

## Objective 2

# Guidelines for Harvesting Coconut Palms in South Pacific Island Countries

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## Coconut Veneer project

*Development of advanced veneer and other product from coconut wood to*



Australian Government  
Australian Centre for  
International Agricultural Research



UNIVERSITY of  
TASMANIA



SPC  
Secretariat  
of the Pacific  
Community

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## 1.0 SCOPE

Many palms in coconut plantations in the South Pacific Islands are old and have lost much of their vitality and productivity. Known as senile coconuts, these palms provide only low nut yields. For example, a 25-year-old coconut may produce up to 35 nuts a year while a 60-year-old senile coconut may only provide 4 nuts. In reality, senile coconut plantations are ready for replacement, or conversion to alternative land use.

Any policies developed to provide specific guidelines for the harvesting of senile palms should take into account the controls required to:

- Harvest and replace senile coconut palms to maintain a sustainable coconut resource base for forecasted future demand.
- Implement safe harvesting practices.
- Address environmental considerations.

A rotary peeled coconut veneer product industry is being investigated as an option for the use of logs that will be extracted when senile palms are harvested. If this option proves attractive, strategic operations will need to be considered to address an increasing demand for peeler-logs. Guidelines for harvest log selections, felling, log handling and site rehabilitation are identified and proposed in this document.

### 1.1 Aims and objectives

These guidelines apply to coconut palm harvesting operations in the Republic of Fiji, Samoa and the Solomon Islands. Their aims and objectives are to:

- Recommend practices that accompany the established native forestry and logging Codes of Practice in these countries.
- Establish sustainable harvesting practices that address the harvesting and replacement of the existing areas of senile coconut palms.
- Establish sustainable harvesting practices which will assist in maintaining the existing plantation areas, in order to meet an assumed future level of demand for coconut products.
- Prescribe desirable safe working practices aimed at protecting the natural environment, its assets and users.
- Allow the execution of economically viable operations within acceptable safety standards.

## **About these Guidelines**

These guidelines are part of the ACIAR-funded CocoVeneer project *FST/2009/062: Development of advanced veneer and other product from coconut wood to enhance livelihoods in South Pacific communities*.

The project team includes researchers and collaborators from the University of Tasmania's Centre for Sustainable Architecture with Wood (CSAW), the Queensland Department of Agriculture and Fisheries (QDAF) Innovative Forest Products Team, the Pacific Community (SPC), the Fiji Department of Fisheries and Forestry, the Samoan Ministry of Natural Resources and Environment, the Solomon Islands' Ministry of Forestry and Research, and industry in Australia and Pacific Islands. The project supports economic development in Fiji, Samoa and the Solomon Islands and includes activity in market and value-chain assessment, log harvesting, veneer production and product manufacture, and the development of viable uses for coconut residues at the harvest site or the production facility. More information about the project is available at [www.cocowood.net](http://www.cocowood.net).

## 2.0 LEGAL COMPLIANCE

The harvesting and logging guidelines presented in this document are intended to complement the regional native forest harvesting and/or logging codes of practice identified below. These are legally binding on all parties and individuals involved in marking, felling and extracting, loading and hauling timber. The guidelines recommend practices and address any additional requirements pertaining to the harvesting and handling of coconut palm logs, or residue by-products from coconut palm plantations.

The relevant codes of practice include:

- Fiji Forest Harvesting Code of Practice 2<sup>nd</sup> Ed. (2013). Republic of Fiji Ministry of Fisheries & Forests. Suva, Viti Levu. Fiji.
- The Revised Solomon Islands Code of Logging Practice (2002). Ministry of Forests, Environment & Conservation. Honiara, Solomon Islands.
- The Samoan Code of Practice for Harvesting of Native Forest and Plantations (2001) URS FORTECH with stakeholders from Industry, Government and Landowner bodies. Prepared for the Samoan Ministry of Agriculture, Forestry, Fisheries and Meteorology.

## 3.0 SUSTAINABLE HARVEST MANAGEMENT

There are established and growing markets for coconut oil health products and goods manufactured from the coconut husk, and from the palm wood after felling. Although future markets for coconut wood veneer are unknown, with increasing demand for other coconut products (PARDI, 2011), it is reasonable to assume there will be a need to maintain the present area of coconut plantations for the future supply of these goods to both domestic and international markets.

A major difficulty for South Pacific Island communities with their coconut plantations is to determine palm harvesting strategies that will concurrently:

- Meet any demand for coconut palm logs.
- Gradually replace older senile coconut palms.
- Maintain an agreed rotation period for a plantation.

Unknown product markets, limited existing processing infrastructure, small-area holdings and the difficulty in storing milled timber, means senile coconut palms cannot be large-scale harvested to an immediate replacement schedule. Log harvesting will likely be performed to match demand, which if high, will require careful harvest planning to ensure the actual number of palms extracted from any particular area or community will not adversely affect ongoing supply for other coconut based products.

### 3.1 Current estimate of the number of senile palms

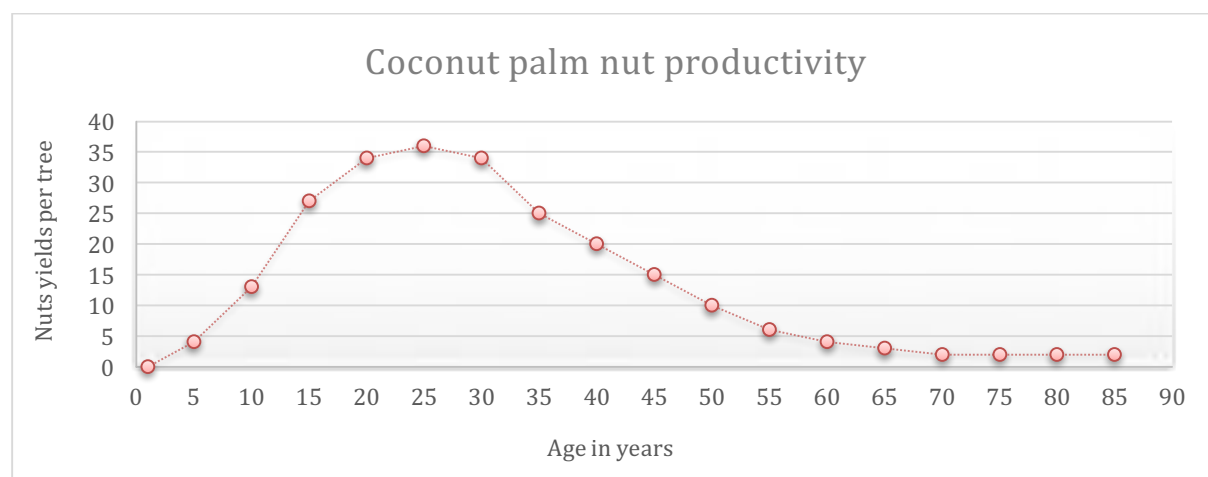
According to the most recent estimates in a report by the Food and Agriculture Organization of the United Nations (2011) the coconut area in Fiji, through either cyclone events or by not replacing those palms previously extracted, has gradually declined to approximately 64,000 hectares, of which approximately 60% or 39,000 hectares are already senile or over-mature and are therefore due for replacement. See Table 1. The same report estimates that through replanting and estate development after devastating cyclones in 1990 and 1991, the coconut plantation area in Samoa has gradually increased to 93,000 hectares and as these are relatively recent plantings only approximately 16% of the total estate is considered senile. An International Trade Centre study (2010) estimates the area of coconut plantation in the Solomon Islands is 59,000 hectares. The age structure of the Solomon Island palms is relatively young with about 50% of the existing stands under smallholder cultivation. These were planted in the 1970's, though a sizeable area of coconuts was planted after the second world-war and it is estimated that approximately 20% of the total Solomon Island's estate is now senile.

In the estimates presented in Tables 1 and 2, it is assumed the present area of these countries coconut plantations are to be maintained and that the planned rotation period of the palms is 60 years, whereby although the palm is still productive, the nut yield is not considered viable for a coconut based products industry. See Figure 1.



**Table 1: Estimate of total harvesting required to replace the existing estate's senile coconut palms.**

|   | Fiji      | Solomons  | Samoa     |
|---|-----------|-----------|-----------|
| Total area of coconut plantations (ha)    | 65,000    | 59,000    | 93,000    |
| Percentage area of senile palms           | 60        | 20        | 16        |
| Total area of senile palms (ha)           | 39,000    | 11,800    | 14,880    |
| Estimated number of existing senile palms | 3,705,000 | 1,121,000 | 1,413,600 |



**Figure 1: Trend of coconut nut productivity yields with palm age. Source: Forstreuter, SPC 2013.**

For logs to be available, coconut plantation owners and smallholders must be willing to harvest the palms under their tenure.

Although a visual estimate of a coconut palms age of can be made by counting the leaf scars, often a plantation's senility and thereby its production yield is only known by the owner, or by the local smallholder communities who have been annually harvesting the coconuts. Other methods of productivity assessment involve surveying a selected plantation or area, and for larger clearances, aerial photography if it is available.

Table 2 shows the total number of senile palms that could potentially presently be extracted for spindleless lathe veneer peeling. The estimates result from the number of palms that are planted at plantation establishment (100 palms per hectare), multiplied by a factor of 0.95 (95%) to account for natural losses over time. This number was then multiplied by a factor of 0.80 (80%) to account for the number of standing palms that would meet a log specification for spindleless lathe veneer peeling. Both these factors were derived from stand assessments made at peeler-log harvesting trials near Savusavu, Viti Levu, Fiji. June, 2015.

**Table 2. Estimate of the number of palms in an estate requiring replacement to address present levels of senility and to maintain the present estate area under a 60 year copra production rotation.**

|  | Fiji         | Solomons     | Samoa        |
|--|--------------|--------------|--------------|
| Present total number of senile palms                     | 3,705,000.00 | 1,121,000.00 | 1,413,600.00 |
| Present total number of productive palms                 | 2,470,000.00 | 4,484,123.00 | 7,421,400.00 |
| Total number of palms in the estate @95% survival        | 6,175,000.00 | 5,605,123.00 | 8,835,000.00 |
| Total number of potential cocoveneer palms in the estate | 4,940,000.00 | 4,484,098.40 | 7,068,000.00 |

### 3.2 Sustainable harvesting in small plantation holdings

It is not feasible to harvest any regions entire senile coconut estate in one schedule. Harvesting will occur to meet the demand for coconut wood products. To match that demand, the stakeholders may wish to harvest a volume in excess of, or far below, the number of senile palms that require replacement in any one area. As well as addressing the replacement of the existing senile palms, if the total estate area is to be maintained for future production, there needs to be a scheduled replacement of the older-age productive palms in the plantation as they also become senile. For logistical reasons, it is improbable that annual palm replacements would occur in any plantation and that harvesting is more likely occur at intervals of five to ten years.

To examine the feasibility of replacing existing levels of senile palm while maintaining coconut palm nut production over a 60 year plantation estate rotation, estimates were made of the number of palms that needed replacement and the impact of that replacement on nut productivity. These estimate are available in Objective 2 report: *Guide to Community Development of Estate Coconut Renewal Plans in South Pacific Island Countries* available at [www.cocowood.net](http://www.cocowood.net).

The final decision to harvest and replace coconut palms will likely be made at the community level where tenure exists over smallholding areas. It is beyond the scope of this objective to examine particular smallholding distributions in larger estates across the South Pacific Islands, so a 20 hectare holding was considered as a representative model. Figures 2 to 7 show the total number of palms that could be extracted from a 20 hectare holding at five-year intervals over a 25 year and a 50 year period in Fiji and, where a lower percentage of the plantations are senile, 15 and 30 years in the Solomon Islands and Samoa. To predict future estimates the following assumptions were made:

- Existing levels of palm senility are addressed over 25 or 50 years for plantations in Fiji and 15 and 30 year periods for plantations in the Solomon Islands and Samoa.
- Productive coconut palm plantations have a 60 year rotation period.
- 1/12<sup>th</sup> of palms in an estate will become senile every 5 years.
- All senile palms will be replaced with those of the same productivity.
- No individual coupe will have a harvest interval greater than 5 years.

The estimates shown in Figures 2 to 7 indicate that for all countries, unless there is an immediate demand for coconut wood veneer with accompanied investment in processing infrastructure, it may be more desirable to extend the period in which to address existing palm senility levels. This is particularly the case in Fiji, shown in Figures 2 & 3, where a greater number of palms require replacement and a shorter replacement period would result in a large number of logs available for a limited period. Whether this is advantageous to community stakeholders will depend on their proximity to downstream processors and the demand for logs extracted from those palms.

The graphs in Figures 2 to 7 also show the affect that palm removal (orange bars) will have on nut productivity (blue lines). The longer period that existing senility levels are addressed over, then the lower the impact on nut yields. The estimates show that with good forward planning palm senility could be addressed with little short term effect on nut yields and with larger increases in yields in the longer term.

It should be noted that the periods of 25 and 50 years for Fiji, and 15 and 30 years for the Solomon Islands and Samoa are representative only, and were chosen as indicator periods. In reality a community of stakeholders may wish to pre-determine alternative harvesting periods based upon the local demand for logs and/or the markets, either existing or predicted, for nut-based products.

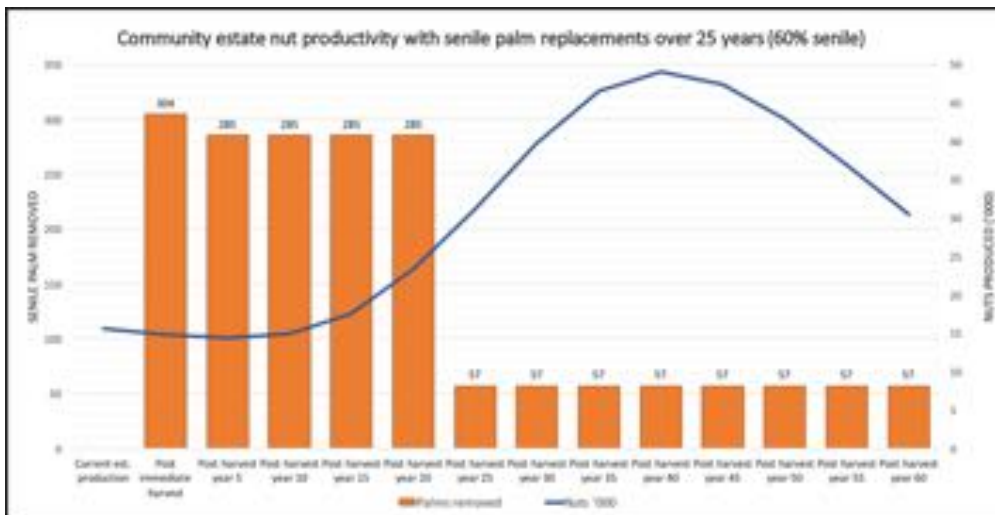


Figure 2: Fiji – 20 ha plantation with present senility estimates addressed over 25 years in a continuing 60 year coconut palm rotation.

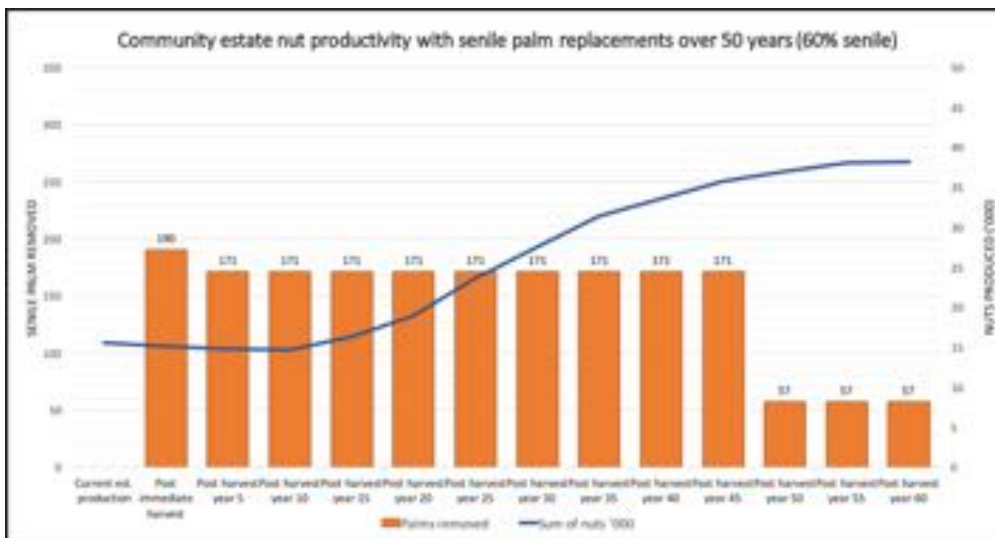


Figure 3. Fiji – 20 ha plantation with present senility estimates addressed over 50 years in a continuing 60 year coconut palm rotation.

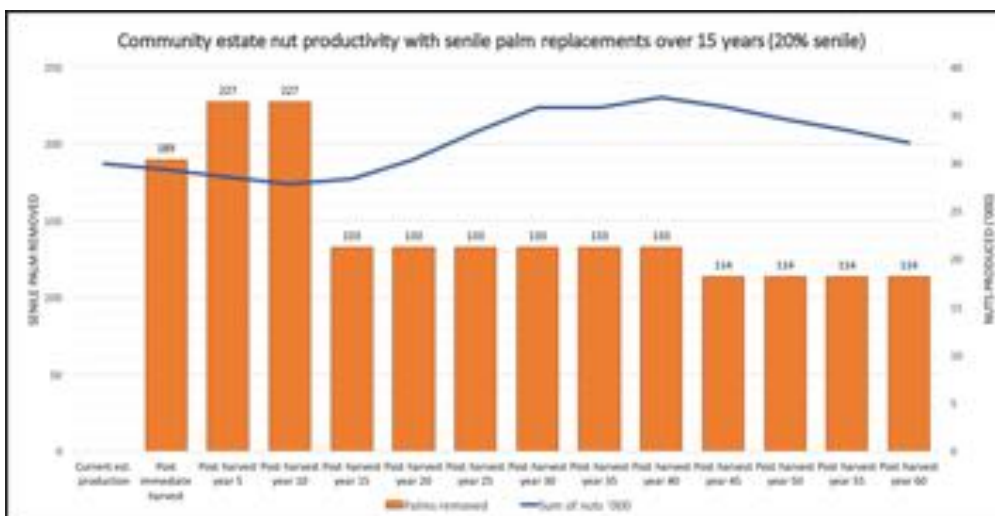


Figure 4. Solomon Islands – 20 ha plantation with present senility estimates addressed over 15 years in a continuing 60 year coconut palm rotation.

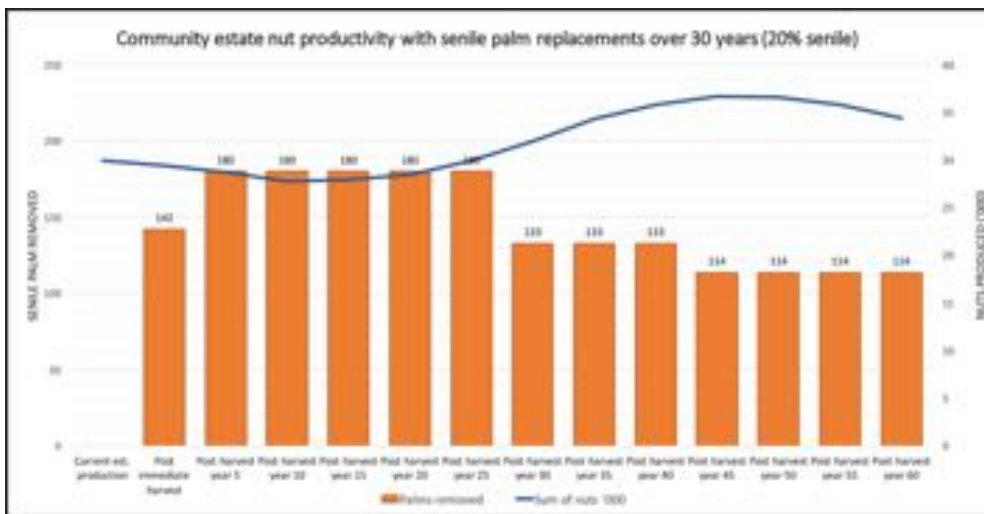


Figure 5. Solomon Islands – 20 ha plantation with present senility estimates addressed over 30 years in a continuing 60 year coconut palm rotation.

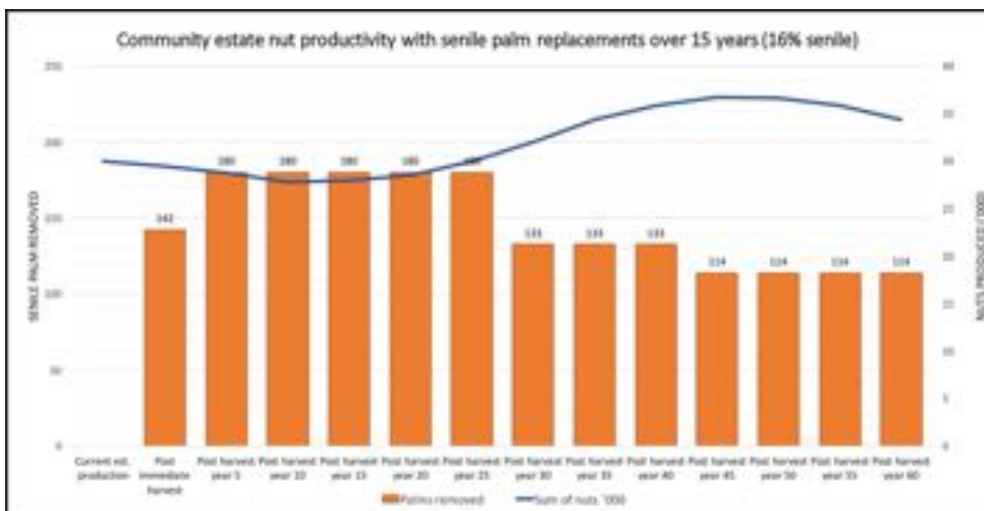


Figure 6. Samoa – 20 ha plantation with present senility estimates addressed over 15 years in a continuing 60 year coconut palm rotation.

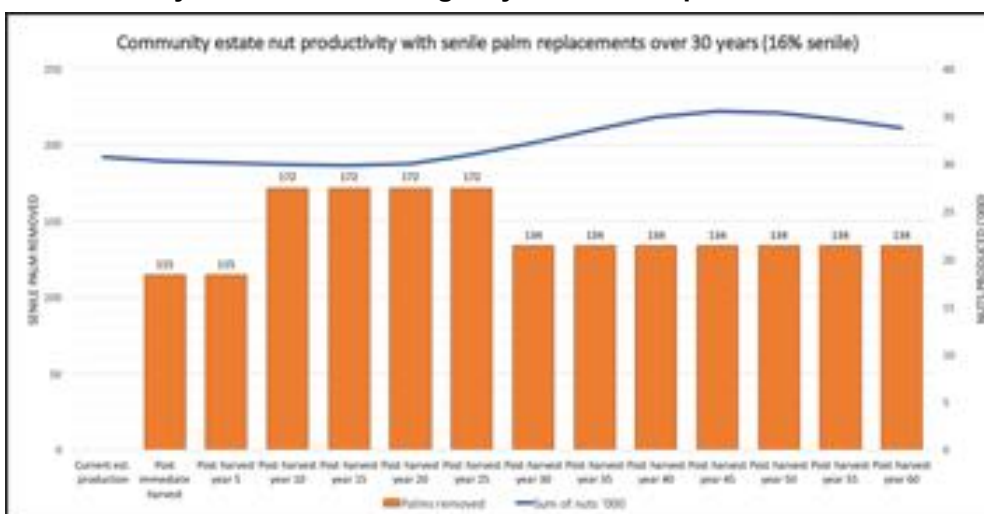


Figure 7. Samoa – 20 ha plantation with present senility estimates addressed over 30 years in a continuing 60 year coconut palm rotation.

## 4.0 PRE-HARVEST ARRANGEMENTS

### 4.1 Meeting of stakeholders

Before commencing harvesting, a meeting of stakeholders must be held to decide the extent of any coconut palm replanting required and/or, which cropping systems will replace the harvested coconut stems. Stakeholders may include;

- Plantation estate owners.
- Representatives of the landowner or community estate.
- Buyers of the harvested logs.
- If required, the harvesting contractor.

### 4.2 Plantation inspection

To determine whether harvesting of coconut palms from a particular plantation is a viable option, stakeholders should inspect the proposed harvesting area. Important points to consider during the inspection include:

- Common boundaries.
- Roads and tracks, including access points to public roads.
- Areas too steep or wet for harvesting.
- How streams and drains will be crossed.
- Where to established protection or buffer zones around:
  - Roadside, coastal vegetation and beach reserves;
  - Streams and plantation drains;
  - Infrastructure related to water or electrical supply;
  - Points of community, historical or archeological significance.
- The extent of pests and disease. In larger plantation clearances and/or where the presence of pest and disease is known, an independent inspection by a person with expertise in identifying coconut palm pests and disease should be made.

### 4.3 Pre-harvest inventory and assessment of potential selections

All stakeholders should make a pre-harvest assessment of a plantation's standing coconut palm suitability and an inventory of potential selections that would meet the log specifications required for their intended end use as coconut sawlogs or peeler logs. The log specification will include:

- Increasing from cut-height, the number of logs that can be extracted from the felled palm.
- Log length.
- Diameter range.
- Log sweep range over a pre-determined length.
- Acceptable/unacceptable levels of defects.

The assessment and inventory will support negotiations on harvesting strategies and costs. Consideration should be made of:

- The age of the coconut stems and whether they are still producing a commercially viable volume of nuts.
- Whether the number of selections estimated to meet log specifications are adequate for the required supply. Note that diameter at breast height can be measured, but sweep can only be estimated. Selections should be marked around the circumference with acrylic spray paint.
- Whether selection-felling or a clear-felling strategy is in the best interests of stakeholders.



**Figure 8. A coconut plantation with palms suitable for good quality coconut veneer logs.**

## 5.0 THE HARVESTING PLAN

### 5.1 Preparation of a Harvesting Plan

Outcomes from the pre-harvest assessment outlined in Sections 4 should be recorded for later reference. When larger scale plantations are to be cleared and re-planted, or converted to alternative land use, a Harvesting Plan with an accompanying map of the area to be harvested should be made.

### 5.2 Harvesting Map details

Depending on the scale of the operation and stakeholder requirements, the Harvesting Map may include:

- The boundary of the harvesting plantation or compartment of a plantation.
- Buffer zones (see Section 5.3).
- Locations of stream crossings and plantation drains.
- Main and access roads, and haulage tracks.
- Loading locations or landings.
- For larger clearances, the location of any camp site established for harvesting contractors.
- Any other features required that the stakeholders agree should be shown to facilitate the felling of palms and the harvesting of logs.

For small plantation coupes, or a limited number of palm selections, a hard-copy lands map or a Google Map image may be sufficient for annotating features of interest.

For larger scale clearances, Geographic Information System (GIS) software packages can provide maps, which may be customised with harvesting information and local geographic features of interest.

### 5.3 Buffer zones

Buffer zones are areas to be protected from the harvesting. They should be established along and around:

- Designated catchments areas.
- Roadsides, beach reserves and streams.
- Infrastructure such as underground and overhead lines for water, sewerage, electricity and telecommunications.
- Areas identified with pest damage or disease infestation.
- Protected flora, reserves, historic and archaeological sites.

### 5.4 Road access and construction

Generally, good access exists for most coconut palm plantations in South Pacific Island countries and the ground surface is adequate to support harvesting machinery.

Where construction of haulage roads is necessary, these must be confined to the road alignment shown in the Harvesting Plan. Where construction of new access tracks or roads are necessary, they must be shown in the Harvesting Plan. In both cases, the roads or tracks should be built in accordance with the requirements detailed in the relevant logging codes of practice.



## 5.5 Construction of landings

The following factors should be considered when determining the size and location of a proposed landing site:

- The planned duration of harvesting operations on the site and the expected stockpiling requirements as determined by loading and haulage logistics.
- Topography and drainage, including gradients to connecting tracks and roads.
- Minimising the movement of haulage trucks across the harvest plantation.
- Disposal of accumulated logging residues.

If a Harvesting Map exists, all landings must be shown.



**Figure 9. Landing design and location to facilitate log storage and handling at Savusavu, 2015.**

## 5.6 Harvesting machinery

Most of the equipment engaged in small-scale coconut palm harvesting operations will be readily available farm equipment, rather than dedicated forest harvesting machinery. However, for any machinery deployed, individual owners or harvesting contractors must comply with Occupational Health and Safety (OH & S) requirements as described in the native forest and/or logging codes of practice for a particular country.

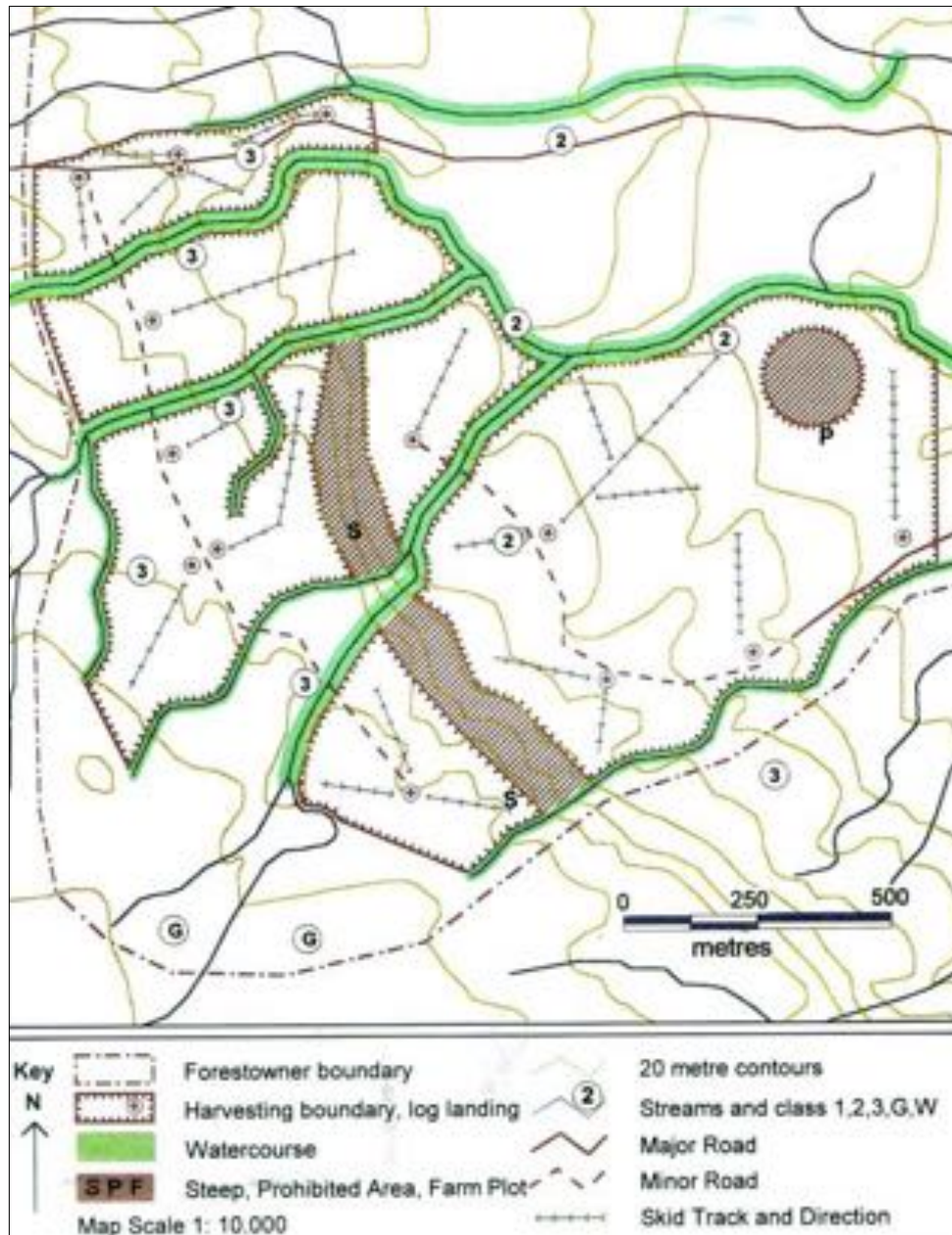


Figure 10. Example of a harvesting plan map (Fiji Forest Harvesting Code of Practice 2010).

## 6.0 HARVESTING PERSONNEL

### 6.1 Harvest staff accreditation

Stakeholders wishing to harvest logs on a smallholding scale, or by individual palm selection, are likely to employ local workers using chainsaws and farm tractor attachments and/or independent loaders. It is the responsibility of the stakeholders to ensure personnel engaged in these activities are adequately trained to do so. Specific qualification requirements for harvesting personnel are detailed in the native forest harvesting and logging codes of practice for a particular country.

For larger-scale operations using powered forestry harvesting equipment, only personnel trained and certified for specific forestry harvesting equipment shall operate machinery.

### 6.2 Harvest Supervision

In all scales of operation, a Harvest Supervisor will be responsible for managing day to day operations and staff engaged to do the work. In larger operations, stakeholders will likely engage independent contractors who will have a staff member qualified for this position. In smaller holdings the stakeholders must nominate a suitable qualified person to undertake this role. The Harvest Supervisor should hold certificates of compliance for all equipment under his supervision. Their main duties and responsibilities are:

- Involvement in pre-harvest planning.
  - Confirm all harvesting staff are adequately qualified to undertake their assigned tasks.
  - Liaison between stakeholders, harvest contractors and any necessary government authority.
- Supervision of all operations and staff to ensure they are in compliance with these guidelines.
  - Maintenance of records as required by law.
  - Monitoring, evaluation and reporting on operation activities to the stakeholders.
  - Implementing safe working practices in accordance with OH &S requirements.
  - Rendering first-aid and if necessary, arranging rapid evacuation of an injured worker.
  - Report on unusual pests and symptoms of diseased, or pest infested coconut palms.
  - Inspection of vehicles and equipment entering and leaving the harvest site.

## 7.0 COCONUT PALM HARVESTING OPERATIONS

The Harvest Supervisor will hold a briefing meeting for all harvesting staff before work commences each day. The meeting will review safety issues, discuss the current harvesting activities and any concerns staff have.

It is the responsibility of the Harvest Supervisor to cease work on operations where adverse weather conditions are likely to cause an increased risk of personal injury or damage to the environment.

### 7.1 Site access

Whilst harvesting operations are underway, no other person besides those under the direct supervision of the Harvest Supervisor shall enter the plantation without the Supervisor's permission.

### 7.2 Protective equipment

Harvesting staff shall be provided with Personal Protective Equipment (PPE) that complies with the standards outlined in a country's OH & S requirements.

The Harvest Supervisor will ensure harvesting staff, visitors and any other persons within the harvesting area wear their PPE at all times.

Chainsaw operators shall wear the recommended PPE and any additional protective clothing to comply with the standards outlined in a country's OH & S requirements.

OH & S - PPE requirements are detailed in the codes of practice for the particular country or other relevant legislation.

### 7.3 Preparation for felling

The following preparations should be made before felling commences:

- The harvest supervisor shall check the number of marked selections confirms with required inventory provided by the stakeholders.
- When felling near a roadside, suitable signboards and precautions must be taken to warn oncoming traffic when coconut palms are being felled within three palm lengths from a road.
- If palms have to be removed less than three lengths their height from the roadside, then permission for removal should be obtained from the local regulatory authority and roadside staff will be engaged to stop traffic while those palms are removed.
- Any underground and overhead lines such as water, sewage, electricity, and telephone must be identified, the relevant authority notified, and the required buffers zones marked on the ground with road marking paint.
- Where an overhead electricity line passes through an area of plantation being harvested, it must be suitably marked and felling must not take place within this area without prior consultation with the local authority.

## 7.4 Palm felling

The following felling requirements will apply to coconut palm felling operations:

### 7.4.1 Chainsaw operators

- At least one chainsaw operator in the plantation being harvested should have previous experience felling coconut palms.
- Chainsaw operators shall work in pairs no closer than two coconut palm lengths (including fronds) apart, but close enough to call for assistance or notice in case of an accident.
- When felling is underway, all other harvesting staff must remain at a distance of at least three coconut palm lengths. Coconuts can be thrown in the felling direction when the palm stem hits the ground.
- Coconut palms should always be directionally felled in a manner that minimises any potential safety hazards or damage to the remaining stand. Things to check include:
  - Established buffer zones.
  - Suitable gaps in the canopy and the intended felling direction.
  - The lean of the palm and the direction and strength of the wind.
  - Obstacles in the way of a palm's fall.
  - Escape routes for the feller and those assisting.
- Coconut palms next to buffer zones must be directionally felled away from the zone or otherwise retained to avoid damage to the protected area.
- Coconut palm crowns shall never be felled into streams.
- Any harvest debris entering streams should be removed immediately and where possible, without any machine involved in the removal entering the buffer zone.

### 7.4.3 Stump height

To maximize merchantable volume of log, the palm stem's cut-height should be above any butt defect or buttressing. After felling, if necessary, the main stem can be cut further to reduce the volume of remaining site residues, or can remain to facilitate stump extraction by drag-chains.

### 7.4.3 Partially cut palms and hung palms

Coconut palms shall not be partially cut and left standing. Where a palm is hung or lodged, it must be brought to the ground as soon as possible.

Coconut palms can be prone to lodging in or around beach reserves, where they are commonly distributed amongst coastal vegetation and the frond region can get hung or lodged in their upper branches. A machine winch is the recommended removal method. When winching, the distance from the tree to the machine must be at least one and a half times the lodged height of the palm.

## 7.5 Log assessment and preparation

Felled palms shall be assessed to establish if logs extracted from them will confirm to the required log specifications as follows:

- The felled palm and crown shall be inspected by the Harvest Supervisor for incidence of present pests or disease, or any historical evidence (e.g. termite galleries).
- The cross-cutting points at the log lengths required shall be marked on the felled palm. A diameter tape can be used to confirm the large- and small-end diameters are within the required specification.
- A string-line extended across each log length and at the point of maximum sweep (as gauged by eye) shall be used to confirm if the log is within sweep specification.
- The chainsaw operator can then cross-cut the logs from the fallen stem.
- Logs for processing shall be marked with an acrylic paint.
- Logs not meeting required specifications and the remaining stem should also be marked with a different colour acrylic paint.

## 7.6 Log handling

### 7.6.1 Log handling during harvest operations

Existing roads and tracks in coconut plantations are usually adequate for harvesting machinery to forward coconut logs from the stump to the landing and to load trucks at the landing. Alternatively, if access is exceptionally good and the ground firm, front-end or Bell loaders can load trucks within the plantation. Coconut logs should be handled as follows:

- Harvesting machines and trucks must not enter any buffer zone or stream except at approved crossing points.
- Coconut logs shall not be forwarded to the landing by skidding. Coconut logs are more fragile than native forest logs, and skidding (dragging across the ground) could severely damage the harvested logs.
- Coconut log stacks shall be built on the designated landing only.
- The height of coconut palm log stacks should be lower than three logs. Coconut logs have no lateral branch stubs and can roll more easily when being stacked, or when stacks are loaded on to haulage trucks.
- Clearances shall be created in between any stacks to allow safety of movement and work.
- After stacking on the landing, to reduce log moisture loss, log-ends should be coated in log-grease or an acrylic paint.
- Logs shall be loaded onto haulage trucks individually.
- Logs shall be secured with straps or chains in such a way as to prevent any movement during transportation.

### 7.6.2 Log handling during transportation and at the point of delivery

- If a considerable distance has to be travelled to the delivery point, logs in transit should be covered to prevent drying.
- At the delivery point, logs shall be unloaded individually and as soon as possible.
- Logs shall be placed on ground bearers and not stacked more than three logs in height.
- If possible, log stacks shall be located out of direct sunlight and wind.
- In drier periods logs stacks shall be hosed with clean water daily and stored under cover.
- If extended delays for truck unloading occur, then covers shall be placed over the logs. Ideally the logs shall be soaked with clean water first.

### 7.7 Harvest contractor's camps

Harvesting crew camps, typical of those required in native and plantation forest harvesting operations, are not usually necessary for harvesting coconut palm plantations. In larger-scale clearances, if overnight camps are required then; fire precautions, campsite standards, their management and hygiene should be in accordance with those detailed in the native forest harvesting and logging codes of practice for a particular country.

### 7.8 Salvaging of windblown palms

Windblown coconut palms may be harvested in accordance with Guidelines on the Management of Cyclone Damage to Forests and Trees in South Pacific Island Countries (Strehike and Sorley, 1997). A Harvesting Plan should be developed to cover major salvage operations.



**Figure 11. Cyclone damaged coconut palms that can be salvaged for coconut wood logs.**

## 8.0 ENVIRONMENTAL PROTECTION

Stakeholders can minimise pest movement through careful- operational planning, harvesting, log storage and transport. The movement of disease across the coconut plantation and of pests from the harvest location to the processing site can be restricted during the harvesting of coconut palms. The Harvest Supervisor should be trained to recognise evidence of pests and symptoms of diseased and infested palms, and during harvesting they shall carry out practices that reduce the risk of spreading pests and disease to other locations.

### 8.1 Practices to minimise spreading plantation pests and disease

- Identify any pest or disease areas during the pre-harvest plantation inspection (discussed in Section 4.2) and report them to the regulatory authority. If harvesting of this plantation proceeds, these areas will be clearly marked on the Harvest Map.
- Mark any palms that are clearly affected by pest or disease and report them to the regulatory local authority covering pests and diseases in coconut plantations. *This is very important in partial plantation harvesting as it will prevent further loss of palms.*
- Consider harvesting only those stands with a high proportion of palms displaying senility.
- Apply best machine harvesting practices to minimise soil erosion and damage to standing palms. Damage weakens them and makes the palms more susceptible to pests and disease.
- The Harvest Supervisor should inspect each machine arriving at the harvest operation and if relevant, the vehicle delivering the machine to ensure they are free from soil-borne pests and disease.
- On completion of the harvest and before removal, the owner or operator of the harvesting equipment should arrange for the removal of all soil, dust and harvest debris that has accumulated on and in their machines. A flat site away from water courses and drains and close to the exit of the plantation, should be chosen to prevent site and vehicle recontamination.

### 8.2 Practices to minimise spreading pests and disease in transit

- Before entering the plantation to load harvested logs for processors, haulage trucks should be inspected by the Harvest Supervisor or a person nominated by them, to make sure they are free of soil and debris that could potentially carry pests and disease.
- During loading at the landing, any log suspected of carrying pests and disease should be removed and placed away from the landing for inspection. If subsequent inspection shows the log to carry pests and/or disease, the area around the log shall be secured off as a 'Quarantine' area and the log burnt or disposed of as soon as possible.
- If the haulage truck has accumulated harvest site soil or debris during loading, then this should be removed from the truck before leaving the plantation.



### **8.3 Practices to minimise spreading pests and disease at the receivers**

- During unloading at the receiver's facility, to prevent any pests or disease infection spreading to surrounding products or areas, logs should be examined to determine if any pests and disease are present.
- Logs suspected of being infected should be set aside in an area marked 'Quarantine' for inspection. The log supplier, haulage contractor and local regulatory authority for the control of pests and disease in coconut plantations should be notified immediately.
- After confirmation and identification of any suspected pest or disease, infected logs should be disposed of in a way which safeguards the remainder of logs and products at the processors site.
- After unloading, trucks should be cleaned and any coconut palm debris should be disposed of immediately.
- To reduce the risk of pest infestations and disease infection, and maintain processing quality, logs should be placed on bearers on a dry gravel surface.

## 9.0 RESTORATION and REHABILITATION OF THE HARVESTED AREA

Restoration measures should be commenced after harvesting to safeguard infrastructure such as roads, tracks and stream crossings. Any rehabilitation measures should be undertaken in a manner that permits the infrastructure to be re-used during replanting, alternative cropping or the next harvesting cycle.

If coconut palms are harvested on a larger-scale, there remains an environmental risk associated with the loss of a soils water-holding capacity, particularly during adverse weather conditions. The risk generally increases with an increase in ground slope and without replanting will make exposed soils vulnerable to erosion. Therefore, coconut replanting and/or alternative cropping should be established as soon as possible after harvesting.

### 9.1 Removal of rubbish

- Any coconut palm debris remaining after the harvesting operation is complete should be removed, buried, burnt or composted.
- Rubbish bins and empty fuel, oil and food containers must be removed to an approved disposal site.

### 9.2 Restoration of landings, haulage access roads and tracks

If heavy machinery is used, site clearance should ideally be performed in dry periods and contour strips can be worked on sloping ground to prevent erosion. If coconut re-planting occurs after the harvesting of palms, then consideration to the re-plant layout should be made to reduce the chance of senile palms remaining in future harvest operations. The following restoration should be made after completion of harvest at all sites:

- Landings must be leveled to minimise erosion and encourage rapid revegetation.
- Access roads and tracks must be left in a good condition with adequate drainage and with no ruts in the surface. If necessary, grading and compaction should be done to leave the road in a stable and serviceable condition.
- All harvesting debris in culverts, streams or drains must be removed by excavators, winches or by hand, if possible avoiding any entry of machinery into the stream or buffer.
- Bridge and culvert openings must allow free water flow.
- All drains and silt traps must be maintained in working order. Soil, vegetation or other material that could obstruct water flow must not be left in drains.

### 9.3 Rehabilitation options

Many present coconut palm plantations in South Pacific Island countries were established as a monocrop that was easily managed under low land-use intensity. The palms morphological characteristics, its conventional wide spacing in plantations and its deep and clustered root system means it is ideally suited to intercropping, which is in keeping with modern farming practices that generally seek to intensify land-use. However, following harvest, future land-use must be carefully planned and based on cash-flow predictions, labour and equipment availability, and community acceptance.

Accumulative cash-flow predictions will vary depending on the production system chosen and if replanting with coconuts as a monocrop, cash-flows will vary overtime with the species chosen. Reduced cash-flows may be expected in the first five years after planting, but new technology, improved plantation husbandry practices and new hybrid species can be adopted to improve longer-term returns. However, in a more intensive system, it is important to carefully also consider the increase cost of inputs, additional equipment and labour, which may reduce the expected net benefits (Opio, F. 1999).

Plantation stakeholders should make the above considerations and decide on which cropping system will replace the harvested coconuts stems before commencing site clearance. Approval of a country's Department of Agriculture will be required for subsequent cropping on the site and details on the intended future use of harvested sites should be included in the Harvesting Plan.

It is beyond the scope of this document to provide extensive detail on rehabilitation choices. Some alternative production cropping system options include:

- Replanting of coconut palms.
- Replanting of coconut palms with inter-row cropping, or inter-row stock grazing pasture.
- Monocrop conversion.
- Stock grazing pasture.
- Multicropping.

### 9.4 Harvest residues

Freshly extracted coconut palm root-boles do not burn readily and will need to be removed with drag chains and/or excavators. To prevent pests or disease infestation, they will require stacking or burying away from any proposed cropping area and may be burned at a future time when dry.

To prevent any contamination from pests and disease, burning the harvesting residues may be the favoured option and should be considered as a residue use. The ash contains valuable plant nutrients and whenever possible should be incorporated into the topsoil especially on sloping sites.

Other potential options for harvest residues include:

- Biochar production for use in crop plantings or for direct product sales. Although careful consideration should be made of the type of biochar that would be produced and its suitability for use in any proposed future cropping system.

- Compost production from chipped harvest residues. Mobile in-field chippers can be utilised to produce compost on site, which may be used directly as a soil amendment and nutrient rich fertiliser for most cropping systems.

Composting is a favoured option if the land is to be prepared for following cropping systems as this activity can be performed at the harvested site. It should be especially encouraged in coastal regions when coconuts are to be replanted. Coconuts are halophyte plants and therefore highly tolerant of elevated levels of ionic salts in the soil, which may be present in compost made from coconut palm residues harvested in coastal regions. The additional salts in the compost may be beneficial in certain areas, as the plant has evolved to need high concentrations of electrolytes in their cells to grow and maintain their water balance (Ohler, J.G. 1999).

The nutrient status of any manufactured compost should be assessed before applying to soils in new or established cropping systems.



**Figure 12. Post-harvest residues.**

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