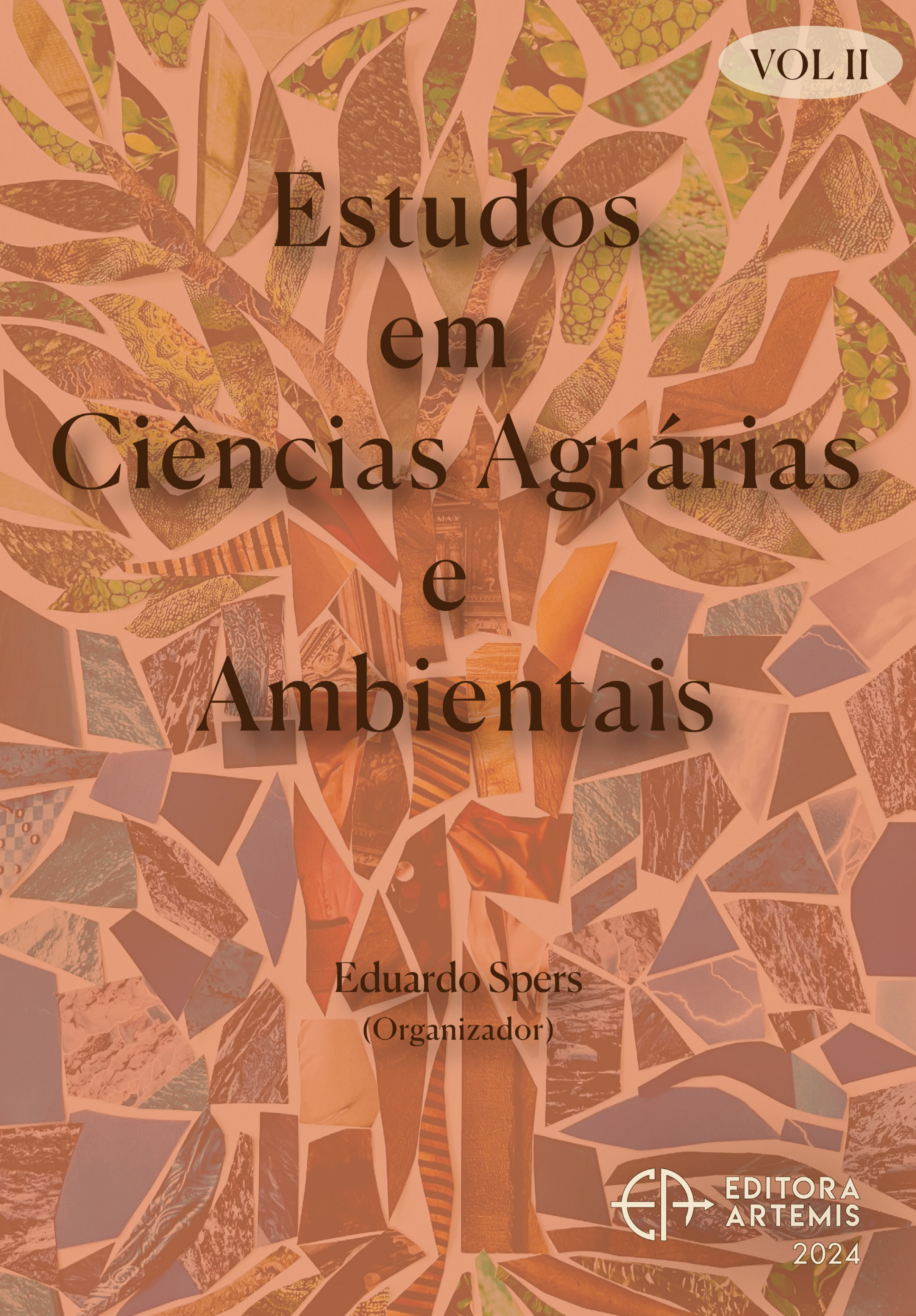

VOL II

Estudos em Ciências Agrárias e Ambientais

Eduardo Spers
(Organizador)

EDITORA ARTEMIS
2024

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APRESENTAÇÃO

O campo das Ciências Agrárias e Ambientais desempenha um papel fundamental na compreensão e solução dos desafios contemporâneos relacionados à produção de alimentos, à conservação ambiental e ao bem-estar animal. Em um mundo em constante transformação, questões como a sustentabilidade dos agroecossistemas, o manejo eficiente dos recursos naturais e a saúde pública se tornam cada vez mais relevantes. É com este espírito que apresentamos o volume II da coletânea "Estudos em Ciências Agrárias e Ambientais", que reúne pesquisas de autores de diversas partes do mundo, cada um contribuindo com sua perspectiva e expertise únicos.

Os quinze artigos que compõem este volume abordam uma variedade de tópicos, refletindo a riqueza e a diversidade das Ciências Agrárias. Desde práticas conservacionistas que buscam melhorar e manter agroecossistemas, até investigações sobre o uso de fitohormonas e fertilização na produção vegetal, o uso de tecnologias de processamento de madeira e a promoção do bagre armado - cada estudo traz à tona questões cruciais que impactam tanto a produção agrícola quanto a saúde ambiental.

Neste volume, também exploramos a crescente relevância dos produtos agrícolas locais, especialmente em tempos desafiadores como os que vivemos, marcados pela pandemia da COVID-19. A importância de circuitos curtos de proximidade se torna evidente, promovendo não apenas a segurança alimentar, mas também a resiliência das comunidades.

Além disso, as contribuições da veterinária destacam a importância do cuidado animal e da saúde pública, ilustrando a interconexão entre os seres humanos, os animais e o meio ambiente.

Esperamos que esta coletânea não apenas informe, mas também inspire debates e colaborações futuras entre pesquisadores, profissionais e estudantes da área. Juntos, podemos avançar em direção a um futuro mais sustentável e equilibrado, em que conhecimento pesquisa sejam os pilares para soluções efetivas.

Agradecemos a todos os autores e colaboradores que tornaram este trabalho possível. É nossa esperança que os estudos aqui apresentados contribuam para um entendimento mais profundo das questões agrárias e ambientais, e que possam servir de base para novas investigações e práticas inovadoras.

Eduardo Eugênio Spers

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PROS AND CONS OF USING FORESTRY AS A COMPENSATION MECHANISM FOR GREENHOUSE GASES EMISSIONS ON NEW ZEALAND PASTORAL FARMS

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Phil Journeaux
Journeaux Economics, Hamilton
New Zealand
https://orcid.org/0009-0002-3534-0147

ABSTRACT: Mitigating or offsetting GHG emissions from pastoral farms is a complex issue. Within New Zealand, mitigation options include fine-tuning farm systems to make them more efficient, and/or land use change into horticulture or arable cropping. Both these approaches have limitations to the degree to which GHG emissions can be reduced. Offsetting via forestry is often the cheapest and most practical option for many farms, although the system to achieve this is also relatively complex and does not reduce gross emissions. The introduction of a value for carbon has resulted in carbon farming being a much more profitable option compared to sheep & beef farming, which has wider economic implications. The proposed introduction of a farm-level levy also provides an incentive to use forestry to offset this.
KEYWORDS: Greenhouse gas mitigation. Agricultural systems. Carbon farming. Forestry offsets.

1 BACKGROUND

Within New Zealand there are a range of factors driving the country's response to climate change. These include:

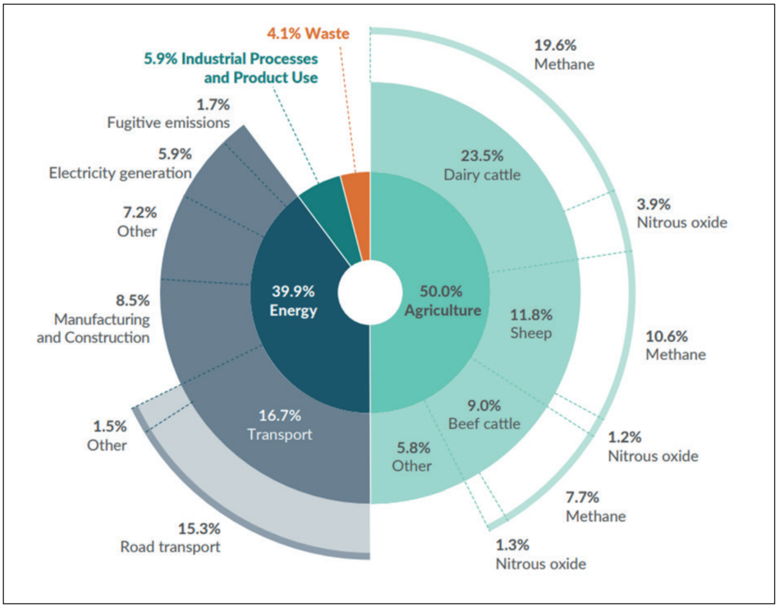
- Signatory to the United Nations Paris Agreement (2020-2030), where our Nationally Determined Contribution is a reduction in emissions of 50% below 2005 levels by 2050.
- Domestically, the Climate Change Response (Zero Carbon) Amendment Act was passed in 2019, with three key factors:
    - ➢ Carbon dioxide and nitrous oxide ("long-lived gases") are net zero by 2050
    - ➢ Methane reduced to 10% below 2017 levels by 2030, and to 24-47% below 2017 levels by 2050
    - ➢ Government must have an Emissions Reduction Plan and a National Adaptation Plan.

As can be seen by the reduction targets, New Zealand has split reduction targets between long-lived gases (CO_2, N_2O) and CH_4, which is a relatively short-term gas. Currently it is the only country in the world to do this.

- The Emissions Trading Scheme (ETS) was set up in 2008, as the main mechanism to value carbon within the domestic economy. People sequestering carbon (very largely by growing forests) are granted carbon credits (NZ Units, = 1 tonne CO_2equivalent) by the government, and then in turn sell these to greenhouse gas emitters, who then have to surrender the NZU's back to government. All sectors of the New Zealand economy, including agricultural processors, are included within the ETS, but not farming.
- In 2019 the government set up a working group which included all the agricultural organisations, representatives of Māori farming, and government to develop a farm-level pricing system for agricultural emissions as an alternative to the ETS. This group, know as *He Waka Eke Noa* (We're all in this together) recommended that a farm-level pricing mechanism be set up, with differential pricing for CH_4 and N_2O. The intent is that farmers will face this pricing mechanism from 2025.
- In 2018 the Climate Change Commission was set up, initially as an "interim" commission, which is an independent body formed to provide advice to government on climate change matters, including emissions budgets.

The key issue that faces New Zealand is that our greenhouse gas (GHG) emission profile is very different to other developed countries, where emissions from our agricultural sector make up 50% of our gross emissions. The nearest OECD country is Ireland, who's agricultural GHG emissions make up 37% of their total emissions, while for most OECD countries, agriculture makes up 5-10% of gross emissions. For New Zealand this is important, as pastoral agriculture makes up around 65% of New Zealand's mercantile exports.

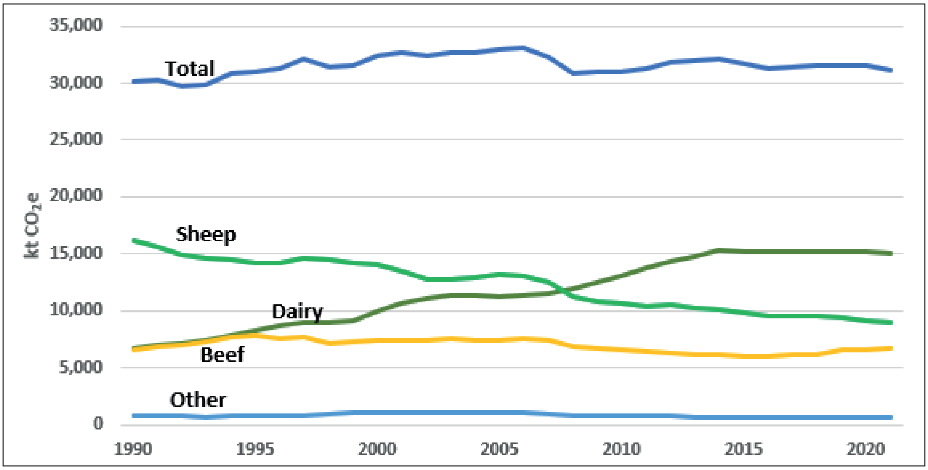
Figure 1: New Zealand GHG Profile 2020.



Source: NZ GHG Inventory 1990-2020, published April 2022 https://environment.govt.nz/publications/new-zealands-greenhouse-gas-inventory-1990-2020/

As can be seen from Figure 1, dairying makes up 47% of agricultural emissions, with sheep & beef farming making up 42%. Within the energy sector, approximately 85% of New Zealand electricity generation is renewable (largely hydro-electric) and moving up to around 95%. This means that the two main sectors where GHG reductions can be made is agriculture and transport.

Figure 2: Changes in NZ Agricultural Greenhouse Gas Emissions by Sector, 1990-2021.



Source: MfE 2022.

Figure 2 shows a reduction in GHG emissions from the sheep sector, due to a large reduction in stock numbers since 2019, a combination of reduced numbers on-farm, plus land use change into either dairying or forestry. Dairy emissions have increased because of significant land use change into dairying over the period, driven by its superior profitability. Beef emissions have been relatively static.

Over the period 1990 to 2020, total livestock GHG emissions (CH_4 + N_2O) have increased by 16.6%, while CH_4 emissions have increased by 8.4% and N_2O emissions by 49.4% (driven largely by significant increases in nitrogen fertiliser usage over the period). (MfE 2022).

2 HE WAKA EKE NOA

As noted, this group, comprising agricultural bodies, Iwi, and government, was set up in 2019 to determine a GHG emissions pricing mechanism for farming which would operate outside of the ETS. The overall system agreed by government included:

- An on-farm pricing system, where the price of CH_4 would be set by Government, while the price of N_2O would be linked to the ETS price (5% in 2025, rising by 1% per year through to 2030 when it would be revised).
- A centralised and standardised GHG calculator to estimate annual GHG emissions at the farm level.
- Emissions levy to be set at the lowest price possible to achieve outcomes; revenue used to incentivise behaviour change.
- Incentive payments to make uptake of mitigation technologies and practices more cost-effective.
- An expansion of the definition of “forestry” to allow for additional areas to be included for carbon sequestration, and for these to eventually be included within the ETS.
- Farms which would face an emissions price would be;
    - ➢ Greater than 550 stock units (sheep, cattle, deer), or
    - ➢ Greater than 50 dairy cows, or
    - ➢ Apply more than 40 tonnes of nitrogen through synthetic fertiliser.

3 EMISSIONS TRADING SCHEME

The ETS as mentioned is the main market mechanism for valuing carbon in New Zealand, whereby GHG emitters can buy such carbon credits as a means of offsetting their emissions. The main means of sequestering carbon is via forestry, and there are a number of rules around eligibility of forests to be registered in the ETS:

- Must have been planted, or regenerated, after 1 January 1990
- Must be 1 hectare or larger,
- Forest canopy width must be greater than 30 metres on average,
- Tress must be able to grow 5 metres or taller,
- The tree canopy must cover at least 30% of the ground, as measured on the horizontal plane.

It excludes any forest which existed prior to 1 January 1990, horticultural tree crops, and shelter belts.

In 2020 the government introduced some further refinements to the ETS:

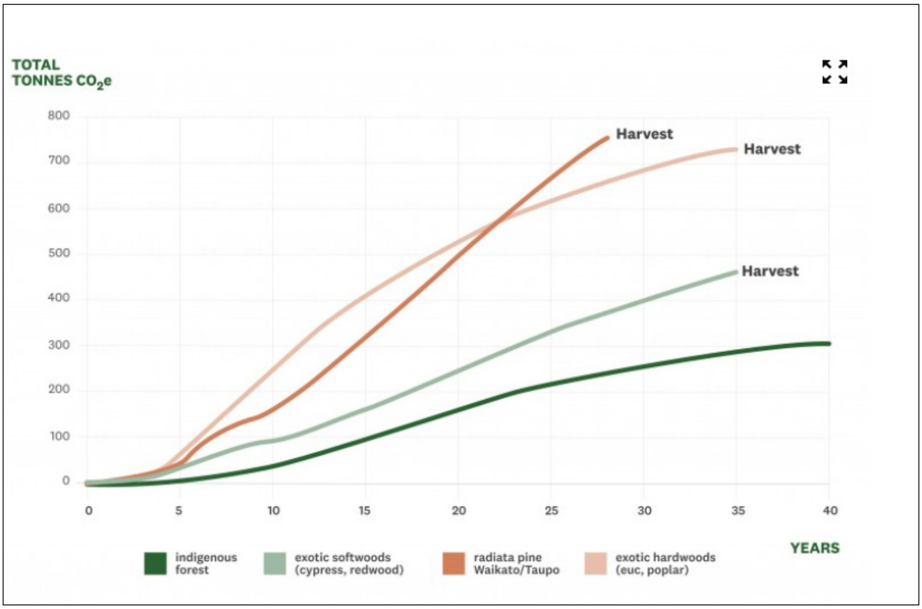
- A cap on total emissions that declines over time, in line with emissions budgets (as set by the Climate Change Commission)
- Auctioning, which was introduced in 2021, whereby the government auctions off a set amount of NZU's quarterly (usually around 4.5 million), as a means of raising funds for Climate Change related actions. Note these NZUs are not backed by any sequestration.
- A phaseout of the free allocation to industrial emitters. This free allocation was 95% in 2020, and reduces by 1% per year through the 2020's, 2% per year through the 2030's, and 3% per year through the 2040's.
- A floor price for NZU's - $30[1] in 2022, rising to $40 in 2027 and increases by 2% per year.
- A ceiling price for NZU's - $70 in 2022, rising to $129.97 in 2027, and again increasing at 2% per year. The Climate Change Commission has been recommending an increase in the ceiling price to $171 immediately, in order to accelerate GHG mitigations.

The amount of sequestration claimable is also controlled to a degree. Any forests less than 100ha in size, in aggregate, are required to use the sequestration rates as per the Ministry for Primary Industry (MPI) Look-up tables (MPI 2017), whereas forests 100 hectares or greater need to be physically measured every 5 years to determine the actual sequestration rate.

The government has stated that if it is not possible to enact the He Waka Eke Noa provisions, farming would be placed within the ETS.

[1] All prices are in $NZ

Figure 3: New Zealand Sequestration Rates.



Source: MPI Carbon Look-up Tables for Forestry.

As can be seen from Figure 3, the fastest sequestration rates are from radiata pine, the main production specie grown in New Zealand (90% of production forests), averaging up to 25 tonnes CO_2e per hectare per year, while indigenous forest average around 6.5 tonnes CO_2e per hectare.

In January 2023, the regime whereby carbon credits could be claimed from forestry was simplified down to two mandatory options:

(i) Averaging. At the start of the ETS, forest owners could claim carbon credits throughout the life of the forest, but needed to repay these, at the price on the day, when the forest was harvested. When the forest was replanted, further carbon credits could be claimed, until again when the forest was harvested. This regime is called the “stock management” regime.

From 1 January 2023, all production forests planted and registered for the ETS must go into the Averaging scheme. Under this system, a forest owner can claim roughly half the carbon sequestered in the first rotation and does not need to pay this back at harvest, provided the forest is replanted. Carbon is claimable only in the first rotation, with none thereafter.

The government has set the period under which carbon can be claimed under the averaging scheme, relative to average rotation lengths:

- Pines - 16 years
- Exotic softwoods (e.g. cypress, redwood) - 22 years
- Exotic hardwoods (e.g. eucalypts, poplars) - 12 years
- Douglas Fir - 26 years

(ii) Permanent forest. As the name suggests, this is a permanent forest which will never be harvested, and where the carbon sequestration claimable is under the stock management approach – i.e. you can claim carbon for as long as the forest is growing. If the forest is ever harvested, or leaves the ETS, then any carbon credits claimed must be repaid. This regime does allow for selective logging, provided the key aspects of the ETS are retained, e.g. 30% canopy cover.

4 FARM LEVEL GHG EMISSIONS

The key determinants of GHG emissions at a farm level are:

- The amount of dry matter (DM) consumed by the animals. There is a direct correlation with the amount of methane produced, and a strong correlation with nitrous oxide emissions, which is then also heavily influenced by;
- The amount of protein in the diet. Protein level in New Zealand pastures are generally quite high – well above average ruminant requirements.
- The amount of nitrogen fertiliser used. While there are some direct N_2O and CO_2 emissions when nitrogen fertiliser is applied to the soil, the key reason for most New Zealand farmers using nitrogen fertiliser is to grow more pasture – i.e. increase the amount of DM on offer to the animals.

With respect to mitigating farm-level GHG emissions therefore, the need is to reduce all of the above, especially DM consumed given it is the main driver by far. The split in the GHG on-farm emissions between CH_4 and N_2O is roughly 80:20.

Table 1: Average New Zealand Farm-Level Biological GHG Emissions

	Average T CO_2e/ha	Range T CO_2e/ha
Dairy	9.6	3.1-18.8
Sheep & Beef	3.6	0.12-7.1

Source: Dairy NZ 2017, AgResearch 2020.

Table 1 shows the per hectare GHG emissions, with a wide range within each sector, driven largely by the intensity of the farming system, and the level of any feed inputs. The proposed carbon pricing levy to be introduced in 2025 will be based on the total farm emissions, which has implications for the sheep & beef sector.

Table 2: Total Farm Emissions and Profitability.

	Average area (ha)	Average T CO_2e/ha	Total T CO_2e	5-year Average EBITDA/ha*
Dairy	155	9.6	1,488	$3,418
Sheep & Beef	695	3.6	2,502	$371

*Dairy NZ Economic Survey 2020/21, Beef + Lamb NZ Economic Survey 2020/21.

Table 2 shows that while the per hectare emissions from sheep & beef farms are 37.5% of that for dairying, total emissions are 68% higher due to the much greater area of the average sheep & beef farm. Which means they will be facing, proportionally, a higher emissions levy, while total profitability is around 50% of that of the average dairy farm. Hence their greater vulnerability to the emissions levy.

One of the options for farmers to mitigate GHG emissions is to alter or fine-tune their farming systems. Research by Journeaux and Kingi 2020, and Journeaux et al 2022(a), has shown that such fine tuning is possible, with reductions in GHG emissions on pastoral farms in the order of 2-10%. Much of this is based around reducing stocking rates, while at the same time increasing per animal productivity in order to maintain or improve farm profitability. Other options include finishing animals to target weights more quickly, or reducing exogenous inputs (e.g. supplementary feed and/or nitrogen fertiliser). The impact of the latter options varies depending on the degree of such inputs, and in almost all cases, reduces farm profitability.

Caution is also needed around such farm-system options, as they require adaptations in farm management to ensure they are successful. Reducing stocking rates means that grazing management must improve. Otherwise, pasture quality is lost, resulting in (often) significant reductions in production and hence profitability. Other options require changes in farm management which will take several years to achieve; there are no overnight fixes.

5 FORESTRY AS AN OFFSET

The decision whether to mitigate or offset an environmental externality depends largely on two factors; the practicality of either and what is the least-cost option.

Within New Zealand, the use of forestry sequestration to offset on-farm emissions is readily accepted, especially given the relative practicality and cost effectiveness of doing so. In noting this, there are of course several issues to take into account.

Table 3: Area required (ha) to offset on-farm emissions.

% offset:	5%	10%	25%	50%	100%
155 ha dairy farm	3.7	7.4	18.5	37.2	74.4
695 ha sheep & beef farm	6.3	12.5	31.3	62.6	125.1

This shows the area (in hectares) need to be planted in *pinus radiata* to offset a percentage of the farm emissions, relative to the national average farm sizes. At the bottom end of the scale, i.e. 5% offset, finding 3.7 hectares on a 155 hectare dairy farm would be something of a push, whereas finding 6.3 hectares on a 695 hectare sheep & beef farm would be very straightforward. At the other extreme, planting 74.4 hectares on a 155-hectare dairy farm means the dairy farm would largely cease to exist. Planting 125 hectares on a 695-hectare sheep & beef farm would be something of a push, given it equals 18% of the farm area – but not necessarily impossible.

Another key factor is that the forest need not be planted directly on the farm itself. As long as it was planted somewhere in New Zealand, the credits could be used for offsetting. Similarly, once an international trading system is developed, the trees could be planted anywhere in the world.

Using forestry as an offset is, in many cases, a least-cost option relative to other mitigation options. This can be illustrated by comparing relative shadow prices, calculated as change in farm profitability, divided by change in biological GHG emissions.

Table 4: Average Shadow Prices ($/T CO2e)

	S&B	Dairy
Reduce stock numbers by 10%	$91	$562
Reduce stock numbers by 10% Increase Productivity	-$348	-$746
Plant 10% pines	-$2	$56
Plant 10% natives	$180	$225
50% N Fertiliser		$145
No bought in supplement		$90

Source: Journeaux and Kingi, 2022

Caution is needed in interpreting these prices, as they are averages based on a small sample. Nevertheless, they indicate the relative cost-effectiveness of using forestry as an offset.

In noting this, using forestry as an offset has its limitations, the main one being it is a relatively short-term solution. As noted earlier, under the averaging scheme, there is a limit on the time carbon credits can be claimed, and only in the first rotation. Assuming therefore that offsetting via forestry is the only mechanism to be used, then additional areas need to be planted at the end of the averaging period. Under the permanent forest scheme, it is possible to plant an initial area which can cover the farm emissions for many years. This is illustrated below, given a hypothetical situation; assume 10 hectares of production pines is sufficient to offset the farm emissions. Under the averaging scheme, the carbon credits from this forest would last 16 years, which means a new area of 10 hectares needs to be planted every 16 years. Conversely, if a native forest was planted as a permanent forest, then planting 36 hectares in year 1 (the larger area is required due to the slower sequestration rate) would be sufficient.

Table 5: Illustration of using forestry as an offset.

	Production Pines (ha)	Total ha Pines	Total ha Natives
Year 1	10	10	36
Year 16	10	20	
Year 32	10	30	
Year 48	10	40	
Year 64	10	50	

This shows the key achilles heel of using production forestry as a carbon offset – that increasing areas need to be planted over time in order to maintain the level of offsetting.

While Table 5 would indicate the desirability of using a permanent forest such as native trees, and many farmers would prefer to plant natives, the biggest drawback is economics: establishing pines cost \$2,500-\$3,000/ha, which then sequester 20-25 Tonnes CO_2e/ha/year, whereas natives cost anything from \$10,000- \$45,000/ha (median is \$13,000-\$15,000/ha) and sequester 6.5 tonnes CO_2e/ha/year. The reason the establishment of natives is so much higher is due to several factors:

- Number of plants planted per hectare is much higher than pines; 2,000-3,000 stems/ha compared to ~1,000 stems/ha for pines. This is because they grow much slower and death rates are much higher.
- Because they grow slower, post-planting management (e.g. weed release) requirements are higher.
- Because there is limited stock available, cost per plant is higher.

6 CALCULATING THE VALUE OF OFFSETTING

At a national level, the calculation is straightforward, tonnes of gross emissions less gross sequestration equal net emissions. For example, in 2020 New Zealand's gross emissions were 77,778 kilotonnes of CO_2e, and sequestration was 23,313 kilotonnes CO_2e, giving net emissions of 55,465 kilotonnes CO_2e (MfE 2022).

At the farm-level, it is a bit more complicated. If a farm was seeking carbon neutral status, then the calculation would again be straightforward; tonnes of CO_2e gross emissions less tonnes CO_2e sequestered.

For the calculation of the farm levy however, everything is calculated through at a monetary value. The formula for this is: A + B – I – C, where:

A = price of methane ($/kg CH_4)

B = price of nitrous oxide ($ T CO_2e)

I = an incentive payment for using new technology, currently suggested as $50/T CO_2e reduced as a result of using the technology

C = the value of sequestered carbon ($/T CO_2e, aka the ETS price)

Table 6: Example of using forestry as an offset at the farm level.

	Total T CH_4 as CO_2e	Total T N_2O as CO_2e	Assumed Sequestration (T CO_2e)	Cost of CH_4	Cost of N_2O	Gross Levy	Value of forestry sequestration	Net Levy
Dairy	1,190	298	72	$5,238	$1,265	$6,503	$6,120	$383
Sheep & Beef	2,002	500	220	$8,807	$2,127	$10,934	$18,700	-$7,766

Note:

(i) The farms used are as per the national average farms (Table 2)

(ii) The sequestration assumed is purely for illustration.

(iii) The pricing used is that proposed by He Waka Eke Noa for 2025 (HWEN 2022)

As can be seen from Table 6, the value of the carbon credits from forestry has a significant impact when used to offset the carbon levy. This can also be illustrated using actual farms, where planting 10% of the farm into forestry has been modelled.

Table 7: Impact of Forestry Offsetting on Proposed Carbon Levy.

Sheep & Beef	Pastoral Area (ha)	Forest Area (ha)	Gross T CO_2e Emissions	Gross Carbon Levy 2025	Forestry Credit	Net Levy 2025
Base	1,632		8,396	$15,159		$15,159
Plant 10% forest - Pines	1,470	162	7,329	$12,092	$304,317	-$292,225
Plant 10% forest - Cypress	1,470	162	7,329	$12,092	$176,256	-$164,164
Plant 10% forest - Natives	1,470	162	7,329	$12,092	$89,505	-$77,413

Table 7 continued.

Dairy	Pastoral Area (ha)	Forest Area (ha)	Gross T CO_2e Emissions	Gross Carbon Levy 2025	Forestry Credit	Net Levy 2025
Base	155.1		2,027	$8,836		$8,836
Plant 10% forest - Pines	140.1	15	1,806	$7,112	$26,520	-$19,408
Plant 10% forest - Cypress	140.1	15	1,806	$7,112	$16,320	-$9,208
Plant 10% forest - Natives	140.1	15	1,806	$7,112	$8,288	-$1,176

Table 7 shows several things:

- Total gross emissions reduce as a result of the forestry planting, due to livestock being displaced by the trees.
- Selling the carbon credits as sequestered by the forestry significantly offsets the cost of the levy, realising that the income from the pines lasts 16 years, the cypress 22 years, and from the natives 200-300 years.
- The faster sequestration by the pines means that the credits generated are much more than from the cypress, which in turn is greater than from native trees.
- If, under the pine scenario, only sufficient carbon credits were sold annually to offset the levy, with the remainder held for later years, then the credits would be sufficient to offset the levy for 30+ years.

7 CARBON FARMING

The advent of the ETS and a value for carbon sequestration via forestry, has given rise to the practice of “carbon farming”, particularly in recent years as the carbon price has risen.

In this enterprise, farms are planted up into forestry, in most instances into *pinus radiata*, which tends to give the greatest returns, and following the end of carbon credits (under averaging), the forest then reverts to a production forest.

The driver for this is of course the economics of the system. As noted in Table 2, the 5-year average EBITDA for sheep & beef farming, is $371 per hectare. Planted in pines, the same land would return around $1,500 per hectare, for 16 years, and $100-$250 per hectare thereafter as a production forest. This means the internal rate of return from the carbon farming is 5-7 times that of sheep & beef farming.

This has driven investors, many from overseas, to buy up whole sheep & beef farms and convert them to forestry, and since 2017, an estimated 175,000 hectares of sheep & beef land has been sold for conversion[2].

[2] Stuff, 15 November 2022. https://www.stuff.co.nz/business/farming/130412293/12000-hectares-approved-for-sale-to-overseas-investors-for-forestry

This in turn has created a degree of angst within New Zealand, particularly from farmers and rural communities whose livelihoods and social services are threatened.

This had led to calls within the community, including from the Parliamentary Commissioner for the Environment, and the Climate Change Commission, to limit the use of forestry as an offset, especially for industrial emitters/fossil fuel users, as they are currently very largely using forestry as an offset rather than mitigating emissions, as it's the least-cost option. It has also been pointed out that if New Zealand relies heavily on offsetting, then (a) our gross emissions won't reduce, and (b) eventually we'll run out of land to plant, aka Table 5.

A recent study by Journeaux et al (2022(b)), illustrates this. This analysis considered two sheep & beef farms, one in Northland, one in Hawke's Bay, which were progressively planted up into forestry: 10%, 30%, 100%, in pines, cypress, and natives. The impacts at both then farm level and regionally were then analysed. The results showed:

(i) At the farm level:

- Planting 10% of the farm into pines had no impact on the farm EBITDA, in the absence of a value for carbon. The areas planted were the lower productive areas on the farms, and therefore wider impact was minimal, given the returns for forestry were similar if not better than the farm returns on those areas.
- Planting greater than 10% of the farm into forestry progressively worsened the profitability of the farm.
- Introducing a value for carbon sequestration basically swamped the rest of the returns from the farming operation. The most profitable option was to plant 100% of the farm into pines, followed by 100% into cypress. All indigenous forest plantings resulted in a much lower EBITDA relative to the pastoral (base) operation.

(ii) At a regional level, this was analysed using Input/Output analysis:

- A positive impact in the initial year, for both value-add and employment, where the benefits of planting the forest offset the loss of the farming production.
- From then on, the impact was negative, both for the region in question and for the rest of New Zealand, through until the forest was harvested.
- In the year of harvest there was a significant increase in both value-add and employment as a result of the harvesting/processing. This resulted in an overall positive Net Present Value (NPV) for the

pines scenarios, and the 10% Cypress scenario. All the indigenous scenarios had a negative NPV.

- From an employment perspective there is a necessity for planting and harvesting to be phased and sequenced in order to maintain a sufficiently skilled labour force for harvest. This was not undertaken in this analysis.
- The addition of a value for carbon provided no net gain in value-add. The impact of a value for carbon is essentially an internal wealth transfer, with no overall net benefit at a national level.

In many respects the mantra from this study is “forests on farms, not farms into forests”.

8 DISCUSSION

The advent of climate change policy, the development of the ETS and the fast-approaching pricing of agricultural emissions is a very complex area, and the implications of these are not well understood.

At a farm-level, there is some opportunity for farmers to reduce GHG emissions by fine-tuning farm systems and improving efficiency. Research would indicate this is relatively limited, to around 2-10% reduction while ensuring the farming system remains profitable. Achieving this will require improvements in farm management, and an extension programme to provide information and advice to farmers. This will take time, as there are no ready “quick fixes”.

Currently there are a number of potentially useful mitigation technologies being researched, but which will take some time to come to fruition and become commercially available.

The use of forestry therefore, as a means of offsetting, is likely to be a tool which many farmers are likely to use, particularly in the sheep & beef sector, and particularly as it is relatively practical, least cost, and has a significant impact in offsetting the proposed carbon levy.

The main drawbacks are that it is not a permanent solution, as more forestry areas would need to be planted in the future, and it does nothing to reduce gross emissions, which is what the regulations, and markets, are calling for. And if carbon farming continues whereby pastoral farms are planted up into forestry, is will radically, and adversely, change the character of rural communities and economies.

Note: New Zealand held a general election in October 2023, electing a new government. The previous government did not pass legislation in time to enact the He

Waka Eke Noa provisions, and the new Government has announced that they will delay the on-farm pricing mechanism potentially through to 2030.

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SOBRE O ORGANIZADOR

EDUARDO EUGENIO SPERS realizou pós-doutorado na Wageningen University (WUR), Holanda, e especialização no IGIA, França. Possui doutorado em Administração pela Universidade de São Paulo (USP). Foi Professor do Programa de Mestrado e Doutorado em Administração e do Mestrado Profissional em Comportamento do Consumidor da ESPM. Líder do tema Teoria, Epistemologia e Métodos de Pesquisa em Marketing na Associação Nacional de Pós-Graduação e Pesquisa em Administração (ANPAD). Participou de diversos projetos de consultoria e pesquisa coordenados pelo PENSA e Markestrat. É Professor Titular no Departamento de Economia, Administração e Sociologia, docente do Mestrado em Administração e Coordenador do Grupo de Extensão MarkEsalq no campus da USP/Esalq. Proferiu palestras em diversos eventos acadêmicos e profissionais, com diversos artigos publicados em periódicos nacionais e internacionais, livros e capítulos de livros sobre agronegócios, com foco no marketing e no comportamento do produtor rural e do consumidor de alimentos.

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