Animal vs herd as replicate in grazing experiments

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Why this paper

Animal grazing systems: production systems at times compared using a single herd (the experimental unit) for each system.

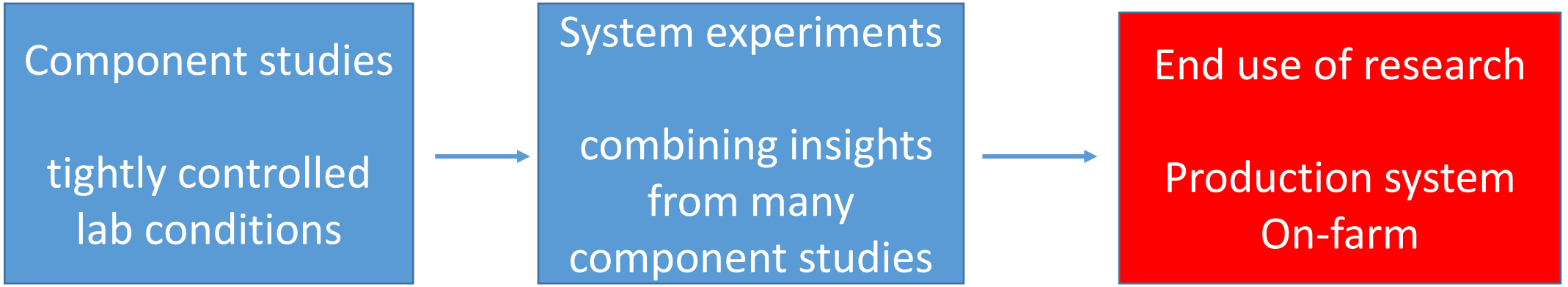
Criticism: need replicated.experimental units (herds)
Comparison of systems based on animal to animal variation within herds is invalid (pseudoreplication, Hurlbert 1983).

Journal policy (some journals): Reject MS where herds are not replicated.

Purpose

- to understand the issues
- is there a basis to review journal policies

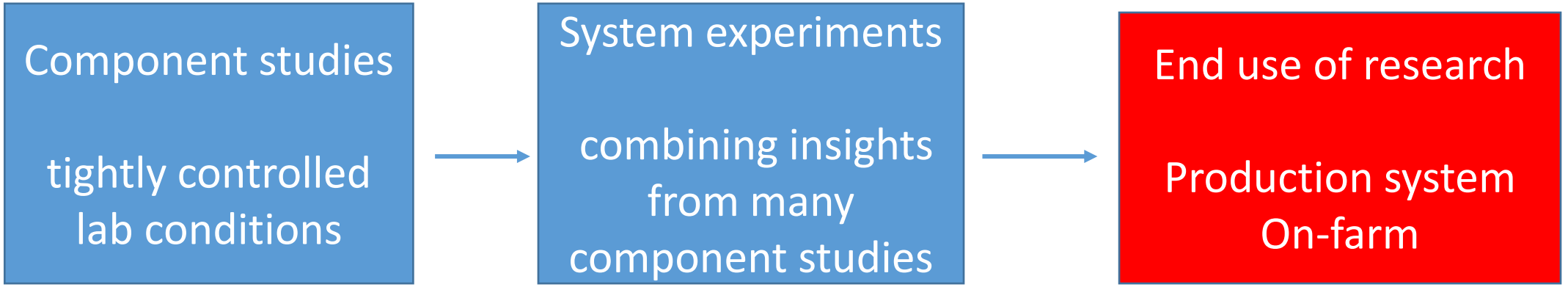
An axis of scientific studies



Perspective on role of these studies in practice

An axis of scientific studies

Bridge



Perspective on role of these studies in practice

Background

Three influential themes from literature of last 60+ years

A **animal behaviour studies** on independence of animal responses in a herd
– relevance?

B **Statistical design theory**
– best can be the enemy of the good?

C **Scientific and practical context of systems studies**
– is the scientific focus of journals sometimes too narrow?

A. Animal Behavioural Studies

Between animals in the same group

Social facilitation (SF): *The behaviour of subject A **affects** that of B*

Behaviour synchronisation (BS): *Animals have same behaviour at same time*

Basic points

- *behaviour of animals in groups **may** introduce dependence among animals through SF and this may arise from BS.*
- *Dependence between animals in behaviour **may** affect statistical tests on other responses (e.g. weight gain)*

A Animal Behavioural Studies

- The BS assessments in Rook et al (1991) provide NO hard evidence that BS is associated with SF and so induces dependence between animals. ***Their argument that individual animals should not be used as replicates in grazing experiments is not justified by their analysis. Critical review (statistics and science) of this and related work needed***
- External factors may affect BS without involving SF (diurnal patterns, weather etc).
- Lack of independence in some responses **does not imply** dependence between animals for all responses

B Statistical context.

Replicated herds would be the surest approach

But, **statistically:**

1. Classical analysis models may be **incomplete** (e.g. omit **competition between animals**)
2. Others suggest alternatives
3. How important is **between herd variation**?
4. **Meta-analysis** of replicated and unreplicated experiments.

    (i) to get more general inference
    (ii) to supplement weaknesses of a single experiment

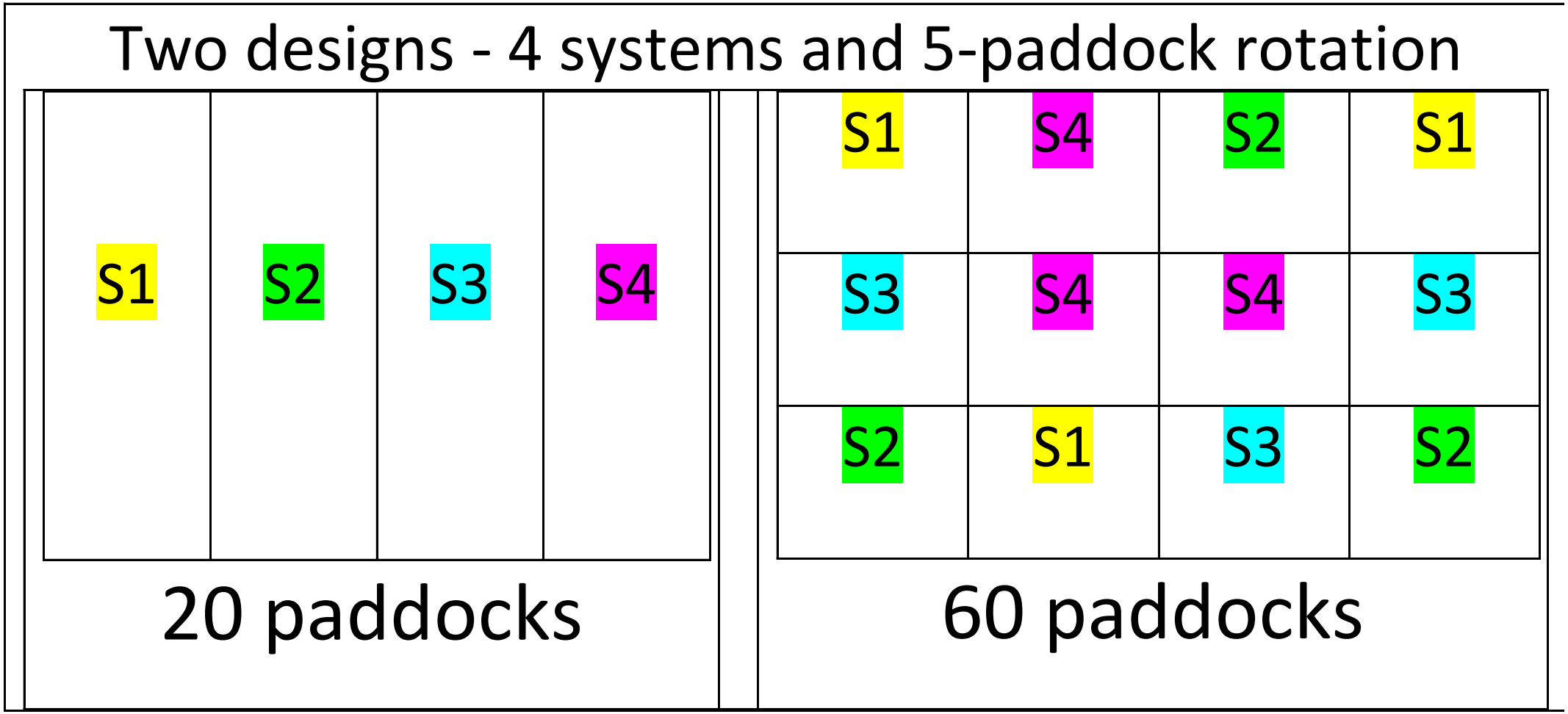
B Statistical context.

But, **practically:**

Forcing classical design methods may be inappropriate

- If 15 animals per herd is appropriate **it may be impossible to replicate** (Colgrave & Ruxton, 2018). Abandon study?
- If one ‘forces’ the use of 3 herds of size 5

Two designs - 4 systems and 5-paddock rotation



- **Is the scientific question changed?**
- Is the value of the experiment in **extension** degraded?

C Scientific and practical context

A systems grazing experiment checks how effectively component research combines in a wider context

- Many **system variables** estimated with lower precision (e.g. dynamics of gaseous emissions and leachates)
- **journal design constraints may**
  - alter the scientific question
  - diminish the bridge to the end-user
  - reduce the number of system experiments - the **loss to science and to practice**?

Journals may need to recognise the particular role of systems experiments

What to do?

It will not be easy to overturn decisions

Make a counter case

How?

Build a case based on Institutional collaboration and Scientific research

Institutional

(a) **Network** of scientists/institutions

(b) Establish **rationale for journal policies**

(c) Collate views on **impact of the journal policies** on system experiments and extension

(d) **Collaborate** on multisite systems experiments

(e) Seek **review of journal policies** (eventually)

Scientific Research

(a) Analyse the arguments based on **animal behaviour studies**

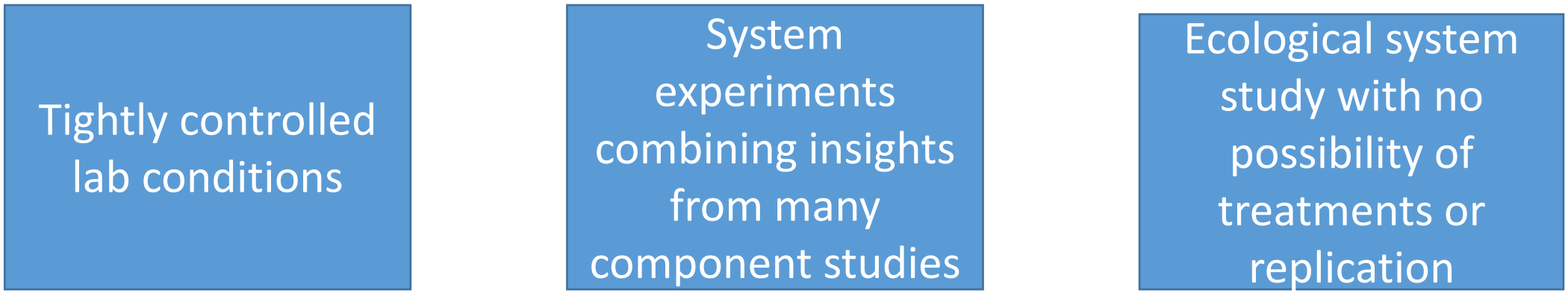
(b) Analyse and extend the **statistical basis** for analysis of system experiments

(c) **Combined analysis** of data from existing experiments with replicated and unreplicated herds

(d) **Review** the basis for using **information** from system experiments (are journal policies too narrow)

Thank you for your attention

An axis of scientific studies



Perspective on role of these studies in science

Background

- Morley & Spedding 1968 - review the issues
- Some early analyses

Source	Species	Expt.-years	Location	Method of comparison*
Petersen & Lucas 1960	Steers	40	10 expt stations SE and Mid West US	(a)
Conniffe 1976	Steers	12	Grange, Moorepark	(a) Grange (b) Moorepark
Connolly 1978	Sheep	7	Grange	(a) (b)
	Mixed Steers & Sheep	3	Creagh	(b)

- More recent series of papers by Rook et al, Phillips, Jason and Elston, Bello et al, etc

Related issues in ‘non-banned’ experimental methodologies

- Discuss whether other experiments have similar issues.

Example 1: Silage experiments with separate animal feeding but no replication of the silage making process

Example 2: Estimation of CO_2 fluxes in experimental plots using single flux towers (Davis et al 2010 Agricultural and Forest Meteorology 150:564-574)

E Related issues in ‘non-banned’ experimental methodologies

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Some references

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Thought experiments

Behaviour synchronisation: *Same behaviour at the same time*

Social facilitation: *The behaviour of subject A affects that of B*

Jack and Jill start breakfast at 8 am and finish at 8.20

Is there behavioural synchronisation?

Is there social facilitation?

Thought experiments

Behaviour synchronisation: *Same behaviour at the same time*

Social facilitation: *The behaviour of subject A affects that of B*

Jack and Jill start breakfast at 8 am and finish at 8.20.

Jack and Jill live together

Is there behavioural synchronisation?

Is there social facilitation?

Thought experiments

Behaviour synchronisation: *Same behaviour at the same time*

Social facilitation: *The behaviour of subject A affects that of B*

Jack and Jill start breakfast at 8 am and finish at 8.20.

Jack lives in Melbourne and Jill in New York

Is there behavioural synchronisation?

Is there social facilitation?

Thought experiments

Behaviour synchronisation: *Same behaviour at the same time*

Social facilitation: *The behaviour of subject A affects that of B*

Cows going to milking: each cow is timed when it passes a gatepost

Is there behaviour synchronisation (behaviour is 'passing the gatepost'?

Is there social facilitation?