Greenhouse gas emissions and the livestock sector: exploring the complexities

BRASS Seminar

27th October 2005

This presentation

Looks at the relationship between meat & greenhouse gas emissions

1. Quick review of what's been said about meat and GHG emissions so far
2. A new way of looking at the issue, taking into account :
   - ❖ Complexities associated with quantifying emissions (inputs & outputs)
   - ❖ Complexities associated with examining mitigation options

What's been said about meat?

- Energy inefficient way of eating
- Generates significant CO_2, CH_4 & N_2O
- Land for animals / feed could be used for other purposes

- Some numbers…

Some numbers

- UNEP : livestock 5-10% anthrop. GHGS
- Agriculture = 10% EU25 GHG emissions
  - ❖of which livestock 52% ie.5% (EEA)
- EIPRO: EU meat and dairy = 13.5% GHG emissions (along whole chain)
- Dutch study: meat & dairy 51% food GHGs
- Inefficient use of inputs? Conversion:
  - ❖7kg grain – 1kg beef
  - ❖4 kg grain – 1kg pork
  - ❖2kg grain – 1kg poultry

But…

- Studies only look at meat & milk (ie. not leather, oleochemicals, tallows etc)
- Generally don’t acknowledge some of the environmental benefits (ie. avoided emissions) of livestock production
- The boundaries of the analyses sometimes don’t go far enough (more benefits, more costs)
- Tend not to look at the ‘what if?’ factor (more later)

And quantifying emissions is hard because:

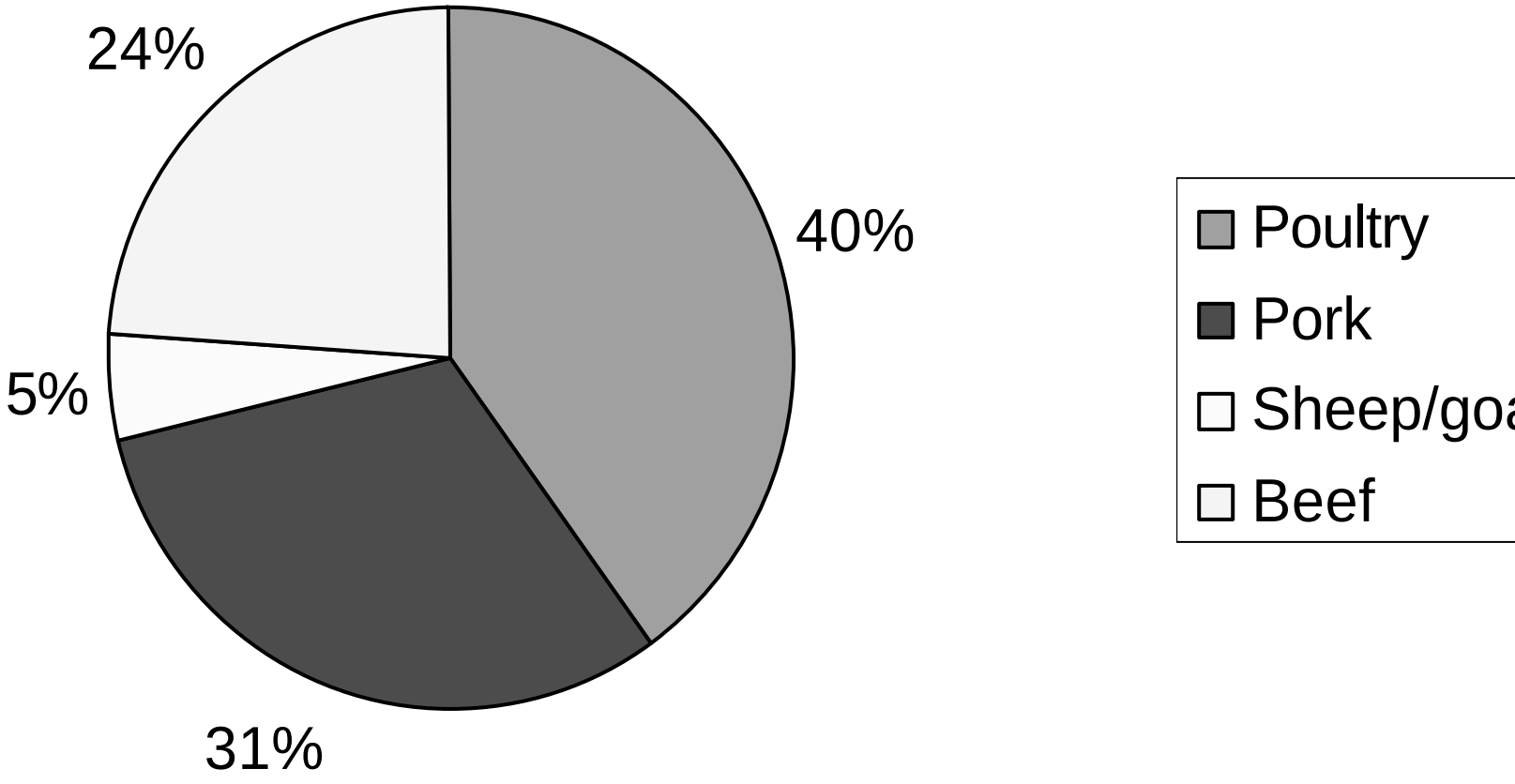
- Of the variability of what goes INTO the system (creating benefits & disbenefits)
- Of the variability of what comes OUT OF the system (gains & costs

Trends

- Global meat demand to rise 55% 1997-2020
- Equates to 119 million tonnes
- Most demand from China
- Milk: projected to grow 30% 2002-2030
- UK and Europe – slower c.15% 1997-2020
- Impact of CAP? Esp. on beef and dairy?

Global increase in meat demand 1997-2020

Source: IFPRI Impact projections June 2001



Purpose of this research

What is the optimum level of meat production & consumption?

Can we define a level of livestock production & consumption at and below which the environmental benefits of livestock production & consumption (defined in terms of GHG emission avoidance) outweigh the environmental disbenefits from livestock production and consumption, also defined in terms of GHG avoidance?

Can a balance be struck?

Limits of analysis

- **EARLY STAGES OF WORK IN PROGRESS!**

- Mainly cows – will look at others too
- UK focus so far – need to take global focus
- Livestock rearing stage only. Omits:
  - ❖ Slaughtering and processing (although some discussion)
  - ❖ Transport and distribution
  - ❖ Cold storage
  - ❖ Retail
  - ❖ Home consumption
  - ❖ Waste

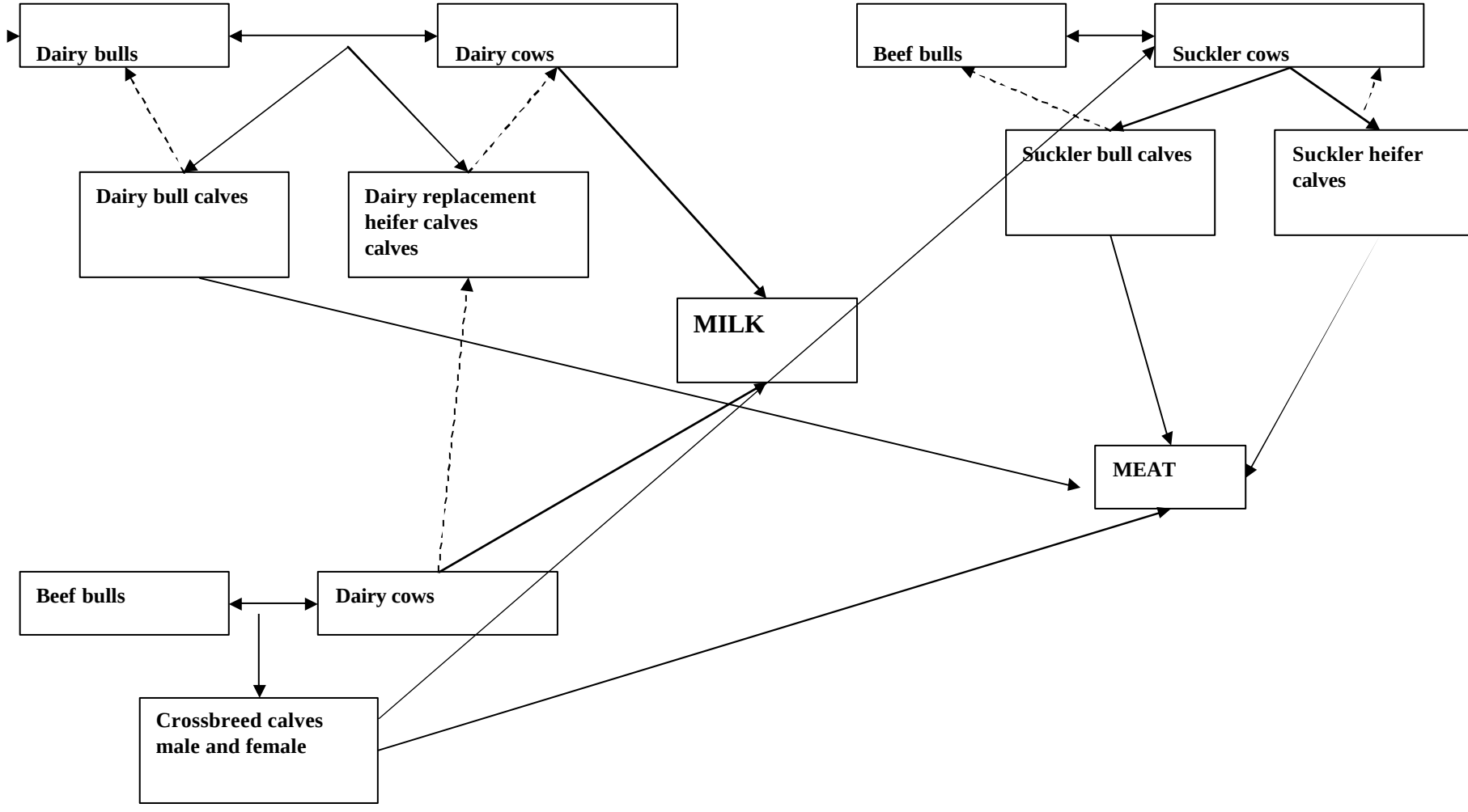
- **INPUTS SOUGHT & WELCOMED**

	LIFE STAGE	PROCESS CREATING EMISSION	TYPE OF EMISSIO
1	**Production of animal feed; silage production; grassland maintenance**	Production of nitrate fertilisers; agricultural machinery;	CO_2; N_20 emissions from grazing land and fodder crops
2	**Animal housing and maintenance; associated machinery**	Heating, lighting (milking), etc	CO_2 , N_2O from housing and pasture
3	**Digestion**	Enteric fermentation; manure production	CH_4, N_20
4	**Slaughtering, processing,**	Machinery, cooking, cooling, lighting, leather and wool production, rendering	CO_2 and ?
5	**Transport, storage**	Transport, cooling, lighting	CO_2
6	**Domestic consumption**	Cooling and cooking	CO_2
7	**Waste disposal**	Transport	CO_2 & methane

The inputs

- Cereals (plus embedded emissions)
- Oilseeds (ditto)
- Grass / silage (ditto)
- Byproducts (ditto)
- But the UK dairy and cattle system is complex…..

Different systems have different feed inputs



Cereals

- UK Livestock consume 42% cereals
  - ❖ Ruminants 1/3 of this = 14% total
- Global: around a third total cereal production
- Issues: Embedded GHG
  - ❖ Fertiliser manufacture and embedded energy
  - ❖ Inefficient feed – food conversion factors
- Issue:Can we feed animals and people?
  - ❖ But: are all cereal harvests useable for humans?
- Issue: Could we use the cereals for biofuels?

- On the other hand …more cereal feed inputs = better livestock nutrition = more milk/meat per burp = less CH_4

Oilseeds (focus: soy)

- Is soy oil a ‘byproduct?’ NO.
  - 20kg oil:80kg cake
  - $ value: 1/3 oil : 2/3 cake
- Demand for cake drives growth in soy oil.
- GHG impacts:
  - Energy use in cultivation, processing etc.
  - Inefficient conversion of plant protein to animal protein
- Soy cultivation: land clearance: lost carbon sequestration (soy encroachment 4% legal Amazonia - underreporting)
- Push factor for further deforestation (cattle)
  - Brazilian beef 4% UK consumption
- How to quantify lost carbon sequestration?
- And yet: soy = excellent feed input = greater animal growth = more milk less methane.

Grass

- Grass/silage approx 60% ruminant diet (but huge variation)
- 76% agricultural N_2O from grazing land (sheep & cows)
- Also N_2O & CO_2 from fert manuf = total 1% UK GHG (for all crops not just animal related)
- But: on some land you can only grow grass
- Grazing & landscape preservation (not a GHG issue but…)
- Alternative land use (biofuels?)

Byproducts

- Egs: molasses cake, citrus pulp, brewing byproducts, husks
- Excellent use of products that would otherwise be wasted?
- 1993 study: byproducts could yield 80% world milk production
- BUT: oilcake included & oilcake doesn't count (see above)
- And: what about byproducts for biofuels?
- And: what about digestibility & methane?

The ‘what if?’ opportunity cost

If we didn’t use the land for cows / growing cow feed inputs could we:

- Grow vegetarian food (better energy conversion efficiencies)?
- Switch to more ‘efficient’ animal husbandry (better energy conversion ratios but chickens can’t eat grass)?
- Grow biofuel crops?
- Sequester carbon?

Summary: the inputs

- It’s complicated!
- Dedicated cereal / oilseed feeds = better fed animals & so more meat/milk per burp
- Dedicated cereals / fertilised land mean more energy & N_2O emissions
- Byproducts / grassland use foods/land that would not otherwise be waste / unusable but = more methane
- Some GHG impacts greater than studies suggest
- The what if? alternative land use factor

The outputs

- Nutrition (protein, calcium, iron)
- Leather (& wool)
- Rendered products (glues, soaps, lard…)
- Soil nutrients (manure)
- NB: other ‘outputs’ might include – landscape preservation, biodiversity maintenance etc etc. Not examined here

Questions

- What benefits do we gain from livestock?
- How much do we *need* these benefits (as opposed to want - are we overproducing them or not?)
- Might there be alternative ways of meeting our needs for these products & would greater or fewer GHGs emissions result?

Nutrition: key benefits

Key benefits:

- Protein
- Calcium
- Iron
- Fat
- (Vitamin B12)

- All of which we need to obtain one way or another to maintain a healthy population

Nutrient consumption UK

NUTRIENT	RECOMMENDED	AV. UK	DIFFERENCE
Protein g	Woman: 39-53.95 Man: 48-66.4	77.5g	20-50% surplus - no UK deficit
Iron mg	Woman: 14.8 Man: 8.7	11.1	Pop. variation
Calcium mg	700 – more for some	932	Pop. variation
Fat % energy	35% energy Satur. Fat 11%	Appr. 35% 13%	Sat. fat too high

Protein

- How much do we eat? More than needed
- >60% animal-origin / 30% ruminants
- Nearly 3 times global average
- Nearly 4 times developing world average
- If we were less fat we'd need less protein
  - ❖Protein requirements based on body weight
- NB: plant / animal food conversion factors better if looking at protein

Calcium

- Some debate around calcium, meat relationship & sources but basically:
- Milk = excellent source of calcium
- 55% calcium intake from animal products
- UK average OK but wide variation
- We can get calcium from elsewhere but harder
- In short – small quantities dairy helpful?

Iron

- Red meat best source (haem vs non-haem)
- 22% Fe from meat sources BUT better absorption & aids non-haem absorption
- Anaemia UK & global problem
- Meat iron not necessary but easier
- Veg/vegans not notably deficient
- In short - small quantities (red) meat helpful?

Fat

- Largest contribution 31% = oils & fats (incl. butter. And note link between meat and veg oils…)
- Meat contribution 23% total. Content varies dramatically:
  - ❖ Spam approx 80% energy from fat
  - ❖ Rump steak approx 35% - and 'good' fat
  - ❖ Grass-fed more 'good' fats
- Industry breeding leaner animals (less efficient conversion ratios)
- Trade-off? No more sausages = more waste = wasted GHG emissions. .

Nutritionally speaking -

- Meat not essential:
  - ❖Nutrients could be obtained from plant sources - GHG impacts? Less?
- In large quantities meat probably damaging (bec. of fat)
- But in small quantities probably beneficial

What if we listened to the WHO?

And ate within recommended fat, sugar and protein levels?

Big impact on livestock production

- Meat: pork down 16%; beef down 4%
- Veg oil down 30-35% (link with meat)
- Butter & cream down 35 & 25%
- Animal fat down by a third

Cereals more or less similar (more for humans, less for animals)

Leather

- How much do we produce?
- How much do we ‘need’ (vs mkt value)?
- What would be the ‘cost’ of producing alternatives?
- Is there an ‘optimum’ level of leather production?

Leather production

- Most raw leather produced in devD world
- Most finished leather/goods in devG world
- Leather value: 7-8% carcass value
- Environmental impacts (no LCAs found):
  - ❖Tanning / leather production
  - ❖Transport (international)
  - ❖Waste & effluents: 100kg hide = 20kg leather
  - ❖Hard to quantify UK emissions as most finished goods produced overseas

How much do we need?

- **Resilient breathable material vital**
- Leather fits description
- Arbitrary definition (mine…) of essential:
  - Shoes - yes
  - Car upholstery and sofas - no
- Shoewear = 56% leather production & share levelled off
- So 40% leather goods non-essential?
- So livestock reduction wouldn’t unshoe us

Alternatives?

- Alternative materials also GHG impact
- So leather production eliminates need to produce substitutes. ‘Offset’ against emissions?
- But substitutes greater or fewer GHG emissions?
- Optimum (environmental) leather production to meet ‘need’ not ‘demand.’

Rendered products

- 1.75 m t (1/3 animal waste) - byproducts :
- 250,000 tonnes fat
  - ❖ Uses: lard, soap, pet food, paints, tyres, oleochemicals
  - ❖ Some tallow burnt to fuel rendering process
  - ❖ 28% burnt as specific risk materials
- 400,000 tonnes of protein meal. Was fed to animals. Now:
  - ❖ Some burnt
  - ❖ Some used for cement
  - ❖ Rest landfilled – industry (environmental cost)
- 110,000 tonnes water

Rendering (2)

- Veg substitutes fats, soaps etc?
- LCA comparisons?
- Rendered products both GHG
  - ❖Benefit (avoid need to produce alternatives);
  - ❖And cost (effluents require energy to manage / dispose of)
- BSE has made a ‘byproduct’ into a scandal

Manure

- Source of fertiliser:
  - 22% global N
  - 38% global P
- BUT: also GHG contribution. Eg. UK:
  - All livestock manure = 0.32% all GHGs
  - Ruminant manure = 0.2% (approx) all GHGs

AND how much would we need to fertilise if we didn't grow crops to feed animals in the first place?

Manure: benefits & disbenefits

- Manure produces N_2O and (less) CH_4
- But manure offsets need for artificial fertiliser
- And livestock rearing useful part of crop rotation
- But some of fertiliser demand is for growing crops to feed animals
- And are there non livestock fertiliser alternatives?
- Can we find a way of quantifying this?

So how much meat is optimum?

- ???
- Less probably than now but how much less?
- Some probably better than none
- Trading off the ‘optimums’ (what might be good for leather might not be for protein or manure) – various ‘answers’
- Need to look at other ‘outputs’ eg. grazing, biodiversity & what would impacts be, defined in GHG emissions if no livestock

Mitigation options

- This is complex too!
- The intensive vs extensive debate:
  - Intensive: higher inputs & more outputs
  - Extensive: lower inputs & lower outputs
- Juggling the gases: relationship & importance
  - CO_2
  - N_2O
  - CH_4
- What can we do?

Intensive

- Intensive = optimise nutrition.
  - ❖More cereals, more soy / oilseeds / greener grass
- Produces milk / meat per burp
  - ❖Therefore less methane
- But more energy (CO_2)
  - ❖Although how significant is CO_2?
- And more N_2O
  - ❖But scope for more efficient uptake?
- Lower fertility / more illness = more resources ‘wasted’ on unproductive rearing
- More specific breeds / segregated functions – impacts?

vs Extensive

- More burp for your milk / meat
  - ❖Therefore more methane
- But less energy used / CO_2 emitted
- Fewer N inputs but what about N uptake/utilisation?
- Where land area is limited…
  - ❖Intensify livestock production and use freed land for biofuels? But what about land take for feed inputs…)

Juggling the gases

- What's the relative importance of the gases?
- One dairy study (CO_2e):
  - N_2O 49%
  - CH_4 42%
  - CO_2 9%
- Beef study: N_2O 60% & CH_4 25%
- Another study: 48-65% CH_4
- Results vary according to inputs and system
- These studies ↑ are straightforward LCAs (don't look at alternative poss land uses, soy deforestation)

Carbon dioxide

- Intensive systems more energy intensive than non-intensive
- Organic uses 2/3 of conventional

- But CO_2 not the main problem?

Methane

- CH_4 = 21 x more potent GHG than CO_2
- Less fed animals = more CH_4 per output
- Two cows producing 3500 l milk/yr each emit more CH_4 than one producing 7000 l
- Fibrous feeds (eg. byproducts)= more CH_4
  - ❖So while byproducts are less GHG intensive to produce…
  - ❖They generate more GHGs when consumed

Nitrous oxides

- N_2O = 310 x more potent GHG than CO_2
- More N inputs = more N outputs
- N inputs:
  - ❖ Protein from feeds (soy, grass, cereals etc)
  - ❖ Indirectly from fertilisers
- N outputs:
  - ❖ Protein from milk, meat,
  - ❖ N_2O in urine, faeces
- ❖ But too much N and not enough starch inhibits digestion = more CH_4 and more N_2O
- GOAL: maximise conversion of what's there into what's wanted & minimise what's not wanted

Is there a CH_4 – N_2O trade-off?

- Possibly … but complex
- Protein (Nitrogen) / starch (Carbon) balance critical
- Optimum N (in relation to C) optimises digestion:
  - Meaning less CH_4
  - Uptake of N into the bits you want = more milk / meat per feed input
  - Optimum = not too much.
  - Too much N is weed out.
- But less N might reduce grass digestibility → more CH4?
- In UK N_2O main problem; developG world CH_4?
- Are we fiddling while Rome burns….. ?

So what should we do?

- Change the feed
- Change the breed
- Change the life/fertility span
- Change the way we manage the outputs
- Change the numbers

- (Vaccines etc - not discussed here)

Change the feed

- High sugar grasses (Defra sponsored research)
- Less N-requiring wheat (ditto)
- The cow rumen is very complex…. Lots of variables
- Targeted feeding similar to ‘targeted’ functional foods for humans?
  - ❖ Ie. individualistic vs ‘greatest good for greatest numbers’ approach (see Lang & Heasman)
- Does this give you the most bang for your buck?

Change the breed

- ‘Genetic merit’ = capacity to produce milk
- But: high yielders die younger
- Studies looking at optimum balance between genetic merit & feed
- What’s good for milk isn’t good for meat – does specialisation lead to waste?

Change the life/fertility span

- High yielders die younger & are less fertile
- More replacement heifers need rearing
- Meaning more inputs ‘wasted’ in getting heifers to lactation stage
- Need to take whole herd approach
- Raising fertility to 1995 levels could reduce methane by 10-11%

Change output management

- Less effective than changing inputs but:
- Increased frequency of manure spreading
- Changing manure storage systems
- Production of biogas from manure

How far will these get you before…..

You have to start thinking about changing the numbers?

Reducing livestock production

- SIMPLER?
- Achieves results whether intensive or extensive
- If extensive systems you achieve:
  - ❖ Other environmental benefits
  - ❖ No land pressures – no need to increase area for livestock because absolute livestock numbers are reduced
  - ❖ More CH_4 per output milk/meat offset by fewer cows
- BUT New Zealand attempt ‘fart tax’ not popular
- Economically unacceptable
- The ‘inalienable right to rear’
- Although…is the CAP doing the job anyway?
- UK / EU is one thing - what about global trends?

(Other issues)

- All important but …
- …Climate change is the greatest long term challenge we face and so…
- … we need to frame these other issues within this one
- Can we find a way of giving these other environmental / social issues a GHG value?

Context for research

Food Climate Research Network

An interdisciplinary, intersectoral initiative set up to research & promote ways of achieving absolute reductions in GHG emissions from the whole UK food chain

Food Climate Research Network

Please join

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