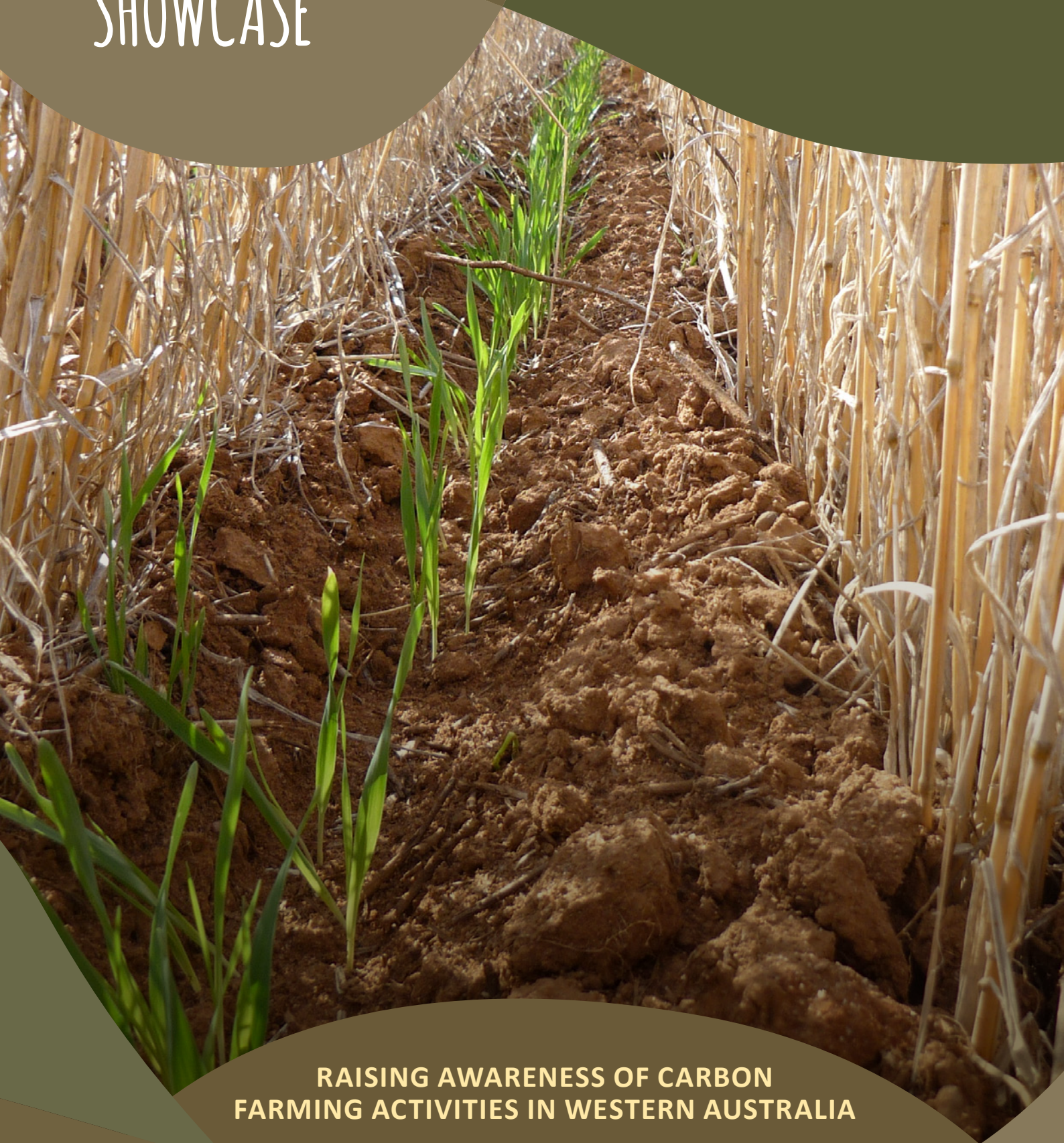
ROYALTIES FOR REGIONS CARBON PROJECT - SHOWCASE



RAISING AWARENESS OF CARBON FARMING ACTIVITIES IN WESTERN AUSTRALIA

SEPTEMBER 2012 – JUNE 2016

THIS PROJECT WAS MADE POSSIBLE BY THE STATE GOVERNMENT ROYALTIES FOR REGIONS PROGRAM

Government of **Western Australia**
Department of **Regional Development**

ROYALTIES FOR REGIONS

GOVERNMENT OF WESTERN AUSTRALIA
Department of **Agriculture and Food**

Rangelands NRM Western Australia

Perth NRM
Creating a sustainable environment

SWCC
south west catchments council

SOUTHCOAST
NATURAL RESOURCE MANAGEMENT

NACC
Managing Natural Resources

wheatbelt natural resource management

NRM WA: CONNECTING COMMUNITIES, LINKING LANDSCAPES

Natural Resource Management (NRM) brings together the people and places of Western Australia through adoption of practical solutions to common issues faced by land managers across our large and diverse State. NRM WA is a collective of seven WA NRM groups, each with a regional focus and direct access to a wealth of grass-roots knowledge as well as the capacity to build efficient networks with industry, research and government.

Western Australia shows clear indications of being negatively affected by a rapidly changing climate. Land managers are at the front line of those affected by climate change and are also leading the way in terms of adopting and trialling innovative practices to improve the resiliency of the landscape.

Our NRM groups have the proven experience to find and work closely with those willing to trial new practices aimed at increasing the sustainability of their farming practices. Therefore, a partnership approach with the Department of Agriculture and Food Western Australia (DAFWA) funded by Royalty for Regions to undertake a carbon awareness outreach program was a natural fit.

By partnering with the NRM groups, the message was taken directly to five regions and delivered by NRM field staff that had established trust networks with members of the community. Through this program, over 1000 land managers were reached through workshops, field days and staffed information displays at regional events. The NRM groups worked with land managers to develop 25 demonstration sites throughout WA to determine how to best capture carbon and restore carbon balance to unique WA land systems.

Despite the conclusion of the formal project, each of the NRM groups has made a commitment to continue to bring the carbon conversation to WA land managers. They will continue to encourage the take up of appropriate carbon practices whether it be encouraging the use of bio-char or driving improvement to soil health. Together we are aiming to put WA land managers at the forefront of making carbon money from their marginal or better land as another income source.

Jim Sullivan, Chair
NRM WA (nrmwa.org.au)
August 2016

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OVERVIEW

In 2012, Royalties for Regions (R4R) awarded funding to the Department of Agriculture and Food Western Australia (DAFWA) to deliver a state-wide, carbon farming awareness project. The project was aimed at building the capacity of WA land managers to gain an improved understanding of the inherent risks and opportunities of carbon farming, take advantage of opportunities as they arise and ultimately grow prosperity through diversification of activities in WA. In order to build capacity at all levels and strengthen linkages between research and land managers, DAFWA opted to partner with six WA NRM groups to deliver the project. Together the partners worked to fill research gaps and improve general understanding of the complex and dynamic federal carbon legislation and carbon market environment.

PUBLIC AWARENESS

By linking the NRM groups together and delegating the responsibility of delivering locally relevant carbon farming information to agencies already located within the communities, DAFWA was able to take advantage of significant economies of scale. Each regional NRM group was able to deliver real, practical information on carbon farming opportunities and risks to the community as well as upskill their project staff—increasing the capacity of the state in carbon related matters at a variety of levels.

Each group delivered public awareness raising activities (workshops, field days and regional events) as well as created and added to a comprehensive package of up-to-date and locally relevant carbon farming science and policy information (webpages, how to guides, case studies).

While it became apparent that land managers were reluctant to engage in exclusively carbon focused efforts, they were open to exploring changes to improve sustainability of their land management practices where carbon was a "bolt on" or supplement to improvements to land management practices. Therefore, the NRM groups put a great deal of energy into attending and manning information displays at regional events, where they were able to engage with a diverse range of land managers and bring the carbon conversation to them while talking about critical local issues—be it dealing with salinity, planting for sandalwood or using compost on dairy farms.

FIELD DEMONSTRATION SITES

For on-ground outcomes and learnings, the NRM groups supported a number of land managers to establish demonstration sites and trials and communicate the results. Through these activities they were able to build the expertise and understanding of carbon farming both in the local land managers as well as in the NRM staff.

During the course of the R4R project, 25 demonstration sites were supported - some with the support of other funding. One site was revisited to gather further samples and thus update results, due to improved methods to derive carbon content of the soil and flora.

The majority of demonstration sites that were established were done so on the proviso that they would test initiatives aimed at generating a direct production benefit and were expected to have carbon co-benefits. Farmers and pastoralists were quick to support initiatives that would directly benefit their bottom line (increase profitability), with openness to explore initiatives that featured improvements to land management practices.

A number of case studies and other publications (i.e. reports) were written to disseminate the results of the demonstration sites more widely. By the end of the project, over 130 communication products were generated (excluding this document) and widely distribution.

The five NRM groups involved included:

- Northern Agriculture Catchment Council (NACC)
- Rangelands NRM (RNRM)
- South West Catchment Council (SWCC)
- South Coast NRM (SCNRM)
- Wheatbelt NRM (WNRM)

NACC (9 SITES DELIVERED)

- Carbon sequestered by mallee eucalypts with Melaleuca shrubs
- Carbon sequestered by saltbush fodder shrubs with scattered Eucalyptus
- Carbon sequestered by salt tolerant species - mixture of trees and shrubs planted along a waterway
- Salt tolerant shrubs and trees with tree species (mainly Eucalyptus) planted on the adjoining lower slopes.
- Shrubs planted on three waterlogged and salt-affected flats
- 3–5 row belts with salt tolerant trees planted on waterlogged and salt-affected flat
- Row belts with salt tolerant trees and some shrubs planted on waterlogged and salt affected flats and gentle slopes
- 2–4 belts of mallees, narrow unplanted alleys between the belts
- Small block planting alongside a saline flat planted with salt tolerant trees and shrubs

RANGELANDS NRM (4 SITES DELIVERED)

- DeGrey (2014) benchmark carbon sequestered above and below ground - 6 land systems
- Muggon (2012) - 3 land systems
- Meka (2013) - 2 land systems
- Yoweragabbie (2013) - 1 land system

SOUTH COAST NRM (4 SITES DELIVERED)

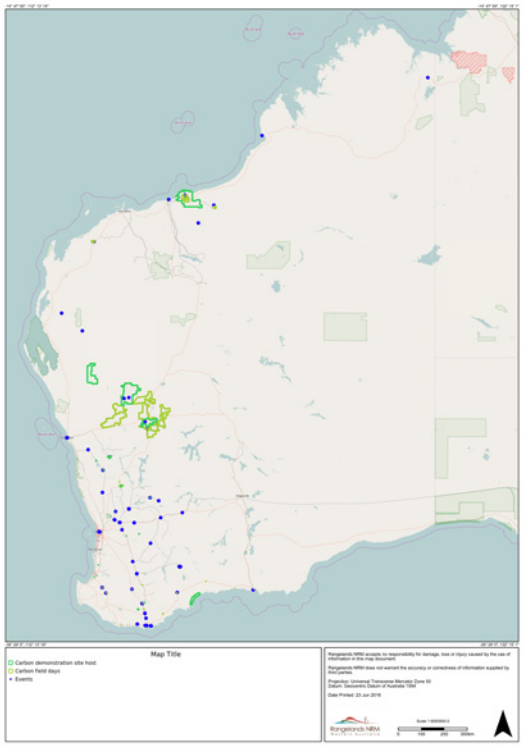
- Comparing soil carbon sequestration under different farm systems
- Reduce methane emissions intensity using different grass species
- Carbon sequestration in native species planting
- Sequesting carbon into soils by improving soil biology - improving bottom line

SOUTH WEST CATCHMENT COUNCIL (3 SITES DELIVERED)

- Soil microbial processes and soil carbon for dairy pastures amended with compost (3 sites)

WHEATBELT NRM (5 SITES DELIVERED)

- Direct seeding of Sandalwood Plantation
- Oil Mallee Mulching - Soil Conditioning
- Browning manuring legumes to increase soil carbon
- Forage shrubs for grazing and carbon
- Forage shrubs for grazing and carbon



FARMER AND PASTORALIST SUPPORT

Due to the complex and dynamic state of land tenure in WA and the limited information in regards to the carbon carrying potential of the majority of WA land systems; there remains a number of systematic constraints limiting the viability and therefore constraining the take-up of carbon projects in WA. However there has been a steady increase in the interest, number of requests for information and willingness to take-up projects with potential carbon co-benefits since 2012.

LEGACY

All groups have a commitment to continue featuring carbon farming information resources on their websites and continue to develop and share information products with land managers working in their regions post project.

Some groups have developed new carbon farming websites. For example, South Coast NRM has developed the Climate Action Website (climateactionfarming.com.au) which is designed to be a one-stop-shop for relevant carbon resources for the WA South Coast region. South Coast NRM and other groups have leveraged the R4R funding with additional grants provided by Action on the Ground (Round 1 and 2) and the National Landcare Funding to expand, continue and diversify trials happening on demonstration sites created through the R4R project.

Other groups such as Rangelands NRM and NACC, have created new data that will guide future land management decisions based on responses to salinity of the soil and WA land systems. More specifically, Rangelands NRM has utilised and updated the findings from previous carbon soil benchmarking trials completed by DAFWA and has plans to disseminate the results more widely over the coming year.

All groups remain committed to continuing to bring the conversation about how to “make money from carbon on your land” direct to WA land managers for the years to come.

Representatives from DAFWA and the NRM groups met on a regular basis. (L to R) Mike Christensen (SWCC), Peter Russell (RNRM), John Silver (RNRM), David Broadhurst (SCNRM), Wendy Wilkins (SWCC), Sarah Jeffery (NACC), Henry Brockman (DAFWA) and Jo Wheeler (WNRM).

CARBON CROSS-REGIONAL COLLABORATION PROVES A GREAT SUCCESS

The Carbon Farming Awareness Project, funded by the Western Australian State Government Royalties for Regions (R4R) Program, saw the Department of Agriculture and Food WA (DAFWA) and five of the Western Australian Natural Resource Management (NRM) groups working with the community to show the profitability and productivity potential of carbon farming.

WHAT IS CARBON FARMING®

Carbon farming is the process of changing agricultural practices or land use to increase the amount of carbon stored in the soil and vegetation (sequestration) and to reduce greenhouse gas emissions from livestock, soil or vegetation (abatement) such as through the management of fire, machinery use, transport, production and use of fertiliser, and rumen fermentation from animals.

Carbon farming offers landholders financial incentives for improved productivity, profitability and environmental co-benefits with the potential of income from participation within the Emissions Reduction Fund (ERF).

COLLABORATIVE EFFORT

The Carbon Farming Awareness Project was a collaborative effort between DAFWA and five regional natural resource management groups: Northern Agricultural Catchments Council (NACC), Rangelands NRM, South Coast NRM, South West Catchment Council (SWCC) and Wheatbelt NRM.

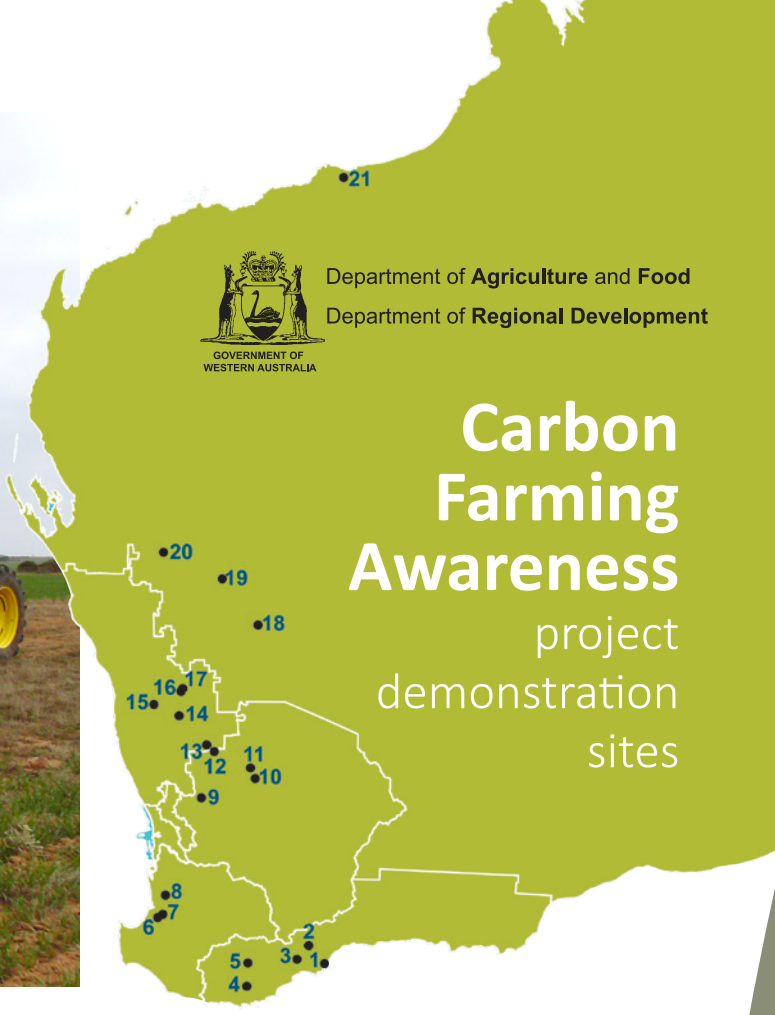
A sixth group, Perth NRM, contributed as coordinator during the first half of the project. The responsibility was subsequently transferred to Rangelands NRM who undertook key coordination tasks including contracting other groups, compiling reporting, undertaking evaluation and assisting with communication.

Dr Henry Brockman, Project Manager Carbon Farming at DAFWA said the way the system was set up with one organisation taking the key coordination role was crucial to the effective delivery of the awareness campaign and to the highly successful collaboration of the five different Regional NRM groups and DAFWA working together.

“The success achieved with this system shows that the Regional NRM groups can deliver a coordinated state-wide delivery of extension and can serve as a model for a future way of working,” he said.

The aim of the collaboration was to work towards developing an understanding in regional WA of the productivity, profitability and sustainability potential of carbon farming, associated risks and supporting communities to responsibly manage their natural resources.

Machine tree planter



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Carbon Farming Awareness project demonstration sites

The project developed a strong understanding of the opportunities and risks that carbon farming presents, establishing demonstration sites and undertaking public events including field days and workshops to showcase a diverse range of carbon farming activities.

"Added benefits have been the feedback received via communications with land managers; plus guidance, a peer review of the process and of information via the steering committee," Dr Brockman said.

DEMONSTRATION SITES ACROSS WA

Since the project was initiated in 2012, 25 demonstration sites have been developed across the Pilbara in the north to the south coast of WA. These sites have shown how diverse carbon farming activities can be.

In the high rainfall regions of the south west, demonstration sites were established evaluating the benefits of adding compost to dairy farms for pasture growth rates and soil organic carbon, while another trial looked at the use of biochar as a carbon sequestration tool. In south coastal regions, soil organic carbon increases under biological farming techniques and reducing emissions from livestock with perennial grazing systems were key carbon farming activities. Across the central and northern Wheatbelt, on-farm examples of carbon farming looked at brown manuring crops, sandalwood plantations and forage shrub plantings for carbon storage. Across the rangelands, sites demonstrated how much carbon is stored above and below the soil.

These sites all feature on the NRM WA Sustainable Agriculture Trial and Demonstration Site website www.agtrialsites.com.

SHARING LEARNINGS WITH EACH OTHER AND THE COMMUNITY

Over the past few years, the groups have been sharing their learnings with each other and the broader community. Having a carbon farming contact in every region has allowed people to ask questions about carbon farming and what this might mean for their enterprise.

Thousands of people have been involved in the program, talking carbon farming with project team members at hundreds of events held across WA.

Sarah Jeffery, Carbon Farming Coordinator at NACC said the collaborative nature of the project meant that all of the regions are working together for the mutual benefit of WA land managers.

"It's been great to see everyone learning from each other and, in turn, all of our land managers also benefiting from it.

I believe that this is what has made this project successful," Ms Jeffery said.

"Linking NACC and the other regional NRMs has undoubtedly increased awareness of carbon farming among farmers across all of the NRM regions as well," she said.

SWCC Project Manager Wendy Wilkins (centre) discusses carbon options at Balingup Small Farm Field Day 2016

"The Carbon world is complex, burdened by shifting policy and vested interests, but it is also exciting".

Rangelands NRM Operations Manager John Silver

Jo Wheeler, Project Manager Sustainable Agriculture at Wheatbelt NRM said the collaboration allowed them to use learnings from the regions to add value to projects happening in their home patch.

"It is great to be able to use other region's research results and information to improve understanding in our community as it means that the wheel doesn't have to be re-invented," Ms Wheeler said.

Dr Peter Russell, former Senior Rangeland Scientist at Rangelands NRM (now a private consultant) said engaging with the other groups helped maintain a high level of enthusiasm for one's own project, even when things were difficult.

BETTER DISSEMINATION OF INFORMATION

As part of this Royalties for Regions program, DAFWA also analysed and captured current and emerging information on carbon farming related policy, legislation and science, to identify carbon farming opportunities and associated risks (www.agric.wa.gov.au/climate-land-water/carbon-farming).

This information was captured in a series of fact sheets, and was then delivered to land managers via the Carbon Farming Awareness Project.

The regular quarterly meetings of all partners provided an opportunity for DAFWA and the NRM groups to share and disseminate results of the project.

Linking the work of the regional NRMs has undoubtedly increased awareness of carbon farming among farmers across all of the NRM regions by taking advantage of existing partnerships and networks and leveraging value.

Dr Mike Christensen, Sustainable Agriculture and Climate Change Planning Program Manager at SWCC said the project has improved collaboration amongst the groups and resulted in better sharing of information.

"The regular communication between groups and individuals has also meant that input from different perspectives on matters relating to project implementation could be gathered," he said.

"The discussion with professional peers also results in improved decision-making based on best practice. This all highlights the fact that having a number of professionals collaborating on a project brings diverse advantages with it, as each person can bring different skill sets to bear on developing responses to management issues."

"We have also benefitted from sharing ideas on how best to undertake extension activities and have been able to have a bigger impact by collaborating on extension activities that reach across the entire state," said Dr Guy Boggs, Program Manager Sustainable Agriculture from Wheatbelt NRM.

This project has not only kept each region's community informed about the ERF, it has proven that cross

region projects do work, allowing farmers to make informed decisions regarding their farming enterprise.

As well as disseminating information through each region's various communication tools, including regular eNews articles and social media updates that reached thousands of people across the state, the group also disseminated carbon farming information and results of trials in 12 monthly instalments of 'RIPE' during 2015—a monthly horticultural, lifestyle and small farms magazine published in WA's biggest selling rural newspaper Farm Weekly.

CONNECTING THE 'COALFACE' OF AGRICULTURE

This project has been able to build on existing projects and initiatives that each NRM region is undertaking with their community, leveraging value from the extensive extension programs and on-ground activities each region is delivering in partnership with growers, community groups, and the broader agricultural industry.

As implemented by not-for-profit, community-based NRM groups, the project has also benefitted from strengthened ties between NRM staff and the community through regular consultation and improved understanding developed at each stage of the process.

Rangelands NRM Operations Manager John Silver said through collaboration, the community now has a better understanding of Carbon abatement and sequestration opportunities.

"The Carbon world is complex, burdened by shifting policy and vested interests, but it is also exciting," he said.

"Changing practices and new information have the potential to produce both an environmental and economic benefit. There are a number of exciting opportunities in which NRM organisations are supporting land managers to incorporate proactive carbon management with business management applications."

New trial planting

Department of Agriculture and Food

GOVERNMENT OF WESTERN AUSTRALIA

Fig. 3 - Walk-Over-Weigher

RANGELAND DECISION SUPPORT SYSTEM (RADSS)

A Pilbara demonstration project used live animal tracking, automatic walk-over-weighing and satellite imagery to improve rangeland management and capture potential carbon farming opportunities.

Previous work by DAFWA indicated that rangeland management can be manipulated to increase the level of carbon stored in rangeland soils and vegetation in certain land types and directly from livestock. Preliminary analysis also suggests that a land manager can successfully sequester carbon while continuing to graze livestock under a modified grazing regime.

The trial—the Rangelands Decision Support System (RaDSS)—was undertaken in a 45,000 hectare 'paddock' on De Grey Station (80km east of Port Hedland); a 380,000 hectare grassland-dominated pastoral station leased and managed by the Bettini family.

The mean annual rainfall is approximately 300mm, summer-dominated with extreme variability. Preparatory work such as familiarisation with proposed trial area, mapping, equipment procurement, trial design and benchmark sampling for carbon content was undertaken during 2014 before the initiation of the animal measurements in late 2014.

Technologies demonstrated and assessed in cooperation with DAFWA, the Federal Department of Agriculture, the Bettinis, De Grey LCDC, Rangelands NRM, CSIRO, Landgate and Revell Science are:

- Taggle live animal tracking: 15 animals with ear tags are tracked; providing live updates every 10 minutes. The 3G-signals from the tags are picked up by three towers (Fig.1) triangularly spaced eight kilometres apart (and sent to a computer). The results are combined over a time period and trends plotted. These trends show where the animals are grazing and over what distance. These trend lines can be retraced to get an indication of what plant species are consumed and to what extent. The tags are also used to track the response of animals to self- shepherding (Fig 2).
- Automatic walk-over-weighing with automated drafting: The solar-powered scale is installed on a watering point and individual animals are weighed (Fig.3) as they cross the scale. Individual animals are identified via NLIS tags and weights sent to the homestead computer. These weights are used in two different ways: i) as a tool to draft animals at a certain weight into a small holding yard to be marketed and ii) as an indication of pasture/forage condition two to three weeks ago (the lag time in animals responding to changes in feed condition). Marketing animals earlier would lead to a reduction in methane production (young animals produce less than older animals; shorten timeframe to produce methane).

Fig. 1 - Towers picking up 3G signals

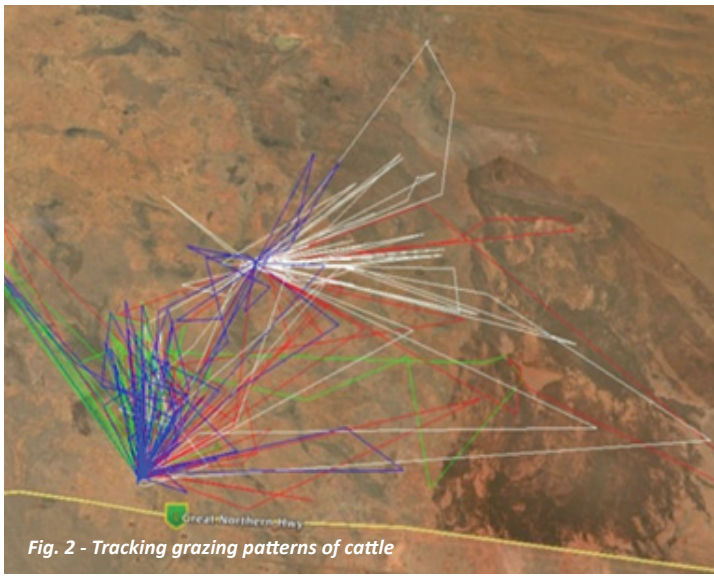


Fig. 2 - Tracking grazing patterns of cattle

- Self-shepherding: Animals are encouraged with feed-attractants to graze under- or un-utilised areas of the landscape/paddock; leading to a more even utilisation of the paddock and the grazing of less palatable plant species.
- Satellite imagery: Pasture cuts and the utilisation of the other mentioned technologies are used to calibrate/validate the RangeWatch biomass model for estimation of pasture growth rate, total green biomass and total biomass. This provides an estimation of available food for cattle and management practises can thus be adjusted accordingly; comparing previous years to the current one. Changes in total biomass would be related to changes in carbon sequestered (Fig. 4 & 5).

This system would be an excellent tool in helping make timely decisions about stock and pasture management; creating a potential record of biomass improvement and therefore potentially earning carbon credits; and be an early warning system for drought conditions.

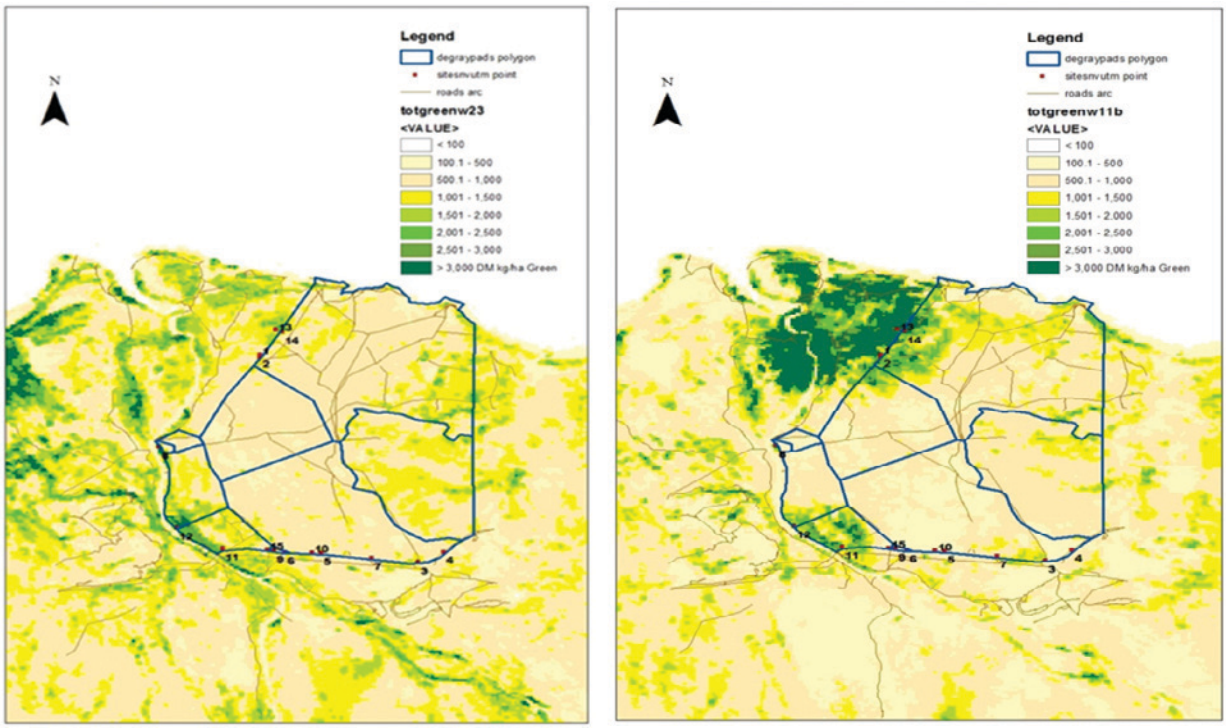


Fig 4 & 5 Changes in total biomass from Week 1 to Week 25 in 2015

Moringa oleifera plant

RENEWABLE CHEMICALS AND BIOPRODUCTS

A potential for agricultural diversification and economic development through carbon sequestration and the avoidance of greenhouse gas emissions

A scoping study was done on renewable chemicals and bio-products and their potential application for WA. Renewable chemicals are a new category of novel products, building blocks and ingredients for the production of chemicals that are produced from renewable feedstock and sustainable advanced manufacturing processes, leaving a smaller environmental footprint than traditional petrochemicals. Bio-based products are mainly non-food products derived from biomass.

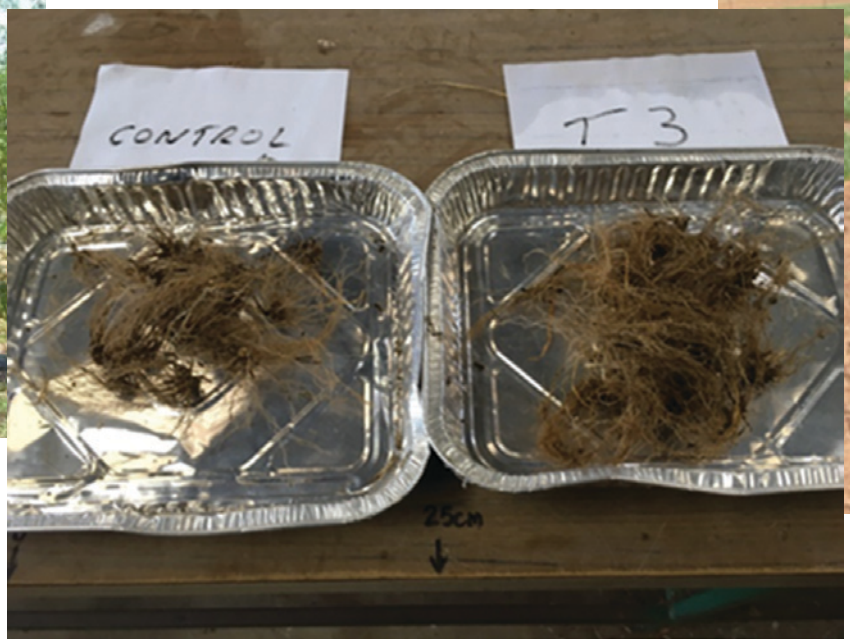
Renewable chemicals represent a market opportunity that is predicted to grow from US$2.8 billion in 2011 to US$98.5 billion by 2020; driven by consumers demanding safer and more environmentally friendly products and the creation of a market advantage by utilising novel products in the manufacturing process.

Capturing a small portion of this market will contribute to doubling the value of agriculture in WA; as well as presenting sustainable diversification options especially for rangeland irrigation precincts (where cold chain management, distance to markets and market competitiveness are negatively influencing traditional horticultural production).

As most of these plant species are perennials, carbon would be sequestered, whilst reducing greenhouse gas emissions through avoidance by replacing synthetics. Opportunities in this regard and positive trends include:

- Irrigation precincts in the rangelands have the potential to provide a wide range of new bio-products and renewable chemicals, which would in the same time, improve the environment. It could vastly expand production on remote locations (e.g. mine dewatering sites) or land not economically viable for traditional horticulture (mainly due to supply chain issues and lack of competiveness in global markets).
- Renewable chemicals present a market opportunity expected to grow dramatically from $2.8billion in 2011 to $98.5 billion by 2020.

DAFWA's Henry Brockman pouring Moringa oil



Impact of phytohormones showed up to a 30 per cent increase in wheat yield

- Market leaders including Dow, BASF, Clariant, Evonik, DuPont, Nestle, Nike, Volkswagen, P&G, Novartis, L'Oreal, ThyssenKrupp, Novamont, Versalis-ENI and M&G Group (part of 44 per cent of 700 chemical companies surveyed) are looking to produce and source more of their chemicals from plant-based feedstock, with plans to increase their use of plant-based materials over the next five years.
- Challenges and new opportunities (such as regulations, activism and new sustainability investment requirements) are rapidly emerging, requiring new thinking, new ideas and new working together throughout value chains and across disciplines.
- On average 94 per cent of resources for manufacturing are discarded as waste. Manufacturers need to make maximum use of every input molecule in the final output product to reduce cost and increase profit.
- New products and markets can create a competitive differentiation/advantage.
- Renewable chemicals have social benefits such as improved health and safety on farm, food safety and human wellbeing.

This scoping study has identified several plant species that merit further investigation through a multi-criteria matrix rating system. *Moringa oleifera* was identified as one of the plant species with the best potential due to its multiple uses with several applications in the food, health, animal feed and chemical industry.

I. Assessments are in process; exploring the commercial use of Moringa leaf protein (up to 30 per cent protein on a dry matter base) as a gluten-free substitute for animal protein in food: a rapidly growing market forecasted to reach US$43 billion in 2020.

II. Moringa oil can be used as cooking oil, cosmetic base or fractionated for industrial and food use.

III. The impact of phytohormones extracted from *M.oleifera* on wheat showed an up to 30 per cent increase in yield. Published data also indicated a 20 per cent increase in yield in tomatoes, peas and maize.

As most of these plant species are perennials, carbon would be sequestered whilst reducing greenhouse gas emissions through avoidance by replacing synthetics.

Vegetation sampling at the Eva's property

MEASURING CARBON IN SALINE AREAS

Chad and Nadine Eva's property, Dookanooka, west of Three Springs provided a perfect location for a collaborative project aimed at measuring levels of carbon sequestration from native species growing in saline soils.

WEST THREE SPRINGS

The 57 hectare trial site was located in a saline valley floor that had been revegetated with a variety of native species that had been planted in 2000 as a wildlife corridor. The plants were all salt tolerant species of trees and shrubs—including a number eucalypts that had been planted on the adjoining lower slopes. On average there were 371 trees and 521 shrubs per hectare.

The trial site was developed by the Northern Agricultural Catchments Council (NACC) and DAFWA, through funding under the Western Australia's State NRM Grants and Royalties for Regions Carbon Awareness Project.

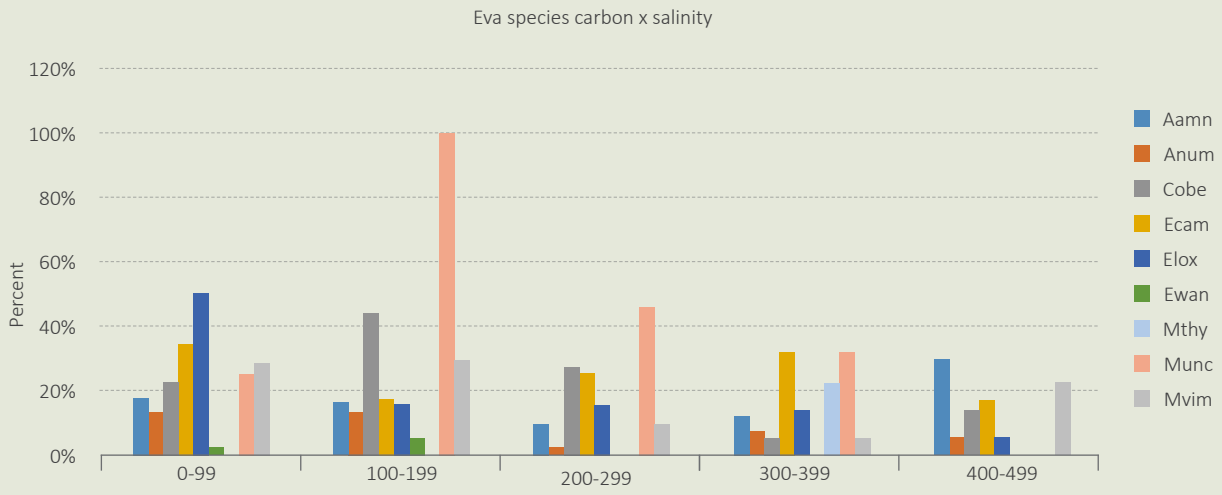
LEVELS OF SALINITY WERE HIGH!

The levels of soil salinity at this site ranged from 37-463 ECa, with a site average of 245 ECa. On the less saline land, it averaged 141 ECa, while on the highly saline areas, it averaged 333 ECa. To put this into some context, wheat starts to lose productivity at 100 ECa, and barley at 150 ECa.

THE PROJECT

A total of 36 plots, each one measuring 0.03ha, were sampled (Figure 1). Within each plot, every tree and shrub was measured - either by stem diameter (trees and mallees), or crown diameter (shrubs). This determined the amount of biomass of each plant and provided the information to estimate the amount of carbon. At every second plot a number of trees and shrubs were destructively sampled to determine the wet and dry biomass, which then allowed allometrics, to be determined.

Figure 1 - Project plots



Graph 1 - Carbon sequestered by each species

THE SPECIES ANALYSED

Nine species were sampled and analysed on this property: *Atriplex amnicola* (River saltbush), *Atriplex nummularia* (Oldman saltbush), *Casuarina obesa* (Swamp sheoak), *Eucalyptus camaldulensis* (Red river gum), *Eucalyptus loxophleba* subsp *lissophloia* (York gum), *Eucalyptus wandoo* (Wandoo), *Melaleuca thyoides* (Salt lake honey myrtle), *Melaleuca uncinata* (Broombush) and *Melaleuca viminea* (Mohan). The range of species provided a great insight into how much carbon could be sequestered by each in varying levels of salinity.

CARBON SEQUESTRATION

The amount of carbon sequestration varied considerably depending on the species and the severity of the salinity. One species which did stand out overall was Broombush ***(Melaleuca uncinata)***. It was found to sequester the highest amount of carbon of all of the species tested. However, on the most saline sites, River saltbush ***(Atriplex amnicola)*** was found to sequester the most carbon.

Graph 1 shows the amount of carbon each species sequestered in a range of salinity levels.

As the salinity levels increased, the amount of carbon which was sequestered dropped. Table 1 shows that there is a clear relationship between the levels of salinity and the amount of carbon sequestered.

Part of the study also looked at the Australian Government's carbon estimation model FullCAM 3.55 and compared these figures with the actual figures recorded from the project (Table 2). The difference between the actual measured figures and the government model figures varied quite dramatically at this site. At the other five sites trialled, only one other overestimated dramatically, while three overestimated, and one underestimated.

Site	Site average carbon at time of measurement (t CO_2-e/ha)	Site area (ha)	Site total carbon (t CO_2-e)
Total site	16.4	56.84	1055
Extreme saline	11	25	275
Low saline	27	32	864

Table 1 - Relationship between salinity and carbon

One of the reasons why the FullCAM 3.55 model may have overestimated at this site is because of the very high levels of salinity. The model doesn't take this into consideration. Also the debris at the site was basically non-existent (potentially due to the young age of the trees), whereas the model will allow a maximum of 35 per cent of the total tree carbon to be used.

Measurement age in years	Salinity (ECa in mS/m)		Tree carbon (t CO_2-e/ha)			Predicted carbon stocks (t CO2-e/ha) from FullCAM 3.55	
	mean	range	At measure age	Predicted 15 yrs	Predicted 30 yrs	Trees only	Trees and Debris*
12.8	245	37-463	16.4	20.4	38.1	64.8	87.4

Table 2 - Comparing estimation with actual carbon

Vegetation sampling in one of the plots

ECONOMICS AND SUMMARY

From the last Australian Government's ERF Carbon Auction (April 2016), the average price paid for carbon was $10.23. This is not a particularly high amount although the top price paid remains undisclosed due to government policies.

With the new regulations for carbon that came into effect on the 1 July 2015, it is no longer possible to claim carbon credits for existing plantings. This means that the Evas can no longer get credits for their plantings.

With the new regulations for carbon that came into effect on the 1 July 2015, it is no longer possible to claim carbon credits for existing plantings.

So what does it mean for farmers who have areas that are affected by salinity? Is it worth revegetating these areas and getting carbon credits? Well, the decision lies entirely with the individual landholder.

There are a number of factors that need to be considered, including but not limited to the following:

- Is the salinity spreading?
- Is it costing the landholder more to put a crop in than the economic returns for this particular area?
- Is the landholder tired of looking at a degraded site on their farm?

Revegetation of these sites is obviously a good idea on many fronts, not least of which being its potential to provide an economic return.

For Eva's site, the amount of measured carbon in revegetated plantings at age 15 years was 20.4t CO_2^{-e}/ha. With the current official price at $10.23 a tonne, this means that in 15 years a landholder will obtain a return of $208.69 per hectare (or on average $13.93/ha/yr). FullCAM 3.55 suggested an even higher return- with this site estimated to sequester 87.4t CO_2^{-e}/ha, realising $894.10/ha (or on average $59.61/ha/yr).

Is it worth it? Some would say yes, others would say no. Some would say that at least it would help with the planting costs, and create an income from non-productive land. Others would say that all of the extra the work is not worth it.

However, it's not just about the money. Financially, carbon credits may, or may not be, worthwhile, but it's all of the additional benefits that come from revegetating these areas that may be even more beneficial. These include increasing biodiversity, providing wildlife corridors, reducing the spread of salinity, reducing input cost hence increasing profit, soil amelioration, surface water management and others.

As shown in this project, species selection is critical when revegetating these sites, and must be a priority consideration in the planning and revegetation of salt-affected areas.

Please note: This Case Study does not constitute financial advice. Please contact a carbon aggregator/company for appropriate financial advice.

Eva Site 1

FOR MORE INFORMATION:

For more information, contact Sarah Jeffery, Carbon Farming Coordinator at NACC on (08) 9938 0110 or at sarah.jeffery@nacc.com.au

Saudi Arabian visitors listen to presentation

INTERNATIONAL VISITORS IMPRESSED WITH WA'S CARBON AGRICULTURE PRACTICES

The Northern Agricultural Catchments Council (NACC) showcased carbon farming practices to eleven senior members of the Saudi Arabian Ministry of Agriculture, who visited the region in November 2014.

The purpose of their visit was to gain a better understanding of how Australian agricultural industries work with farmers in poor soil quality areas, and in the process, the potential of 'carbon farming'.

The visitors were well looked after, with NACC, DAFWA, Farmwoods and local farmers Gary and Kerry Butcher playing host, and showcasing a local project site that had involved measurement of the carbon stocks in trees growing in saline soils.

The Saudi officials expressed some amazement at the high degree of collaboration between industry and farmers, identifying such collaboration as one of the great accomplishments for Australian agriculture. They lamented that partnerships between the sectors were not so well established in their country.

"It was great to be able to show them one of the region's six carbon salinity sites to compare, share and discuss international practices," NACC Carbon Farming Coordinator Sarah Jeffery said.

While the quantity of carbon sequestered at the site was not especially high, land-owner Gary Butcher said the vegetation on the site was still extremely important to the whole farm system.

"The stubble, the pasture, the saltbush, and the trees all work together," Mr Butcher said.

The Saudi Arabian officials also showed particular interest in better understanding Australia's approach to revegetation on farms, including what species were used and the amount of carbon sequestered.

One species that created a lot of interest was the bluebush (*Maireana brevifolia*)—as the visitors had not come across this species before, and were interested in how it self-sowed without having to be planted. Another relatively common species, Oldman saltbush (*Atriplex nummularia*), was also major talking point at the site—as this species is also used in Saudi Arabia for revegetation of saline land.

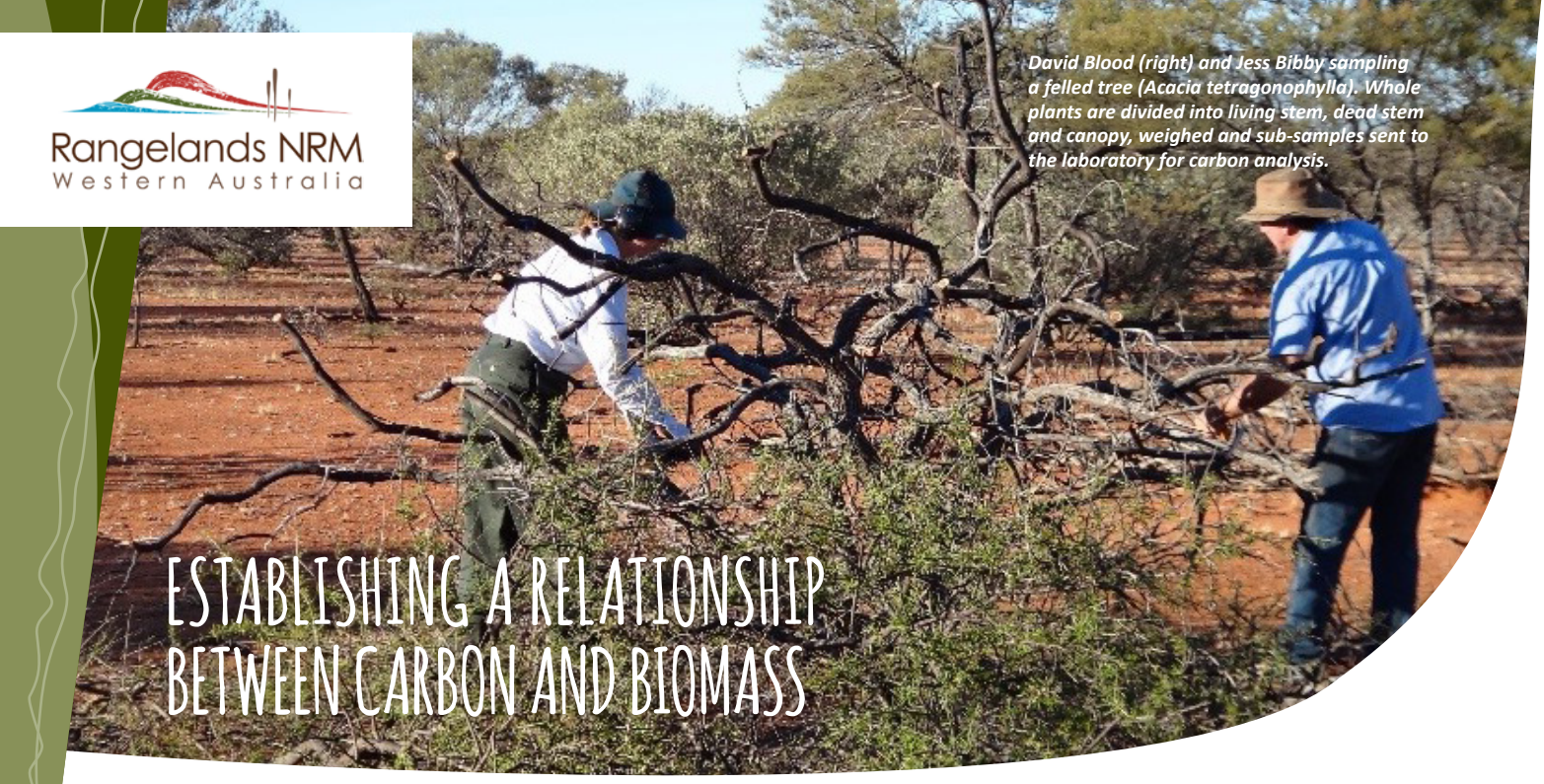
"Another interesting discovery was learning that in Saudi Arabia, much like in many of the drier parts of Australia, they often have little or unpredictable success with direct seeding for revegetation and also use seedlings over direct-seeding," Ms Jeffery said.

"This was actually quite fascinating. They explained to us that they had been using seedlings as a preferred method to direct-seeding, but were under the impression that this might be seen as the non-preferred practise and almost seemed relieved to find out that we actually do this too."

"Another great outcome was hearing from their tour guide for the trip, Adrian Williams, who mentioned that the Saudi officials went home with a new perspective on land management and farm forestry. How can that not make Australia feel proud," Ms Jeffery said.

The visit was funded by the Food and Agricultural Organisation of the United Nations (FAO) and the Western Australian Government's Royalties for Regions program.

Rangelands NRM
Western Australia



David Blood (right) and Jess Bibby sampling a felled tree (Acacia tetragonophylla). Whole plants are divided into living stem, dead stem and canopy, weighed and sub-samples sent to the laboratory for carbon analysis.

ESTABLISHING A RELATIONSHIP BETWEEN CARBON AND BIOMASS

As part of the Royalties for Regions Carbon Awareness Program, Rangelands NRM undertook an extensive, land system-based soil sampling and vegetation measurement program across the Murchison and Pilbara regions of WA.

Working with pastoralists and other land managers, a number of demonstration projects were set up. Each project consisted of a substantial field campaign of soil and vegetation sampling on particular land systems, in areas where a change of land use, management practice or intervention was to be implemented.

The primary aim was to accurately estimate carbon stocks and study its distribution across the landscape. Through extrapolation, this data may then be used to estimate above- and below ground carbon stocks for particular defined areas such as a paddock, group of paddocks or entire land system.

Dr Peter Russell, of Peter Russell Living Geology (former Senior Rangeland Scientist at Rangelands NRM) said this work has allowed carbon stocks for each trial site to be calculated.

The program also aimed to increase awareness of the opportunities, benefits and risks for pastoralists and other land managers and custodians in the WA rangelands who are considering participation in future carbon abatement programs in the form of 'carbon sequestration'—storing organic carbon in vegetation and soil.

CARBON TRIAL SITES

Three project areas were set up as new trials—Meka Station (in the Murchison, north of Yalgoo and west of Cue), De Grey Station (in the Pilbara, 80km east of Port Hedland) and Yoweragabbie Station (in the Murchison, between Mount Magnet and Yalgoo).

Previous to this project, two other sites had been sampled: one land system on Yalleen Station (in the Murchison, near Pannawonica) - with rotational grazing (2011); and three land systems on Muggon Station (in the Murchison, near Mullewa) de-stocked (2012).

During the course of data analysis, it was decided that the previously sampled Muggon Station lacked some crucial data, and so it was visited for resampling, becoming the fourth and final demonstration site.

An important aspect of this work, known as 'land system characterisation', helps to understand the distribution of sequestered organic carbon stocks in the rangelands. Different land systems have different proportions and amounts (stocks) of carbon held in the above-ground biomass (vegetation) compared with that held by below-ground (soil) biomass. This is absolutely essential information for future feasibility studies that will need to be done by carbon credit or offset project proponents.

Example of sparsely vegetated mulga shrubland of the Yanganoo-Belele land system, Meka Station (May 2013)

Quadrat for sampling above-ground litter.

Data was collected to enable calculation of total above-ground biomass and carbon density or concentration (tonnes of carbon per hectare- tC/ha) for the parts of each land system sampled.

- De Grey Station – six land systems: 1) Horse Flat 2) Nita 3) Anna 4) Yamerina 5) Little Sandy 6) Paradise
- Meka Station – one land system 1) Yanganoo-Belele
- Yoweragabbie – one land system 1) Woodline
- Muggon Station- collection of further biomass sample data to bring Muggon data in line with Meka and Yoweragabbie data.

Field sampling techniques and procedures were developed by ecologists for these projects. Separate sampling of tree and shrub parts (foliage, branches, trunk and standing dead), grasses, herbs, and ground litter) were undertaken for above-ground carbon. Soil core samples were taken for below-ground carbon analysis. All samples were sent to ChemCentre for chemical analysis.

These techniques and procedures were appraised for practical efficacy, accuracy and precision as part of a broader effort to develop a suite of practical field-based and remotely-sensed techniques that can be cost-effectively applied in WA rangelands. Equipment included a portable, hand-operated and vehicle-mounted drilling machines for soil sampling, grass biomass estimation techniques (Comparative Yield and Falling-plate techniques) and directly measured field estimates of shrub and tree biomass to calibrate remotely sensed biomass estimates.

Field sampling methods more cost effective

One aim of this work was to reduce the number of field measurements and samples taken in each plot, and ultimately make the field sampling more cost effective.

Dr Russell said as a result of the thorough field data collection method designed by project ecologists, very detailed statistical exploration of relationships between the plant metrics and contained biomass and organic carbon was able to be undertaken.

“As more and more field data was accumulated from each successive project, the field method was progressively refined and streamlined so that only those metrics showing promising relationships were measured,” he said.

The result of this detailed systematic work was that the number of useful field measurements and samples was considerably reduced, and statistically robust relationships between a few simple plant metrics and contained biomass and carbon were established.

Establishing a statistical relationship

Another aim of the work was to establish a statistical relationship between total above-ground biomass and total below-ground carbon for each land system.

Dr Russell said the relative amount of organic carbon sequestered (stored) above-ground in the vegetation and below-ground in plant roots and soil is known as partitioning, and is a fundamental characteristic of land systems in the rangelands and a function of soil and vegetation types.

“Based on the work in the Pilbara and Murchison regions it was found, in general, land systems comprised of grasslands on alluvial soils partition more carbon below-ground compared to above-ground,” Dr Russell said.

“In contrast, land systems comprised of ‘woody’ vegetation such as mulga woodlands on sandy loams over shallow ‘hardpan’ partition most of the carbon above-ground.”

He added, “Of course, land systems comprising a combination of ‘woody’ vegetation over alluvial soil will usually have more even partitioning of carbon stocks, and there are some land systems with extreme partitioning.”

Weighing biomass as part of carbon sampling at Muggon Station

THE FUTURE: REMOTELY ESTIMATING CARBON CONTENT

Given the time and resources it takes to sample both above and below ground in order to determine carbon content, finding an existing relationship that can be used to estimate the carbon content by looking just at vegetation, would be very advantageous.

In the tussock and hummock grasslands of the northern rangelands of WA, it was already well established that a relationship exists between grass canopy diameter and contained biomass (and carbon).

> "From this work we have successfully established statistically robust relationships between selected plant morphological metrics and contained biomass and carbon," Dr Russell said.

"This means that remotely-sensed estimates of biomass, when calibrated by direct field-measurements such as the Comparative Yield Method, are reasonably reliable," Dr Peter Russell said.

However, the situation in the shrublands/woodlands of the southern rangelands is very different, particularly in the mulga woodlands, and it has been a challenge to adequately measure above-ground carbon stocks without having to harvest and weigh all plants in each sample plot. Additionally, most of the above-ground carbon is held in the 'woody' plants such as mulga, compared with the limited amount held by shrubs and grasses.

To address this major difficulty, a huge effort was put into the Meka and Yoweragabbie demo projects, with some significant results.

"From this work we have successfully established statistically robust relationships between selected plant morphological metrics and contained biomass and carbon," Dr Russell said.

The most consistent robust tree metrics are particular canopy dimensions.

"This is a very good finding because trees, which contain most of the carbon, can be easily measured using particular remote-sensing techniques," he said.

"This means that the current high cost of carbon stocks assessment by field methods could be reduced substantially by the use of remote-sensing."

Dr Russell added that the new data will be used to inform computer (numerical) models of carbon sequestration in order to predict future carbon stocks under a variety of land management scenarios and will also inform or calibrate remotely-sensed biomass data acquired by satellites, unmanned aerial vehicles (UAVs) and light aircraft.

"In the near future, we believe remotely-sensed estimations of carbon stocks will become routine and very cost effective," Dr Russell said.

Sampling ground organic matter or litter, an important component of the above-ground biomass in a mulga woodland.

INCREASING CARBON KNOWLEDGE IN THE RANGELANDS

George Woolston undertaking soil surface condition assessment at De Grey Station.

Extensive land system-based soil sampling and vegetation measurements has been undertaken at several stations in the Murchison and Pilbara regions to estimate carbon stocks and study distribution across the landscape in areas where a change of management practice or rehabilitation is proposed.

The original trial sites were undertaken in areas where a change of land use, management practice or intervention was to be implemented.

As part of this project, a specific grazing trial was undertaken on De Grey Station. Carbon samples were taken to provide benchmark carbon figures, so that the effect of the grazing trial on carbon sequestration can be properly estimated in the future.

Dr Peter Russell said changes in carbon storage in rangelands occur due to differences in rangeland management.

“Changes to pasture management can influence grass growth, increase carbon capture from the atmosphere through photosynthesis, and increase soil microbial activity,” he said.

“This means that carbon farming in rangelands through changes in rangeland management could be a viable option in the future,” he said.

Dr Russell said changes to management aiming for increased carbon sequestration needs to focus on the major carbon storage route—trees in woodlands/shrublands and grass in grasslands.

“Removing livestock may enhance tree recruitment, but may not influence the growth of trees that are taller than the grazing browse line, although removal of goats and other feral animals will reduce browsing,” he said.

Once grazing/browsing is removed, tree growth and carbon storage are influenced by soil moisture and soil fertility. Soil moisture can be enhanced by pitting and other landscape rehydration techniques, and soil fertility can be enhanced by promoting soil microbial activity.

These robust benchmark studies, completed prior to change implementation, provide fundamental information to those considering the bold new carbon world. Participation in carbon credit projects will take considerable courage and knowledge, but the ability to do so could be the catalyst for major necessary changes to land management. These changes include multiple, integrated land use in the pastoral rangelands to improve ecological health, productivity, enterprise viability and wider social benefits.

Carbon awareness supports our vision for economically sustainable and ecologically healthy rangelands, recognising the pragmatic necessity to balance derivation of income from use of natural resources, including use in cultural and recreational pursuits and the maintenance of intact, functional ecosystems.

9.5 year old ewes lambing

INCREASING SOIL ORGANIC CARBON – THROUGH BIOLOGICAL FARMING

Stephen and Kerry Frost farm at Narrikup, a small town located approximately half-way between Albany and Mt Barker in the Great Southern region of Western Australia. The Frosts have spent many years investigating and implementing a wide range of land management practices centred on maintaining and improving the health of their soils. These practices have allowed them to 'grow their own carbon'.

The Frosts hold the firm belief that when actively engaging in conservation practices and striving to increase biodiversity in a whole-of-farm management system, not only does the productivity improve, but so too does the profit.

NAME: Stephen & Kerry Frost
LOCATION: Stonemeal Farm, Narrikup, WA
AVERAGE ANNUAL RAINFALL: 692 mm
ENTERPRISE: 100 per cent livestock (wool & prime lamb production)
PROPERTY SIZE: 275 ha, including 40 ha of protected & managed remnant vegetation & 57 ha of blue gum plantation in second rotation
SOIL TYPE: Sandy duplex

THE IMPETUS FOR CHANGE

Red flags were raised when differences were observed between newly cleared and established lands, particularly:

- Stock health was better on the new land.
- Salinity was rapidly developing on the new land.
- Pasture disease was prevalent on the old land (red-legged earth mite, pasture scorch and powdery mildew).
- Clover growth was significant on new land, while the older land had decreasing clover in well-established pastures.
- Fecundity of ewes was lower on the older land.
- Wool from ewes aged six and a half years and older, was found to be going off (yellowing and excess greasiness) on the older land.

The conventional approach to tackling these issues required a reliance on chemicals, increasing input costs and the development of an increasingly complicated and environmentally stressful farming systems.

Stephen Frost feels today's conventional farm management forces farmers to deal reactively with issues facing them.

"Whether it's stock health, soil issues, plant health and disease, with never enough time to be proactive and preventative in management. Biological farming has allowed us to be proactive, leading to a lot fewer issues in our farming program," he said.

So, in the mid-1990s, the Frosts decided that 'a living soil was their number one priority, their greatest asset' and they set about making changes to their management principles and practices, based around biological farming ideals.

The Frosts' initial focus was on applying mineral fertilisers to 're-mineralise the soil' for plant growth and optimal animal and human nutrition. This was done with the understanding that the difference between the newly cleared land and the established land, was mineral related, with mineral deficiency symptoms being observed in their animals.

Stephen began looking at the non-take-up of minerals by plants. Following their focus on re-mineralisation and further networking, investigation and research, the Frosts were introduced to soil microbes and began using them on their farm.


Stephen Frost in Big Dam


Rye crop at Big Dam


Pasture establishment

BIG DAM PADDOCK: LOW PH, HIGH SODIUM WITH DENSE PASTURES

Of particular interest at Stonemeal Farm is the paddock known as Big Dam. This paddock, which has numerous granitic dykes dissecting the landscape, was cleared in the 1980s. Salinity was expressed shortly thereafter, evidenced by bare, salt scalded ground, salt tolerant grass dominated pastures (barley grass) and groundwater and surface water monitoring results.

After implementing biological management practices (introducing minerals and soil microbes), the paddock now has no salt scald present or salt tolerant varieties dominating. It currently produces dense clover and rye dominated pastures with "exceptional grazing and fodder production".

During a fodder production phase, the Frosts will graze a sown paddock two to three times and then lock it up in August, generally yielding 25, 6ft rolls/ha.

In 2014, the Big Dam paddock was grazed through to mid-October and due to late rains, was opportunistically locked up and cut in mid-November yielding 16, 6ft rolls/ha.

Ongoing monitoring indicates that soil and water salt levels remain high. However, Stephen feels the effects are drastically reduced in the Big Dam paddock as a result of the applied biological farming principles.

With so much conflicting information, science and advice about soil health, Stephen encourages farmers to "find someone who is successfully working on an area of interest to them and find out what they are up to."

Total organic matter indicated in 2012 in the Big Dam paddock sampled topsoils was measured at 7.4 per cent with organic carbon at 4.4 per cent.

Show paddock, which also exhibits low pH soils, has an increasing total organic matter and organic carbon level.

Total organic matter increased from 5.5 per cent to 8.4 per cent and organic carbon increased from 3.3 per cent to 5 per cent in the decade between 2002 and 2012.

Biological management principles and monitoring are ongoing at Stonemeal Farm. Stephen feels the microbial carbon and organic matter carbon of soils "are a direct result of how you treat the soil and what you don't do to it".

STONEMEAL FARM PRODUCTION TODAY

Stonemeal Farm is highly profitable, producing prime lambs and wool with Merino, moving to Multi-Purpose Merino breeds. The Frosts' focus is on high lambing percentages and utilising the full reproductive age of their ewes, with one mob lambing in 2015 at nine and a half years old. Stephen expects this mob to lamb at between 140 and 150 percent in the 2015 season. The Frosts' lamb selling percentage for 2014 was 126 percent (with the family's yearly lamb supply held back) indicating a high proportion of multiples. In mid-May 2015, when most mobs were lambing, Stonemeal Farm was carrying 'three ewes per acre" (7.41 ewes/ ha). When accounting for the lactating ewes and the prominence of twinning, the dry sheep equivalent (DSE) at Stonemeal Farm at that time was between approximately 17 and 20 DSE (DPI, 1997), which is well above the long-term district average stocking rate for Mt Barker of between eight and 10 DSE/ ha (Hyder et al, 2002 and MLA, 2008)

"Since using both mineral fertilisers and soil microbial inputs, we have found other farm inputs have reduced considerably," Stephen said.

"There is little to no requirement for broad-acre pesticides, no nitrogen inputs for fodder crops, less requirement for liming to maintain and improve production, no requirement for stock mineral supplements and reduced veterinary intervention. The farm is primarily self-sustaining in fodder production".

The Frosts "hardly ever cultivate" having moved to direct drilling of perennial grasses into established pasture without the use of herbicides.

"It is more economical and also allows the pasture to be grazed a lot sooner," Stephen said.

The build-up of carbon in their soils is just one of the benefits of adopting a more integrated farming system.

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The full article and more can be found at - climateactionfarming.com.au

USING NATIVE GRASSES TO INCREASE SOIL CARBON AND REDUCE SALT SCALD

Compared with current annual-based systems, perennial pastures introduced into Australian farming systems offer an acceptable balance between food and fibre production as well as many environmental benefits.

Tim & Val Saggers in kangaroo grass stand

NAME: Tim and Val Saggers
LOCATION: Kendenup, WA
AVERAGE ANNUAL RAINFALL: 400 mm
ENTERPRISE: 90 per cent livestock (sheep), 10 per cent cropping
PROPERTY SIZE: 480 ha
SOIL TYPE: Gravel over clay

The ability of perennial pastures to utilise dry season moisture extends the growing season in summer and autumn, thereby increasing production potential.

Along with this direct economic benefit, perennial plants have a vital role in reducing land degradation (e.g. salinity, erosion, acidity) through their deep root system which in turn, prevents loss of potentially productive land.

Tim and Val Saggers have a keen interest in their farm's soil carbon as a means of continuing their environmentally managed farming system.

"Our aim was to build up biomass in the salt affected areas by using natives such as chenopods (samphire, saltbush, blue bush and rhagodia), acacias, eucalypts, casuarinas, kangaroo and wallaby grass," Tim Saggers said.

Carbon farming aims to assist in mitigating climate change by increasing production and sequestering carbon in the landscape.

Perennial pasture is generally expected to store more soil carbon than annual pasture due to highly developed root systems.

In December 2012, an assessment of soil carbon was conducted on a stand of native perennial pasture kangaroo grass (*Themedatriandra*).

Although it was evident a slight trend towards native perennials showed higher total carbon and nitrogen than annual pasture, the difference between them was not significant. At the time of testing, the native perennial pasture had been established for three years. As this type may be less productive than annual pasture over the first two or three years (Butler, 2008), a longer assessment period could explore greater details of carbon dynamics.

"We could see our soil had improved just by looking at it. So, as a next step, it would be good to know if we're seeing any benefits of increased soil carbon through adoption of our environmentally managed farming system," Val said.

"The landcare over the past 10 years has helped the salt scald land become viable again. Planting up the farm's fragile areas with native perennials means it's more sustainable and productive for future use."

REFERENCE –

R. Butler (2008) *Native Perennial Grass-based Pastures in the Eastern Wheatbelt*, Department of Food and Agriculture Western Australia, Note 234, Merredin.

The full article and more can be found here- climateactionfarming.com.au

Salt scald

RESOURCES HELP UNDERSTAND CLIMATE PREDICTIONS

The South Coast region is already experiencing the impact of climate change. Rainfall has decreased 10–20 per cent in the past 30 years and there has been an overall warming of temperatures. Further declines in rainfall are predicted. The Climate Action Farming website aims to provide the South Coast community with resources to help understand climate predictions for the region, how they might impact their farming enterprise, and what they can do to manage that risk.

To help the community and land managers to adapt to these climatic changes, the website contains information relevant to the south coast region. The website includes Carbon Farming in WA (DAFWA) that focuses on typical West Australian agricultural topics. It also includes a series of Royalties for regions "How to Guides and case studies".

General information is complemented by information from carbon focused projects such as the Australian Government's Action on the Ground projects that examined soil carbon and methane emissions. This part of the website features farmer case studies and short films. More case studies and short films are being added so check in regularly to view new content.

South Coast NRM has produced maps that can help land managers to plan for climate change. These include maps of the latest climate predictions for the region and actions such as revegetation that will help to improve landscape resilience under a changing climate. These maps also identify preferred

sites for carbon plantings that take into consideration priority agricultural land, hydrology and biodiversity

The maps were developed using observations and expertise from local community members and technical experts. The mapping tool used was Multi Criteria Analysis Shell (MCAS-S) The web site also includes a regularly updated list of carbon related links as well as your local contacts for the south coast.

climateactionfarming.com.au

SPREADING THE CARBON STORY THROUGH PARTNERSHIPS!

Maximising soil carbon should be a priority for every farmer. Soils high in soil carbon have better water holding capacity, diverse bacterial communities, provide nutrients and energy for biological processes, improve the structural stability of soils, alter soil thermal properties, enhance pH buffering and enhance cation exchange.

To spread the word about the value of soil carbon, South Coast NRM partnered with a variety of research institutes, industry groups and farmers to conduct locally based demonstration, research and extension helping to provide information on the carbon story. While conducting the Royalties for Regions Carbon Project, South Coast NRM implemented complementary carbon/climate change programs to provide depth to our understanding and to create an ongoing legacy regarding carbon, carbon farming and the carbon economy.

An example of this is South Coast NRM partnering with CSIRO and the Gillamii Centre to measure methane emissions and live weight gain from merino sheep grazing perennial forages established on marginal farmland compared with an oat stubble site in Cranbrook during autumn 2016.

The results of this trial are encouraging. Merino sheep weight gain was higher during the autumn period compared to the stubble fed group. Methane levels also increased in the perennial forage group however the rise was not proportional to the increase in live weight gain, but still resulted in a more efficient outcome from the shrubs than the stubble grazing.

This result is positive for farmers in the region. The use of perennial forage shrubs in marginal farmland has the potential to:

- significantly increase livestock production without major increases in livestock methane emissions;
- reduce the impact of the autumn feed gap;
- provide direct on-farm environmental benefits; and
- provide an opportunity for the land manager to participate in the carbon economy.

South Coast NRM will continue to foster partnerships that encourage local research and extension efforts to provide farmers with examples of how farms can increase soil carbon, reduce methane emissions while maintaining or improving production in their own patch.

This project is supported by South Coast NRM, through funding from the Australian Government Department of Agriculture and Water Resources—Action on the Ground program and the Commonwealth Scientific and Industrial Research Organisation (CSIRO).

RAISING CARBON FARMING AWARENESS IN THE SOUTH WEST NRM REGION

Landholders in the South West Catchments Council (SWCC) region are much better informed about the risks and opportunities of carbon farming as a result of the Carbon Farming Awareness project that ran from 2014 to 2016.

The Project Manager attended seven regional events, held four field days and two workshops, and established three demonstration sites from Walpole to Harvey and from Vasse to Katanning. A total of 1,106 Project Fact Sheets were taken at the events. One case study, two fact sheets, one trial report, six tailor-made handouts and one event write-up were also produced. Project materials are available on the SWCC website.

BIOCHAR–BLACK MAGIC?

Mystery surrounds the benefits of Biochar, so it was little wonder that the "Biochar - Black Magic?" Workshop held in Bridgetown on December 1, 2014 attracted so many eager participants.

Middlesex avocado and cattle farmer, Doug Pow, described the innovative practice he has put in place of feeding biochar to cows and getting dung beetles to bury it and the significant benefits he has seen from doing this.

"After going for five years without adding phosphorus or potassium whilst increasing production, it seems that what I am doing is making mineral fertilisers available to the plants that have been applied over decades, but have been locked up in the soil," Mr Pow said.

Mr Pow also discussed a trial he is undertaking with SWCC using activated biochar on a new avocado orchard.

Dr Paul Blackwell of DAFWA has been involved in trials using biochar and presented what the data shows for crops, pastures and horticulture and the implications for stock nutrition and growth.

"Biochars are very variable in their composition and impact; therefore we need to be cautious in their use. Independent evaluation and testing, and careful plans on supply and product costs, will help achieve benefits for agricultural businesses," Dr Blackwell said.

At the conclusion of the workshop Dr Blackwell demonstrated how to make biochar using a homemade TLUD (top lift updraft) kiln.

Demo of a TLUD kiln at Biochar workshop in Bridgetown

Dr Geoff Woodall presenting at the sandalwood workshop

Growing Sandalwood and Carbon in the WA Wheatbelt

Participants travelled to Katanning from as far away as Augusta and York on April 1, 2016 to attend the "Growing Sandalwood and Carbon in the WA Wheatbelt" workshop and hear from Drs Geoff Woodall and Peter Ritson.

Dr Woodall, a native plant agronomist, started with a field demonstration harvesting sandalwood and estimating its value. Later in the classroom, he shared his journey of establishing multi-purpose, biodiverse and profitable sandalwood systems utilising unprofitable parts of the farm.

"There is still plenty of opportunity to incorporate native WA sandalwood into agricultural enterprises without reducing or compromising agriculture production," Dr Woodall said.

Dr Ritson, a national expert in quantifying carbon accumulation by tree plantings, took participants through the complexity of obtaining carbon credits from sandalwood systems. He described the Australian Government's ERF auction system and the many rules about participating in it.

The carbon accounting methods for reforestation activities on cleared land are:

- Environmental and mallee plantings;
- Reforestation and Afforestation; and
- Farm forestry.

He suggested that the environmental and mallee plantings method was currently the most likely suitable method for sandalwood. The Full Carbon Accounting Model (FullCAM) is used to estimate carbon sequestration. The main requirements of this method was that all local native species be used with a mix of trees and shrubs and that there is no commercial harvest in the Permanence Period, i.e. 25 years.

Currently, other methods being developed that may be applicable to sandalwood are combined forest sequestration and plantation forests.

According to Dr Ritson, if a tree grower was to participate in the ERF through an aggregation project, they could expect total net returns over 10 years of $200 to $500/ha for block plantings and higher returns for belt plantings.

As one participant said in his evaluation of the event, "Growing sandalwood on the periphery of land with acacia is a 'no brainer' for wool and wheatbelt farmers".

Get the Dirt on Soil Biology

This field day, held at Southampton Homestead in Balingup, was so popular people were turned away.

The agenda included presentations on soil carbon dynamics in annual and perennial pastures; microbial processes linked to soil organic matter; and the relationships between practices and soil biology by E/Professor Lyn Abbott. Jeff Pow and Michelle McManus also took participants on a guided tour of their Southampton Homestead property.

"We often say that we are 'microbe farmers' and 'grass farmers' before we are chicken farmers, that's how essential healthy soil is to our operation and our business. We use Holistic Management to regenerate the pastures and the soil. We also process the birds on the farm and market directly to our customers, which is better for the animals and our soil and pastures," said Ms McManus.

"Growing sandalwood on the periphery of land with acacia is a 'no brainer' for wool and wheatbelt farmers".
Workshop participant

Catching Carbon with Trees

Sixteen landowners participated in SWCC's "Catching Carbon with Trees" field day in Bridgetown.

The enthusiastic participants saw that trees have created a special sense of place for David Jenkins as

Cell grazing demo at Southampton Homestead

well as providing many benefits for the farm over the years. They heard the latest on types of tree growing activities that are eligible for carbon credit payments and they estimated the amount of carbon stored in David's agroforest by undertaking a practical tree measuring exercise.

David Jenkins shared his experiences of growing a variety of trees on his 230-hectare property near Bridgetown over the past 38 years. The benefits have been many and varied. For example, patches of spotted gum planted on rocky ground are producing timber and providing shelter, while deciduous trees provide autumn colours and have helped protect the house and sheds from bushfires. The agroforest, established in 1987, provided good grazing in the early years and, since then, have yielded 3,741 tonnes of wood over several harvests worth more than $110,000.

Over the past decade, David has added value to his timber by milling some of his mature eucalypt sawlogs (more than 50cm in diameter) for flooring and other products. He has also used his own timber for various projects on the farm, including the barn where the first part of the field day was held. The magnificent barn was built by David for his son's wedding almost entirely from timber from trees he had planted. But for David, it's about more than income, aesthetics and lifestyle, it is also about the attachment to the land, a sense of place and purpose that growing trees has provided.

The average car emits approximately 5 tonnes of CO_2 equivalent (CO_2–e) every year. A 28-year-old managed agroforestry plantation at Bridgetown sequesters 13 tonnes of CO_2–e per hectare per year.

Participants at a Catching Carbon with Trees Field Day in Bridgetown

Current opportunities for carbon farming

Peter Ritson, forest scientist and now private consultant, reminded participants that carbon dioxide (CO_2) is removed from the atmosphere by trees. Through the process of photosynthesis, carbon is stored (sequestered) in new growth and oxygen released. Removing CO_2 from the atmosphere is an important means of slowing climate change.

Carbon credits may be paid for eligible tree growing activities. The two main types of eligible activities are permanent plantings (no commercial harvest) and farm forestry plantings (with commercial harvest). The main requirement for permanent plantings is that they were established on cleared land after 1 July 2007. Key requirements for farm forestry plantings include being part of a working farm, that they were established after 1 July 2010 and area limitations depending on rainfall.

Eligible tree growing activities also need an approved 'method' for carbon accounting, including standards for assessment, reporting and auditing. The accounting work can be onerous, especially for smaller growers.

Under the Australian Government's ERF, tree growing projects can be paid for carbon credits if all requirements are met.

Calculating the amount of carbon stored in trees—a practical exercise

Richard Moore then led a hands-on tree measuring exercise. Working in small teams, and after some instruction, participants measured the amount of wood in a sample of David's agroforest. Once teams had estimated the amount of wood per hectare in the stems of the trees they calculated the amount of 'CO_2 equivalent' (CO_2–e) by allowing for wood density, amount of wood in roots, branches, bark and leaves, the proportion of carbon in wood and finally converting to weight of CO_2–e.

The amount of CO_2–e currently stored in a hectare of David's agroforest was calculated to be 363 tonnes. Averaged over the 28 years that the trees have been growing, this equates to 13 tonnes of CO_2–e/Ha/year, not including the CO_2–e stored by trees that have already been harvested from the forest.

The day gave participants a better understanding of 1) what trees can do for landowners, 2) the carbon market, and 3) what's involved in estimating the amount of CO_2–e stored in forests. If the level of discussion and number of questions are anything to go by, there was lot of learning going on.

COMPOST USE IN DAIRY PASTURES

Composting manures is an option for management and re-use of valuable nutrient resources on dairy farms, although the expense and time involved in effective composting and distribution of the compost can be a challenge.

Dairy Effluent	Benefits of use	Disadvantages of use
Manure	• Available without further treatment • High concentration of soluble nutrients (especially N) • Improves soil structure	• Difficult and expensive to transport • Specialized equipment required • High risk of nutrient loss especially in waterlogged or rainy conditions
Composted Manure	• Moderate cost • Reduces pathogen load • Slow nutrient release reduces leaching and other loss • Easy to transport and spread	• Time required to convert manure to compost • Slow release of nutrients may be inefficient for high nutrient requirement • Specialised equipment required

Dairy effluent and manures contain significant amounts of carbon and essential plant nutrients but these nutrients are often in a relatively dilute form making the transportation of large volumes of organic matter impractical and uneconomical.

On-farm composting could be a solution for local use of dairy effluent. It has the potential to alleviate constraints to production by improving the soil's structure, buffering capacity and nutrient availability. It is essential that composted manures are matched to the crop nutrient requirements, machinery and operations to avoid any undesirable effects.

There can be some apparent disadvantages in using compost on dairy farms such as the time involved in handling the compost, the need to spread it and the slow release of nutrients from well composted manures. However, the longer-term soil benefits from effective use of well-composted manures may contribute to productivity and profitability. Micro-organisms are involved in both the production of compost and its decomposition after being applied to soil. Micro-organisms transform the carbon in manure into stable forms which benefit soil conditions over time—so soil improvements from dairy compost may not be immediately noticeable after its application.

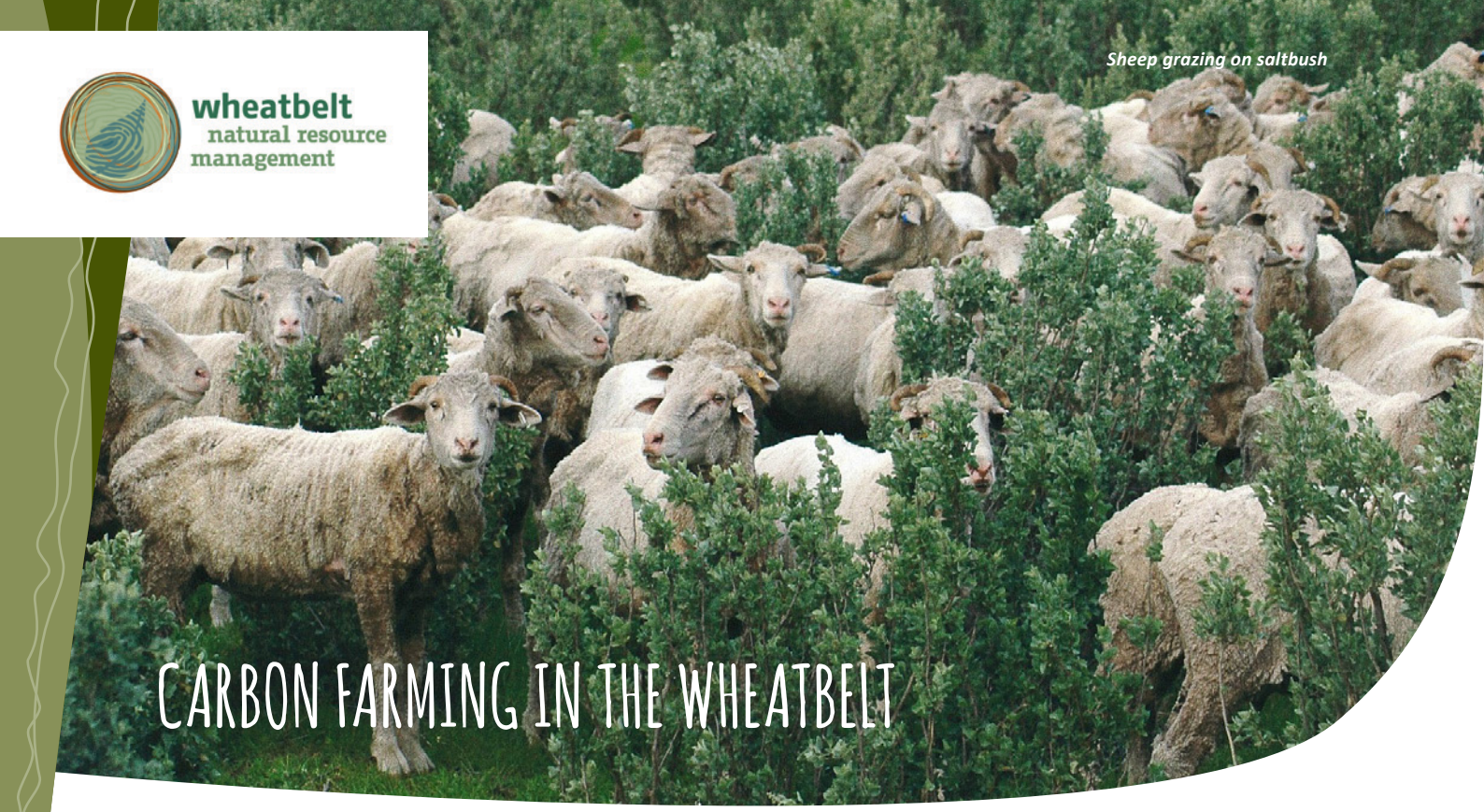
Compost applied to the surface of a dairy pasture will gradually become incorporated into the upper layers of the soil. The rate at which it decomposes depends on the stage of the composting process. If the composting process is well advanced, there will be low concentrations of soluble nutrients present and the organic matter will be less available to soil organisms as a source of carbon.

Application of immature compost to dairy pastures can lead to problems such as nitrogen draw-down. This occurs when the nitrogen is rapidly used by soil organisms as they decompose the unstabilized organic carbon within the immature compost, reducing its immediate availability to plants.

Mature composts are less easily degraded by micro-organisms once applied to soil. Despite releasing nutrients more slowly, they provide wider and more long-term benefits to soil health.

Making compost with dairy waste

wheatbelt natural resource management



Sheep grazing on saltbush

CARBON FARMING IN THE WHEATBELT

People are talking about Carbon Farming—but what does it mean? It could be called Greenhouse Gas Farming, but that is just too hard to say. Carbon farming is all about capturing and storing carbon in the soil or vegetation and reducing the greenhouse gas emissions from farming practices. Most farm practices can be changed to reduce emissions or store carbon and most have been shown to improve farm productivity.

WHY SHOULD WHEATBELT FARMERS BE INTERESTED?

Agriculture is responsible for 16 per cent of all Australian greenhouse emissions. It is responsible for 58 per cent of all the methane (CH_4) emissions and 86 per cent of all the nitrous oxide (N_2O) emissions. These gases are important as they have high global warming potential. Global warming potential is a value that is used to compare different gases ability to trap heat in the atmosphere. It is based on the heat absorbing abilities of each gas compared to carbon dioxide (CO_2). Methane and nitrous oxide are the biggest concern for agriculture as they absorb heat well and they're long lived in the atmosphere. They are not the only gases that are problematic, there are fluorinated gases that are man-made and used in industries like refrigeration.

The global warming potential of methane is 25 times greater than CO_2 and the warming potential of nitrous oxide is 298. Table 1 shows which farming practices relevant to Wheatbelt farmers that produce these gases.

Farm Practice	Gases produced		
Fuel usage	CO_2		
Cultivation	CO_2		
Soil Organic Matter	CO_2		
Crop residue breakdown	CO_2		
N application			
Burning stubbles		N_2O	CH_4
Biological N fixation		N_2O	
Waterlogging			CH_4
Livestock emissions			CH_4
Manure management			CH_4

Table 1. Farm practices and gas production

WHAT CAN WHEATBELT FARMERS DO?

Wheatbelt farmers are already adapting to climate change—dry seeding, minimum tillage, changing to crop varieties that are more drought tolerant. They are changing what they do, to continue to be able to produce. The following strategies are just some of the mitigation techniques available to reduce emissions, sequester carbon into the farming landscape and enhance farm productivity.

One of the most important activities that Wheatbelt farmers can undertake is to test their soils to identify any potential constraints that exist within the soil profile. Soil constraints in the Wheatbelt are widespread, with soil acidity, compaction, non-wetting, water logging, sodicity, and erosion all reducing the efficiency of our farming systems. When farms have soil constraints they require larger

Crop rotations are critical to the success of each season

amounts of water, carbon and nitrogen applied to the system to produce the same amount of grain. By improving soils, farms can add carbon to soils and improve water and nitrogen use efficiencies, making the whole system more efficient, productive and profitable.

For example, by moving the pH of farm surface/subsurface soil to levels above 5.5/5.0, the soil environment becomes more suitable for aerobic respiration by microbes. These microbes are essential for good soil/plant interactions and they don't produce nitrous oxide as a by-product.

Fertiliser application rates can be adjusted to suit soil needs based on the results of the soil tests, which could mean a lower rate of fertiliser application over some soil types—saving money and reducing the potential of nitrous oxide emissions from excess nitrogen in the soil. Soil samples should be taken at surface and sub-surface levels and measured for nutrient sufficiency, which compares the values against known critical ranges for soils, is similarly important to ensure fertiliser decisions are addressing the most important nutrient deficiency. One of the largest sources of emissions from fertiliser use is in the transporting of the fertiliser from the country of origin to the farm. If the amount of fertiliser transported is reduced, the carbon footprint of the grain produced is also reduced.

Soil compaction is a big issue for some soil types. Compaction can lead to anaerobic conditions in the soil which releases nitrous oxide. If the soil becomes waterlogged as well, bacteria in the soil will release methane with the result of reduced fertiliser efficiency.

If the soil constraints are not economical to fix, these soils could be utilised for permanent pastures, forage shrubs, agroforestry plantations or revegetated with local native species. Perennial vegetation stores carbon both in the soil and in the structure of the plants. Perennial vegetation on farms can help with shade and shelter of stock, income stream diversity and bringing biodiversity back into the landscape.

Crop rotations are critical to the success of each season. Changing the rotation to include a legume which may not have a good profit margin itself, but will help the following crop, either with reduced fertiliser needed or reduced pest control, and potentially increase overall profitability. Summer cropping or summer active pastures can help reduce N_2O emissions in the event of summer rainfall events and reduce associated soil carbon losses which can be significant.

Changing the feed of your livestock is a great way of reducing emissions and improving productivity. Research has shown that improving the feed of ruminants can reduce methane emissions as the feed changes the mixture of micro-organisms in the stomach. Biserrula pastures and forage species have been shown to greatly reduce methane production. If animals are producing less methane they are utilising their feed for greater growth.

THE FUTURE

Research continues into the best management practices to continue to produce our agricultural products in the face of a changing climate and to mitigate or sequester more carbon into farming systems. New varieties of crops are being developed, livestock genetics are being selected for low methane emissions, biofuels for machinery use, soil amendments and how they fit into cropping programs are all practices are currently being studied. What is already clear is that carbon farming has a strong role to play in the future of our industry, helping make our farming practices more efficient and building resilience in our land.

Forage at Pingelly

Lupin crop

BROWN MANURING OF LUPINS IN BOLGART

Brown and green manuring of leguminous crops is a great way to control weeds, increase soil cover, improve soil fertility, conserve soil moisture and increase soil fertility. Adding legume mulch can also increase the levels of carbon within the soil.

Wheatbelt NRM has been working with Bolgart farmer Trevor Syme to find out if brown manuring of lupin crops can help improve his soil fertility, decrease the weed burden and improve the levels of carbon.

"In the past we have grown up to 50 per cent of our cropping program to lupins as a cash crop and also as a legume for natural nitrogen. Now with the onset of chemical resistant weeds and drier rainfall years it has become uneconomical to grow lupins, but in saying that our highest yielding wheat crops are those that follow a lupin crop," Trevor said.

This has led Trevor to look for other options for the wheat/lupin rotation.

"It is all about a systems approach by rotating chemicals, crops and by using every tool in the shed too stay sustainable and profitable."

Trevor has opted for cutting the lupin crop with a knife roller as his preferred method of brown manuring. The residue is then left on the surface where it protects the sandy soil from wind erosion and helps reduce the soil moisture loss; to maximise the productivity of the subsequent wheat crop.

Trials carried out at three separate sites by DAFWA, have shown that soil organic carbon content can be increased by 1–3 years of green manuring, although rainfall has a big impact on the amount returned to the soil. Results from Trevor's trial will be analysed over the next couple of years to see the impact of the brown manuring on the soil fertility and soil carbon content.

Of interest to farmers contemplating earning soil carbon credits is the new ERF method that the Department of Environment has recently released- ***Carbon Credits (Carbon Farming Initiative—Estimating Sequestration of Carbon in Soil Using Default Values) Methodology Determination 2015.*** Within this method is the ability to run sustainable intensification projects using default soil carbon storage figures that have been calculated using FullCAM, which means that intensive field sampling is not required.

A sustainable intensification project must use at least two of the following activities to be eligible:

(a) nutrient management;
(b) managing soil acidity;
(c) introducing irrigation;
(d) pasture renovation.

Based on this methodology, brown or green manuring leguminous crops in the paddock may be eligible, with the crop residue left in the paddock potentially counting as a nutrient management activity. As written in the method, a qualified person will need to approve these activities as appropriate techniques to improve nutrients within the soil. The nutrient management activity would need to be combined with another activity, such as managing the soil acidity. Combined, these approaches offer the potential to generate carbon credits, while also helping with soil fertility, weed management and soil moisture protection.

For more information on this method and others, visit the Clean Energy Regulator website at www.cleanenergyregulator.gov.au. Information on the trial being conducted by Trevor can be found on the NRM Sustainable Agriculture Trial and Demonstration sites at www.agtrials.com.

Bolgart farmer Trevor Syme

REDUCING METHANE EMISSIONS FROM LIVESTOCK USING PRODUCTIVE, PROFITABLE GRAZING OPTIONS

Pasture species Biserrula

Methane is a natural by-product in ruminants due to the fermentation of feed during digestion. It is an energy loss to the system that can be reduced with the type of feed supplied to the animals. This is both good for the farming system, the animal and the environment.

The Enrich Project has shown that many shrubs can reduce the methane production of sheep; one worthy of mentioning is *Eremophila glabra* according to Professor Phil Vercoe of University of Western Australia.

"While it is a small plant it doesn't need to be a large part of the animal's diet to make a significant reduction in methane production," he said.

If pastures are more suited to the farming system than forage shrubs, then Biserrula is the pick of the pasture species for reducing methane emissions, by a very large margin.

Biserrula is a persistent annual pasture legume that can work in a mixed farming system, with seed persisting for as many as three consecutive grain crops. Biserrula also provides an excellent source of biological nitrogen and can assist with weed management.

By improving the annual pastures species available to sheep and integrating these with a diverse range of forage shrubs, whole of farm profitability can be improved. This can be seen in the Enrich Project's MIDAS modelling. Animal health can be improved by eating a range of feed that incorporates a variety of nutrients and the natural resource management benefits of growing perennials include reducing wind and water erosion, increasing biodiversity and improving soil condition.

While currently there is no ERF method approved for emissions avoidance in reducing methane emissions in sheep by feeding specific shrubs or pastures, there is an approved method for feeding nitrates to beef cattle that could be used as a complimentary method. But the benefits to farm productivity of adopting this system may be its downfall under the ERF as there is a risk that the carbon sequestered in the shrubs won't be retained under grazing pressure. DAFWA have produced a fact sheet about managing sheep pastures to reduce methane production and its potential in carbon farming. For this, and other relevant carbon farming fact sheets see www.wheatbeltnrm.org.au/what-we-do/sustainable-agriculture/carbon-farming.

RESOURCE LIST

All demonstration sites are available on www.agtrialsites.com/

DAFWA

www.agric.wa.gov.au/climate-land-water/carbon-farming

FEDERAL

What is Carbon? www.rangelandswa.com.au/419/what-is-carbon-
Climate Change www.rangelandswa.com.au/421/climate-change
Carbon Farming Initiative transitioning www.environment.gov.au/climate-change/emissions-reduction-fund/carbon-farming-initiative-project-transition
Emissions Reduction Fund www.cleanenergyregulator.gov.au/ERF
Managing Climate Variability www.managingclimate.gov.au/

NRM GROUPS

NACC www.nacc.com.au
Perth NRM www.perthregionnrm.com
RNRM www.rangelandswa.com.au
SCNRM climateactionfarming.com.au
SWCC swccnrm.org.au/work/sustainable-agriculture-2/carbon-farming-awareness/
(NOTE SWCC will be updating the website soon and this link will change)
www.swnrmstrategy.org.au
(SWCC climate change website)
WNRM wheatbeltnrm.org.au
plus the upcoming site wheatbeltnrm.org.au/carbonfarming

OTHER

WANTFA www.wantfa.com.au/project-carbon-farming/
CSIRO/Bureau of Meteorology www.climatechangeinaustralia.gov.au/en/
NRM WA website www.nrmwa.org.au
Royalties for Regions website www.drd.wa.gov.au/rfr/Pages/default.aspx
Full Carbon Accounting Model (FullCAM) www.environment.gov.au/climate-change/greenhouse-gas-measurement/land-sector
RIPE Magazine/Farm Weekly www.farmweekly.com.au/specialfeatures/

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Royalties for Regions Carbon Project - Showcase

ROYALTIES FOR REGIONS CARBON PROJECT - SHOWCASE

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SOUTHCOAST NATURAL RESOURCE MANAGEMENT

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