Fertiliser spreading: Getting the mechanics right

Fertiliser association of Ireland
2011 meeting

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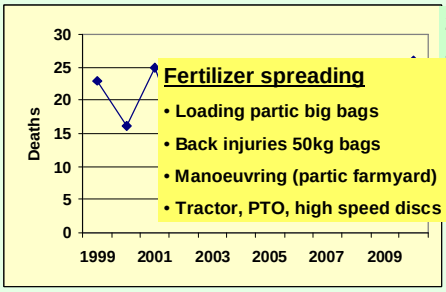
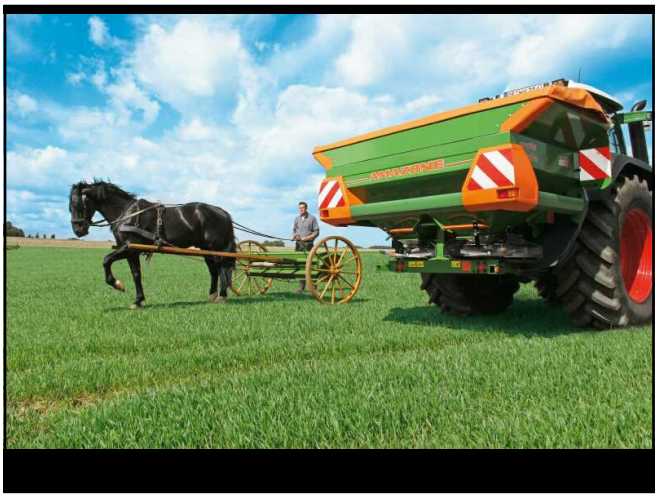
Teagasc
Oak Park Crops Research

Think Safety, Farm Safely



2010 – 26 Deaths
- 6% workforce
- % deaths
- mes rate



Outline

- **Machine developments**
  - Spreading mechanisms
- **Applying the correct rate**
  - Rate control
  - Calibration
- **Spreading evenly**
  - Test hall performance
  - Field performance
- **The cost of uneven spreading**
- **Practical considerations**

Basic functions!

- **Transport fertilizer**
- **Spread fertilizer evenly**
  - **Correct rate**
  - **Applied evenly**
    - **i.e. correct rate everywhere (0.25m^2)**

Transport

- Merchant to farm
  - Truck and Pallets
  - Truck and bulk
  - Spreader and spread +/- nurse delivery trailer
- Within farm
  - Pallets on trailer
  - Direct spreading.
- Which is the most efficient?

Bulk Spread vs others

- Advantages
  - Avoids cost and hassle of packaging and storage
  - Complete fast service, labour etc included
  - Cost efficient?
- Disadvantages
  - Emphasis on fast delivery of accurate quantity.
  - Less emphasis on even spreading?
  - Heavy equipment often on questionable ground conditions (partic. ploughed ground etc)

Spreading mechanism

- Types
  - Twin Disc development dominates
  - Single disc – one sided
  - Reciprocating Spout limited to 9 – 12m max
  - Pneumatic
    - Too expensive particularly >> 12m
    - Maintenance and corrosion issues
    - Test hall CVs no better
    - Windy conditions advantage
    - Sharp shut-off – research farms

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Twin disc machines

- Up to 50+m bout widths (in test halls!)
- Current machines developed in era of independent testing in 1990s
  - Capable of good test-hall CVs
- Detailed disc design
  - Disc Size, Shape, Speed, Rotation
  - Vane Size/Length, Shape, Angle, Number
  - Delivery point of fertiliser

Applying the correct rate

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- Fertiliser flow rate
- Tractor forward speed
- Correct bout width

- Flow control mechanisms
  - Gravity based with agitators and variable shutter
  - Variable belt speed and adjustable shutter
  - Force feed type (seed drill type) with variable speed rollers or variable area rollers
- Calibration essential

Calibration

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- Without calibration!
  - Farmer with 40ha in 5 fields
  - Start with last years settings or poor 'book' value
  - Spread the first field at 20% more than intended
  - Adjust: 2nd field at 15% less than intended rate
  - Adjust: 3rd field at 5% more than intended
  - Adjust: Last 2 fields correct
  - Overall farm rate is correct but 40% of area well outside target rates

Calibration practice

- Manufacturers support
  - Rate charts
  - Web based material
  - Tests of Irish fertiliser
  - Test kits (sieve test and ID charts)
  - Flow testers
  - Calibration procedures
  - On-board weighing and automatic calibration

Calibration practice-2

- Calibration
  - Flow Rate measurement
    - Time flow and weigh
    - Discs removed, or stopped + calibration kit
    - Varies with machine – easy best
  - Driving speed check (wheelslip – 20% ploughed)
  - Bout width check (GPS, measure)

Active rate control

- Constant rate with:
  - Variable forward speed
  - Variable flow rate
- Can change application rate on the go
  - Manually
  - Variable rate Precision Ag type system
- Controlled headland operation
  - Graduated shut off etc

Spreading evenly

- Machine design
  - Spreading elements:
    - discs, vanes and fertiliser delivery point
- Machine setting
  - Disc speed and type,
  - Vane type, length, number, angle
  - Fertiliser drop position
  - Hopper angle
  - Height over ground / crop
- Absence of wear on spreading components
- Fertiliser characteristics
- Weather conditions

Fertiliser characteristics

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- Granule size, shape, density and strength.
- Subject of research
- Influences:
  - Movement on disc
  - Throw off from vanes
  - Movement through air
- Ideal:
  - 80% of particles in 2-4mm range
  - Rounded and smooth
  - Blend components should be similar: mean particle size within 10% of mean
- Move to 'Bulk' – deterioration in spread characteristics
- Interaction between fertiliser and spreader

Evenness testing

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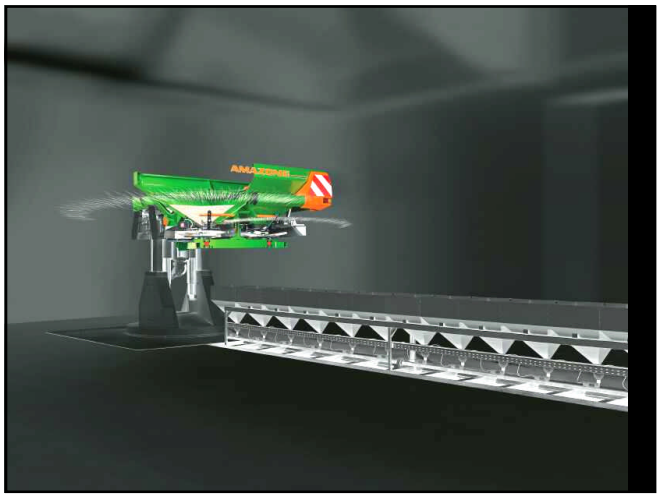
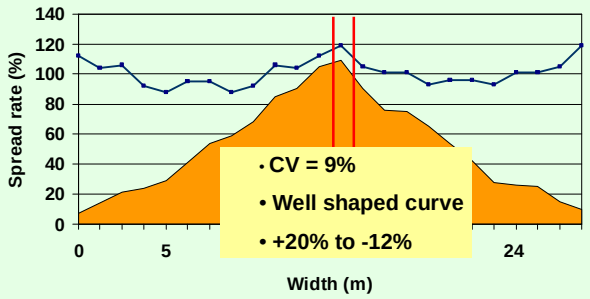
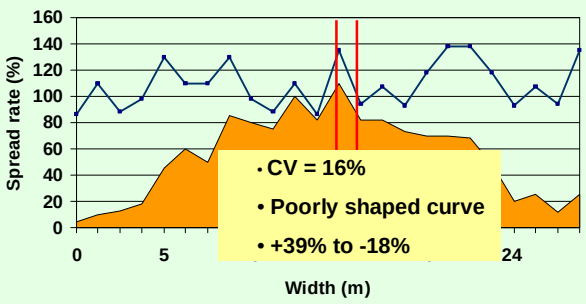
- Test hall – indoor controlled environment – 0.25m2 trays – detailed basic pattern
  - Standard tests (Bygholm, CEMAGREF)
  - Manufacturers test halls
  - CV values and shape of spread pattern
  - CV: less than 15% = acceptable but some <5%
- Field full testing – very little
  - Poor repeatability
- Field checking – 4-7 trays
  - Overlapped pattern
  - Poor repeatability



Good spread pattern



Poor spread pattern



Field performance

- Variations in fertiliser physical quality
- Variations in disc speed
- Angle of disc to crop:
  - Linkage mo
    variation; s
- Bumpy cond
- Inadequate
- Incorrect c
- Wear in spreading components
- Weather conditions: wind

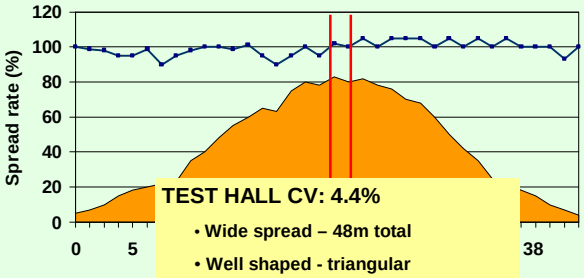
TEST HALL CV of 5%

- Field CV ???
- 10%
- 20%
- 30% (striping)

1999 -2000 tests

- Test Hall tests
- Independent at Bygholm
- All major twin discs tested
- Very comprehensive
- Many Widths and Fert types
- Influenced Fert spreader development
- Little since!!!

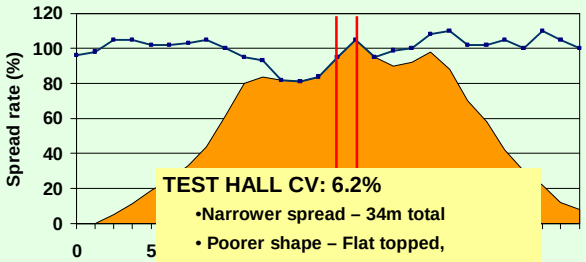
Independent test: A 18m



TEST HALL CV: 4.4%

- Wide spread – 48m total
- Well shaped - triangular
- Likely to be more forgiving of
  - Fertiliser, Setting, Wind

Independent test: B 18m



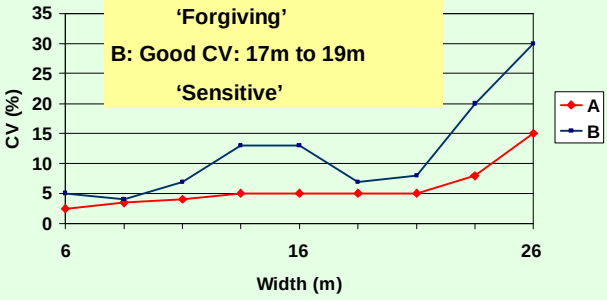
TEST HALL CV: 6.2%

- Narrower spread – 34m total
- Poorer shape – Flat topped, shouldered
- Likely to be less forgiving of
  - Fertiliser, Setting, Wind

CV vs width: Spreaders A, B

A : Excellent CV: 6m to 24m 'Forgiving'

B: Good CV: 17m to 19m 'Sensitive'



Direction of discs !

- Lely, Bogballe, Bredal – towards centre
- Strong overlapping of discs
- More forgiving pattern
- Less ability to shut-off part width
- Not a guarantee of good spread!!

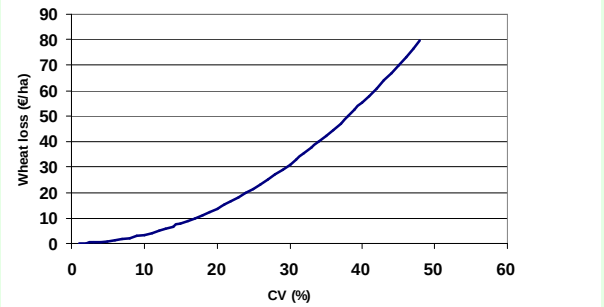
Cost of poor spreading

- Two factors contribute
  - Spread quality on farms – unknown
  - Cost of poor spread quality
- Some research
  - Frequently theoretical studies
  - Millar et al most recent – 2009
  - Theoretical based on winter wheat
  - Effect of problem patterns modelled
    - Impact on CV and Cost

5 pattern defects

Problem	CV range	Cost range (€/ha)
Skewed side distrib.(Pn)	6 – 21	1 - 14
Incorrect width (disp)	5 – 27	1 - 23
Asymmetric pattern	5 – 50	1 - 74
Quadratic spline (disp)	7 – 57	2 – 135
Twin spline (disp)	7 – 55	2 – 75
Twin spline asymmetric	8 – 41	2 - 47

CV and Wheat loss



Likely losses

- Poor spreading:
  - If visible CV=25% - 40% ?
  - Loss in WW: €22 - €55/ha
  - 5% to 10% = €2/ha
- Focus on improving 'field' performance
- Lodging and quality
  - Lodging – big loss potential
  - Quality – malting barley, grass

Practical considerations

- Spreader choice:
  - Even spreading: CV + robust pattern
  - Correct spec: hopper, headland equip, control systems, calibration equip.
- Fertiliser choice:
  - Actively look for good spread quality
- Use Manufacturers resources:
  - Instruction manuals - invaluable
  - Web resources re fert settings
  - Calibration and fert test equipment
- Calibrate the spreader, tractor and feet!
- Maintenance and check for wear

Finally

- Fertiliser spreading – hugely important technical task
  - Must get it right
  - Still true of contract spreading
- Researchers / Manufacturers
  - Focus on field performance

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Poor spread pattern

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