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Communicating risk

David Pannell

Question 1

Scan the QR or use link to join

The probability that a randomly chosen woman has breast cancer is 0.8 percent. If a woman who has breast cancer undergoes a mammogram, the probability is 90 percent that the mammogram result will be positive (i.e. indicating that she does have breast cancer). If a woman who does not have breast cancer undergoes a mammogram, the probability is 7 percent that she will have a positive mammogram. Imagine a woman who has a positive mammogram. What is the probability that she actually has breast cancer?

Give a number between zero and 1 (2 decimal places).

- Gigerenzer (2002) asked a sample of physicians
- 8% got it correct

Gigerenzer, G. (2002). *Reckoning With Risk*, Penguin.

Question 2

Eight out of every 1000 women have breast cancer. Of these 8 women with breast cancer, 7 will have a positive mammogram. Of the remaining 992 women who don't have breast cancer, 70 will still have a positive mammogram. Imagine a randomly selected sample of 100 women who have positive mammograms. How many of these women actually have breast cancer?
Give a number between zero and 100 (a whole number).

Scan the QR or use link to join

- Gigerenzer (2002) asked another sample of physicians
- 46% of them got it correct

The Answer

- Of the 77 women who would test positive, 7 have cancer and 70 don't
- 9% of women with positive tests had cancer

Gigerenzer, G. (2002). *Reckoning With Risk*, Penguin.

Probabilities are hard

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- People often struggle to think in probabilities
- They may do better if the problem is expressed in frequencies or number of cases
  - More concrete
  - Less abstract
  - Easier to process

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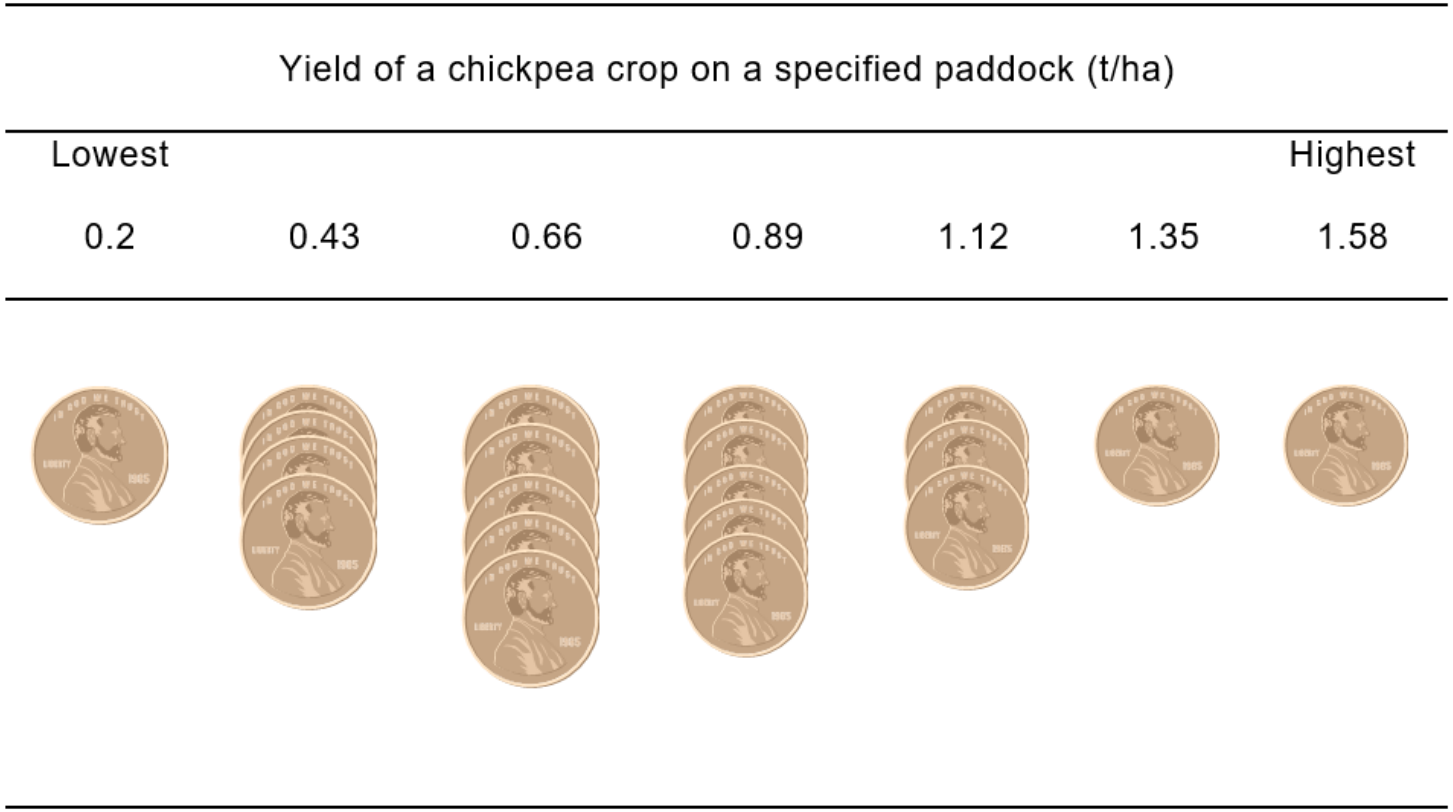
Helping farmers communicate risk to us

A one-to-one exercise

- Abadi et al. (2003)
- Ask farmers to estimate worst and best yields over next 20 years
- Seven categories
- Ask them to allocate 20 counters each representing a year
- A histogram!



Abadi Ghadim, A.K. & Pannell, D.J. (2003). Risk attitudes and risk perceptions of crop producers in Western Australia, *Risk Management and the Environment: Agriculture in Perspective*, Kluwer, pp. 113-133.

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Options for conveying information about risk to farmers

Context:

- **Depict or describe the riskiness of a decision option**
- **Generic**

Many options for communicating risk

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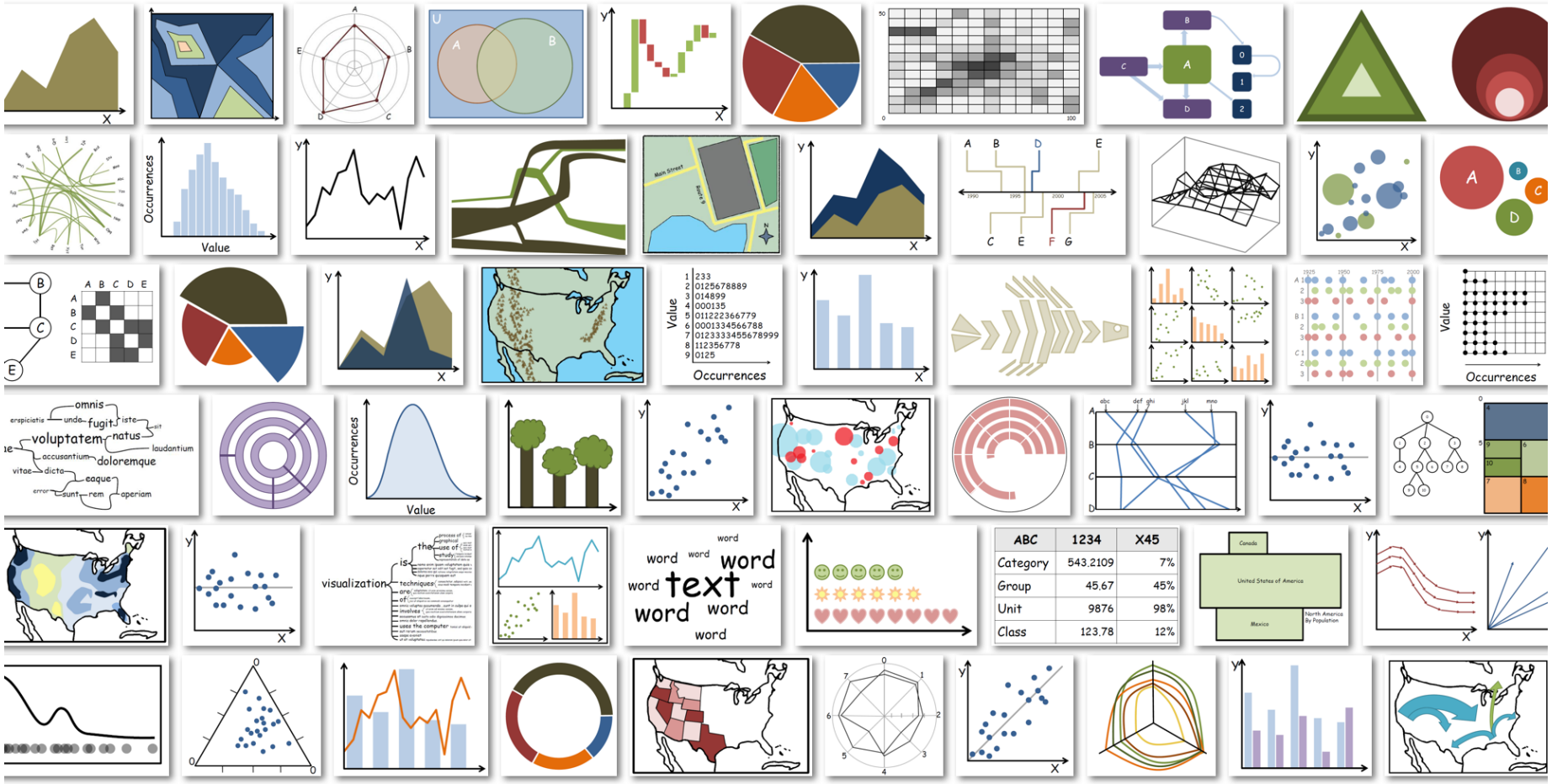
- Graphs
- Diagrams
- Maps
- Tables
- Words
- Games
- Role plays
- Experiments



Mostly graphs

Some people struggle to read graphs

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- Galesic and Garcia-Retamero (2011)
- About a third of German and American adults had "low graph literacy"

Graph Literacy: A Cross-Cultural Comparison

Mirta Galesic, PhD, Rocio Garcia-Retamero, PhD

Background. *Visual displays are often used to communicate important medical information to patients. However, even the simplest graphs are not understood by everyone.* ***Objective***. *To develop and test a scale to measure health-related graph literacy and investigate the level of graph literacy in the United States and Germany.* ***Design***. *Experimental and questionnaire studies.* ***Setting***. *Computerized studies in the laboratory and on probabilistic national samples in the United States and Germany.* ***Participants***. *Nationally representative samples of people 25 to 69 years of age in Germany (n = 495) and the United States (n = 492). Laboratory pretest on 60 younger and 60 older people.* ***Measurements***. *Psychometric properties of the scale (i.e., reliability, validity, discriminability) and level of graph literacy in the two countries.* ***Results***. *The new graph literacy scale predicted which patients can benefit from visual aids and had promising measurement properties. Participants in both countries completed approximately 9 of 13 items correctly (in Germany, $\bar{x} = 9.4$, $s = 2.6$; in the United States, $\bar{x} = 9.3$, $s = 2.9$). Approximately one third of the population in both countries had both low graph literacy and low numeracy skills.* ***Limitations***. *The authors focused on basic graph literacy only. They used a computerized scale; comparability with paper-and-pencil versions should be checked.* ***Conclusions***. *The new graph literacy scale seems to be a suitable tool for assessing whether patients understand common graphical formats and shows that not everyone profits from standard visual displays. Research is needed on communication formats that can overcome the barriers of both low numeracy and graph literacy.* ***Key words:*** *patient decision making; risk communication; risk perception; shared decision making; education.* ***(Med Decis Making 2011;31:444–457)***

Graph literacy, or the ability to understand graphically presented information, is essential in everyday life: graphs are ubiquitous in newspapers and magazines, on television, and on the Internet. Graphs often provide important information for medical, financial, nutritional, and political choices.

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Recent studies have shown that graphical displays—bar charts, pie charts, line plots, and icon arrays—can improve understanding of the risks and benefits associated with medical treatments, screenings, and lifestyles.[1–3] For example, icon arrays help people with low numeracy skills to understand treatment-related risk reductions.[4–6] They can also promote consideration of beneficial treatments that have side effects[7] and limit the biases induced by anecdotal narratives.[8]

However, even the simplest graphs may be difficult to understand for many people. Bar charts, pie charts, and line plots were first used in the late 18th and early 19th centuries. William Playfair, an economist and author of *Commercial and Political Atlas* (1786) and *Statistical Breviary* (1801), first used those graphical formats.[9,10] Icon arrays are even more recent: they began to be widely used only in the early 20th century, when Otto Neurath (1882–1945), a philosopher, economist, and a prominent member of the Vienna Circle, used them to explain complex social and economic statistics to uneducated Viennese.[11] In other words, in most of human history, there were no graphical representations of statistical

Galesic, M. and Garcia-Retamero, R. (2011). Graph literacy: A cross-cultural comparison, *Medical Decision Making* 31(3), 444–457.

Possible reasons for the struggle

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- Complexity or ambiguity of the graphs
- Lack of comfort with maths
- Haven't been trained to read a graph
- Difficulty interpreting spatial relationships in an image and relating them to the real world

Make your graphs:

- Simple
- Clear
- Well-labelled
- Large enough to read
- Well-explained

Use a combination of approaches

Probability distribution (histogram)

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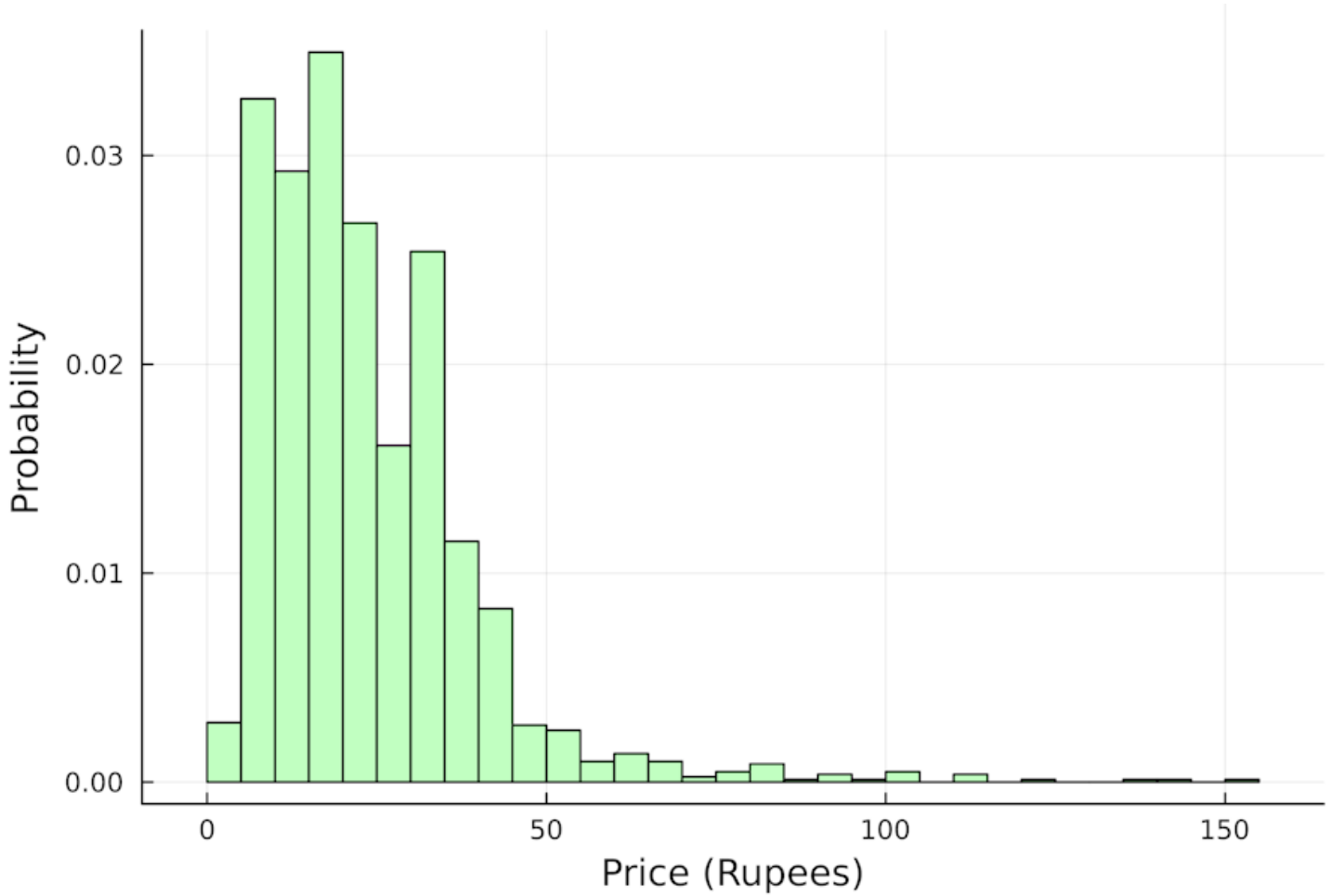
- My view
- Relatively simple and clear
- Might work slightly better in a frequency version

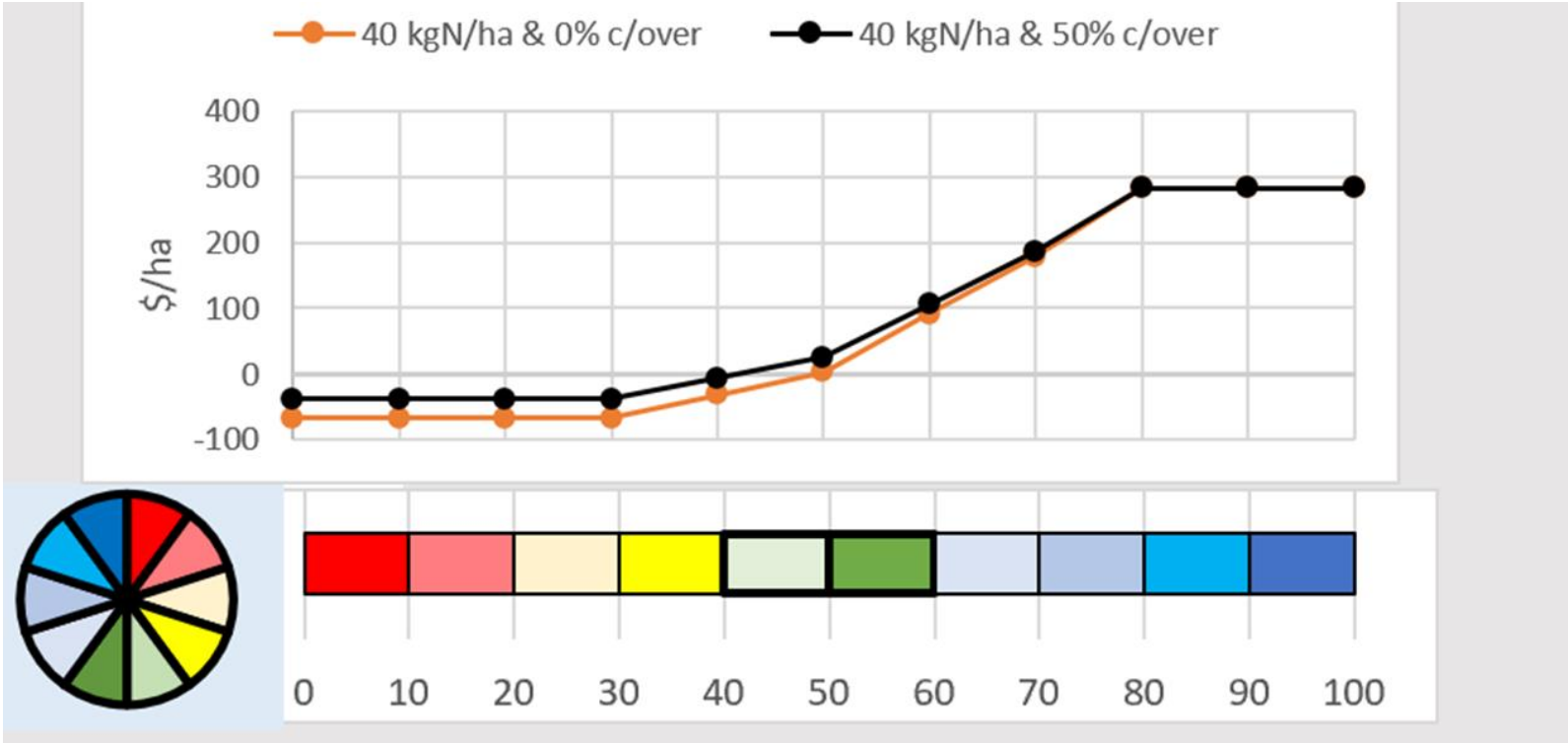


Fast Graphs (Mudge and Hayman)

One N rate x 10 outcomes. Answers the questions "what is upside and downside of X KgN/ha and what is the long term average of X kgN /ha

Can see how this changes with carryover and forecast by changing assumptions in column B

- Different axes
- Conveys sense of risk
- Only rainfall deciles
- Familiar/comfortable
- There is additional rainfall risk
- Misses other factors
  - Grain prices
  - Input costs
  - Frost
  - Labour



Yield by deciles (Yield Prophet Lite)

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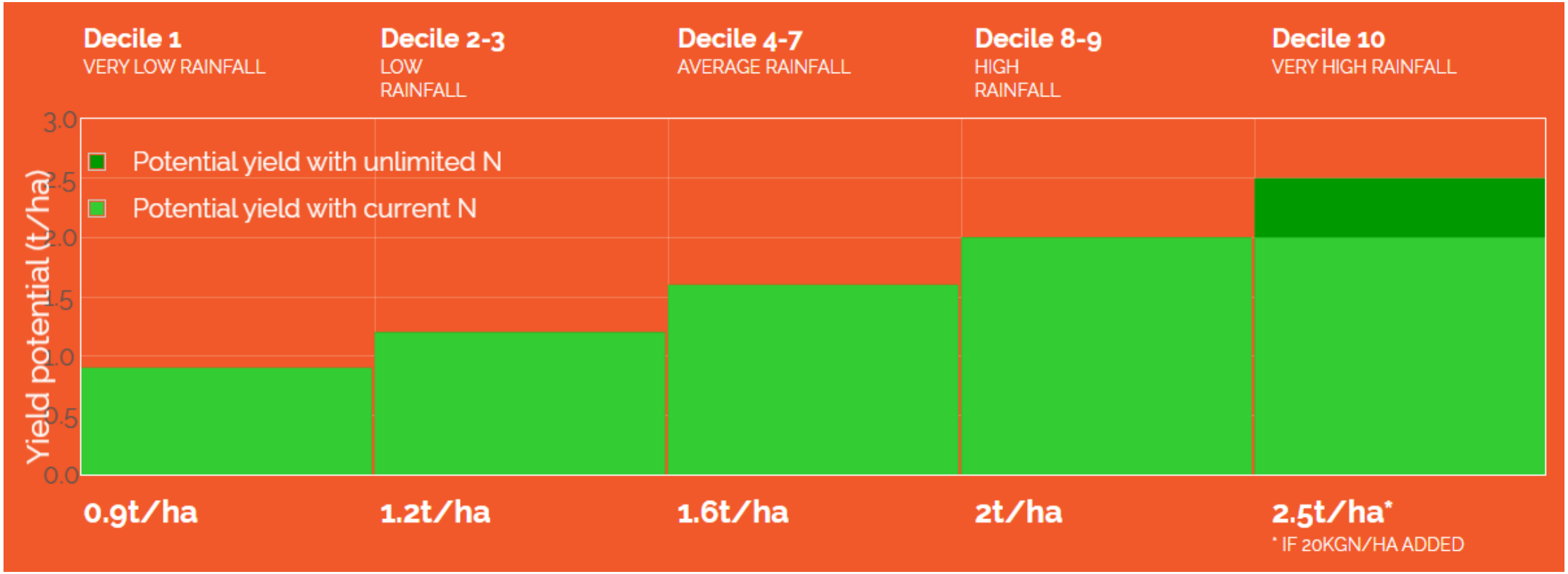

Cum. Prob./Prob. of Exceedance (Fallow ARM)

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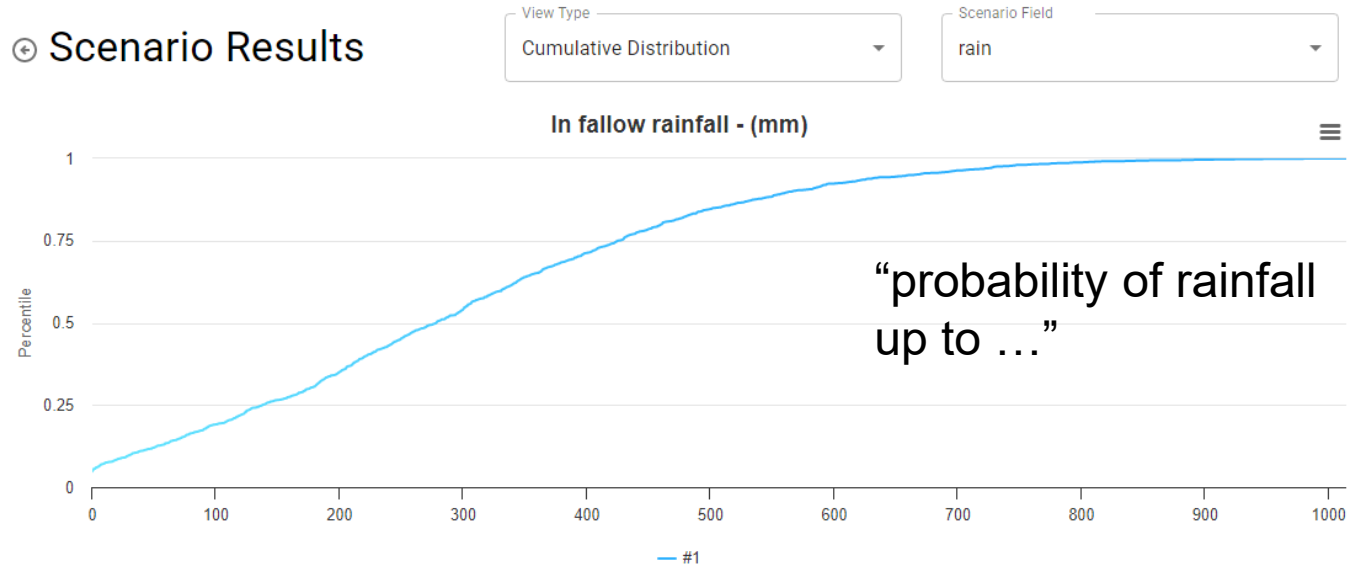
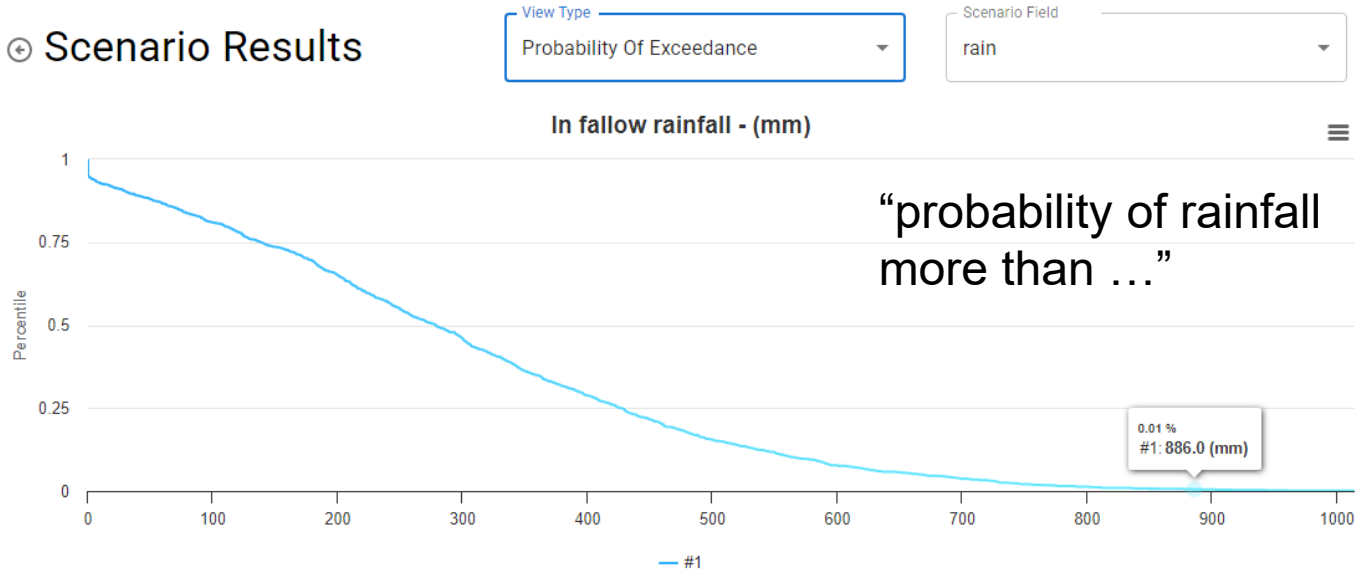
- I'm not a fan of these for communicating with farmers
- They use probabilities, not frequencies
- To my mind, they require more mental work to interpret





Bar chart over time (Crop ARM)

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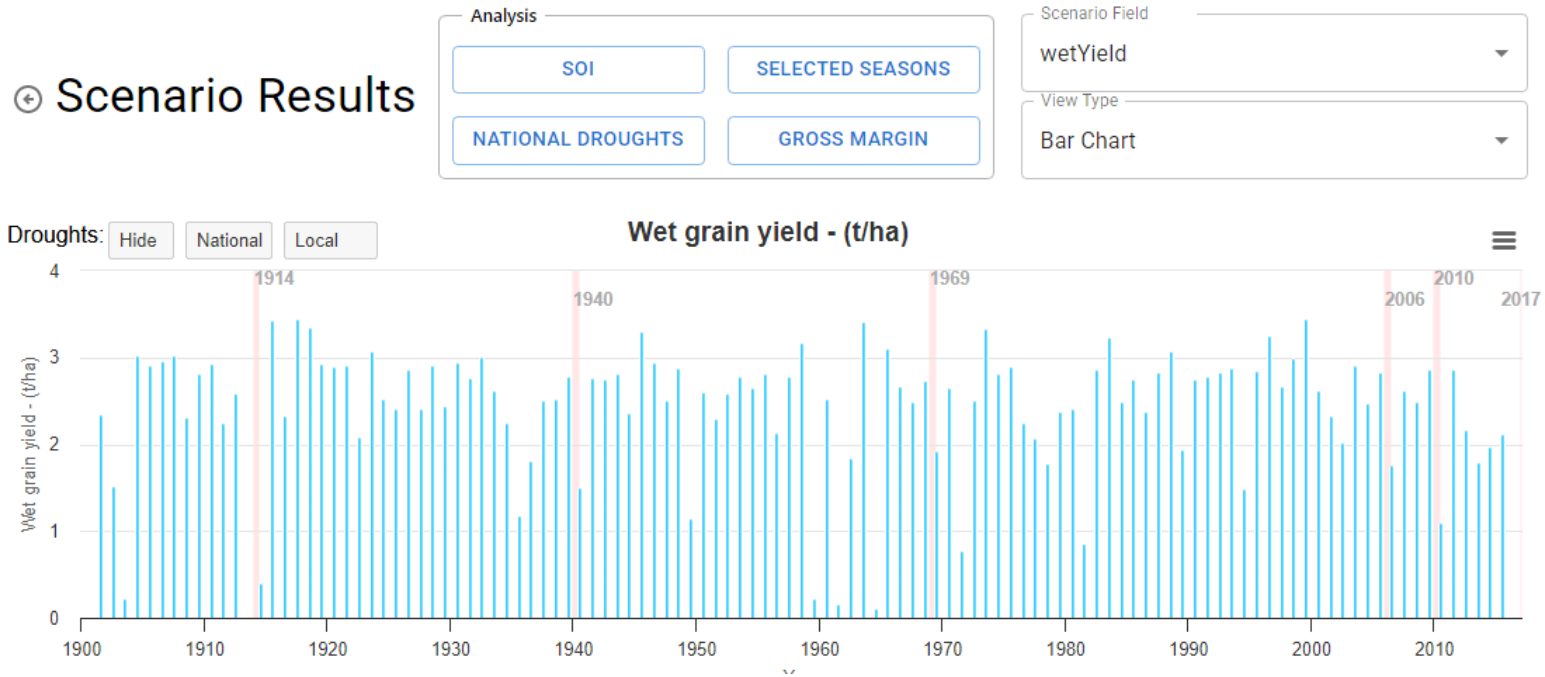
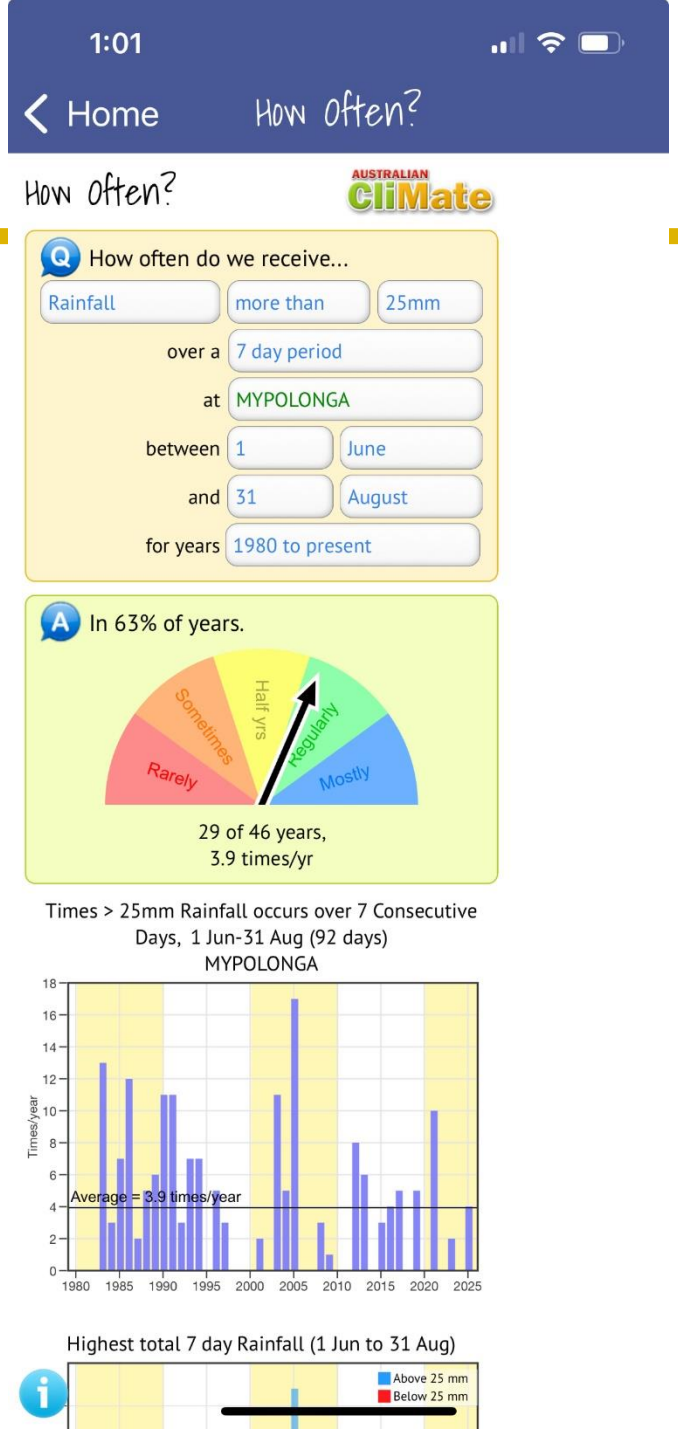
- Concrete
- Simple
- Might be hard to mentally summarise to a distribution
- Maybe combine with a histogram



Bar chart over time (CliMate)

- Combined with a description
  - Rarely
  - Sometimes
  - Half years
  - Frequently
  - Mostly
- Plus a percentage



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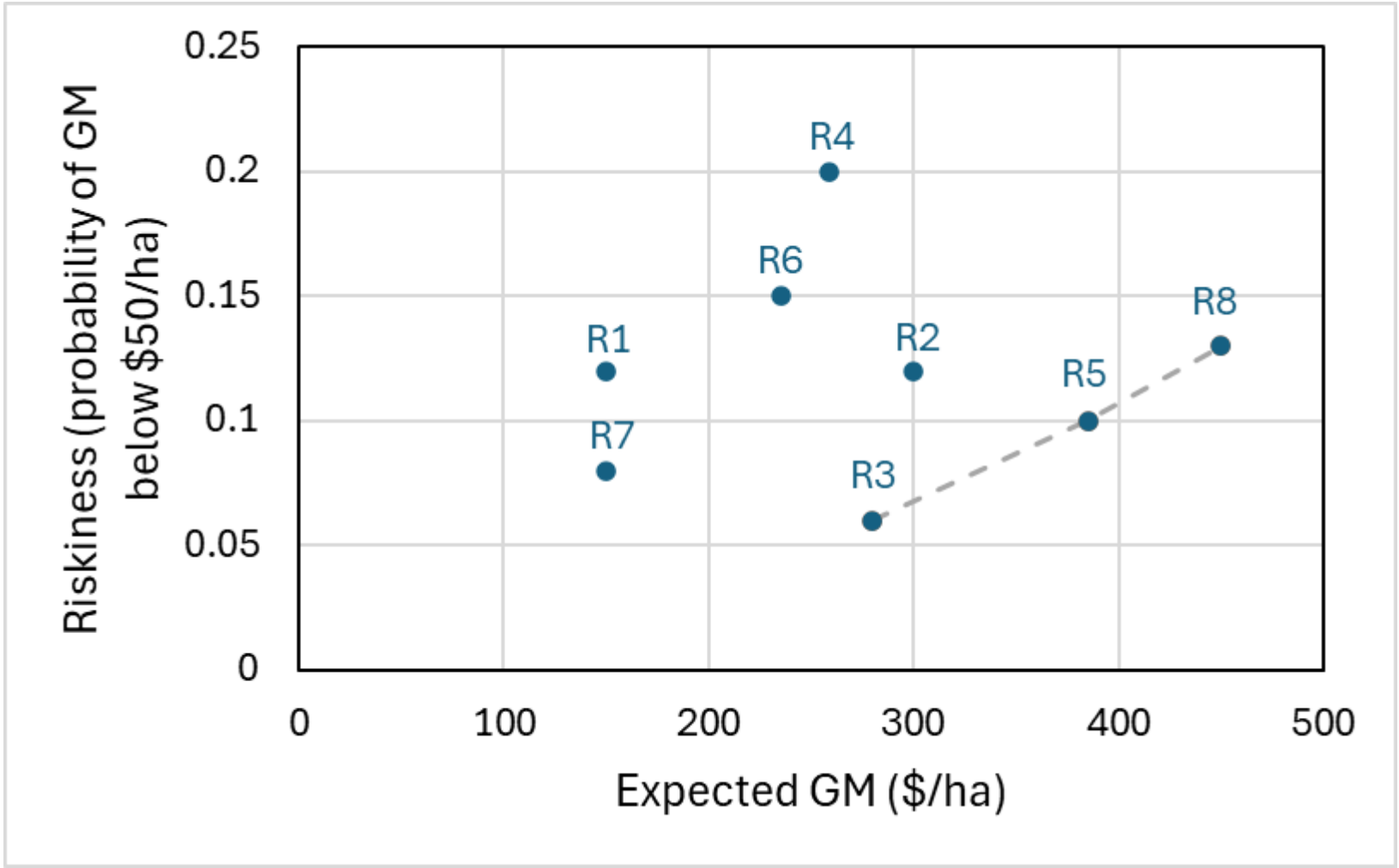
Risk-Reward trade-off

- More complex
- Conveys more
- This version uses probabilities



Line graph over time – multiple scenarios

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- Price scenarios
- Conveys that risk increases in future
- The chaos might intimidate people
- Needs a good explanation

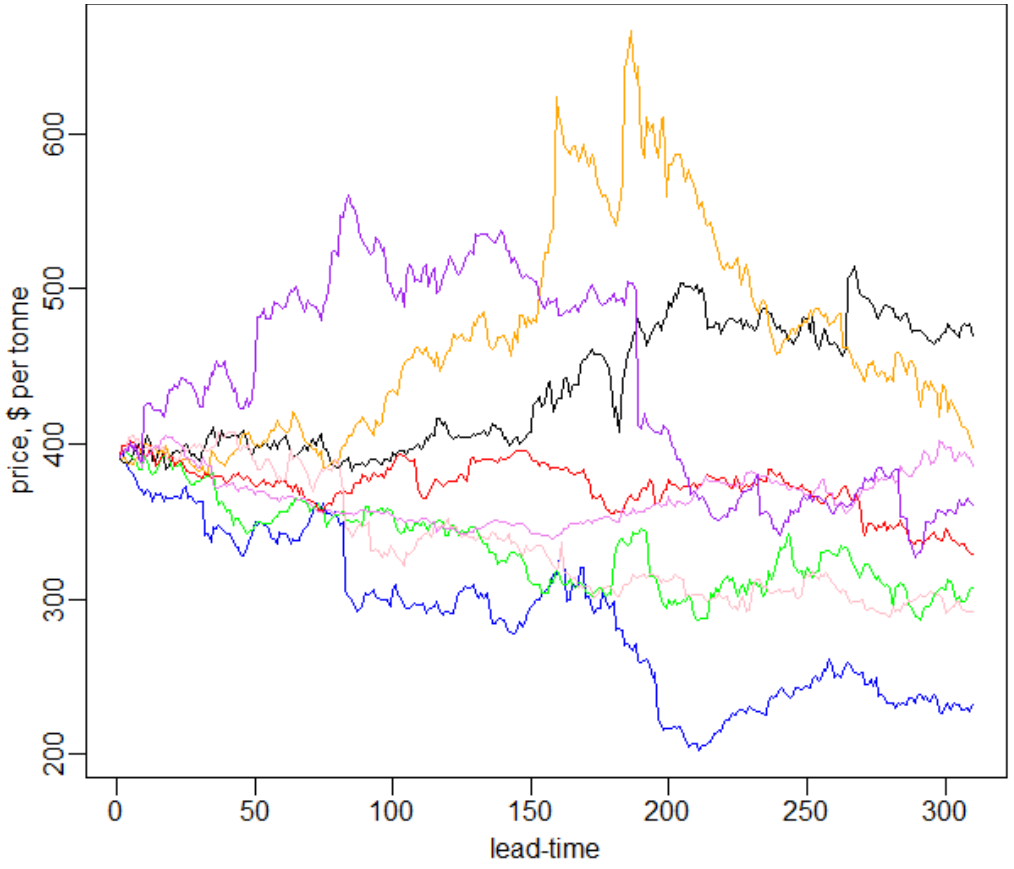
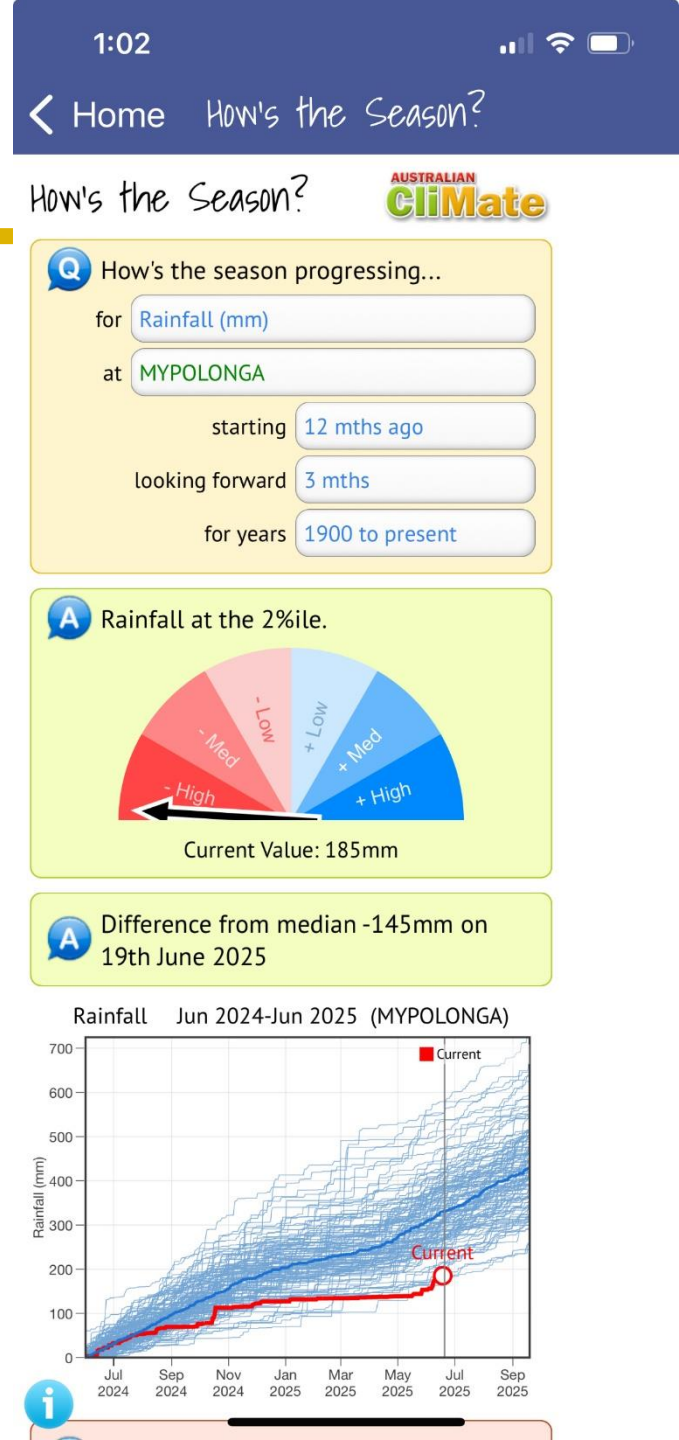


Figure 8 Example random price trajectories, for up a lead-time of 310 trading days

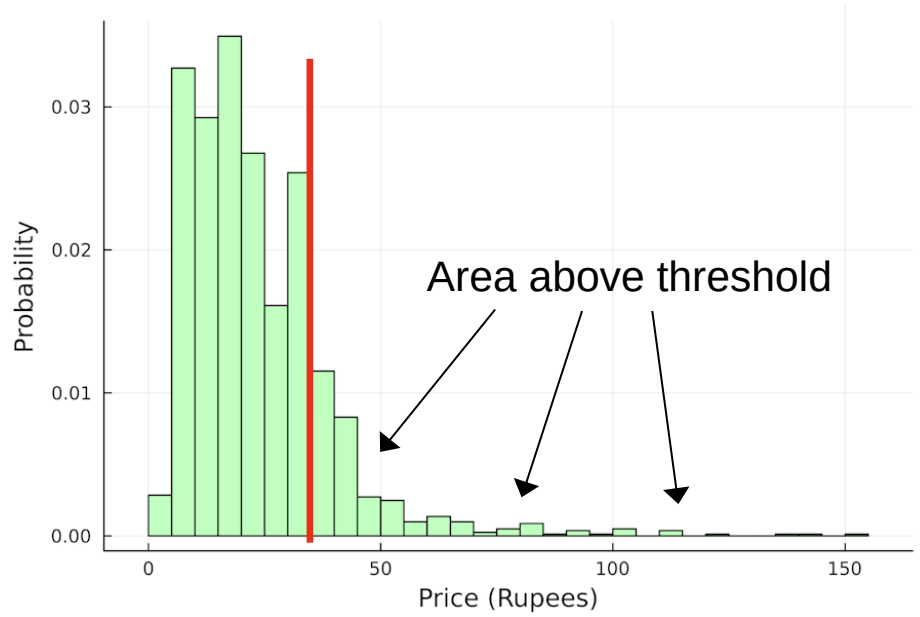
Similar but backwards looking (CliMate)

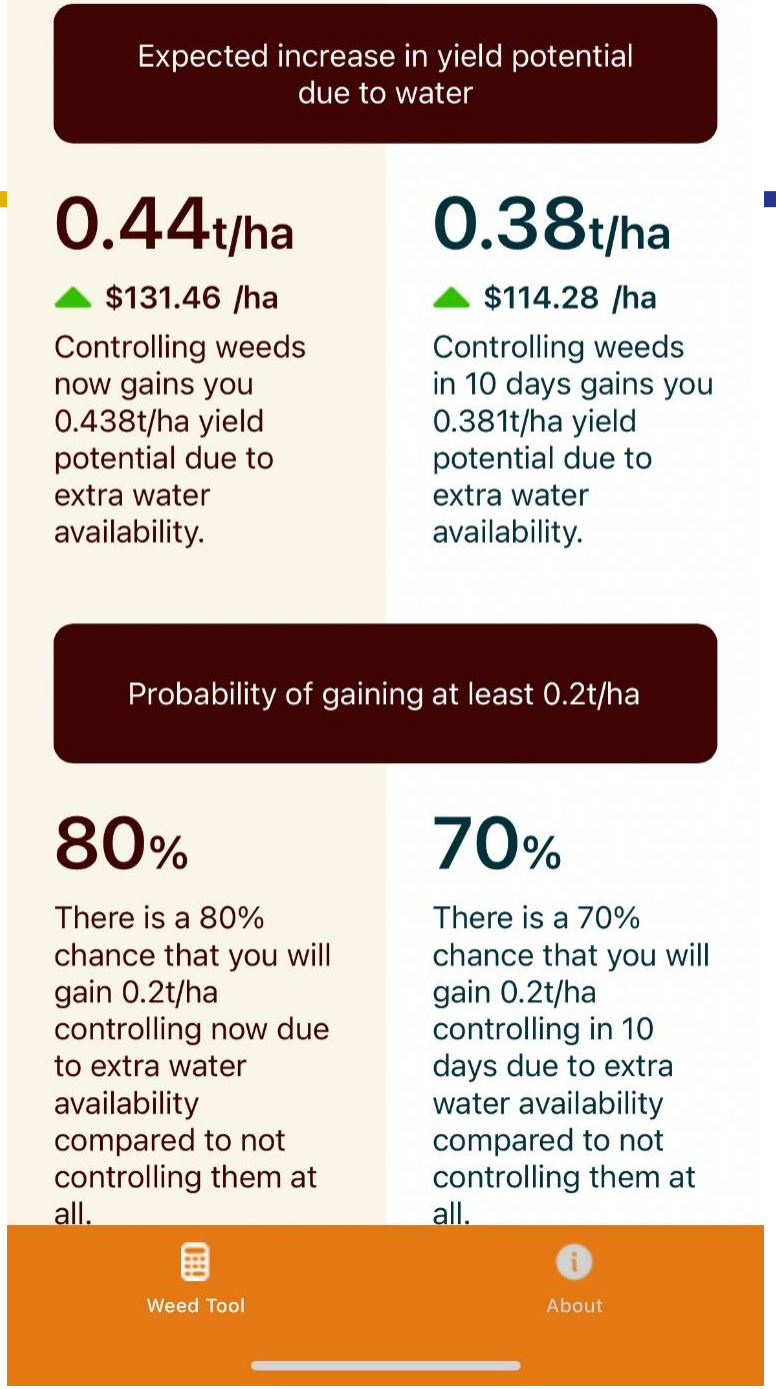
- Compares cumulative rainfall of current year with previous years
- Combined with descriptions
  - − High
  - − Med
  - − Low
  - + Low
  - + Med
  - + High
- And the percentile: 2%ile



Words (CliMate)

- Often involves simplifying the distribution into two parts
  - Probability above some level
  - Probability below some level





Box and whiskers (Crop ARM)

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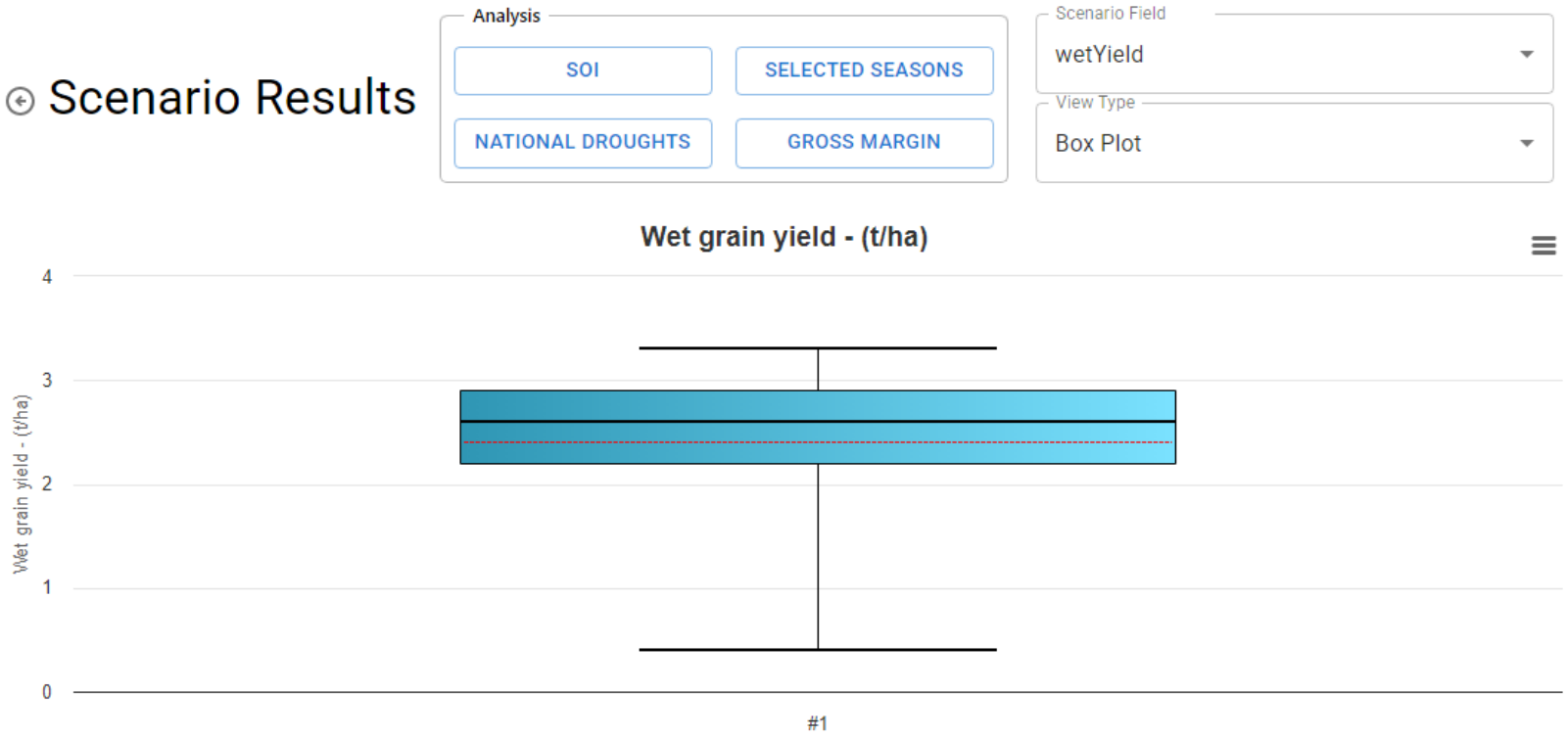
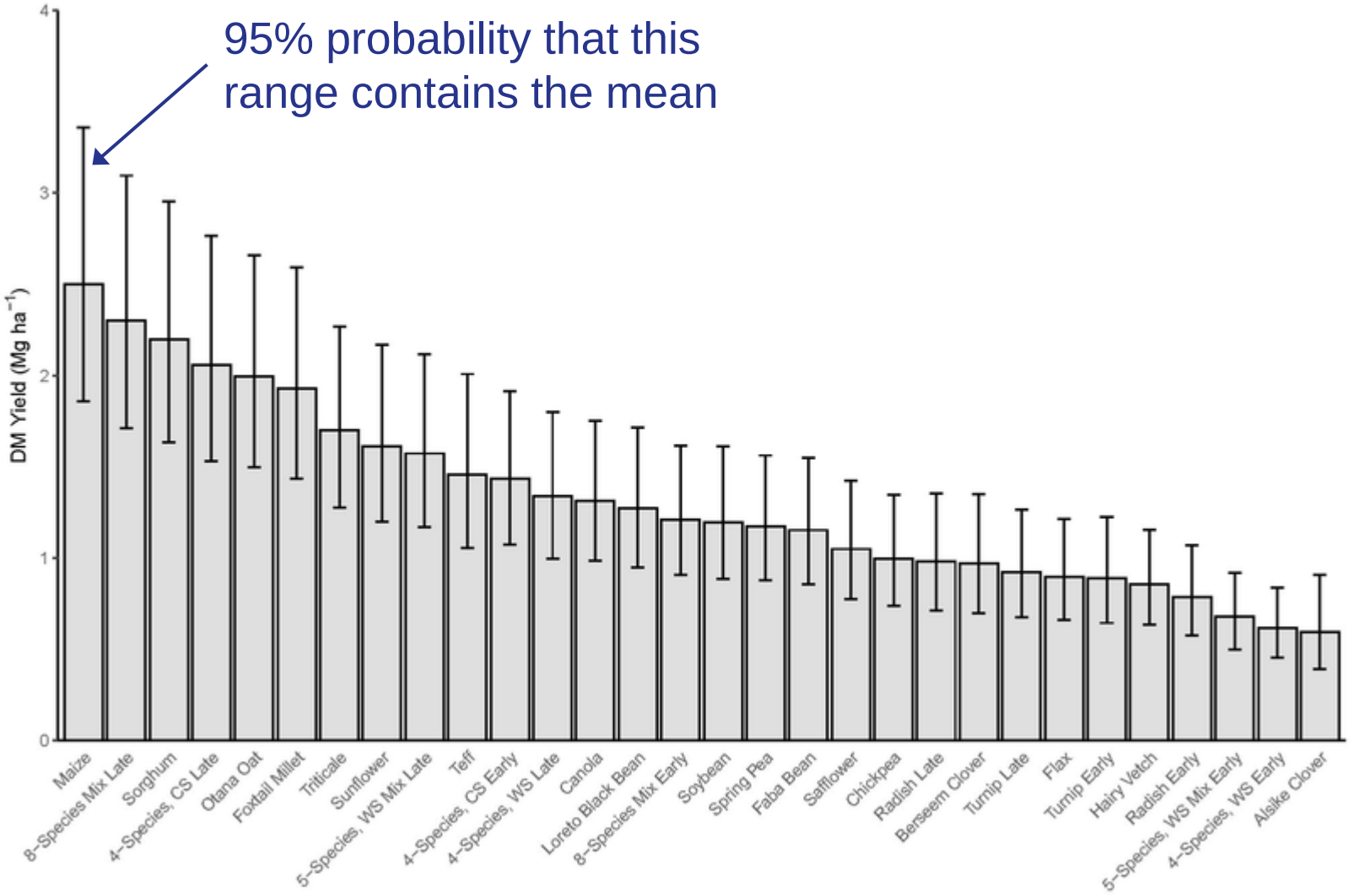
- I think this is less intuitive and less informative than a distribution
- More abstract
- Uses probability, not frequency
- Implicitly cumulative



Confidence intervals

- CI of the mean often reported
- Useful for statistical inference
- Not for farm management
- Understates risk



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Conclusion

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- GRDC products rarely talk about risk
- Many options – don't lose your audience
- Get the basics right with any graphs
  - Simple, Clear, Well-labelled, Large enough, Well-explained
- Frequencies/cases better than probabilities
- Combine approaches
  - Graph + Words
  - Graph 1 + Graph 2
- Avoid confidence intervals of means
- Avoid cumulative probability graphs