3

Current and prospective adaptations

'…there's no drought at my place'[1]

3.1 During the course of the inquiry, the Committee took evidence and saw at first hand a range of current and prospective adaptations to the impacts of climate variability and climate change on agriculture. Farming practices examined in this chapter have a strong emphasis on improving soil health, water use efficiency and diversification of operations to improve overall productivity, and mitigation strategies to reduce greenhouse gas emissions in agriculture.

3.2 One of the common themes that emerged from the submissions and evidence presented to the Committee during the course of this inquiry was the capacity of Australian farmers to adapt to climate variability. There is certainly a culture of innovation within the farming community. The Committee saw plenty of reasons to believe that with sufficient support and careful management, many of the challenges of climate variability and climate change could be overcome, and by using techniques and technology already available.

Soil carbon

3.3 The Committee heard evidence that one of the most important adaptations to promote resilience against changes in weather patterns is improving the quality of the soil. The importance of soil carbon in improving soil health and in mitigating greenhouse gas emissions was a recurring theme during

1 Carbon Coalition Against Global Warming, Submission no. 50, p. 9.

the inquiry. Evidence presented to the Committee throughout the course of this inquiry reveals that improving soil carbon offers a way to establish greater resilience in the face of weather variability.

3.4 The need to increase soil carbon in agricultural soils was a recurring theme in the range of submissions received by the Committee. Mr David Matthews, a farmer in Kilcoy, Queensland, described the importance of soil carbon:

> As we know soil organic carbon is the building block for all vegetation. It is obtained by green growing plants when they convert the sun's energy and atmospheric carbon dioxide into liquid carbon compounds which relocate to the plant roots. These plant nutrients feed the plant (approx 30% of nutrients produced) and the remainder feeds soil fungi and bacteria which are living in symbiotic relationship with the plant. By harvesting the plant (grazing or mowing) the plant sheds a similar amount of its root base and humification of the shed material occurs and soil carbon levels may increase. This organic carbon now in the form of humus is also the water storage unit in the soil. A hectare of soil to a depth of 30 cm with an organic carbon content of 1 % can hold 170 000 litres of water.
>
> A 25 mm rainfall event drops 250 000 litres of water on a hectare of ground surface. Thus when soil carbon is only 1% about one third of the water cannot be stored in the soil and runoff occurs. This runoff has the potential to become soil erosion events.
>
> Thus by reducing our soil carbon content we have effectively reduced the ability of the landscape to hold water for plant growth in dry times as well as reduced recharge for our rivers and streams. We really have encouraged the rainfall we are now getting to run out to sea because it is just not possible to store the water in the soil.[2]

3.5 In evidence heard by the Committee, soil biologist Dr Christine Jones said that to increase soil carbon, farming practices need to change:

> In our never-ending quest for technological quick fixes we frequently overlook the obvious, the simplest and the most effective solutions. Without doubt, increasing the level of carbon in agricultural soils is the most obvious, simple and effective

2 David Matthews, Biodynamic Agriculture Australia, attachment to Submission no. 49.

solution to climate change. But we cannot increase soil carbon unless we change farming methods.[3]

Figure 3.1 The plant-animal relationship

Grass plants grow on a sigmoid basis. If left ungrazed, at some stage in their growth the above-ground or leaf and stem portions of the plant begin to change their cell structure. The cells in the above ground parts of the plant begin to lignify or become 'woody'. If left ungrazed the plant begins to suffer and will eventually die of 'over-rest'.

On the other hand, plants can also be grazed too early. When a plant is grazed, the natural balance between above ground and below ground structures is disturbed. Just as it is not possible to sustain a large leaf mass upon a small root system, neither is it possible, postgrazing, to sustain a large root system below ground when there remains a smaller post-grazing leaf mass above ground.

Immediately following the act of grazing the plant begins to slough off some of its roots, trying to restore balance to its structure. This material is 58% carbon by weight, the building block of soil carbon. Given time, as post-grazing leaf growth recommences the plant will begin to build new roots to replace those it sloughed off. It does this in order to maintain balance as it recovers from the grazing that was so necessary to sustain its life.

During this period of post-grazing recovery though, the plant is at risk of 'over-grazing'. If the plant is bitten again before it has fully rebuilt its root system there is a net damage to the plant. If frequent biting is allowed to continue for too long, the plant will die from root destruction directly arising from too frequent grazing. The left-hand pot in the photo to the right shows a balanced but very unhealthy plant that is close to death, having been 'grazed' too frequently.

Source: Dr John White, Submission no. 60.1, p. 26.

3.6 Dr Jones oversees 12 carbon measuring sites in Western Australia on properties that have changed farming practices. During evidence heard by the Committee, Dr Jones showed photographs of one of the test sites and explained:

> There was not any rain until two or three weeks ago, so they have had their longest number of consecutive days with no rain and yet these perennial grasses have survived. If they were not there, that would be bare sand. These grasses have been planted with the

3 Dr Christine Jones, *Transcript of Evidence*, 24 June 2009, p. 11.

> specific purpose of increasing soil carbon and also to form the base for annual cropping. So there will be a grain crop in winter time sown into these summer active grasses. So there will be something green all summer and then something green all winter. We are talking about yearlong green, because the only way to get carbon into soil is with a green plant. If you have the bare sand, you are going to be losing carbon, losing soil water holding capacity and losing nutrient status.[4]

3.7 The Wentworth Group of Concerned Scientists, in their report *Optimising carbon in the Australian landscape*, also advocate a shift in farming practices to increase soil carbon. With the increase in soil carbon, increases in agricultural production are expected and opportunities arise for biosequestration:

> Agricultural practices over the past century have mined Australian soils of their carbon stores. Nearly 40% of carbon stocks have been lost from Australia's cropping soils. The loss of soil carbon is a primary cause of land and water degradation, acidification and the destruction of soil structure. This reveals the great co-benefit of improving soil carbon. Soil carbon sequesters carbon from the atmosphere which also improves soil health and as a consequence, agricultural production. CSIRO have identified the significant biosequestration potential of the Australian landscape to absorb carbon. The paradox in their analysis is that whilst nearly 50% of terrestrial carbon in the Australian landscape occurs in grasslands and croplands, less than 20% of the estimated potential of the Australian landscape to store carbon occurs in these landscapes. This is because without changes to existing agricultural practices, any increase in carbon will come at the cost of agricultural production.
>
> Experts believe that it is technically feasible for Australian agricultural landscapes to increase soil carbon levels by 2% per year. This would result in the storage of an additional 900Mt of CO_2e per anum.[5]

3.8 In his submission to the Committee, Dr White of Ignite Energy, summarised the benefits of improved soil carbon for farmers:

- Better plant resistance to pests and diseases

4 Dr Christine Jones, *Transcript of Evidence*, 24 June 2009, p. 12.

5 *Optimising Carbon in the Australian Landscape*, Wentworth Group of Concerned Scientists, p. 8.

- Increased ability of soils to transfer nutrients to plants, for greater productivity which can improve farmers' incomes
- Increased soil water-holding capacity, holding the water until it can be used by the plants rather than letting it run off into waterways, ie, increased drought resistance
- Increased soil stability which means greater resistance to erosion, which in turn means cleaner waterways
- Unlocking of nutrient overload from synthetic chemical fertilisers
- Reduced recharge to groundwater and reduction or elimination of salination
- Improved biodiversity: soil organic matter contributes to the health of soil microbial 'wildlife' and micro-flora which are the very start of the food chain
- Healthier, climate-change compliant products that should avoid trade restrictions and attract premium prices.[6]

3.9 The Carbon Coalition Against Global Warming made the same points in its submission to the Committee about the benefits of improved soil carbon for farmers. The submission also made particular note of the micro-climate effect that can be achieved with the consistent green vegetation that becomes possible when 'carbon farming':

> [T]here is another way that Australian farmers can influence the climate: by creating a micro- climate around their property. A micro-climate will affect wind, rainfall, sunshine, and air temperature. It is a technique normally used by croppers. They use slope and row placement and alignment to determine a 'solar budget'. They use alley-cropping and shelter belts and mulches…
>
> Often a land manager will say, in the depth of a drought, 'there's no drought at my place'. By that they mean that they have managed their vegetation such that they have retained moisture in the landscape. When you protect your groundcover and don't overgraze or strip the earth bare by poisoning weeds or ploughing, you build or moisture reserves. Then water starts to cycle on your property. Some managers report receiving 1 mm a day in dew from fogs and mists.[7]

6 Dr John White, Ignite Energy, Submission No. 60, p. 6.

7 Carbon Coalition Against Global Warming, Submission no. 50, p. 9.

Perennial pastures

3.10 Perennial grasses are being used by an increasing number of farmers for ground cover, grazing, improved moisture retention and the improvement of soil carbon. The root systems of perennial grasses are longer than annual grasses offering greater resilience in dry times.

3.11 The benefits of using of perennial grasses are multiple. In evidence to the Committee, Mr Kevin Goss, of Future Farm Industries CRC, stated:

> Perennial plants are plants that have the ability to use rainfall whenever it occurs and to make the most of soil moisture whenever rainfall is not occurring. They are proving to be incredibly robust in both grazing and cropping systems.[8]

3.12 In evidence before the Committee, Dr Brian Keating, Director of the Sustainable Agriculture Flagship, CSIRO, further stated that:

> a perennial pasture tends to be more deeply rooted than an annual crop, so you will get, potentially, more efficient use of water that falls. That falls below the root zone of the annual crop and the perennial pasture can make use of that.[9]

3.13 In its submission to the Committee, the Southern Midlands Council Landcare unit stated:

> Healthy perennial pastures can produce some of the most carbon rich soils and may contain up to 350 tonnes of organic carbon per hectare.[10]

3.14 In her submission to the Committee, Dr Christine Jones pointed to additional benefits of perennial grasses:

> Perennial groundcover has multiple agricultural, ecosystem and landscape benefits in addition to restoring soil health. For example, weeds cost the Australian economy $8 billion annually when the value of lost production and reduced biodiversity are added to money spent directly on weed control. If land is left 'empty' it creates a space for weeds to colonise.[11]

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8 Mr Kevin Goss, Chief Executive Officer and Executive Director, Future Farm Industries CRC Ltd, *Transcript of Evidence*, 9 September 2009, p. 2.

9 Dr Brian Keating, *Transcript of Evidence*, Canberra 21 October 2009, p. 8.

10 Southern Midlands Council Landcare Unit, Submission no. 9, p. 2.

11 Dr Christine Jones, Submission no. 52, p. 3.

3.15 In a 2003 Land and Water Australia publication, the authors point to yet other benefits of perennial pastures:

> The farmers using native perennials have all reduced their fertiliser inputs and claim the use of native perennials is beginning to address the issue of nutrient balance. [12]

3.16 The reduction of fertiliser inputs associated with the use of perennial grasses is made possible through biological processes that occur in the root zone of the grasses. In her submission to the Committee Dr Christine Jones explained some of biological processes:

> Soil benefits in many ways from the presence of living plants year-round, due to reduced erosion, buffered temperatures, enhanced infiltration and markedly improved habitat for soil biota. Significantly, it is not 'biomass' per se which is the driver for soil carbon sequestration, but the soil life that the biomass supports, via photosynthetic capacity.
>
> Mycorrhizal fungi differ quite significantly from decomposer type microbes in that they acquire their energy in a liquid form, as soluble carbon directly from actively growing plant roofs. By this process they are actively drawing down atmospheric carbon and turning it into humus, often quite deep in the soil profile, where it is protected from oxidation.
>
> Where mycorrhizae are functioning efficiently, 40-80% of the carbon fixed in green leaves can be channelled directly into soil as soluble carbon, where it is rapidly polymerised with minerals and nitrogen and converted to stable humic compounds in the soil food-web. The humates formed by soil biota are high molecular weight gel-like substances that hold between four and twenty times their own weight in water. Humic substances significantly improve soil structure, porosity, cation exchange capacity and plant growth.
>
> Mycorrhizal fungi access and transport nutrients such as phosphorus, zinc and nitrogen in exchange for carbon from their living host. Plant growth is usually higher in the presence of mycorrhizal fungi than in their absence. In perennial grasslands, mycorrhizal fungi form extended networks that take several years to develop. They have mechanisms that enable them to survive

12 *Review of farmer initiated innovative farming systems*, Land & Water Australia, Australian Government, p.18.

> while host plants are dormant but **cannot survive** if host plants are completely removed from the ecosystem.
>
> Under appropriately managed perennial groundcover, soil water balance is improved by hydraulic lift and hydraulic redistribution in seasonally dry environments. These processes bring moisture to the root-zone that would not be available to an annual crop or pasture.[13]

3.17 Species of perennial grasses for pasture vary from region to region. Western Australia, for example, has no native perennial grasses and relies largely on Mediterranean species.

3.18 Certain species of perennial pasture grasses are favoured over others by different farmers according to region, soil types, or personal preference.

3.19 Perennial pastures are also used as part of pasture cropping and some managed grazing systems.

Pasture cropping

3.20 The submission made by the Southern Midlands Council Landcare Unit outlines the method, process and benefits of pasture cropping, also known as perennial cover cropping:

> Pasture cropping is a land management method where cropping and grazing are combined into a single technique with each enterprise enhancing each other economically and environmentally. The process of pasture cropping involves direct-drilling an annual grain crop without herbicide into dormant perennial groundcover. The practice enhances plant-microbial associations, vastly improves rates of biological nitrogen fixation, stimulates nutrient cycling, facilitates sequestration of highly stable, humified soil carbon and promotes formation of new topsoil.
>
> Perennial cover cropping (pasture cropping) is becoming more widely adopted in Australia and has been implemented in most states with outstanding success. On the mainland a grain crop is largely sown in winter while the perennial grasses are dormant. Additionally, there were good results in Victoria and New South Wales by sowing summer forage crops into winter dominant

13 Dr Christine Jones, Submission no. 52, p. 11.

> native perennial pastures. This is likely to be the most effective technique for adoption in Tasmania.
>
> Cropping into dormant perennial groundcover is a one-pass operation that markedly reduces fuel costs and largely eliminates the need for fossil-fuel based herbicides, fungicides and pesticides. Perennial cover cropping has many similarities to annual cover cropping but brings with it the ecosystem benefits of perennial groundcover.[14]

3.21 In her submission to the Committee, Dr Christine Jones also discussed the benefits of pasture cropping and provided the example of NSW central west farmer Nigel Kerin:

> Nigel Kerin was NSW Farmer of the Year in 2008. The first photo shows Mr Kerin in his newly sown crop (no bare ground) and in the second Mr Kerin is admiring his bounty closer to harvest (perennial croplands look like any other farmland once they approach maturity). This 'yearlong green' land management technique produces high quality, nourishing food simultaneously with restoring landscape function and providing ecosystem services such as oxygen-rich air and clean water.[15]

3.22 This successful example of pasture cropping notwithstanding, Dr Jones also pointed to the need for further research:

> Broadacre cropping could benefit enormously from widely spaced rows or clumps of long-lived perennial grasses and fodder shrubs. As yet we do not know the required critical mass to restore soil ecosystem function, but it might only need to be 5-10% perennial cover. The benefit of permanent mycelial networks in terms of aggregate stability, porosity, improved soil water holding capacity, reduced erosivity and enhanced nutrient availability would be immense.[16]

3.23 In his evidence to the Committee, Dr Mark Howden, Chief Research Scientist of CSIRO's Climate Adaptation Flagship, while also noting the benefits of pasture cropping, was not convinced of its universal application:

> In some circumstances that system has significant benefits, because it uses both the summer and winter rainfall. The challenge

14 Southern Midlands Council Landcare Unit, Submission no. 9, p. 2.

15 Dr Christine Jones, Submission no. 52, p. 4.

16 Dr Christine Jones, Submission no. 52, p. 11.

> is in places where there is a lack of summer rainfall, in having effective persistent perennial grass in that system, and so we are challenged by having a grass that will grow adequately in very dry conditions and be grazed at the same time. So there are some issues there in just getting that system to work outside of the core areas in central New South Wales where it was initiated, but in those places where we have both adequate summer and adequate winter rainfall it is a system that makes a lot of sense.[17]

Rotational grazing

3.24 The Committee heard evidence and took submissions about different kinds of managed grazing systems. Some managed grazing systems are used in conjunction with perennial grasses and pasture cropping.

Holistic management

3.25 In its submission to the Committee, the Fenner School of Environment and Society outlined holistic management (HM):

> Unlike many other adaptive strategies to climate change, HM grazing is a proactive, low-tech solution that has at its core a different way of thinking about grazing systems, combined with the smarter application of known management techniques. Adoption of HM grazing signals a change in farming mentality from trying to gain control over the land to working with natural variability and embracing an ethic of land stewardship. Farmers using HM grazing have reported a wide range of benefits, including reduced soil erosion, increased water efficiency, improved pasture species cover and composition, improved quality of life, and more stable financial returns. Public good benefits include increased carbon sequestration, more biodiversity, and reduced nutrient loads off-farm.[18]

3.26 The submission went on to explain some of the distinguishing features of HM grazing:

> HM grazing is a particular way of running a livestock grazing enterprise that is used by a moderate but rapidly growing number

17 Dr Mark Howden, Chief Research Scientist, Theme Leader, Climate Adaptation Flagship, CSIRO, *Transcript of Evidence*, 21 October 2009, p. 7.

18 The Fenner School of Environment and Society, Submission no. 4, p. 1.

> of farmers. It increases the resilience of individual farm enterprises to changes or uncertainties in climate. HM grazing can be distinguished from other ways of managing a grazing enterprise at levels: a fundamental level, and a technical level:
>
> - Fundamentally, HM grazing is based on an explicit decision framework; explicit goal-setting; monitoring practices and adaptive management; and the principle that the health of the land is a fundamentally important basis for profitable farming.
> - Technically, HM grazing is based on high-intensity short-duration grazing (an extreme version of rotational grazing) rather than continuous grazing; and the keeping of 'grazing charts' that provide a means of anticipating feed availability and periods of drought.[19]

3.27 The submission notes that the use of grazing charts is one of the key tools of HM grazing:

> One fundamentally important aspect of holistic resource management is the emphasis it places on the natural resource base as the ultimate source of income and quality of life…Farmers employing HM grazing use a number of practical tools to help them manage their livestock rotation schedule. The most important of these tools is a 'grazing chart', which maps out how much feed is available in any given paddock at any point in time. These are easily created with graph paper and a pencil, and are updated after each rain. Using these charts, an HM manager will know at any given point in time how many 'days of feed' he has ahead of himself, if it does not rain. If the number of 'days of feed ahead' becomes too small, the farmers can make strategic decisions such as de-stocking before a drought actually hits, before expensive supplementary feeding becomes necessary, and before the health of the land is compromised.[20]

3.28 The Committee also heard evidence from Dr Fischer that HM grazing has additional benefits over time:

> One of the interesting things about rotational grazing is that, when you bring a mob onto a patch, they no longer feed in a selective way. If livestock are on the same patch of land for a long time, they basically eat their favourite species of grass over and over, and that leads to overgrazing. With rotational grazing you bring in a big mob and they nibble whatever they can get their mouths on.

19 The Fenner School of Environment and Society, Submission no. 4, p. 2.

20 The Fenner School of Environment and Society, Submission no. 4, p. 3.

> So some of the things that the livestock do not typically go for will get grazed as well. There are case studies of people who have employed this for a long time and can demonstrate that they have less weed cover than they used to have and instead have more perennial grasses than they used to have. Even though they have not used any chemicals in the process, through time the nutrient balance in the soil changes in such a way that it is no longer favourable to those weeds and becomes more favourable towards the things that are favourable from an economic perspective. So it is not as instant as spraying, but over time, if you give it 10 years or so, you will get changes in the system that are basically self-perpetuating.[21]

3.29 As part of the inquiry, the Committee visited the property of Mr David Marsh, north of Boorowa in New South Wales, who uses HM grazing techniques. There the Committee also met with Mr Bruce Ward, a leading exponent of HM grazing. HM grazing is a both a production technique and a decision making process that matches landscape, production and lifestyle. The rapid rotation of stock through feeding paddocks ensured the recovery of grasses after feeding. There is also the additional benefit of weed control, as stock tend feed less selectively under rapid rotation. Use of a mixture of species of perennial grasses ensured soil cover, soil health, soil moisture and over-competition of weed species. Flexible stocking rates ensured that the system was never put under unsustainable pressure. While overall productivity was lower than in high input systems, HM grazing was more sustainable, reliable and had much lower input costs, which also made it more flexible. On the day of its visit, the Committee was impressed by the evident health of the pasture and the animals on farm.

Biodynamic farming

3.30 Biodynamic farming uses a series of natural preparations to improve soil biology and soil structure. In their submission to the Committee, the Carbon Coalition Against Global Warming describe the broad approach:

> Biodynamics adopts a homeopathic approach to preparing natural fertiliser and times activities to align with cycles of the moon and

21 Dr Joern Fischer, Research Fellow, Fenner School of Environment and Society, Australian National University, *Transcript of Evidence*, 17 June 2009, p. 9.

> the stars. Many ordinary, sober farmers report great results with biodynamic preparations.[22]

3.31 In their submission to the Committee, Biodynamic Agriculture Australia explained the extent of uptake and some of the benefits of biodynamic farming:

> Biodynamic practitioners can be found throughout Australia, in every state and territory, across a wide range of agricultural production - grazing, cropping, horticulture, viticulture and dairy.
>
> Biodynamic practitioners have anecdotally reported significant drought tolerance over the past 10 years; they experience better production and returns than would be expected from previous drought situations. In times of flood soils with better soil structure also do not erode or bog as badly as low organic matter soils.[23]

3.32 In evidence to the Committee, Ms Cheryl Tillett of Biodynamic Agriculture Australia expanded further on the benefits of biodynamic agriculture:

> Various studies have been conducted over the years and, in general, it can be concluded that biodynamic farming practices have many benefits. The total energy for fuel production of mineral fertilisers and pesticides et cetera to produce a dry matter unit of crop was 20 per cent to 56 per cent lower. Biodynamically grown fruit had significantly higher brix levels. This is due to the use of horn silica (501). With regard to soil aggregate stability, soil pH, humus formation, soil calcium, microbial biomass and faunal biomass, the biodynamic system was improved.[24]

3.33 Ms Tillett went on to enumerate some of whole-of-farm benefits that promote greater resilience through the improvement of soil:

> By using the biodynamic system you are looking at the whole farm organism. You are building up the health of the farm organism and building up the humus content and the structure of the soil so that there are better water retention capabilities. As well as the water retention capabilities, there is a reduction in the amount of irrigation. For instance, if the farm is in an area where they need to irrigate, people who are using biodynamics tend not to have to use

22 Carbon Coalition Against Global Warming, Submission no. 50, p.8.

23 Biodynamic Agriculture Australia Submission no. 49, p. 1.

24 Ms Cheryl Tillett, Acting Business Manager, Biodynamic Agriculture Australia, *Transcript of Evidence*, 14 July 2009, p. 53.

> the same quantity of water for the same outcome as a conventional farmer might have to do. So there is the building of the carbon in the soil through the build-up of humus, the sequestering of the carbon from the atmosphere into the soil and then the water retention as a bonus so that the whole farm becomes more resilient to changes that might be happening.[25]

3.34 In their submission to the Committee, Ms Julia Weston and Mr Frank Giles of Seaview Farm provided an overview of how the use of biological farming methods and practices has increased production and provided resilience during drought on their Tasmanian property. They do not name the biological farming practices they use, but show by example what farmers can do to adapt to changes in climate:

> We like the story of two farmers in North East Tasmania (not us!) One follows a similar philosophy and practice as ours. His paddocks are rich and green, his stock healthy. Just across the fence another farmer has poor pastures and has to resort to pesticides and herbicides just to keep control of the place. It is necessary to give his cattle bullets of mineral supplements whereas the other farmer does not. And yet, the farmer with the poor paddocks with simply a fence separating the two never asks "What are you doing that I am not?"
>
> It doesn't matter what you call it: biological, biodynamic, organic or a mixture of all three, if it works use it! And if we are looking at the effects of climate change and how to promote resilience then there is an urgent need to change current farming practices which largely dominate the thinking in agricultural circles today.
>
> …It is an approach that is gaining ground even in mainstream farming communities simply because it makes good sense, it does work, and in the long term is cost effective.[26]

Tillage practices

3.35 Numerous submissions to the Committee referred to the benefits of conservation tillage practices, often as part of a broader farming system.

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25 Ms Cheryl Tillett, Acting Business Manager, Biodynamic Agriculture Australia, *Transcript of Evidence*, 14 July 2009, p. 54.

26 Ms Julia Weston, Submission no. 23, p. 5.

The most commonly cited benefits were improved soil health and fertility, greater water efficiency, and energy saving.

3.36 In conservation tillage, crops are grown with minimal cultivation of the soil. When the amount of tillage is reduced, the stubble or plant residues are not completely incorporated, and most or all remain on top of the soil rather than being ploughed or disked into the soil. The new crop is planted into this stubble. The tillage practices are commonly referred to in the submissions as zero-till, no-till, and min-till and are differentiated from traditional tillage methods mainly in the degree to which the soil is disturbed prior to planting.

3.37 The tillage-based conventional approach did produce reliable crop yields for some years. However a realisation began to emerge that the system was inherently unstable in that soil structure was degraded, soil erosion was accentuated, organic matter was reduced and energy inputs were high. The effects of this system on soil erosion could be dramatic, with massive erosion events occurring in southern areas of Australia, for example in the mallee soils of Victoria and South Australia. This realisation was based on the impact such an aggressive system had on soil structure, with structural decline being widely found following repeated tillage operations.[27]

3.38 In its submission to the Committee, the Conservation Agriculture Alliance of Australia and New Zealand (CAAANZ) articulated the benefits of no-till:

> The current farming practice of No Tillage, including full stubble retention, has the ability to adapt to variable climate conditions (and is doing so now) due to its seeding date flexibility, water harvesting capacity and improved water use efficiency that leads to massive yield benefits over conventional farming systems during periods of below average rainfall. The system also improves soil health leading to long term sustainability of the farm sector in Australia. To quote one of our farmer members "The No tillage farming system is climate change ready".[28]

3.39 A research paper published by the Grains Council of Australia, while enunciating the same benefits of conservation tillage practices as CAAANZ, also noted that these practices protect soil from erosion, play

27 Alan Umbers, "Farming Practices in Australian Grain Growing – the means for both Productive and Environmental Sustainability," Grains Council of Australia Limited, p.4.

28 The Conservation Agriculture Alliance of Australia and New Zealand, Submission 54, pp. 1-2.

an important role for increasing soil carbon, and increase soil biomass, all leading to increased productivity.[29]

3.40 The Grains Council paper and a Landcare Australia booklet both note that conservation tillage practices also use substantially less fuel. The Landcare Australia booklet, aimed at farmers, makes clear observations about the relationship between tillage and carbon dioxide:

> Excessive soil disturbance can expose soil carbon compounds to oxidation and lead to their loss as carbon dioxide. The combustion of fossil fuels to produce the energy used in soil tillage also results in emissions of carbon dioxide.[30]

3.41 The Committee heard evidence from Mr Dale Park, of the Western Australian Farmers Federation, indicating the uptake of conservation tillage practices in Western Australia:

> I would say that at least 90 per cent, and probably 95 per cent, of cultivation these days is min till or no till. It is virtually not done anymore. I know a couple of farmers up in the north-east do still use ploughs in some of their country but they also do not put in crops every now and again because they have not got enough rain. The vast majority are min till.[31]

Controlled traffic farming

3.42 In its submission to the Committee, the Tasmanian Institute of Agricultural Research, described Controlled Traffic Farming (CTF):

> In CTF systems, all machinery used in crop production is restricted to permanently located wheel tracks. A paddock farmed using controlled traffic can be thought of as a series of uncompacted "root beds" that are ideally suited to crop growth, separated by compacted "road beds" that are ideally suited to traffic. CTF can directly address soil erosion, soil structure decline and organic matter decline caused by conventional tillage and traffic practices. CTF can also improve water use efficiency and

29 *Farming Practices in Australian Grain Growing – the means for both Productive and Environmental Sustainability*, Alan Umbers, Grains Council of Australia Limited, 2006.

30 *Landcare Australia: Meeting the Greenhouse Challenge*, Australian Greenhouse Office, Department of the Environment and Heritage, 2005, p. 19.

31 Mr Dale Park, Land Management and Climate Change Executive Portfolio Holder, Western Australian Farmers Federation Inc., *Transcript of Evidence*, 24 September 2009, p. 4.

> crop productivity, while reducing energy and fertiliser related greenhouse gas emissions. The essence of CTF is as simple as - "Plants grow better in soft soil, wheels run better on roads".[32]

3.43 The TIAR submission also draws attention to CTF as a system that leverages the advantages of a range of existing practices, such as zero-till.[33]

3.44 Dr Tullberg, of the Australian Controlled Traffic Farming (ACTF) Association, gave evidence to the Committee about the benefits of CTF in reducing on-farm emissions:

> It is well known that, by reducing tillage, you reduce the amount of fuel you use, so you reduce the amount of carbon dioxide that gets produced as a result of burning diesel fuel…If you are going on permanent wheel tracks which are hard you use a lot less fuel - about half the fuel. Those are the emissions related to diesel fuel use.
>
> People often do not consider the energy that goes into producing herbicides, which is one of the issues of zero tillage… But the big one in terms of energy going into modern cropping systems, as I am sure you know, is nitrogen fertiliser. There is very little difference between conventional mulch tillage and zero till. There is a significant improvement in controlled traffic again because of course you do not put fertiliser on permanent wheel tracks and because you do not get the inefficient fertiliser use associated with compacted soil.
>
> The final one to be concerned with is emissions from the soil, primarily nitrous oxide. Nitrous oxide is produced when you have soil at a particular levels of water filled porosity. That occurs much more often when you have a compacted layer further down the profile. You avoid this in controlled traffic farming. Zero tillage alone actually increases emissions because you will get more soil compaction, particularly in heavy soils…CTF can reduce emissions by approximately 45 per cent.[34]

3.45 The Committee also heard from Dr Tullberg that using CTF would increase soil carbon:

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32 Tasmanian Institute of Agricultural Research, Submission no. 15, pp. 3-4.

33 Tasmanian Institute of Agricultural Research, Submission no. 15, p. 4.

34 Dr Tullberg, Australian Controlled Traffic Farming Association, *Transcript of Evidence,* 14 July 2009, p.45.

> The other thing that should be mentioned is that because you are producing more crops, more biomass, you are also going to provide the maximum chance of increasing soil carbon because you have absolute minimal soil disturbance; you do not need to disturb beneath seeding depth. If you are in non-compacted soil, it maximises the chance of carbon sequestration.[35]

3.46 One of the issues hindering the broader adoption of CTF is the reliance on global satellite positioning technology and the required base stations. Mr John McPhee, an employee of the TIAR appearing in a private capacity, told the Committee:

> You would not bother trying to do controlled traffic farming without satellite guidance. As you would be aware, most growers around the country who have moved in that direction have bought their own base stations.[36]

3.47 In its submission to the Committee, the TIAR explains further:

> Regardless of the industry, successful adoption of CTF is dependent on access to high quality Global Navigation Satellite System (GNSS) signals and data for machine guidance. The uptake of GNSS guidance for tractors and harvesters in Australia has been rapid. Almost without exception, growers have maintained their independence and bought individual guidance systems to suit their needs. Victoria has taken a lead in the establishment of a Continuously Operating Reference Station (CORS) network that will ultimately cover the state, and render the use of individually owned base stations obsolete.[37]

3.48 CTF Solutions, in its submission to the Committee, expressed frustrations similar to those of the TIAR and the ACTF Association with the individual systems of different machinery manufacturers:

> Australian farmers have bought about 4000 RTK GPS base stations[38], for about $100 million. This is more than is required to cover the whole of Australia with the same quality signal but only gives coverage to about 20% of Australia's cropping country. This

35 Dr Tullberg, Australian Controlled Traffic Farming Association, *Transcript of Evidence,* 14 July 2009, p.45.

36 Mr John Mc Phee, *Transcript of Evidence*, 21 September 2009, p. 4.

37 Tasmanian institute of Agricultural Research, Submission no. 15, p.9.

38 RTK, Real Time Kinematic, satellite navigation is a technique used in land survey and in hydrographic survey where a single base station provides the real-time corrections to a very high level of accuracy.

> is because the GPS suppliers to agriculture decided to provide only proprietary signals, i.e. differentiated by each company. These same companies supply the same service to surveying applications with non-proprietary signals. This is a rip-off, constrains CTF uptake since the GPS equipment is not compatible with different makes of tractors and harvesters (the general norm on Australian farms), and contractors cannot use the layouts of the farm owner. This enormous cost to Australian agriculture is all unnecessary.[39]

3.49 The TIAR, in its submission to the Committee, recognised an opportunity for government to augment a shift to farming practices that promote greater resilience in the face of climate variability:

> There is an ideal opportunity for government to show leadership, and in conjunction with the private sector, facilitate the establishment of CORS networks nation-wide, at least in the major cropping areas. Such infrastructure would be invaluable in the expansion of CTF and would lead to significant efficiencies in farming operations, not to mention a range of other emergency services, infrastructure and environmental benefits.[40]

Surface irrigation

3.50 The submission to the Committee from the Murray Irrigators Support Group describes methods to promote greater resilience in the face of climate variability by saving irrigation water and using it more efficiently. Some key points include:

- The Padman Stop, an invention by John Padman, [is] a 100% water tight control structure used in conjunction with the Fast Watering System also called low energy irrigation developed by John Padman.
- Trials of over 500 farms have shown that the faster the water is applied to the bay, the less water is used.
- Further to this it has been demonstrated at the Padman Stops trial research site that it is possible to control water application fairly accurately on to the bay, and to achieve the highest efficiency possible, more research needs to be done on application rates and frequency of irrigation.

39 CTF Solutions, Submission no. 45, p. 9.

40 The Tasmanian Institute of Agricultural Research, Submission no. 15, p. 9.

- Higher flows can easily be achieved by using the channels as storage.
- This form of irrigation is carbon positive because it uses less energy and produces more crops, which in turn will increase carbon sequestration.[41]

3.51 In evidence to the Committee, Mr Padman, a member of the Murray Irrigators Supporters Group, talked about the Fast Watering system he developed:

> We are about water savings productivity, sustainability and carbon reductions. That all sounds good, but we have demonstrated that we can achieve all of these things. By way of background, 80 per cent of Australia's water is used in irrigation, 70 per cent of which is flood irrigation, which we now refer to as surface irrigation. 'Flood' is a sort of bad word. This irrigation has long been recognised as a low efficiency industry. After doing a bit of research ourselves, we found that efficiency to be around 60 per cent. It was clear to me when I started this project in about 2004 that we had to do something about it…I guess for years we had plenty of water and all of a sudden our water just disappeared and things just happened in a hurry.
>
> At that time I did trials on what we called fast watering technology. To prove this we built a pump with a meter on it and started doing real farm trials. The results were magnificent. We started getting results of between 30 per cent and 50 per cent water savings. For the first three farms we submitted the results to the National Save Water Awards, and about this time last year we won those awards.
>
> Traditionally in surface irrigation it might take eight to 10 hours for the water to pass over the field. Fast watering permits watering many times faster than farmers normally would. The key to fast watering is to irrigate faster than the water can soak below the root zone. All of a sudden you start to get a very efficient irrigation without water logging. Quite common with the trials was a 30 per cent water saving. We found that, if you extenuate that and start to add a few of the other things we put in our submission, such as soil moisture monitoring, automation and event documentation, you can get up to 50 per cent water savings.[42]

41 Murray Irrigators Support Group, Submission no. 8, p. 2.

42 Mr John Padman, *Transcript of Evidence*, 3 September 2009, p. 41.

3.52 Mr Bryant, another member of the Murray Irrigators Support Group, gave evidence to the Committee about his personal experience:

> [M]y son bought the home farm from us three years ago… and I thought I had the place all A's and done pretty well—he put in the Padman Stops. We used to use 22 mega litres to water this particular area. When he put in the Padman Stops—nothing else changed—it went down to 12 mega litres. That shows you the savings that are there. I suspect that he grew a fair bit more tonnage, too, because the plant was never waterlogged. Because you are not putting as much water on you are not getting waterlogging.[43]

Property inspections

3.53 During the course of the inquiry, the Committee visited several properties engaged in practices which assist in the adaptation to climate change. It is interesting to note that many of the farmers the Committee spoke to during these inspections, while aware of the climate change benefits of the practices they were undertaking, were often motivated by the need to improve productivity or manage environmental degradation. There was also a strong sense that these innovations are being adopted in isolation, outside of any policy framework, and without the benefit of government research support or verification.

3.54 The Committee visited several properties in the Geraldton area which are working with Dr Christine Jones in the use of perennial grasses to maintain ground cover and build up soil carbon, thereby improving fertility and moisture retention. The Committee was impressed by the obvious health of the plants and soil and the apparent increase in carrying capacity of the pasture. Moreover, the farmers involved are heavily engaged in the work of testing individual solutions to their particular situations. Different mixes of grasses and shrubs are being tried by each farmer to suit their individual needs. Different grazing regimes are being utilised to suit the various plants. The Committee also visited a test site for pasture cropping, where winter crops are planted directly into dormant summer pasture. This has great potential to increase productivity and diversity of income, a significant factor in improving the reliance of farm enterprises.

43 Mr Dudley Bryant, Murray Irrigators Support Group, *Transcript of Evidence*, 3 September 2009, p. 43.

Members of the Committee inspecting a property in the Geraldton area with Dr Christine Jones.

3.55 Mr Cam McKellar, a farmer near Spring Ridge on the Liverpool Plains of New South Wales, is undertaking the restoration of soil carbon on his property. He noted that the naturally carbon rich soils of the area were badly depleted over decades of intensive cultivation using conventional tillage and artificial fertilizers. Using carbon rich humus as the principle fertilizer he has raised soil carbon on his property to 3% (from 0.5%). He has reduced pesticide use, increased soil biology and is maintaining yields despite limited use of nitrogen fertilisers. Improving soil health is also improving the nutritional value of the food produced.

3.56 Mr Andrew Pursehouse, of Breeza Station on the Liverpool Plains, has been using no-till farming methods since 1992. Breeza Station produces a range of summer and winter crops. Mr Pursehouse indicated that no-till methods are quite successful on his property and that he sees no reason to move away from them.

3.57 Mr David Wallis is a biological farmer at Quirindi, and processor of fodder for horse silage. He is passionate about value adding, noting that the horse silage business was drawing produce from a dozen farms around the district. He converted to biological farming methods, which has improved soil carbon levels and retention of moisture in the soil. He finds that better soil also made plants more pest resistant. He advises, however, that the switch from conventional farming methods is something

that takes time and money to produce results. He urges more research into biological farming methods to test and demonstrate the results he and others are getting.

3.58 Mr Neal Johansen, a farmer at Dululu, in the Rockhampton district of Queensland, is using controlled traffic farming methods to produce a rotation of wheat and legume crops. Improved moisture retention means that he is able to sow opportunistically with a lower risk of crop failure. The principal concern with controlled traffic farming is the need to have standardised machinery and access to GPS technology (which also needs to be standardised).

3.59 On their property near Rockhampton, Anne and Gordon Stunzner run cattle. They find that pasture improvement is the key to maintaining fertility and productivity amongst the animals and improving moisture retention in the soil. Perhaps somewhat against conventional wisdom, they use ripping to mitigate soil compaction by the cattle. They also manage and harvest native vegetation for commercial use and value adding on site using portable milling equipment to produce sawn timber. They note that unmanaged regrowth is of little environmental or commercial value.

3.60 The Groves family grow fruit at a property near Rockhampton. They irrigate with their own bores and dams and have a comprehensive strategy to deal with climate variability, including extremes of drought, storms, fire, flood and pests. They noted that moisture monitoring is expensive to install but ultimately pays for itself, and that use of drip irrigation has reduced water use by two-thirds. They uses extensive ground cover and mulching for moisture retention, and ground cover to prevent erosion. They use native trees as windbreaks and to bring in birds and bats to control insects. Slashing and grazing are used to reduce fire risks.

3.61 The Committee also visited the property of Arcturus Downs, near Emerald in Queensland. Arcturus Downs had 15 000 ha of dryland farming, 1000 ha of irrigated farming and ran 5000 head of cattle. On-site dams allow flood harvesting for irrigation. Minimum tillage is used across the property; however, controlled traffic techniques are restricted to the graded irrigated land. Some tillage is regarded as essential for weed control, especially with the appearance of herbicide resistant weeds. A mixture of drip and flood irrigation is used. There was some discussion of the relative merits of each. Drip irrigation is more water efficient and produces better yields. It is also far more expensive than flood irrigation, and maintenance intensive. There is a belief that current and prospective

adaptations will allow Arcturus Downs to meet the future challenge of climate variability.

3.62 The Committee visited several properties in the Hamilton district of Victoria. Jigsaw Farms, owned and run by Mr Mark Wootton, runs a mixture of lambs, wool, beef and timber. Some 24% of the property is under timber, meaning the enterprise was covering its own emissions about twice over. The timber provides environmental services and commercial return. There is extensive use of ephemeral wetlands which are good for biodiversity and provide environmental services. The system is otherwise high input to maximise production.

3.63 At 'North Skene', the Committee met with David Robertson and Graeme Moyle, two farmers who moved out of the traditional mixed farming of the Hamilton region into pure cropping. The cropping system they use is controlled traffic farming on raised beds (for drainage) with stubble retention for moisture and soil carbon. David and Graeme are members of Southern Farming Systems, a farmer/subscriber based research organisation which focuses on cropping in high rainfall areas.

Committee conclusions

3.64 The evidence presented to the Committee during the course of its inquiry has highlighted the importance of soil carbon in Australian agriculture. It is clear to the Committee that improving soil carbon is one way to develop resilience in the face of climate variability and climate change. The Committee applauds the work being undertaken by individuals to improve soil carbon in agricultural soils, and supports the recommendation of the Standing Committee on Rural and Regional Affairs and Transport recommendation that:

> The Government should significantly increase the research effort in relation to the potential of soil carbon as a climate mitigation measure, as a means of reducing the capital input costs to agriculture as a means of increasing resilience in agricultural systems.[44]

3.65 There are a significant range of potential adaptations that could increase the resilience of Australian farmers in the face of climate variability and climate change. Many have win-win-win potential, in that they improve productivity, environmental sustainability and reduce or mitigate

44 Standing Committee on Rural and Regional Affairs and Transport, *Climate change and the Australian agricultural sector*, 2008, p. 47-48.

emissions. They will also confer social benefits as improved productivity and sustainability increase personal and community resilience.

3.66 The Committee is concerned, however, that many of these adaptations are not being identified, tested and disseminated in any organised way. Much of the research into these adaptations is being undertaken by farmers in isolation or with limited support. Given the potential consequences of climate change, and the potential benefits of many of these adaptations, it would seem that a better coordinated research and extension effort is required. The Committee is aware of recent initiatives being undertaken by the Australian Government. It will deal more closely with this issue in Chapters 6 and 7.

3.67 Given the increasing importance of GPS technology to farming, the Committee is also concerned about the lack of GPS signal compatibility between different makes of farming equipment. This situation, whereby different machinery on the same farm cannot have GPS compatibility, or where contractors cannot integrate their equipment with that of farmers, requires adjustment. The Committee believes that action should be taken to establish a national CORS network across Australia and that signal compatibility between different GPS systems should be required by law.

Recommendation 3

3.68 **The Committee recommends that the Australian Government, as part of its overall response to issues affecting agriculture and climate change, invest research funding in the following high priority areas:**

- **Soil carbon sequestration;**
- **Soil stabilisation and pasture improvements using methods such as perennial pastures, pasture cropping, rotational grazing, biodynamic farming, minimum/no till cultivation and controlled traffic farming;**
- **Soil water retention strategies and water use efficiency;**
- **Landscape planning and natural resource management; and**
- **Risk management.**

Recommendation 4

3.69 **The Committee recommends that the Australian Government, in conjunction with State and Territory Governments, establish a national Continuously Operating Reference Station network across Australia and regulate for signal compatibility between different GPS systems.**

Biochar

3.70 Biochar is being investigated by a number of bodies as a soil conditioner, alternative fuel source, and for its carbon sequestration potential. Biochar is a form of fine-grain charcoal which is created by converting organic matter (such as wood, leaves, food wastes and manure), though heating in a low or zero oxygen environment.

3.71 The biochar production process begins with biomass being fed into a pyrolysis kiln—a furnace that burns with little or no oxygen. At the end of this, two main products come out of the kiln. The first is biochar, usually representing about 50 per cent of the carbon content of the biomass. The other is biofuel.[45] (See Chapter 4).

3.72 Biochar production can be customised to suit the end purpose of the product:

> The pyrolysis conditions can be optimised for bioenergy or biochar production. Biochar qualities can also be tailored for desired properties (e.g. high stability, high adsorptive capacity, increased cation exchange capacity, high nutrient content) through selection of feedstock and processing conditions.[46]

3.73 In evidence presented to the Committee, the Grains Research and Development Corporation flagged some potential for the use of biochar in grain production:

> We are interested because there are indications that it can improve cation exchange capacity and improve crop nutrition and have some benefits to crop production. That is the focus of our two projects. We are looking at about 12 different source materials for

45 *The basics of biochar*, Background Note, Parliamentary Library, 10 September 2009, http://www.aph.gov.au/library/pubs/bn/sci/Biochar.htm.

46 *An Analysis of Greenhouse Gas Mitigation and Carbon Biosequestration Opportunities from Rural Land Use*, CSIRO, 2009, p. 143.

> chars—making them through a number of processes and looking at their functionality and their benefits to crop production through a series of trials, both for glasshouse and in the field, and seeing if there is real benefit for crop production.[47]

3.74 A 2009 CSIRO report enumerates the benefits of biochar for plant production when used as a soil amendment:

- reduce soil acidity,
- increase or retain plant productivity with a lower amount of fertiliser use, and
- more efficiently retain nutrients and avoid leaching from the soil profile.

> Furthermore, biochar may enable soil and vegetation to adapt to climate change by increasing water holding capacity of soils, and by increasing soil pliability and water infiltration.[48]

3.75 In its submission to the Committee, the National Association of Forest Industries points to the multiple applications of biochar:

> Biochar can be incorporated in biofuel production as well as provide an additional carbon sink with potential for increasing the quality and fertility of agricultural soils. Further evaluation of these types of new technologies is warranted.[49]

3.76 Under the Climate Change Research Program, the Australian Government has provided funding for a research project into biochar, which will target gaps in our understanding of this emerging technology and address uncertainties about its use:

> This project will draw together leading researchers in Australia in the areas of biochar, bioenergy, soil science, emissions management and life-cycle assessment into a national effort, aimed to address key aspects of biochar generation and application in Australian agriculture.[50]
>
> Key activities under the project will include:

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47 Dr Martin Blumenthal, Program Manager, Agronomy, Soils and Environment, Grains Research and Development Corporation, *Transcript of Evidence*, 27 May 2009, p. 10.

48 *An Analysis of Greenhouse Gas Mitigation and Carbon Biosequestration Opportunities from Rural Land Use*, CSIRO, 2009, p. 143.

49 National Association of Forest Industries, Submission no. 51, p. 9.

50 http://www.daff.gov.au/about/obligations/grants_reporting_requirements/november_2009 accessed 14 December 2009.

- a life cycle assessment of biochar from feedstock source to production to sink, including costs, risks, benefits and implications for farmers
- categorisation of biochars according to their properties and suggested usage
- economic assessment of biochar for both net greenhouse gas emissions and potential profitability to land owners
- analysis of risk factors in terms of rates of applications as well as the potential production of toxic by-products during pyrolysis.[51]

Lignite

3.77 The Committee heard evidence from Dr John White about a lignite-based fertilisation system. The system complements and is used in conjunction with other farming methodologies and improves soil biology. Lignite occurs in most states.

> It is a system. It is not just a product and it is not just one company's product. There are many suppliers of this, although at small scale still; they need expanding. It means that you want to keep grass coverage; you do not want bare paddocks. You do not want deep ploughing; you want low tillage. You want seed drilling. You do not want to burn stubble; you want to use folia sprays with biology to digest the stubble and add to the soil and not burn it and kill more. You want to use biological organic based fertilisers. You want to keep grass cover. It is a system, but it does not require technology or knowledge that does not already exist and almost every farmer can convert to it.[52]

> Traditional farming in a range of ways has killed most biology in most soils. You do not find an earth worm in many farm paddocks any more; you do not find the fungi and bacteria mix that you need for healthy plant, grass, crop, and tree growth. The main point of this fertilisation system and other biological farming systems is to use modern technology and better products to rebuild that biology and carbon mix to get healthy, fertile soils and plant growth— and the worms reappear within a year or so.[53]

51 http://www.daff.gov.au/climatechange/australias-farming-future/climate-change-and-productivity-research/emissions_reduction2?SQ_DESIGN_NAME=spaced&SQ_ACTION=set_design_name, accessed 14 December 2009.

52 Dr John White, Ignite Energy Resources, *Transcript of Evidence*, 3 September 2009, p. 95.

53 Dr John White, Ignite Energy Resources, *Transcript of Evidence*, 3 September 2009, p. 94.

3.78 Dr White noted:

> My confidence is based on the fact that a company we are in joint venture with… has been developing and building this biological farming system over 15 to 20 years. Its founder and managing director is a fifth-generation wheat farmer, so he knows. He now has three factories that are manufacturing a range of biological carbon based fertiliser products—liquid powder and high compressive strength granules—to be used in the same farm machinery that they use for spraying and MAP and DAP.[54] He is now fertilising over 300 farms, spreading from the WA wheat belt right across South Australia… into western and south-western Victoria and heading to Gippsland. He is fertilising regularly every year over 300 000 hectares. This is not R&D. This is not speculative. The soil carbon and biology increase and crop yield—the productivity and profitability—on these farms are measured, proven and known. It is spreading across the farm fence because farmers look over and see their neighbour doing better at less cost, regrowing biology and worms.[55]

3.79 Dr White described the fertiliser production process using lignite:

> …which is brown coal. Certain patches of the lignite are very young and just past being peat. Much of our brown coal is as good as or better than peat… It is so young; it is pure, clean organic material. There is nothing dirty about brown coal. It is two thirds water. It is low sulphur, low ash and low heavy metals. It is pristine, beautiful organic material. Of course, if you burn wet brown coal, you consume an enormous amount of heat to evaporate the water and you make a lot of CO_2.[56]
>
> We blend [the lignite] with the required nutrients, such as soft rock phosphate; with the trace elements, such as calcium, magnesium and zinc, that you need for the soil; and particularly with a mix of bacteria, fungi and enzymes that the soils need in a proper balance in order to be fertile. We mix that with the brown coal and other nutrients.[57]

3.80 Dr White went to describe how the fertiliser is used:

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54 Monoammonium phosphate (MAP), and Diammonium phosphate (DAP).

55 Dr John White, Ignite Energy Resources, *Transcript of Evidence*, 3 September 2009, p. 94-95.

56 Dr John White, Ignite Energy Resources, *Transcript of Evidence*, 3 September 2009, p. 98.

57 Dr John White, Ignite Energy Resources, *Transcript of Evidence*, 3 September 2009, p. 99.

> It has an inoculant of biology to restart the biological activity in the otherwise chemically killed, fungicide killed soil. It is not surprising that, when you spray fungicides, you kill the essential fungi in the soil that is needed for healthy plant growth. We make it in three types. We make a liquid extract of high-concentrate humic-fulvic, which can be sprayed. For example, you would spray it on stubble with a bacteria mix to biologically digest the stubble within six months rather than have to burn it for the next sowing season. We make a powder blend, which can be put out through a circular spreader. Alternatively, we make a high compressive strength granule, which can be seed drilled in the same way as MAP and DAP granules are. So it is a range of products used in a range of different ways. But it is quite inexpensive to make.[58]

Committee conclusions

3.81 The Committee believes that biochar and similar products have significant potential to play a part in Australian farming systems, both as a soil additive and a form of carbon sequestration. It welcomes the Australian Government's investment in biochar research.

Farm Forestry

3.82 A number of submissions to the Committee suggested that another way for Australian agriculture to adapt to changes in climate and weather is to diversify on-farm income. Growing trees on farms as part of an integrated farm plan has potential to diversify farm income and provide other benefits such as shelter for stock, enhanced biodiversity and carbon sequestration. Several submissions outlined different ways of incorporating trees on farms, each with a different emphasis on the numerous benefits that growing trees on farms can bring.

3.83 In evidence before the Committee, Mr Allan Hansard, CEO of the National Association of Forest Industries stated:

> Forestry can also complement a range of agricultural activities which may be at greater risk from the effects of climate change. Trees used strategically in the landscape can enhance pasture and plant production and provide direct livestock production and

58 Dr John White, Ignite Energy Resources, *Transcript of Evidence*, 3 September 2009, p. 99.

> calving benefits through provision of shade and shelter, particularly during periods of climatic stress. As a long-term perennial, trees are generally not as susceptible to seasonal and climatic variations as some other types of crop. Trees can be planted as woodlots and plantations or used in specific configurations to provide shelter functions for some crops and pastures. This is not about forestry competing against Australia's food basket; it is about coexistence resulting in a potentially larger, healthier and sustainable food basket.
>
> Consequently, the forestry sector's role as a complementary land use can help reduce farm reliance on drought assistance and provide alternative income sources in dealing with the longer term impacts of climate change—in the same way the full recognition of wood biomass provides farmers with a viable, alternative source of income. As part of a sustainable system, farmers could provide wood biomass to regional based generation facilities, reducing the reliance on fossil fuel energy and creating greater long-term energy security for regional Australia.[59]

3.84 Mr Hansard also pointed out the particular benefits of farm forestry for farms within proximity of commercial plantations:

> What we have noticed over the development of the commercial plantation industry over the last 40 or 50 years in Australia is that farm forestry and agroforestry can benefit through proximity to commercial plantations. Where you have farmers that grow trees that are close to existing plantations, they can often piggy-back on a lot of the infrastructure and there are often economies of scale that come with a commercial-size plantation. Often, we have seen the development of commercial plantations in parallel with the development of farm forestry.[60]

Trees on farms

3.85 Forestry Tasmania has developed a program which integrates forestry in the farm landscape called Trees on Farms. In evidence to the Committee, Dr Hans Drielsma of Forestry Tasmania explained:

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59 Mr Allan Hansard, Chief Executive Officer, National Association of Forest Industries, *Transcript of Evidence*, 24 June 2009, pp. 2-3.

60 Mr Allan Hansard, Chief Executive Officer, National Association of Forest Industries, *Transcript of Evidence*, 24 June 2009, p. 4.

> This innovative program will provide farmers with the opportunity to plant trees to reclaim weed infested land, secure a new revenue stream, capture carbon and provide long-term habitat for threatened species such as the swift parrot. This is a commercial solution to an environmental problem. Reclaiming land infested with weeds, particularly gorse, is an expensive problem for farmers, but we believe Trees on Farms converts that problem into an opportunity. In a nutshell, Trees on Farms will enable landowners to joint venture with Forestry Tasmania to established commercial wood lots on cleared land, particularly degraded land with low agricultural productivity. In the first instance we will work with individual farmers to identify suitable sites. Once these sites are identified we will then enter into a contract where we undertake to plant the trees at no cost to the farmer and the farmer undertakes to protect the growing trees from browsing animals and stock. After 15 to 20 years, when the wood lot is ready to be harvested for timber, Forestry Tasmania and the landowner will share in the revenue. If the parties agree, a new crop of trees can then be grown.[61]

3.86 The Committee visited Mt Vernon, the property of Mr Peter Downie, who is participating in the Trees on Farms program. His property contains plantations of both native and introduced species with a view to providing environmental services and commercial returns. Aside from demonstrating the value of farm forestry on his property, Mr Downie also displayed a keen knowledge of the impact of past agricultural practices upon the health of the soil and the hydrology of the landscape, and the way in which the productivity of the land had been undermined by land clearing and inappropriate production methods. It provided an insight into the intergenerational impacts of past actions and the fact that some acts of landscape restoration may require perspectives of 100 years or more.

61 Dr Johannes Drielsma, Executive General Manager, Forestry Tasmania, *Transcript of Evidence*, 21 September 2009, p. 28

Committee members talking to Peter Downie, Kempton, Tasmania

Agroforestry

3.87 The Otway Agroforestry Network (OAN) offers an extension service similar to that of Forestry Tasmania except the focus is on community development. OAN is a not-for-profit community organisation promoting the wider adoption of vegetation management as an integral component of productive and environmentally sustainable agriculture. The work of the Otway Agroforestry Network centres on trees as part of the farm infrastructure, providing aesthetic value, environmental services (habitat for birds as part of integrated pest management, stock shelter and revegetation of water courses) while also providing an income stream through the production of high quality saw logs. The key to success was giving each farmer the training and tools to manage the timber on their own properties, within the context of group leadership and peer support. Farmers undertook formal training through the Master Treegrowers course, and had access to expertise and support within the network. Network cooperation meant that relatively small stands of timber could be harvested at commercial rates. The result of the Network's operation was a significant increase in tree cover without loss of productivity, and an improvement in the commercial and environmental sustainability of individual enterprises.

3.88 In its submission to the Committee, OAN described its approach:

> We focus on facilitating and supporting farmer participation in R&D using social networking, peer support, education, product research, and market development. We help farmers design and manage forests that meet their own needs as well as providing environmental and commercial benefits for the wider community.[62]

3.89 The OAN submission went on to describe agroforestry and some of its benefits:

> Agroforestry is the strategic integration of multipurpose trees and shrubs into farming systems to enhance productivity and protect natural resources. Agroforestry offers a means of implementing multi-functional agriculture - something which is urgently needed across the nation. Improved water quality in our streams, protection of soils, crops and livestock, the conservation of our unique flora and fauna and the promise of alternative timber sources and other forest products, make well managed trees on farms a good story for rural communities and the nation as a whole.[63]

Engineered woodlands

3.90 The Engineered Woodlands Project run by Southern New England Landcare was a variation on the theme explored in the section above, with similar outcomes in mind. Trees provided carbon offsets and other environmental services such as windbreaks and stock shelters. They also provided a harvestable resource. Through careful design, it was possible to place a substantial proportion of a property under trees with no loss of carrying capacity or productivity.

3.91 In its submission, Southern New England Landcare stated:

> The Engineered Woodlands Project aims to demonstrate a profitable land use that integrates the growing of native trees and shrubs for biodiversity carbon and timber values within agricultural production systems. Engineered woodlands are paddock-wide tree crops where the trees are wide-spaced and allow normal agriculture to operate between them. In short, the plantings do not displace pastures and conventional crops but are integrated with them.

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62 Otway Agroforestry Network, Submission no. 71, p.1.

63 Otway Agroforestry Network, Submission no. 71, p.1.

Key benefits of an Engineered Woodland are:

- Shade and shelter for better livestock, crop and pasture production,
- Better habitat connectivity for biodiversity,
- Improved soil nutrient cycling and water use efficiency, and
- Income from timber and carbon credits.

Key features of an Engineered Woodland are:

- Designed to produce multiple products from traditional agriculture as well as the trees
- The use of the entire paddock for tree establishment minimises fencing costs, thus substantially reduces establishment costs
- Agricultural activity can continue between belts once trees are sufficiently established (within 1-3 yrs for most sites)
- Tree belts or copses are established at spacings to suit machinery, pasture and stock management and are aligned to maximise microclimate benefits.[64]

Members of the Committee, with representatives of Southern New England Landcare, inspecting an example of engineered woodland in the Tamworth region.

64 Southern New England Land Care Ltd, Submission no. 39, p. 3.

3.92 In evidence to the Committee, Mr David Thompson of Northern Inland Forestry Investment Group provided an example of productivity increases on one farm involved in the Engineered Woodlands project:

> For that particular farm [shown in the powerpoint presentation], the one with the contours, we estimated that 70 per cent of the benefit for that farm was going from stock shelter. On that particular farm, there was a 50 per cent reduction in sheep losses and a 10 per cent increase in lambing rates, with 11 per cent of the farm under trees. That translated to around about $20 000 per year of increased income.[65]

Committee conclusions

3.93 Farm forestry provides a real opportunity for farmers to diversify income while improving the environmental sustainability of their properties within the context of existing production mixes. It is not about the wholesale replacement of agriculture by forestry with all its attendant social, economic and environmental consequences. Farm forestry also provides for emissions offsets through the storage of carbon in trees, and, potentially, the creation of income through carbon credits.

3.94 During the course of the inquiry, the Committee had the opportunity to inspect sites related to all three of the above programs and was impressed by them all. They had in common a desire to see forestry incorporated into the existing farm enterprise rather than simply bolted on, and all showed sensitivity for the ecological impacts of forestry in the landscape. None was a case of simply changing land use for commercial return regardless of the environmental, economic or social consequences. The key difference between them was the level of ownership, responsibility and direct involvement in the forestry enterprise by the farmer. All three provide models for future action.

65 Mr David Thompson, Project Manager, Northern Inland Forestry Investment Group, *Transcript of Evidence,* 19 August 2009, p. 11.

Mitigation

Ruminant emissions

3.95 Australia's agricultural gas emissions are estimated to be sixteen percent of the net national total.[66] It is also estimated that 80 per cent of agriculture's emissions are generated by the digestive processes of ruminant animals. This process, enteric fermentation, produces methane. Methane emissions from ruminant livestock represent a loss of carbon during feed conversion, which has implications for both animal productivity and the environment because this gas is considered to be one of the more potent forms of greenhouses gases contributing to global warming. In his evidence to the Committee, Mr Robert Young, NSW Department of Primary Industries, informed the Committee of recent ruminant emissions research:

> We received $1.6 million … to undertake research on how we might reduce methane emissions from ruminant livestock. That research again is part of a national collaborative program, so different groups around Australia are doing different components of that. Meat and Livestock Australia are also integral to it. Our parts of the program are to look at the genetic capacity of both cattle and sheep, through breeding, to reduce methane emissions and to look at feeding strategies and ruminant manipulation as options to reduce methane emissions.
>
> To give you some examples, there is about a 20 per cent difference between high-emitting methane livestock and low-emitting methane livestock just because of their genetics. Methane is a net loss to the system, if you like. If you can stop that methane emission you could convert that into wool or meat or milk or whatever. It is a deadweight loss. If we can improve the adoption of the livestock that are predisposed to low-methane emissions—sheep, goats et cetera—there are significant gains.[67]

3.96 Another area of research to reduce methane emissions in livestock looks at different types of stock feed. Mr Young continued:

> In the area that you specifically mentioned, which was tannins in legumes, yes, we recognise there are a number of options—and

66 *Carbon Pollution Reduction Scheme Green Paper*, Department of Climate Change, July 2008, p. 14.

67 Mr Robert Young, Climate Change and Water Research, Department of Primary Industries, NSW, *Transcript of Evidence*, 1 July 2009, pp. 25-26.

> not just in legumes. There are a number of shrubs as well that have high tannins with the capacity to reduce methane emissions from livestock. We are also looking at a range of rumen additives and a number of other factors.[68]

3.97 In his evidence to the Committee Dr Keating of the CSIRO told the Committee of similar research being undertaken:

> We do have an active program of work on tropical beef and the emissions story in … Rockhampton. We are looking at a couple of things and I will make three comments. Firstly, we are looking at the fundamental relationships between animal diet and emissions. There are some early suggestions—and I hasten to add that this is not yet peer-reviewed literature—that the emissions levels in our current accounts, which do have an extra factor in them for tropical beef, may be slightly overestimating the emissions of those tropical beef. So there is a small potential gain. I do hasten to add that these emissions and the protocols have to be internationally peer reviewed, but CSIRO is very active in making sure that we have the best data going into that, so one would hope in the near future that that material will be published and go into the peer review. Secondly, there are some suggestions that some feed mixes may actually be reducing the methane per unit intake. There are some suggestions that leucaena as part of the diet might be having that effect… It is a tropical leguminous shrub that is grown in Central Queensland and other regions. That is just one example. We are looking for those sorts of feed additives that may have some positives. It is very early days. Thirdly, one of the big mitigation opportunities with the northern beef herd is to raise productivity. If we can feed animals better, get offtake in a year earlier, we can have a significant impact on the methane load per unit production.[69]

68 Mr Robert Young, Climate Change and Water Research, Department of Primary Industries, NSW, *Transcript of Evidence*, 1 July 2009, pp. 25-26.

69 Dr Brian Keating, Director, Sustainable Agriculture Flagship, *Transcript of Evidence*, 21 October 2009, p. 11.

Committee conclusions

3.98 The Committee is conscious that emissions from agriculture form a significant part of overall greenhouse gas emissions and supports further research efforts into the mitigation of greenhouse gas emissions from agriculture.

Recommendation 5

3.99 **The Committee recommends that the Australian Government support further research efforts into the mitigation of greenhouse gas emissions from agriculture.**