Emissions trading for forestry and agriculture: policy design and integrated simulations in New Zealand

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New Zealand has introduced an all-sources all-gases emissions trading system

2008	Forestry
2010 (July)	Liquid fuels – upstream
	Stationary sources – including cement and aluminium
2015?	Agriculture

What will be the environmental and economic effects of forestry and agriculture – can we improve their design?

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Why should you care?

- Globally important issue
  - Deforestation and agricultural emissions are large contributors to global climate change
  - Reforestation is a significant mitigation option
  - Forests have other benefits/food is important!
- Offsets are a disaster yet the key policy option considered
  - Baselines / adverse selection
  - Leakage
- Why not use cap and trade?

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Talk outline

1. Outline of ETS policies and challenges
2. Scale of credits and liabilities
   - Agriculture
   - Forestry/Scrub
3. Land use modelling
4. Simulations
   - land use responses
   - marginal abatement costs
5. Future directions

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Agricultural Emissions Trading – from 2015?

If point of obligation is at farm

- Issue tradable emission units to farmers by sale or gift.
- Make farmers responsible to
  - Report information to model greenhouse gas emissions from their activities
  - Surrender emission units that match the modelled emissions

Alternative is processor level

Challenges in including agriculture in an ETS

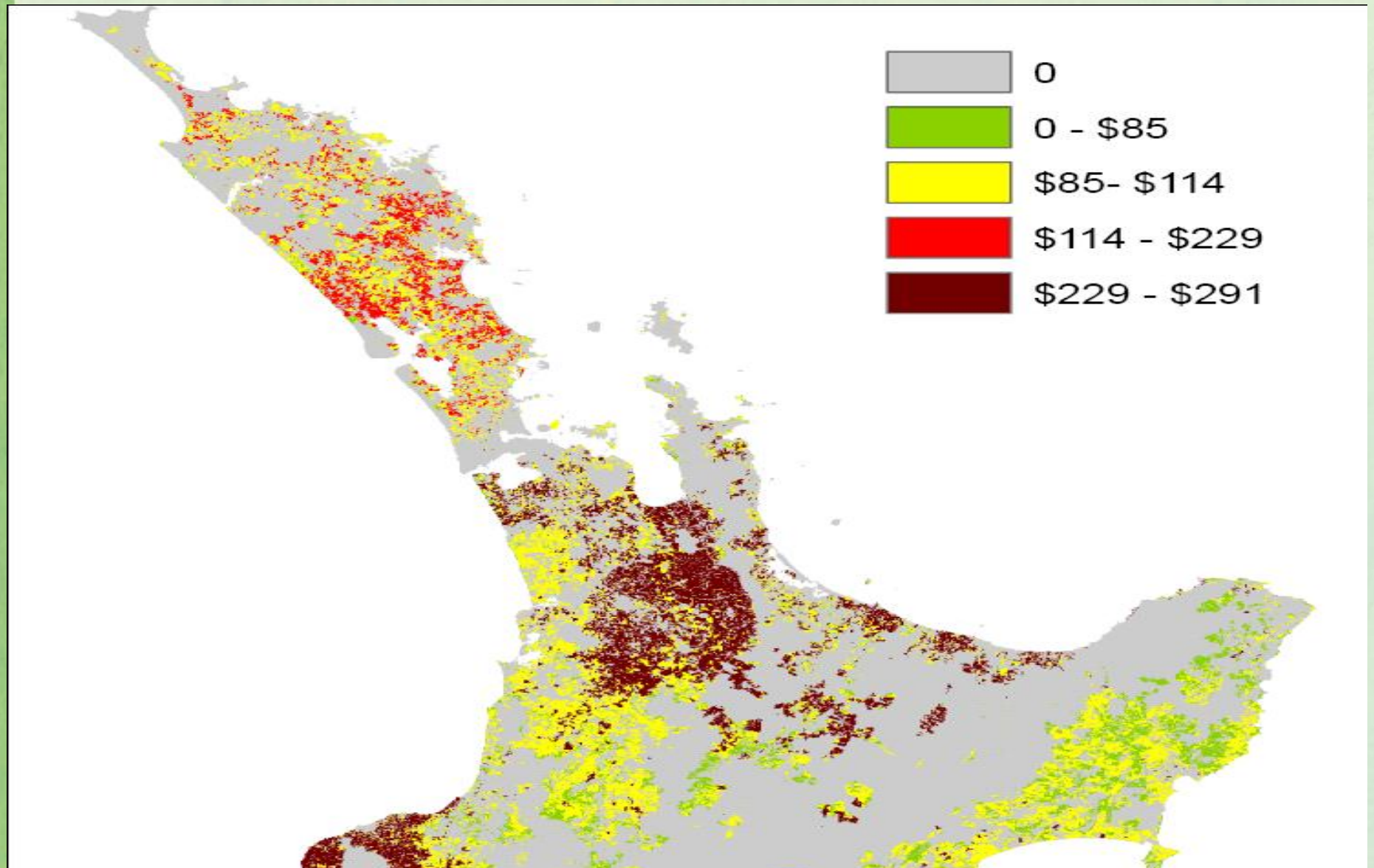
- Point of obligation/reporting and verification
- Leakage
- Distribution – cost bearing
- Compliance

Sheep/beef – % change in economic profit by region and class:

Average (2001-2008) at $25 per tonne CO_2-e

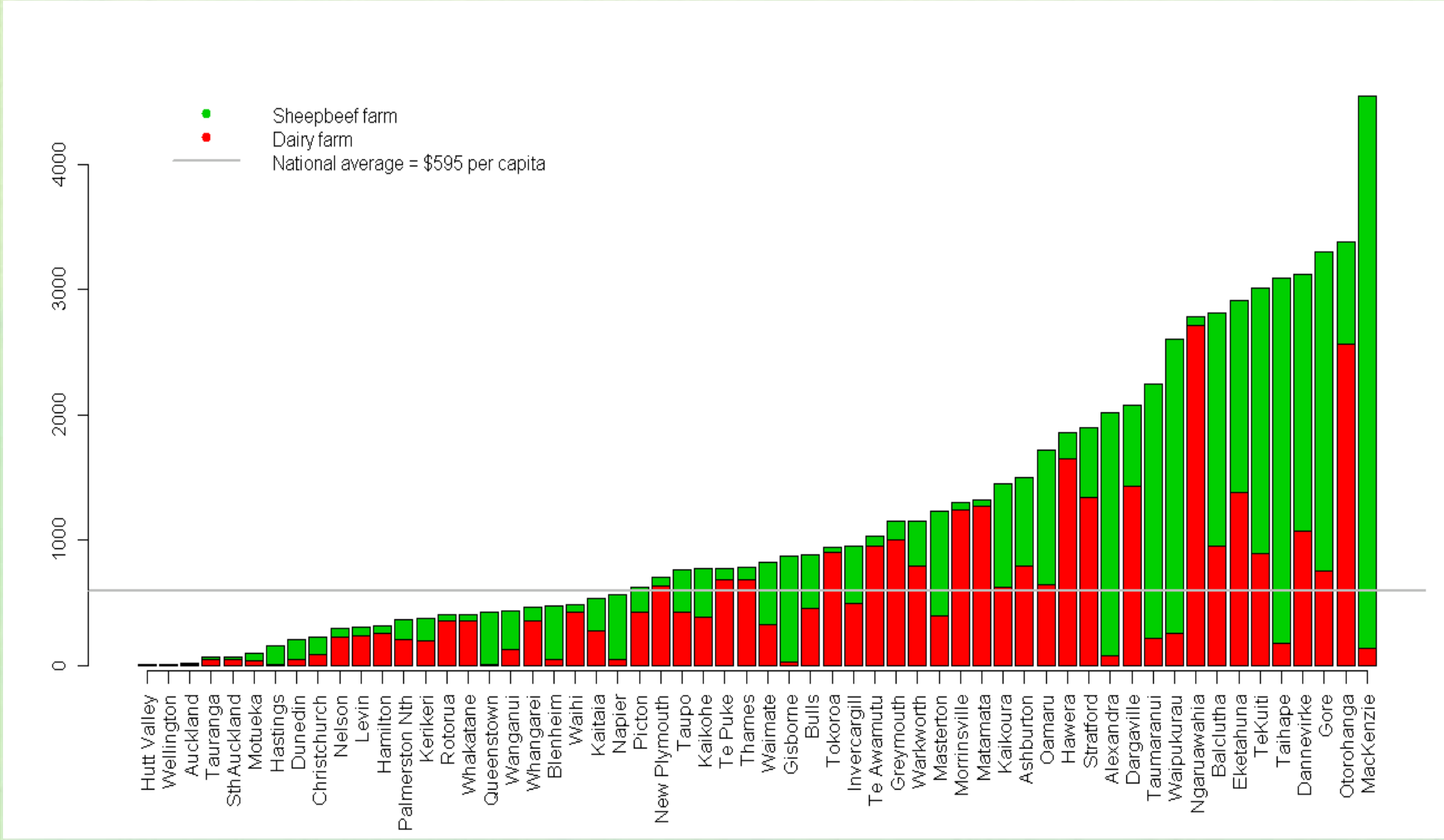
	Class							
Region	1	2	3	4	5	6	7	8
East Coast			61%	38%	32%			
Taranaki-Manawatu			48%	40%	38%			
Northland-Waikato-BoP			49%	41%	27%			
Marlborough-Canterbury	67%	54%				41%		14%
Otago/Southland	79%	48%				35%	30%	
New Zealand	70%	50%	52%	39%	31%	38%	30%	14%

Dairy and sheep/beef combined liability per ha



Emission liability per capita by LMA

2007 dollars, average 2001-2008

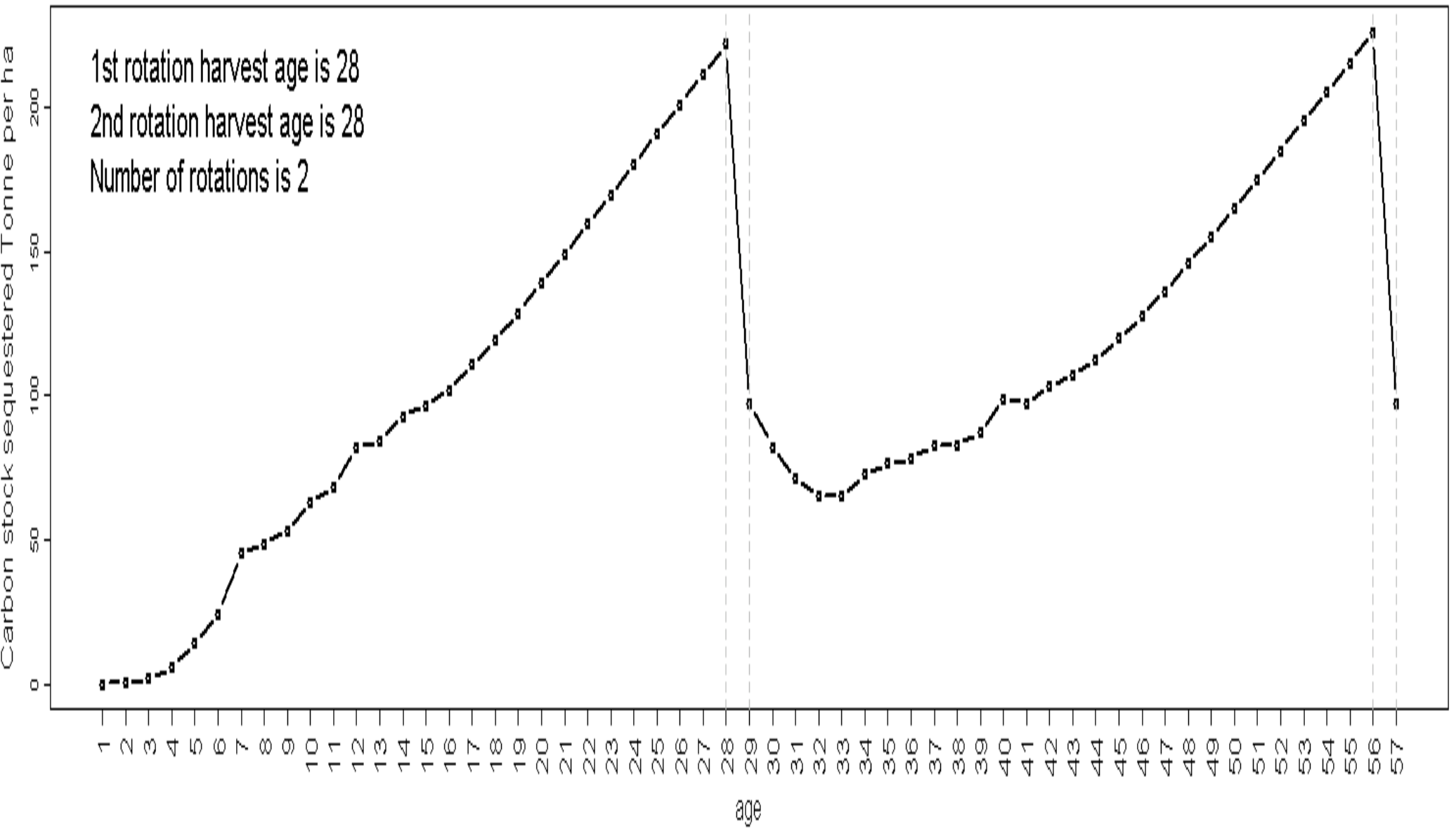


Plantation forests carbon credit policy – active from 1 Jan 2008

Forests sequester carbon and release most of it on harvest.

A forest stand will always have positive carbon stocks.

Carbon stock across rotations



Basic features of NZ system

- A credit is one tonne of carbon sequestered in plantation forests (or scrub)
- Landowners receive credits as forests grow and are required to surrender them on harvest.
- Only forests planted after 1990 are fully involved.
- Participation is voluntary but baseline is no planting since 1990 – no adverse selection but expensive
- Forests planted before 1990 are involved only if they choose to deforest.
- Only forests above 50 ha are liable for deforestation. (scrub is not liable if no credits given)

How is carbon monitored?

Monitor forest area:

- Self reporting auditable by satellite imagery for small forests
- Self reporting with auditable records for large forests
- Self reporting of newly established forests
- Require reporting of harvest / deforestation

Multiply by modeled carbon stock:

- regional carbon yield tables
- Larger areas must provide more accurate, certified measures

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Carbon liabilities

On harvest:

- Equal to carbon stored at age of harvest net of biomass left on site
- If not replanted, extra liability a few years later equal to the biomass that would have been left on site.
- Liability for ‘new’ forests is limited to credits provided

On deforestation:

- Equal to carbon stored at age of harvest

Key problem: deforestation liability

- Current deforestation is driven by decisions made as long as 30 years ago
- No ability to pass on costs
- Deforestation liability is highly concentrated and particularly affects Maori (indigenous people).
- Equity / political feasibility issues
- Encourage cooperation
  - Difficulties in monitoring
  - Not all forests are alike
  - Potential improvement in responsiveness

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$$Credit = \frac{\sum_{t=0}^{62} P_{Co2}(1+g)^t OC[Y(t+1) - Y(t)](1+r)^{Hage-t}}{National\ average\ volume\ per\ ha}$$

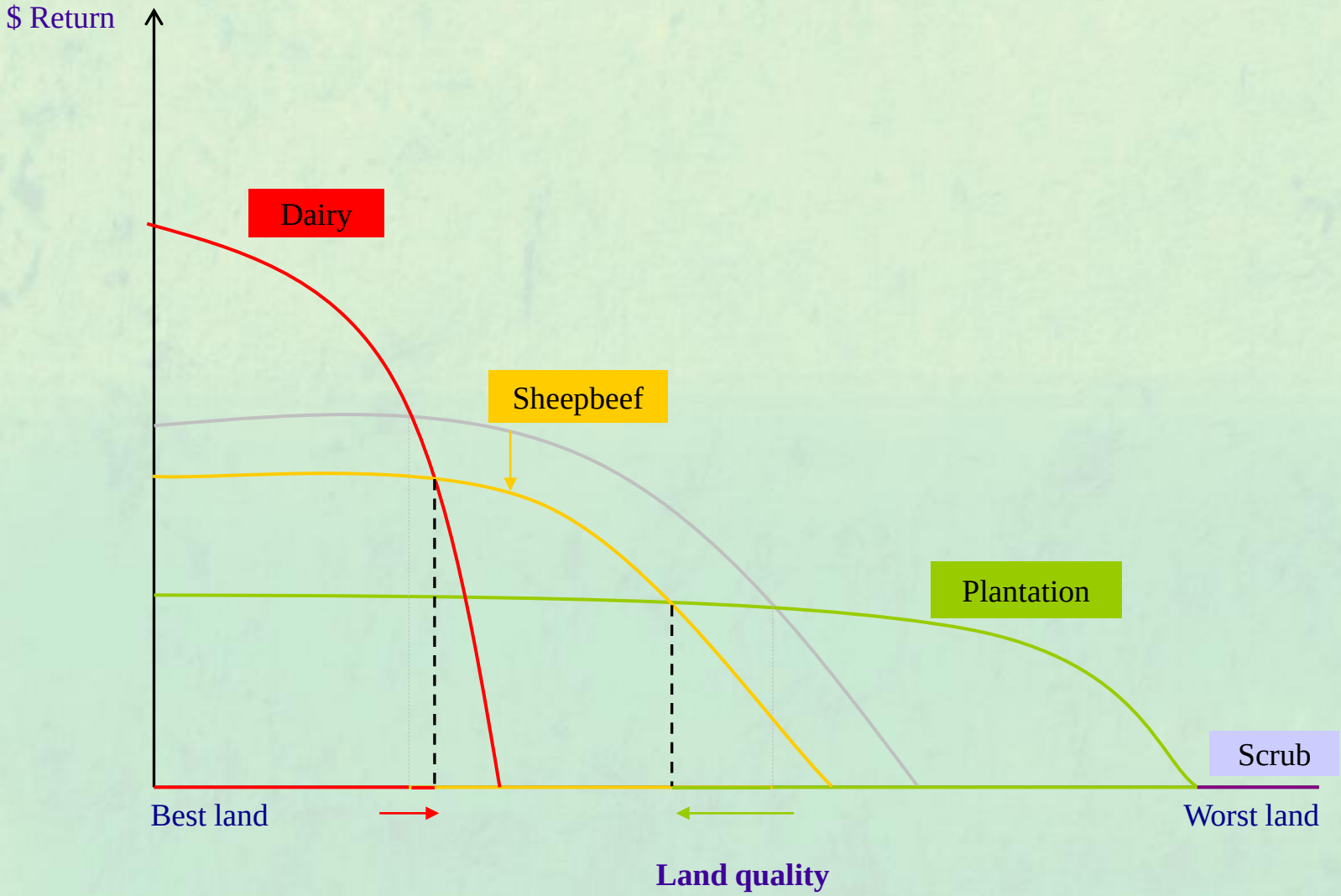
- P_{CO2} is the price of a tonne of CO_2-e
- *g* is the growth rate of P_{CO_2}
- *Y(t)* is the carbon stock sequestered at age t
- *r* is the discount rate
- *OC* is the C to CO_2 converter = 3.667
- *Hage* is harvest age: assumed to be 28 years
- *National average volume per ha* = 465 m^3

Value of credits earned under different Co_2 price growth rates - initial price $25

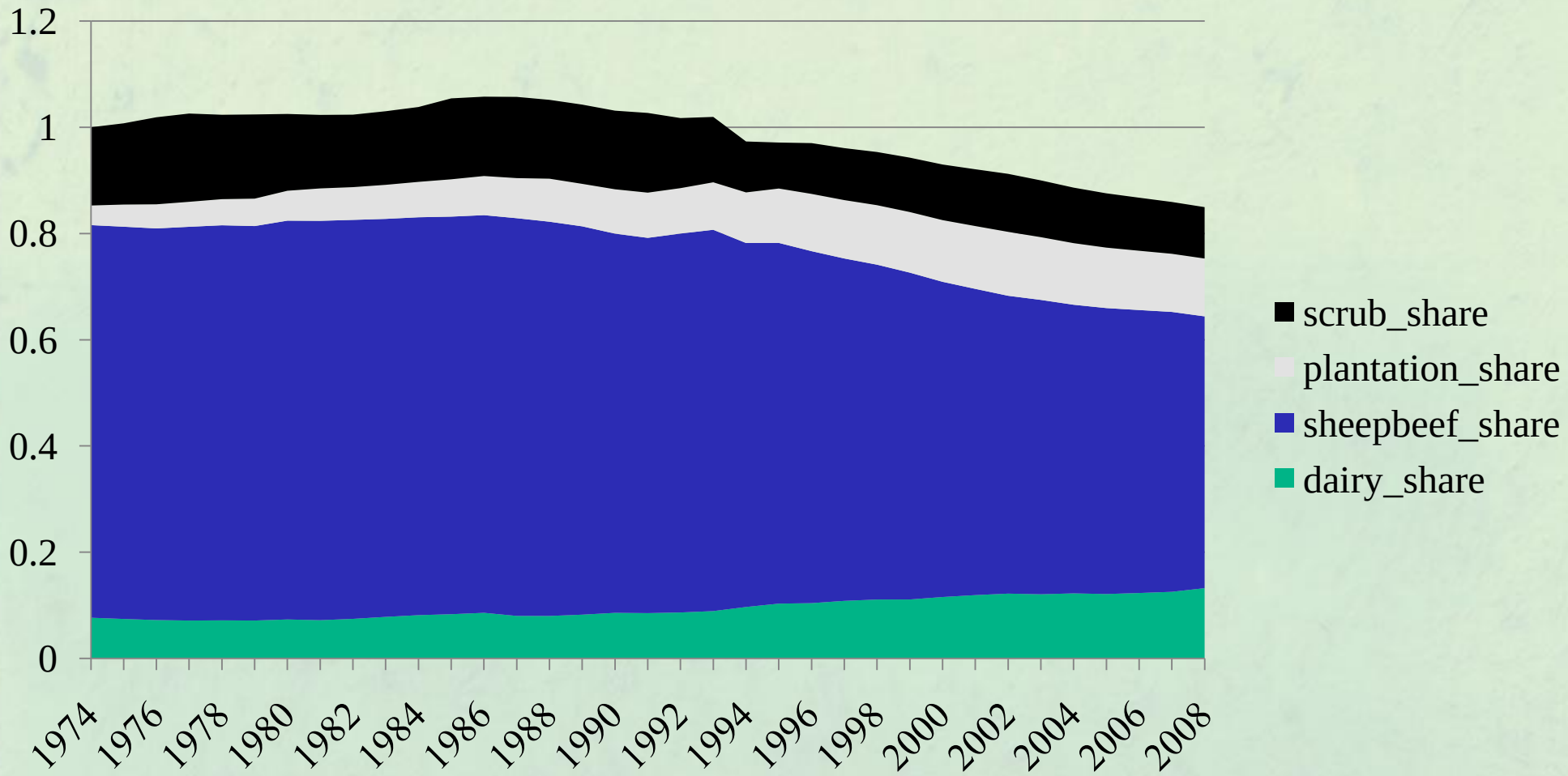
Co_2 price Growth rate	Credit $ per m^3 2008 price	Credit as a percent of average log price (1974 to 2008)
0	146.47	92%
0.01	159.54	100%
0.02	173.47	108%
0.03	187.99	117%
0.04	202.52	127%
0.05	215.79	135%
0.06	225.29	141%
0.07	226.03	141%
0.08	208.45	130%

Land Use Model

Effect of Fall in Sheep/Beef Prices



Rural Land Use Shares



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Land use modelling

Gradual adjustment model

Long: $s_i = \alpha_i + \beta_i OL + \Sigma_j \gamma_{ij} \log p_j + \delta_{1i} r + \delta_{2i} time + \varepsilon_i$

Short: $\Delta s_i = \alpha_i + \beta_i \Delta OL + \Sigma_j \gamma_{ij} \log p_j + \delta_{1i} r + \Sigma_j \delta_{2j} \varepsilon_i + \mu_i$

Cross equation restrictions impose a total 'rural' land constraint.

Use set of expert rules to allocate land spatially

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Land use modelling directions

- We currently need to constrain some coefficients based on priors to get reasonable simulation results
- Working on improved econometrics – panel and GIS layers
- Have introduced uncertainty to allow us to take off constraints

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Response of land use to ETS

Adjust prices per unit output by liability or credit per unit output

We have no price response estimate for scrub land – assume Slutsky symmetry.

- E.g. response of forestry to scrub price = response of scrub to forestry price

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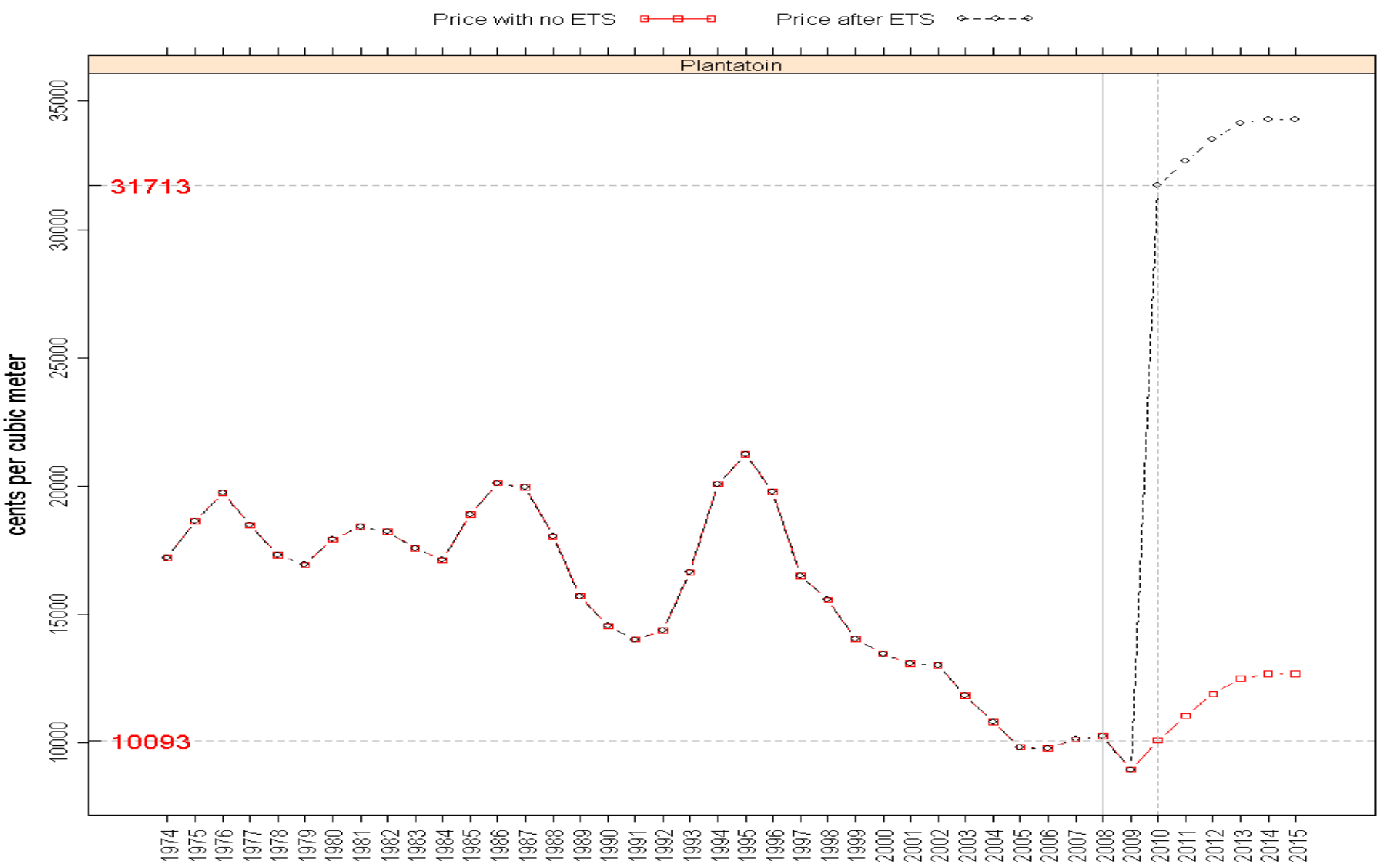
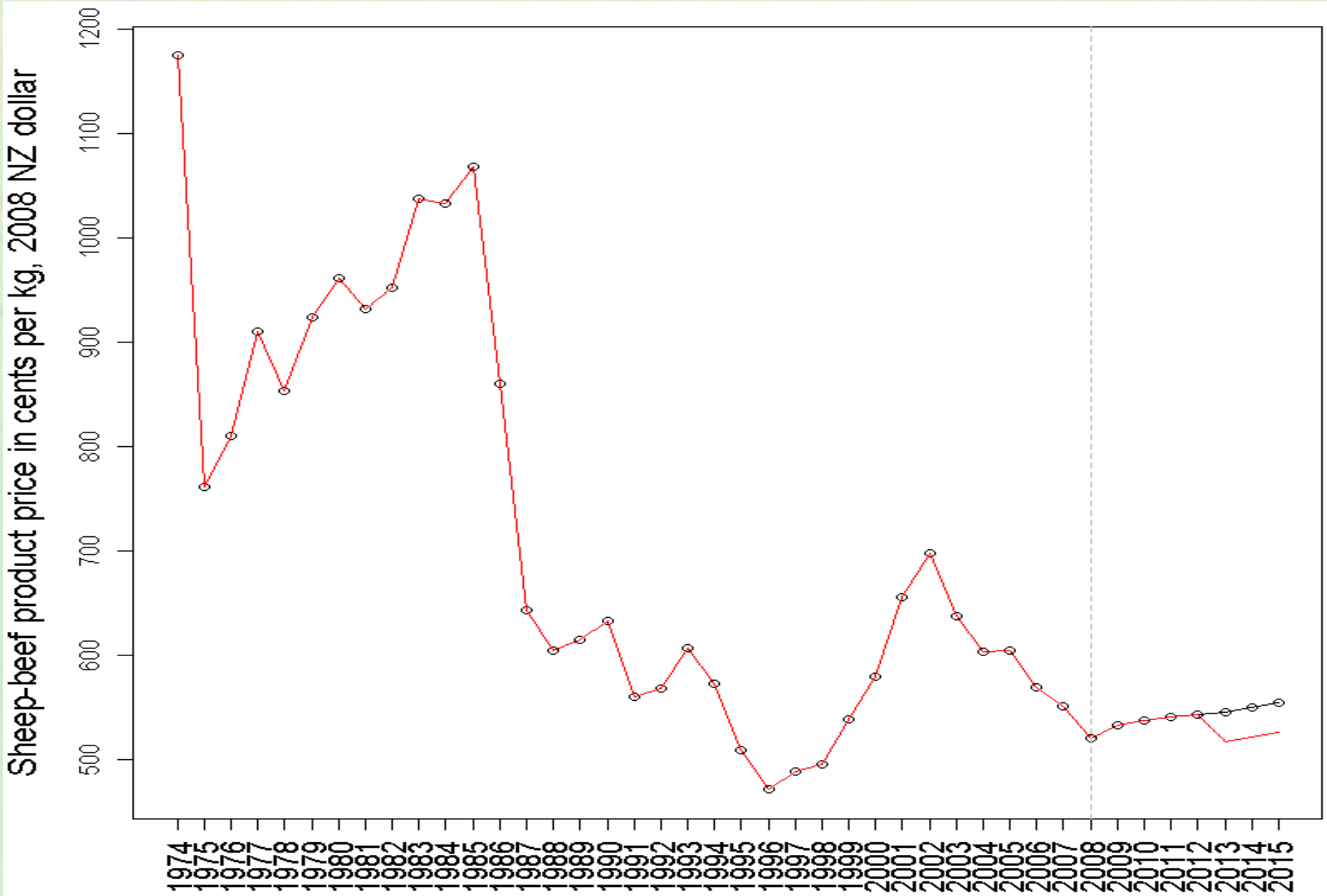
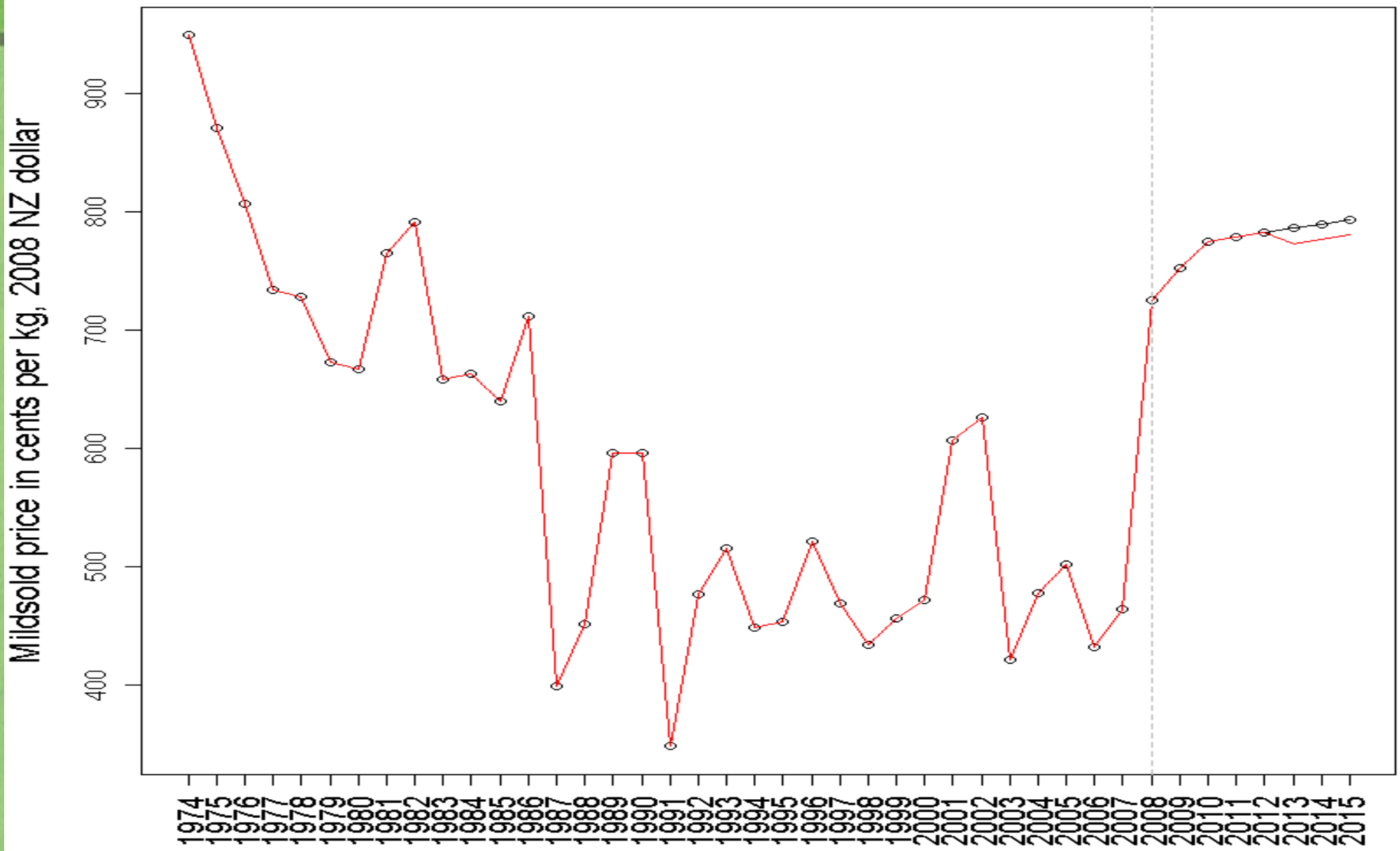
Forestry price change



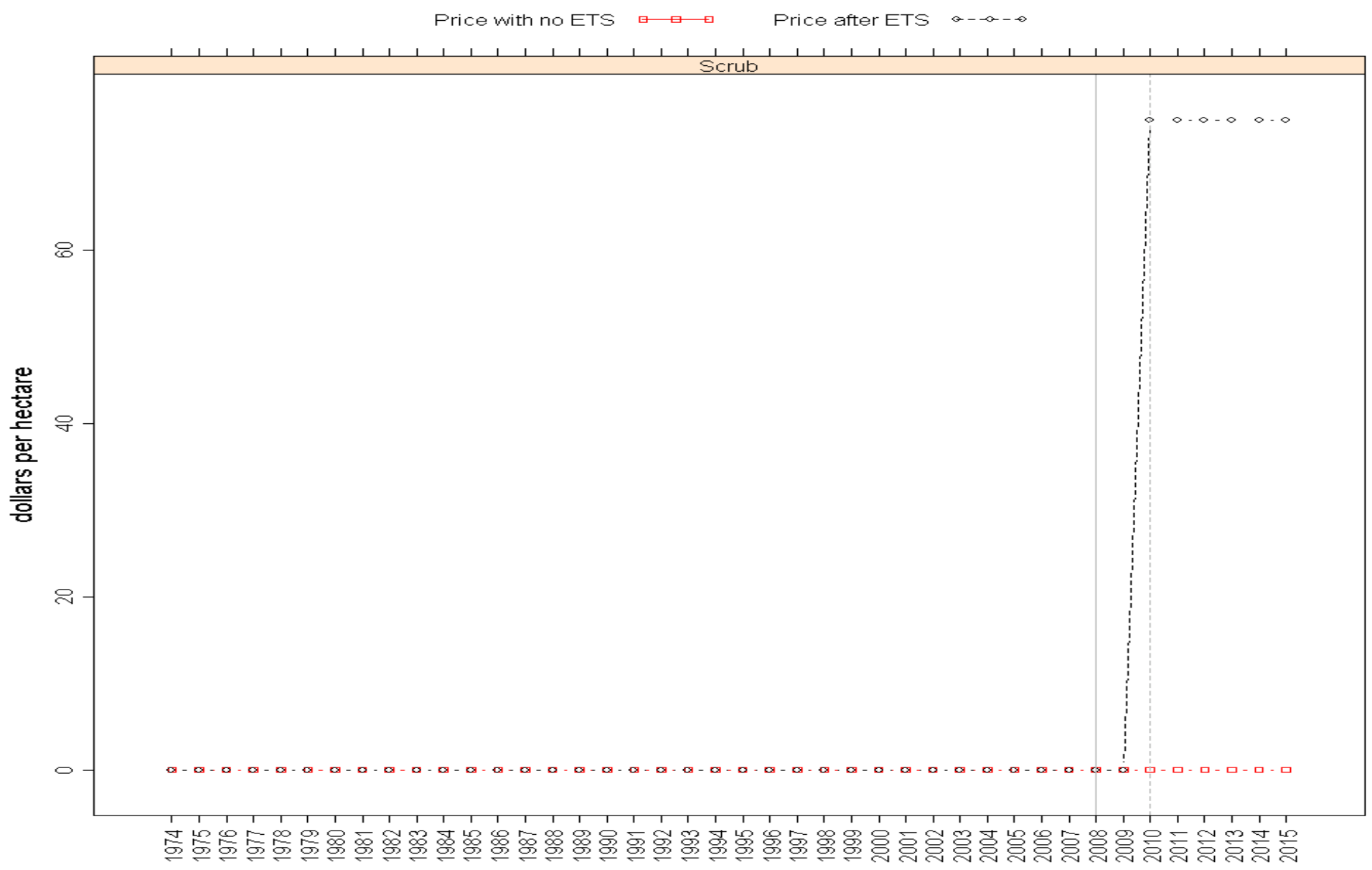
Sheep/beef price change



Dairy (milksolid) price change



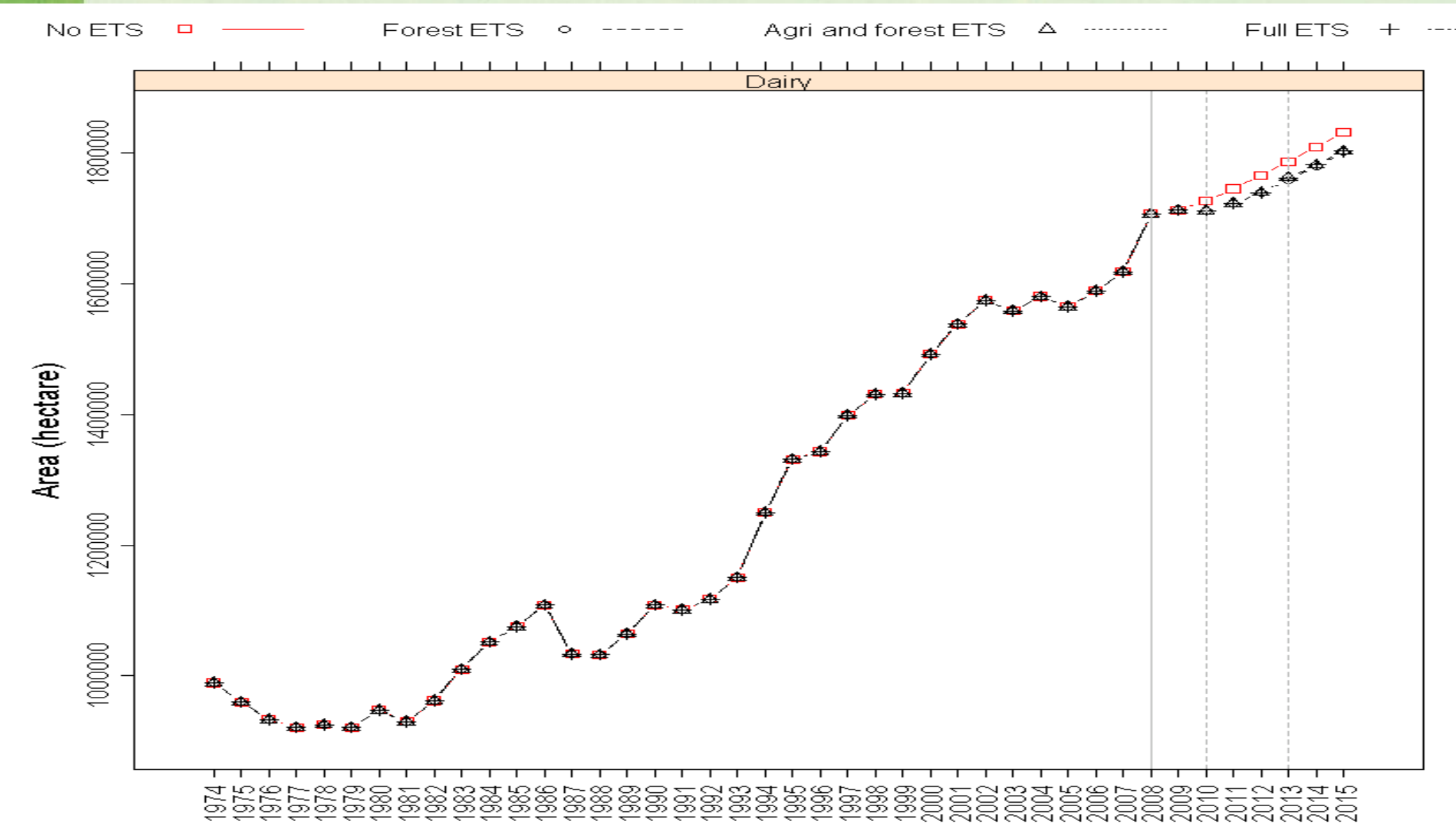
Scrub price change



Key scenarios

1. Plantation forestry ETS only
2. Agriculture and forestry
3. Full ETS: forestry, agriculture and scrub credits

Dairy


No ETS
Forest ETS
Agri and forest ETS
Full ETS
Dairy
Area (hectare)
1000000
1200000
1400000
1600000
1800000
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
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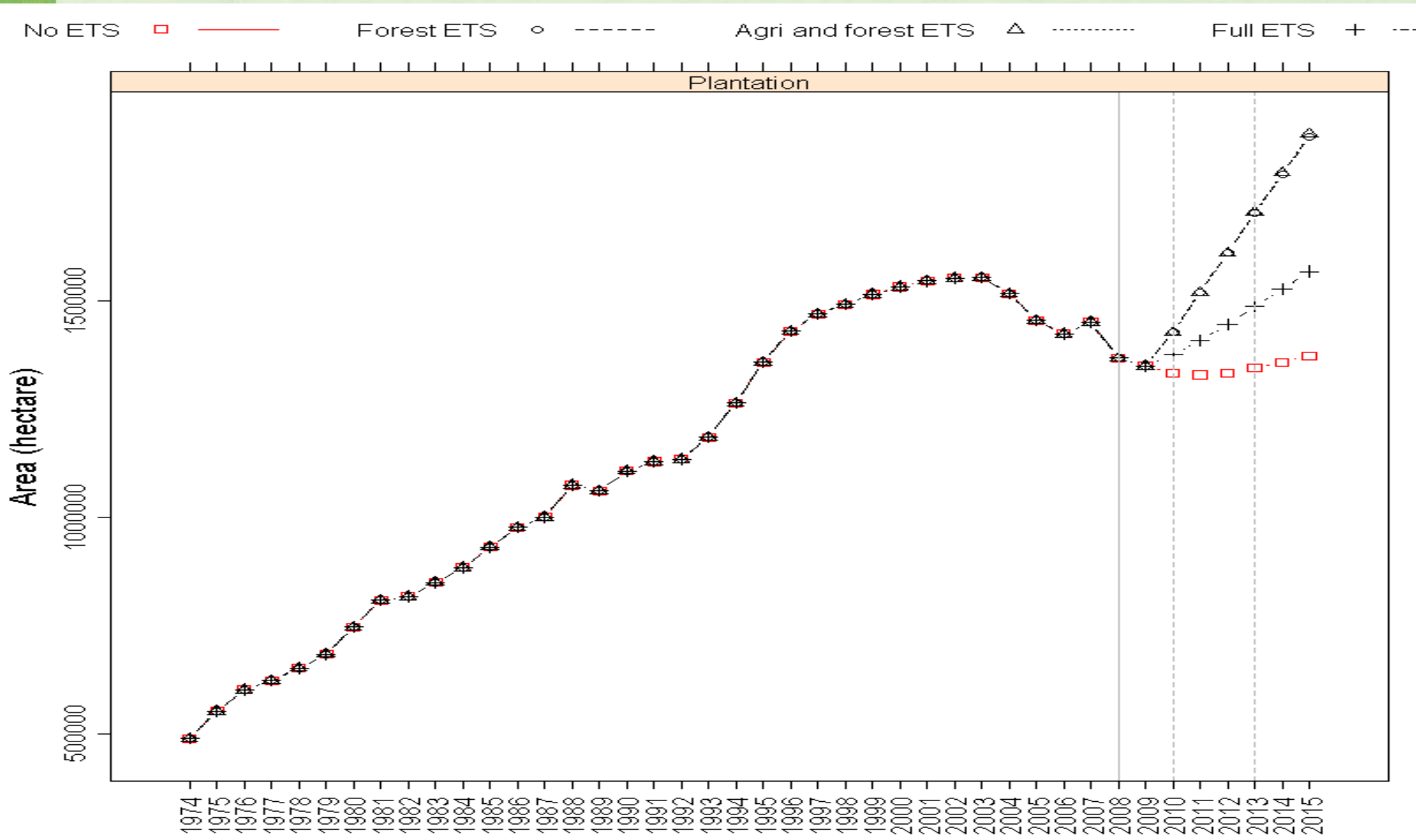
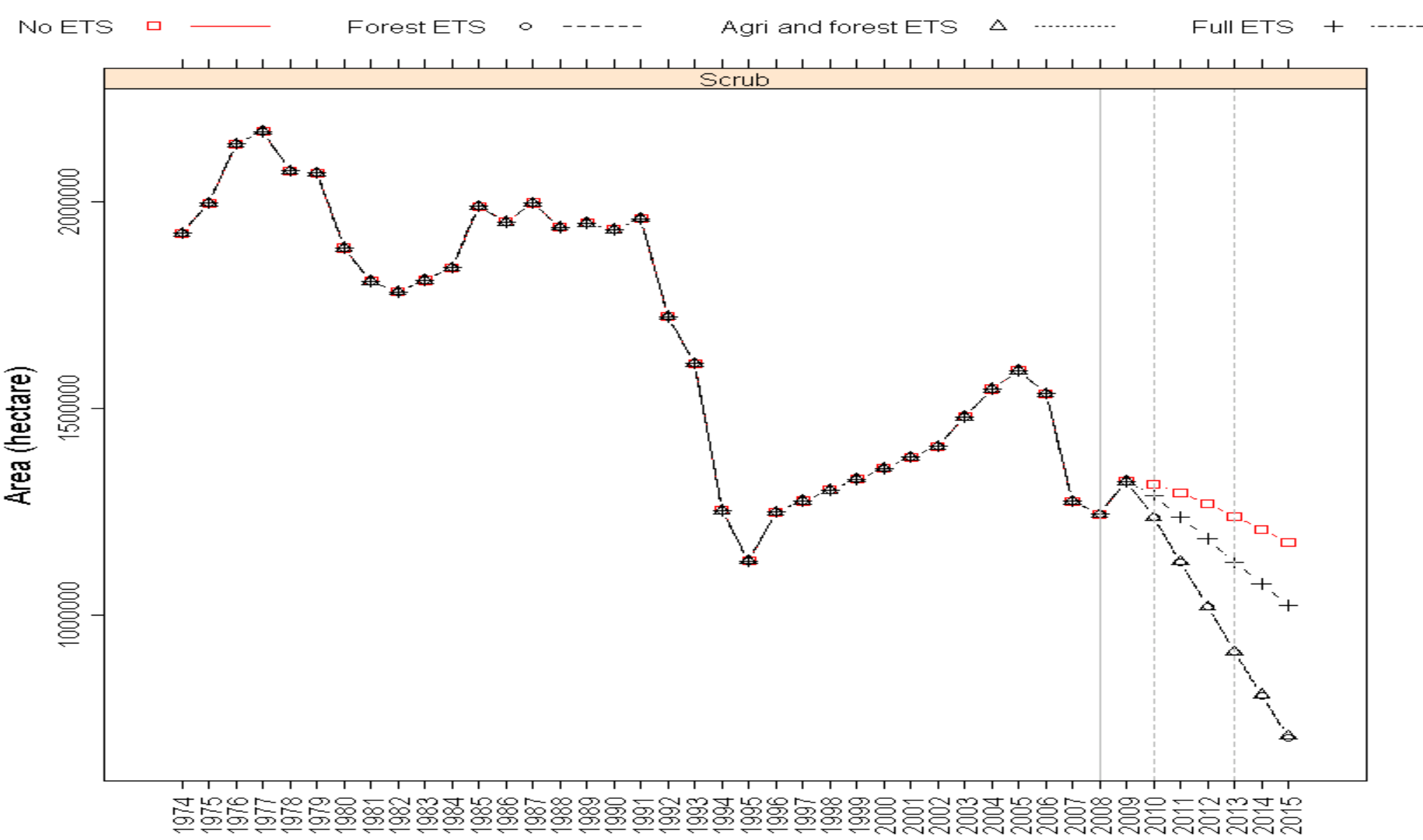
2015

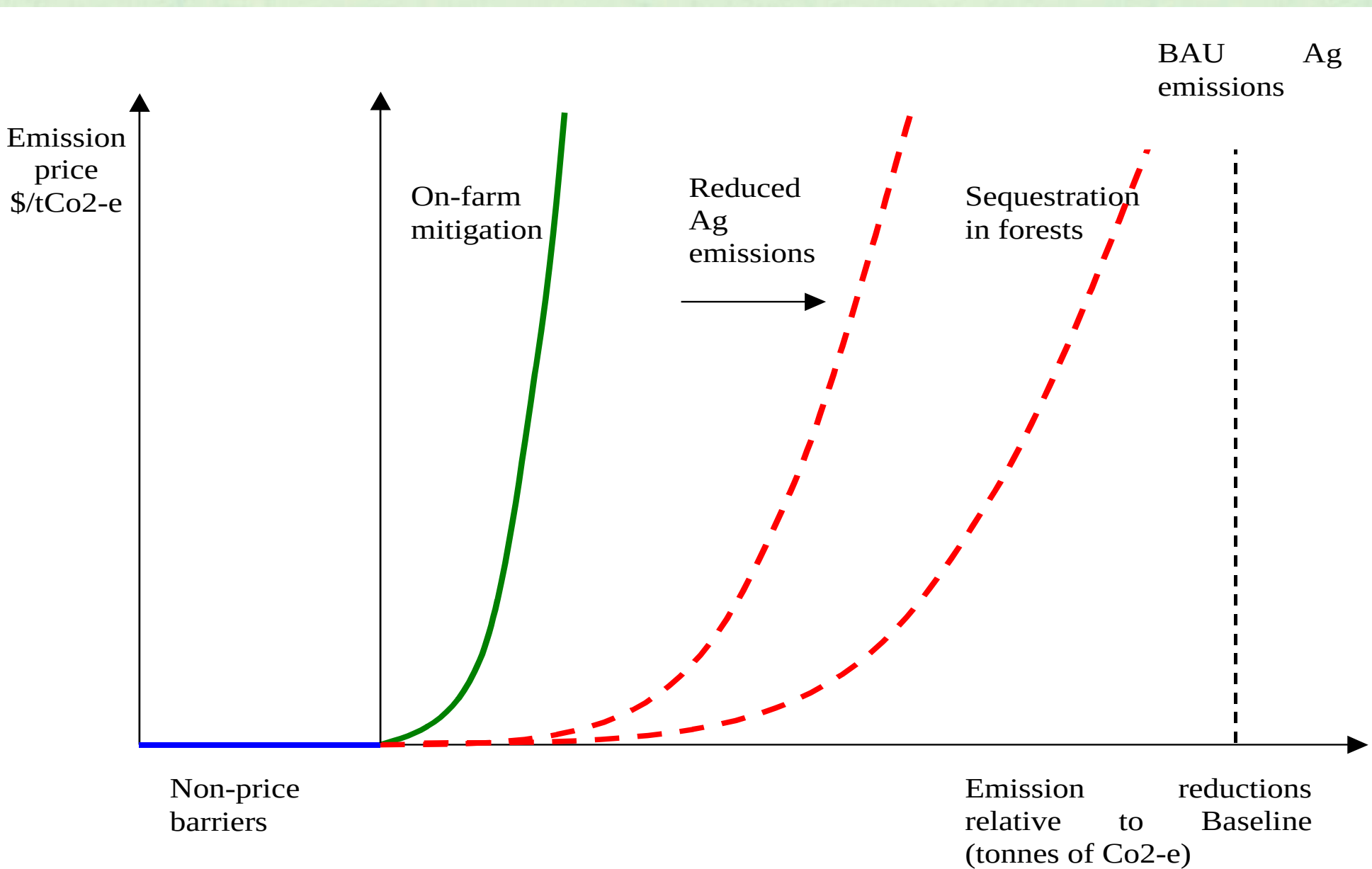
Plantation forest



Scrub – indigenous forest



Marginal abatement costs

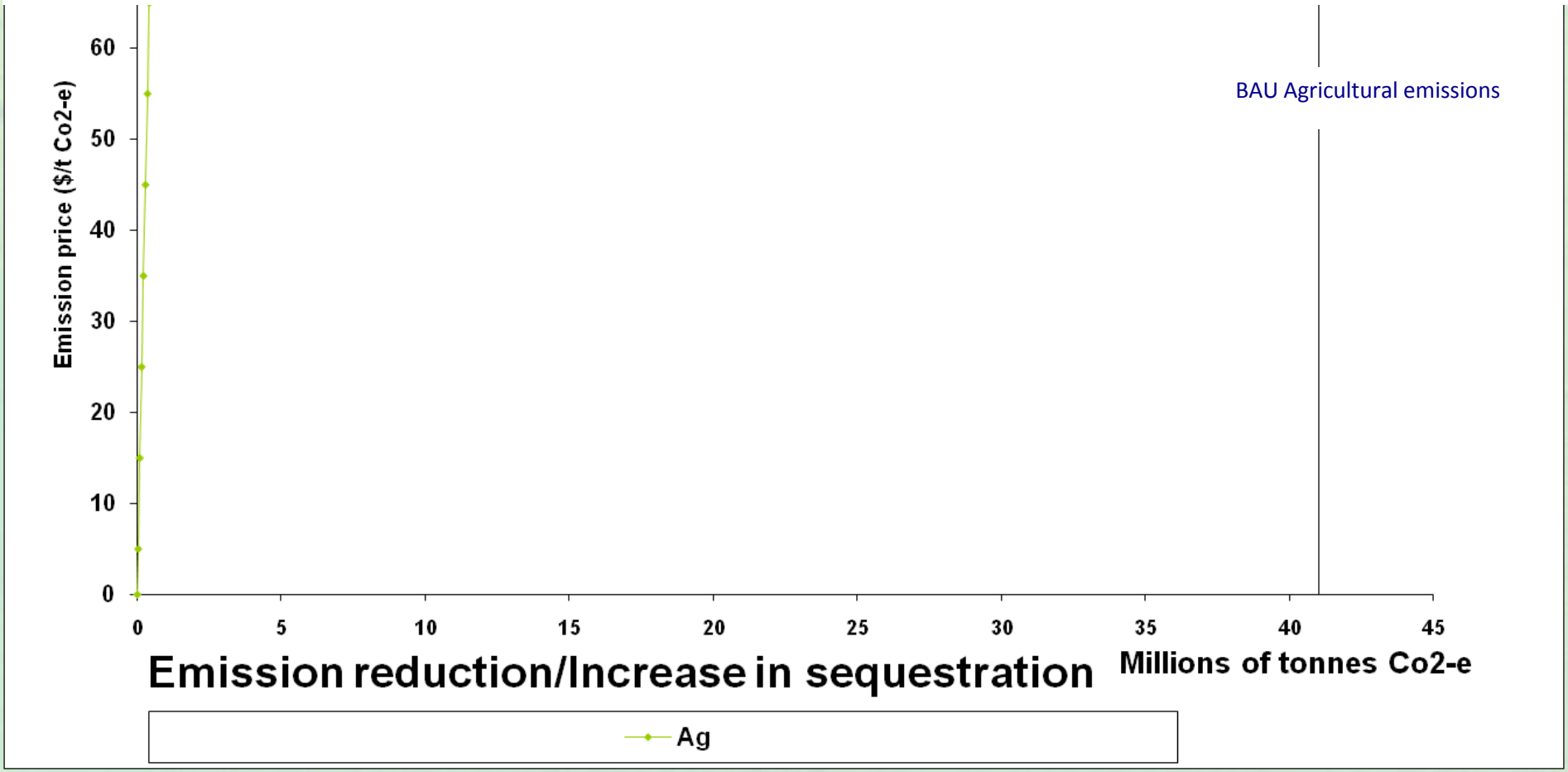


Land-use change: marginal abatement cost curve

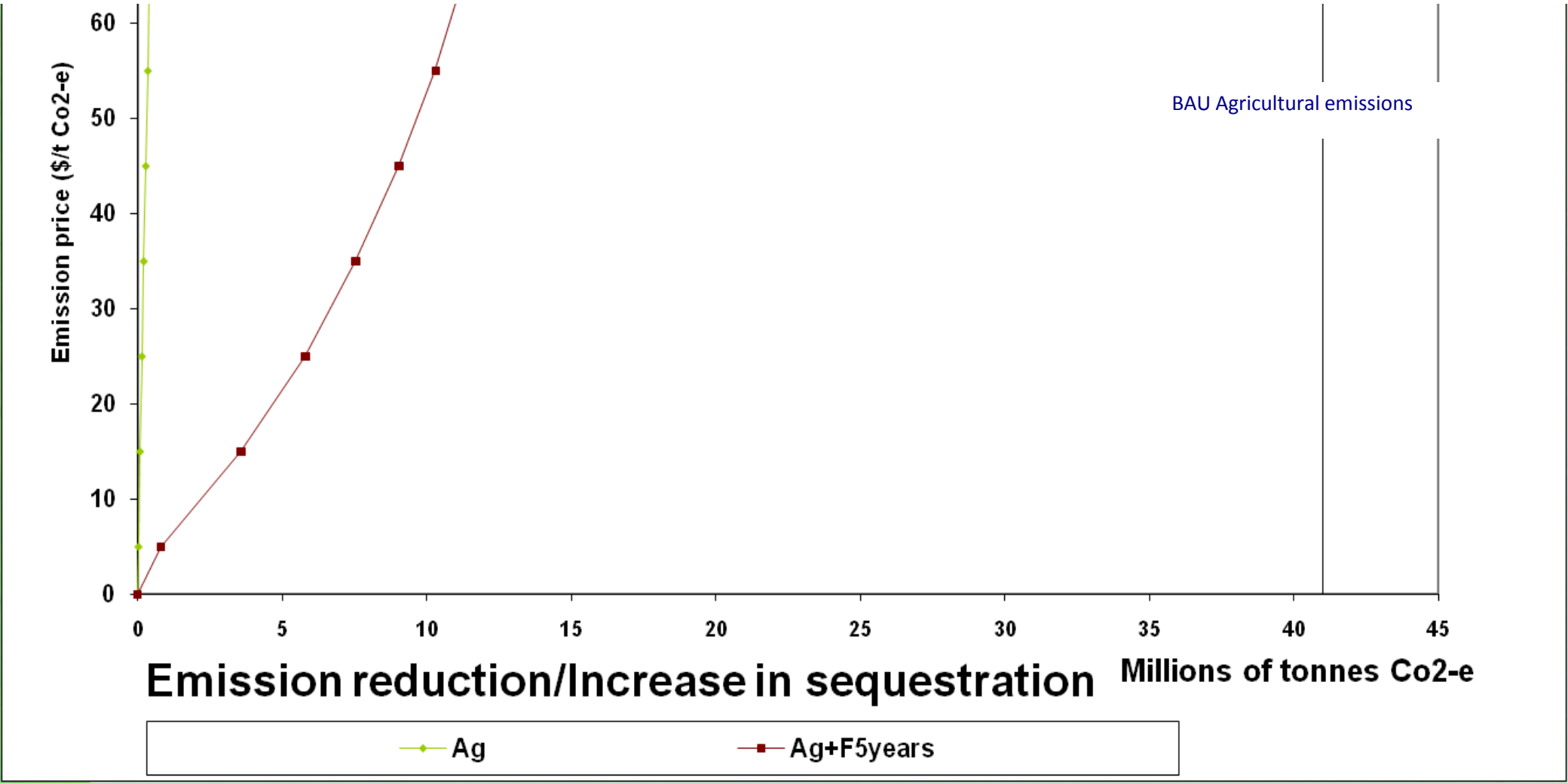
Methodology

- Simulate the changes in land-use in response to the ETS (using LURNZ)
- Generate the associated emission and profit implications
- Approach 1: emissions responses to CO_2 price
- Approach 2: emissions against expected financial losses at each CO_2 price

Approach 1: Marginal abatement cost through agricultural land use change



Approach 1: Marginal abatement cost with Forestry



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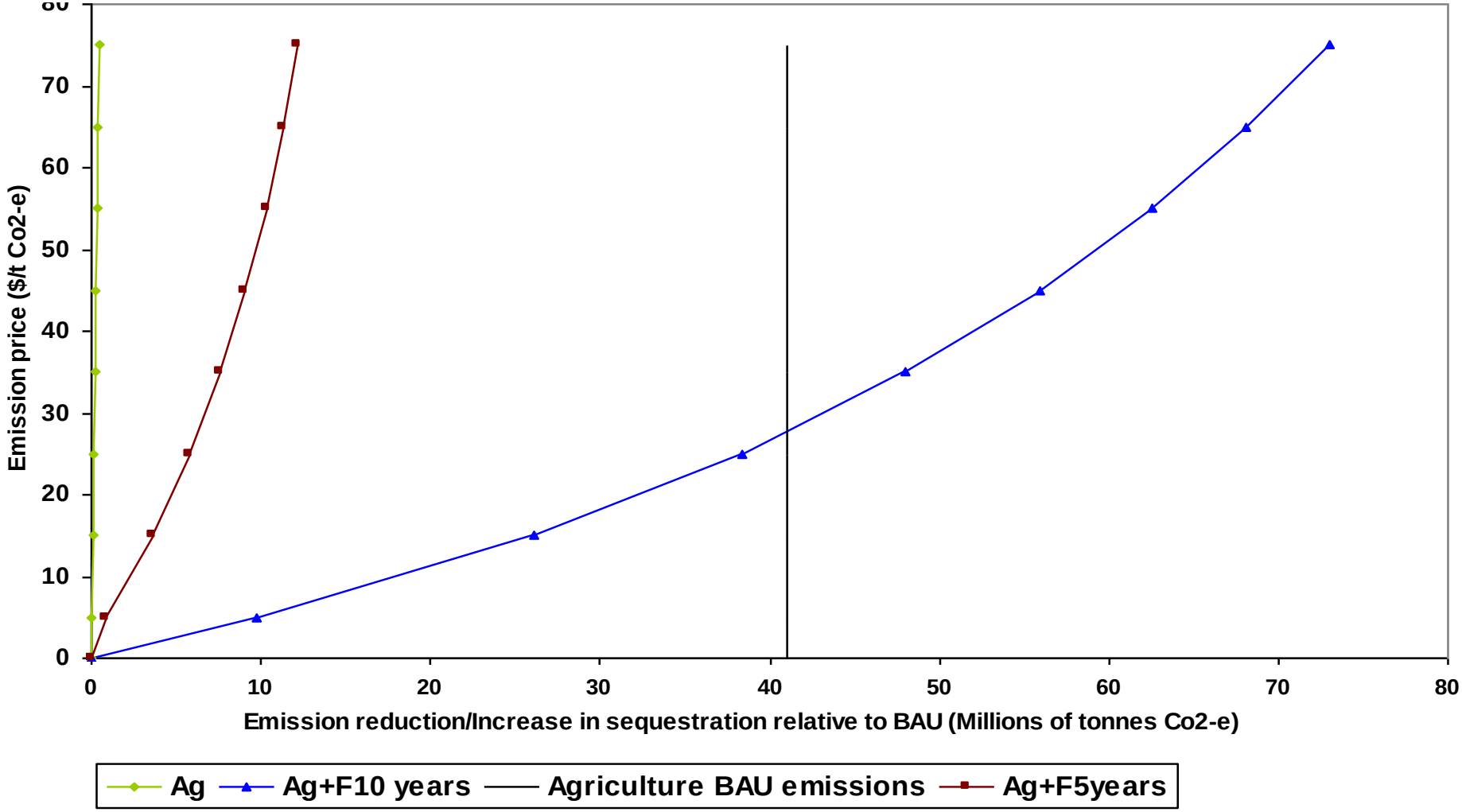
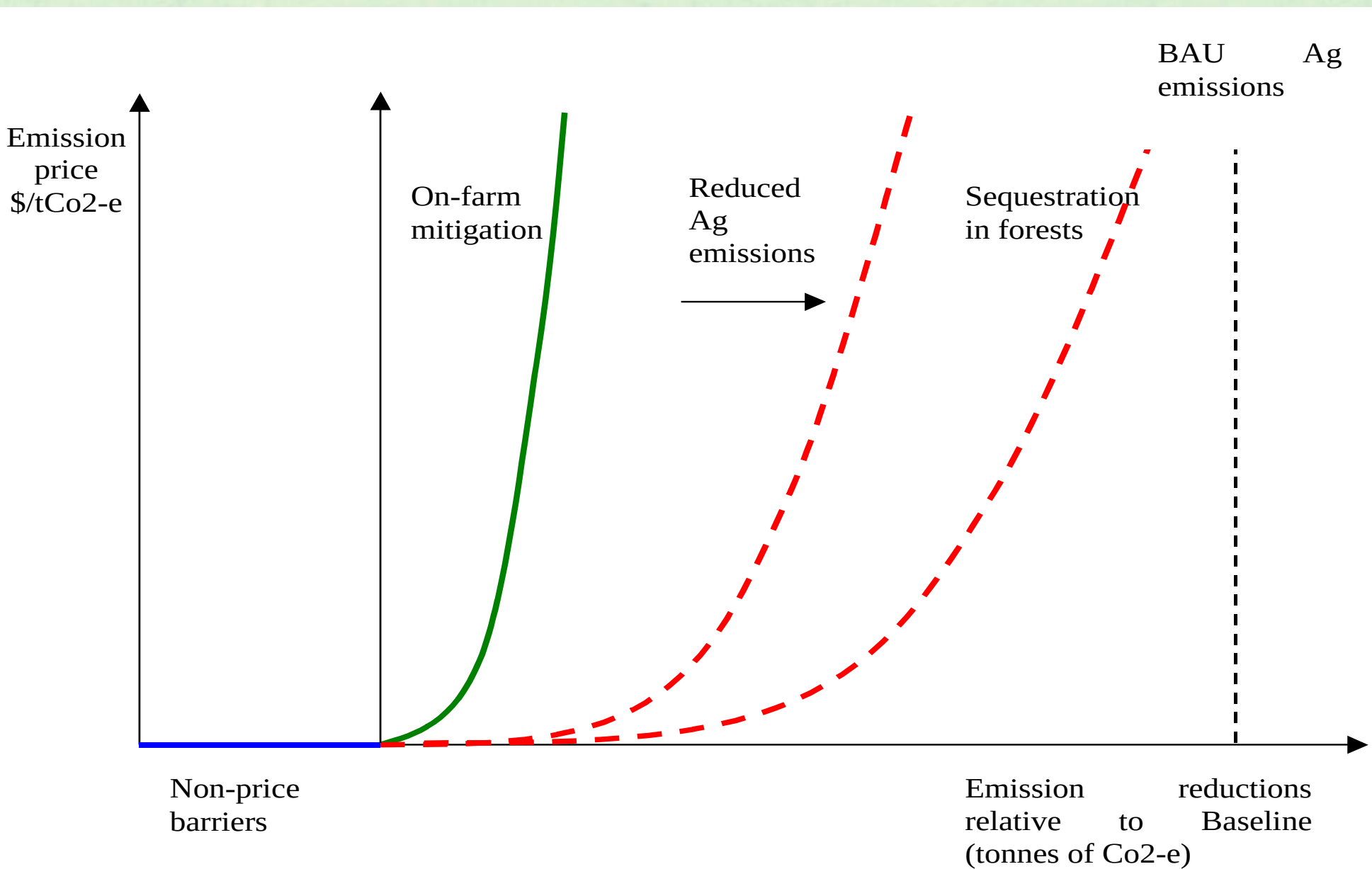


Marginal abatement costs



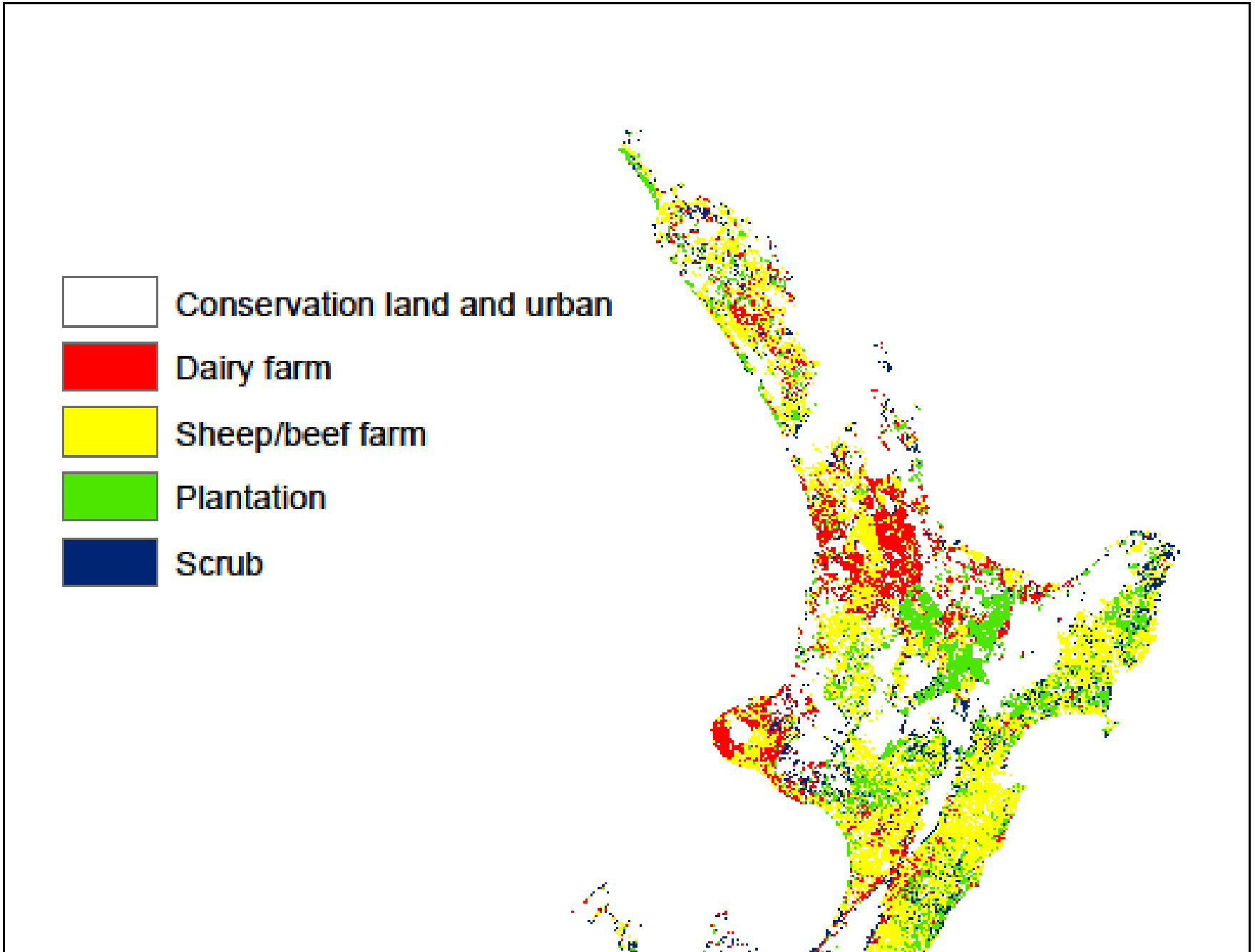
Approach 2

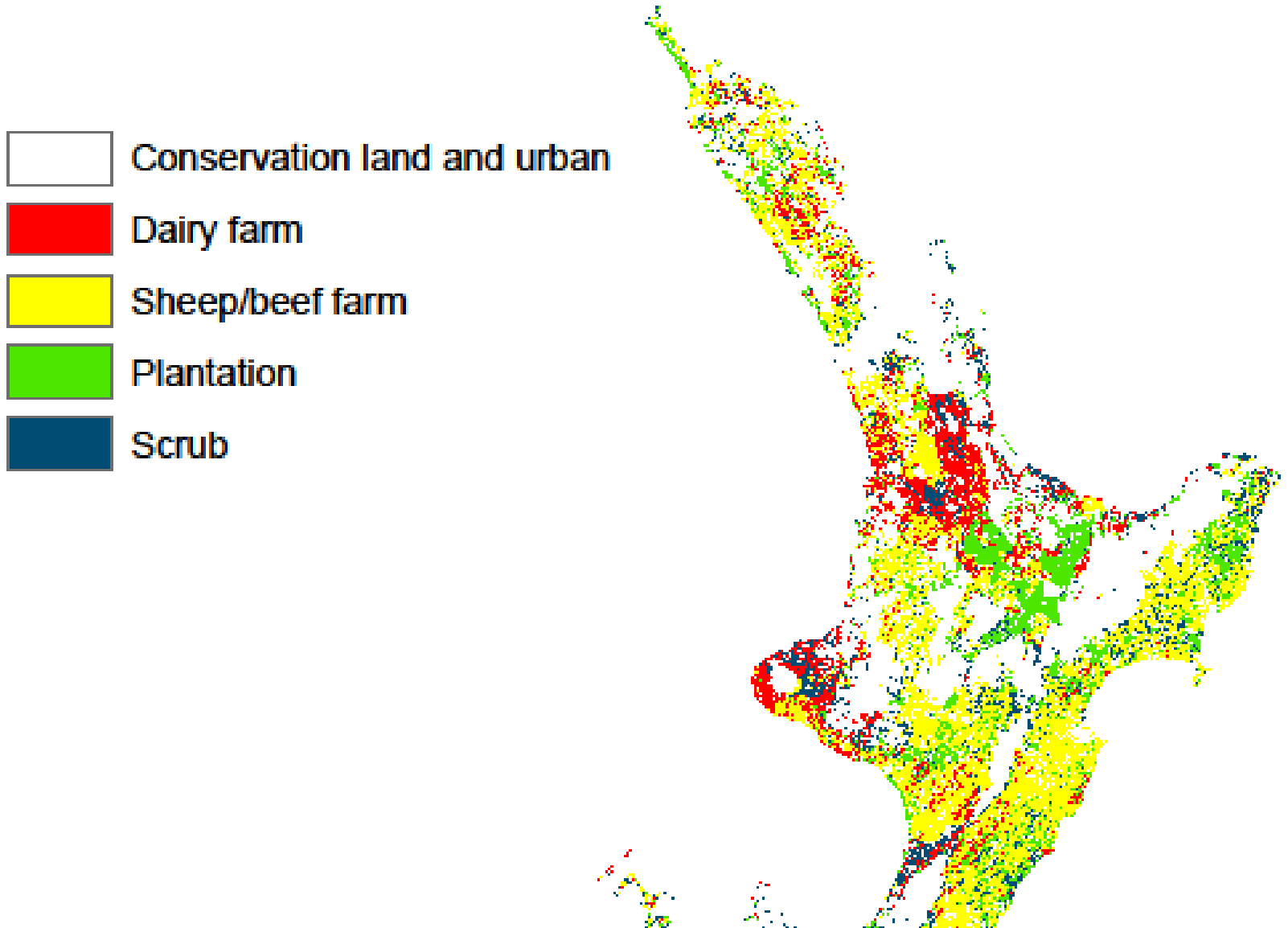
Use LURNZ predicted spatial pattern of land use change

Compare profit in BAU with profit in alternative use

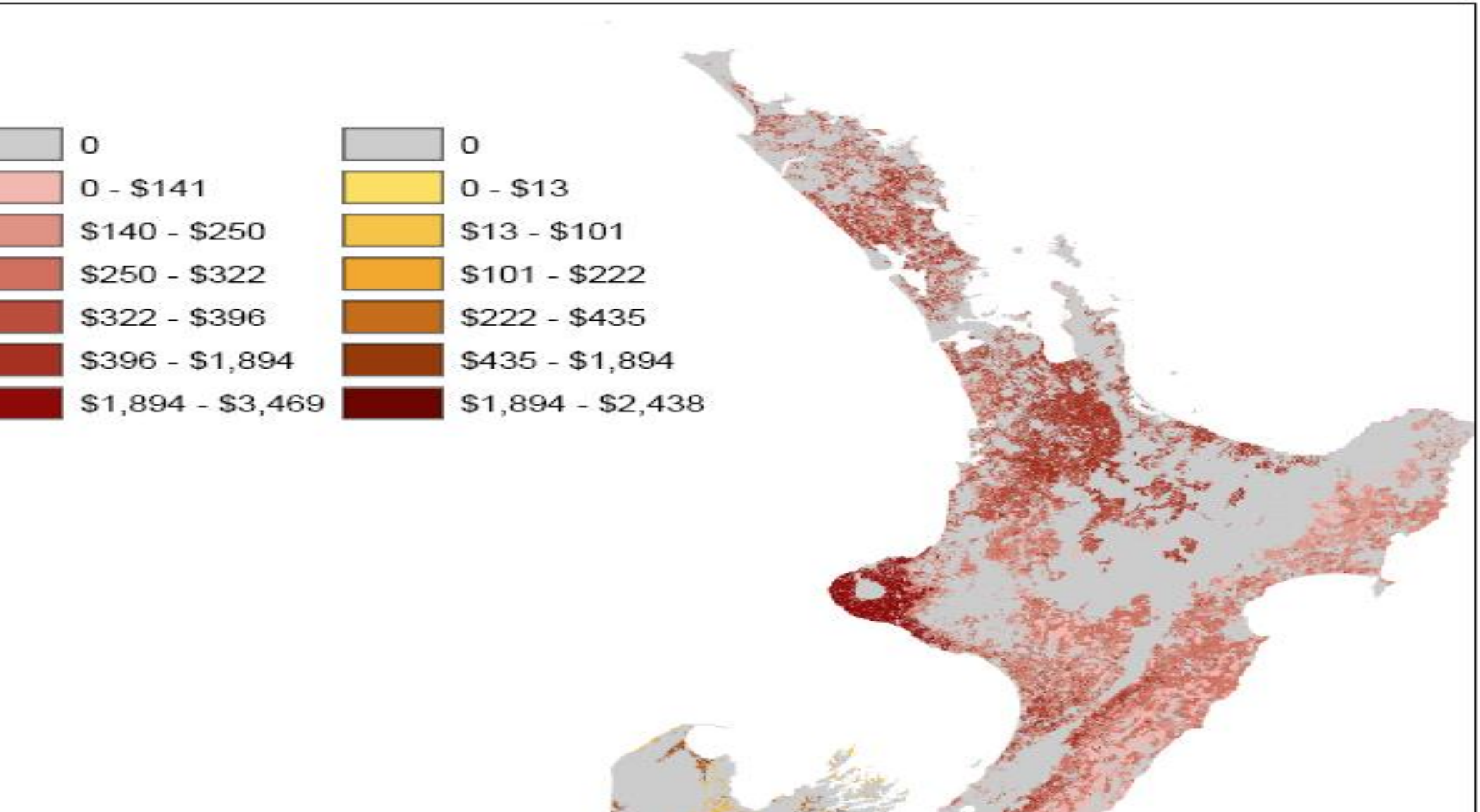
Misses good reasons why landowners do not choose use with highest expected return

- risk
- options


Conservation land and urban
Dairy farm
Sheep/beef farm
Plantation
Scrub

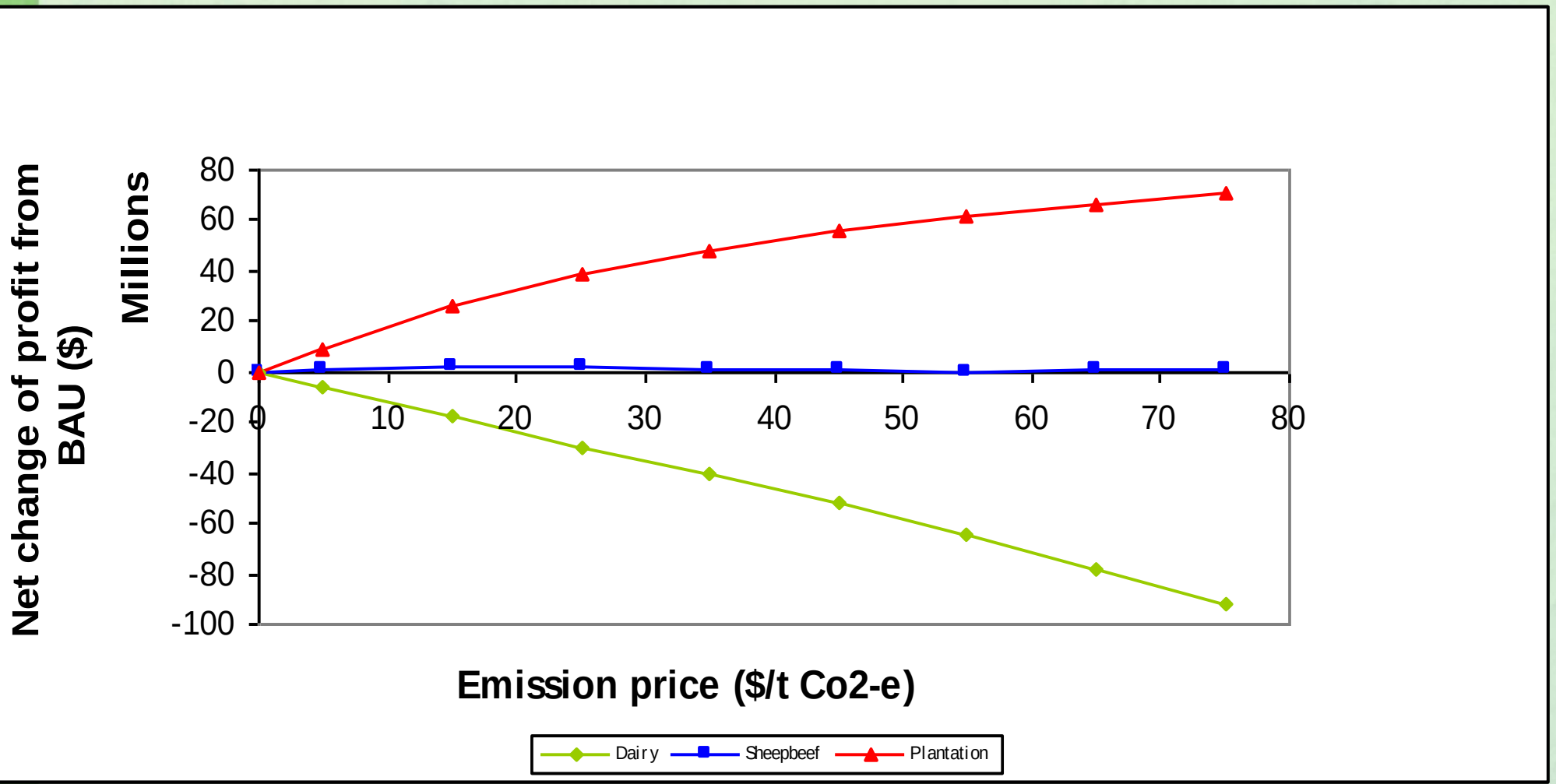

Conservation land and urban
Dairy farm
Sheep/beef farm
Plantation
Scrub

Map of dairy and sheep/beef profit

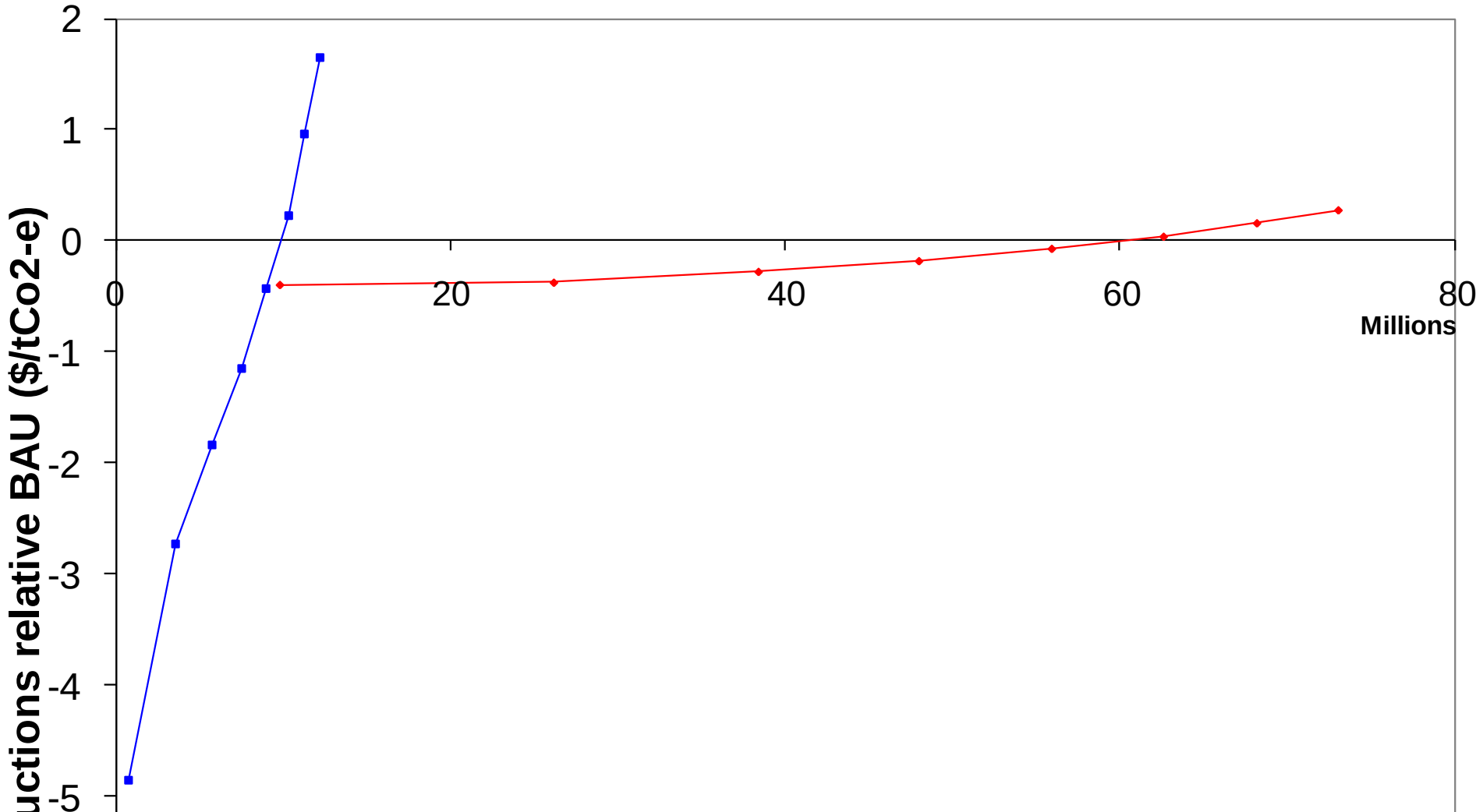


Profit changes relative to Baseline

(not including emissions costs/seq reward)



Approach 2: MAC



Summary

- Pastoral land uses seem quite unresponsive to GHG prices
  - Few concerns about leakage
  - How much value incorporating them in program? (domestic diet changes?)
- Forestry
  - Forestry could be a significant contributor
  - Puzzle about why so little land goes into forestry
- Forestry expansion threatens indigenous scrub

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Future directions

- Better understanding of drivers of land use
  - Better econometrics
  - Incorporation of option values associated with forestry
- Incorporation of uncertainty
  - More realistic interpretation of results
  - Modelling of voluntary participation
- Incorporation of mitigation and forestry management options
- Evaluate actual forestry outcomes
- Help design appropriate agricultural policies

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