Department of
Primary Industries and Regional Development

GOVERNMENT OF WESTERN AUSTRALIA

SAGI
Statistics for the Australian Grains Industry
National | North | West | South

Trial design, implementation and analysis

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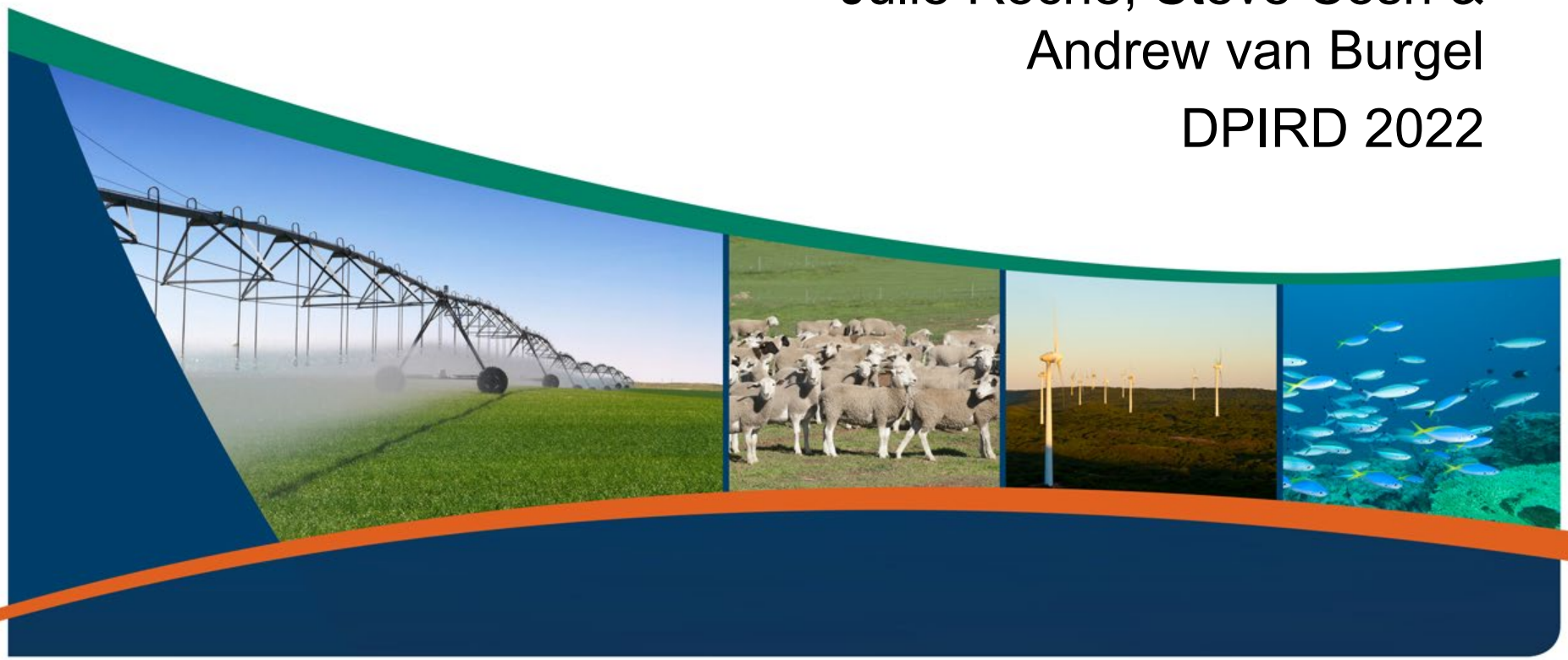
Andrew van Burgel
DPIRD 2022



Workshop outline

Section 1 – Design

Section 2 – Site selection

Section 3 – Analysis

Section 4 – Presenting results

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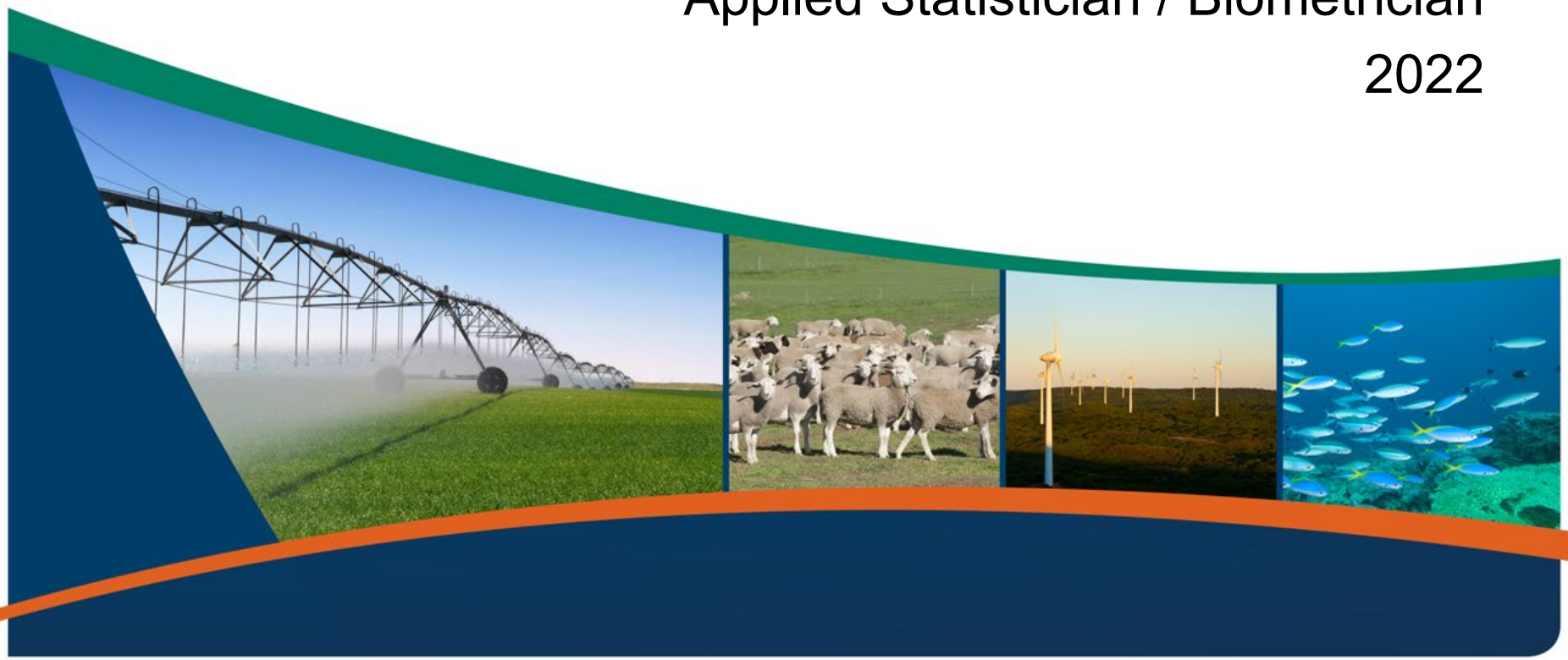
Trial Design

Andrew van Burgel
Applied Statistician / Biometrician

2022



About myself

- Biometrician or Applied Statistician.
- Working in this role since 2003
- Honours degree in Statistics from UWA
- Based in Albany, but assist research across WA
- Mostly cropping research, but also livestock, horticulture, …
- Two colleagues in our Perth office: Karyn Reeves and Rebecca O'Leary
- Also collaborate with SAGI (Statistics for the Australian Grains Industry) funded by GRDC.

A successful research trial has many aspects...

Some we wont be expanding on today:

- Defining clearly the research question
- Finding out what others have done
- Choosing an appropriate set of treatments
- Deciding what you are going to measure

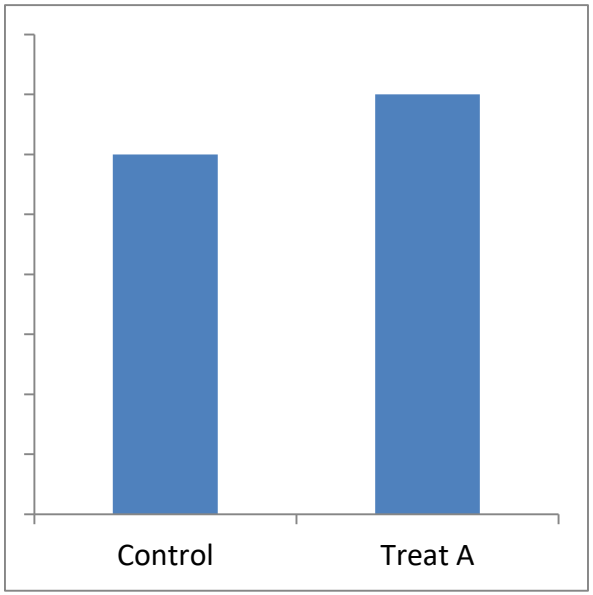
Others we will be exploring today:

- Trial design, especially including replication of all treatments
- Selecting a suitable location and implementing the trial well
- Appropriate statistical analysis
- Sound presentation of results

Why bother with a design?

Why not just try a treatment and see if it works?

- The results we observe include both:
  - Treatment effect
  - Other effects (error / variation)



- Treatment A may have given a higher result because of other factors while Treatment A actually has no positive effect.

- Conclusions should be reached only if we have high confidence the results we observe are due to treatment effects and not error / variation.

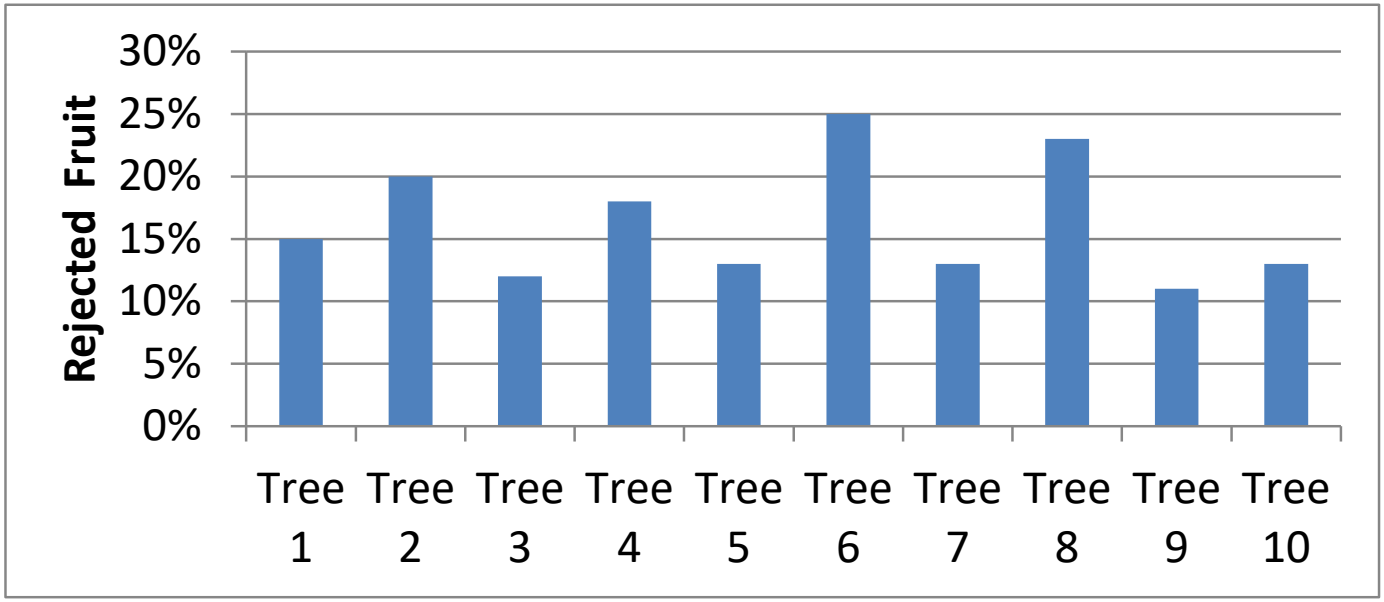
Variation

Variation is present in all trials

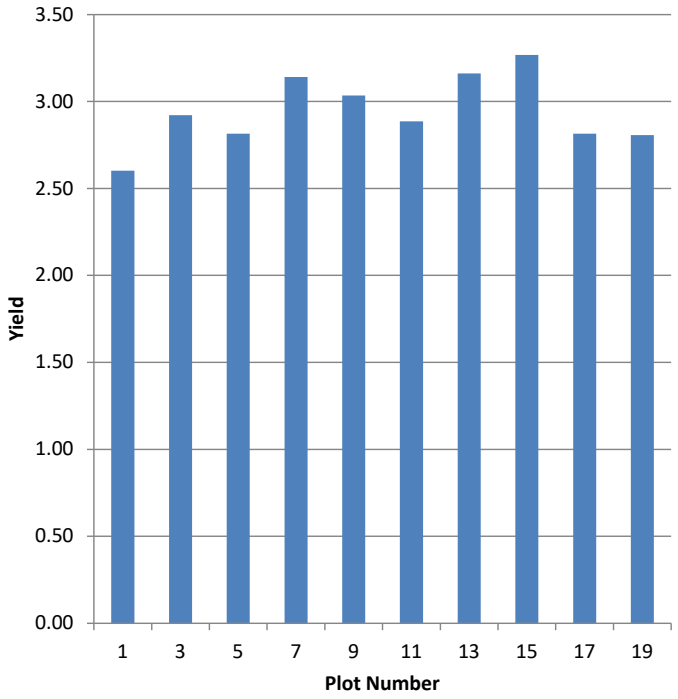
- environmental variation (soil, water, tree vigour, etc)
- sampling, operator and mechanical error/variation

Variation Example 1 (Horticulture)

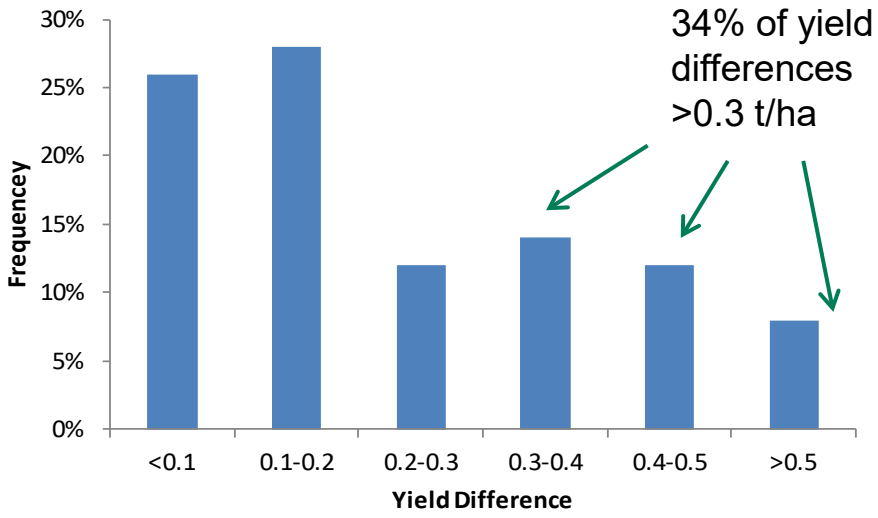
- % of fruit rejected due to wind blemish based on 100 fruit sampled on each of 10 trees



Variation Example 2 (Cropping)



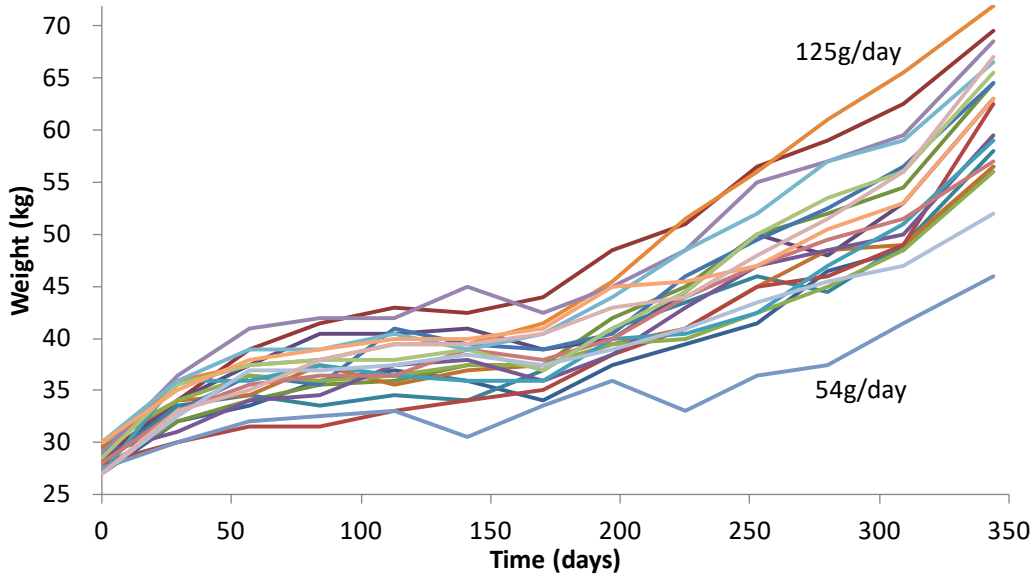
Control yields (every 2nd plot in this trial)



Differences between consecutive control plots (2010 wheat trials, 12 farms, 50 differences)

Variation Example 3 (Livestock)

- ***Variation in growth from animals receiving the same feed treatment***



Assume no replication

There is no way to tell if the difference is due to treatment or something else!

- **It could be a 'once-off'.**

Average results from all 13 reps: Untreated 3.4 t/ha vs Seed treated 3.4 t/ha

- **No difference!**

Replication

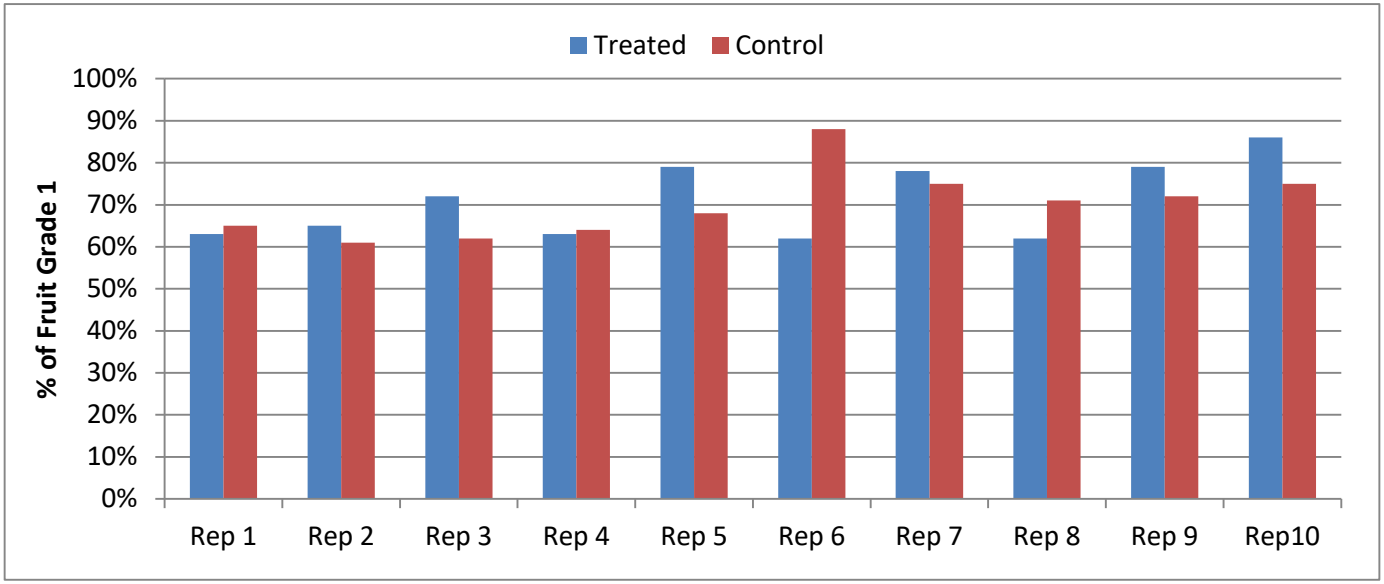
Benefits of Replication

- gives confidence that our treatment effect is not a “once-off” or due to other factors
- greater accuracy to the size of the treatment effect
- gives a measure of background variability
  - essential for a statistical analysis to determine if we have high confidence the treatment effect is real

If you don’t have resources to replicate, I would consider not doing the trial due to the high risk of coming to a wrong conclusion.

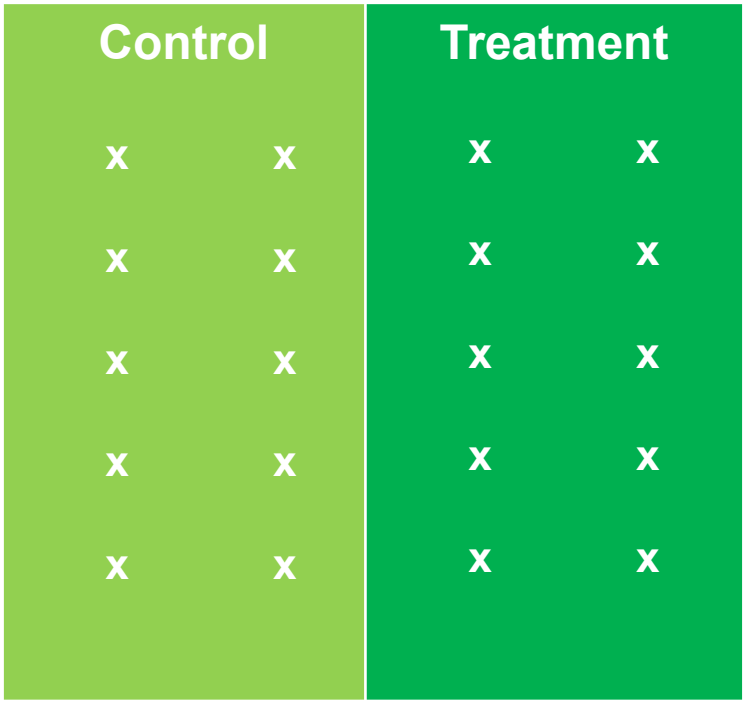
Replication

Results from a 10 rep trial

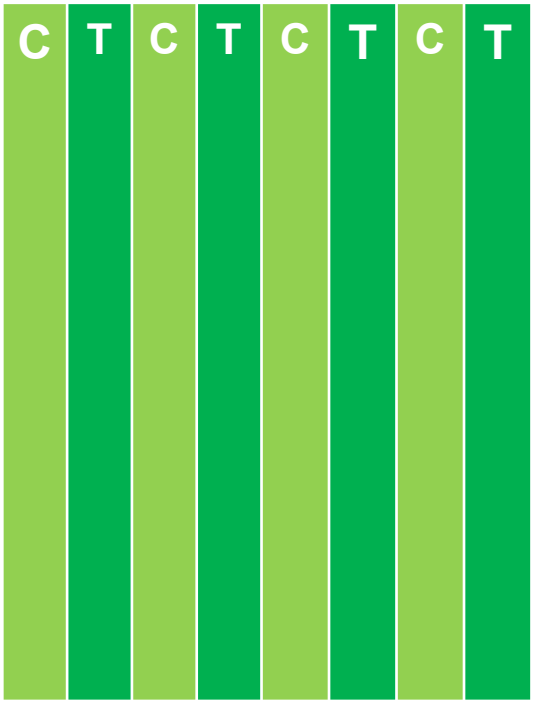


- Average difference is very small (<1%) and not significant
- If only 1 rep was done (eg. Rep 5 or 6) a wrong conclusion could easily be reached.

True and false replication – Example 1



False replication



True replication

True and false replication – Example 2

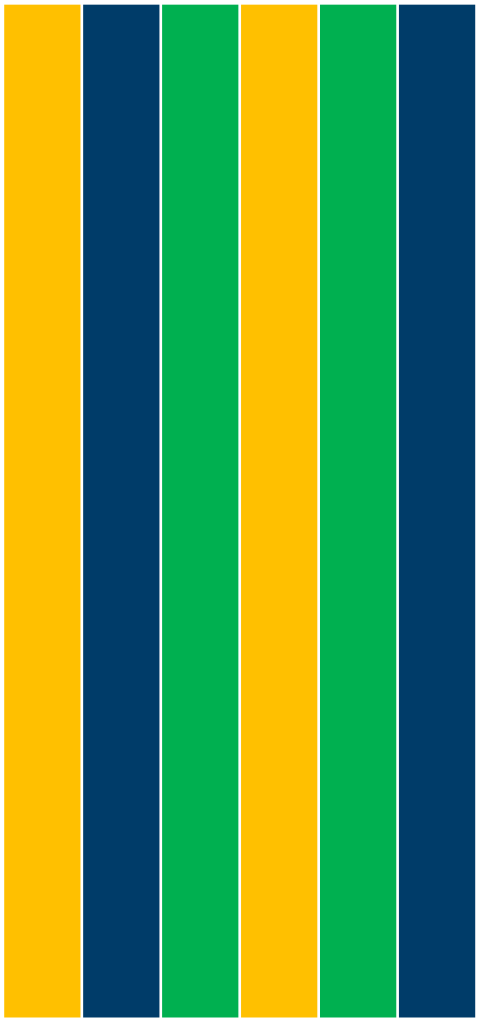
- 2 treatments (* = tree with net, * = tree without net)
- single row of trees

Good design (true replication)

Poor design (false replication)

How many treatments and reps?

- **Minimum of 2 reps by 3 treatments**
  - eg. with 2 reps, may need treatments to be different by about 0.5 t/ha (in a high yielding environment) to have high confidence (95%) the difference is real.
- **More reps is better**
  - gives greater confidence in the results and less risk of wrong or inconclusive results
- **How about only one strip of each treatment?**
  - could have replication at say 200m intervals down the strip
  - risk is that variation/error impacting the whole strip (e.g. wind, harvest width) appears as treatment effects.
  - also limits the ability to analyse zones



Trial design

Poor design:

1. treatments comparison may not be valid
2. usually can't be fixed by clever analysis
3. can give wrong conclusions:

Real Treatment Effect	Conclusion from Experiment	Industry impact
Yes	No	Lost opportunity
No	Yes	Extra cost for no benefit

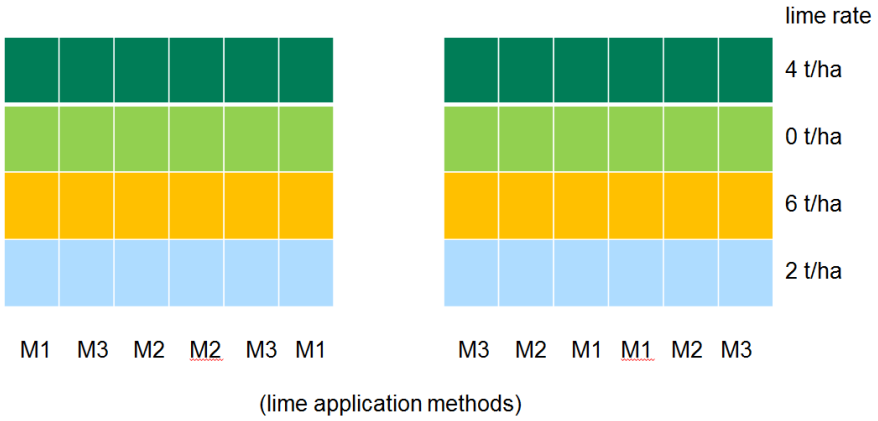
Design is a very important step!

- Recommend: careful planning and biometrician input.

Design

Examples where the design could be improved:

Raised bed and control treatments



4 lime rates by 3 application methods (M1, M2, M3)

Take Home Messages

- There is always variation/error
- A good design includes true replication, a minimum of 2 reps of all treatments
- Questions…

Thank you

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