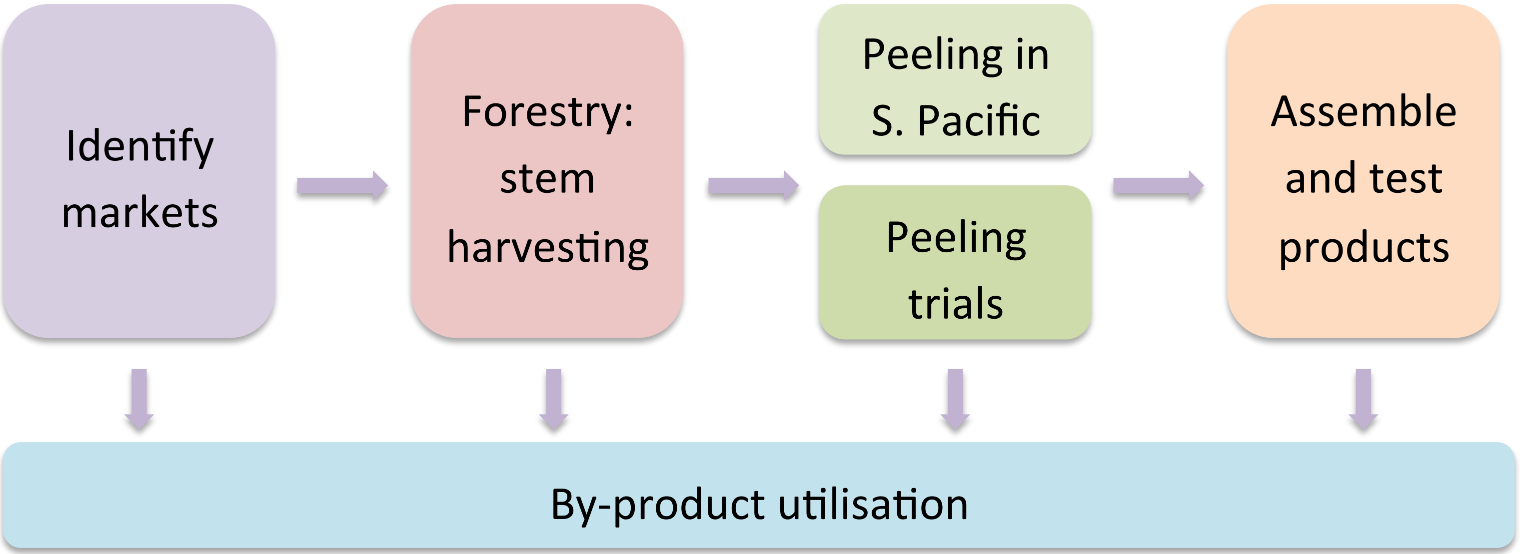
Objective 6

Determine the costs and benefits of using the residual cortex and soft, central cores for bio-char and other agricultural products

Project Objectives



Objective 6 – By-product utilisation

By-
product
utilisation

Objective 6 - Determine the costs and benefits of using the residual cortex and soft, central cores for bio-char and other agricultural products

6.1 – Collaboration with agricultural projects

6.2 – Biochar

Objective 6 – By-product utilisation

Potential by-products from harvesting and peeling coconut palms

On-site burning (ash nutrients)

Biochar

In-field chipping for growing mediums

In-field chipping for composting

Traditional practice with known results - not examined any further

Ongoing trials and assessment of results

6.1 – Collaboration with agricultural projects

By-product utilisation

- Secondary products from the harvesting and peeling processes.
  - Not the intended primary product
- Generally considered to be of lower value when compared to the main product
- If marketable residue products may provide additional income

6.1 – Collaboration with agricultural projects

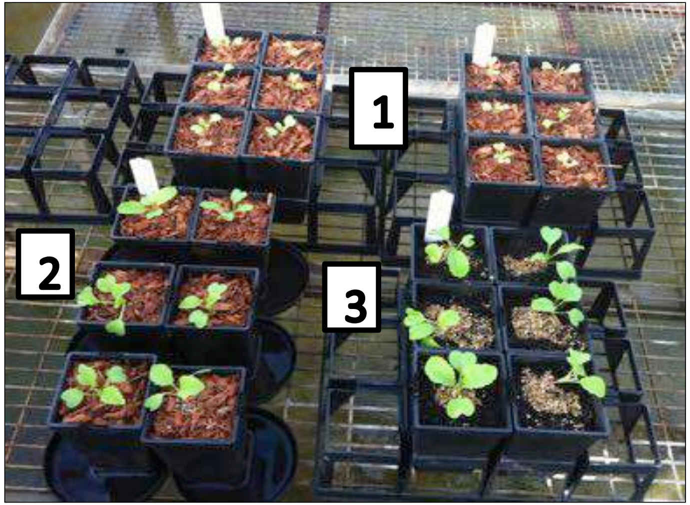
- Wood chips obtained from Fiji
- Chips produced from Pacific Green cores chipped by Tropic Forest Joint Venture Co Ltd
- TFJV typically chip for Fiji Sugar
- Thanks to Faiz Javed Jan of TFVC and Pacific Green

6.1 – Collaboration with agricultural projects

- Chips used for ‘proof of concept’ testing at UTAS
- Processes refined through proof of concept can be used to inform trials/practices in PCs
- UTAS tests include
  - Cocowood growing medium
  - Cocowood mushroom substrate
  - Cocowood composting
  - Cocowood as peat substitute

6.1 – Collaboration with agricultural projects

Coconut woodchip as a plant growing medium - 1



1. Coconut woodchip and water
2. Coconut woodchip and nutrient solution
3. Premium potting mix

Seedlings (Radish) health and root lengths from (1) were examined and measured after 10 days growth Initial test results suggest the coconut woodchip is not toxic to germinating seeds. However, lower growth rates in treatment 1 indicate a lack of available nutrients and/or excessive air-fill-porosity.

6.1 – Collaboration with agricultural projects

Coconut woodchip as a plant growing medium -2



To reduce air-filled–porosity, coconut woodchip was screened to <3.0 mm particle size similar to a commercial growing mix.
Pea and Corn seedlings grew well. Further testing is underway to examine its use as a substitute for peat in nursery potting mixes.

6.1 – Collaboration with agricultural projects

Coconut woodchip as a plant growing medium -3

From the limited studies made so far, coconut woodchip is showing some potential as:

- Plant growing medium provided particle size is reduced and additions are made for required crop specific nutrients.
- Potential medium for windrow composting.

Previous studies show coconut wood is high in carbohydrates. With additional nitrate sources (perhaps fishing industry by-products), good quality compost could be made with limited equipment chipping and windrowing residues at harvested sites.

6.1 – Collaboration with agricultural projects

Coconut woodchip as a mushroom growing substrate

Coconut woodchip was sterilized and inoculated with pearl oyster mushroom spawn

Mushrooms production was successful – ongoing substrate trial assessments in 2014

6.1 – Collaboration with agricultural projects

Coconut woodchip as a composting medium -1

Compost although not a novel by-product, would be particularly useful for intercropping short-maturing crops until new coconut plantations become productive, or for new crop rotations.

6.1 – Collaboration with agricultural projects

Coconut woodchip as a composting medium -2

Passive composting involves very limited equipment and labour, but the production time is longer.

With investment in equipment and labour, a high quality compost can be produced much faster than passive composting methods.

To further test as a composting medium and replicate field bacteria, and temperature conditions, a minimum 30 m^3 of woodchip is necessary.

6.1 – Collaboration with agricultural projects

- Engagement with industry and scientists is Aus ongoing
- Briefing paper produced for engagement in PCs

velopment of advanced veneer and other product from coconut wood to enhance
elihoods in South Pacific communities ACIAR project FST 2009/062

iefing Paper: Potential for composting residues from harvesting of older age Cocos nucifera

ms and objectives

e aim of the proposed trial is to examine if coconut stem harvesting residues can be compos
ovide a nutrient rich plant growing medium. The outcome will inform interested project part
the potential to further develop this process.

erview

mposting of organic wastes is an environmentally sound method of converting material gen
garded as waste into a product that can be used in agriculture, horticulture, landscaping and
mediation of contaminated sites. An increased tendency for intercropping and/or mixed farm
erations in the Pacific Islands means more products are removed from the land and therefor
port of nutrients is high. The composting of coconut wood residues would provide the oppor
address that nutrient loss and potentially increase crop productivity, and further opportuni
oduct sales could exist. Evidence from previous studies, assessment of the material residues
scussion with Australian commercial composters during this project, suggests that coconut
oodchip is suitable for composting into a nutrient rich medium that can be readily used for
proving future crop yields. Additionally the Pacific Island region has an appropriate climate f
st effective composting.

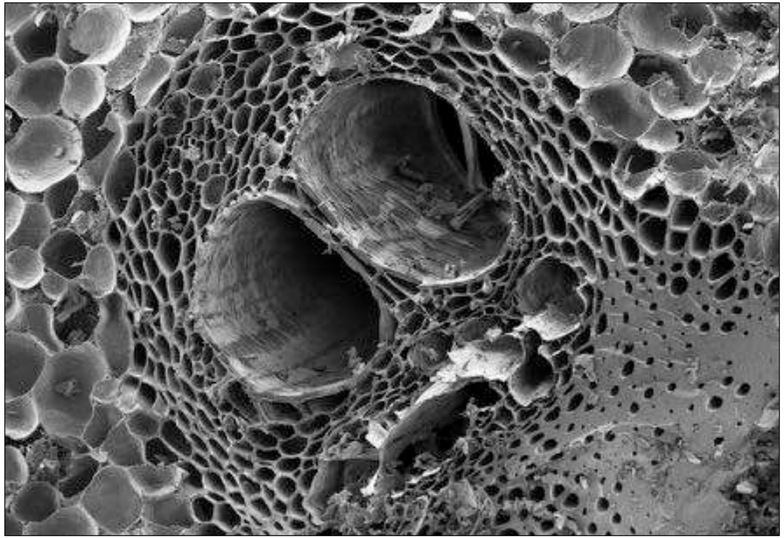
6.2 - Biochar

By-product utilisation

- Biochar is a type of charcoal produced by pyrolysis where organic materials such as crop wastes and woodchips are heated in low oxygen levels.
- The biochar produced is a stable form of carbon, which if added to a soil won't easily break down.
- Biochars differ– the type of organic material used and the temperature and time of the heating process affects the final product properties.

6.2 - Biochar

Biochar from coconut wood pyrolysis



Porous material has a high surface area

6.2.- Biochar

Pyrolysis stoves don't need to be high tech.

Small units can produce biochar

for small scale crop production.

Larger pyrolysis plants can produce biochar and convert waste organic material into bio-oils and gas.

6.2 – Pacific biochar trials

By-
product
utilisation

Benefits from biochar are not universal

- Soil types respond differently

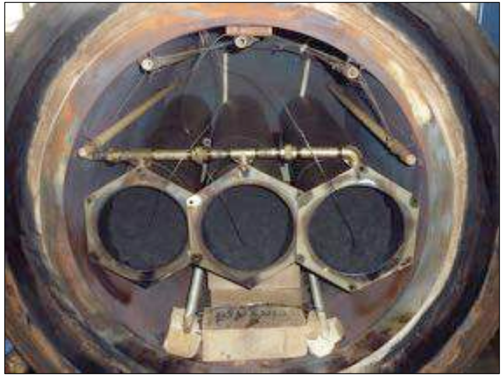
Applying biochar to soil in the Pacific may have beneficial effects

- Increased crop productivity through higher nutrient use efficiency
- A retention of nutrients - limits nutrient leaching
- An increase in water-holding capacity
- A decrease in soil acidity

6.2 - Biochar

Biochar trials

- Coconut woodchip were pyrolised into three different biochars
- These were analysed to determine chemical and physical properties
- The biochars were used in field and pot trials in partner countries



6.2 - Biochar

Initial results look good!

		350 C		500 C		750 C	
Analyte	Units	Result	Status	Result	Status	Result	Status
pH ($CaCl_2$)	-	8.49	very high	9.02	very high	10.61	very high
EC	dS/m	2.01	moderate	2.24	moderate	3.96	high
Organic Carbon	%	9.38	high	8.48	high	6.5	high
Sodium (NH_4Cl)	meq/100g	47.83	very high	68.24	very high	130.8	very high
Aluminium (KCl)	meq/100g	0.01	very low	0.01	very low	0	very low
Colwell P	ppm	181	very high	277	very high	242	very high
Colwell K	ppm	1296.86	very high	1388.19	very high	2095.81	very high
Boron (hot water)	ppm	0.43	low	0.42	low	0.45	low
Copper (DTPA)	ppm	0.07	low	0.05	low	0.09	low
Iron (DTPA)	ppm	0.78	low	0.5	low	1.55	low
Zinc (DTPA)	ppm	0.18	low	0.31	low	2.01	very high
CECe	meq/100g	51.6	very high	76.08	very high	142.01	very high
Calcium (% CEC)	%	3.55	very low	6.62	very low	3.94	very low
Magnesium (% CEC)	%	1.4	very low	0.95	very low	0.88	very low
Potassium (% CEC)	%	2.35	low	2.74	low	3.07	low
Sodium (% CEC)	%	92.7		89.7		92.1	
Total Carbon	%	69.24		80.06		85.92	
Total Nitrogen	%	0.53		0.49		0.66	

Potential liming effect

Reduced risk of toxicity

Plant available K and P

Reduced risk of toxicity

Helps release K and P

6.2 - Biochar

- Pot trials in Suva in conjunction with Dr Halavatau from SPC
- Four biochar primers
- One control
- 25 specimens (maize)

6.2 - Biochar

- Field trials on Taveuni working with Geoff Dean and local farmers
- All biochars were crushed in a modified grinder
- Primed treatments were mixed with fishmeal; soft rock phosphate fortified with additional K; molasses; a small amount of compost; water. Mixed in cement mixer.
- Incorporated bc treatments spread and mixed with tractor mounted rotivator.
- Holes were dug by hand (fork) and relevant in-hole bc treatments applied. A multi-nutrient fertiliser (25g/hole) and soft rock phosphate fortified with additional K (25g/hole) was applied to each hole.
- Planting material was graded for size and planted

6.2 - Biochar

trt	code	bc source	temp	incorpn	bc rate		primed	Treatment justification
1	h-0/np	none	-	bc applied into hole at planting	0	g/hole	-	control- no biochar applied to hole
2	h-0/+y	none	-	bc applied into hole at planting	0	g/hole	+y	control- equivalent primer added to hole
3	cnut-A350/h100y	cnut-Aus	350	bc applied into hole at planting	100	g/hole	y	Aust biochar -effect of temp on biochar properties and plant growth
4	cnut-A500/h100y	cnut-Aus	500	bc applied into hole at planting	100	g/hole	y	"
5	cnut-A750/h100y	cnut-Aus	750	bc applied into hole at planting	100	g/hole	y	"
6	cnut-T500/h50y	cnut-Tav	500	bc applied into hole at planting	50	g/hole	y	rate trial with Tav cnut (amts/hole may be large but on a t/ha is very low so there m
7	cnut-T500/h100y	cnut-Tav	500	bc applied into hole at planting	100	g/hole	y	"
8	cnut-T500/h200y	cnut-Tav	500	bc applied into hole at planting	200	g/hole	y	"
9	cnut-T500/h100n	cnut-Tav	500	bc applied into hole at planting	100	g/hole	no	Tav cnut -no priming comparison
10	gv-T500/h100y	guava-Tav	500	bc applied into hole at planting	100	g/hole	y	Tav guava -mod rate
11	gv-T500/h200y	guava-Tav	500	bc applied into hole at planting	200	g/hole	y	Tav guava -high rate
12	gv-T500/h100n	guava-Tav	500	bc applied into hole at planting	100	g/hole	no	Tav guava -no priming comparison
	full 0/np	none	-	full-bc spread and incorp with rotivator	0	t/ha	-	not included as this same as trt1 as all plots rotivated
13	full 0/+y	none	-	full-bc spread and incorp with rotivator	0	t/ha	+y	control- equivalent amt of primer spread and incorp
14	cnut-T500/full10y	cnut-Tav	500	full-bc spread and incorp with rotivator	10	t/ha	y	c'nut -comparison of broadacre "conventional" application with in hole application
15	gv-T500/full10y	guava-Tav	500	full-bc spread and incorp with rotivator	10	t/ha	y	guava -"
16	gv-T500/full10n	guava-Tav	500	full-bc spread and incorp with rotivator	10	t/ha	no	Tav guava -no priming

Site -Vunivasa Mollisol soil (acidic and moderate fertility)

Split plot design with Aust cnut trts blocked together

5x 4m ie 20 taro plants, 4 reps

6.2 - Biochar

trt	code	bc source	temp	incorpn	bc rate		primed	Treatment justification
1	h:0/np	none	-	bc applied into hole at planting	0	g/hole	-	control- no biochar applied to hole
2	h:0/+y	none	-	bc applied into hole at planting	0	g/hole	+y	control- equivalent primer added to hole
3	cnut-A350;h100y	cnut-Aus	350	bc applied into hole at planting	100	g/hole	y	Aust biochar -effect of temp on biochar properties and plant growth
4	cnut-A500;h100y	cnut-Aus	500	bc applied into hole at planting	100	g/hole	y	"
5	cnut-A750;h100y	cnut-Aus	750	bc applied into hole at planting	100	g/hole	y	"
6	cnut-T500;h50y	cnut-Tav	500	bc applied into hole at planting	50	g/hole	y	rate trial with Tav cnut (amts/hole may be large but on a t/ha is very low so there m...
7	cnut-T500;h100y	cnut-Tav	500	bc applied into hole at planting	100	g/hole	y	"
8	cnut-T500;h200y	cnut-Tav	500	bc applied into hole at planting	200	g/hole	y	"
9	cnut-T500;h100np	cnut-Tav	500	bc applied into hole at planting	100	g/hole	no	Tav cnut -no priming comparison
10	gv-T500;h100y	guava-Tav	500	bc applied into hole at planting	100	g/hole	y	Tav guava -mod rate
11	gv-T500;h200y	guava-Tav	500	bc applied into hole at planting	200	g/hole	y	Tav guava -high rate
12	gv-T500;h100np	guava-Tav	500	bc applied into hole at planting	100	g/hole	no	Tav guava -no priming comparison
	full 0/np	none	-	full-bc spread and incorp with rotivator	0	t/ha	-	not included as this same as trt1 as all plots rotivated
13	full 0/+y	none	-	full-bc spread and incorp with rotivator	0	t/ha	+y	control- equivalent amt of primer spread and incorp
14	cnut-T500;full10y	cnut-Tav	500	full-bc spread and incorp with rotivator	10	t/ha	y	c'nut -comparison of broadacre "conventional" application with in hole application
15	gv-T500;full10y	guava-Tav	500	full-bc spread and incorp with rotivator	10	t/ha	y	guava -"
16	gv-T500;full10np	guava-Tav	500	full-bc spread and incorp with rotivator	10	t/ha	no	Tav guava -no priming

Site -Vunivasa — Mollisol soil (acidic and moderate fertility)

Split plot design with Aust cnut trts blocked together

5x 4m ie 20 taro plants; 4 reps

6.2 - Biochar

6.2 - Biochar

Objective 6 – By-product utilisation

By-product utilisation

In Summary

- Biochar will have a liming effect, increase K and P soil availability with a possible increase in cation exchange (Mg^{++}, Na^{+}, Ca^{++}, Al^{+++}, K^{+}).
- At sawdust particle size coconut wood is showing potential as a plant growing medium.
- Coconut woodchip can be used as a mushroom growing substrate.
- Composting coconut wood could provide a plant nutrient rich medium for crop production.

Objective 6 – By-product utilisation

By-product utilisation

Key completion dates –

Activity	Planned	Actual
Mulching trials complete	April 2014	Ongoing
Softcore material in Samoan ag. trials	November 2014	January 2015
Assessment of biochar completed	November 2013	April 2014
Biochar produced and used in trials	July 2014	August 2014
Fijiian biochar production trial and reported	November 2014	November 2014

Objective 6 – By-product utilisation

By-product utilisation

Key activities next 12 months –

Activity	Anticipated completion
Report on biochar pot and field trials	April 2015
Continue growing medium trials	December 2014
Developed mushroom growing protocol	January 2015
Commence mushroom trials in PCs	January 2015
Complete compost trial at TTT	June 2015

Objective 6 – By-product utilisation

By-product utilisation

Questions?