

# On-Farm Fertiliser Applicator Calibration

Dan Bloomer

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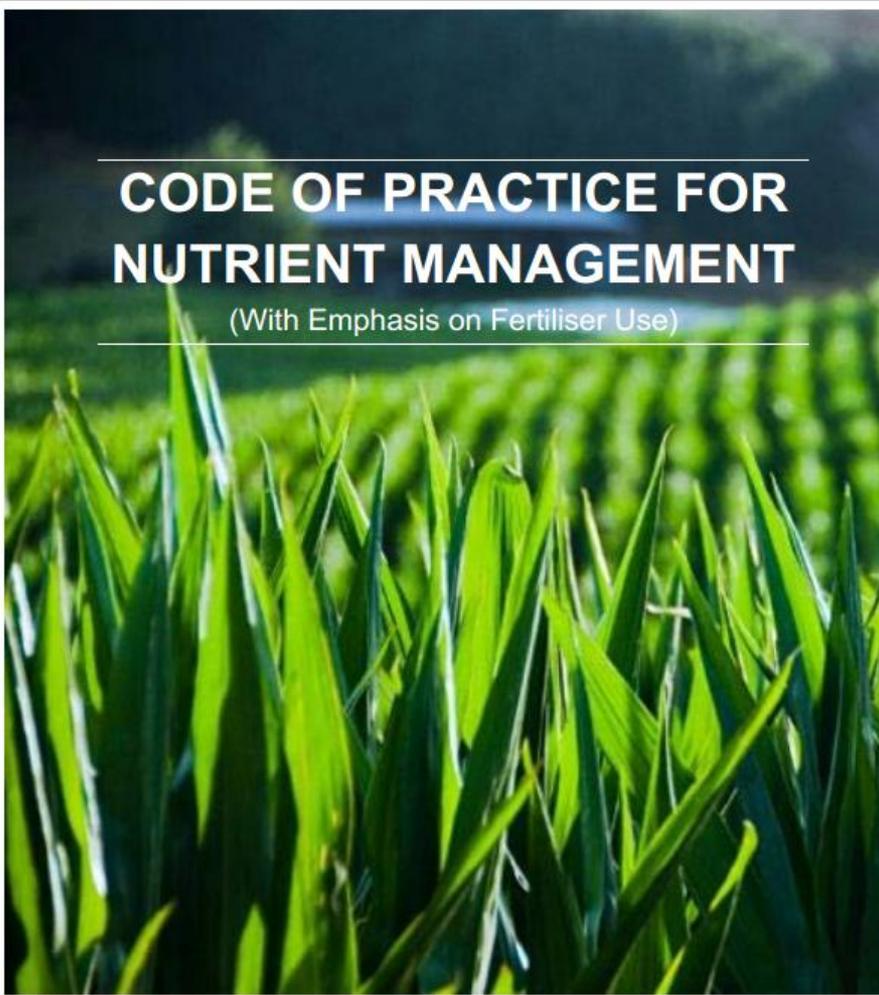
**Avoid profit loss  
Protect the environment**

# Why check equipment performance?

- Avoid profit loss
  - Excess use wastes money
  - Uneven application reduces yield
  - Uneven application reduces quality
- Protect environment
  - Excess use drives leaching
  - Uneven application increases leaching risk

# CODE OF PRACTICE FOR NUTRIENT MANAGEMENT

(With Emphasis on Fertiliser Use)



## CODE OF PRACTICE

### For the Placement of Fertiliser in New Zealand

The Spreadmark Code of Practice

Policy and plans

Coastal

Energy

Hazard and catchment management

Long term plan, annual plan, annual report and community outcomes

Plans under development

Policy effectiveness reports

Regional Pest Management Plan

Regional Policy Statement

Rules and regulation

Air quality strategy

Navigation safety bylaw

Protecting Lake Taupo

Regional Coastal Plan

Waikato Regional Plan

Waikato Regional Plan (online version)

Glossary of Terms

Water allocation variation

Transport

Waipa Catchment Plan

Waste management

Search Council

## 3 Water Module

### 3.9 Non-Point Source Discharges\*

#### 3.9.7 Guidance Notes for the Use of Fertiliser

- a. Waikato Regional Council supports the New Zealand Fertiliser Manufacturers' Research Association Code of Practice for Fertiliser Use 1998 with the exception that Waikato Regional Council recommends a maximum nitrogen loading rate not to exceed 150 kilogram/hectare/year for animal effluent irrigated pasture (compared to 200 kilogram/hectare/year recommended by the Code). The maximum nitrogen loading rate should include all sources of applied nitrogen including fertiliser, biosolids and irrigated farm effluent.
- b. The publication 'Nitrogen Fertiliser Use on Waikato Dairy Farms: Bulletin One – August 1995: Waikato Regional Council' is available free of charge from Waikato Regional Council. This addresses time and rate of nitrogen applications, influence of other factors on effectiveness of nitrogen applications, minimisation of adverse environmental effects and avoidance of excessive nitrogen use. Waikato Regional Council is proposing to publish a further, similar guide related to fertiliser use on commercial vegetable production.
- c. Landowners should maintain a nutrient budget model for their properties in order to demonstrate compliance with conditions in Rule 3.9.4.11.
- d. Considerable care should be taken when irrigating fertilised areas. In this regard, refer to Rule 3.4.4.5 concerning the use of water for irrigation purposes. Compliance with the conditions for that Rule should ensure no significant adverse effects from irrigation of fertilised land.
- e. Care must also be taken when fertilising areas of land that have been subject to applications of farm animal effluent within the preceding 12 months. Refer to Rule 3.9.4.11 condition f) in this respect.
- f. All practical steps should be taken to avoid direct discharge of fertiliser to water. This activity is not permitted under the RMA or this Plan and, subject to the level of any adverse effects, constitutes an offence regarding which Waikato Regional Council may take enforcement action.
- g. Where fertiliser application is proposed near property boundaries, the operator is encouraged to notify any neighbours that might be affected by the fertiliser application.
- h. Where fertiliser is being applied onto an area of more than one hectare, the operator is encouraged to undertake the application using certified or calibrated equipment. [The Spreadmark Certification scheme](#) operated by the New Zealand Groundspread Fertilisers Association is an example of a certification scheme that provides certainty that the fertiliser is being applied at an even rate and distribution pattern.
- i. Operators are encouraged to identify and have regard to all locations that are sensitive to the effects of fertiliser (e.g. wetlands, streams, lakes, ponds or neighbours' houses) and identify means to minimise the effect of fertilisers on these areas.
- j. Operators are encouraged to keep good fertiliser application records including the following:
  - i. nutrient requirements of the crop(s)
  - ii. date of the fertiliser applications
  - iii. timing of cultivation and the area of land cultivated
  - iv. fertiliser application rates (kilogram/hectare) and method(s) of application
  - v. the areas of land in hectares that was cropped and fertilised
  - vi. the type(s) of fertilisers used



**Application Rate – kg/ha**  
**Application Uniformity – C.V.**

# Performance Indicators

- Application Rate
  - Kilograms of fertiliser per hectare covered
- Application Uniformity
  - Coefficient of Variation (CV)
    - Nitrogen fertilisers 15% CV
    - Other fertilisers 25% CV

# Uneven Application of Lime



# Crop Striping

A wide-angle photograph of a lush green field, likely a crop field, showing signs of crop striping. The field is filled with dense, green vegetation. In the background, there are rolling hills and a line of trees under a bright blue sky with scattered white clouds. The overall scene is a rural landscape.

**Only visible at in-field CV ~ 40%**  
**Gives yield reduction of at least 20%**

# Striping

- Only visible at in-field CV  $\sim$  40%
  - Gives a yield reduction of at least 20%
- Economic impact increases exponentially as in-field CV increases
  - Double CV, 4 x economic loss
  - Triple CV, 9 x economic loss

Mersmann et al, 2013 and Yule and Grafton, 2013

# Factors affecting placement



Machine Settings

Application Conditions

Fertiliser Characteristics

# Machine settings



# Machine settings

- Control application rate and spread pattern
  - Bout width
  - Travel speed
  - Machine alignment – horizontal axes
  - Discharge door opening
  - Roller condition
  - Duct design and settings
  - Fan speed
  - Drop tube design and condition



# Application conditions

- Impact spread pattern
  - Humidity
  - Ground contour
  - Soil condition especially wetness

# Fertiliser characteristics

- Flow and ballistics affect spread pattern and rate
  - Fertiliser density
  - Particle size
  - Particle shape
  - Moisture content
  - Crushing Strength
  - Flow characteristics

# Particle Ballistics

- Ballistics effect greater at higher velocities
- Blended products with different ballistics separate when spread
  - Not wise
    - Potassium chloride and Ammonium sulphate
  - Probably ok
    - Potassium chloride and Urea

# Fertiliser Ballistics and Blends

- Common materials with different physical properties
  - differences significant at 30 - 40m/s
- Unless mixes have similar properties
  - blends not be applied at bout widths > 20m

# Bout Width

- 30m bout requires 45m spread
  - 45m spread = 22.5m throw
- To propel particles 22.5m from 1.5m height
  - must leave disk at  $60\text{m/s} = 216\text{km/h}$
- At these speeds blended fertilisers separate
  - rate of deceleration through drag due to
    - particle density
    - size and
    - shape



# Particle Travel at Eject Velocities

Horiz velocity	AmSulf	DAP	MAP	KCl	Urea	SSP 1.0mm	SSP 2.9mm	SSP 4.7mm
60 <sup>ms-1</sup>	17.0	17.9	18.8	21.8	23.6	17.9	24.0	25.2
50 <sup>ms-1</sup>	15.3	16.0	16.6	18.6	19.8	16.0	20.0	20.9
40 <sup>ms-1</sup>	13.1	13.5	13.8	15.1	15.8	13.5	16.0	16.5
30 <sup>ms-1</sup>	10.2	10.4	10.6	11.3	11.7	10.5	11.7	12.0
20 <sup>ms-1</sup>	6.9	6.9	7.0	7.3	7.4	7.0	7.5	7.6
10 <sup>ms-1</sup>	3.1	3.1	3.2	3.2	3.2	3.1	3.2	3.3

# Conclusion

1. Be aware of products' ballistic properties
2. Blending products with differing ballistic properties increases in-field CV
3. Increasing in-field CV reduces yield
4. Cost saving of increased bout widths often less than loss from striping
5. Reducing the number of applications by blending fertilisers may also be a false saving

# International Protocols

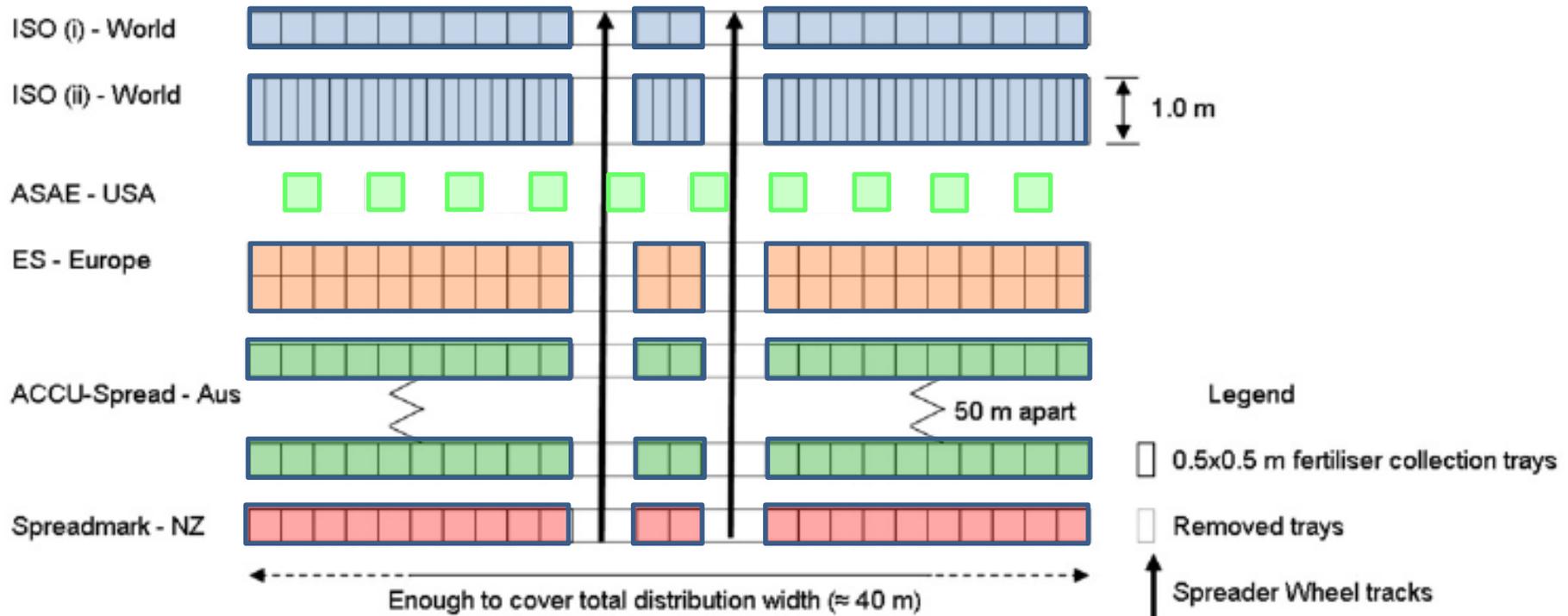
- ISO Standard (i) (ISO 1985)
- ISO Standard (ii) (ISO 1985)
- ASAE Standard S341.2, (ASAE 1999)
- European Standard (CEN 1999)
- Accu-Spread (AFSA 2001)
- Spreadmark (NZFQC 2006)
  
- All use catch trays across travel path

# Lawrence 2006/2007



- 1400 tray matrix used to collect 18 simultaneous transverse tests on a Transpread “W” twin chain spreader

# International Tests: Tray Layouts



Adapted from Jones, Lawrence & Yule, 2007

# Protocol Comparison

	Standard Tray Size <sup>a</sup>	Tray Frequency <sup>a</sup>	Transverse Spacing <sup>a</sup>	Application Rate	Statistical Quality <sup>b</sup>
<b>ISO 5690/1 (World)</b>	0.5×0.5m	Cover total distributing width	Continuous	3 fertilisers 1 pass each	3
<b>ISO 5690/2 (World)</b>	0.25×1.0m <sup>a</sup>	Cover total distributing width	Continuous	3 fertilisers 1 pass each	3
<b>ASAE S341.3 (USA)</b>	> 0.3 m < 10% swath width	10 per swath	Uniform spacing	1 pass	4
<b>ES (Europe)</b>	0.5×0.5m	224 per 56 m (2 rows fixed)	Continuous	6 fertilisers 1 pass each	2
<b>Accu-Spread (Aus)</b>	0.5×0.5m	50 (2 rows 50 m apart)	1.0 m centre to centre	600 kg/ha min Passes to meet	1
<b>Spreadmark (NZ)</b>	0.5×0.5m	60 per 30 m	Continuous	3 fertilisers 1 pass each	3

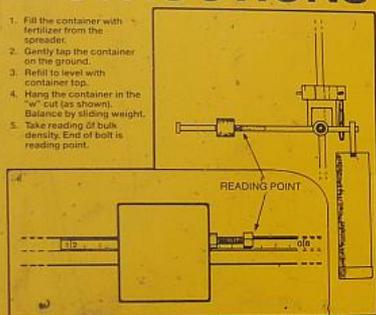
<sup>a</sup>Lawrence, 2007; <sup>b</sup>Jones, Lawrence & Yule, 2007

# On-Farm Checks

- Machine condition and settings
- Fertiliser properties
- Application Rate
- Application Uniformity

## INSTRUCTIONS

- Fill the container with fertilizer from the spreader.
- Getty tap the container on the ground.
- Refill to level with container top.
- Hang the container in the "W" cut (as shown). Balance by sliding weight.
- Take reading of bulk density. End of bolt is reading point.



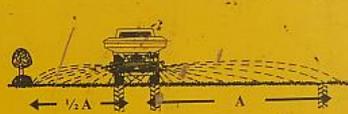
**Setting application rate**

All setting in the spread chart are in liters/ha. It is necessary to know the bulk density in kg/litre of the material to be spread, to convert to kg/ha.

Example:  
Required application rate: 400 kg/ha. Bulk density: 0,8.  
Liters/ha:  $400 \div 0,8 = 500$  l

### Kantspredning / Headland / Bordure Kantspridning / Grenzstreuen

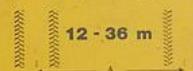
**12 - 28 m**



A	2x	1	1/2
12 m	4,0	1/2	400
15 m	4,0	1/2	450
16 m	4,0	1/2	500
18 m	5,0	1/2	600
20 m	5,0	1/2	700
24 m	5,0	1/2	900
28 m	6,0	1/2	1000

### Spredning i marken / In Field Spreading / EPANDAGE PLEIN CHAMP / Streuen af dem Acker / Spridning på fältet

**12 - 36 m**



A	2x	1	1/2
12 m	0		450
15 m	1		540
16 m	1		540
18 m	2		600
20 m	2,5		700
24 m	4		900
28 m	4		1000
30 m	4,5		1000
32 m	5		1000
36 m	5,5		1000

\* Pilet gødning max 800 rpm / Pilede læstiler max 800 rpm / Gevælt Dønger max 800 rpm.  
Gevoende for gødningsrøper som ændret i instruktionsbogen.  
Værdi for læstiler types som stædt i håndboken.  
VALABLE POUR DES ENGRAIS IDENTIQUES A CELUX MENTIONNÉS  
DANS LE MANUEL D'UTILISATION.  
Für Düngemittel, die aufgeführt sind in der Bedienungsanleitung.

# Machine Condition and Settings

1. Ensure machine is working correctly
  - Components in good order
  - Disks spinning
2. Ensure machine is correctly set up
  - Horizontal
  - Height
  - Disk vanes
  - Doors





1500



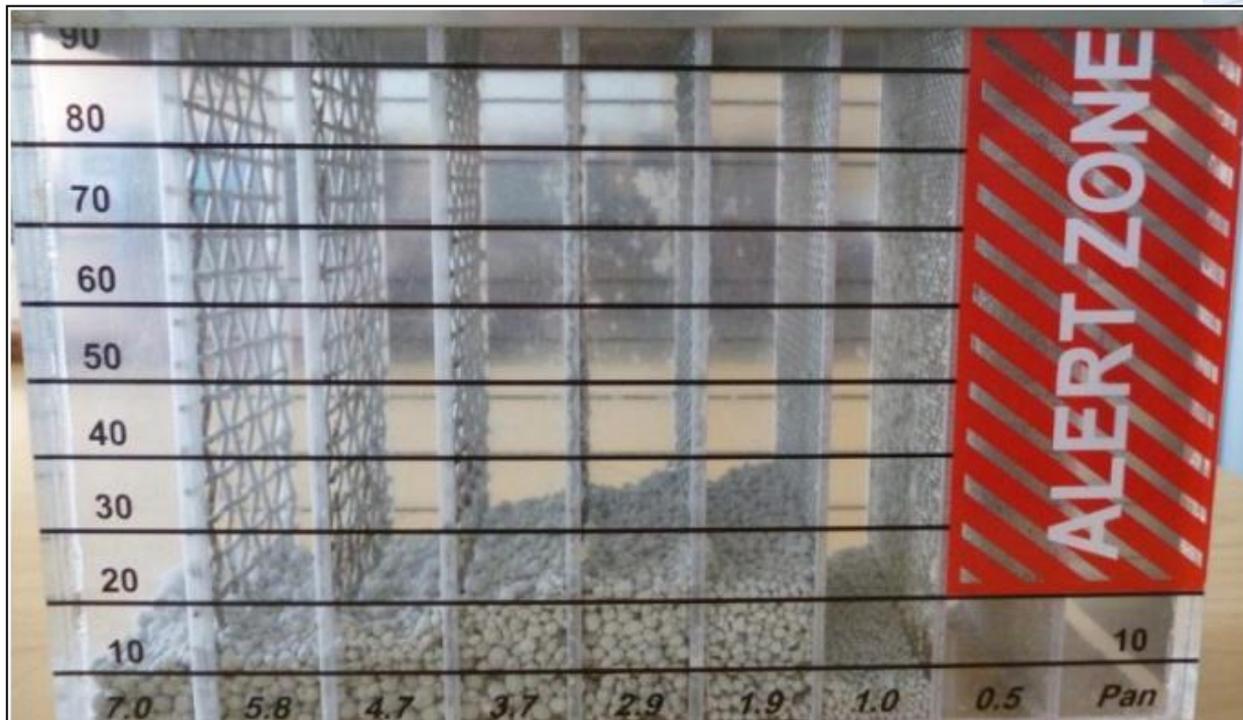


DPX 28



# Fertiliser Properties

- Bulk density
- Size Guide Number
- Uniformity Index



# Application Rate

Mass per area (kg/ha)

1. Load known quantity of fertiliser
2. Drive set distance applying fertiliser
3. Calculate weight of fertiliser applied
4. Determine Discharge Rate
5. Determine Application Rate
6. Compare to Target Rate

ze Guide Number

Uniformity Index

**RATE CALCULATION**

Target fert/m run

Fertiliser caught

Time catching

Fertiliser Flow rate

Target travel speed

**MISCELLANEOUS**

Wind Speed

Wind Angle to Travel

Nozzle Size

kg/m

kg

sec

kg/min

km/h

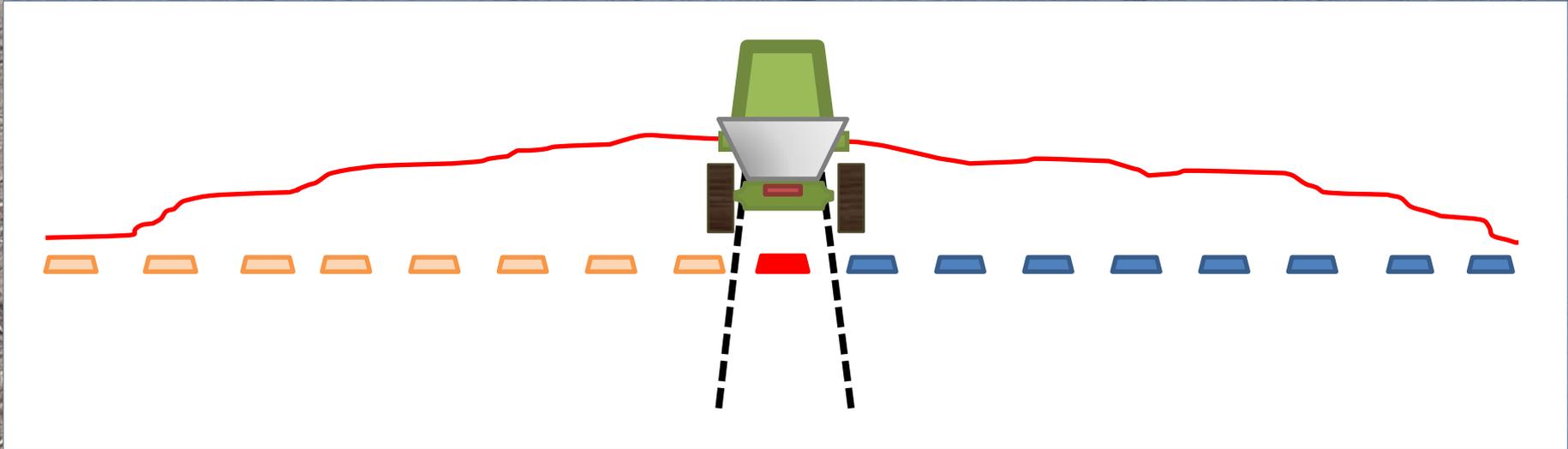
m/s

dm

# Application Uniformity

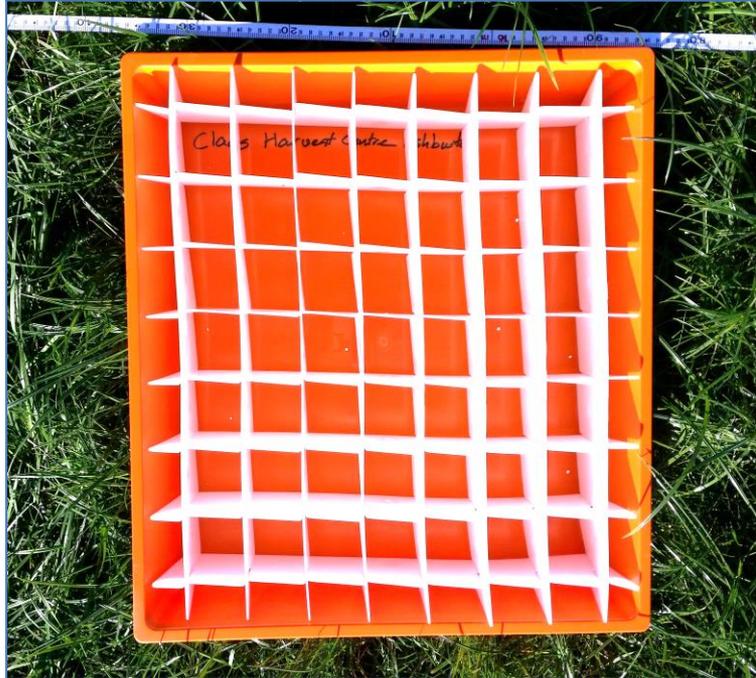
1. Place trays equally spaced across swath
  - Central tray under tractor
  - Equal numbers each side to adjacent runs
  - Record bout width
2. Drive over trays at normal application rate
  - Record speed
3. Collect caught fertiliser in labelled containers
4. Weigh each sample

# Layout





# Baffled Collection Trays



# Apply Fertiliser

- Single pass
- Application Rate normally used
- If want more to weigh, drive twice
- DO NOT increase application rate



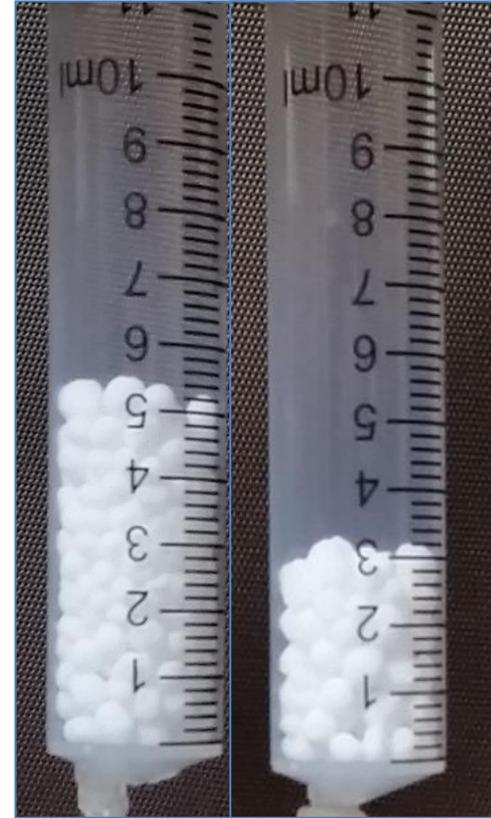


# Weigh Samples

- Need to be accurate
  - Scales must read to 0.01g
  - Very small quantities
  - Weigh out of wind/air movement
  - Easiest inside

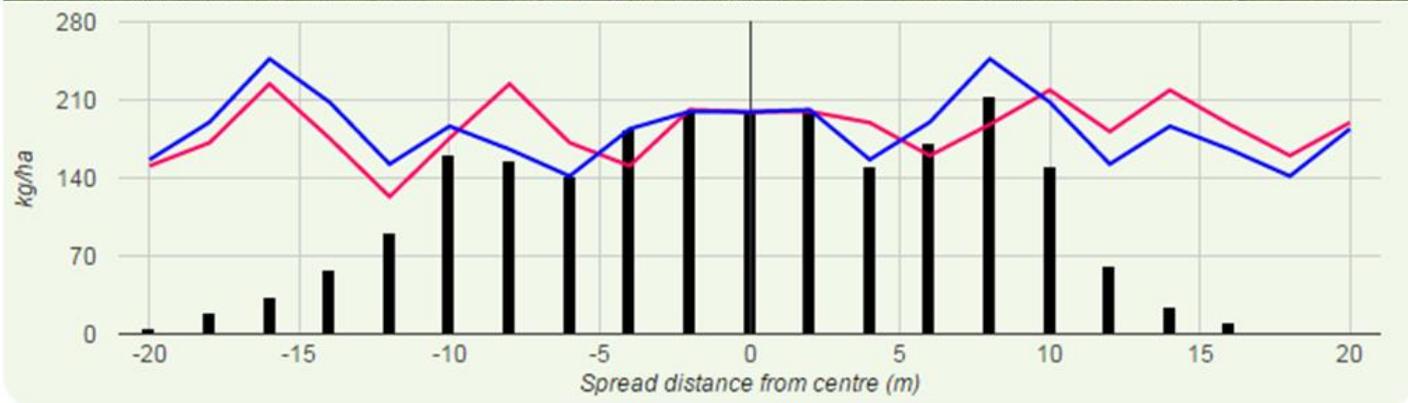


# Alternatively Use Volumes



- Need to convert: multiply by bulk density

# FertSpread



[www.fertspread.nz](http://www.fertspread.nz)



# Record Data on Field Sheet

**LandWISE** Fertiliser Association Sustainable Farming Fund

### Fertiliser Applicator Calibration: Calculator Field Sheet

**TEST DETAILS**

Date	30/4/15
Assessor	Dan
Site	Greenme Pastures
Test Number	2
Client	Craig Mackenzie
Address 1	
Address 2	
Address 3	

**VEHICLE DETAILS**

Vehicle	JD
Registration #	
Engine speed	
PTO speed	
Travel Distance	
Travel Time	
Travel Speed	

**SPREADER DETAILS**

Brand	
Model	
Spreader type	
Condition	
Age	
Discharge height	
Spinner Revs	
Door	
Vanes	
Bout width	
Spread Width	
Adjacent bouts	Round+Round

**FERTILISER**

Fertiliser Type	Nitrogen	Non-Nitrogen
Fertiliser		
Target Rate		
Fertiliser Density		
Sieve Size (mm)		
Pan		
0.5		
1.0		
1.9		
2.9		
3.7		
4.7		
5.8		
7		
Sum		
Size Guide Number		
Uniformity Index		

**RATE CALCULATION**

Target fert/m run		kg/m
Fertiliser caught		kg
Time catching		sec
Fertiliser Flow rate		kg/min
Target travel speed		km/h

**MISCELLANEOUS**

Wind Speed		m/s
Wind Angle to Travel		deg
Tray Size		m <sup>2</sup>
Tray Spacing		m

with support of MPI Sustainable Farming Fund, Foundation for Arable Research and Fertiliser Association

Download from [www.fertspread.nz](http://www.fertspread.nz)

## Fertiliser Applicator Calibration: Calculator Field Sheet

### TEST DETAILS

Date	
Assessor	
Site	
Test Number	
Client	
Address 1	
Address 2	
Address 3	

### VEHICLE DETAILS

Vehicle	
Registration #	
Engine speed	rpm
PTO speed	rpm
Travel Distance	m
Travel Time	sec
Travel Speed	km/h

### SPREADER DETAILS

Brand	
Model	
Spreader type	
Condition	
Age	
Discharge height	m
Spinner Revs	
Door	
Vanes	
Bout width	m
Spread Width	m
Adjacent bouts	Round+Round To+Fro

### FERTILISER

Fertiliser Type	Nitrogen	Non-Nitrogen
Fertiliser		
Target Rate		kg/ha
Fertiliser Density		kg/L
Sieve Size (mm)	% of Particles	
Pan		
0.5		
1.0		
1.9		
2.9		
3.7		
4.7		
5.8		
7		
Sum		
Size Guide Number		
Uniformity Index		

### RATE CALCULATION

Target fert/m run	$\frac{\text{Target rate} \times \text{bout width}}{10,000}$	kg/m
Fertiliser caught		kg
Time catching		sec
Fertiliser Flow rate	$\frac{\text{Fertiliser Caught}}{\text{Time Catching}}$	kg/min
Target travel speed	$\frac{\text{Fert Flow Rate} \times 60}{\text{Target/m run} \times 1000}$	km/h

### MISCELLANEOUS

Wind Speed		m/s
Wind Angle to Travel		deg
Tray Size		m <sup>2</sup>
Tray Spacing		m

### CATCH DETAILS Run Number:

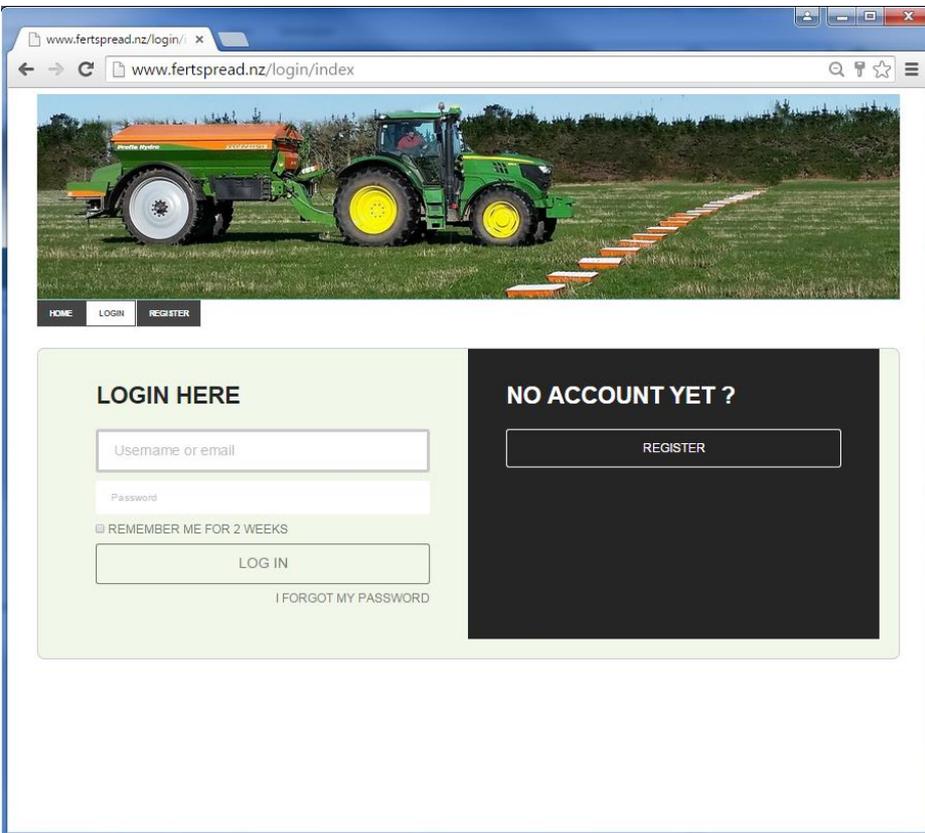
Tray	Dist from Centre	Weight
LEFT	-20	
	-19	
	-18	
	-17	
	-16	
	-15	
	-14	
	-13	
	-12	
	-11	
	-10	
-9		
-8		
-7		
-6		
-5		
-4		
-3		
-2		
-1		
0		
RIGHT	1	
	2	
	3	
	4	
	5	
	6	
	7	
	8	
	9	
	10	
	11	
12		
13		
14		
15		
16		
17		
18		
19		
20		

### CATCH DETAILS Run Number:

Tray	Dist from Centre	Weight
LEFT	-20	
	-19	
	-18	
	-17	
	-16	
	-15	
	-14	
	-13	
	-12	
	-11	
	-10	
-9		
-8		
-7		
-6		
-5		
-4		
-3		
-2		
-1		
0		
RIGHT	1	
	2	
	3	
	4	
	5	
	6	
	7	
	8	
	9	
	10	
	11	
12		
13		
14		
15		
16		
17		
18		
19		
20		

# Enter Data in FertSpread

- Log into account (or Register)



www.fertspread.nz/login/ x  
www.fertspread.nz/login/index



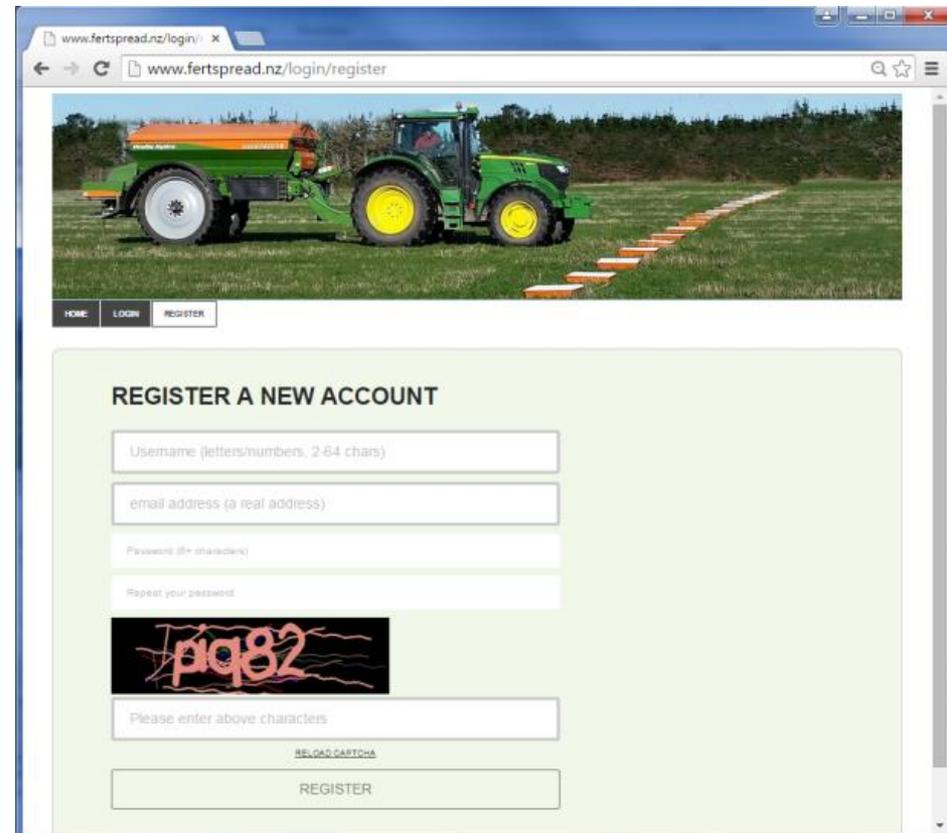
HOME LOGIN REGISTER

### LOGIN HERE

REMEMBER ME FOR 2 WEEKS

[I FORGOT MY PASSWORD](#)

### NO ACCOUNT YET ?



www.fertspread.nz/login/ x  
www.fertspread.nz/login/register



HOME LOGIN REGISTER

### REGISTER A NEW ACCOUNT



[RELOAD CAPTCHA](#)



HOME

START ASSESSMENT

RATE CALCULATOR

VIEW REPORTS

MY ACCOUNT

# Fertiliser Spread Analysis & Calibration Tool

This site allows you to use your test results to calculate your fertiliser product Size Guide Number (SGN) and Uniformity Index (UI) ensuring that it is within the recommended ranges.

You can calculate your fertiliser flow rate and determine how many kg/ha you're actually placing.

Finally and most importantly the tool allows you to analyse your Broadcast spreader configuration and based on your test results allows you to optimise your bout widths and ensure that you're laying consistent, cost effective fertiliser spread patterns where ever possible.

## Download the field sheet

You can download the latest Fertiliser Applicator Calibration Calculator (FACC) field sheet from the link below.

[Download the FACC field sheet](#)



HOME

START ASSESSMENT

RATE CALCULATOR

VIEW REPORTS

MY ACCOUNT

## Enter Test Details

Test Date:

Test Site:

Company Name:

Contact Name:

Email Address:

Phone Number:

Address:

Region:

Country:

Continue

www.fertspread.nz/report. x

www.fertspread.nz/report/editVehicleDetails



HOME START ASSESSMENT RATE CALCULATOR VIEW REPORTS MY ACCOUNT

## Update Vehicle Details

Vehicle:

Registration #:

Engine Speed:

PTO Speed:

Travel Distance:

Travel Time:

Travel Speed:

Continue

www.fertspread.nz/report

www.fertspread.nz/report/editSpreaderDetails



HOME START ASSESSMENT RATE CALCULATOR VIEW REPORTS MY ACCOUNT

## Update Spreader Details

Make:	Vicon
Model:	GeoSpread
Condition:	Good
Age:	3
Discharge Height:	2
Spinner Revs:	540
Door:	Auto
Vanes:	Vanes
Bout Width:	24.00
Spread Width:	40.00
Adjacent Bouts:	TF

Continue



## Update Fertiliser Details

Fertiliser Product:	<input type="text" value="Urea"/>
Nitrogen Based:	<input type="text" value="y"/>
Target Rate (kg/ha):	<input type="text" value="150"/>
Bulk Density (kg/L):	<input type="text" value="0.74"/>
Sieve Sizes (mm):	<input type="text" value="% of Particles"/>
Pan:	<input type="text" value="0"/>
0.5 Aperture Size:	<input type="text" value="0"/>
1.0 Aperture Size:	<input type="text" value="0"/>
1.9 Aperture Size:	<input type="text" value="3"/>
2.9 Aperture Size:	<input type="text" value="58"/>
3.7 Aperture Size:	<input type="text" value="34"/>
4.7 Aperture Size:	<input type="text" value="5"/>
5.8 Aperture Size:	<input type="text" value="0"/>
7.0 Aperture Size:	<input type="text" value="0"/>
Sum:	<input type="text" value="100"/>
Size Guide Number:	<input type="text" value="255"/>
Uniformity Index:	<input type="text" value="64"/>



### Update Catch Details

Tray Count:

Tray Size:

Tray Spacing:

Wind Speed:

Wind Direction:

Tray Count

Tray Size

Tray Spacing

Tray	Distance from Centre (m)	Weight (g)
LEFT	-10	0.14
	-6	0.46
	-6	0.82
	-7	1.44
	-6	2.27
	-5	4.03
	-4	3.88
	-3	3.54
	-2	4.6
	-1	4.99
0	0.0	4.98
RIGHT	1	5.03
	2	3.77
	3	4.29
	4	5.35
	5	3.76
	6	1.54
	7	0.63
	8	0.26
	9	0
	10	20.00

Weight Caught

Continue



## Select Report

Choose Test: FertSpread Calculator, Trial Farm, 2015-07-15

Edit Report

View Report

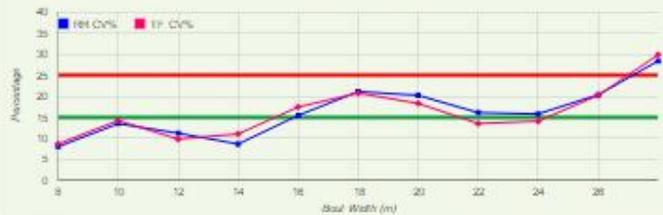
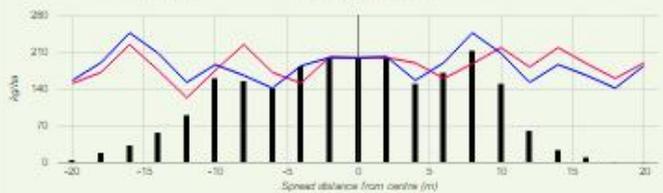


# Fertiliser Spread Assessment Report

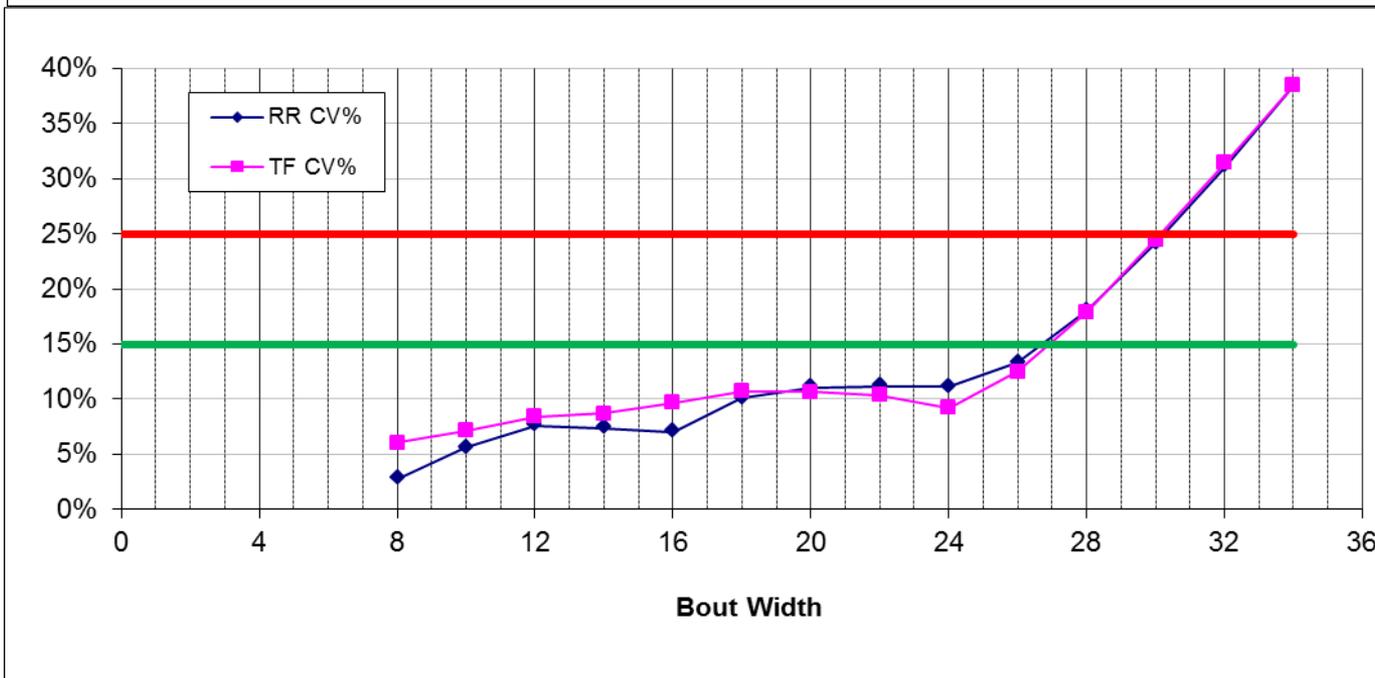
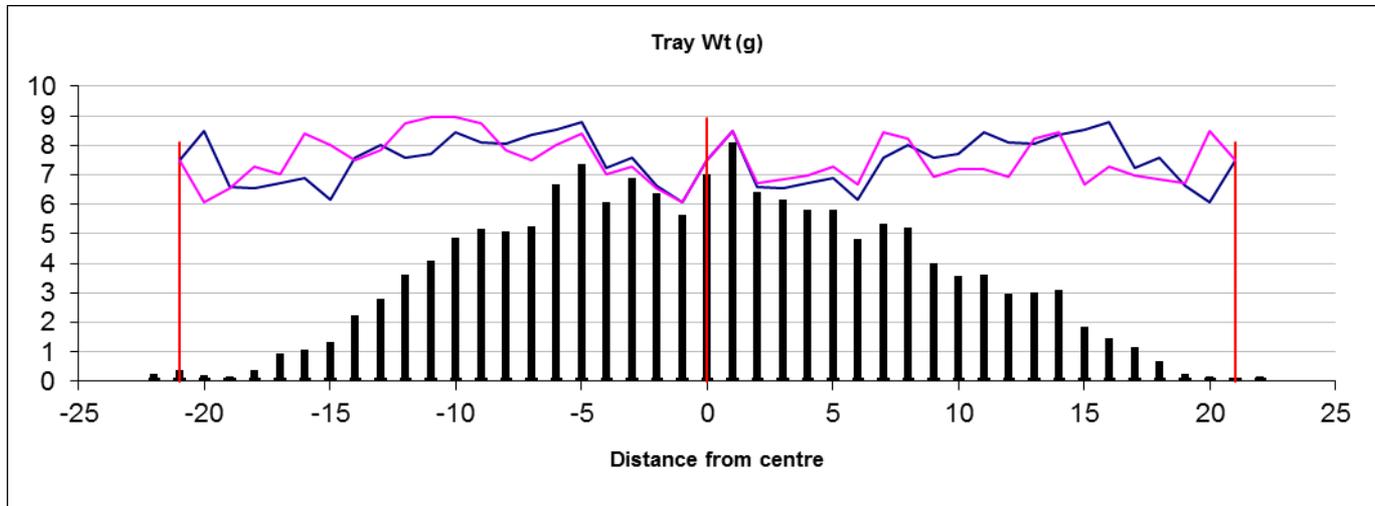
Create PDF

Company Name: FertSpread Calculator	Product: Urea	Particle Size Distribution
Site Tested: Tria Farm	Nitrogen: 7	
Test Date: 2015-07-15	Bulk Density: 0.74 kg/L	
Treated By: Manager	Plan: 0 %	
Wind Speed: 5.00 m/s	0.5 mm: 0 %	
Wind Direction: 45 deg	1.0 mm: 0 %	
Vehicle: JCB	1.9 mm: 3 %	
Registration #:	2.9 mm: 58 %	
Spreader Make: Vicor	3.7 mm: 34 %	
Spreader Model: Gridspread	4.7 mm: 5 %	
Spreader Age: 3	5.8 mm: 0 %	
Spreader Condition: Good	7.0 mm: 0 %	
Discharge Height: 2	SGN: 255	
Spinner Revs: 540	UL: 64	
Door: Auto		
Vans:		

Set Bout: 24.00 m	Tray Size: 0.25 m <sup>2</sup>	C/a at Set Bout: 80%	15.7/88	EP%: 14.08/76
Set Rate: 300 kg/ha	Tray Spacing: 2.00 m	Measured Rate: 104 kg/ha	Left %: 51.52	Right %: 48.48



# Spread Pattern & CV



# Testing Placement Machine



