ACIAR FST/2009/062 Development of advanced veneer and other products from coconut wood to enhance livelihoods in South Pacific communities

DAF Report – Cocoveneer product development

Report 1

August 2015

Queensland Government

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Summary

Identifying suitable products and markets for cocoveneer and cocoveneer based products will be critical for the successful development of a profitable cocoveneer industry in the South Pacific region. To assist with the identification of some potential products and to increase the understanding on how cocoveneer may appear and perform, a range of product samples using either entirely cocoveneer or cocoveneer blended with other materials have been manufactured. The products were manufactured and/ or finished using various methods to enable evaluation and comparison. While the product manufacturing trial focused predominantly on existing and common veneer-based wood products, there are many other products and markets that could potentially utilise the unique properties of cocoveneer. Given the range of qualities that are produced during veneer processing (e.g. colour, density) it may be necessary to target several end-products in order to efficiently utilise the veneers produced during peeling.

Table of contents

Table of images

1 Introduction

Identifying suitable products and markets for cocoveneer and cocoveneer based products will be critical for the successful development of a profitable cocoveneer industry in the South Pacific region. While established markets exist for solid wood products manufactured from predominately sawn coconut stems, little product and/or market knowledge is known relating to cocoveneer. To assist with the identification of some potential products and to increase the understanding on how cocoveneer may appear and perform in a range of potential products, the Queensland Department of Agriculture and Fisheries (DAF) have undertaken a preliminary product development trial. The trial was part of the Australian Centre for International Agricultural Research (ACIAR) project, *FST/2009/062 Development of advanced veneer and other products from coconut wood to enhance livelihoods in South Pacific communities*.

The trial intended to produce a range of product samples using either entirely cocoveneer or cocoveneer blended with other materials. The products were manufactured and/ or finished using various methods to enable evaluation and comparison. Assessments of the various sample products will help the decision making processes for follow-on product development activities within the FST/2009/062 project.

2 Material and methods

2.1 Veneer

Veneer used for the sample product manufacture was produced during the Veneer Processing Trial 3, conducted in August 2014 at the Fiji Ministry of Fisheries and Forests, Timber Utilisation and Research Division Facility (TUD) in Nasinu, Fiji. The processing trial included twenty-three coconut logs sourced from Pacific Green Industries Ltd. Logs were docked to 1300 mm lengths, pre-conditioned using saturated steam and rotary peeled using a modified spindleless veneer lathe. Resulting veneer was dried to approximately 10% moisture content before being transported to DAF's Salisbury Research Facility for detailed quality assessments. More detailed description of the processing trial and grade quality assessments is described by McGavin (2015).

Using the sheet density measurements recorded during the veneer quality assessments, the available veneer were segregated into four broad density groups:

- Low density (<400kg/m^3)
- Medium density (400-600kg/m^3)
- Medium-high density (600-800kg/m^3)
- High density (>800kg/m^3).

These groups were then used to guide veneer selection in line with product specific construction strategies. In addition, the selection of veneers with minimal defects such as splits, compression *etc.* were targeted.

2.2 Products

Cocoveneer has the potential to be used in the manufacture of structural products, appearance products or products that demand both structural and appearance qualities. Specific products will demand certain veneer qualities in line with non-technical expectations (e.g. colour preference) and/or technical requirements (e.g. mechanical properties). Veneer characteristic examples include density, modulus of elasticity (MoE), modulus of rupture (MoR), hardness, surface roughness, wearing capabilities and colour.

A range of product types and construction strategies were selected to provide a variety of potential products and manufacturing strategies. It is acknowledged that the opportunities for cocoveneer based products is much larger than just those included in this trial.

In addition, more optimal veneer grade selection and construction strategies may be necessary to better meet the potential market expectations and requirements.

2.2.1 Plywood

Plywood is a major traditional use of rotary-peeled veneer and is comprised of layers of veneer known as plies, glued together with the grain of adjacent plies alternating by 90°.

Opportunities exist to adopt construction strategies that use entirely cocoveneer or use cocoveneer blended with other veneers from more traditional forest resources. The selection of veneer qualities within a plywood construction strategy depends on final product performance requirements.

To maximise the use of the limited veneer available, plywood samples were manufactured using a softwood core with cocoveneer faces.

Two different panel construction strategies were adopted during manufacture:

1. High density front face and medium density back face
2. Medium-high density front face and low density back face.

A simple 5-ply construction was implemented using three 3 mm softwood core veneers and two 3.0 mm face cocoveneers.

2.2.2 Laminated veneer lumber (LVL)

Laminated veneer lumber is a solid wood substitute manufactured from rotary-peeled veneers adhered in parallel layers to form a beam. This product has made in-roads to many markets as a substitute for sawn timber or steel, especially in load carrying beam applications such as:

- lintels and headers over windows, doors, verandahs and other openings in construction
- sub-floor framing as joists and bearers
- internal framing
- furniture
- bridge components

Two different product construction strategies were used during manufacture to produce samples measuring 100 mm x 60 mm:

1. Medium density veneers
2. Alternating medium-high density and medium density veneers.

2.2.3 Overlay panel

For many non-structural applications, it has been common practise to use reconstituted wood-based panel products such as medium density fibre boards or

particle board combined with a surface layer(s) of veneer. This construction strategy can maximise the veneer utilisation and value, while reducing the final product costs.

One panel construction strategy was used during manufacture with two different surface veneer treatments. The face veneer was grooved at 75 mm intervals to provide a traditional VJ style wall panelling appearance. The back veneer was not grooved. Medium density cocoveneers overlaid on 12 mm MDF were used for the manufacture of the overlay panels.

2.2.4 Engineered flooring

While traditional timber flooring was manufactured from solid sawn timber often machined with a tongue and groove profile, internationally the acceptance is rapidly growing for engineered flooring as a substitute. The engineered flooring has many benefits over traditional solid flooring systems.

A coconut engineered flooring system was developed during the recent *FST/2004/054 Improving value and marketability of coconut wood* project (Bailleres *et al.* 2010). This system used thin sawn coconut (or cocowood) overlaid over a veneer-based wood substrate (plywood).

Using a veneer based surface opposed to a thin sawn laminate has several key advantages. This includes a higher recovery of surface area from the coconut log, reduced variation in quality (especially colour and hardness) and reduced feedstock preparations.

Image 1. Engineered flooring combining sawn coconut and plywood.

One panel construction strategy was used during manufacture with two different flooring profiles (85 mm and 130 mm cover widths). A medium-high density cocoveneer face was overlaid over a softwood veneer-based wood substrate (plywood). A simple 5-ply substrate construction was adopted using 3 mm softwood core veneers and a 3 mm face cocoveneer provided a 18 mm finished product thickness.

2.2.5 Multilaminar wood (MLW)

MLW is a material made of superimposed layers of veneer first spread with adhesive and then pressed so as to form a block from which sliced veneers or sawn pieces are obtained, mainly for decorative purposes. The construction strategy is usually similar to that of LVL. Various effects, colours, forms and patterns can be achieved by mixing qualities, bleaching or dyeing veneers, using different glue types with varying colours, block moulding and also slicing or sawing the blocks at different angles.

Four different product construction strategies were used during manufacture to produce blocks measuring 60 mm in thickness:

1. Low density veneers
2. Medium density veneers
3. Medium-high density veneers
4. Alternating medium-high density and medium density veneers.

From the manufactured blocks, a number of sections were sawn using three different processing approaches. The various processing approaches aimed to provide a range of differing appearances.

In addition to square edge sawn pieces (sawn timber substitute), samples of the MLW were used to further manufacture turned articles including a table leg and a specialty handle.

2.2.6 Surface finishes

All sample products were coated with an estapol style finish. Some products were coated with a coloured estapol stain before a finish coat(s) of clear estapol. The use of stains aimed to enhance the visual appeal of the more ‘pale’ coloured cocoveneer.

Stains included in the trial focused on the following colour groups:

- Light brown
- Dark brown
- Golden
- Red.

3 Results

A range of veneer-based cocoveneer sample products were manufactured. Some general observations are listed:

Positive observations:

- High density dark coloured veneers have the most striking visual appearance due to the marked difference in colour between the vascular bundles and surrounding parenchyma tissue.
- Lower density veneers have a more appealing visual appearance compared to sawn coconut of the same density. Unlike more traditional forest resources where rotary peeling can reduce the visual appeal, rotary peeling coconut enhances the visual characteristics especially in the lower density ranges.
- Pale coloured cocoveneers can have the colour enhanced with conventional staining systems.
- The multilaminar product provides opportunity for the further processing of a wide range of products of varying dimension and grain pattern. This product also provides great opportunity to utilise a range of qualities, depending on the end use.

Negative observations:

- Loose peeled veneers and rough veneer surfaces can provide a rough surface which may not be suitable for many appearance products. Improvements in the veneer quality is expected with improved processing protocols (McGavin 2015).
- The end-grain of the cocoveneer was prone to splintering during product sawing (e.g. dimensioning sample products). This was more pronounced in lower density veneers and thicker veneers. Improved sawing protocols may reduce the problem.
- Many surface coatings were necessary to provide a quality surface finish. Improvements in the veneer quality (e.g. looseness, roughness) may reduce the need for excessive layers of coatings. Pre-coating with a sealing system may also assist.

3.1 Plywood

The manufactured plywood panels provide an example of cocoveneer with a range of densities and colours (Images 2 and 3). Note that colour can be a poor indicator of density. In general, the higher density veneers provided a smoother surface with fewer splits. Opportunities may exist to use cocoveneer based plywood in decorative

applications or structural application, depending on structural performance requirements.

Image 2. Example of high density (top left), medium-high density (top right), medium density (bottom left) and low density (bottom right) cocoveneer face veneer in a plywood construction.

Image 3. Cocoveneer blended with other forest resources in a plywood construction.

3.2 Laminated veneer lumber (LVL)

Laminated veneer lumber manufactured from cocoveneer could prove to be a useful substitute for conventional sawn timber (Image 4). Opportunities exist to developed construction strategies that utilise the range of available qualities without compromising required final product properties. Opportunities may exist to use cocoveneer based LVL in decorative applications or structural application, depending on structural performance requirements.

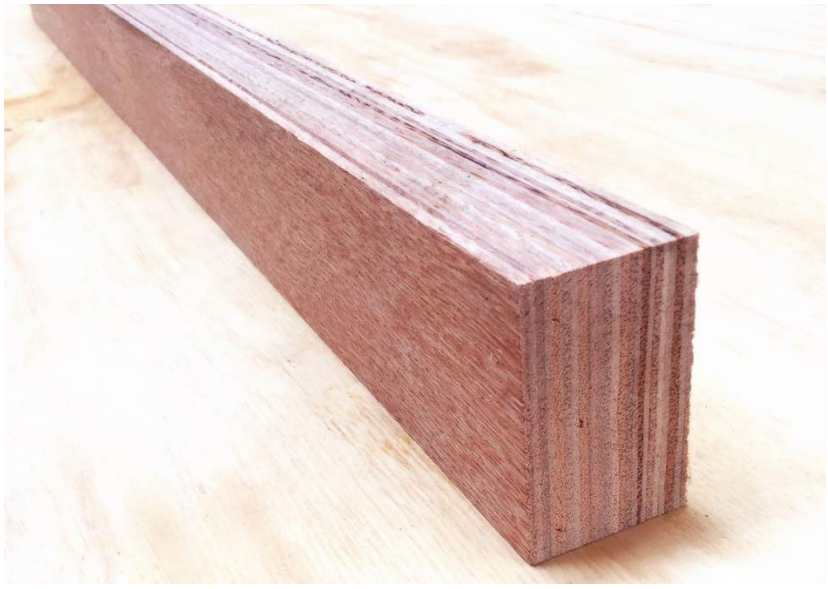

Image 4. Laminated veneer lumber manufactured from cocoveneer.

3.3 Overlay panel

Overlay panels could provide a good product range to maximise the utilisation of cocoveneer by combining an overlay of veneer(s) with a relatively low-cost substrate material such MDF or particle board (Image 5). Options exist to manufacture flat overlay panels (Image 6) or manipulate the surface quality to suit particular markets such as VJ wall panelling (Image 7) or colour staining (Image 8).

Image 5. Veneer overlay panel using medium density cocoveneer on MDF.

Image 6. Flat overlay panel using medium density cocoveneer on MDF.

Image 7. VJ style wall panelling using medium density cocoveneer on MDF

Image 8. VJ style wall panelling using medium density cocoveneer on MDF. Surface finishes included red (left), golden, clear (middle), dark brown and light brown (right) stains.

3.4 Engineered flooring

It is not common to use rotary veneer as the exposed surface for engineered flooring systems due to the market demand for a solid wood look, which is often lost in a rotary veneer. However, coconut stems can produce a more appealing appearance in rotary veneer form than sawn timber. This is especially true for the lower density material (<700kg/m^3). Images 9 to 11 illustrate examples of engineered flooring using cocoveneer for the exposed face in two cover widths, a variety of surface finishes and a construction strategy that blends cocoveneer with other forest resources.

Image 9. Engineered flooring combining cocoveneer blended with other forest resources.

Image 10. Engineered flooring combining medium-high density cocoveneer and plywood. 130 mm cover width profile with clear finish.

Image 11. Engineered flooring combining medium-high density cocoveneer and plywood. 85 mm cover width profile with dark brown stain finish.

3.5 Sawn multilaminar wood

Multilaminar wood provides an opportunity to use a wide range of veneer qualities to produce a range of products that can have high aesthetic appeal. Using the large manufactured block as a base (Image 12), sawn sections of various sizes can be produced and depending on the processing approach, a range of appearances can be achieved. This includes more classical appearances when sawn longitudinally (Images 13 and 14) or quite unique appearance when sawn across the grain to expose the ends of the vascular bundles (Images 15 and 16). A wide range of opportunities exist to manipulate the veneers and the manufacturing protocols in the manufacture of these products to change patterns, colours etc. which can influence the visual qualities of the end product. Sawn sections of multilaminar wood are well suited to furniture and joinery applications.

Image 12. Cocoveneer multlaminar block.

Image 13. Multilaminar wood section sawn longitudinally at 90 degrees to the veneer direction.

Image 14. Multilaminar wood section sawn longitudinally at 20 degrees to the veneer direction.

Image 15. Multilaminar wood section sawn across the grain at 90 degrees to the veneer direction.

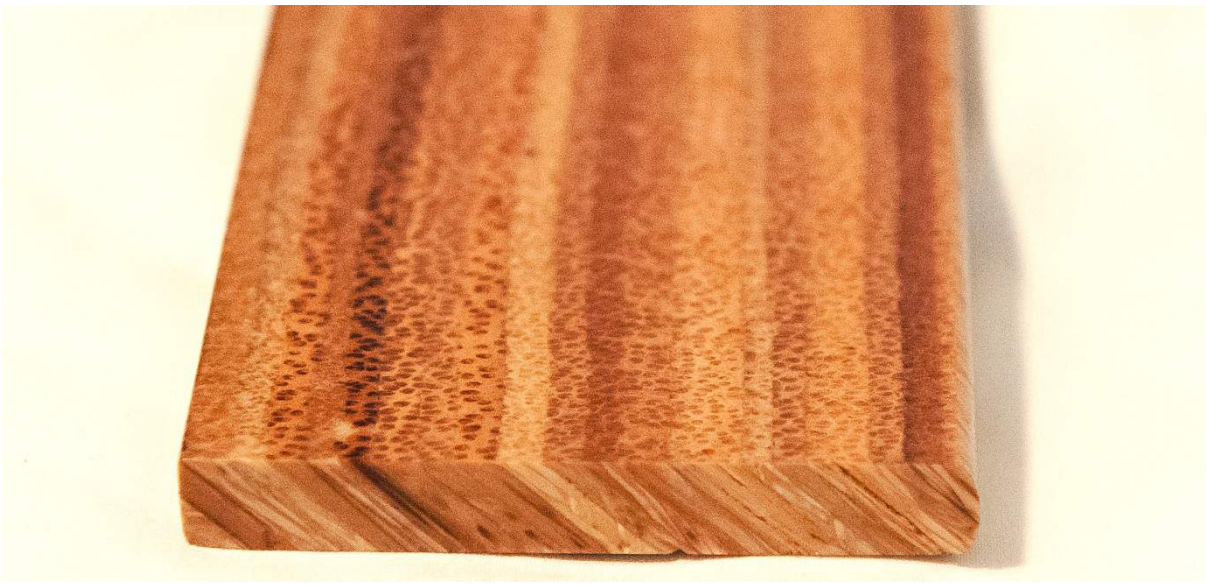

Image 16. Multilaminar wood section sawn across the grain at 45 degrees to the veneer direction.

3.6 Turned multilaminar wood

In addition to sawn sections produces from multilaminar wood (section 3.5), opportunities exist to produce turned articles (Images 17 and 18). A wide range of opportunities exist to manipulate the veneers and the manufacturing protocols in the manufacture of these products to change patterns, colours etc. which can influence the visual qualities of the end product.

Image 17. Table leg made from cocoveneer multliaminar wood. Surface finishes include golden (left), clear (middle) and dark brown (right) stains.

Image 18. Specialty handle made from cocoveneer multlaminar wood. Surface finishes include golden (left), clear (middle) and dark brown (right) stains.

4 Discussion

A range of potential products exist that could use cocoveneer blended with other more traditional forest resources or use cocoveneer as a direct substitute. The trial has demonstrated the manufacture and provided demonstration product of some of these products.

While the product manufacturing trial has focused predominantly on existing and common veneer-based wood products, there are many other products and markets that could potentially utilise the unique properties of cocoveneer. Given the range of qualities that are produced during veneer processing (e.g. colour, density) it may be necessary to target several end-products in order to efficiently utilise the veneers produced during peeling.

Future evaluations of possible products and markets should consider:

- The veneer qualities (and range of qualities) and grade recoveries being produced from veneer processing trials undertaken through the *FST/2009/062 Development of advanced veneer and other products from coconut wood to enhance livelihoods in South Pacific communities* project (e.g. McGavin 2015).
- The visual appearance of product samples manufactured during this trial.
- The knowledge gained during this trial.
- Veneer and product performance testing scheduled to be undertaken through the *FST/2009/062* project. While some veneer grade quality data exists (e.g. McGavin 2015), limited product performance data exists (e.g. hardness, wearing characteristics, MoE, MoR, shear, bond characteristics).
- General market and wood product knowledge and information.
- Collaboration with innovative members of the forest product industry (e.g. wood processors, engineered wood product manufacturers), designers, architects and engineers.

5 Acknowledgements

The *Development of advanced veneer and other products from coconut wood to enhance livelihoods in South Pacific communities* (FST/2009/062) project was supported by the Australian Centre for International Agricultural Research (ACIAR). The project was undertaken in collaboration with ACIAR, the Queensland Government Department of Agriculture and Fisheries (DAF), the University of Tasmania (UTAS), the Secretariat of the Pacific Community (SPC), the Fiji Ministry of Fisheries and Forests, Samoa Ministry of Natural Resources and Environment, and Solomon Island Ministry of Forestry.

The author acknowledges the contributions to the project made by ACIAR, DAF, UTAS, the Fiji Ministry of Fisheries and Forests and SPC.

The individual contributions of DAF researchers including Dr Henri Bailleres and Rica Minnet are acknowledged.

The support provided by DAF through the provision of the unique facilitates located at the Salisbury Research Facility is acknowledged as critical to facilitate product manufacturing studies of this nature.

The *FST/2009/062* project team are acknowledged for their contributions towards the supply of cocoveneer.

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