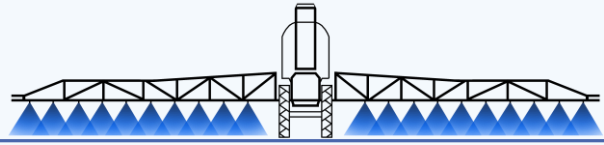
Post-emergence herbicide application

Clare Butler Ellis,

Silsoe Spray Applications Unit

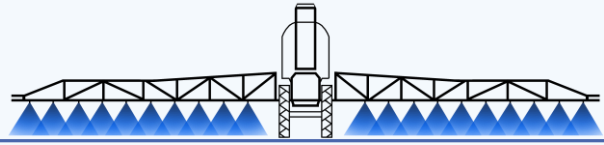
BCPC weed review Nov 2018



Let's go back in history…..

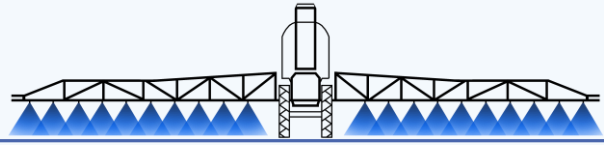
In 1994, a review of application for post-emergence herbicides was published

- Knocke, M (1994) Effect of droplet size and carrier volume on performance of foliage-applied herbicides. Crop protection **13** 163-178
  - 146 references
  - 1950 – 1993
  - Large number of studies from the 1980s



Knoche's main conclusions

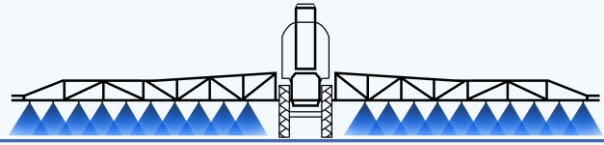
- Findings were often not consistent across different studies
  - Clear trends sometimes difficult to identify
- Performance improved with reducing droplet size
  - Most consistent for systemic herbicides
- Volume effects not so clear
  - Optimum volume between 100 and 400 L/ha
  - Most consistent for difficult-to-wet plants
  - Glyphosate had consistently better performance for reduced volume



Since 1994 -

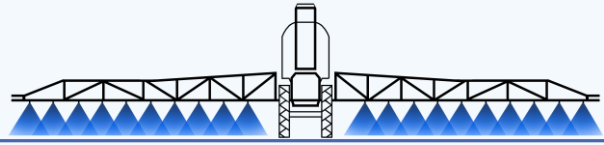
- Air-induction nozzles
- Angled nozzles
- Loss of chemicals
- Improved formulations

We therefore know less now than we did in 1994!



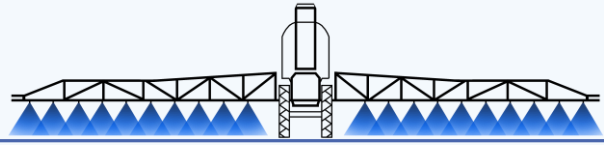
More recent UK reviews – covering all sprayed PPPs

- HGCA nozzle chart – first in 2004?
- Defra desk study: A review of methods of reducing drift without compromising efficacy (Orson, Miller) 2006 – PS2010
  - ~ 50 references (many from the 1980s)
  - 8 refs on post-em herbicide efficacy since 1994
- Further revisions of the HGCA nozzle chart (last in 2010) much less formal
- There is a significant number of studies on herbicides since 1994 – not so much from the UK, but Europe and USA



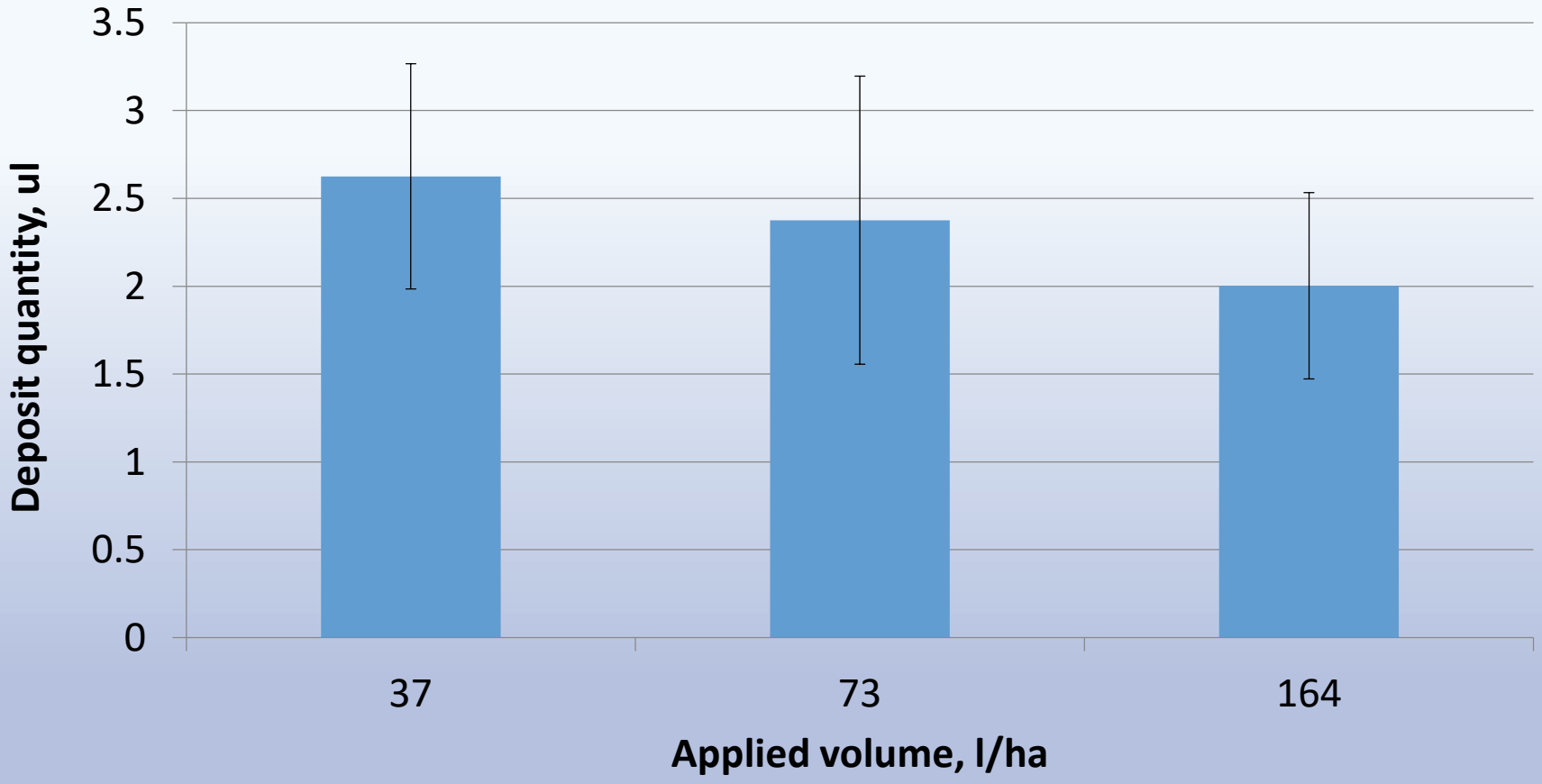
But we still have some understanding of the basic principles from which we can deduce performance in the absence of data

- How application affects the quantity of spray deposited on plants
  - Should correlate to efficacy providing the experiment is on the right part of the dose-response curve
- How application affects the area of plant surface covered by spray
  - Hypothesised correlation with efficacy in some circumstances
  - Not sure that this is supported by experimental data



Effect of volume on quantity of spray deposited on the target

Effect of volume on deposit quantity: deposit on 10 ryegrass plants



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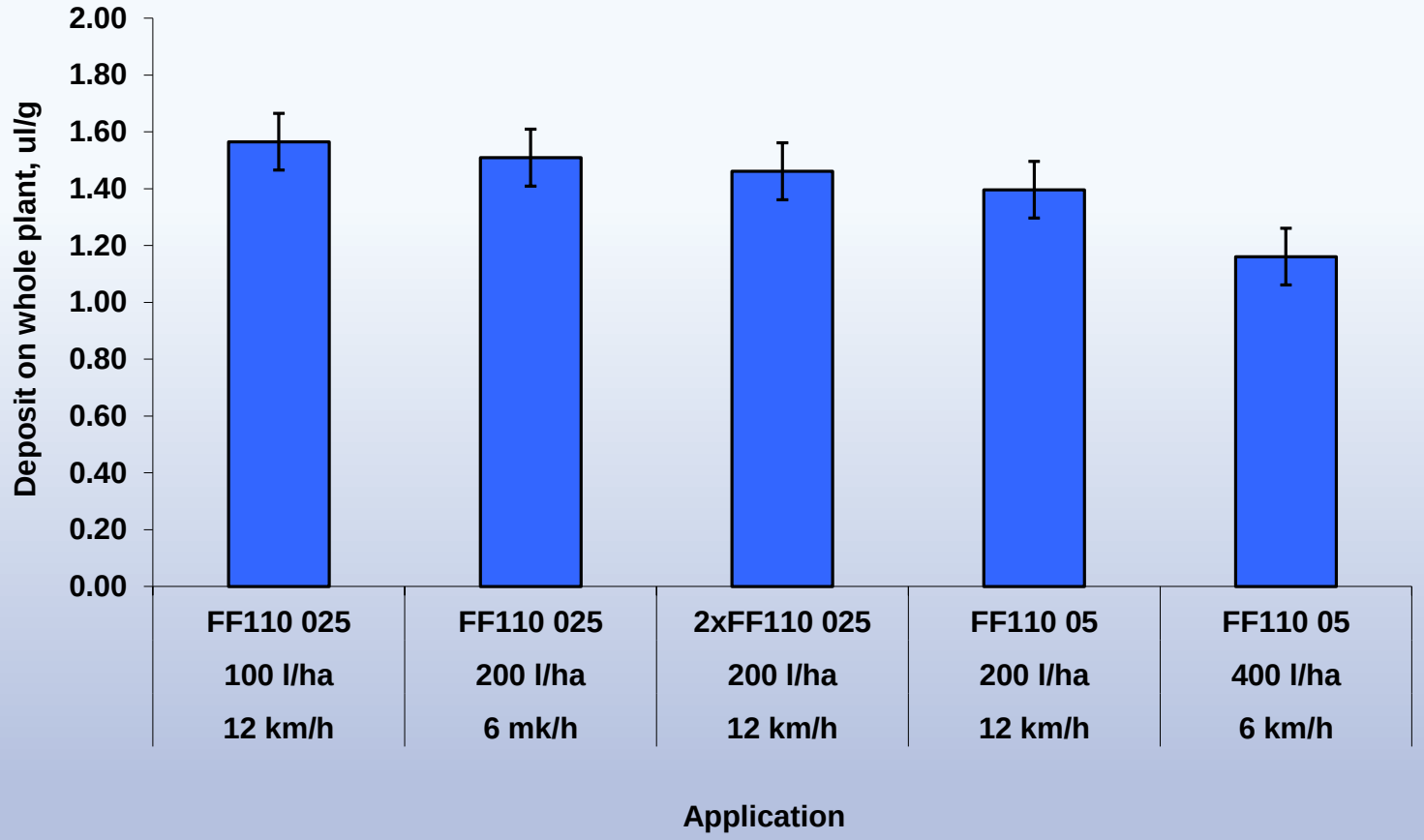
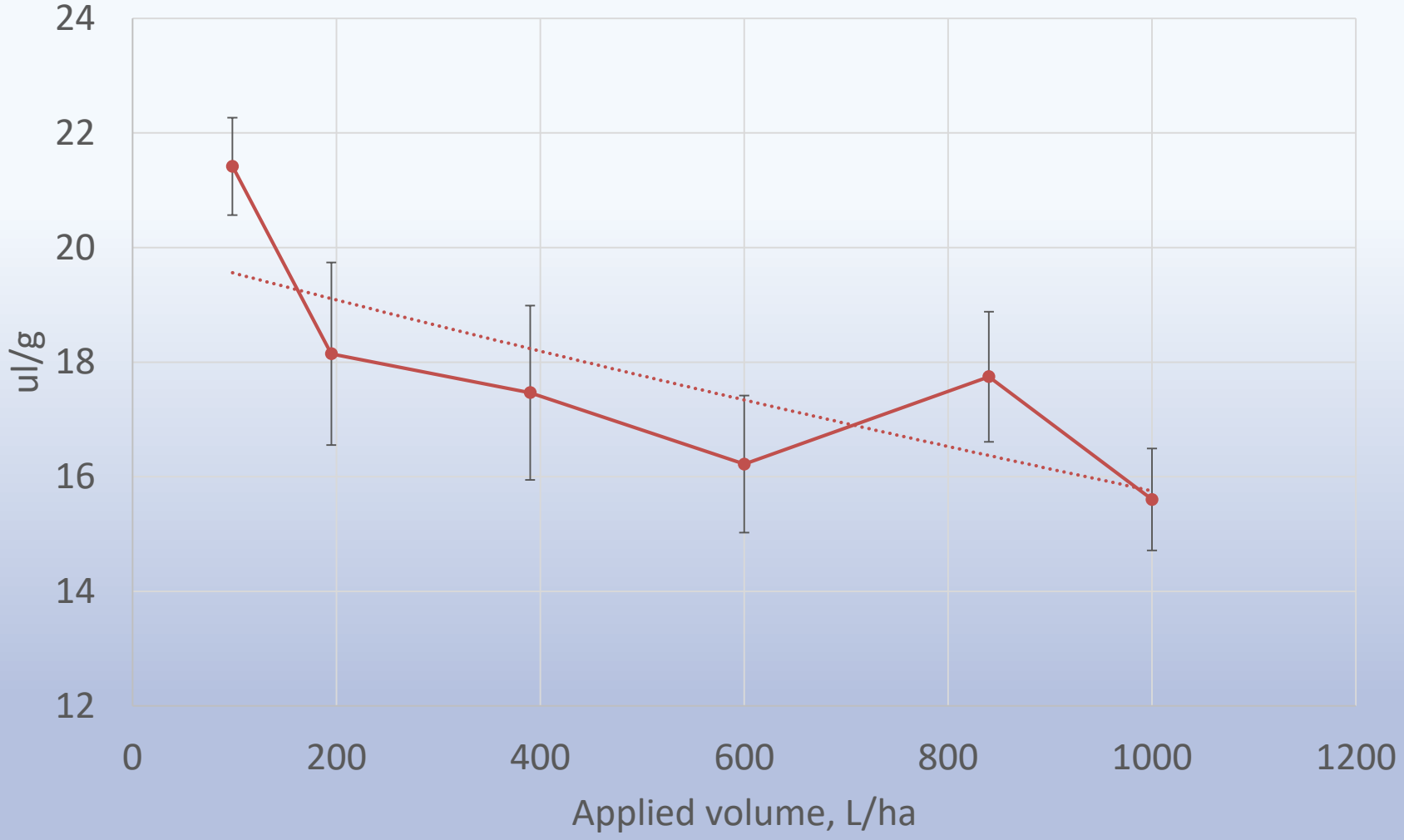
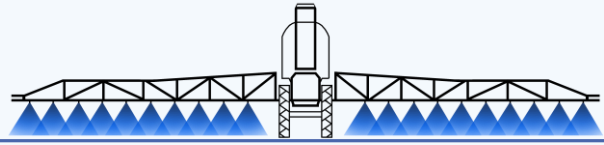
Effect of volume on deposit quantity: deposit on winter wheat crop at T2 timing



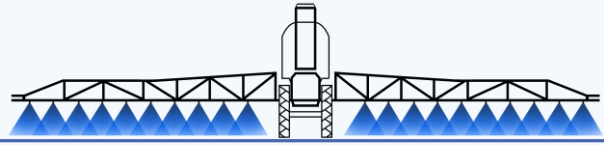
Normalised (active substance) deposit on whole plant





Effect of volume on deposit quantity:

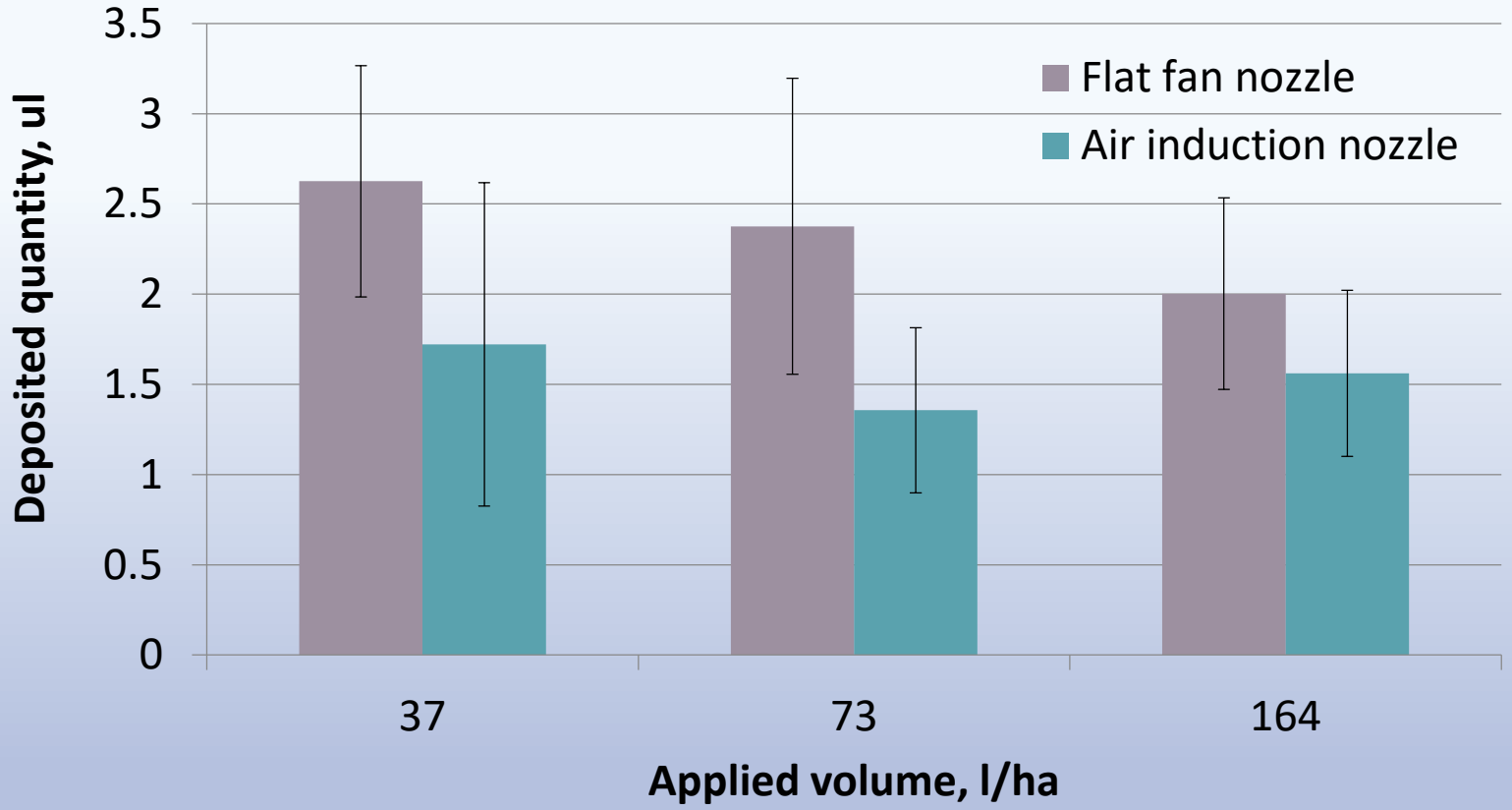
- Less active ingredient deposited on plants for higher volumes
- Greatest effect on small vertical structures
- No effect on soil deposits



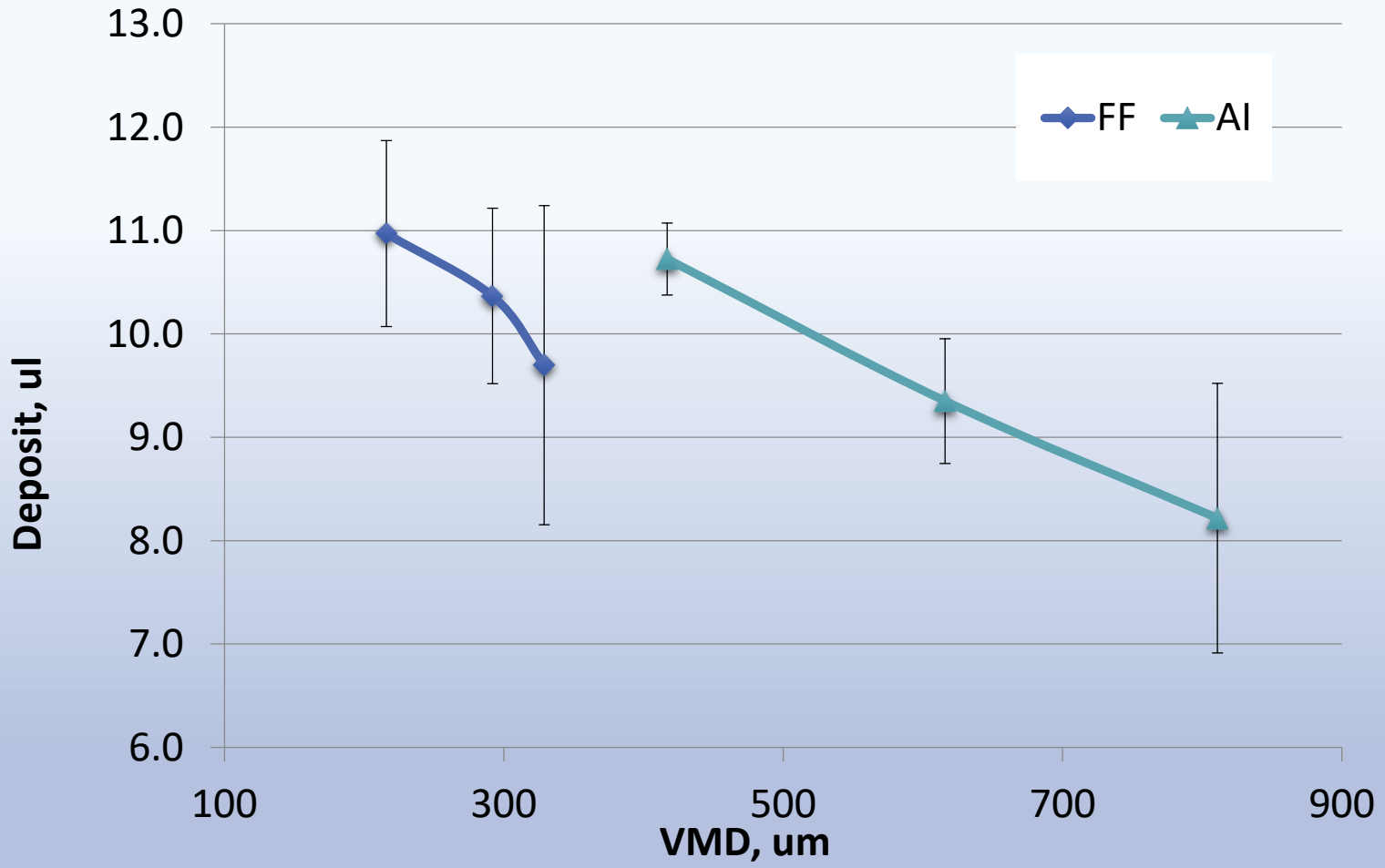
Effect of droplet size on quantity of spray deposited on plants

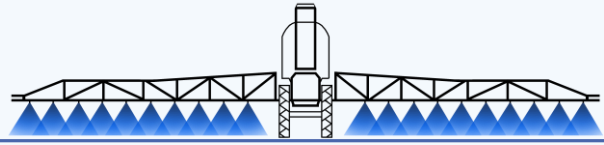
- Smaller droplets = higher deposits
- Lower velocities = higher deposits
- Air induction nozzles have larger droplets at lower velocities – with air bubbles ➔ lower deposits (droplet energy = ½ m v^2)

Effect of droplet size on quantity deposited – 10 ryegrass plants



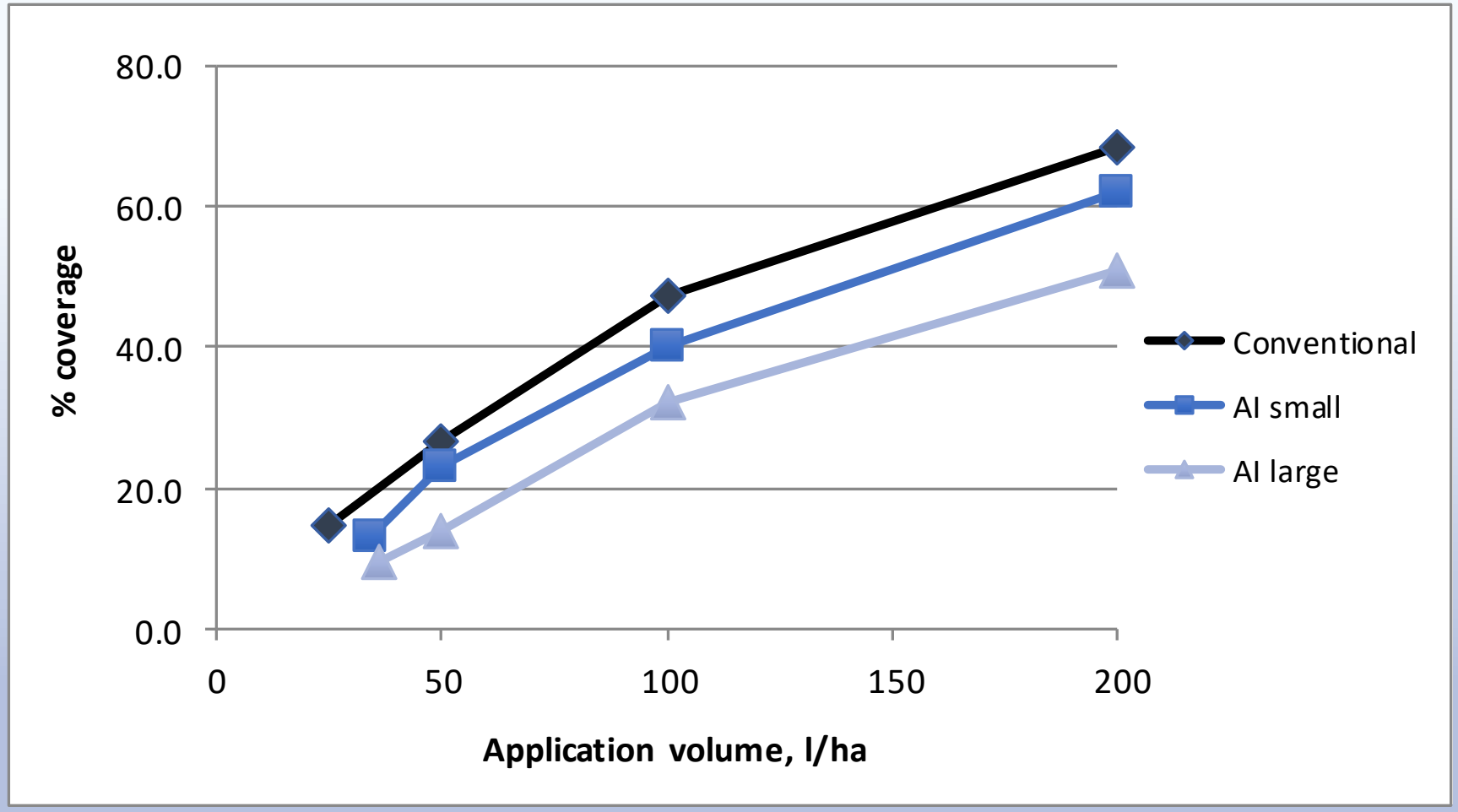
Effect of droplet size on deposit quantity – wind tunnel, small targets



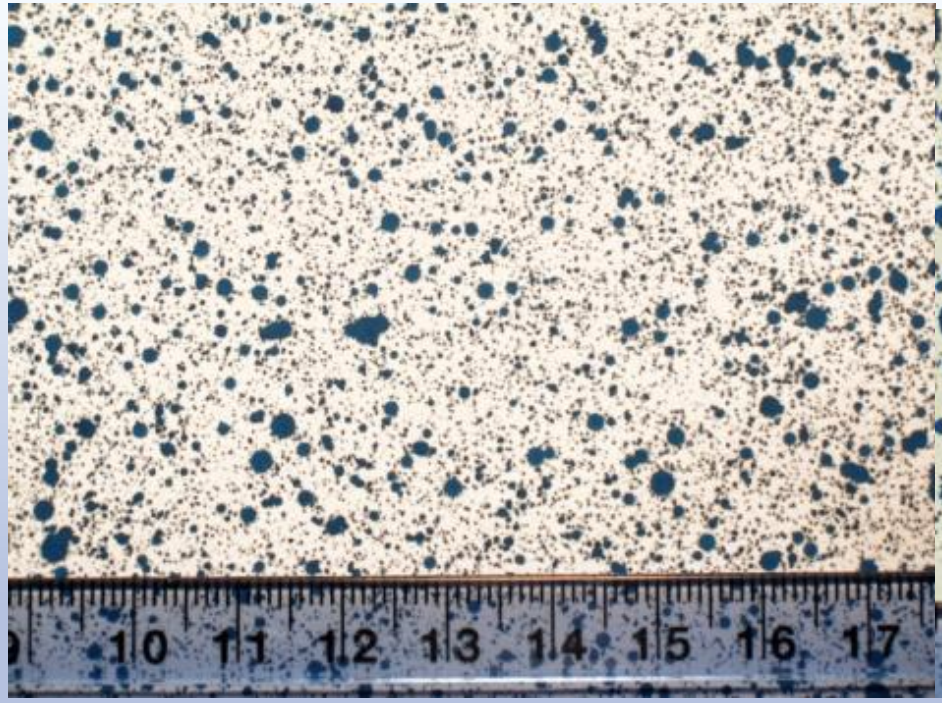


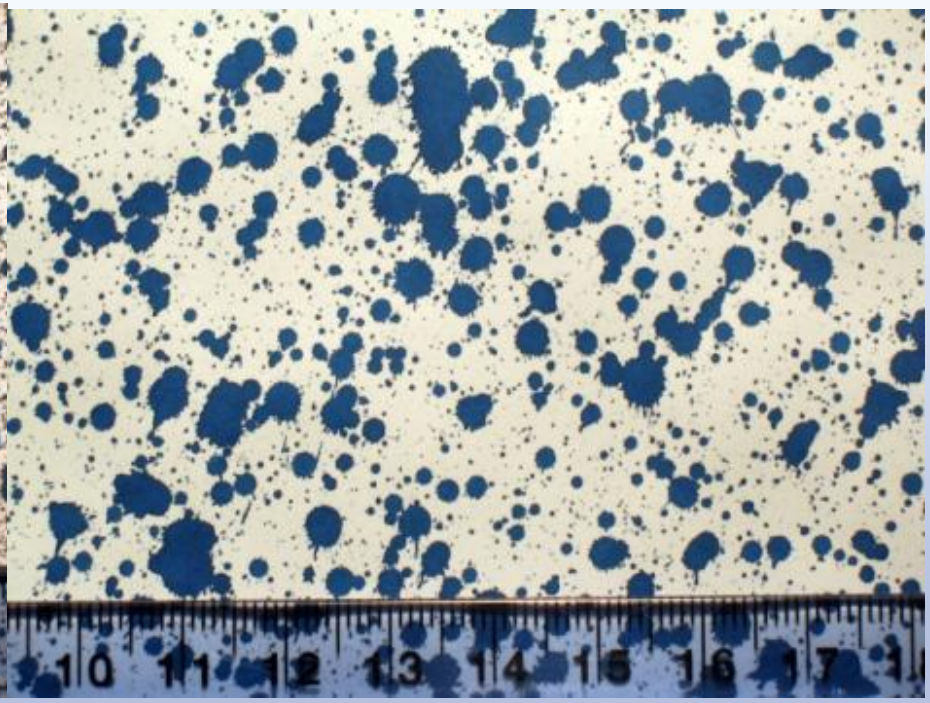
Effect of volume and droplet size on ‘coverage’ of the target

Effect of application on area covered by spray liquid



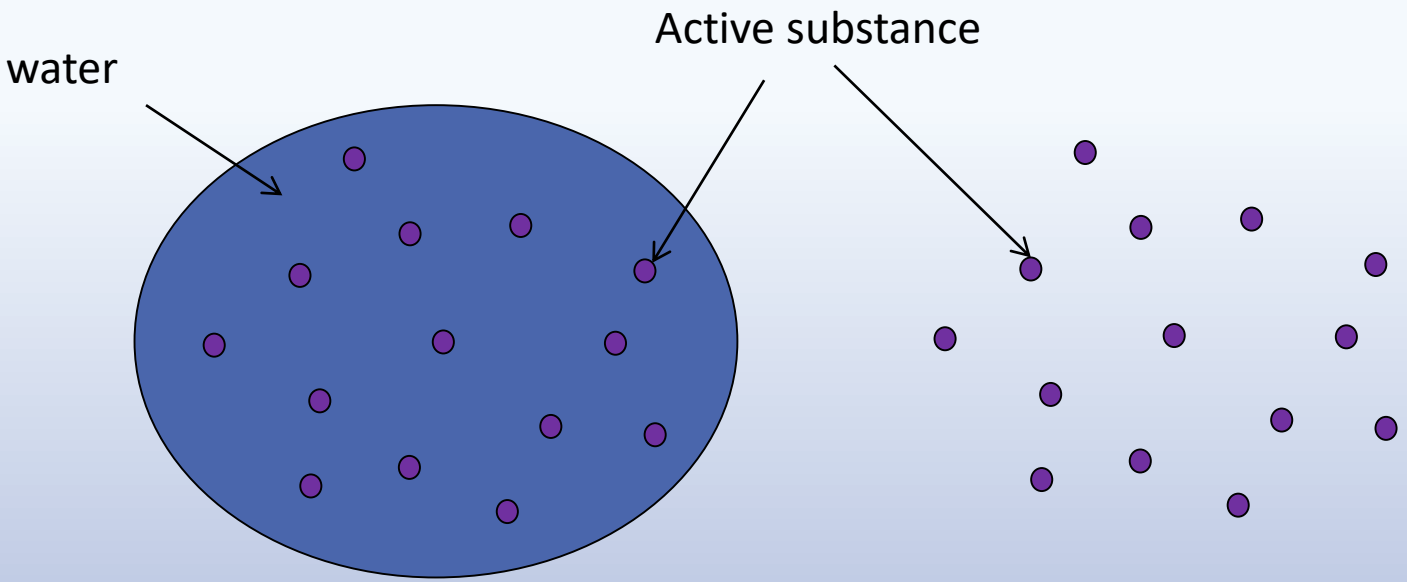
100 L/ha FF vs 200 L/ha AI



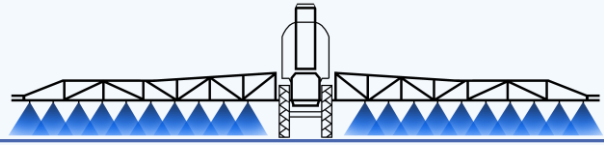


But in 2018, formulation is everything …

Coverage by active ingredient – suspension or emulsion

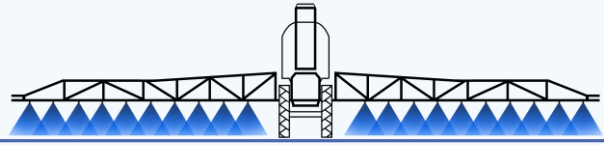


Area covered by droplets may be large but area covered by active substance is independent of water volume



Effect of application on ‘coverage’

- … is complicated!
- Greater area of plant covered by water at higher volumes
- Do you need a greater area of plant covered by water???
- How the *active substance* is distributed is likely to be more important

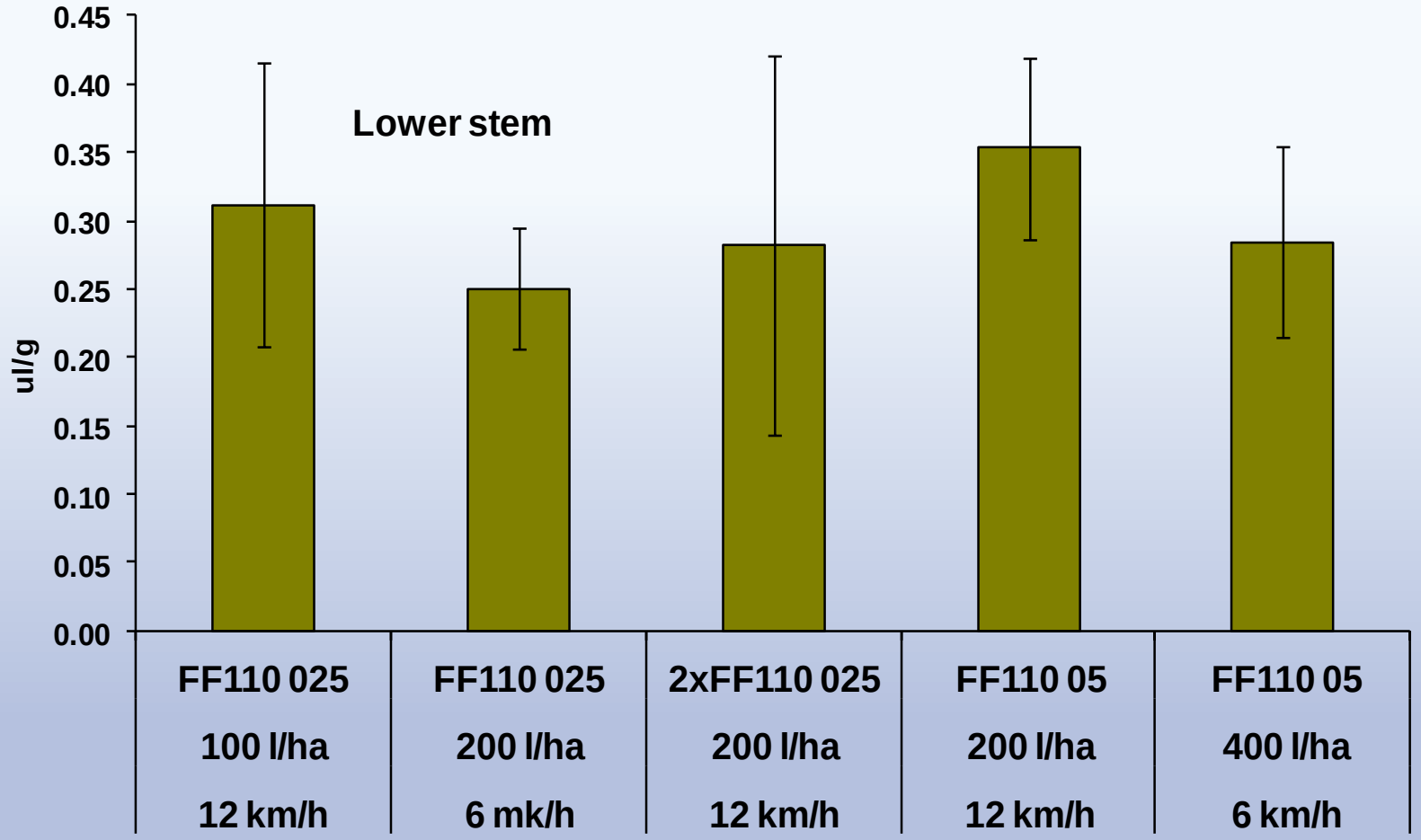


Effect of volume on distribution within the canopy

Penetration into a canopy

- Labels often state for denser crops and later growth stages, use higher volumes
- 3 years of data from an HGCA-funded project on cereals
  - Application technique much less important than growth stage of crop
- Other data on other crops shows similar results:-
  - **Increasing volume does not increase penetration**

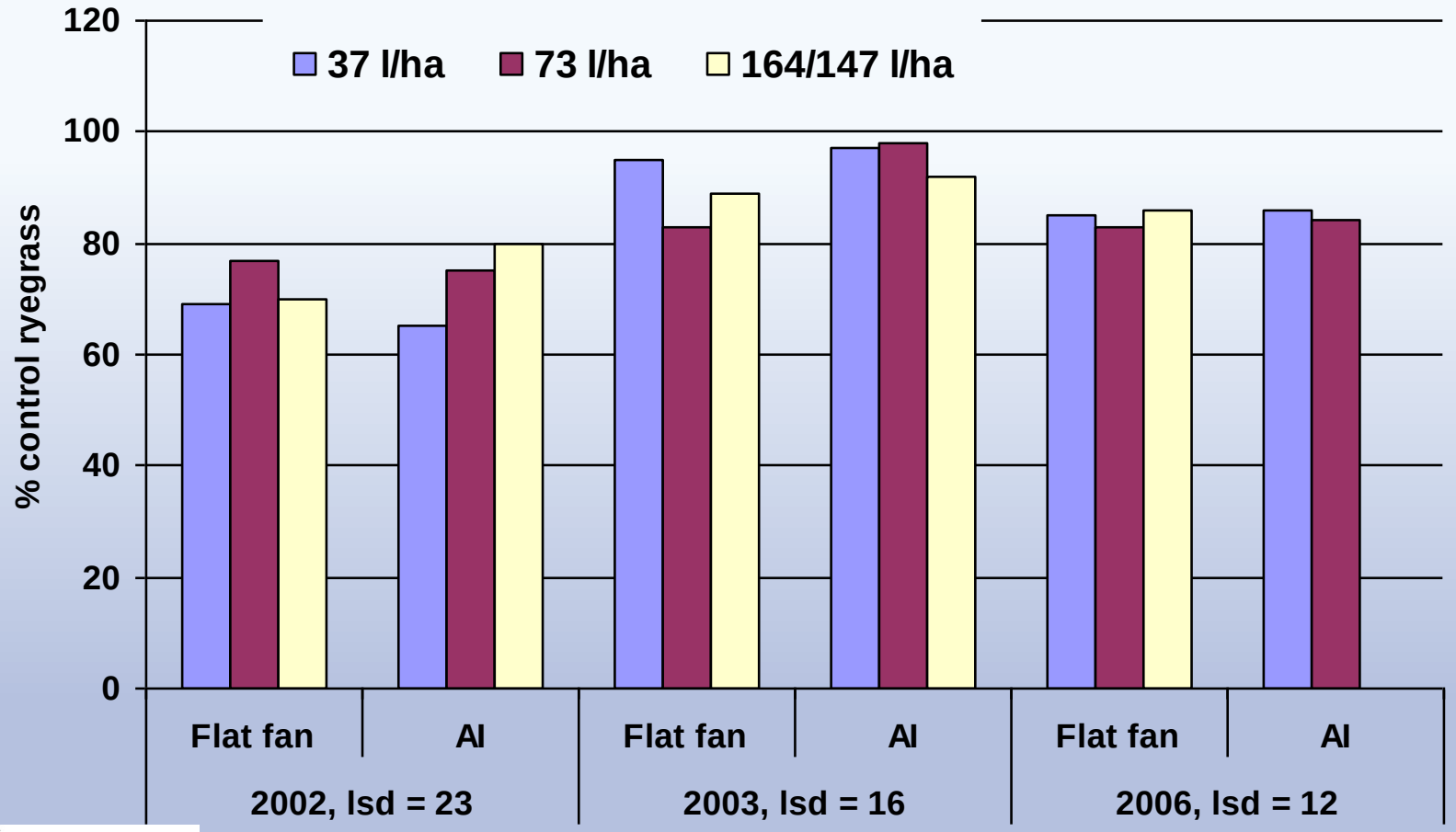
Effect of volume on distribution in canopy - wheat

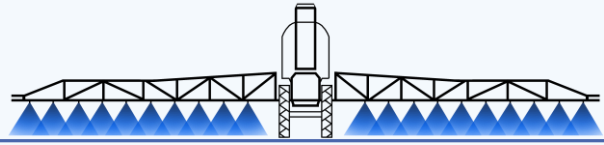


What do we know about low volumes and weed control since 1994?

- Low volumes LINK project found no significant change in performance with volumes down to 25 l/ha (flat fan, twin fluid and air induction nozzles)
  - Grass & broadleaved weeds
  - Biggest effect was seen between traditional flat fan and large droplet air induction nozzles
- Soil applied herbicides – information is confusing
  - HGCA & TAG funded trials showed pre-emergence weed treatments tended to work better at 100 l/ha than at 200 l/ha
  - A brief review of published data suggests no volume effect (paper in CPSB Feb 2017)

Effect of spray volume and nozzle type on 1-2 leaf rye-grass with 0.7 l/ha Grasp

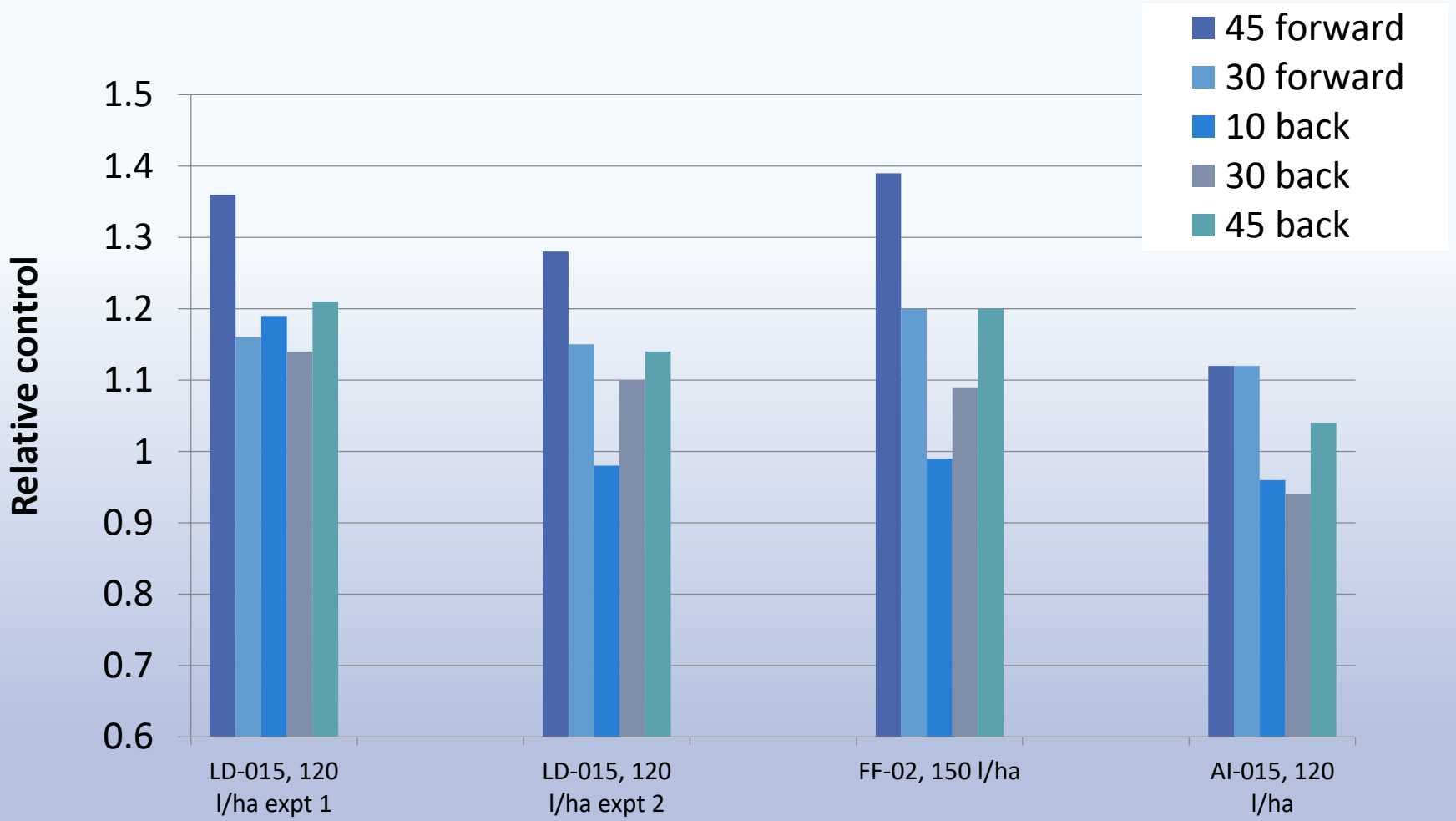




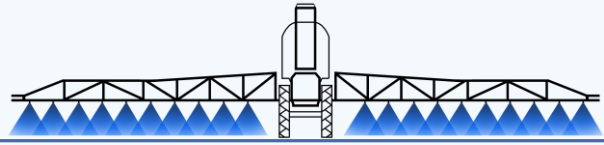
Nozzle angling

- Nozzles angled by 30^{o} or more now commercially available
  - Forwards, backwards, alternate f&b, twin, asymmetric twin etc
  - Or take your favourite nozzle and put into a twin cap or single angled cap
- Put more on vertical targets
  - Forward angling has bigger effect than backwards
- Have little impact on other targets
- Particularly effective for small upright grass weeds

Effect of nozzle angle on relative performance of herbicide on perennial ryegrass

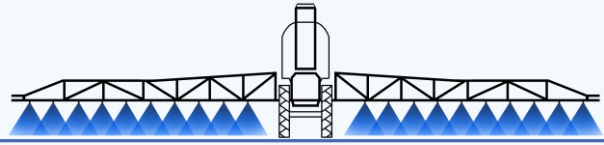


P K Jensen, 2010, International Advances in Pesticide Application, p81-88



Field studies into the effect of application on efficacy are difficult -

- Large areas are needed for full-scale equipment at realistic speeds
- Weeds are patchy over large areas
  - Pre-emergence is particularly challenging as you don't have 'before' and 'after'
- Good control of application difficult with real sprayers
- Plot sprayers are not relevant to real application conditions
- Everything is connected – so usually cannot change one parameter without changing something else
- Need to be on the right part of the dose-response curve
- Knoche's review shows that multiple trials needed to identify the main 'trends'



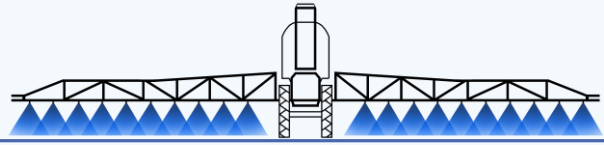
Understanding underlying processes is very important

- Target location on plant
- Mode of action
- Uptake into plant/movement across surface
- Distribution over target
- Pre- and post-application losses

SSAU's approach is to explore underlying mechanisms to develop hypotheses and inform limited field trials – most cost effective

To summarise:

- Physics suggests low application volumes may give better performance than high, for a number of reasons
  - More retained on plants
  - Higher concentration may be more important than higher ‘coverage’
  - Good formulation can also result in high ‘coverage’ even with low volumes
  - No reduction in pesticide reaching the lower part of a cereal canopy (within typical practical volume ranges)
  - Consistent, as far as we can establish, with measurements of efficacy.
- Where a high level of coverage of the plant surface by water is genuinely beneficial, higher volumes may work best.



Thank you for your attention

Thanks to the team at SSAU who contributed to all aspects of this work