-62-PD 40/00 REV.4 (I)
Starting Date of the Project	:	1 December 2007
Duration of the Project	:	49 months
Project Cost	:	US $ 600,000.00

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Place and Date The Report was issued : Bogor, March 15, 2012

PREFACE

This Completion report of CFC/ITTO/62-PD 40/00 Rev. 4 (I) Utilization of Small Diameter Logs From Sustainable Source for Bio-Composite Products was prepared with reference to the format provided in Annex D of the ITTO manual for Project Monitoring, Review and Evaluation, ITTO, May 1999.

The project was funded by Common Fund for Commodities (CFC) and International Tropical Timber Organization (ITTO) for a forty nine-month project entitled "Utilization of Small Diameter Logs From Sustainable Source for Bio-Composite Products" (of CFC/ITTO/62-PD 40/00 Rev. 4 (I)) starting from December 1, 2007 to 15 December 2011.

The Project was executed by Bogor Agriculrural University (IPB) - Indonesia in collaboration with Forest Products Research Centre Ministry of Forestry (FPRC MoF) – Indonesia, Universiti Putra Malaysia (UPM), Forest Product Research and Development Institute (FPRDI) – Philippines, Forest Research Institute (FRI) – Papua New Guinea. This CFC/ITTO Project has two national partners, namely PT. Sumalindo Lestari Jaya and PT. Bumi Sari Kusuma.

The overall achievement of this forty-month project was very significant and remarkable to the bio-composite industries. This was indicated by the number of companies which actively involved to support the execution of the projects. The remarkable contribution comes from PT. Sumalindo Lestari Jaya, PT. Sari Bumi Kusuma, PT. Andatu Plywood Industry, PT. Sumber Graha Sejahtera, PT. Majora inkas, PT. Paparti Pertama, PT. Masari Dwisepakat Fiber, PT. Kutai Timber Indonesia, PT. Erna Djuliawati, and PT. Wijaya Tri Utama.

On behalf of the Project Executing Agency, I would like to acknowledge all the assistance and guidance received from CFC and ITTO. Without its financial support, this project would have not been implemented and successfully completed. Special thanks go to Mr. Ramon Carrillo (Forest Industry Project Manager, ITTO) and Ms. Yukiko Tomihisa (CFC Project Assistant Manager) for their excellent assistance and support during the implementation of the project. Appreciation and thanks too, to the project collaborating agencies: FPRC MoF – Indonesia, UPM – Malaysia, FPRDI – Philippines, and FRI – Papua New Guinea. To the companies supported the project and the members of the Project Steering , we would like to express our sincere thanks and appreciation for their support,

guidance and invaluable inputs and constructive criticism. Colleagues in IPB and FORDA are gratefully acknowledged for their comments, inputs, and support during the execution of the project activities.

With strong good will from all parties, we do hope that this effort will generate substantial and remarkable benefits for utilization of Small Diameter Logs from Sustainable Source for Bio-Composite Products in Indonesia and all over the world.

Bogor, March 2012
Project Coordinator,

Prof. Yusuf Sudo Hadi

EXECUTIVE SUMMARY

The project has collected and made available comprehensive information on small diameter logs (SDL) and their potential utilization in value added products for the bio-composite products. The small diameter logs could be produced from plantation and natural forests. The specific objectives of this project are the following:

a. To asses market needs of biocomposite products made from SDL from the tropical rain forest.
b. Determine the wood properties and utilization technology of SDL and transfer this technology for manufacturing of value added bio-composite products.

The research was focused on the present and future markets of bio-composite products, the physical and mechanical properties of SDL as raw material of biocomposite products, and fundamental properties of bio-composite products such as Plywood, Laminated Veneer Lumber (LVL), Glued Laminated Timber or Lumber (Glulam), Particleboard and Medium Density Fiberboard (MDF). Outcome of the research were implemented to the mills for optimal products and they could be sold in the global market with fulfilled the standard requirements.

The review market data and examine trends to understand what bio-Composite products are sold today and where are they sold, were the first focused of this study. The market and trend review provide an analysis of production, export, import, consumption, trade and prices for each wood-composite products: plywood, veneer sheets, particleboard and fiberboard; in World, ITTO countries, Indonesia, Malaysia, and Papua New Guinea.

Veneer sheet production during the period of 2002-2006 by ITTO country member was more than 15 million m^3 and produced by Malaysia, Brazil, Indonesia, Ghana, India, the Philippines, and Côte d'Ivoire. Major tropical veneer sheet importers were The Republic of Korea, Taiwan, French, China and Italy. For plywood production in the same period was more than 84 million m^3 produced by Indonesia, Malaysia, Brazil and India. Major tropical plywood importers were Japan, United States of America, The Republic of Korea, Taiwan,

China, and, a few Western European countries. Particleboard production was about 19 million m^3 and produced by Brazil, Thailand, Malaysia, and Indonesia. For fiberboard production in the same period was about 24 million m^3 produced by Brazil, Malaysia, Thailand, Indonesia, Venezuela and India.

Based on current world's demand and its trend, shares of Indonesia's bio composite product imports of total bio composite product imports in each major country destination as reported by importer countries and considering the principal policies and market forces that are likely to affect the global and regional markets, both plywood and medium density fibreboard made from small diameter log would be plausible to be developed for international market (i.e. Japan, China, the Republic of Korea, Taiwan, Saudi Arabia, and United Arab Emirates) as well as for domestic market. Meanwhile, veneer sheets and particleboard made from small diameter log would be plausible to be developed for domestic market.

The second focused of this study was to identify suitable wood species and evaluate physical and mechanical properties of small diameter logs. Research on small diameter logs of 24 species from natural forest and 14 species from plantation or community forest in Indonesia was carried out for physical, mechanical, and chemical properties regarding to biocomposite products feasibility. The results showed that low and medium densities wood were feasible for bicomposite products, and regarding to the result of market analysis, the prospectus products are plywood, laminated veneer lumaber (LVL), particleboard, medium density fiberboard (MDF), and glued laminated lumber (Glulam).

UPM Malaysia considered 9 groups of SDL have the potential as alternative raw materials for the production of bio-composite products, especially for plywood, laminated veneer lumber, oriented strand board (OSB), cement board and medium density fibreboard manufacturing. FPRDI Philippine did research on *Eucalyptus citriodora, Eucalyptus europhylla* and *Alstonia macrophylla* G. Don in terms of basic properties, and these wood species were investigated for cement board feasibility. PNG Forest Research Institute and Bogor Agricultural University did research on basic properties of 6 wood species of PNG, and several SDL species are feasible for bio-composite products (plywood, LVL, glulam, particleboard and MDF), however some of them only

feasible for particleboard and MDF.

In order to produce the high quality product, several milling issues and quality control concerns for raw material were identified. Some milling issues regarding to utilize SDL for LVL and plywood are determining on wood fundamental properties, spindle less rotary machine for veneer production, low quality of produced veneer, hot press veneer drying, pay attention to veneer repair and compose, gluing technique, and pressing process. The main problem to be addressed in Glulam production using SDL is in board production, drying lumber (lamella), and gluing process. In particleboard manufacturing reported that there is no technical problem in producing high quality particleboard and MDF using SDL, however low density SDL is avoided due to the economical point of view.

Regarding to the change of logs supply in Indonesia from natural forest to plantation or community forest, monitoring system for quality and quantity of incoming raw material is very important in terms of wood species, grade, moisture content, dimensions, volume, and visual appearance of SDL for checked and documented. The important issues related to the utilization of SDL as raw materials for Bio-composite products (glulam, LVL, plywood, particleboard and MDF) are wood density, spiral and interlocked grain, knots, juvenile wood, decay, and extractive content. The SDL incoming raw material should be processed as soon as possible due to the low natural durability.

The following research was done for fundamental properties of biocomposite products manufactured from SDL. Evaluation of appropriate properties of plywood from SDL can be mentioned that the surface quality of Urea Formaldehyde bonded and Melamine Formaldehyde bonded plywoods was classified as grade 1, and all of the plywood shear strength parallel and perpendicular to the face or back veneer grain in dry and wet condition fulfilled the JAS Standard for plywood No. 232 year 2003. The average rotary veneer yield of SDL from community and plantation forest using spindle-less rotary lathe was 62 % with standard deviation of 9.9%.

Evaluation of appropriate properties of Laminated Veneer Lumber (LVL) from SDL, the moderate specific gravity wood possessed had better characteristics as compared to those of LVL from other specific gravity group, and fulfilled the

standard of JAS SE-11 2003 and SNI 01-6240-2000 of LVL for structural uses. On the basis of these phenomena, it could be suggested that LVL from SDL of moderate specific gravity woods were suitable to be used for structural uses such as for supporting poles, frame in house, roof timbering, floor joint, and other structural uses.

Evaluation of appropriate properties of Glued Laminated Lumber (Glulam) from SDL the some Glulams were classified to the group E10-E11 based on modulus of elasticity properties, but based on the value of modulus of rupture Glulam was classified or grouped as E10-E17, and some the other had lower grade depending on wood species used. As an example Glulam made from mixed species from jabon-mangium and mangium-manii were not eligible for construction (E<E10), but Glulam made from mangium, jabon and mixed pine-mangium met the JAS (2003) can be used for wood construction and quality pertained E10 or more. The recovery of glulam manufacture from SDL plantation timber ranged from 31-53% with an average of 38%.

Evaluation of appropriate properties of particleboard from SDL could be mentioned that wood species used in the experiment could be utilized for particleboard and these species did not much affect particleboard properties, single species and mixture of species were not different regarding to physical and mechanical particleboard properties. Low density particleboard was still lower in terms of performance related to physical and mechanical properties, but medium and high density particleboards exhibited satisfied performance for physical and mechanical properties. Regarding to termite test the results showed that higher wood density had higher resistant to termite attack, and the resistance was related to its constituent wood or in other words more resistant wood species produced more resistant particleboard to termite attack.

Evaluation of appropriate properties of medium density fiberboard (MDF) from SDL could be mentioned that physical properties of MDF made from rubber wood, mangium, and mixture of both species were excellent and was matched to JIS Standard 5905-2003. The MDF modulus of rupture was lower than the JIS Standard 5905-2003 requirements, however the modulus of elasticity (MOE) value fulfilled JIS standard, and the species used had significant effect on MOE of

the resulting MDF, where the mixture of rubber wood and mangium wood resulted in a highest MOE values.

The next activities were to determine equipment needs for production and manufacturing constraints, including review equipment availability, and identify source and costs for equipment. Regarding to equipment availability, all the mills have satisfied equipment required and can produce biocomposite products for export marker to varied countries destinations. In conventional plywood mill the raw material uses logs with diameter more than 40 cm, but nowadays and further future the logs supply will be dominated by SDL, in this case the mill has to provide some equipments namely spindle-less rotary lathe and hot press dryer, and also more activity in veneer repairing and veneer composing. But for the other products (not based on veneer products) the available equipment in the mills are still satisfied.

Information of source and costs for equipments of hot press dryer for veneer and spindle-less rotary lathe are mainly produced by China because the price is much cheaper compare to the equipments produced by Taiwan, Japan, Germany, Italy and other countries. As an example, hot press dryer BJG48-40-12 made in China costs USD 46,875, spindle-less rotary lathe 9' 9HL-W-3-350 consists of input conveyor costs USD 4,162, spndle-less lathe costs USD 49,210, output conveyor USD 4,995, and spindle-less rotary lathe 9' made in Taiwan costs USD 90,000. Other spindle-less rotary lathe 5' 5HL-W-3-350 made in China costs USD 22,800, and spindle-less rotary lathe 5' made in Taiwan costs USD 60,000.

Regarding to implementation of SDL for biocomposite products, work with mills to identify issues when incorporating SDL into the production process was done. Implementation of SDL for plywood mills has to pay attention that the portion of high quality plywood resulted from SDL is very low as compared to that of large diameter log (LDL), however laminated veneer lumber, glulam, medium deinsity fiberboard and particleboard industries did not report any inferior products. Some critical issues in SDL implementation compared to LDL at plywood mill are log pond needs more space for logs storage, debarking and log cutting have more activity, SDL cannot be round up in the conventional rotary lathe because the minimum diameter to be processed in conventional rotary lathe

is 40 cm, and plywood produced from SDL is relatively lighter compared to those made from LDL, veneer resulted from SDL cannot be dried using conventional dryer because it tends to be wavy and the portion of narrow veneer was very high and the veneer resulted from SDL should use hot press dryer, veneer storage could be a problem because dried veneer easily attacked by mold due to the minimum extractive content, veneer resulted from SDL need repairing process with much more time and skilled human resources as compared to those of LDL veneer, the capacity of veneer jointer decreased sharply when incorporating SDL into the production process because the portion of narrow veneer was very high as compared to those of LDL.

The next process is assembling veneers to be plywood, and some attention should be intensively done at veneer arrangement or veneer composing which needs more time because so many jointing in one sheet veneer; moreover arrangement of face and back veneer should be conducted more carefully, glue spreading needs more time when incorporating SDL into the production process as compared to those of LDL because glue spreading process need two times process for avoiding veneer being overlapped and detached and for avoiding core gap, prepress should be arrange very carefully to adjust glue penetration and veneer overlap, materials requirement on the plywood industry increased sharply especially glue tread, hot melt, gummed tape, cutter and knife because the total number of jointer increased by about 300 %, other aspect is also important i.e. skill of human resources should be improved to facilitate production of high quality plywood made from SDL.

The other work was done to identify potential trade barriers trough standards for selected products and markets, to ensure compliance and to verify that appropriate test were conducted. Several standards known for bio-composite products such as plywood, LVL, glulam, particleboard and MDF. Among the international standard being used by Indonesian bio-composite industries are Japan Standard (JPIC/JAS), British Standard (BS), United States Standard (IHPA), German Standard (DIN). However, Japan Standard is the most popular used in Indonesian Bio-composite industries. Field research to the various bio-composite (plywood, LVL, glulam, particleboard and MDF) industries in

Indonesia shown that most of the bio-composite products quality which was produced from small diameter logs fulfills the international standards.

To ensure quality assurance, establish quality control procedures were conducted ensuring that products are meet with certain standard. Quality control involves the examination of a product or process for certain minimum levels of quality. The goal of a quality control is to identify products that do not meet a company's specified standards of quality. If a problem is identified, the job of a quality control team or professional may involve stopping production temporarily. Depending on the particular product, as well as the type of problem identified, production or implementation may not easy entirely.

The quality characterize of the products depends on the panel being produced. Since the plywood is produced by assembled from layers of veneer, the moisture content and shear strength is the critical quality that shoud be meet with a certain minimum levels. The surface quality of plywood, such as knot, roughness, decay, discolouration, etc. are the additional quality characterize of plywood which will drive the market penetration. In case of glulam and LVL, the bending strength and shear strength are the essential quality that should be fulfilled. The density, internal bond strength, and bending strength are the performance of particleboard and MDF that should be meet with the certain standard.

Concerning coordination with international standard bodies, Indonesian USDL team have actively involved to contribute for ISO standards improvement through the Ministry of Forestry Republic of Indonesia based on the USDL research results, experiences and their expertise in bio-composite products.

To complete the project, regional workshop has been organized and convened in Bogor Indonesia in December 2010 to facilitate the transfer of technology on SDL management and utilization for biocomposite products to regional academicians, the timber industry sectors, and related government officers. Scientists, students, researchers, related industries representatives, birocrate or decision makers, experts, related association or society, and Non-Governmental Groups from Indonesia, and some representatives from Malaysia, Philippines, and Papua New Guinea have been involved the actively. We discused

all topics concerning current and future markets of bicomposite products, basic properties of some wood species from Indonesia, Malaysia, Philippine, and Papua New Guinea and the possibility for biocomposite products, biocomposite products properties from SDL utilization, and the issues to implement SDL to the mills production.

We realize that SDL especially from plantation forest will be the future logs supply, and it is possible to utilize for biocomposte products such as plywood, laminated veneer lumber, glued laminated lumber (glulam), particleboard, medium density fiberboard, and also cement board. All the boards can meet the standard requirements by regulating the factors in processing variables. Furthermore facing to global market orientation, logs from sustainable forest management is required and the products should have a document explaining timber legality assurance.