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The Impacts of the New Zealand Emissions Trading Scheme on Economic and Environmental Factors

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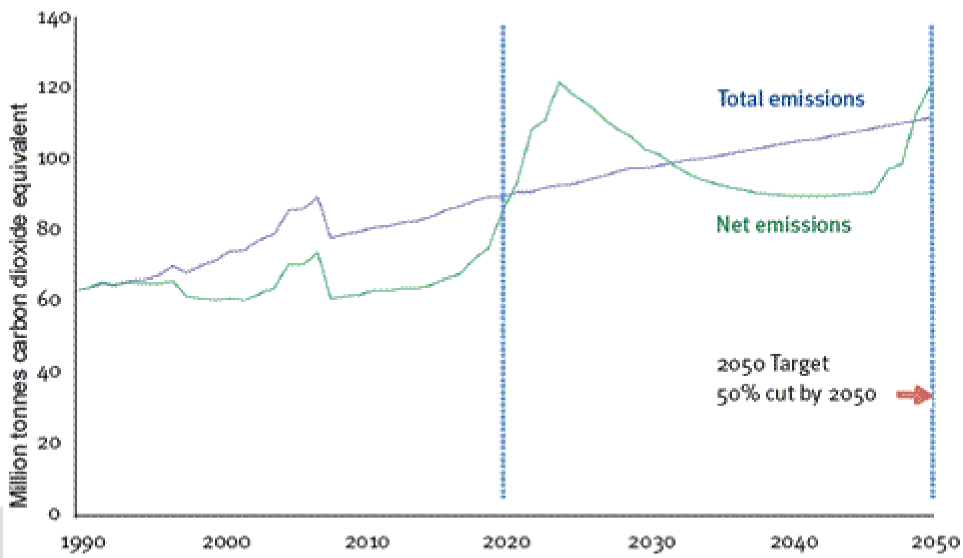
Abstract

New Zealand implemented an emissions trading scheme, the NZ ETS, to regulate the production of Greenhouse Gases. This ETS is the first of its kind to include the agricultural sector, as is expected to significantly raise costs to both producers and consumers. The aim of the paper is to assess the potential impact of the New Zealand ETS on the economy and the environment. The paper reports first on the development and nature of the legislation itself, and then continues by mapping the cost of the ETS on producers, and then furthermore the transfer of these costs as increased prices. Then by utilising the Lincoln Trade and Environment Model, or LTEM, a partial equilibrium model which forecasts international trade and domestic production and consumption of agricultural commodities, a number of scenarios revolving around the NZ ETS are projected. The paper finally presents the results gathered from the LTEM, showing the impact of the NZ ETS on both the production of agricultural commodities, and the production of GHGs by the industry. These results demonstrate the potential cost of the NZ ETS on the agricultural sector, and its ability to reduce emissions.

New Zealand Emissions Trading Scheme

In 2008, an emissions trading scheme was legislated in New Zealand. It was created as the primary response to New Zealand's obligations to lower emissions under the Kyoto Protocol. New Zealand under Kyoto agreed to limit greenhouse gas emissions to 1990 levels. However, emissions in New Zealand had risen from 60.8 million tonnes to 74.7 million tonnes from 1990 to 2010, largely due to the energy and transport sectors.. However, due to increases in forest area it seems likely that these emissions will be offset. However, as Figure 1 below shows the felling of forest means New Zealand's net position deteriorates from 2020 to 2030. The commitment for the second Kyoto period is a 20 per cent reduction in emissions by 2020 and a 50 per cent cut by 2050. The estimated cost of emissions by 2020 is predicted to be $1 billion with cost of $9.5 billion over the period 2011 to 2020.

Figure 1: New Zealand's total and net greenhouse gas emissions and removals (historical and projected), under business as usual 1990-2050



Source : Ministry for the Environment http://www.mfe.govt.nz//publications/climate/nz-2050-emissions-target/index.html

As part of the NZ ETS a new emissions unit was created, the New Zealand Unit (NZU), equivalent to one tonne of carbon dioxide equivalent of gases harmful to the atmosphere, to be surrendered by businesses as greenhouse gases (GHGs) are produced. Alternatively the government awards NZUs to the Forestry sector, as forests sequestrate carbon. Unlike some other schemes there is no limit to the amount of NZUs that the government may issue. NZUs also have a price cap of 25 NZD, until the end of 2013, where the price will become subject to the international market. Forestry entered the ETS first in January 2008 with stationery energy (Coal and Gas); Fertiliser and concrete manufacture; and petrol and diesel in July 2010; waste is due to enter in 2013 and agriculture in 2015. The surrender of NZUs began at the start of July 2010 for all industries, with the exception of agriculture, for which the mandatory surrender of units begins in 2015.

The NZ ETS is unique as unlike most other proposed and implemented ETSs it includes the agricultural sector. This is because in New Zealand agriculture accounts for the largest proportion of the country's total GHG emissions. For example, in 2007 48% of the total emissions produced were from the agricultural sector. Comparatively, other major producers of GHGs, the transport and stationary energy industries, produced only 20 and 15% of total emissions respectively. For perspective, if we look to the United Kingdom, emissions from agriculture in the same year contributed only 0.08% of the UK's total emissions. Thus it is imperative for New Zealand to regulate emissions from the agricultural sector, accounting for almost half the country's total emissions.

As stated above the Emission Trading Scheme (ETS) was legislated in 2008 but the change of government that year led to some changes in the legislation. This was mainly a slowing down of the implementation of the scheme and its transition period especially for agriculture as well as changes to associated schemes such as The Permanent Forest Sink Initiative (PFSI) and the Afforestation Grant Scheme (AFS).

The agricultural ETS has as point of obligation is at the processor level not the individual farm level, although farmers can enter the ETS for forestry. Thus the NZ ETS applies mainly to those who:

- slaughter ruminant animals, pigs or poultry under a risk management programme;
- export live cattle, sheep or pigs in accordance with an animal welfare certificate;
- process milk or colostrum under a risk management programme;
- produce eggs and operate a risk management programme;
- import or manufacture synthetic fertiliser containing nitrogen.

This does have the advantage of the ease of implementation but the disadvantage of not incentivising individual framers to reduce emissions unless the processors develop an incentive scheme themselves.

Whilst agriculture is included in the NZ ETS the monitoring and surrender of units begins much later than in any other industry. This later inclusion date was due to the government's worries that sufficient technologies for mitigating emissions were not yet available. Thus it is argued a later date would both soften the impact for producers and allow time for research to develop. Voluntary reporting of emissions starts in 2011 with the Mandatory monitoring of emissions for the agricultural sector in 2012. Agriculture will then enter the ETS in 2015, however, the government will allocate 90% of free NZUs to producers, based on yearly average output within the industry. This free allocation will be phased out beginning in 2016 at a yearly rate of 1.3%. This clearly reduces the impact of the ETS considerably from the original proposal whereby agriculture would be responsible for 100 per cent of emissions by 2030 to it being responsible for 50 per cent by 2050.

The forest ETS scheme has two categories of forest that planted before 1990 and that after 1989. For the newer forest planted after 1989 owners can apply for credits of emission units. The forest must be at least one hectare and of certain species, height and cover[1]. Owners will then have to pay for emissions at harvests. Pre 1990 forests do not have to account for carbon except at deforestation. In recognition of the impact of ETS on land prices however the government has offered free allocation of 60 NZUs per hectare and exemption for blocks under 50 hectares can be applied for.

Impact of the ETS on Agriculture

The focus of this paper is the potential impacts the NZ ETS on the agricultural sector in NZ. There various comments on the debate within the agricultural sector which reflect concerns that the NZ ETS and its implications to the future of the agricultural industry. These are mostly around the concern that the added costs from the NZ ETS will raise the price of goods, making New Zealand's agricultural produce less competitive in the international market. It is also commented that as NZ is such an insignificant part of world emission that the ETS will fail to effectively reduce GHGs. The paper therefore assesses the impact of the ETS by analysing the potential costs of the ETS to producers. Then the paper explores under various scenarios the impact of the ETS on trade for New Zealand.

[1] That is, the species must be capable of reaching 5 metres and have 30 per cent tree crown cover.

Clearly there are concerns in New Zealand agriculture about the impact of the ETS on farmer returns. The potential impact of the ETS has received some attention with case studies of various farm types. These are uncertain given controversy over measurement of emission and the allocation of these from processors to farmers. Table 1 illustrates the impact on a series of case study farms and shows the impact in 2015 is around four thousand for the livestock farms and just over $700 for the arable farm. However, the impact when the scheme is fully implemented, assuming no change in technology or price of carbon, is obviously much higher. This represents in 2015 around 6 per cent of farm profit before tax for sheep and beef, 2 per cent for dairy and under half a per cent for arable. However, for full obligation this rises to 67 per cent for sheep and beef 22 per cent for dairy and 7 per cent for arable. More realistically though the 50 per cent liability by 2050 means that the impact is half that at 33, 11 and 4 per cent respectively.

Table 1: Impact of the ETS on case study farms

	Area	Herd	Total Emissions NZU /yr	Financial impact in 2015 ($25/t)	Financial impact when fully implemented
Sheep and Beef	600	2862 ewes 469 cattle	1802	$4375	$45,050
Dairy	178	535 cows 260 heifers	1929	$4150	$48,225
Arable	290	860 ewes	598	$725	$14,950

Source: Carbon farming group (2009) and own calculations based from MAF Farm Monitoring Report 2010

Thus for the arable and dairy sectors the impact on profit whilst significant is not as high as for sheep and beef. Moreover the variability in sheep and beef returns across the sector and over time does suggest this industry may well be seriously impacted by the scheme.

MAF also have calculated the impact of the ETS on farm profit before tax as shown in Table 2. These have used the MAF Farm Monitoring model farms and show the variation in impact across farm types. The greatest impact is not surprisingly on South Island Greenhouse tomatoes which are affected by ETS on electricity and coal. The impact on dairy is the next largest and this calculation has assumed, however, a low payout for dairy which is much more likely to be around $5 to 6 per kg ms which explains the large difference between Tables 1 and 2 for the impact on dairy. The impact of full emissions

Table 2: Percentage change in profit before tax 2006/7

		Allocation of 90% of 2005 emissions from each species	Full Liability
	Carbon Price>	**$25**	**$25**
Milk Solids	c/kg	-8.5	-26.7
Non-dairy Beef	c/kg.cwe	-1.1	-27.6
Sheepmeat	c/kg.cwe	-5.0	-64.6
Venison	c/kg.cwe	-1.4	-99.5

	Allocation of 90% of 2005 emissions from each species	Full Price of Emissions
Carbon Price>	**$25**	**$25**
Model		
National Dairy (assumes base year payout of $ 4.14 per kg ms)	-20.4	-61.6
National Sheep and Beef	-7.9	-80.3
North Island Deer	-6.6	-99.9
South Island Deer	-2.6	-53.1
Canterbury Arable	-8.8	-29.3
Bay of Plenty Kiwifruit	-7.9	-9.8
Hawkes Bay Pipfruit	-10.4	-10.5
North Island Greenhouse Tomatoes	-36.0	-36.7
South Island Greenhouse Tomatoes	-98.5	-99.2
Marlborough Viticulture	-0.84	-0.86

Source : MAF - Projected Impacts of the NZ Emissions Trading Scheme at the Farm Level.

Modelling the trade impact of the New Zealand ETS

Secondly, by utilizing the LTEM, a multi-country, multi-commodity, partial equilibrium trade model, to project the impact of the NZ ETS on production, trade and the environment. The LTEM maps international trade, production and consumption of agricultural commodities. Using this model, several scenarios involving the introduction of the NZ ETS, the introduction of similar programs in other developed nations, and the development of mitigation technologies, have been calculated. Such scenarios give us an insight into the economic impacts of the NZ ETS on New Zealand's agricultural sector. Furthermore, by again using the LTEM, the changes in GHGs produced by various agricultural industries have been projected for each of the previously mentioned scenarios, allowing an analysis of how effective the NZ ETS will be in incentivising the reduction of GHG emissions.

The scenarios were designed around four dimensions. The first dimension was the presence of climate change. Some scenarios included impacts of climate change estimated from the IPCC scenario A2. However, there are significant uncertainties around future climate change and the impacts on agricultural productivity. Some scenarios without climate change impacts were thus included. This approach allows the results to be used more widely for understanding potential impacts of policy and market trends, holding the level of climate change constant. To model climate change effects, the productivity impacts described in Kaye-Blake, et al. (2009) were used to modify the supply shift parameters, which is shf_{qs} in equations 38 and 39.

The second dimension considered in the modelling was the extent of policies to curb greenhouse gas emissions. A number of policy tools have been discussed in the literature, including carbon taxes and cap-and-trade policies. These policies all have the impact of placing a direct or implicit price on carbon. They can all be modelled similarly, that is, as an increase in the cost of production that is proportional to the amount of GHG emissions. They were therefore modelled as changes to the supply shift parameter in equations 38 and 39. The impact on productivity was calculated based on emissions from beef, sheep, and dairy in the different countries and a price of US$25 per tonne of CO_2 equivalents. This productivity impact was then used to calculate a new supply shift parameter. The policies were further divided into two possibilities. One possibility is that all Annex 1 countries include agriculture in greenhouse gas emissions policies, and Non-Annex 1 countries are exempt. The second possibility is that New Zealand includes its agricultural sector in its ETS, but no other country follows suit. Both of these possibilities have been modelled.

The third dimension that formed part of the scenario development was the use of mitigation technologies. As discussed in Kaye-Blake, et al. (2009), there are techniques and technologies with the potential to reduce greenhouse gas emissions from agriculture. If these technologies are implemented, there are two impacts. They reduce the potential liability from GHG policies, reducing the added costs that the primary sector would incur from such policies. In addition, they reduce the amount of GHG emitted per unit of production. In the present research, mitigation technologies were modelled alongside GHG policies, to investigate the joint impacts of technological improvements and price signals. Around one-half of New Zealand production was modelled as having no reductions in emissions, while the other half was modelled was having a 30 per cent reduction. This level of reduction is based on the scientific research discussed in Kaye-Blake, et al. (2009), and represents some of the highest levels of reduction. This mitigation level may therefore represent the potential of current research, rather than mitigation that is actually achievable on-farm.

For the scenarios presented in this paper, the split-commodity capability of the model was employed. The production in every country was divided evenly between standard production and low-emissions production. Between the two methods of production, each commodity was highly substitutable to avoid constraining production of one type or the other. The standard production method produced the current (2004) level of greenhouse gases. The low-emissions method produced 30 per cent less GHG emissions per unit of production. This difference was modelled by adjusting the supply shift parameters so that the low-emissions product had a 30 per cent lower shift than the conventional product.

Results

The model was used to investigate the impact of several different future scenarios on the agricultural and forestry sectors in New Zealand. The results of modelling these different scenarios are presented below. Two summary measures are used to describe the impact of each scenario. The first is a financial measure: the net change in producer returns. Producer returns indicate the total revenue earned by a sector, and are calculated by multiplying the amount of a commodity produced in New Zealand by its price. The second measure is the change in greenhouse gas emissions. The model focused on the production of methane and nitrous oxide from animal production, as well as total greenhouse gas emissions from agriculture. The change in emissions from animals is based on the number of animals produced and the uptake of emissions-reducing techniques and technologies.

Scenarios with climate change

The first set of scenario results are based on the climate change scenarios developed for IPCC research. The trade model was modified to reproduce the productivity impacts expected under climate change scenario A2. These impacts affected both agricultural and forestry commodities, and have been estimated for several regions and many specific countries, including New Zealand. The productivity impacts were then placed alongside other potential changes in the agricultural sector and the net results calculated.

The results from these scenarios are presented in two tables. Table 3 presents the percentage changes in producer returns expected under the different scenarios. The producer returns are presented for all New Zealand agriculture, and then for the separate industries of beef, sheepmeat, and dairy.

The first scenario examined the expected impacts on New Zealand of worldwide climate change under IPCC climate scenario A2. With climate change, production in some regions and countries declines, while in others, production increases. New Zealand productivity declines, but not as much as in some other countries. Reduced quantities of commodities also lead to higher prices. The net result is that a scenario including only climate change and no policy or market impacts produces an increase in producer revenues in the New Zealand primary sector. Beef revenues decline slightly, as a result of higher impacts on dryland pastures in New Zealand and productivity gains overseas, such as in the United States. Sheepmeat and dairy revenues increase, a combination of domestic productivity impacts, overseas climate changes, and New Zealand's contribution to international trade of these commodities.

Table 3: Percentage changes in New Zealand producer returns, climate change scenario A2

Scenario	All agriculture	Beef	Sheepmeat	Dairy
Climate change	14.6	-0.9	18.2	21.5
With worldwide GHG policy	31.0	2.2	32.2	55.2
With worldwide GHG policy and mitigation	28.3	1.7	29.8	49.6
With NZ-only ETS	7.6	-8.0	13.5	18.3
With NZ-only ETS and mitigation	8.6	-7.1	14.2	18.7

The second scenario in Table 3 includes both the climate change impacts as well as implementation of GHG policies in all Annex 1 countries at US$25 per tonne. The policies are modelled in the LTEM as affecting the cost of production and thus reducing the productivity of farmers: increased inputs are required to produce the same level of outputs. As a result, greenhouse gas policies reinforce the impacts of climate change. Production becomes more expensive, commodity prices increase, and the primary sector producer revenues increase.

The third scenario shows the impact of including mitigation efforts in the model alongside worldwide GHG policies and climate change. Mitigation reduces some of the impacts of GHG policies: producers become more 'carbon efficient' and therefore have lower costs associated with the policies. As a result, their productivity relative to other producers is increased and price are lower on average.

For agricultural products, the net result is a decrease in producer returns relative to a scenario with no mitigation, but the returns are higher than in a scenario with no GHG policies at all.

The fourth and fifth scenarios in Table 3 indicates the impacts on New Zealand from global climate change, but only a domestic GHG policy, such as the ETS. Other Annex 1 countries, in these two scenarios, exempt their agricultural sectors from GHG policies. In addition, the fifth scenario also includes mitigation technologies, which have economic impacts only in New Zealand. Under these conditions, New Zealand does gain in relation to the baseline, as a result of higher prices and lower worldwide production brought about by climate change. However, relative to other climate change scenarios, New Zealand primary sector producers have lower revenues. The difference relative to the scenario with no GHG policies at all is a seven per cent reduction in producer returns across agriculture. Of the livestock sectors, dairy is the least affected.

The model also allowed calculation of the impact on GHG emissions from agriculture of the different scenarios. The results are presented in Table 4. The scenarios are the same as those discussed with the previous table.

Table 4: Percentage changes in New Zealand methane and nitrous oxide emissions, climate change scenario A2

	All livestock	Beef	Sheepmeat	Dairy
Climate change only	0.1	-9.8	0.9	5.8
With worldwide GHG policy	-1.3	-18.6	-1.2	10.2
With worldwide GHG policy and mitigation	-14.3	-28.4	-14.6	-4.6
With NZ-only ETS	-7.4	-16.6	-7.0	-1.6
With NZ-only ETS and mitigation	-18.8	-26.8	-18.9	-13.4

Climate change is expected to reduce agricultural production in general, and regional variation is also expected. The impact on New Zealand is partially bio-physical, that is, the amount of production that could be sustained given soils, climate, etc. The impact is also partially a result of changes to production that flow through to international markets. If production falls overseas for commodities of which New Zealand is a major supplier, then the country is likely to see a large impact. If other suppliers of a commodity are not significantly affected, or even see increases in production (such as are predicted for some regions in some climate change projections), then New Zealand production could even decline.

The results presented in Table 4 indicate that these different pressures on production and markets will have uneven impacts across New Zealand agriculture. For example, climate change scenario A2, when modelled with the LTEM, led to increases in dairy production and thus increased GHG emissions, nearly constant production in the sheep sector, and decreases in beef production with accompanying falls in emissions.

The unevenness of the impacts is exacerbated by worldwide GHG policies. Implementation of policies leads to general decreases in New Zealand emissions from livestock. However, the beef sector reduces emissions by nearly 20 per cent, while the dairy sector actually increases its emissions by over ten per cent. If mitigation technologies are implemented worldwide alongside carbon charges and climate change, then New Zealand beef and sheep producers have large decreases in emissions, while dairying has smaller reductions.

The general pattern is repeated in the scenarios in which only New Zealand implements GHG policies. Emissions fall, mirroring the fall in producer returns discussed above, but fall the most in the beef sector and least in dairy. Mitigation technologies reduce emissions even more, with the livestock sectors showing an overall decrease of nearly 20 per cent. Once again, these decreases are achieved unevenly across the sectors

Table 5: Percentage changes in EU producer returns, climate change scenario A2

	All agriculture	Beef	Sheepmeat	Dairy
Climate change only	11.8	11.8	15.8	12.2
With worldwide carbon policy	19.3	21.9	12.7	31.9
With worldwide carbon policy and mitigation	18.2	20.5	13.8	28.7
With NZ-only ETS	12.7	12.4	21.2	13.7
With NZ-only ETS and mitigation	12.5	12.3	20.3	13.5

In the EU the scenarios show an increase in producer returns reflecting the price impact of climate change as illustrated by Table 5. This is around 12 per cent for beef and dairy and 16 per cent for sheepmeat with climate change only. With a worldwide climate change policy (and when mitigation is included in this) the increase is greater especially in beef and dairy. When a NZ ETS is applied on its own returns in the EU increase by slightly more than when no policy is applied at all.

Table 6: Percentage changes in EU methane and nitrous oxide emissions, climate change scenario A2

	All livestock	Beef	Sheepmeat	Dairy
Climate change only	-0.7	0.4	-1.8	-0.3
With worldwide carbon policy	-7.9	-4.2	-16.4	-1.3
With worldwide carbon policy and mitigation	-24.0	-21.5	-30.5	-18.9
With NZ-only ETS	-0.4	0.7	-1.4	-0.1
With NZ-only ETS and mitigation	-18.9	-18.2	-20.2	-18.1

As of Table 6, the impact on the EU emissions of climate change only is negligible. Whereas if the EU is part of worldwide scheme then emissions reduce by between 1 per cent for dairy and 16 per cent for sheep. The third and fourth scenarios in Table 6 demonstrate that if mitigation is also used falls in GHG emissions increase considerably to between 19 and 30 per cent.

Scenarios without climate change

Another set of scenarios removed the impacts of climate change. These results indicate the impacts of GHG policies, mitigation, and consumer reactions, without the additional impacts of climate change.

Table 7 provides the changes to New Zealand producer returns under four different scenarios. The first scenario is the implementation of GHG policies in all Annex 1 countries. These policies increase the cost of producing agricultural products, reducing production. The result is an increase in market prices. The net impact on New Zealand agriculture is an increase in producer returns.

Table 7: Percentage changes in New Zealand producer returns, climate change impacts removed

	All agriculture	Beef	Sheepmeat	Dairy
With worldwide GHG policy	13.5	3.5	11.5	26.6
With worldwide GHG policy and mitigation	11.2	2.9	9.5	22.1
With NZ-only ETS	-5.9	-6.5	-3.8	-2.6
With NZ-only ETS and mitigation	-5.1	-5.6	-3.3	-2.2

The second scenario in Table 7 combines Annex 1 GHG policies with mitigation technologies. This combination leads to increased producer returns in agriculture, with large gains for dairy and lower returns for beef and sheepmeat. The increases are somewhat lower than in the previous scenario, as mitigation technologies reduce the costs of GHG policies.

The next two scenarios examine the impacts of a GHG policy implemented only in New Zealand. In both scenarios, the producer returns in New Zealand are reduced. Returns for beef fall the most, while returns in the dairy industry fall least. With mitigation technologies, the reduction in producer returns is lessened as a result of lower costs for GHG emissions.

The impact on GHG emissions were also calculated for these scenarios, and are reported in Table 8. With GHG policies in all Annex 1 countries, emissions are somewhat reduced overall, but the impacts are uneven. Emissions from dairy increase, as New Zealand increases its production to replace reduced production overseas. Emissions from beef and sheep production in New Zealand decline. With mitigation included alongside the GHG policies, emissions fall for all the commodities.

Table 8: Percentage changes in New Zealand methane and nitrous oxide emissions, climate change impacts removed

	All livestock	Beef	Sheepmeat	Dairy
With worldwide GHG policy	-1.4	-9.2	-1.7	4.0
With worldwide GHG policy and mitigation	-14.4	-20.1	-15.0	-9.9
With NZ-only ETS	-7.0	-6.9	-7.3	-6.8
With NZ-only ETS and mitigation	-18.6	-18.4	-19.2	-18.0

The second two scenarios in Table 8 examine the impact of a New Zealand-only GHG policy. For the first of the two, mitigation is not included. With the policy, emissions are reduced from all the commodities. The reduction in emissions is increased by the addition of mitigation policies. The reductions are fairly even across all the commodities.

The impacts of the same scenarios upon the EU were also projected. In Table 9, the impact on the EU without climate change shows increase in producer returns increase with a worldwide greenhouse gas policy except for sheepmeat. These returns are lower when the NZ ETS is applied alone.

Table 9: Percentage changes in EU producer returns, climate change impacts removed

	All agriculture	Beef	Sheepmeat	Dairy
With worldwide carbon policy	7.4	11.5	-2.1	17.8
With worldwide carbon policy and mitigation	6.4	10.2	-1.1	15.0
With NZ-only ETS	1.6	3.1	5.3	1.9
With NZ-only ETS and mitigation	1.5	3.0	4.6	1.7

Furthermore, as shown in Table 10, the impact on EU emissions is a fall across all agriculture with the greatest fall in sheepmeat of 14 per cent. When mitigation is included this increases to around 20 per cent. There is a slight increase in emission if NZ applies a scheme alone whereas NZ and mitigation again show a decrease in EU emissions.

Table 10: Percentage changes in EU methane and nitrous oxide emissions, climate change impacts removed

	All livestock	Beef	Sheepmeat	Dairy
With worldwide carbon policy	-6.7	-3.9	-14.4	-0.6
With worldwide carbon policy and mitigation	-23.1	-21.2	-28.8	-18.3

With NZ-only ETS	0.8	0.9	0.8	0.6
With NZ-only ETS and mitigation	-18.0	-17.9	-18.5	-17.5

Conclusion

NZ ETS is the first to include agriculture. The implementation period and impact of this has been extended and thus reduced the potential impact of the scheme. Nonetheless assuming no changes in technology or prices the impact of this scheme at farm level when fully implemented would be significant especially for the sheep and beef sector.

At the industry or macro level the results from the LTEM indicate that the ETS alone will have both a minimum effect on GHG emissions and production in agriculture, however if employed alongside mitigation technologies may effectively reduce emissions almost 20% by 2020.

Similarly in the EU, projected GHG policies would have a marginal effect on reducing GHG emissions and agricultural production without the application of mitigation technologies, which if utilized in conjunction with GHG policies could reduce emissions by over 20% than with neither policies or mitigation.

References

Buongiorno, J., C.S. Liu, and J. Turner. 2001. Estimating international wood and fiber utilization accounts in the presence of measurement errors. *Journal of Forest Economics* 7(2): 101-124.

Buongiorno, J., S. Zhu, D. Zhang, J.A. Turner, and D. Tomberlin. 2003. The Global Forest Products Model: Structure, Estimation and Applications. Academic Press, San Diego. 301 pp.

Cesar, M. 1995. Global outlook for recovered paper. *In* Tappi Global Fiber Supply Symposium, Tappi Press, Atlanta, GA. pp. 81-94.

Energy Information Administration (EIA). 2004. Energy Outlook Study 2004. Department of Energy, Energy Information Administration, Washington D.C.

Food and Agriculture Organisation (FAO). 2005. Forest Resource Assessment 2005. Food and Agriculture Organization of the United Nations, Rome. www.fao.org/forestry/site/fra/en (Accessed 14 November 2005).

Food and Agriculture Organisation (FAO). 2008. Online FAO Yearbook of Forest Products, FAOSTAT statistics database. Food and Agriculture Organization of the United Nations, Rome. http://apps.fao.org/ (Accessed 16 May 2008)

Ince, P.J. 1994. Recycling and long-range timber outlook. General Technical Report GTR-RM-242. USDA Forest Service. 23 pp. Mabee, W.E. 1998. The importance of recovered fibres in global fibre supply. Unasylva 49(193): 31-36.

Kaye-Blake, W., Greenhalgh, S., Turner, J., Holbek, E., Sinclair, R., and Matunga, T. 2009. A Review of Research on Economic Impacts of Climate Change. AERU Research Report #314. Lincoln, NZ: Agribusiness and Economics Research Unit, April.

Mabee, W.E., and H. Pande. 1997. Recovered and non-wood fiber: Effects of alternative fibers on global fiber supply. Working Paper GFSS/WP/04. Food and Agriculture Organization of the United Nations.

Ministry of Agriculture and Forestry, July 09, 2008. Projected Impacts of the New Zealand Emissions Trading Scheme at the Farm Level, NZ

Ministry of Agriculture and Forestry,

Organization for Economic Cooperation and Development (OECD). 2004. OECD Economic Outlook No. 76, January 2005. Organization for Economic Cooperation and Development, Paris.

Cagatay, S., Saunders, C. M. and Wreford, A. 2003. Lincoln Trade and Environment Model (LTEM): Linking Trade and Environment. AERU Research Report No. 263, Lincoln University, NZ.

Cagatay, S.and Saunders, C. 2003. Lincoln Trade and Environment Model (LTEM): An Agricultural Multi-Country, Multi-Commodity Partial Equilibrium Framework. AERU Research Report No. 254, Lincoln University, NZ.

Simangunsong, B., and J. Buongiorno. 2001. International demand for forest products: A comparison of methods. *Scandinavian Journal of Forest Research* 16: 155-172.

Turner, J., and J. Buongiorno. 2001. International freight rates for forest products: Structure, past trends and forecasts. *International Forestry Review* 3(2): 136-145.

Turner, J.A., J. Buongiorno, S. Zhu, and R. Li. 2005. Calibrating and updating the Global Forest Products Model (GFPM version 2005). Staff Paper Series #57. Department of Forest Ecology and Management, University of Wisconsin-Madison. Madison, WI.

Turner, J.A., J. Buongiorno, and S. Zhu. 2006a. An economic model of international wood supply, forest stock and forest area change. *Scandinavian Journal of Forest Research* 21: 73-86.

Turner, J.A., J. Buongiorno, F. Maplesden, S. Zhu, S. Bates, and R. Li. 2006b. World Wood Industries Outlook: 2005-2030. *Forest Research Bulletin 230*. Ensis, Rotorua, New Zealand. 84 p. ISBN 0-478-11014-6.

United Nations. 2004. World Population Prospects: The 2004 Revision. Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat. http://esa.un.org/unpp, (Accessed 14 June 2005).

United Nations. 2005. World Economic Situation and Prospects 2005. Department of Economic and Social Affairs, United Nations, New York.

United Nations Economic Commission for Europe/ Food and Agriculture Organization (UNECE/FAO). 2002. Forecasts of the Economic Growth in OECD Countries and Central and Eastern European Countries for the Period 2000-2040. United Nations, New York.

World Bank. 2005. World Development Indicators online database. World Bank, Washington, D.C.