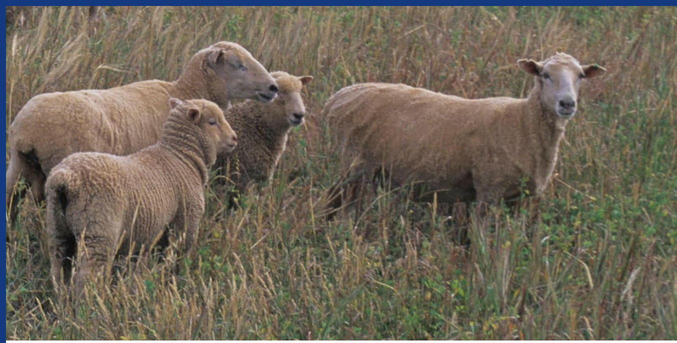
Opportunities for sequestration and emissions reduction from the NSW agricultural sector

NSW GOVERNMENT | Department of Primary Industries



Summary

Primary producers can play an important role in reducing emissions and increasing carbon sequestration. Agriculture currently contributes about 15 per cent of the NSW greenhouse gas emissions. The total increase in emissions due to human activity is contributing to climate change globally, across Australia and in NSW. Actions that take up and store carbon in vegetation and soil (sequestration) and reduce greenhouse gases released by livestock, soil and vegetation clearing (emissions reduction) address climate change, create environmental benefits and contribute to regional economic growth (see Figure 1).

This document summarises the report *Abatement Opportunities from the Agricultural Sector in New South Wales* (available at https://www.dpi.nsw.gov.au/climate-and-emergencies/climate-change-research-strategy). Researchers used the Full Carbon Accounting Model (FullCAM) to calculate the potential for carbon sequestration through vegetation management and agricultural practices. They also determined potential soil carbon sequestration from changes in vegetation cover. Some opportunities satisfy the criteria for market-based activities aligned to the Emissions Reduction Fund (ERF), while others could occur outside the ERF. These non-market opportunities include small-scale, on-farm activities that often complement agricultural production.

Sequestration by vegetation and soil

Avoiding deforestation, retaining remnant vegetation, encouraging regrowth, and reforestation with multi-stemmed Eucalyptus species (mallees) and other native species can protect and build the carbon stocks in plant biomass and soil. Carbon can also be stored in the soil beneath trees, crops and pastures, so the sequestration potential from vegetation management is an underestimate because the amounts listed here exclude associated increases in soil carbon.

Protecting or enhancing native vegetation is one of the most cost-effective vegetation-based sequestration activities. The ERF market calls these activities ‘avoided deforestation’ and ‘avoided clearing’. There are opportunities for non-market incentives to encourage retention of native vegetation and retain **25.6 Mt CO_2e**, by 2030[1].

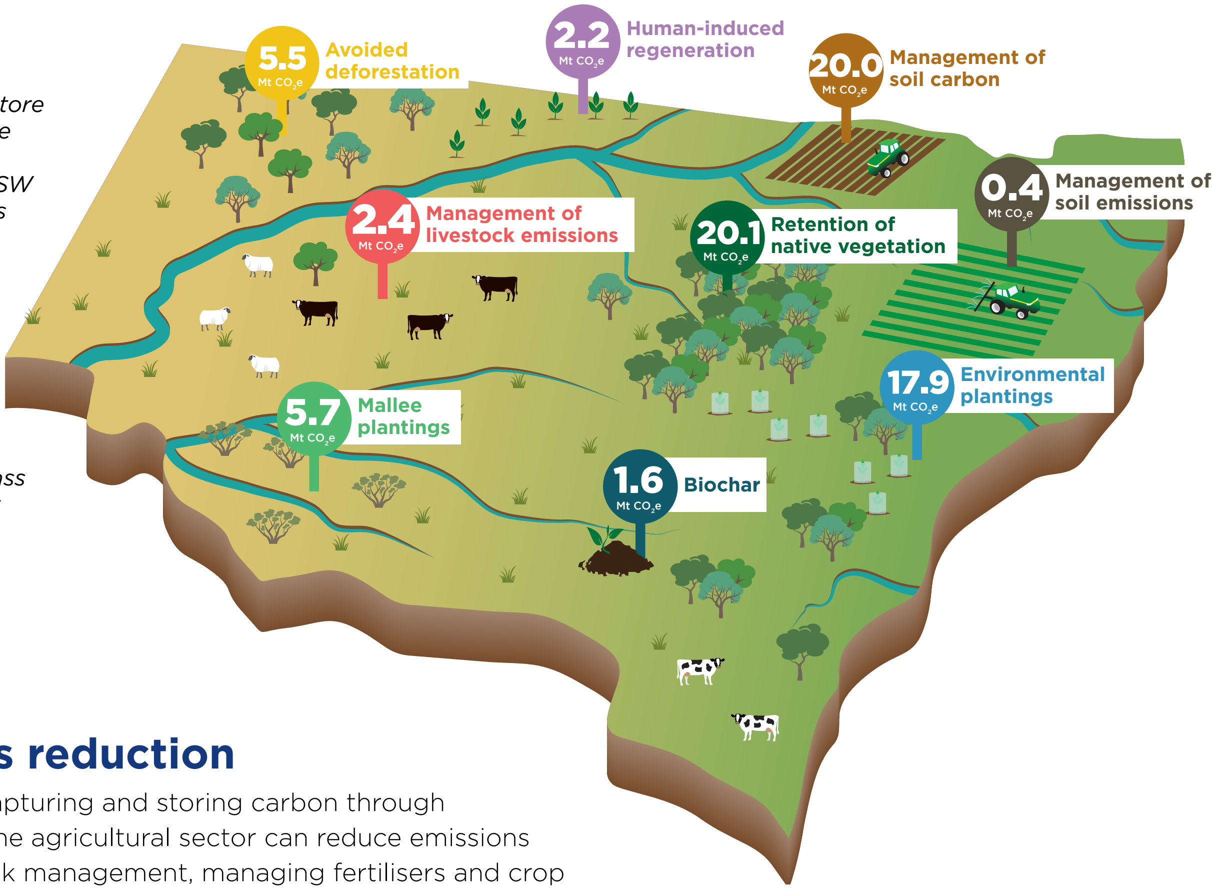
Another cost-effective vegetation-based sequestration activity is the management of natural regeneration or regrowth, referred to in the ERF market as ‘human-induced regeneration’. Activities to promote regrowth include reducing livestock grazing intensity, stopping regrowth control, and suppressing weeds and pests. Non-ERF market activities include natural regeneration to provide stock shelter, managing regrowth for the restoration of degraded or low productivity areas, and enhancing remnant vegetation. Managing vegetation regrowth could sequester **2.2 Mt CO_2e** in vegetation.

Reforestation can provide significant abatement over the next 20 years and includes activities such as planting seedlings as shelterbelts, for restoring degraded areas, and for erosion control. These activities may increase livestock production, control dryland salinity, increase native vegetation connectivity and create wildlife corridors. Reforestation can also include non-market activities such as environmental plantings for wildlife habitat, and small scale farm forestry and bioenergy plantings. Environmental plantings of mixed species could potentially sequester **17.9 Mt CO_2e** in vegetation. In addition, establishment and management of mallees could deliver a total of **5.7 Mt CO_2e** in vegetation.

Managing carbon in soil contributes to the ERF methods known as ‘estimating sequestration of carbon in soil using default values’, and ‘measurement of soil carbon sequestration in agricultural systems’. Under these methods, activities to manage soil carbon include conversion of croplands to pasture, pasture and grazing management, and cropping methods such as reduced tillage and stubble retention. Other activities include remediation of degraded landscapes, the incorporation of legumes in perennial pastures, and sustainable intensification. These activities to manage soil carbon could deliver **20.0 Mt CO_2e** of carbon sequestration. Increasing woody and ground cover across NSW would also reduce soil carbon losses from erosion. The researchers estimated that a 10 per cent increase in cover could sequester between 2.5 and 15 tonnes of carbon per hectare, or **1,913 Mt CO_2e** across NSW.

1 Megatonnes of carbon dioxide equivalent, which is a measure of all greenhouse gases, including carbon dioxide, methane and nitrous oxide, that would give the same warming as the equivalent concentration of carbon dioxide alone.

Figure 1: Feasible opportunities to store carbon and reduce greenhouse gas emissions from NSW agriculture. Values are in Mt CO_2e (megatonnes of carbon dioxide equivalent). Values for vegetation management show sequestration potential in biomass (above and below ground) by 2030.



Emissions reduction

In addition to capturing and storing carbon through sequestration, the agricultural sector can reduce emissions through livestock management, managing fertilisers and crop residues, production and use of biochar, managing manure, and modifying rice cultivation.

Methane released by livestock, produced by their digestive processes, represents around 75 per cent of greenhouse gas emissions from agriculture in NSW. Strategies to reduce these emissions can improve productivity because methane production from the food consumed by animals represents a waste of energy.

ERF methods that encourage activities to reduce methane from livestock digestion through dietary manipulation include 'reducing greenhouse gas emissions by feeding nitrates to beef cattle' and 'reducing greenhouse gas emissions by feeding dietary additives to milking cows'. The ERF method 'beef cattle herd management' reduces methane emissions by planting improved pastures, controlling grazing to enhance pasture quality, culling unproductive animals, selecting for higher fertility, and providing additional watering points. The feasible abatement from a combination of dietary additives and herd management is estimated to be **1.7 Mt CO_2e** per year (in 2030) for cattle and **0.5 Mt CO_2e** for sheep.

Emissions of methane and nitrous oxide from manure contribute around 4 per cent of agriculture emissions in NSW, largely from piggeries and cattle feedlots. The 'animal effluent management' ERF method could reduce emissions by **0.2 Mt CO_2e** per year.

Nitrous oxide – emitted from fertilisers, manure and urine of grazing livestock, and decomposing plant material – is about 300 times more powerful at warming the planet than carbon dioxide, and makes up about 20 per cent of NSW agriculture emissions. The ERF method 'reducing greenhouse gas emissions from fertiliser in irrigated cotton' encourages reduction in nitrous oxide through modified fertiliser and irrigation management. Practices that are not covered by ERF methods include using nitrification inhibitors and fertiliser management in crops other than cotton.

Biochar – produced by heating biomass in the absence of oxygen – can reduce methane, nitrous oxide and ammonia emissions from composting manure (and also reduce odour). Biochar is not currently included in the national inventory but storing carbon in biochar could be recognised in a future ERF method.

Irrigated rice releases large quantities of methane due to decomposition of organic matter in flooded conditions where there is limited oxygen. Modified management of crop stubble and irrigation practices, using drill sowing and delayed flooding, can more than halve methane emissions.

The combined efforts of managing fertilisers and crop residues to reduce nitrous oxide, production and use of biochar, and modifying rice cultivation could reduce emissions by **1.9 Mt CO_2e** per year.

Responding to climate change in NSW

The concentration of greenhouse gases due to human activities has dramatically increased in the atmosphere. This has led to warming globally, including across Australia. The average temperature in New South Wales has risen steadily since the 1950s, with the rate of increase accelerating in recent years to about half a degree per decade.

Climate influences every aspect of our lives. Climate change will exacerbate natural climate variability, making it more difficult to manage our landscapes and ecosystems and the human activities that depend on them. Agriculture is dependent on climate, so as the intensity and incidence of severe weather events increases into the future, productivity risk will also increase.

Australia is one of 187 countries that have committed to the Paris Agreement goal to keep global temperature rise to well below 2 °C. NSW has committed to a net zero emissions target by 2050 as a step towards addressing the impacts of climate change.

Primary producers and landowners will play an important role in reducing greenhouse gas emissions in NSW. Agriculture contributes about 15 per cent of the state's emissions. Methane (CH_4) released from livestock represents about three-quarters of agricultural emissions, with most of the remainder comprising nitrous oxide from soils and fertilisers, as well as emissions from manure, crop waste decomposition, rice cultivation and stubble burning (see Figure 2). These amounts exclude additional emissions from land clearing and energy used on farms or in activities such as fertiliser manufacture.

The primary industries sector presents myriad opportunities to address climate change over the short- (2030) and long-term (2050) through actions that take up and store carbon in vegetation and soil (sequestration) and through reducing greenhouse gases released by livestock, soil and vegetation clearing (emissions reduction). The extensive nature of agricultural land-use in NSW provides a large potential 'carbon sink' through sequestration. Sequestration and emissions reduction also contribute to economic growth for regional communities and create environmental benefits (see Box: Benefits to agriculture).

Benefits to agriculture

Many activities that sequester carbon or reduce greenhouse gas emissions assist farm businesses, for example by improving soil quality. These benefits can help farmers adapt to a more variable climate.

Building soil organic matter improves nutrient and water-holding capacity of soils and buffers against drought. Increased perenniality and ground cover will protect soil from erosion during storms and increased tree cover can provide shelter to stock and crops in heat waves. Greater tree cover can also provide habitat and food for wildlife and increase resilience to disease and pests. These practices will be vital to maintaining agricultural productivity under climate change.

Generating income through carbon sequestration or emissions reduction ('carbon farming') can provide an additional income stream, which can be used to reinvest on farms, employ local contractors and improve the resilience of farming systems. The money can be used to restore land, while carbon sequestration through vegetation and soil management supports biodiversity and improves soil quality.

Benefits from carbon farming

- sustainable land management and environmental stewardship, which are increasingly required to maintain existing market share and to ensure future access to international markets
- environmental benefits, such as reduced land degradation, increased vegetation cover and less erosion
- creation of additional income streams through carbon farming
- an estimated 10,500 to 21,000 new jobs and $10-24 billion generated by the Australian carbon market
- benefits to agricultural production such as increased livestock shelter and enhanced soil fertility
- increased extent and quality of habitat for biodiversity
- social benefits, such as greater well-being and resilience.

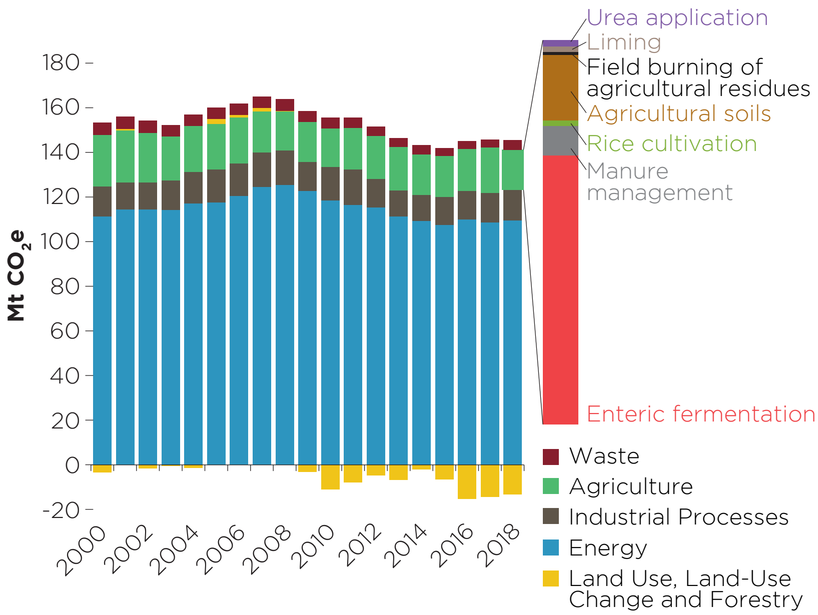


Figure 2: NSW emissions, highlighting the contribution of agriculture in 2018 (source: AGEIS, DISER)

The following pages summarise a detailed report that identifies opportunities and provides estimates of sequestration and emissions reduction from the agricultural sector. Some opportunities satisfy the criteria for market-based activities aligned to the Emissions Reduction Fund (ERF), while other activities could occur outside the ERF (see Box: Market and non-market opportunities).

Trade-offs and co-benefits of carbon farming

The adoption rates estimated in this summary account for land-use trade-offs between agricultural production and carbon farming activities.

Encouragement of carbon sequestration and emissions reduction, such as the retention of native vegetation (avoiding clearing), needs to be balanced against the effect on crop and livestock production. Also, the carbon benefits of converting cropping to pasture need to be balanced against any increased emissions from livestock.

Abatement will need to be delivered in combination with continued production of food and fibre, in ways that increase farm income streams and resilience of farm businesses and regional communities.

Trade-offs can be managed by offsetting lost production through the investment of carbon income into intensification to increase productivity and farm improvements.

Farmers recognise the value of sequestration activities such as reforestation. The many benefits include improved livestock survival from shade and shelter provided by trees, pasture and crop protection, integrated pest management and pollination, creation of wildlife corridors, and reducing land degradation.

Market and non-market opportunities

The Emissions Reduction Fund (ERF) is an important mechanism for delivering Australia's commitments under the 2015 Paris Agreement. The ERF encourages projects that generate carbon credits that can be traded. Associated legislation specifies the rules for accounting emission reduction and sequestration under a range of different project types or 'methods'. Some of these methods include vegetation-based sequestration, soil carbon sequestration, the management of livestock herds and manure management to reduce emissions.

In 2017-18, Australian agricultural areas contributed 8.7 million tonnes of greenhouse gas abatement, valued at $105 million – putting carbon credits just outside the top 50 Australian agricultural products.

In the past 5 years, Australian agriculture has rapidly adopted carbon farming practices, particularly in the semi-arid rangelands of western NSW. Compared with higher rainfall areas, rangelands have low agricultural productivity, so carbon farming activities such as regeneration or protection of native vegetation do not displace valuable farming activities (see Box: Trade-offs). Expansion of carbon farming activities beyond the rangelands, and covering a broader range of ERF project types for sequestering carbon and avoiding greenhouse gas emissions, would broaden opportunities to include other agricultural areas in NSW. It would also reduce risks of having projects geographically concentrated in western NSW where rainfall is low and highly variable.

There are opportunities for sequestration and emissions reduction from small-scale activities that are not currently captured through the ERF. These unrealised opportunities include small-scale, on-farm activities that often complement agricultural production.

Sequestration in vegetation and soil

There is considerable potential for sequestration in vegetation and soil in NSW agricultural regions (see Figure 3). Avoiding deforestation, retaining remnant vegetation, encouraging regrowth, and reforestation with mallees and other native species can protect and build the carbon stocks in plant biomass and soil. Carbon can also be stored in the soil beneath crops and pastures.

The estimated potential for each of these is provided below as Mt CO_2e. The sequestration potential from vegetation management is an underestimate, because the amounts listed here exclude associated increases in soil carbon. The opportunities recognise production and environmental benefits of abatement activities. These estimates recognise the barriers to adoption and current developments to address these (see Box: Barriers to adoption).

Sequestration

Sequestration is abatement of carbon through vegetation and soil.

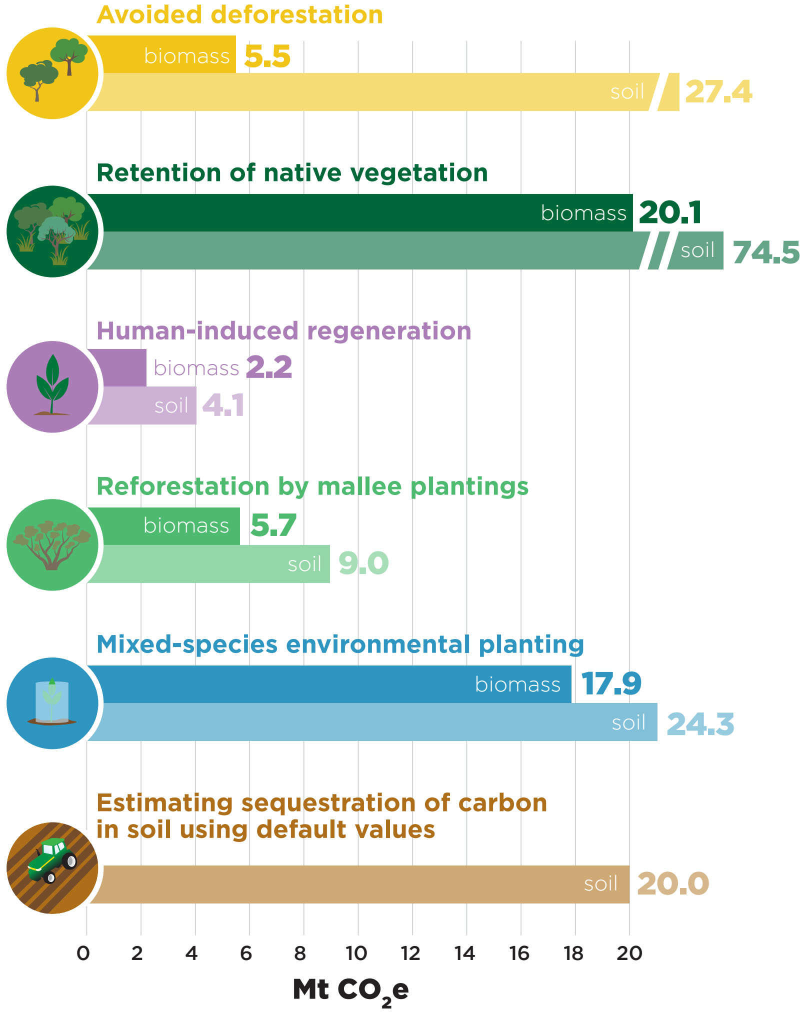


Figure 3: Potential amount of carbon that can be sequestered through vegetation and soil management on agricultural land in NSW by 2030.

Carbon sequestration in vegetation

Avoiding deforestation and retention of native vegetation

Protecting or enhancing native vegetation is one of the most cost-effective vegetation-based sequestration activities. The ERF market calls these activities 'avoided deforestation' and 'avoided clearing' (see below). They could involve enhancing remnant vegetation, or managing regrowth and rehabilitation of degraded or low productivity areas. There are also opportunities for non-market incentives to encourage retention of native vegetation.

Some of the greatest opportunities to avoid emissions through retention of native vegetation occur in higher rainfall areas of eastern NSW. Here, because landscapes are highly fragmented, additional environmental benefits can be expected by retaining native vegetation. Prioritising zones within a farm such as riparian, floodplain or drainage lines may support the greatest sequestration rates in semi-arid areas.

The total area in NSW suitable for avoided deforestation, avoided clearing, or non-ERF activities to retain native vegetation is 9,503,100 ha. Only 964,121 ha is being managed for sequestration, leaving more than 8.5 million hectares that could be managed to sequester 25.6 Mt CO_2e from retaining native vegetation.

Managing vegetation regrowth

Another cost-effective vegetation-based sequestration activity is the management of natural regeneration or regrowth, referred to in the ERF market as 'human-induced regeneration'. Activities to promote regrowth include reducing livestock grazing intensity, stopping regrowth control, and suppressing weeds and pests to enable revegetation or rehabilitation. Non-ERF market activities include natural regeneration to provide stock shelter, managing regrowth for the restoration of degraded or low productivity areas, and enhancing remnant vegetation.

The greatest opportunities for natural regeneration activities occur across extensive areas in western NSW.

The area suitable for human-induced regeneration is 3,338,500 ha, which could sequester 2.2 Mt CO_2e in vegetation.

Reforestation with mallee and other species

Avoided deforestation (as described above) and reforestation provide the largest abatement opportunities. Reforestation activities include direct seeding or planting tree seedlings in areas where there is currently no forest.

The ERF market distinguishes between reforestation involving environmental plantings and mallee plantings. Reforestation includes activities such as planting seedlings as shelterbelts, for restoring degraded areas, and for erosion control. These activities may increase livestock production, control dryland salinity, increase native vegetation connectivity and create wildlife corridors. Reforestation can also include non-market activities such as environmental plantings for wildlife habitat, and small scale farm forestry and bioenergy plantings.

Temperate areas of NSW, where rainfall is reliable, offer the highest rates of sequestration, but an expansion of planting activities to central and northern NSW will also provide significant abatement opportunities. Environmental plantings could potentially sequester 17.9 Mt CO_2e in vegetation.

In addition to environmental plantings of mixed species, establishment and management of multi-stemmed Eucalyptus species (mallees) in the low rainfall areas of southern NSW, where crop production is increasingly challenged by climate change, may provide benefits through a transition from cropping to mixed farming. Mallee plantings could deliver a total of 5.7 Mt CO_2e in vegetation.

How carbon sequestration was estimated

The Full Carbon Accounting Model (FullCAM) is a computer model that predicts forest growth, (above and below ground biomass) and carbon in the soil.

Researchers identified and mapped areas across NSW suitable for carbon sequestration in soil, trees and other vegetation, to consider abatement potential. They assumed low on-farm adoption rates (1 to 10 per cent) to ensure food and fibre production was not displaced, although for some agricultural sectors, agricultural land-use is unlikely to be affected even by 20 per cent adoption of carbon sequestration activities (see Box: Trade-offs).

Researchers used FullCAM to calculate the feasible potential for carbon sequestration by 2030 (that is, the adoption rate multiplied by the area suitable for activities and the rate of sequestration).

Integrated assessment modelling and machine learning

FullCAM calculations are based on today's climate. Hence, the model does not allow for changes in climate or carbon dioxide level in the atmosphere, so cannot account for the impacts of climate change on sequestration. To address this, the researchers used integrated assessment modelling to account for future climate impacts, changes in greenhouse gas concentrations and the cost of switching from current land use to carbon farming.

Changes in rainfall and temperature are likely to affect tree growth. Increased photosynthesis from elevated carbon dioxide concentrations (the 'CO_2 fertilisation effect') may stimulate forest growth, although perhaps not in Australia, where growth is limited by low water and nutrient availability.

Researchers explored projections of solar radiation, maximum temperature, minimum temperature and rainfall for high and low greenhouse gas emissions scenarios through to 2100. They also examined possible impacts of climate change in areas of NSW that have potential for carbon sequestration through natural vegetation regrowth management. Ongoing research will examine the future climate impacts on other ERF methods.

In addition, they used machine learning to compare soil carbon stocks under current land use and vegetation cover with future carbon stocks under increased vegetation cover that promotes soil carbon sequestration. The difference revealed the potential for soil carbon sequestration through changes in land use and land management.

Integrated assessment modelling identified that climate change impacts on sequestration appear to be regionally specific.

Carbon sequestration in soil

Managing carbon in soil contributes to the ERF methods known as 'estimating sequestration of carbon in soil using default values', and 'measurement of soil carbon sequestration in agricultural systems'.

Activities to manage soil carbon include conversion of croplands to pasture, pasture and grazing management, and cropping practices such as reduced tillage and stubble retention across cropping and mixed farming zones. Other activities include remediation of degraded landscapes, the incorporation of legumes in perennial pastures, and sustainable intensification (for example, managing nutrients and soil acidity, and new irrigation). Increasing woody and ground vegetation cover across NSW would also reduce soil carbon losses from erosion (see Figure 4).

Using ERF default values, these activities to manage soil carbon could deliver 20.0 Mt CO_2e of carbon sequestration; however, the potential using other activities may be considerably higher (Figure 4). Distinct trends in sequestration potential with different climate, soil types and vegetation-cover levels are apparent (Figure 5).

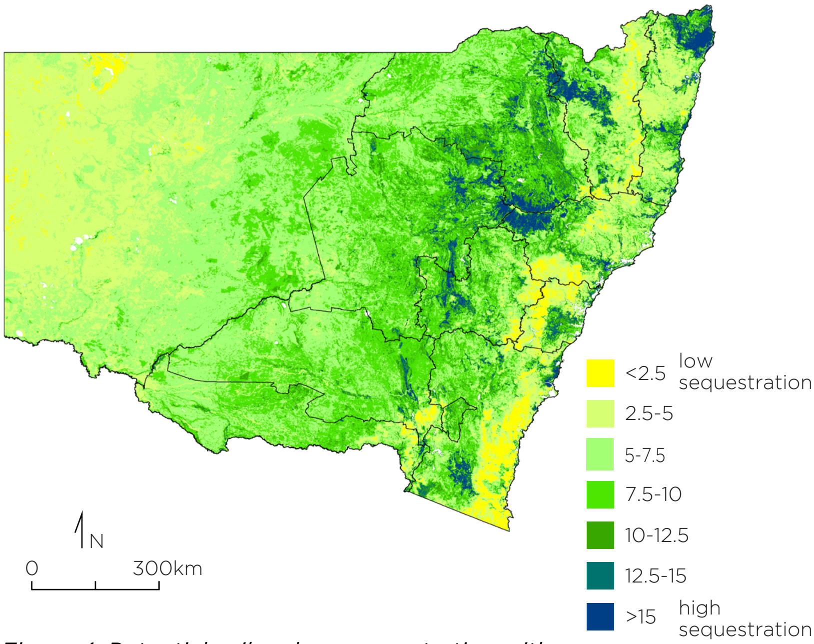


Figure 4: Potential soil carbon sequestration with 10 per cent increased vegetation cover (t ha^{-1}).

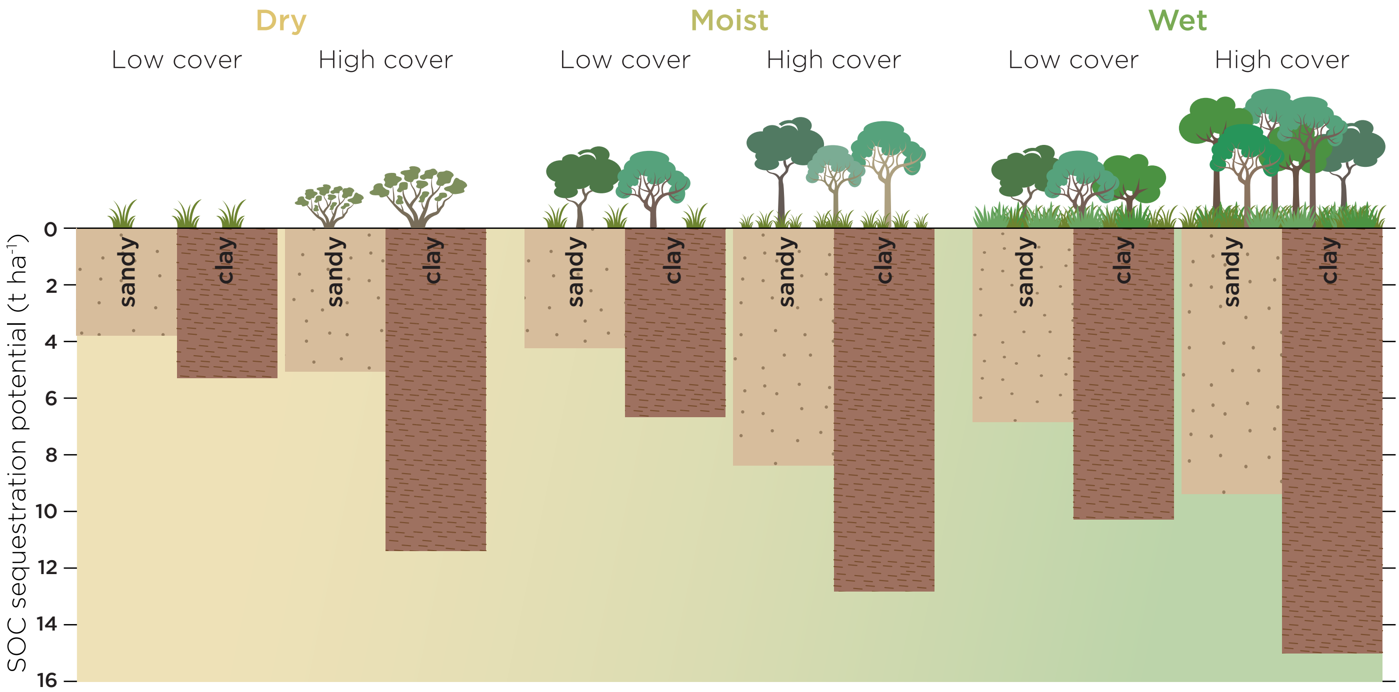


Figure 5. Potential soil carbon sequestration (0-30 cm) across different soil types, rainfall and vegetation-cover levels in NSW.

Barriers to adoption

The estimates presented here assume that barriers to the adoption of activities by the agriculture sector will be overcome by the provision of information about carbon market opportunities by various government and other organisations. The emissions reduction estimates also include assumptions that regulatory barriers are overcome, that ERF methods are developed to provide a financial incentive and that commercial products become available. However, there will be challenges for land managers to find ways to incorporate sequestration and emissions reduction activities into farm businesses.

Barriers include administrative complexities of the ERF eligibility rules and audit requirements, which result in high transactional costs. A major barrier to the adoption of some ERF methods has been the costs associated with developing projects at a sufficient scale, and the expense of baseline measurements for soil carbon projects. The uncertain financial return from some carbon projects is a barrier to adoption as income will depend on the price of carbon and the capacity of the land to store carbon. Another barrier is that ERF eligibility rules preclude using non-ERF methods; for example, clearing native vegetation could be slowed if sequestration opportunities were recognised and farmers could generate income from hosting significant patches of existing vegetation. Trade-offs with existing agricultural production can also be a barrier (see Box: Trade-offs).

Areas of high agricultural productivity will need a higher carbon price to overcome barriers and increase adoption. Non-financial drivers of adoption may be important, including knowledge of co-benefits such as yield increases and environmental benefits. Knowing other adopters also helps overcome barriers related to awareness and confidence.

The following actions would encourage agricultural abatement activities

- methods are modified to address issues of scale and provide new opportunities for agriculture to participate in carbon farming
- the Federal Government streamlines method compliance and modifies the ERF to increase the supply of carbon credits
- state governments and industry more aggressively seek net-zero targets, driving demand for carbon sequestration and reduction activities.

Emissions reduction

In addition to capturing and storing carbon through sequestration (see previous pages), the agricultural sector can further reduce emissions (see Figure 6).

Researchers determined emissions reduction opportunities by assessing technologies and regulatory, economic and social barriers to their adoption. They considered future numbers of beef and dairy cattle, sheep and pigs but excluded other livestock such as goats and horses as they contribute less than one per cent of NSW emissions.

The study included emissions reductions from feed additives, livestock herd management, managing fertilisers and crop residues, production and use of biochar, managing manure, and modifying rice cultivation.

Reducing methane from livestock

Bacteria in the intestines of ruminant livestock release methane during digestion. The gas is the major source (around 75 per cent) of greenhouse gas emissions from agriculture in NSW. Strategies to reduce methane emissions can improve productivity because methane production from the food consumed by animals represents a waste of energy.

ERF methods that encourage activities to reduce methane from livestock digestion include ‘reducing greenhouse gas emissions by feeding nitrates to beef cattle’, ‘reducing greenhouse gas emissions by feeding dietary additives to milking cows’, and ‘beef cattle herd management’.

Manipulating diet

Dietary manipulation is most applicable to dairy and feedlot cattle that eat supplementary feed or full rations.

Three feed additives are particularly effective at reducing methane. Nitrate decreases methane production by competing for hydrogen in the rumen. An organic compound called 3-nitrooxypropanol (or 3-NOP) inhibits microorganisms from producing methane. Asparagopsis is a seaweed that produces bromoform, which inhibits the formation of methane. These feed additives reduce methane yield on average by 16, 29 and 49 per cent, respectively. Feed additives based on 3-NOP and Asparagopsis are expected to become commercially available within 2 to 5 years.

Managing herds, breeding and vaccines

Herd management can reduce methane emissions by 5 to 25 per cent and is most applicable in grazing systems. The management activities include installing fences, planting improved pastures, controlling grazing to enhance pasture quality, culling unproductive animals, selecting for higher fertility, and providing additional watering points. As well as reducing methane emissions, herd management increases productivity of meat, milk or wool per unit of feed. These activities are all consistent with good management and increased profitability, so are likely to be readily adopted.

Breeding by selecting animals with a lower feed intake for the same growth, or lower methane production for the same feed intake, could reduce methane emissions. Breeding is a slow approach but would deliver ongoing gains and has the potential to be readily adopted.

Research to develop a vaccine to reduce methane emissions by combatting methane-producing microbes is ongoing but an effective vaccine is unlikely before 2030.

Based on the number of livestock projected for NSW in 2030, the feasible abatement from a combination of dietary additives and herd management is estimated to be 1.7 Mt CO_2e per year for cattle and 0.5 Mt CO_2e for sheep, representing a 20 per cent reduction in methane emissions.

Manure management

Emissions of methane and nitrous oxide from manure contribute around 4 per cent of agriculture emissions in NSW, largely from piggeries and cattle feedlots.

The ‘animal effluent management’ ERF method recognises emissions reductions through either separating solids for processing (such as by composting) or processing manure in an anaerobic digester or covered pond. Covering effluent ponds to capture and flare methane reduces emissions by 90 per cent, and the biogas can be used for heat or to generate electricity. Feasible abatement from modified manure management is estimated at 0.2 Mt CO_2e in 2030.

Avoiding emissions from soil

Managing fertilisers and crop residues

Nitrous oxide is about 300 times more powerful at warming the planet than carbon dioxide, and makes up about 20 per cent of NSW agriculture emissions. Nitrous oxide is emitted from soil – particularly in waterlogged, low oxygen conditions – from nitrogen applied in fertilisers, from manure and urine of grazing livestock, and from decomposing plant material.

Emissions of nitrous oxide can be reduced by using fertilisers with slow-release coatings or nitrification inhibitors, and by changing the rate, timing and placement of fertiliser to avoid rainfall and irrigation (when oxygen availability is low). Nitrification inhibitors can reduce emissions by more than 70 per cent. Removing crop residues before they decompose, incorporating manure into the soil and introducing dung beetles can also reduce nitrous oxide emissions.

Reduction in nitrous oxide through modified fertiliser and irrigation management is encouraged by the ERF method 'reducing greenhouse gas emissions from fertiliser in irrigated cotton'. Practices that are not covered by ERF methods include using nitrification inhibitors and fertiliser management in crops other than cotton.

Biochar

Pyrolysis (heating in the absence of oxygen) of biomass produces biochar. When biomass is converted to biochar and applied to soil, carbon is locked up for hundreds to thousands of years.

Biochar can reduce methane, nitrous oxide and ammonia emissions from composting manure (and also reduce odour), reducing climate change impact and retaining valuable nutrients.

Biochar is not currently included in the national inventory but storing carbon in biochar could be recognised in a future ERF method. The production and use of biochar could reduce emissions from decomposition of organic residues by 1.56 Mt CO_2e. Biochar can also reduce emissions in the energy sector through the production of renewable heat and electricity.

Rice cultivation

Irrigated rice releases large quantities of methane due to decomposition of organic matter in flooded conditions where there is limited oxygen. In some years, rice cultivation contributes more than 3 per cent of NSW agriculture emissions.

Modified management of crop stubble and irrigation practices, using drill sowing and delayed flooding, can reduce methane emissions by more than half.

The combined efforts of managing fertilisers and crop residues to reduce nitrous oxide, production and use of biochar, and modifying rice production could reduce emissions by 1.9 Mt CO_2e.

Emissions reduction

Practices that reduce greenhouse gas emissions from livestock and soil.

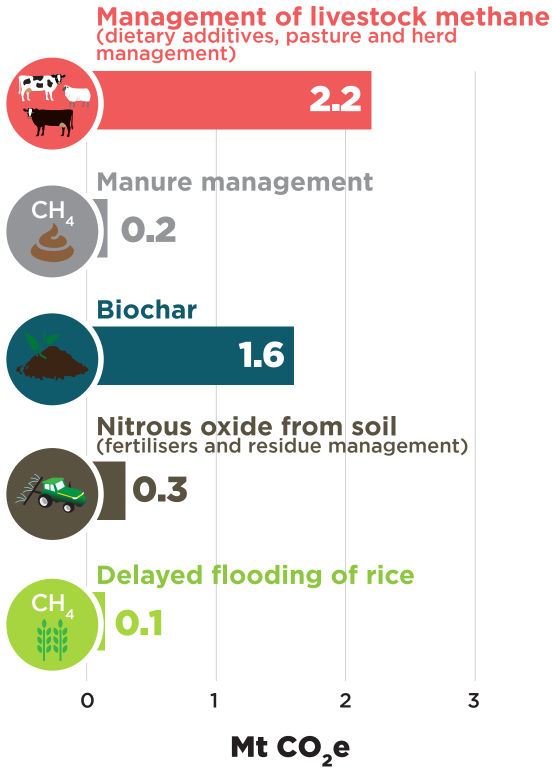
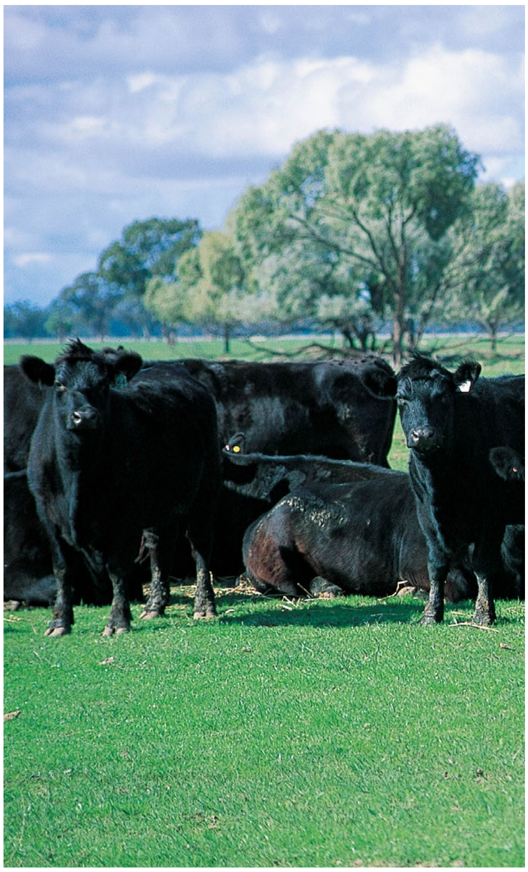


Figure 6: The feasible abatement through emissions reduction in 2030.



This summary was prepared by Scientell and designed by Hodge Environmental. It summarises the report Abatement Opportunities from the Agricultural Sector in New South Wales by Cathy Waters, Annette Cowie, Bin Wang, Marja Simpson, Jonathan Gray, Aaron Simmons and Scott Stephens, 2020.

Full report available at https://www.dpi.nsw.gov.au/climate-and-emergencies/climate-change-research-strategy

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