*Chapter Four notes* ***for Agri-food research***

Summary from page 119

*Causation, in the statistical sense, means that when we intervene, the chances of different outcomes are systematically changed.*

Much of agri-food research is about causation – we want to **intervene** to do things like: capture more carbon in fields, increase crop yields, have happier and more productive cows, reduce bacteria counts in food being processed etc etc

*Causation is difficult to establish statistically, but well-designed randomized trials are the best available framework.*

‘**Correlation Does Not Imply Causation**’. Unfortunately, statistics is about quantifying and modelling correlations! Causal knowledge requires the integration of data, background knowledge, science and imagination!

Ideally, we would like to know how each unit in an experiment with two treatments **would have responded under both treatments (in exactly the same time and set-up).** We only ever measure the result for one treatment at a time – this is the **facts** on which we do statistics. Counter-factual reasoning is thinking about if the facts were different – in this context “how the same units would have gone with the other treatment”.

Randomising “treatments” among a homogenous population and measuring differences between treatments is a “gold standard” for contributing to causal knowledge.

Partly because this is step closer to “counter-factual” observation. And partly because the risk of biases are controlled (on average).

*Principles of blinding, intention-to-treat and so on have enabled large-scale clinical trials to identify moderate but important effects.*

Not so relevant to agri-food research. Exceptions may be with animal behavioural studies and other animal-based experiments.

*Observational data may have background factors influencing the apparent observed relationships between an exposure and an outcome, which may be either observed confounders or lurking factors.*

Think of the cherry tree example in the summary notes for Chapter Three (see those notes).

*Statistical methods exist for adjusting for other factors, but judgement is always required as to the confidence with which causation can be claimed.*

Judgement includes incorporating things like (see page 115):

**Direct evidence**:

The size of the effect is so large that it cannot be explained by plausible confounding.

There is appropriate temporal and/or spatial proximity, in that cause precedes effect and effect occurs after a plausible interval, and/or cause occurs at the same site as the effect.

Dose responsiveness and reversibility: the effect increases as the exposure increases, and the evidence is even stronger if the effect reduces upon reduction of the dose.

**Mechanistic evidence:**

There is a plausible mechanism of action, which could be biological, chemical, or mechanical, with external evidence for a ‘causal chain’.

**Parallel evidence:**

The effect fits with what is known already.

The effect is found when the study is replicated.

The effect is found in similar, but not identical, studies.

**Q. How do these 7 things relate to the urchin data?**