Current estimates of the costs of spreading manure by reduced emission spreading techniques in the UK

J Webb (AEA), John Morgan and Brian Pain
(Creedy Associates)

Background to this presentation

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+ No new work has been carried out
+ the objective has been to make the 2009 cost calculations transparent in order to:
  - identify the major cost components
  - estimate how changes to these influence the final cost estimates
  - make comparisons with the estimates from other countries to understand reasons for variations within Europe
  - make comparison with output from GAINS

The basis of the methodology

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- A considerable element of the overall cost with most machine-based operations on farm is the running cost of the tractor pulling the implement
- hence, the annual running costs of a suitable tractor were reviewed alongside those associated with reduced-NH_3 emission spreading equipment such as
  - trailing hose (TH),
  - trailing shoe (TS)
  - and open slot injection (OSI) machines
  - as well as cultivation equipment required to incorporate solid manures

The basis of the methodology

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+ The input values used in 2009 were as follows:
  - purchase price of machines
  - depreciation, of both the tractor and the spreader
  - interest rates, on loan or expended capital
  - fuel consumption
  - repair costs
  - labour costs

Difference between splash plate machines and reduced-NH_3 emission spreaders

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- The key differences when calculating the direct differences in cost were:
- greater cost of reduced-NH_3 emission spreaders
  - typically < half the cost of splashplate
  - but no consistent differences between the costs of TH, TS and OSI
- slower work rate of reduced-NH_3 emission spreaders and therefore greater tractor costs per unit of slurry spread
- smaller repair costs associated with splash plate machinery due to less soil/machine contact than the TS and OSI machines and less moving parts

Results

	Basis 1	Basis 2	Annual cost	% of total
Labour	£9.50/ h	+9%	9,500	26.6
Fuel	£0.38/ L	18-25 L/ha	8,170	22.9
Repairs	8% capital		4,080	11.4
Depreciation	10 years	10%/ year	3,500	9.8
Interest	4.5%		1,150	3.2
Insurance	2.0% capital		510	1.4
Tractor total			**26,910**	**75.5**
Spread depr	6 years	15%/ year	4,200	11.8
Repairs	13%		3,540	10.2
Interest	4.5%		630	1.8
Insurance	2.0%		280	0.8
Spreader total			**8,750**	**24.5**

Results - Labour

- It is not the labour cost *per se* but the increase
- when spreading with a tanker-based system, most of the time taken is a result of the travel to and from the field
- even with slower application rates of reduced-NH_3 emission spreaders, the overall increase in work rate is relatively small

	Fill time	Travel time	Spread time	Loads/ 8h (80% eff)
	4	8	4	24
	4	8	6	22
Diff	0	0	2	9%

Results - Labour

- How sensitive are the estimates to the assumptions in the above table?
- the original assumption of 4 minutes travel time might seem rather short
- increasing the travel time does not much diminish the estimated difference in time between the surface and reduced-NH_3 emission spreaders

Travel time	Loads/ 8h (80% eff)	% Difference
4	27	14
8	**22**	**9**
12	17	9
20	13	7

Results - Fuel consumption

- In April 2010 agricultural diesel oil increased to £0.55/L
- however, while fuel costs were the second largest cost component, as with labour, much of the fuel consumption will be required for travel and hence a *c*. 50% increase in price will not give rise to a 50% increased in costs of reduced-NH_3 emission spreading
- 0.23 * 1.5 * 0.1 = 0.03

Results - Fuel consumption

- No explicit mention is made of additional fuel consumption arising from pulling the reduced-emission spreaders
- average fuel consumption of 18-25 L/working hour are quoted for 100 – 180 Horse Power tractors
- based on these consumption rates fuel costs per hour of between £6.84 and £9.50 were calculated as typical
- feedback from the farm pilot study indicated that tanker-mounted applicators require a tractor of 100+ H.P
- hence in the 2010 update an average fuel cost per hour of £8.17 was used

Results - Fuel consumption

- A revised calculation might be made assuming £6.84 per hour for splashplate application
  - and £9.50 for reduced-NH_3 emission spreaders
- three of the Pilot study contractors indicated they were able to use the same tractors
- one bought a 200 hp tractor
- this may be a major reason why the 2009 review reported contractors were not charging extra for application by reduced-NH_3 emission spreaders
  - since tractor costs represent the majority of spreading costs
  - if the reduced-NH_3 spreaders can be hauled by tractors already used this major cost will remain largely unchanged

Results - Repairs

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+ Repair costs of individual farm machines are rarely kept over a long enough to give genuine averages
+ budgeting estimates of 7% of initial purchase price are quoted for the first 200 hours of use
  - with a further 2% of price per 100 hours above this 200 h base for machines with limited soil to machine contact
+ annual repair costs of *c*. 13% of the price should therefore be budgeted on machines that do 500+ h
+ based on the capital cost of a tanker plus reduced-NH_3 spreader of £28,000
  - repairs/maintenance costs would thus be £3640/yr

Results - Repairs

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- From the Pilot study annual maintenance costs of the new slurry applicators were estimated to range from £185 to £2640
  - with a mean of £1100
  - compared with £3640 in the 2009 review
- however, consistent with the view expressed by Creedy that most farmers do not keep records of repair and maintenance costs, those for the Pilot study were mostly estimates based on the capital cost of the equipment
  - costs for splashplate machines were generally 2% of capital cost,
  - those for reduced-NH_3 emission spreaders were 4-5% of cost.

Results - Interest rates

- In the 2009 review we used 4.5% to reflect the current economic situation.
- 7% has been used in previous calculations

Consequences for the final cost estimates (spreading costs £/m3)

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- Total tractor costs (£/m3)
  - 2009: 1.00
  - 2010: 1.23-1.32
- reduced-emission spreader costs
  - 0.65
- total
  - 2009: 1.65
  - 2010: 1.88-1.97
- splash plate
  - 2009: 1.13
  - 2010; 1.26
- difference
  - 2009: 0.52
  - 2010: 0.62-0.69

Spreading costs, comparison with UK Pilot farms study £/m3

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- There was a wide range of costs depending on the volume of slurry to be applied and the type of new systems adopted
- the pre-abatement costs of slurry spreading ranged from £0.26 to £1.59 per m^3 slurry: mean £0.80
- following adoption of reduced-emission spreading equipment, costs increased to between £0.64 and £3.75 per m^3: mean £1.78
  - an overall average increase of 128%: £0.98
- 4/9 farms studies the additional costs were within the estimate of additional costs made in the 2009 review
- there was a trend for the increase in costs from reduced-application slurry application to decrease with the increased volume of slurry to be spread

Comparison of estimates with actual costs charged by contractors

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- In the 2009 review we did not make separate calculations for contractor costs
  - nd had we done so the approach would have been exactly the same as for the farmer-owned machines
  - hence any errors would have been perpetuated.
- Instead the contractor charges were based on information obtained on what is actually being charged
  - £0.28-0.42 per m^3
- we considered the average of £0.35 to be an independent validation of our calculations (£0.52)
- we would expect contractor costs to be less due to the typically greater annual volumes of slurry to be spread

BREF method for cost calculation

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- Method given on p329 of BREF doc
- unit costs should be calculated as below:
  - current costs should be used for all calculations
  - capital expenditure should be annualised over the economic life of the investment
  - annual running costs should be included
  - take into account changes in performance
  - total sum is divided by the annual throughput to determine the 'unit cost'
- This latter point is crucial and the estimated throughput will have a big influence on the final estimate of unit costs

Spreading costs, impact of slurry volume - results from D, €/m3

- The volumes used range from 500-3000 m^3 yr^{-1}
- volumes cited in the UK Pilot farms study ranged from 2200-16,000 m^3 yr^{-1}
- the rate of slurry application in the 2009 review was 13,500 m^3 yr^{-1}
- hence UK estimates of spreading costs, expressed as m^{-3}, would be less than those from many other European countries.

	500 m^3 yr^{-1}	1000 m^3 yr^{-1}	3000 m^3 yr^{-1}
Splash plate	5.2	3.9	2.3
Trailing hose	6.8	5.5	3.0
Trailing shoe	9.3	7.5	3.9
Open slot inj.	11.7	8.9	4.5
Incorp.	6.0	4.7	3.0

BREF method for cost calculation - points to consider

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- BREF example for additional time taken by injection is *2 that of splashplate
  - 2009 review *1.5
  - but majority of time taken by travel and filling
- BREF example difference in application rate 21%
  - 2009 review 9% (smaller increase in spreading time)
- BREF example 2000 m^3 annual throughput
  - average volume from Pilot farms study 6500 m^3
- BREF example extra cost €1.92
  - updated review additional cost € 0.74-0.83
- but had the BREF example used a throughput of 5000 m^3
  - additional cost would have been € 0.77

Comparison with GAINS (€/kg NH_3-N abated)

- The GAINs costs are for the 'high-efficieny option'
- except to T Hose which is low efficiency
- cost of sheep manure incorp $239-957 /kg N
- but unit cost' = 4.27 [MEuro/act.unit]
- (unit: number of animals; kg N)

	€ per NH_3-N conserved	GAINS estimate for UK
T shoe, dairy slurry	1.0	4.9
T hose, pig slurry	1.2	12.5
Slot injec., pig slurry	0.5	5.9
Incorp., dairy FYM	1.8	10.1
Incorp., layer manure	0.1	0.7

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Depreciation

- Depreciation occurs for three reasons
  - obsolescence
  - deterioration with age
  - deterioration as a result of use (wear and tear)
- the first two reasons are largely age-related
- wear and tear is directly linked to the hours a machine is worked during a year
- if the first two reasons predominate then depreciation tends to be more of a fixed cost
- if the machine does many hours the wear and tear becomes the key element making deprecation more of a variable cost (rises proportionately as hours worked increases) than a fixed one

Depreciation

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- Hence while depreciation is not only dependent on hours worked there is a close link between the two
- the more hours a machine works the less the depreciation per hour
  - **and hence per m^3 of slurry spread**
- the reduced rate of depreciation will to some extent be countered by the likely increase in repairs and maintenance cost as the hours worked increases
- the estimates assumed a 6 year write-off for the machines
  - and a final sale price of 10% of the purchase price

Interest rates

- Typically interest is calculated on half the initial capital cost
  - on the basis that the machine is being written off over the time and the depreciation money is being invested and earning interest in preparation for the machines replacement
- the interest rate will depend on the personal situation of the machine's owner and the interest rates at the time
- rates paid in the UK are to a large extent linked to the Bank of England base rate

Repairs

- Certain repair costs are related to the machines age
  - an example is battery life
- nevertheless, repair costs tend to be linked to hours worked
- for tractors repairs are typically assumed to be in the region of 8% of the initial capital purchase price of the machine
- repair costs for spreaders, tends to be more directly linked to the number of hours worked

Labour costs

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+ It might be argued that there are no inherent extra costs associated with rapid incorporation of solid manures since incorporation will usually occur at some stage

- but in the interval between ploughing subsequent soil settlement and weed growth might require another cultivation before seedbed establishment

+ hence if manures are to be incorporated soon after spreading this is likely to introduce an additional cultivation

Labour costs

- There is also an issue with respect to logistics
- for small farming operations rapid incorporation relies on the farmer regularly swapping machines on his tractor which can waste significant quantities of time and slow down work rates

Results - Depreciation/purchase price

- Using an initial capital cost of a tanker plus band spreader of £28,000 based on information obtained from suppliers over winter 2008/9
- depreciation would typically be £4200/year

Comparison with cost estimates from Es

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+ Purchase price (capital cost)
  - not cited
+ discount rate (depreciation)
  - UK: 6 years
  - Es: 5-7 years
  - both somewhat less than reported in the UK Pilot farms (6-12)
+ interest rate
  - UK 4.5%, Es 5.0%
+ labour cost
+ fuel cost
  - not cited

Comparison with cost estimates from Es

- Repairs
  - UK: 13% of capital cost
  - ES: uses those cited in Nix
- results are presented but not worked through
  - so no indication of which elements are most important in determining costs and hence not possible to compare uncertainty

BREF method for cost calculation - points to consider

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+ Farmers’input should be charged at the opportunity cost'
  - e.g. rapid incorporation of manures