Methane Abatement Options for the Dairy Industry

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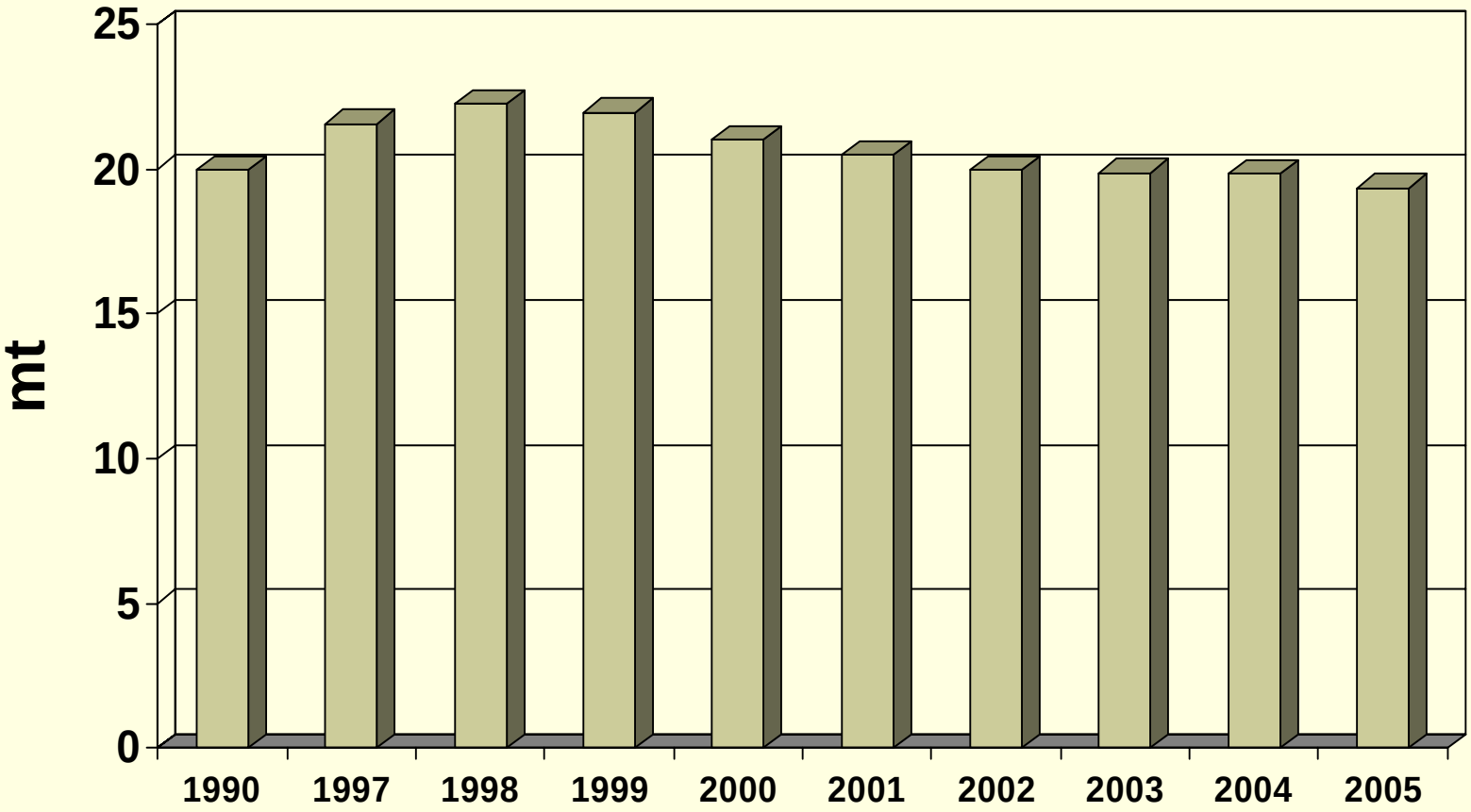
Moorepark

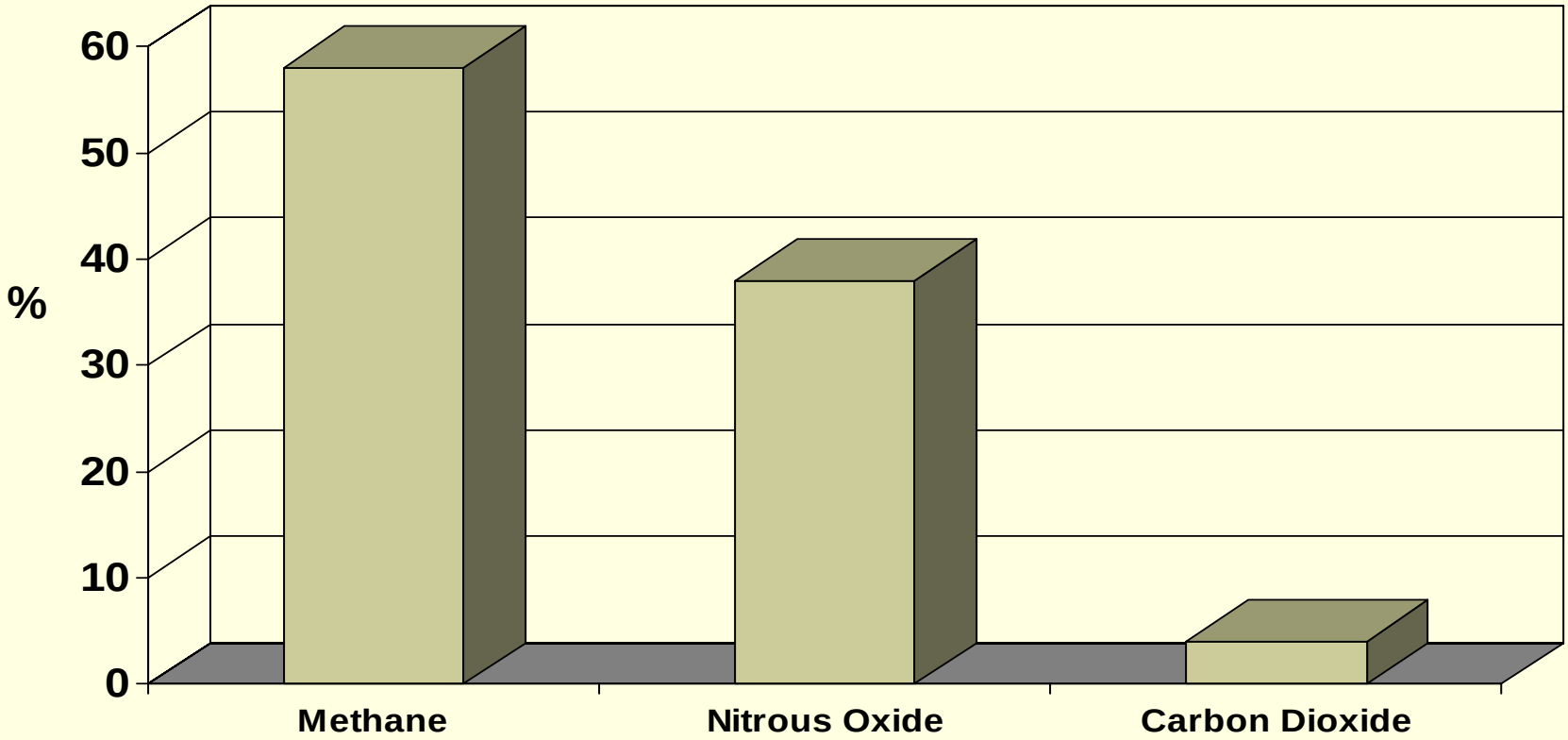
26th March '08

Emissions of CO_2 equivalents from the Agriculture, Forestry and Fishing Sector



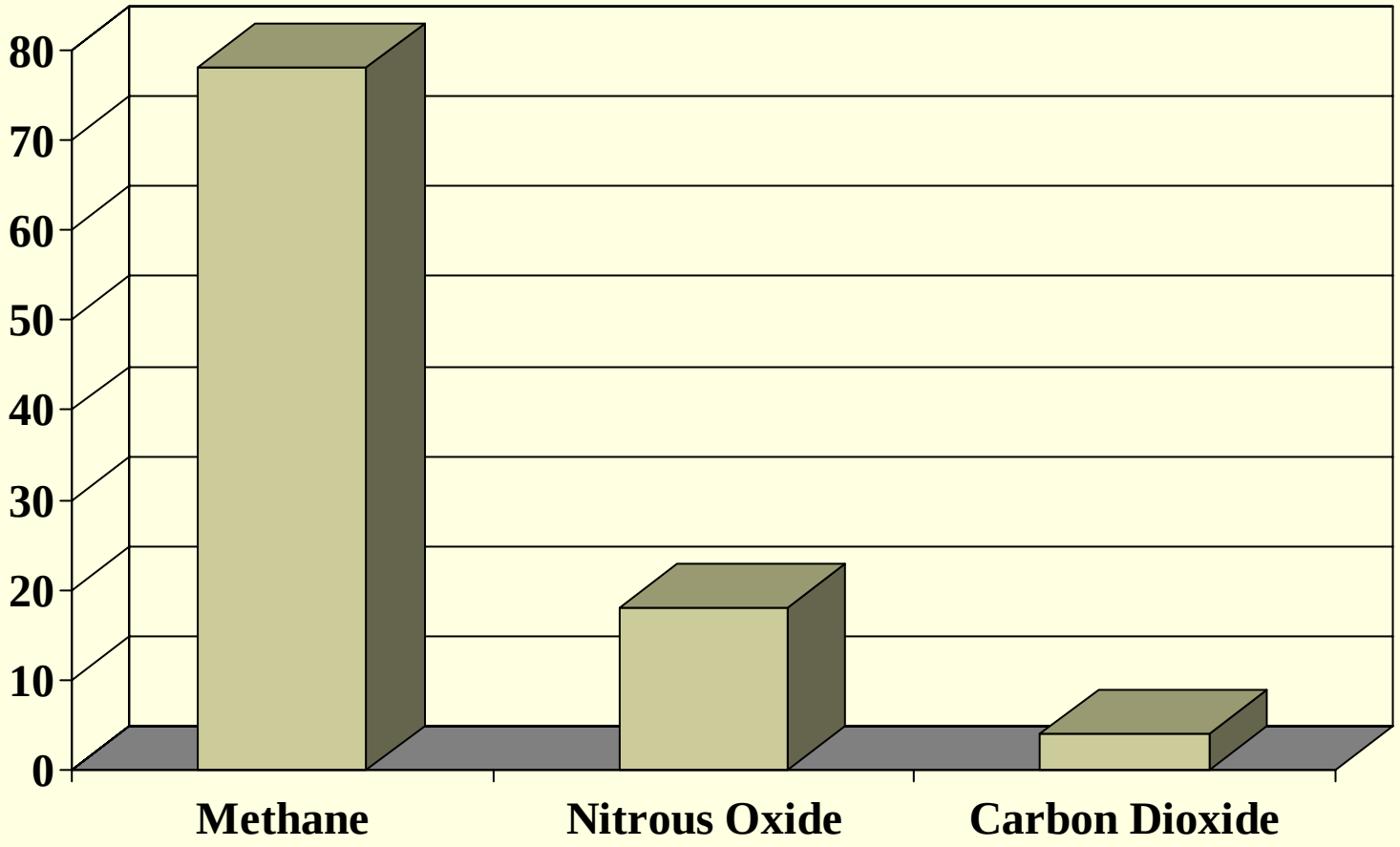
CSO 2007

Percentage of emissions as CH_4, N_2O and CO_2 (in CO_2 equivalents) in the Agriculture, Forestry and Fisheries sector in Ireland in 2005



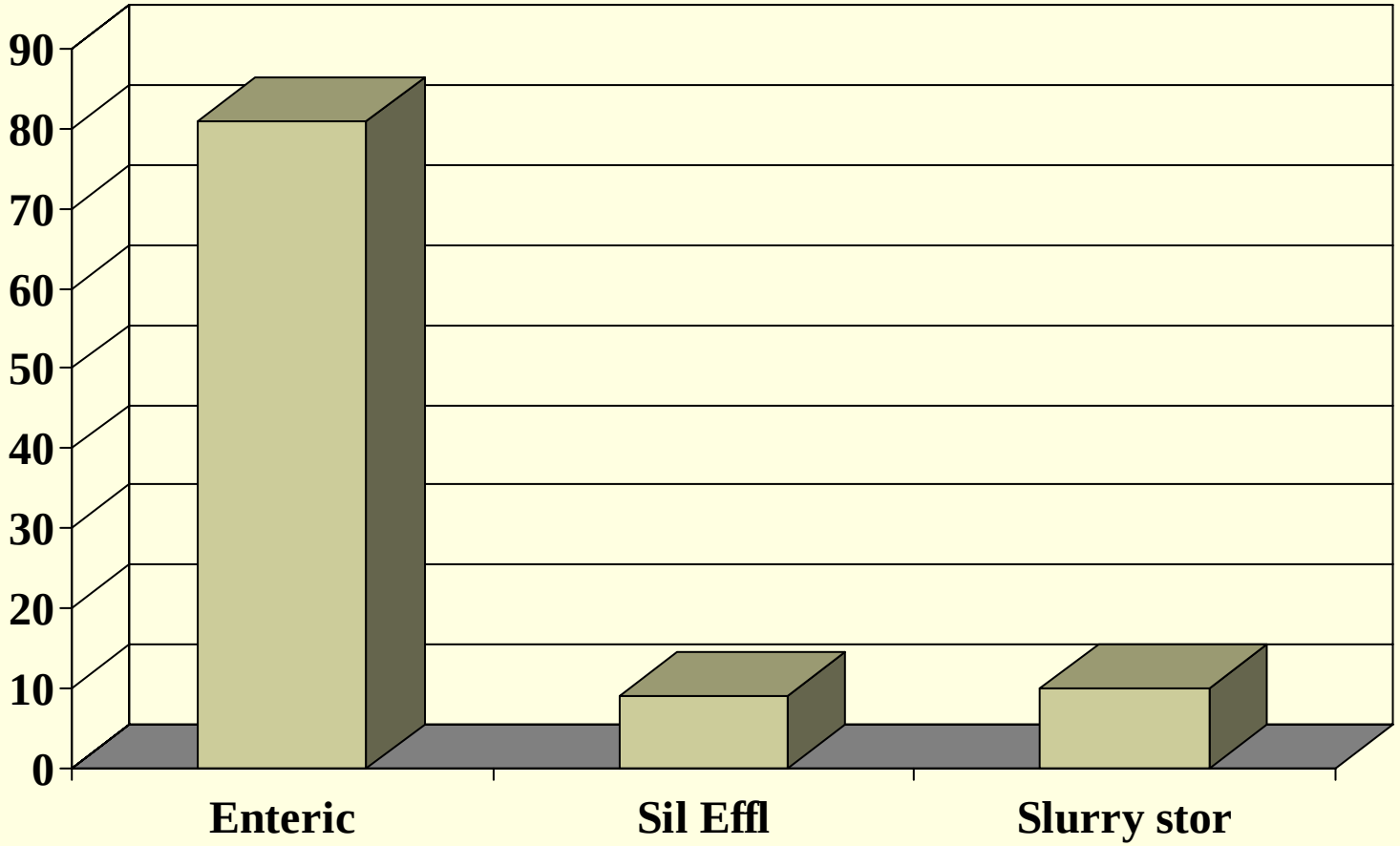
CSO 2007

Percentage of on-farm GHG emissions as CH_4, N_2O and CO_2 in milk production



Lovett et al. 2008

Percentage of on-farm CH_4 emissions from different sources in milk production



Lovett et al. 2008

Abatement strategies for decreasing CH_4 emissions from dairying

1. Increasing the length of the grazing season
2. Increasing genetic merit
3. Improving pasture digestibility
4. Feeding oils
5. Replacing roughage with concentrates
6. Increasing clover in swards
7. Replacing grass silage with maize/whole crop cereal silage
8. Other supplementary factors

Increasing the length of the grazing season

Grazing Days	250	149
CH_4 emissions/cow per year (t CO_2 equiv.)		
Enteric	2.96	3.07
Silage Effluent	0.33	0.63
Slurry Storage	0.38	0.55
Total	3.67	4.25

Overall reduction of 0.17% in CO_2 equivalents on-farm per one day increase in grazing season length. A 70 day increase in grazing would result in ~12% decrease in GHG emissions and ~€9500 greater profit (for a 50 cow herd)

Lovett et al. 2008

Increasing genetic merit

- Decreases CH_4 production per kg of milk in a quota scenario because

  (a) less cows required to produce the quota

  (b) less replacements required
- If quotas are relaxed cow numbers will increase but the better fertility will mean that eventually less replacements will be required to expand or maintain a particular size of national herd and CH_4 production per kg of milk will be less for a higher genetic merit cow
- Therefore the strategy will still have value in reducing the magnitude of the absolute increase in methane output from the national dairy herd
- A profitable strategy for dairy farmers

Improving pasture quality

- Theoretically it should reduce enteric CH_4 production because of a less fibrous forage resulting in a more propionate type rumen fermentation
- Data so far are ambiguous
- Lovett et al. 2008 indicated a 2% reduction in on-farm GHG emissions due to an improvement of +0.05 UFL/kg in pasture

Feeding oils

- Based on the equation of Beauchemin et al. 2008 (CH_4 reduction % = 4.79 added fat % + 4.4) feeding 4 % oil in the diet would decrease enteric methane output per cow per day by 23%
- Effects may be due to a reduction in rumen protozoa, reduced fibre digestion, reduced intake, and H_2 use for saturation of unsaturated fatty acids
- A number of questions arise
  - (a) Does the effect persist over a full lactation?
  - (b) What are the effects on cow performance?
  - (c) Is type of oil important – milk composition?
  - (d) Is it a profitable strategy?

Replacing roughage with concentrates

Increased concentrate supplementation has been shown to decrease enteric CH4 production - results in a greater proportion of propionate in rumen VFA and therefore less H_2 for CH_4 synthesis

Concentrates (kg/cow per year)	**736**	**1403**
Kg CO_2 equiv./kg of milk	0.759	0.714
t CO_2 equiv./cow	5.79	5.86

Lovett et al. 2006

Increasing clover in swards

- Legume based forages compared to grasses reduce enteric CH_4 production per unit of DMI possibly because of lower fibre and faster rate of passage
- In particular legumes containing high concentrations of condensed tannins have been shown to reduce enteric CH_4 production
- Need further data
  - (a) Do they reduce diet digestibility?
  - (b) What proportion of the forage mixture should they constitute to be effective?

Replacing grass silage with maize/whole crop cereal silage

- In theory this strategy should reduce enteric CH_4 because of greater starch intake resulting in greater propionate production, and a faster rate of passage (less fermentation in the rumen)
- Absence of data with direct comparisons of enteric CH_4 production on grass silage and maize or whole crop cereal silages
- This strategy may be limited by other negative environmental impacts

Other supplementary factors with potential to decrease enteric CH_4

- Fumaric and Malic acid (substrates for succinate/propionate)
- Saponins (reduce protozoa)
- Enzymes (improve fibre digestibility)
- Yeast (?)
- Ionophores (antibacterial effects shifting fermentation towards propionate)

New Research Project - RSF 07 517

Mitigation strategies for methane emissions by dairy cows in Irish milk production systems

- Teagasc Moorepark
- Teagasc Grange
- UCD School of AFSVM
- UCD School of BES
- AFBI Hillsborough

Grant Aided by The Department of Agriculture, Fisheries and Food

Objectives of RSF 07 517

1. Develop and quantify CH_4 abatement strategies for dairying based on
   (a) evaluations of a range of indoor diets (using already collected respiration chamber data)
   (b) improving the digestibility of grazed grass
   (c) offering total mixed ration (TMR) diets or buffering pasture based diets with TMR
   (d) supplementing with different oil supplements at pasture
   (e) evaluations of different breeds and cow genetic merits
2. Relate the rumen microbial community to enteric CH_4 production
3. Model the effect of these strategies in a life cycle assessment of total GHG fluxes in a pastoral milk production system
4. Provide the relevant data to allow adjustment of national GHG inventories

Conclusions

- There are strategies available that will decrease CH_4 and total GHG emissions in a quota situation
- Those that simultaneously increase technical efficiency of milk production, farm profit and GHG reductions are most likely to be adopted
- In a non quota scenario it is likely that increasing cow numbers will increase total GHG emissions from the dairy sector but the abatement strategies discussed will reduce the magnitude of the increase
- Much further research is required to completely understand enteric CH_4 production and quantify the effects of dietary and management interventions on CH_4 and total GHG emissions
- This research is being undertaken both internationally and nationally at present

Tasks in RSF 07 517

1. Build capacity to undertake CH_4 emissions in Teagasc Moorepark
2. Assess CH_4 production from different grasses and legumes using *in-vitro* gas production and Rusitec
3. Relate Microbial community composition in the rumen of dairy cows and CH_4 production
4. Quantify the effect of grass quality on methane emissions
5. Quantify methane production on PMR and TMR diets

Tasks in RSF 07 517 contd.

6. Quantify and understand variations in CH_4 emissions within different breed and genetic merit dairy cows
7. Quantify the CH_4 mitigation potential of different oils fed to dairy cows
8. Develop prediction models for CH_4 emissions indoors from already collected respiration chamber data and validate the SF6 technique in comparison to respiration chamber measurements
9. Develop and apply a systems approach/lifecycle model to quantify GHG emissions from the total pastoral dairy production system
10. Disseminate results

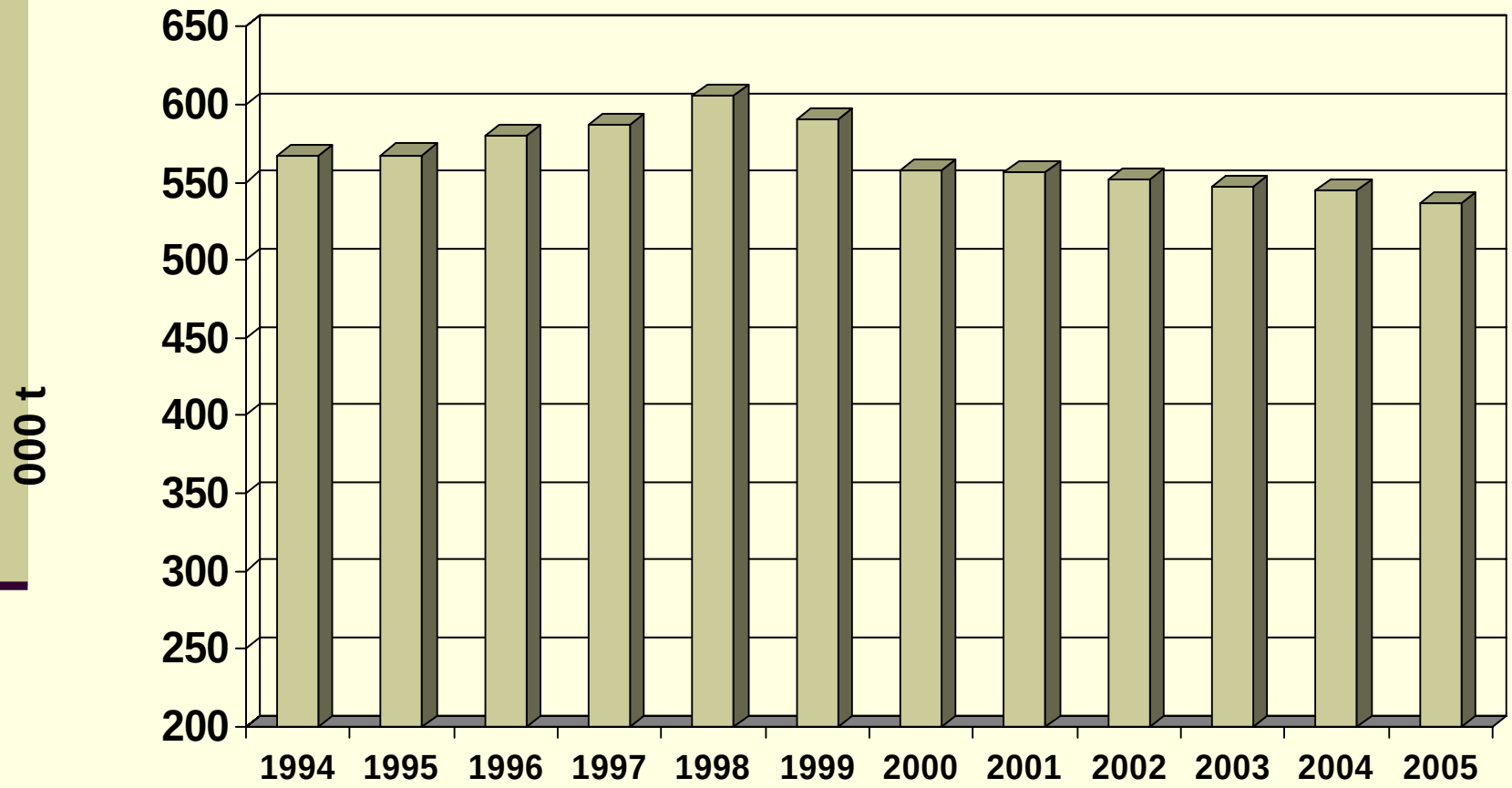
Staff in RSF 07 517

Permanent scientists	16
Temporary scientists	8
Permanent technicians	4
Temporary technicians	1
PhD students	5

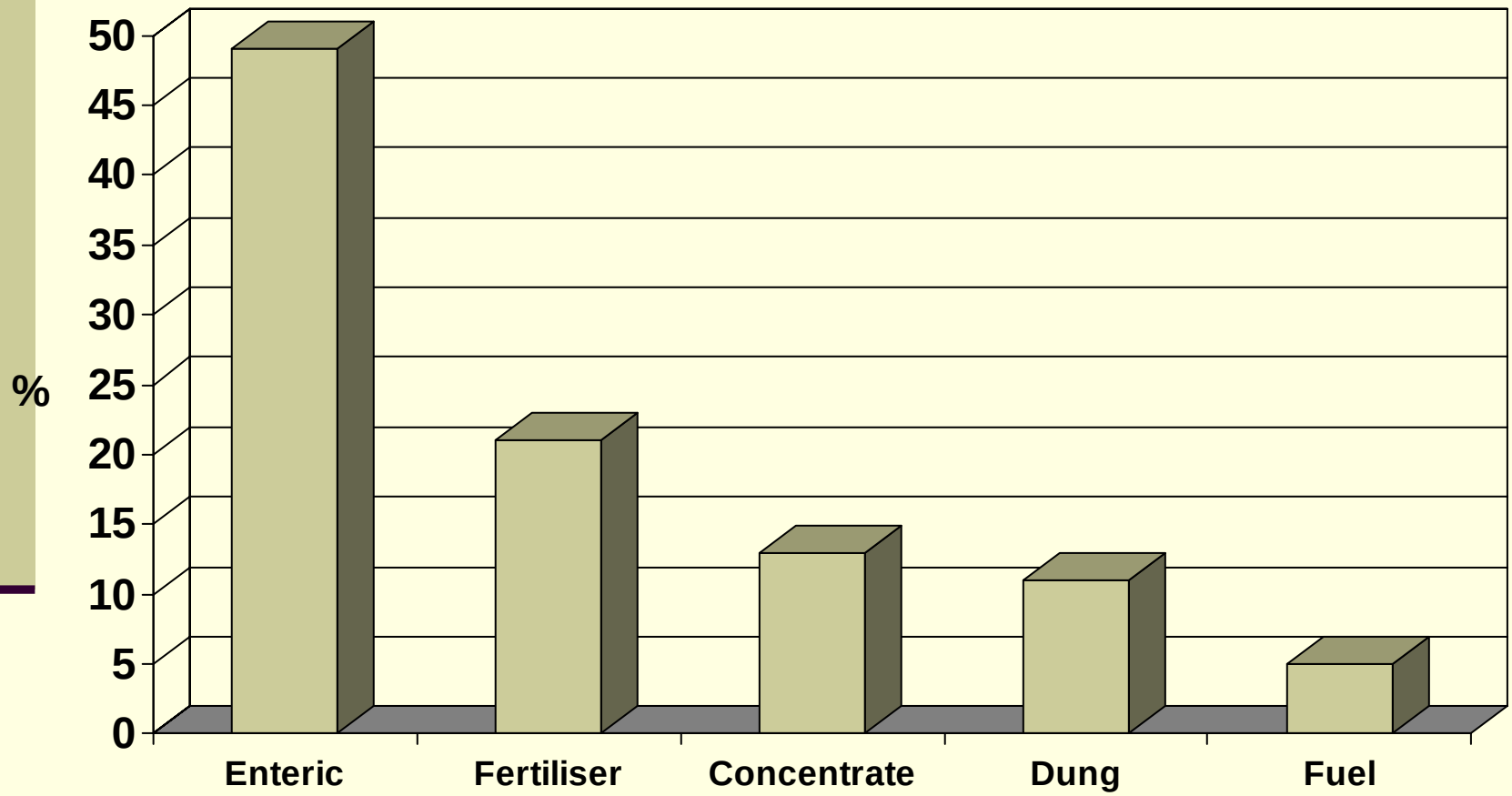
Grant Allocation – RSF 07 517

Institution	Grant (€)
Teagasc Moorepark	503,322
Teagasc Grange	212,050
UCD School of AFSVM	203,599
UCD School of BES	234,189
AFBI Hillsborough	209,580

CH_4 Emissions from the Agriculture, Forestry and Fishing Sector

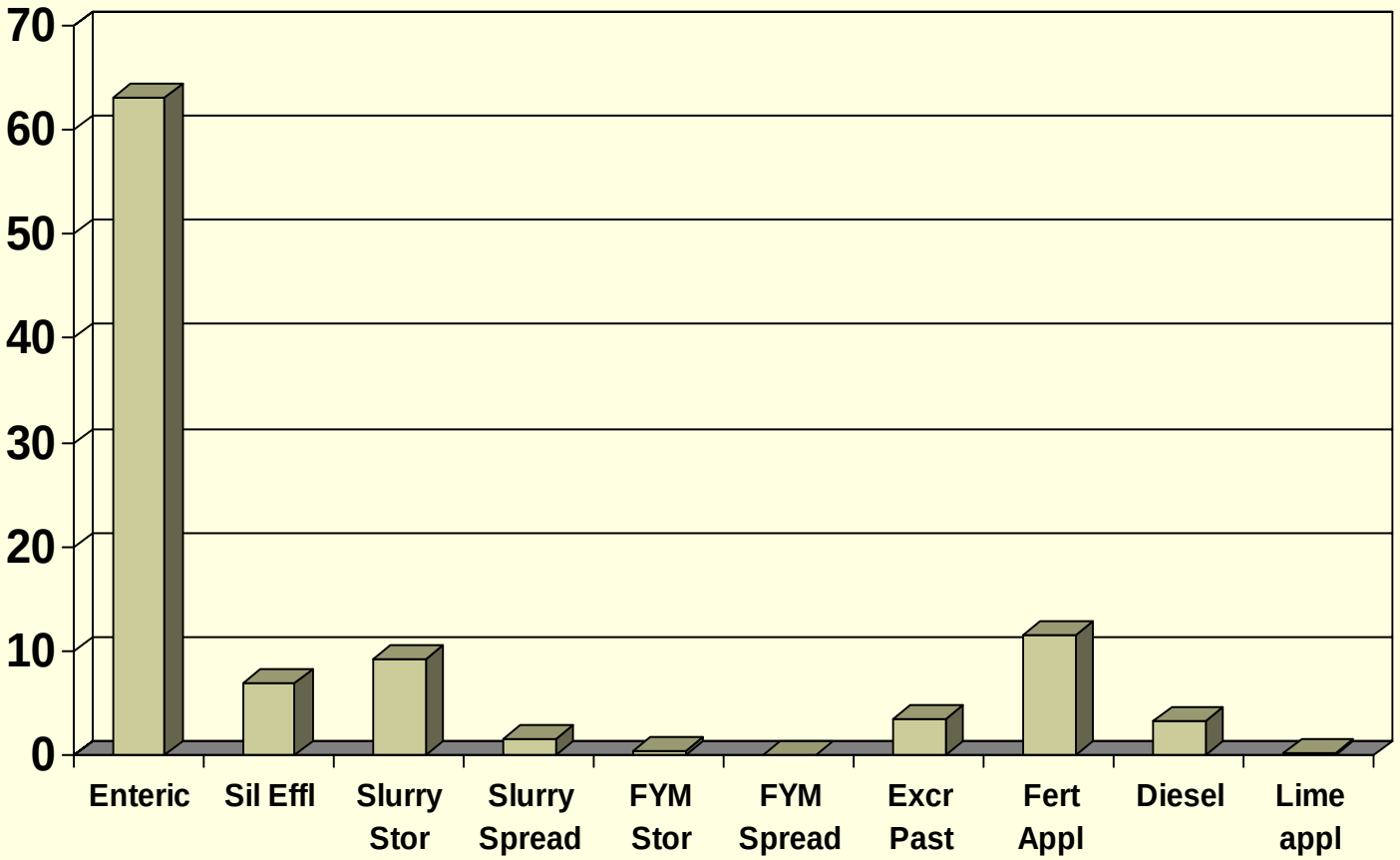


Emissions of CO_2 equivalents in a Dairy System



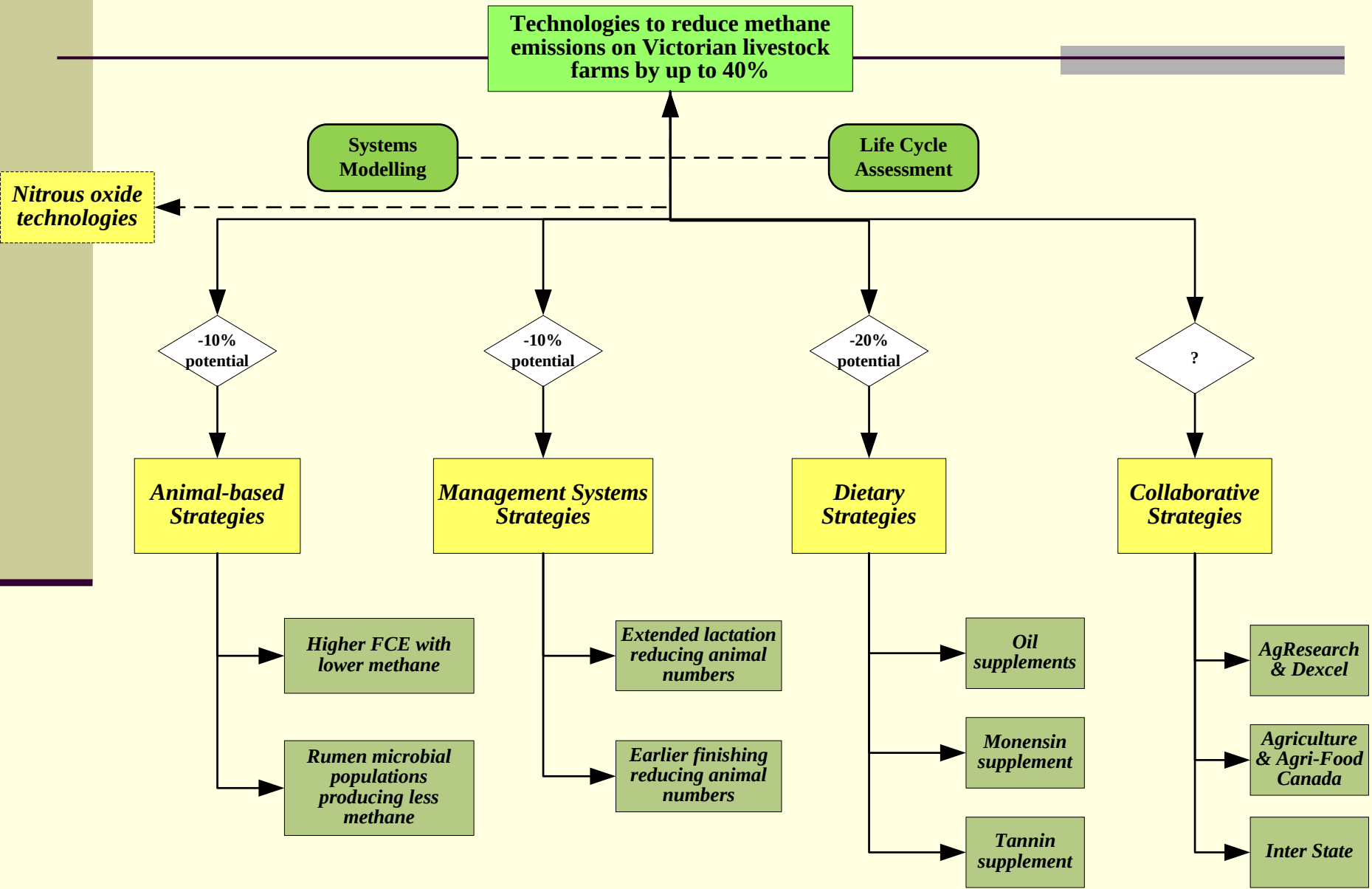
Casey and Holden 2005

Percentage of on-farm GHG emissions from different sources in milk production



Lovett et al. 2006

Framework for Research (source C. Grainger)



RSF 07 517

Mitigation strategies for methane emissions by dairy cows in Irish milk production systems

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Scope of RSF 07 517 Project

- Duration – December 2007 to November 2011
- Five collaborating research sites
- Ten tasks
- Overall Grant from DAFF of €1.36 m