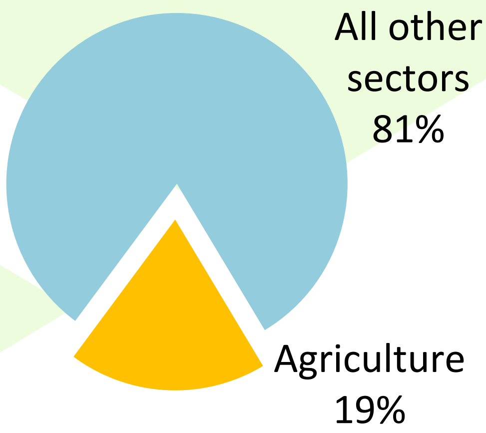
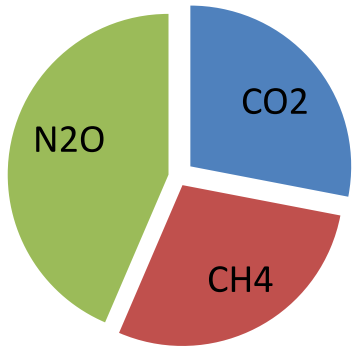
Comparing the cost effectiveness of GHG mitigation options on different Scottish dairy farm groups

Shailesh Shrestha and Vera Eory
Land Economy, Environment and Society Research Group

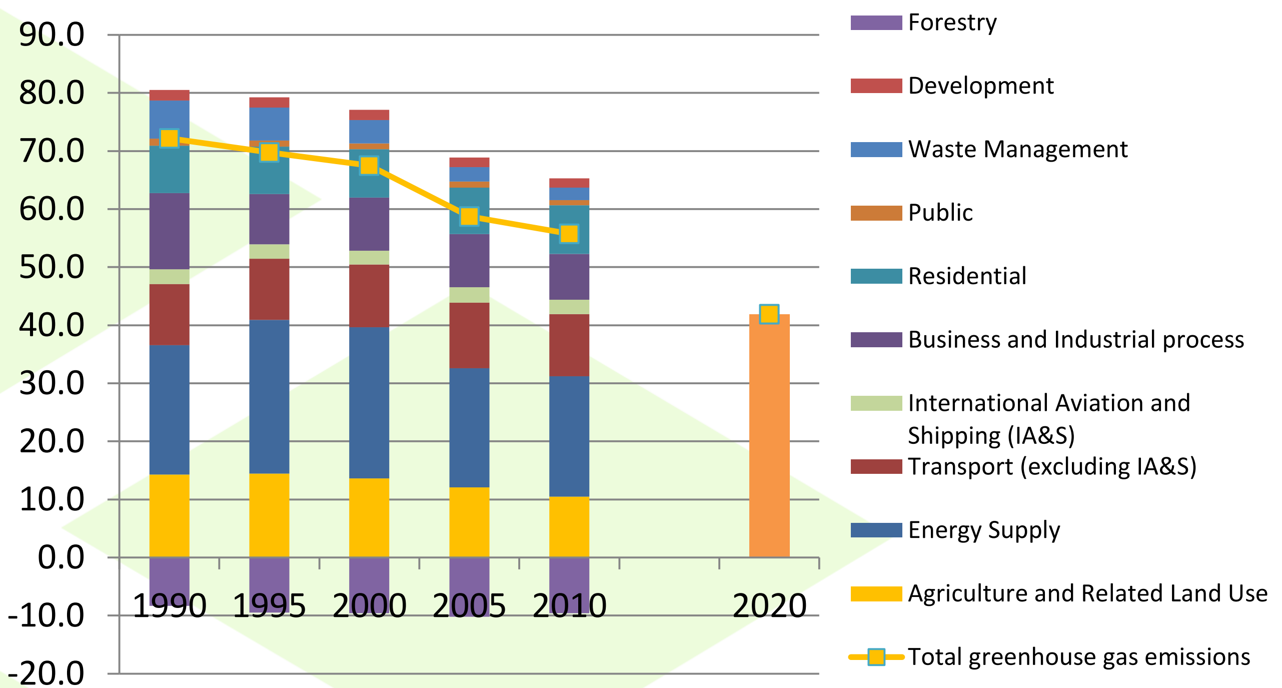
Background

- GHG emissions – one of the challenges faced by farmers
- UK committed to reduce GHG emission by 80% by 2050 (from 1990 levels)





GHG targets in Scotland



Aim:
-42%

So far:
-23%

‘Farming for a Better Climate’

- cost effective practices to make farms more energy efficient
- Agricultural Resource Efficiency calculator (AgRE calc)

Mitigations

- Mitigation options
  - feed additives, feed rationing, genetic improvement, anaerobic digester, sexed semen, soil management, milking, manure management etc.
- Optimal option – based on farm types
- Balancing act between cost effectiveness and GHG emission

Dairy

- Concentrated to the south of Scotland
- Among the most efficient and profitable sector
- Data – Scottish National Farm Survey data (FAS)
  - Farm level data from 55 specialist dairy farms
  - Farms are further grouped based on size and characteristics – medium and large dairy farms

	Grass land	Arable land	Rough grazing	Family labour	Dairy herd	Milk yield	Var costs	Milk price	Stock rate	SFP pay
Dairy medium	99.5	11.7	12.1	2.1	150	6735	205.3	0.23	1.3	383.8
Dairy large	227.9	0	88.7	2.3	300	5657	206.8	0.24	1.16	423.5

Models used

- ScotFarm
  - a farm level optimising model
  - optimises farm profits within limiting farm resources such as land, feed and labour
  - consisting a number of modules linked together
    - Dairy, crop, feed and labour
  - Time frame – 15 years
    - activities, decisions taken in a year are based on those taken in the previous year

Mitigation options

Four GHG mitigation scenarios were used;

- Sexed semen
  - decreases proportion of cows for insemination from 70% to 40%
  - decrease the number of ‘by-product’ male calves
- Anaerobic digester
  - an anaerobic digester installed to digest manure collected during in-house period (2-3 months)
  - the installation generates both heat and electricity
- Fat additive in feed
  - 3% linseed added
  - only fed to the in-house cows (2-3 months)
- High clover swards
  - 20% white clover-grass mix
  - constant yield assumed
  - decrease in fertiliser use (50kg N/ha *vs* 190 kgN/ha)

Economics behind scenarios

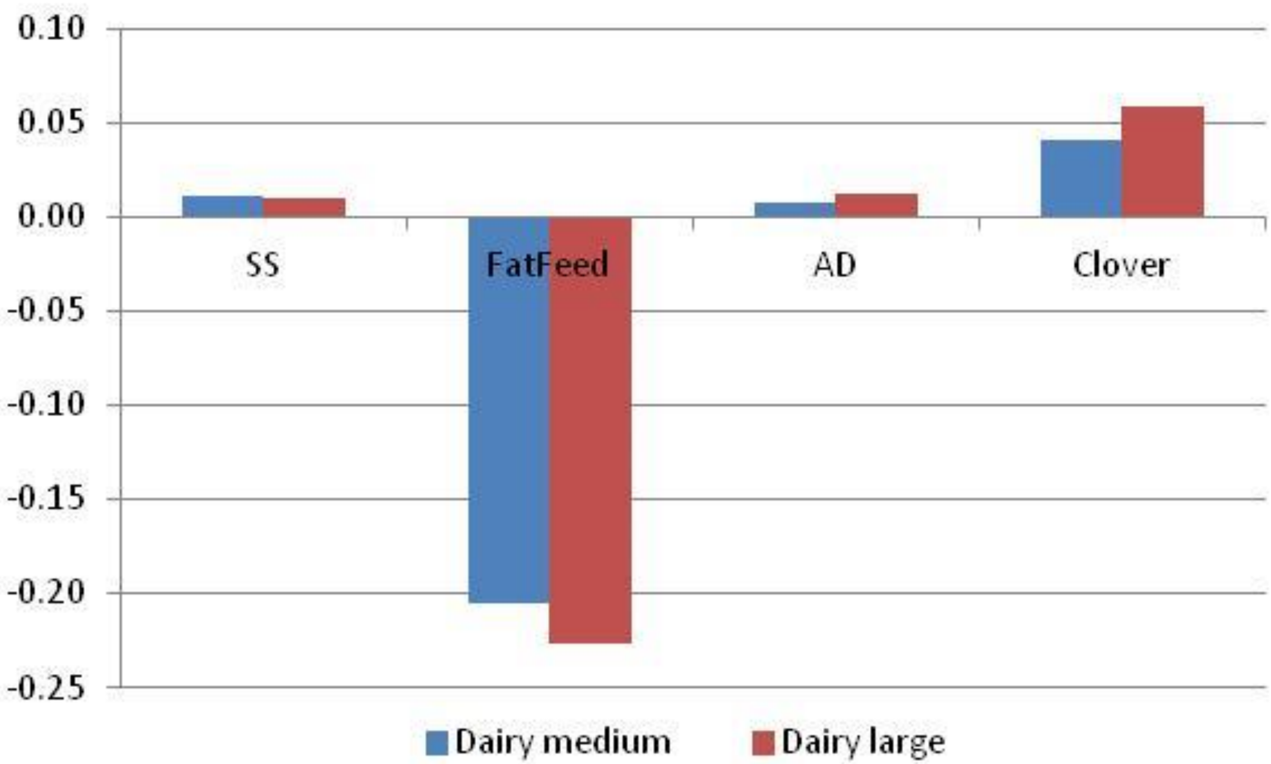
- Sexed semen
  - increase in variable costs by *£10/straw*
  - double the revenue from high value crossbred calves
- Anaerobic digester
  - Initial investment cost (based on capacity ≈ $C = -0.939 lnX + 3.1714$
  - Operational cost
  - Savings from generating electricity *@ £0.10/kWh* and heat *@ £ 0.05/kWh*
- High clover swards
  - Reduced synthetic fertiliser *@£238/t*
  - Increased seed costs *@ £10/kg seed (4 kg /ha)*
- Fat in feed
  - Added cracked linseed *@ £430/t* in the feed

GHG savings under scenarios

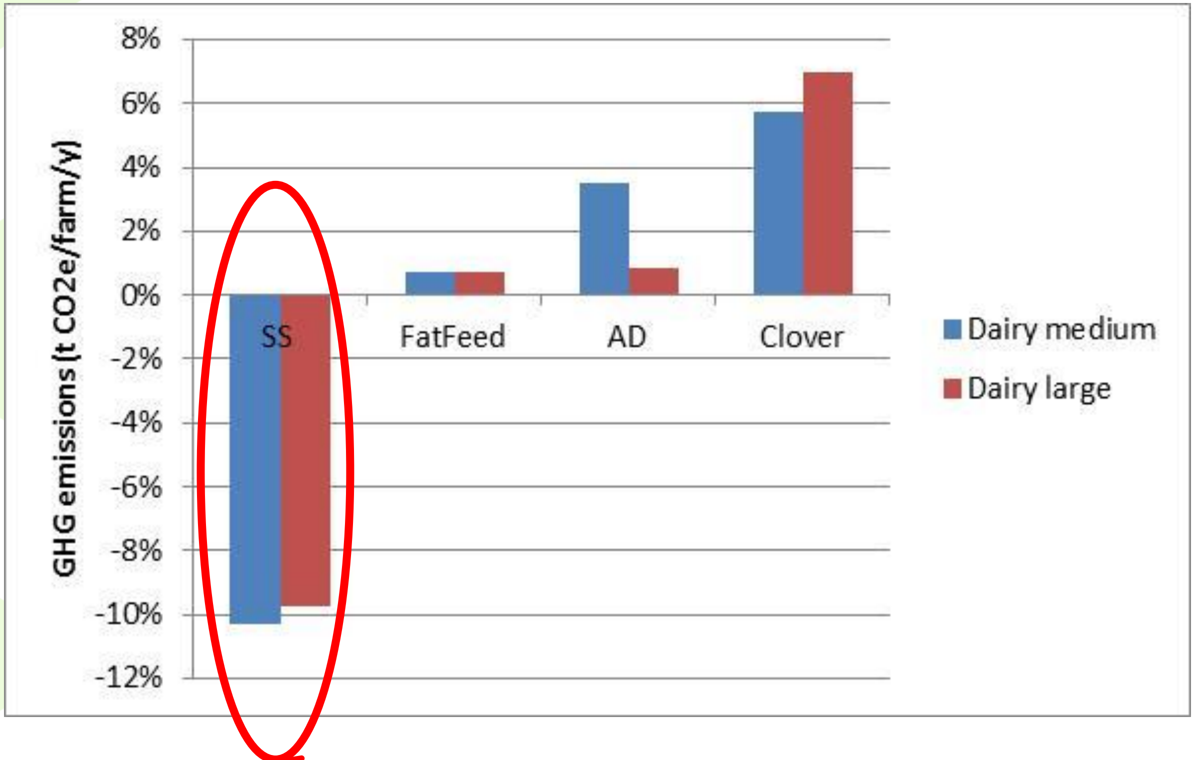
- Sexed semen
  - reduced ‘by-product’ dairy male calves
  - Increase cross bred beef calves which have higher emission index
- Anaerobic digester
  - reduced CH_4 emissions, GHG emission replaced by electricity and heat, increased CO_2 emission
- Fat in feed
  - the GHG emission savings due to reduced enteric CH_4 production ≈ $Y = 24.65 - 0.103X$
- High clover sward
  - reduction in direct and indirect soil N_2O emission

Results - economics

Change in farm profits



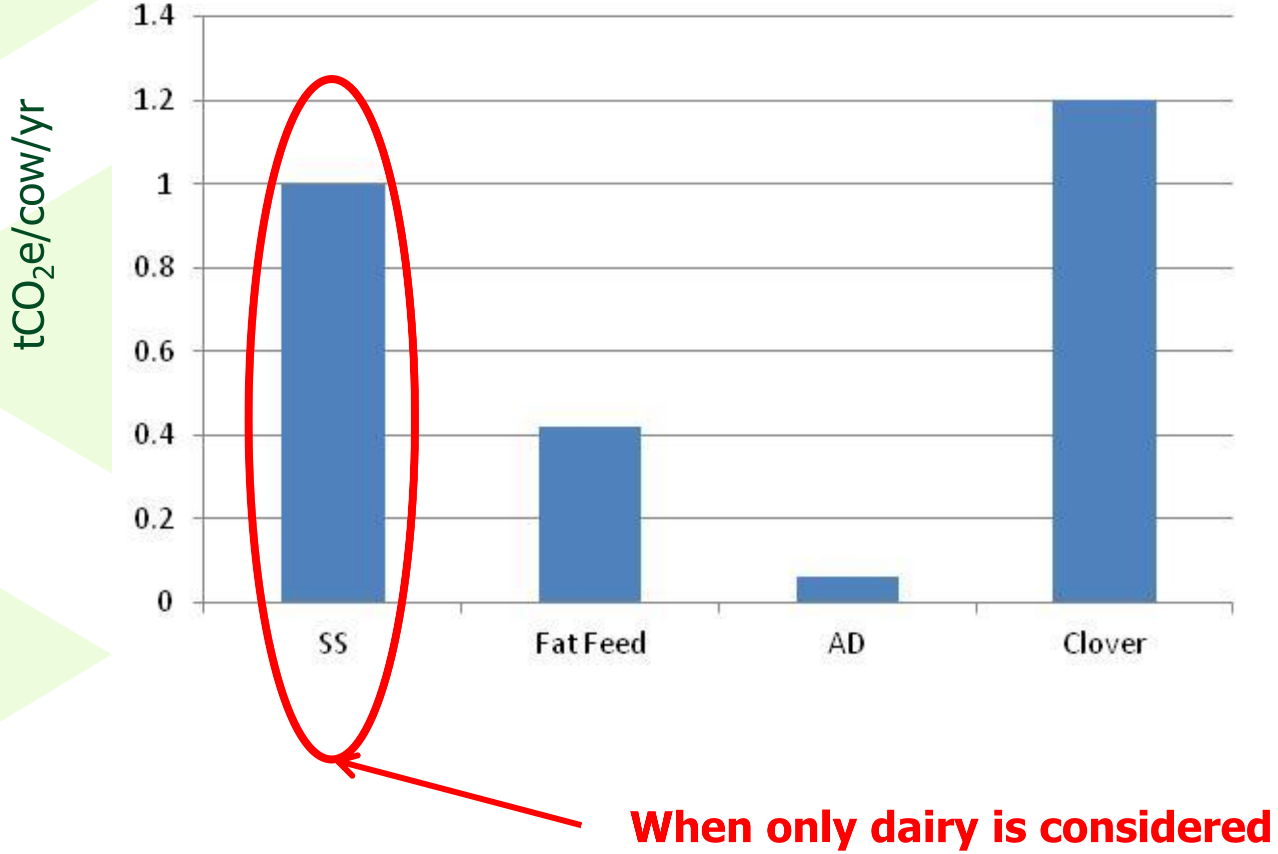
Results – GHG emissions



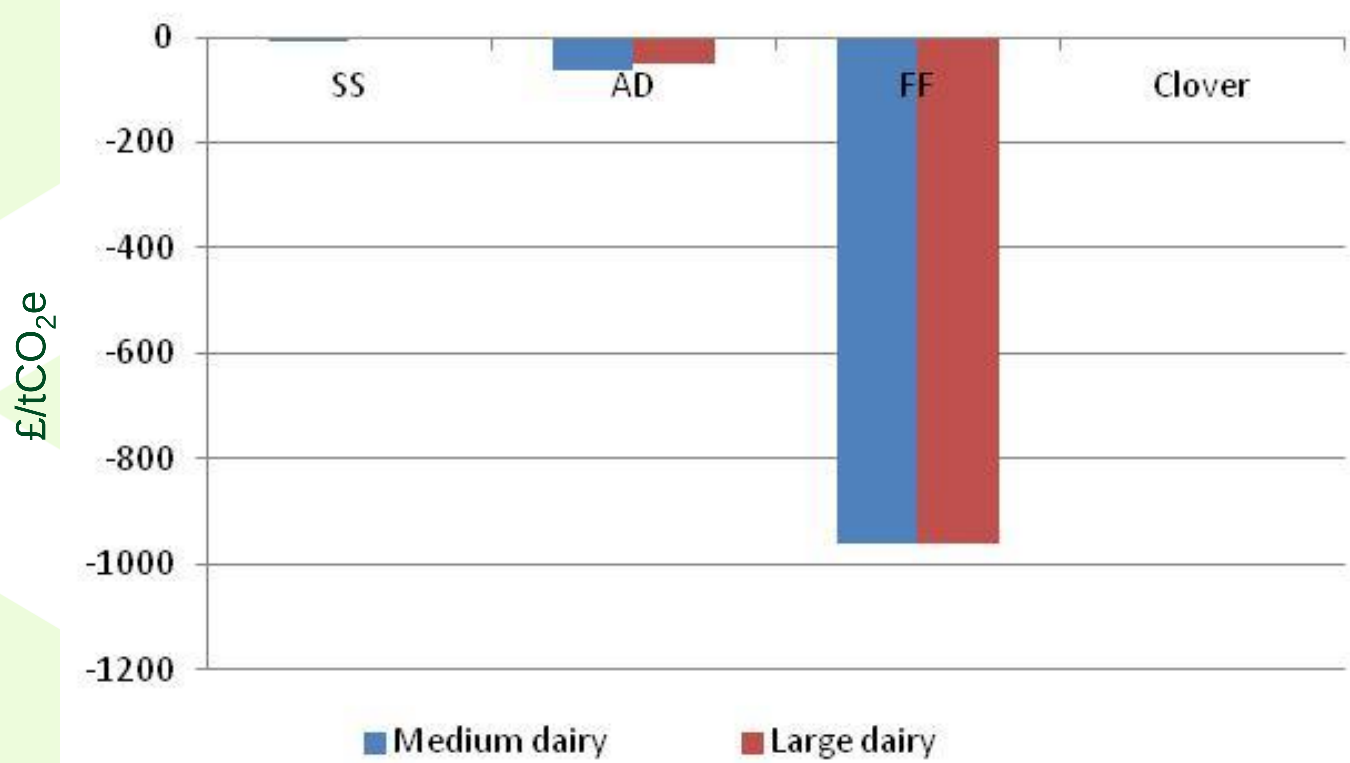
Life cycle assessment included

Results – GHG emissions

GHG emissions savings

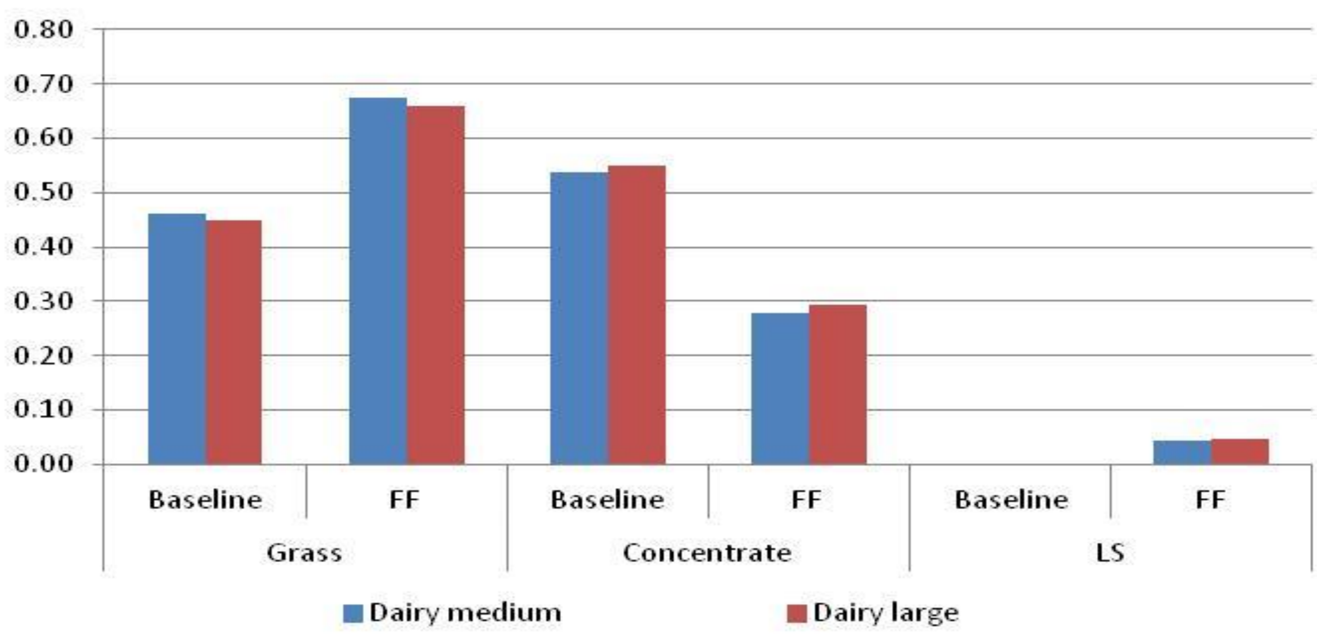


Results – cost effectiveness



Results - farms' responses

Changes in feed ration



Only manifested in Fat in feed scenario.

Feed pattern changed forcefully as 3% of relatively expensive fat additive is used in feed

Farmers decreased animal number by up to 26% to reduce costs of production

Conclusions

- Cost of effectiveness is a useful way to compare different mitigation options.
- Farmers make better decisions when impact on farm profits along with the GHG emissions are provided.
- Including clover in grassland is the most cost effective measure among 4 studied measures.
- Life cycle assessment needs to be included in these types of studies to wider impacts