Leaching losses from diverse pasture

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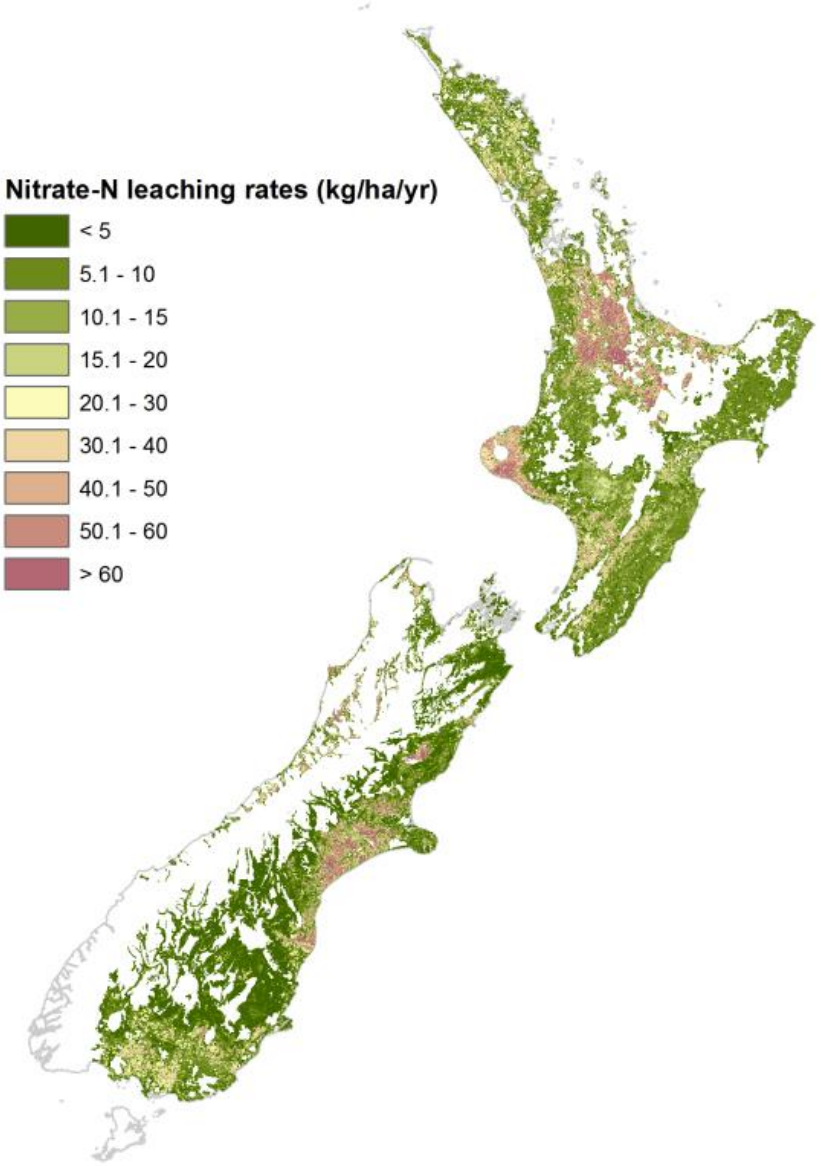
Context

- Leaching of nutrients (N & P) from livestock farming is a risk to surface and groundwater
- National and Regional regulations for reduced N leaching
- Farmer-led catchment groups also interested in solutions
- More diverse pastures are a potential mitigation option, but largely unverified



from Ausseil & Manderson 2018

What do we mean by ‘diverse pasture’?

- Positive relationship between species diversity and ecosystem function (e.g. soil N retention)

- Mixes of grass, legumes and other forbs, including functional traits:
  - Winter-active (Italian ryegrass)
  - Nitrogen fixation (red/white clover, lucerne)
  - Deep-rooted (red clover, lucerne)
  - Biological nitrification inhibitor (plantain)

Ryegrass-clover pasture

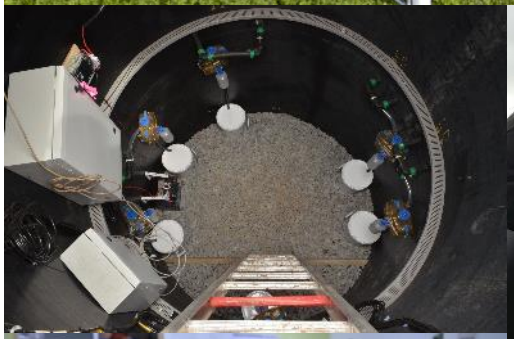
Diverse pasture

How do we measure leaching losses?

- **Lysimeters** – **<u>direct</u>** measurement of leachate from an enclosed volume of soil

- Advantages of large lysimeters:
  - Large volume of soil, integrating heterogeneity
  - Spatial variability in inputs
  - Paddock-scale management

- Limitations:
  - No animal mediated effects
  - Simulated grazing
  - Replication



MWLR's network of large lysimeters

Ashley Dene Research & Development Station

Irrigated/effluent

- 3 ryegrass-clover, 3 diverse (5 species) large lysimeters
- **350 – 500 kg N/ha/y** input (fert, effluent, excreta)

Irrigation only

- 3 diverse (5 species) large lysimeters
- **55 – 210 kg N/ha/y** input

Non-irrigated

- 6 diverse (8 species) large lysimeters
- **25 – 130 kg N/ha/y** input
- 600-850 mm rain

Very stony, up to 70% in subsoil

Tihoi

Non-irrigated

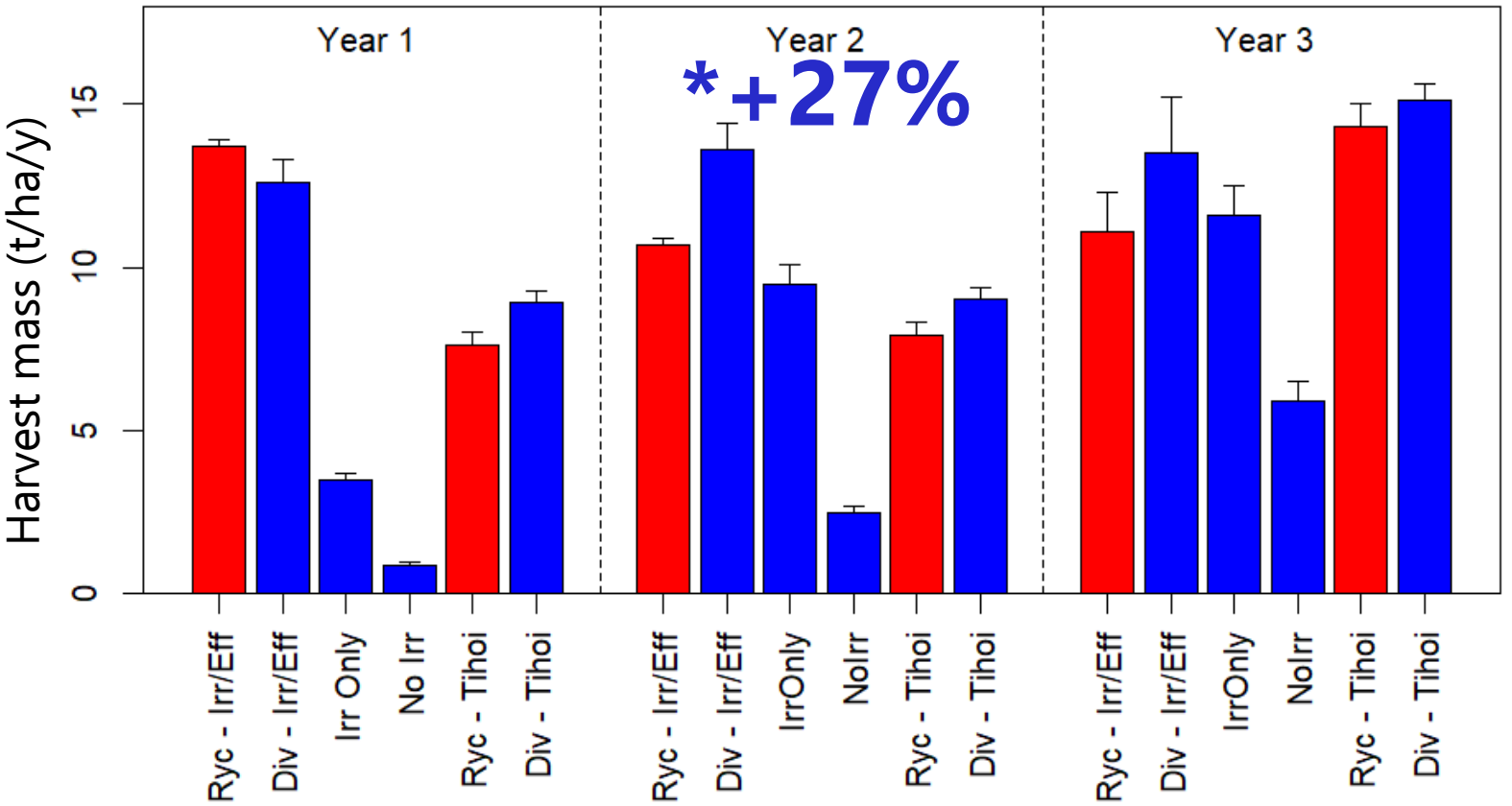
- 8 ryegrass-clover, 12 diverse (6 species)
- **207- 230 kg N/ha/y** input
- Non-irrigated, 1300 – 1600 mm rain

Deep volcanic pumice soil

Management intensity

Soil/Climate

Dry matter production

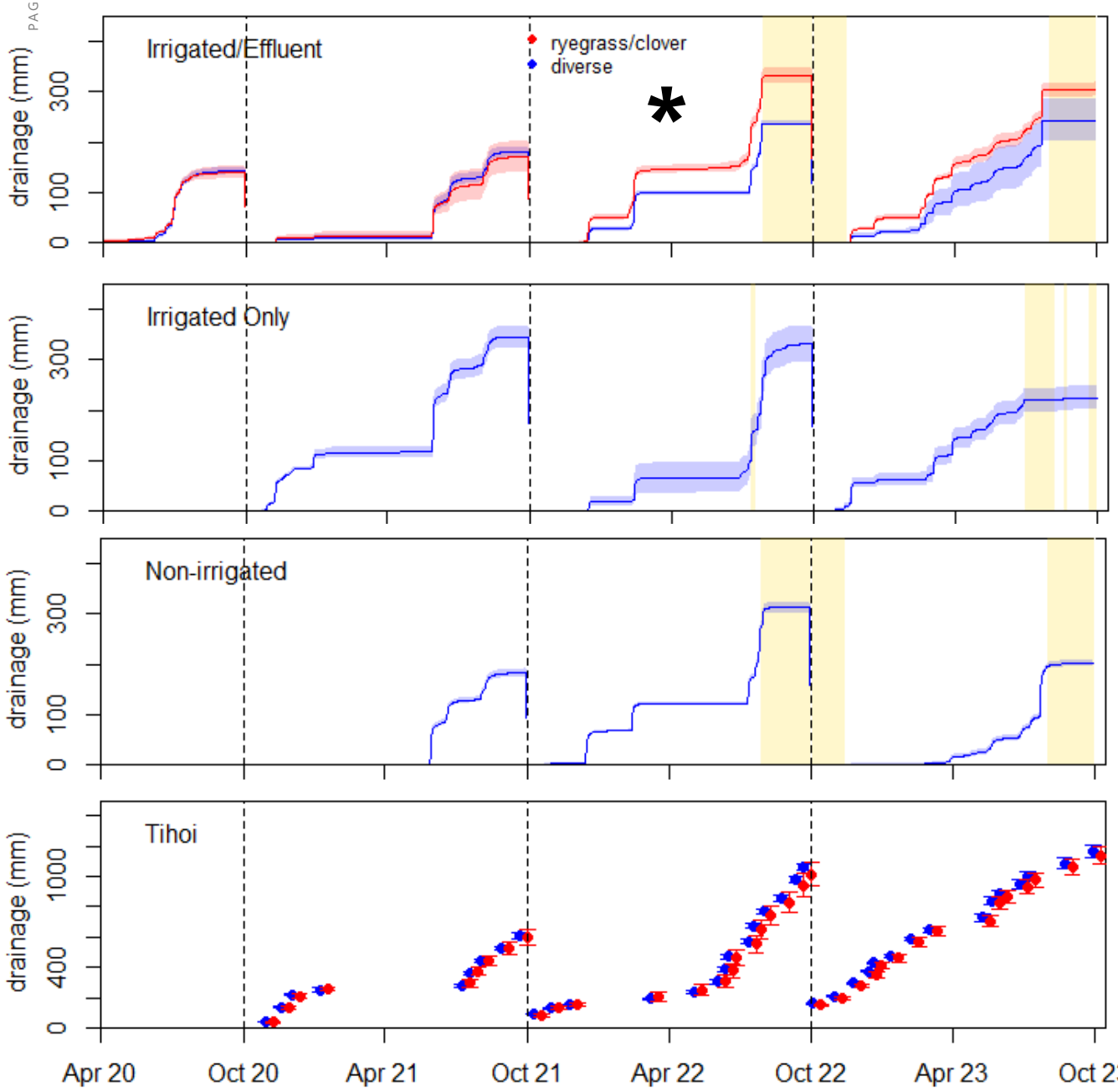


Ryegrass -clover
Diverse pasture

- Ashley Dene Irrigated/effluent **10.5 – 13.5** t/ha/y
- Irrigated Only **3.5 – 11.5** t/ha/y
- Non-irrigated **1-6** t/ha/y
- Tihoi **7.5 – 15** t/ha/y
- Poor establishment at some sites

- **No difference in pasture type**, except Year 2 at Ashley Dene
- Increasing production with management intensity
- Variable species/functional group representation through time

Soil drainage volume



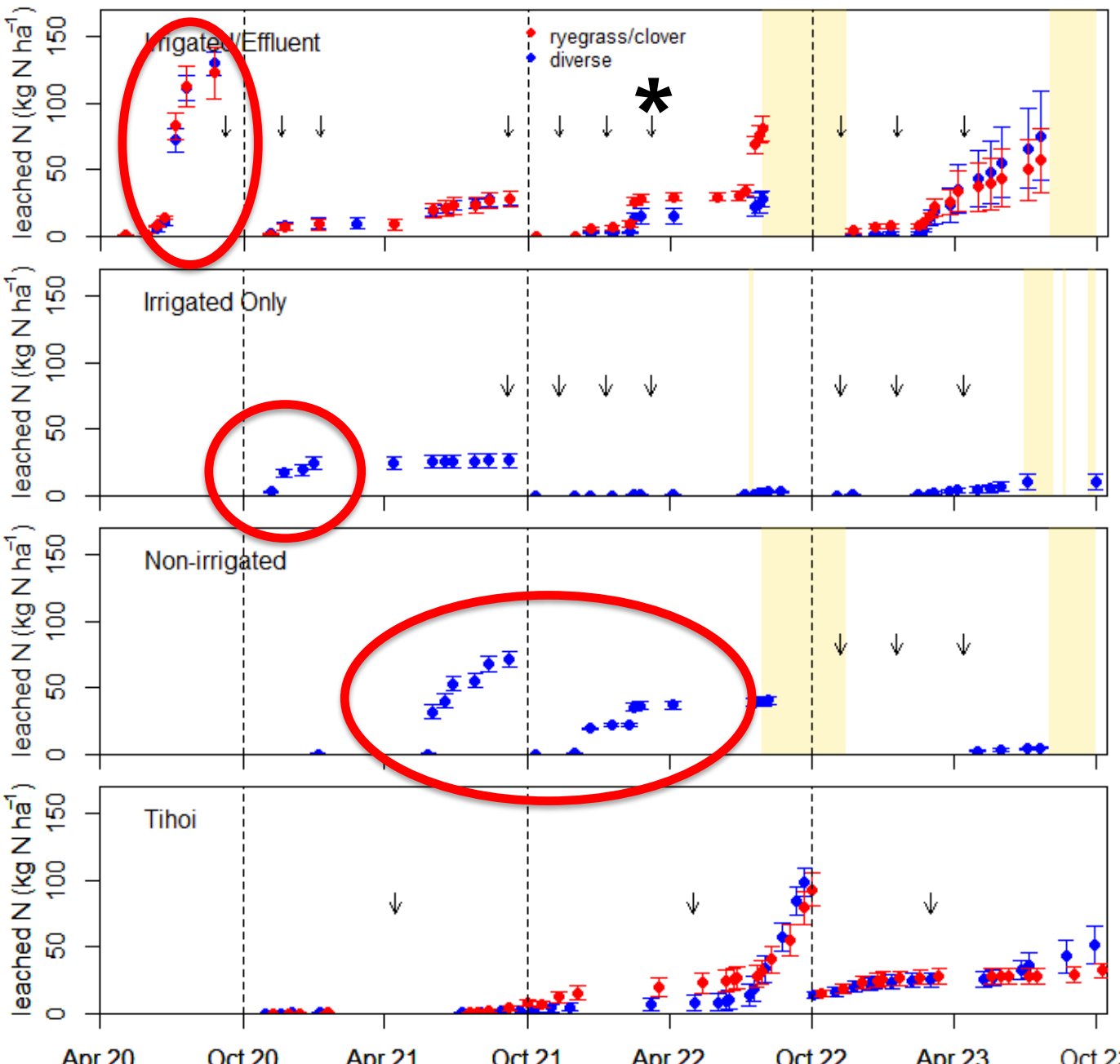
- 170 – 330 mm
- Year 2: **29%** less drainage from diverse

- 225 – 345 mm

- 180 – 310 mm

- 595 – 1160 mm
- No difference in pasture type
- Progressively wetter years

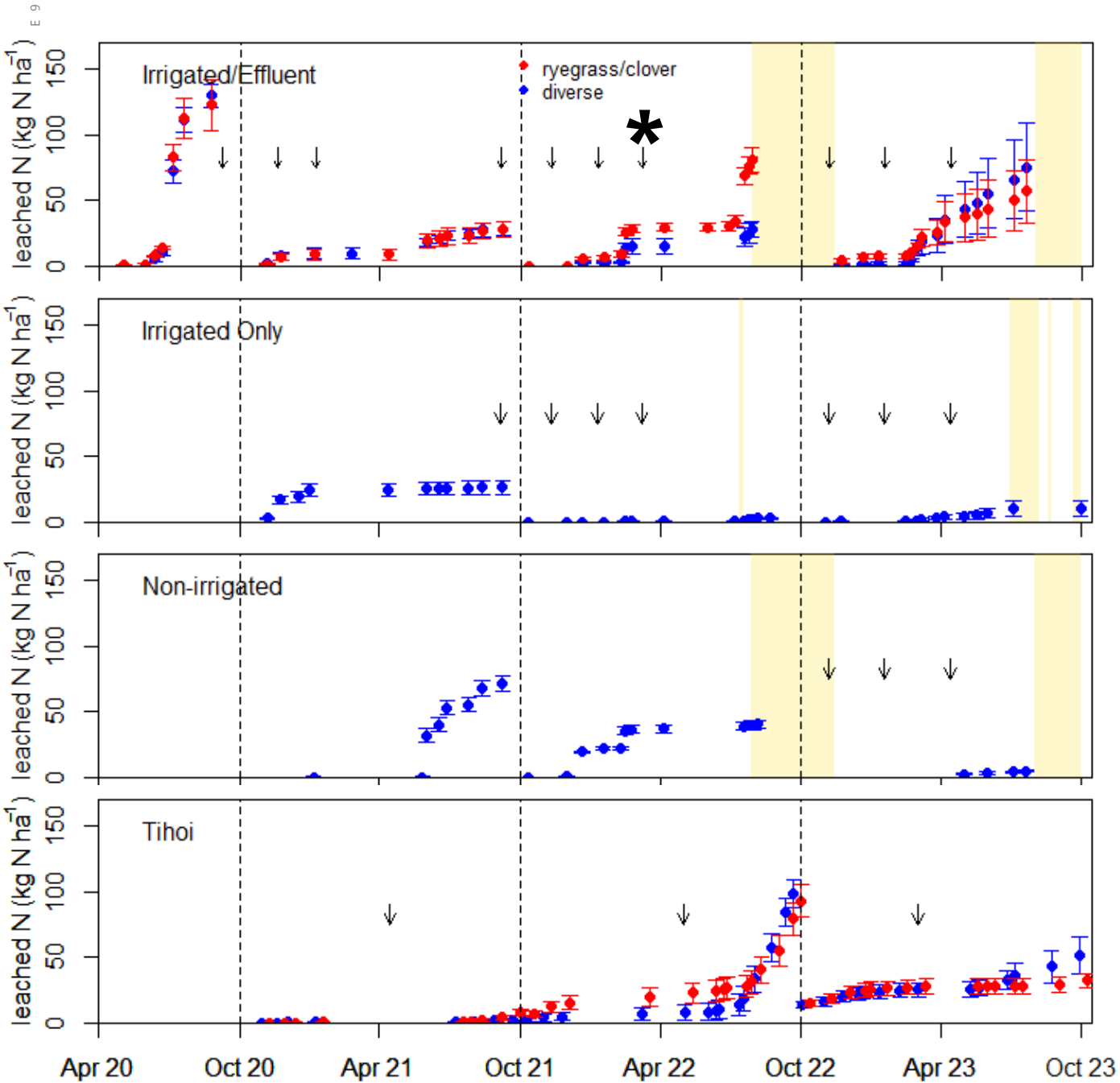
Nitrogen leaching



>120 kg N/ha/y losses from autumn conversion

- losses from spring conversion and spring drainage
- losses from spring conversion and poor establishment
- No conversion-related losses from spring conversion

Nitrogen leaching



27-80 kg N/ha/y

Year 2: losses **2.8 times higher** from rye-clover

- 3-26 kg N/ha/y

- 5-70 kg/N/ha/y
- High conversion losses

- 2-98 kg/N/ha/y
- **No difference** in pasture type
- **Not** paddock-scale loss

Summary & conclusions

- Annual leaching losses from diverse pasture were **2 – 80 kg N/ha/y**, depending on:
  - Plant production
  - Volume and timing of drainage
  - Quantity and timing of N inputs
  - Timing of conversion activities

- Harvested dry matter, drainage volume, and leaching losses from diverse pasture were **not different from ryegrass-clover pasture** (NOTE: changes to animal inputs because of diet are not considered)

Summary & conclusions

- More work is needed on pathways to maintaining higher species and functional diversity, including:
  - Management intervention
  - Highly diverse species mixes (see Orwin et al. 2022)

- Process-based modelling will make our data generalisable for Overseer and other decision support tools

- Co-benefits and trade-offs should be considered (see Laubach et al. 2023)

Recommendations for reducing leaching losses

- Manage irrigation to minimise drainage events during the growing season
- Time management activities (e.g. cultivation, renewal) to ensure full pasture cover before the drainage season
- Intensive activities, including irrigation and fertilisation, when used to facilitate establishment can reduce losses

Thanks for your attention!

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Other reading:

Graham, S. L., et al. (2022). "Irrigation and grazing management affect leaching losses and soil nitrogen balance of lucerne." Agricultural Water Management 259: 107233.

Laubach, J., et al. (2023). "Mitigation potential and trade-offs for nitrous oxide emissions and carbon balances of irrigated mixed-species and ryegrass-clover pastures." Agricultural and Forest Meteorology 330: 109310.

Orwin, K. H., et al. (2022). "Integrating design and ecological theory to achieve adaptive diverse pastures." Trends in Ecology & Evolution 37(10): 861-871.