

Tillage effects, soil quality and production potential of kikuyu-ryegrass pastures in South Africa

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Introduction – Temperate pastures



- Temperate cultivated pastures for dairy production
 - Require high inputs for favourable cost-to-income ratio
- Kikuyu-based, over-sown with ryegrass
- Worldwide production potential: 12 - 22 t DM ha⁻¹
 - South Africa: 15 - 18 t DM ha⁻¹

Intensive management of soil – yield effects?



Introduction - Soil quality



- The capacity of the soil to function
- Soil potential for pasture production – suitable environment for root growth
- Determining soil quality have been studied
- Few attempt to link it to production



Introduction – Data mining



- Partial least-squares (PLS) regression analysis
 - Multivariate technique
 - Relate several correlated variables, to several response variables
 - Analysis of NIR and remote sensing data
 - Has not been applied for understanding the relationship between soil quality and yield



Hypothesis



- Certain soil quality indicators will be associated with yield more than others.
- Because soil quality is affected by tillage, the indicators that are associated with yield may change as the soil recovers after disturbance.

AIM:

To identify soil quality properties which best model pasture yield

Relating those soil quality indicators with variations in pasture yield as a result of a soil disturbance gradient caused by tillage



Materials and Methods



Study site



- Outeniqua Research Farm (Western Cape Dept of Agriculture)
- Kikuyu-based pasture
- Spodosol/Podzol (Witfontein soil form)
- Permanent irrigation (scheduled)
- Grazed by Jersey cows every 28 – 35 days



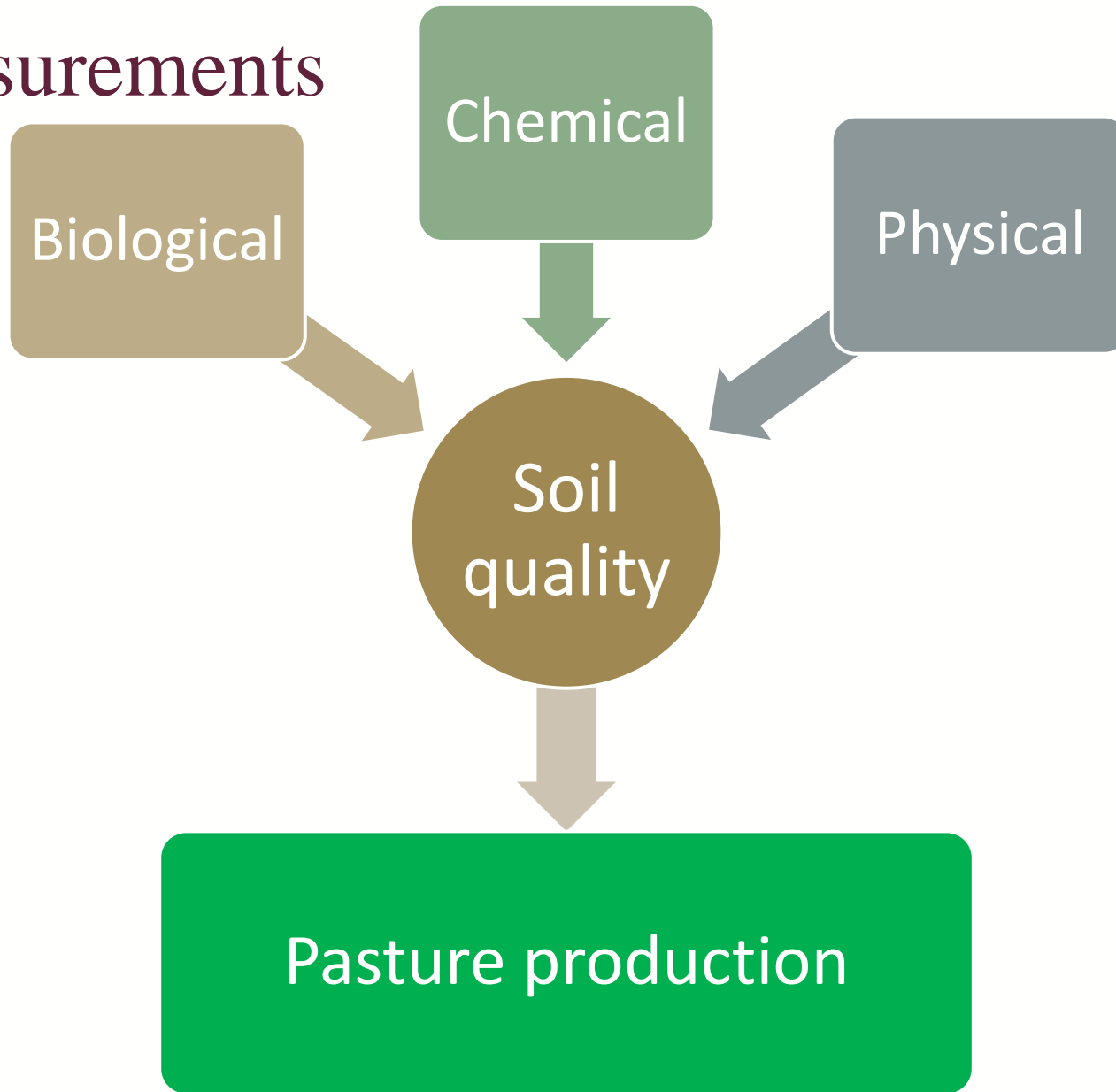
Treatments

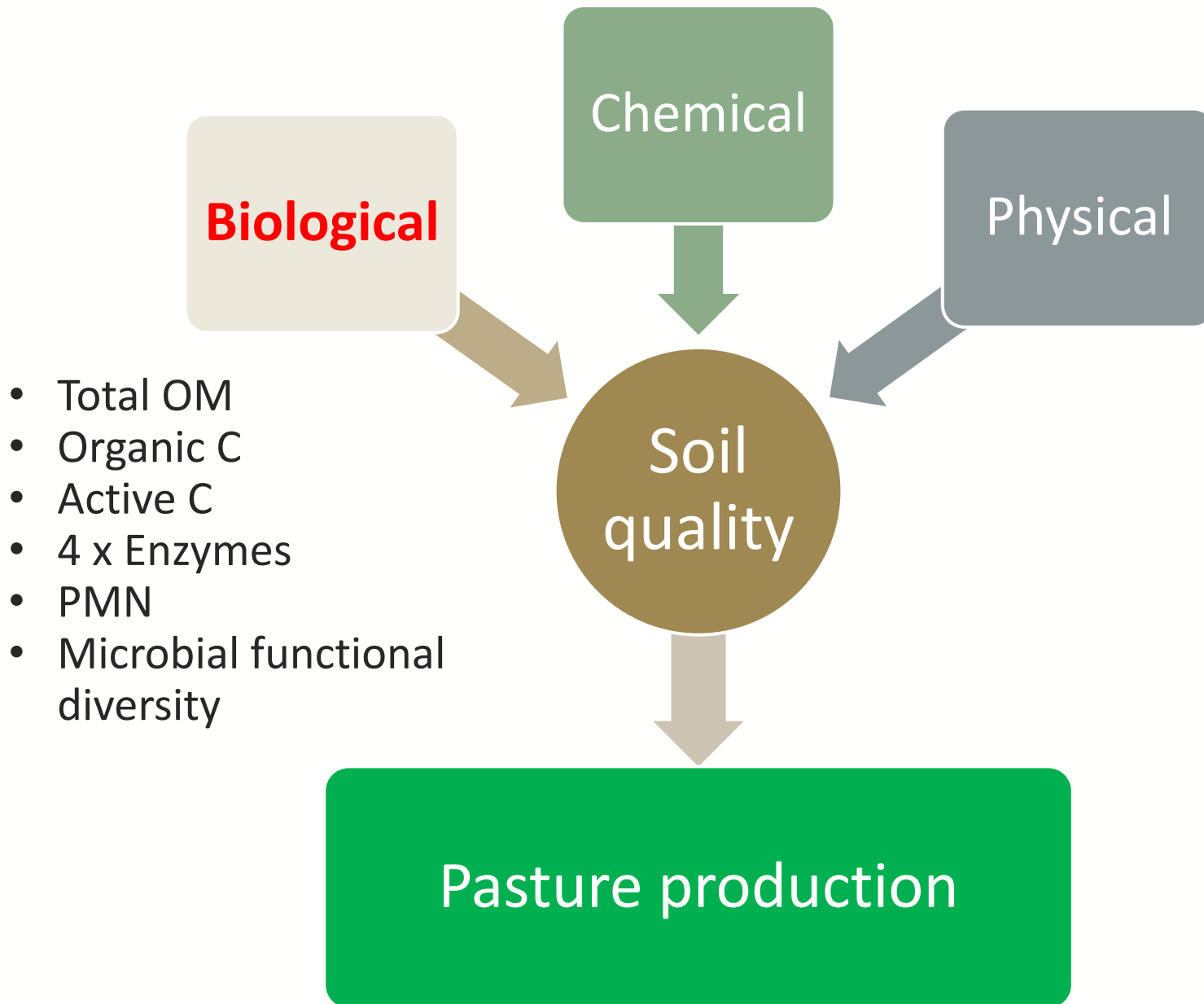


- Randomized block design
- 5 treatments
 - Control (pure kikuyu)
 - Kikuyu-ryegrass (minimum-tillage)
 - Herbicide treatment (chemical disturbance)
 - Shallow tillage/Scarification (<150mm)
 - Deep tillage and soil inversion (>150mm)



Measurements





Chemical

Biological

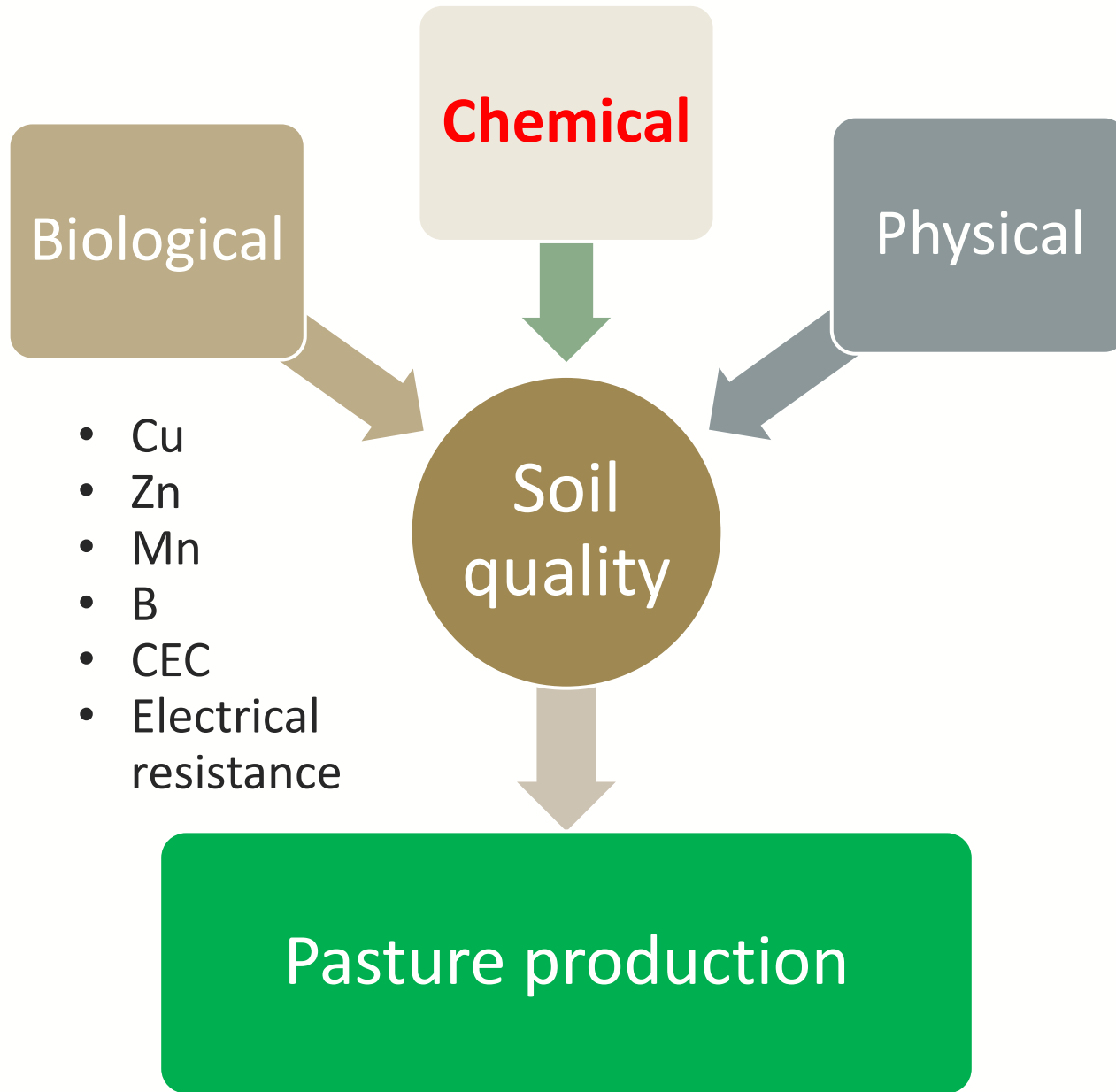
Physical

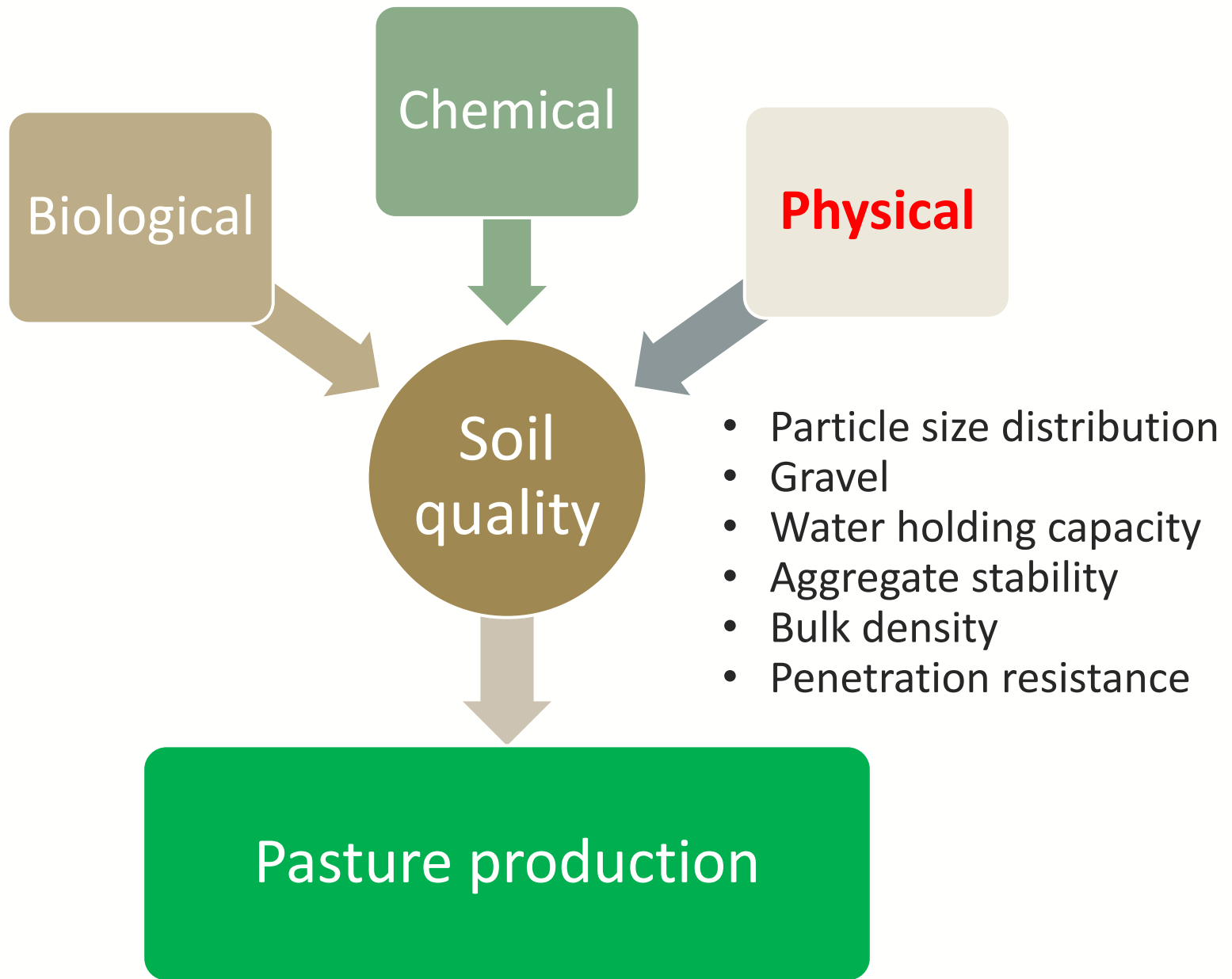
**Soil
quality**

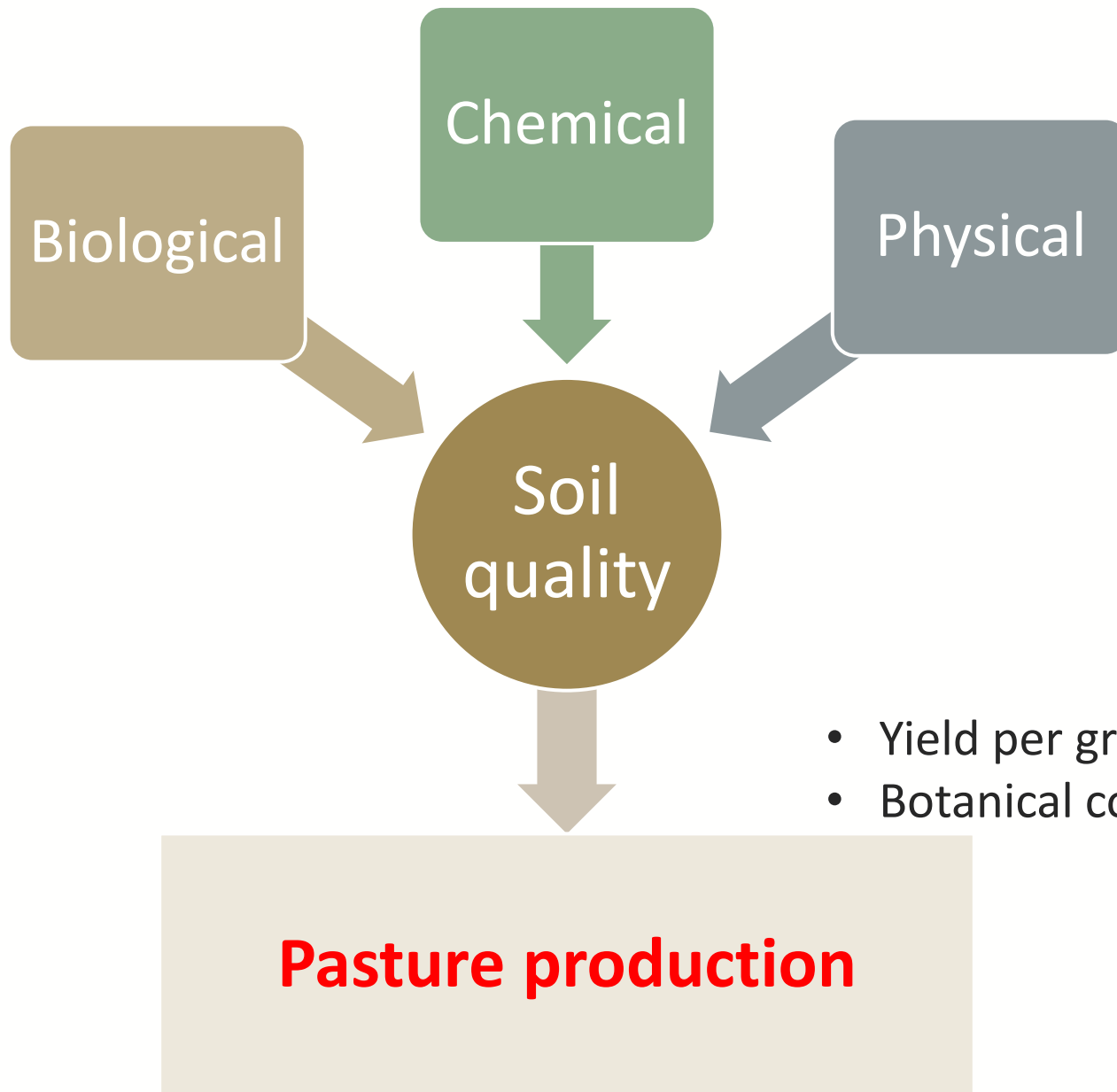
Pasture production

- pH
- P
- K
- S
- Ca
- Mg
- Na

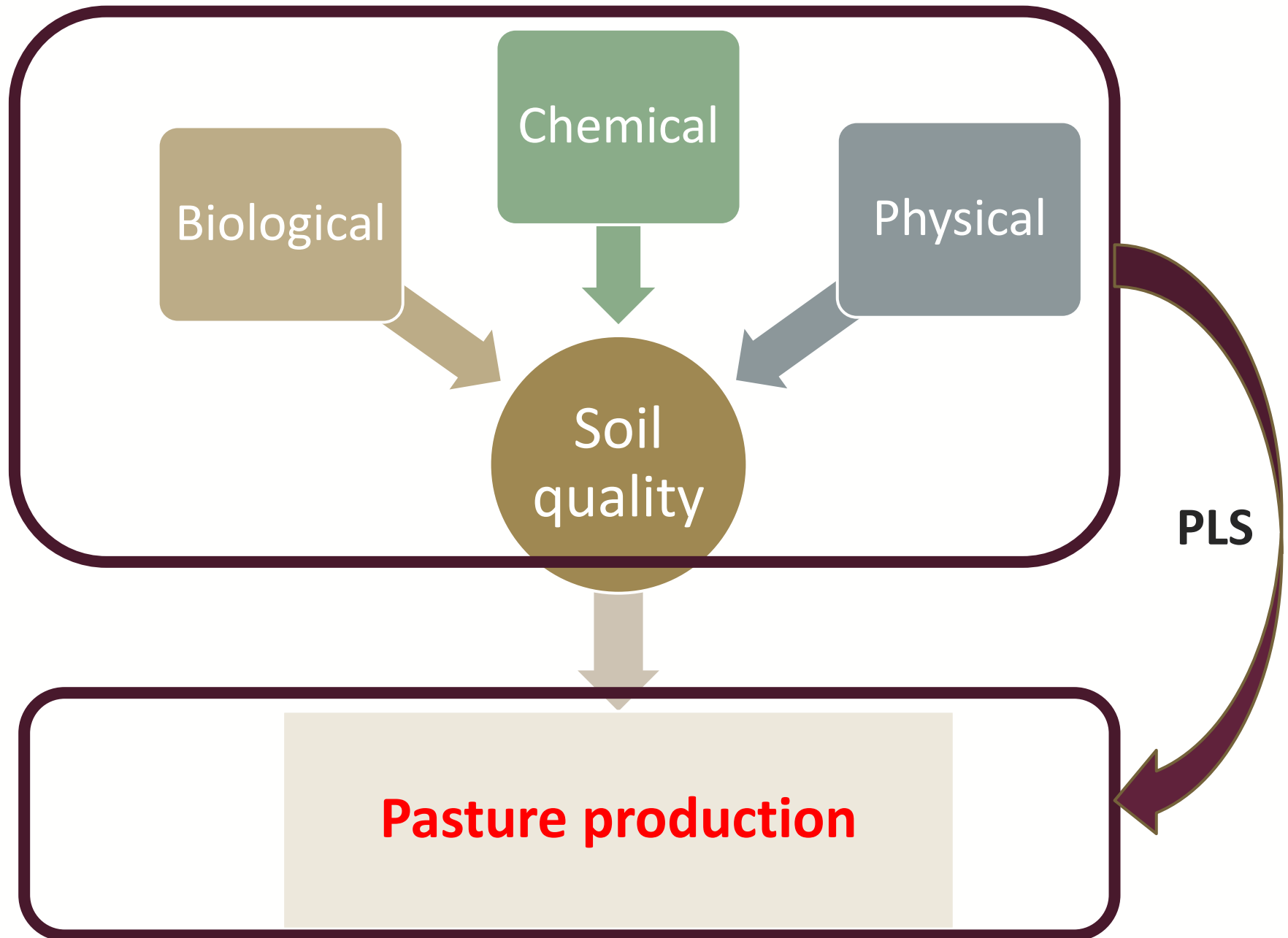
- Cu
- Zn
- Mn
- B
- CEC
- Electrical resistance







- Yield per grazing cycle
- Botanical composition

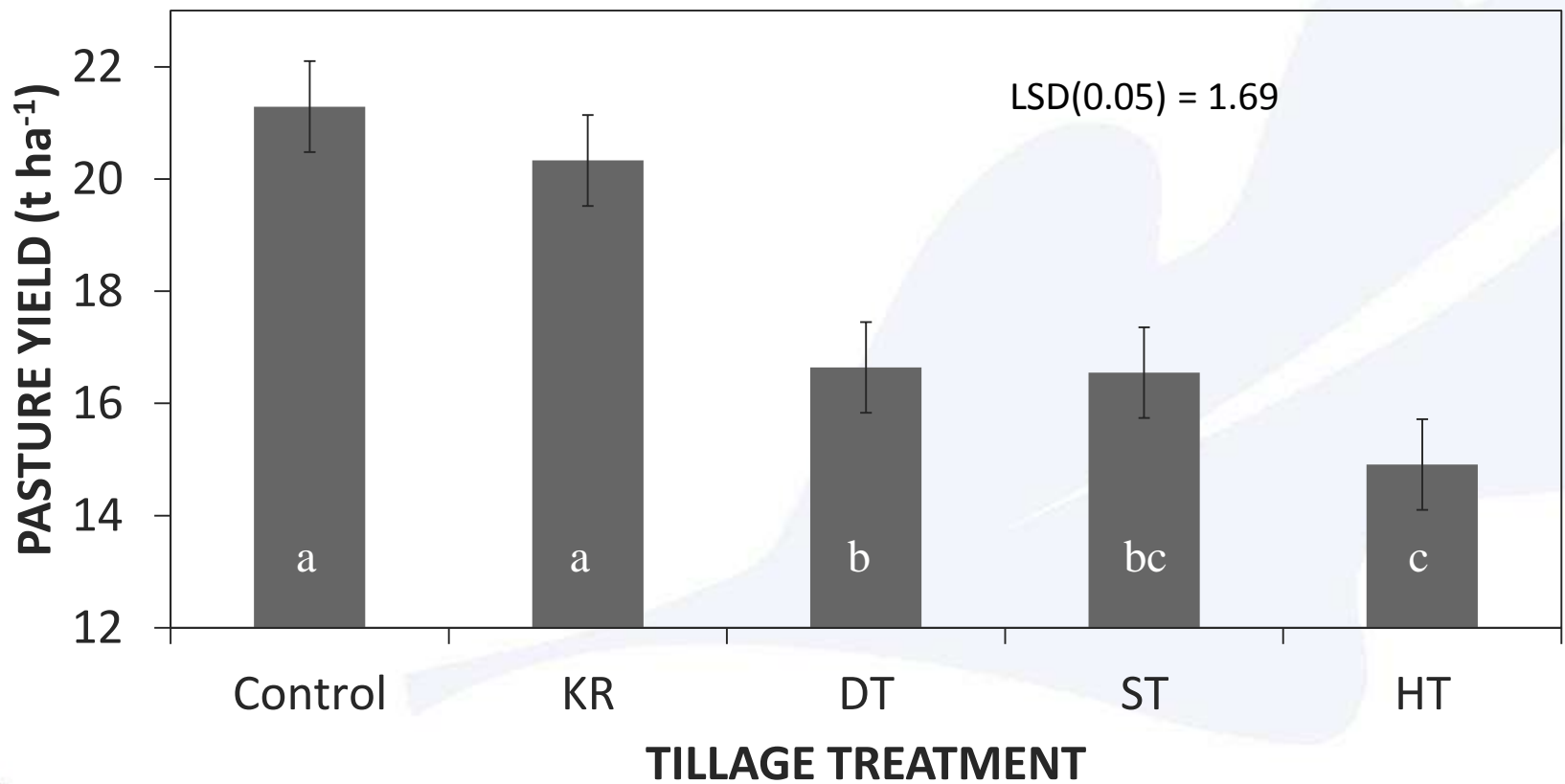




Results



Pasture yield

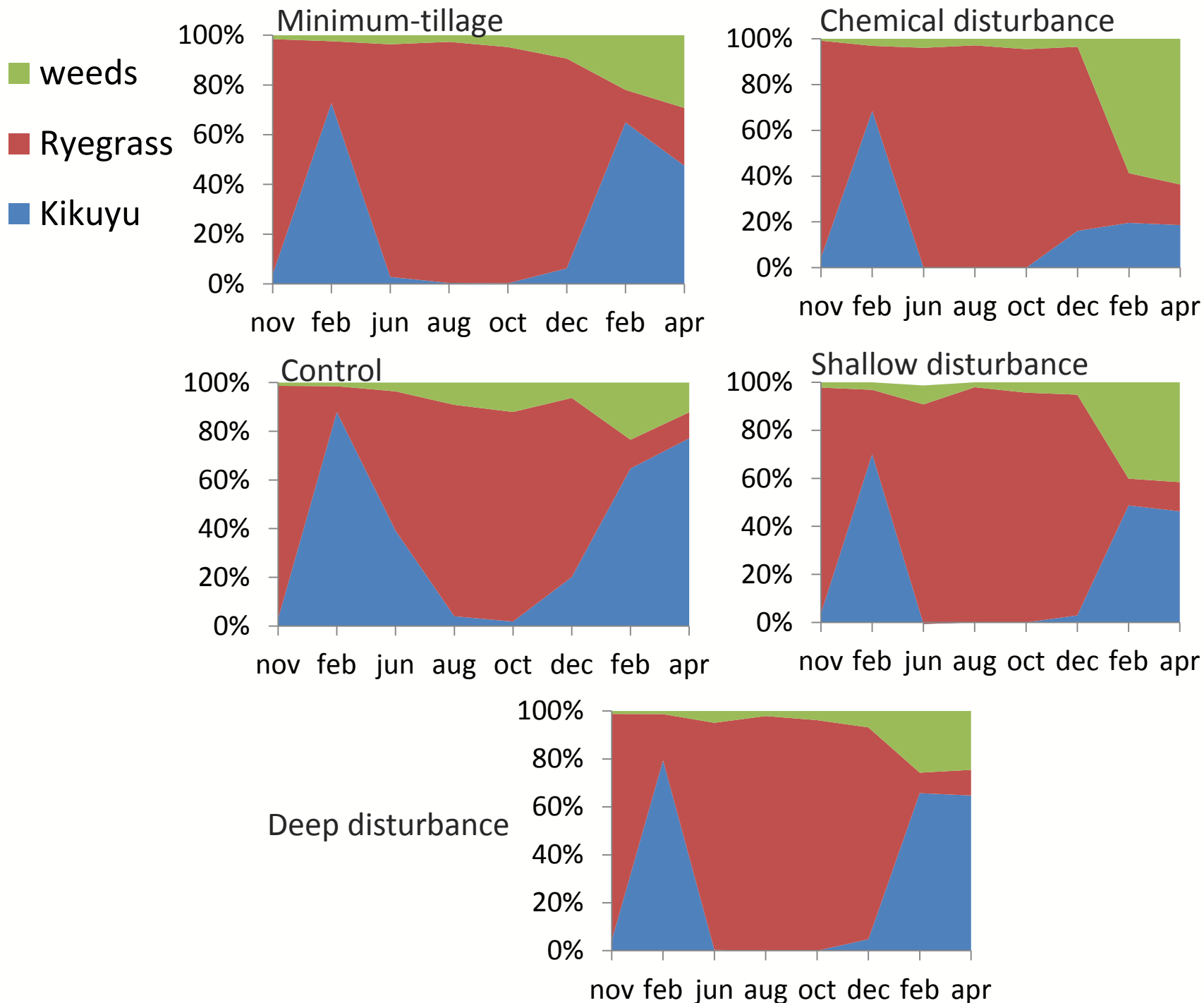


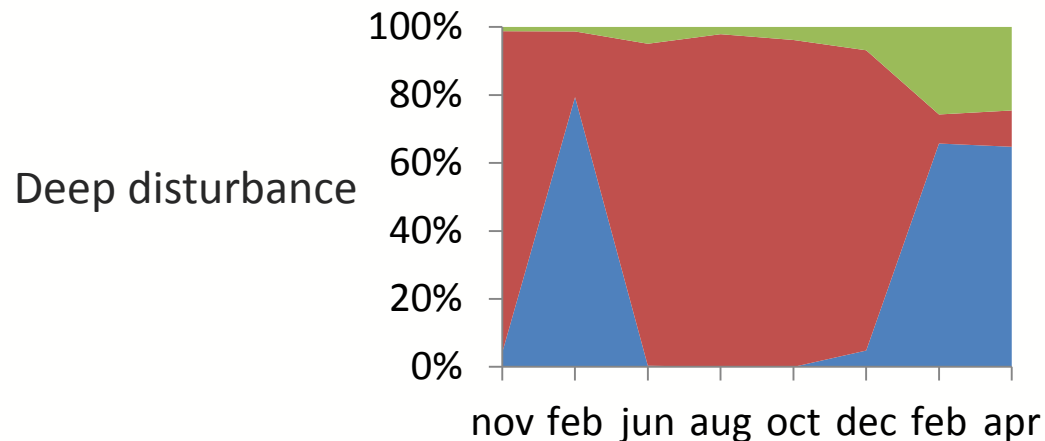
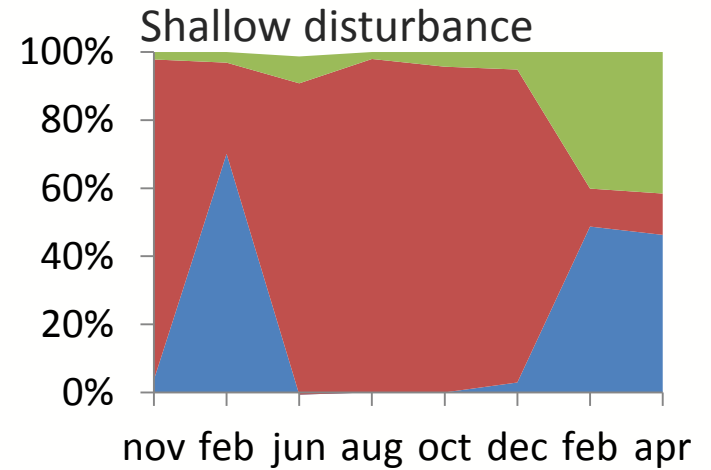
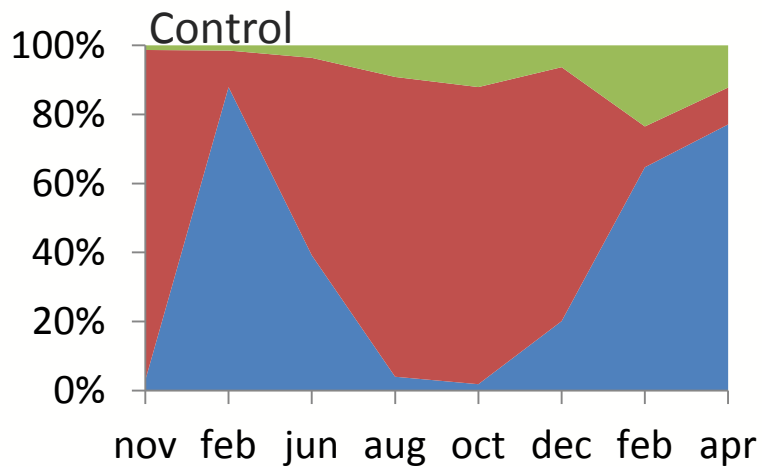
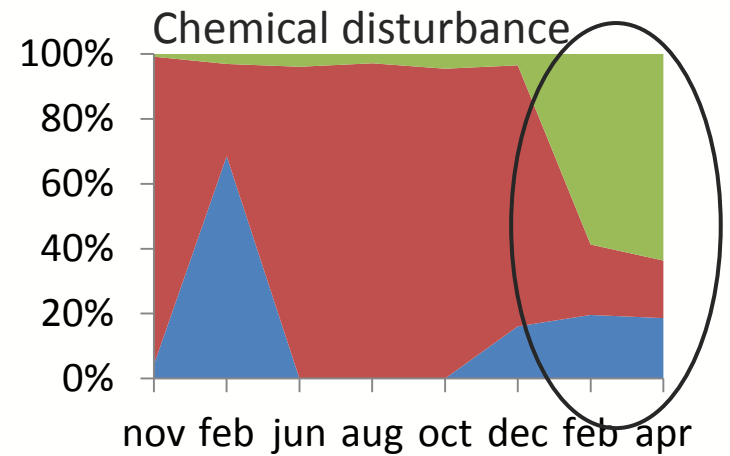
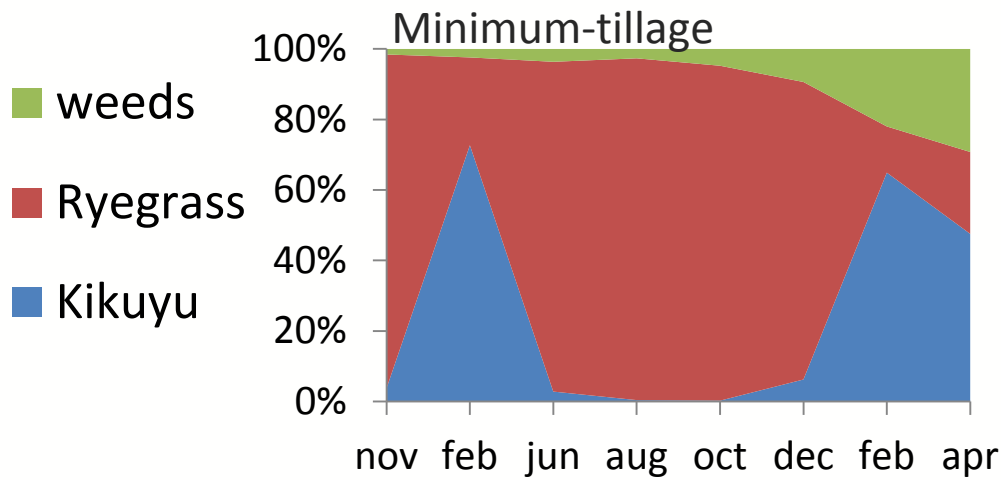
Implication of variance in pasture yield

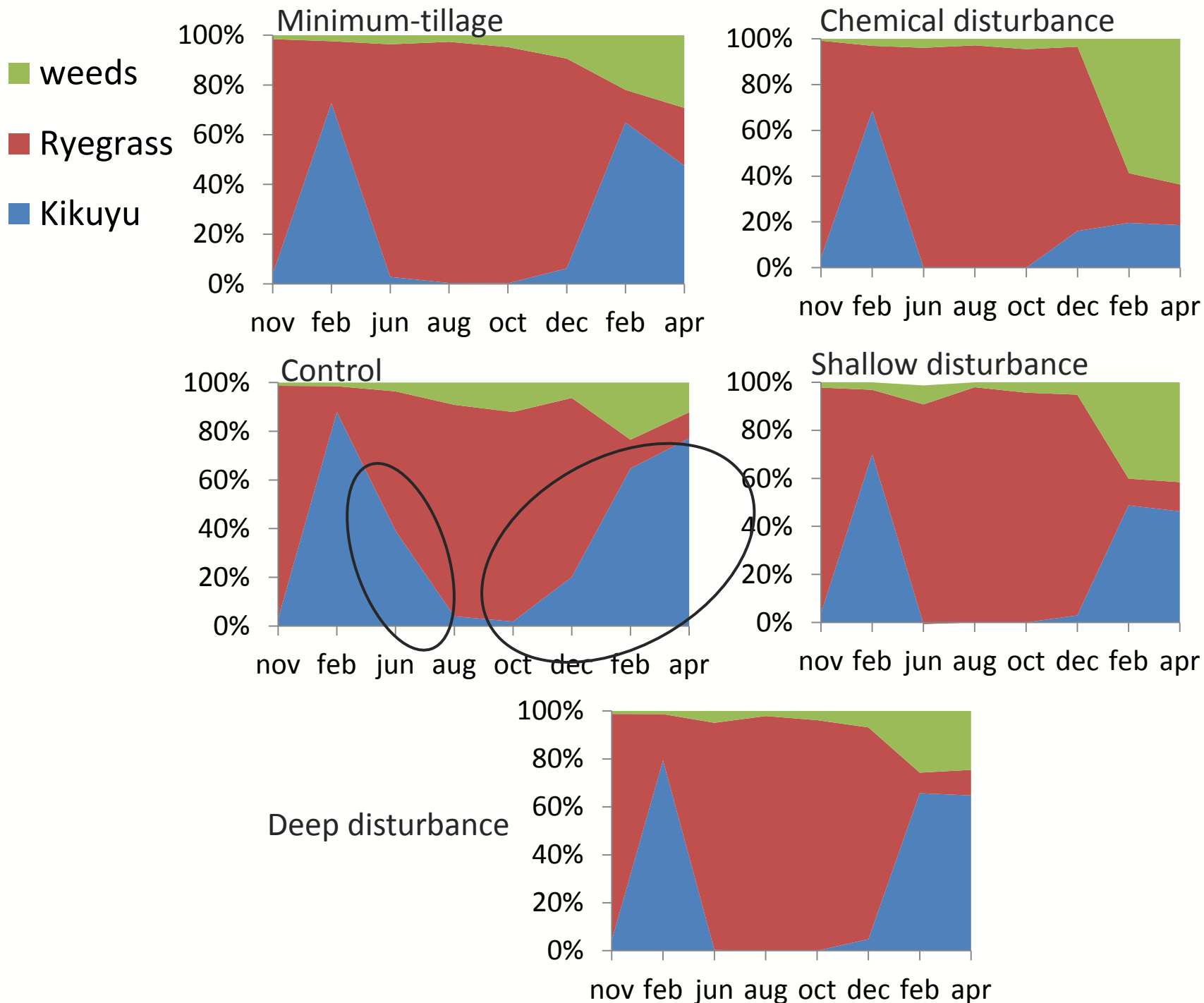


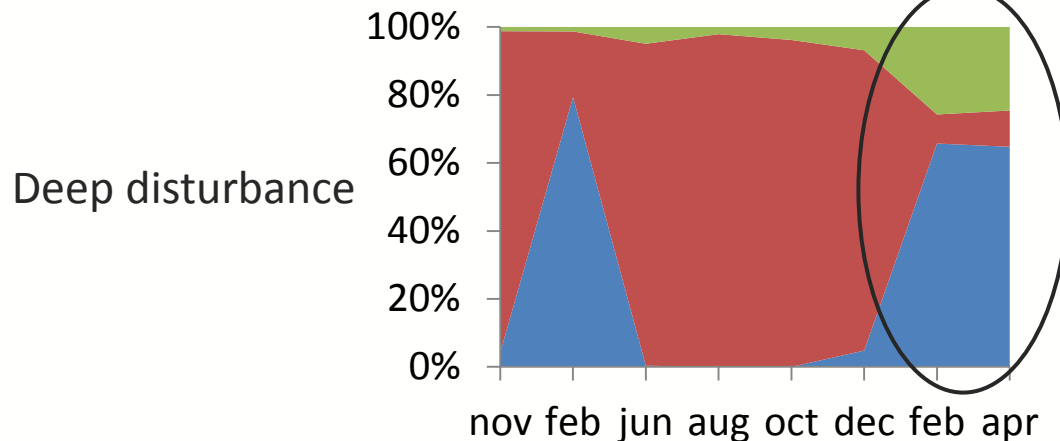
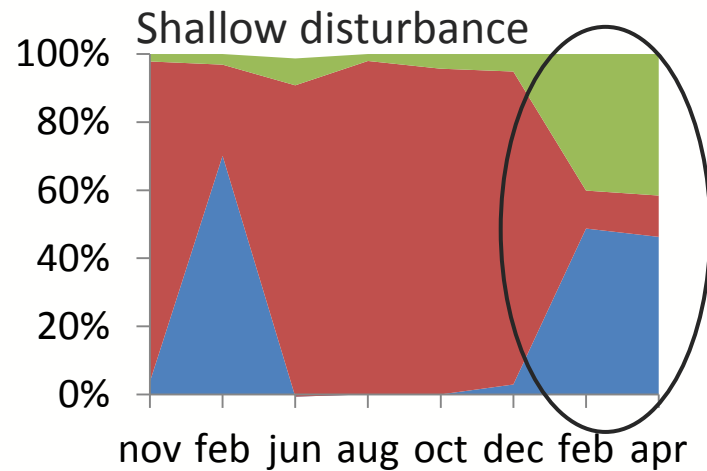
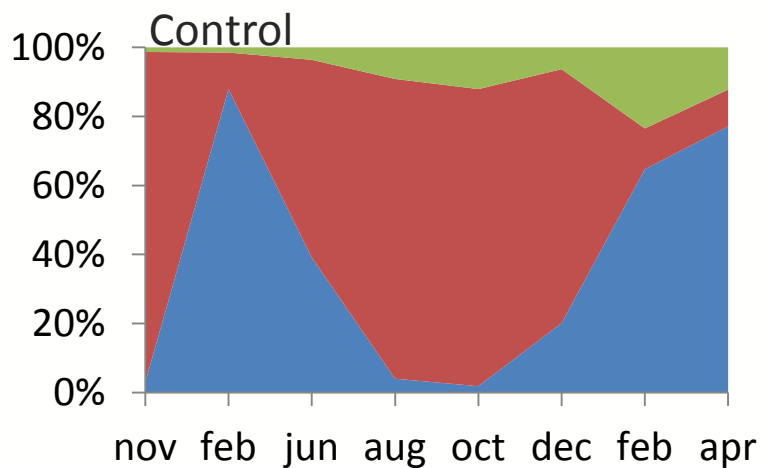
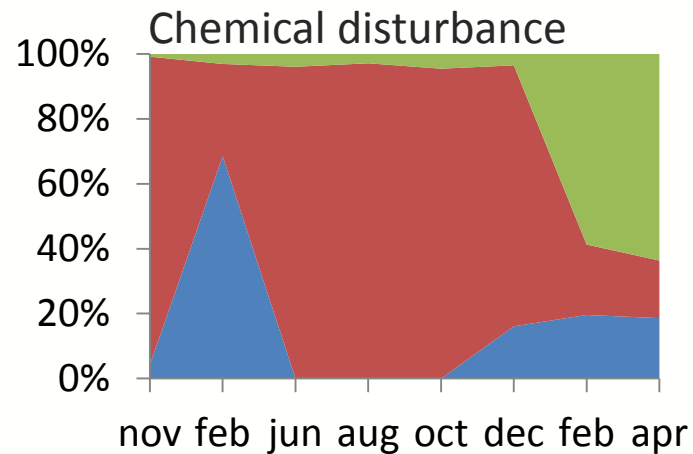
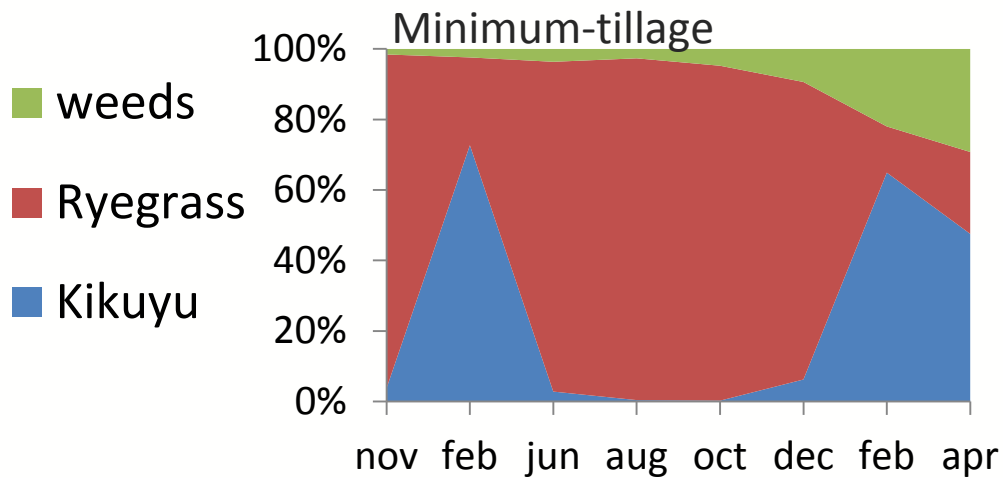
- The difference between lowest and highest yield was 6.38 t ha^{-1}
- Implications on milk production and profitability could be substantial
 - Average milk production for kikuyu-ryegrass pastures on Outeniqua Research Farm = c. $30\,420 \text{ kg milk ha}^{-1}$
 - Penalty of c. $11\,400 \text{ kg milk per year}$ when soil management practices are followed leading to a low herbage yield (HT treatment)



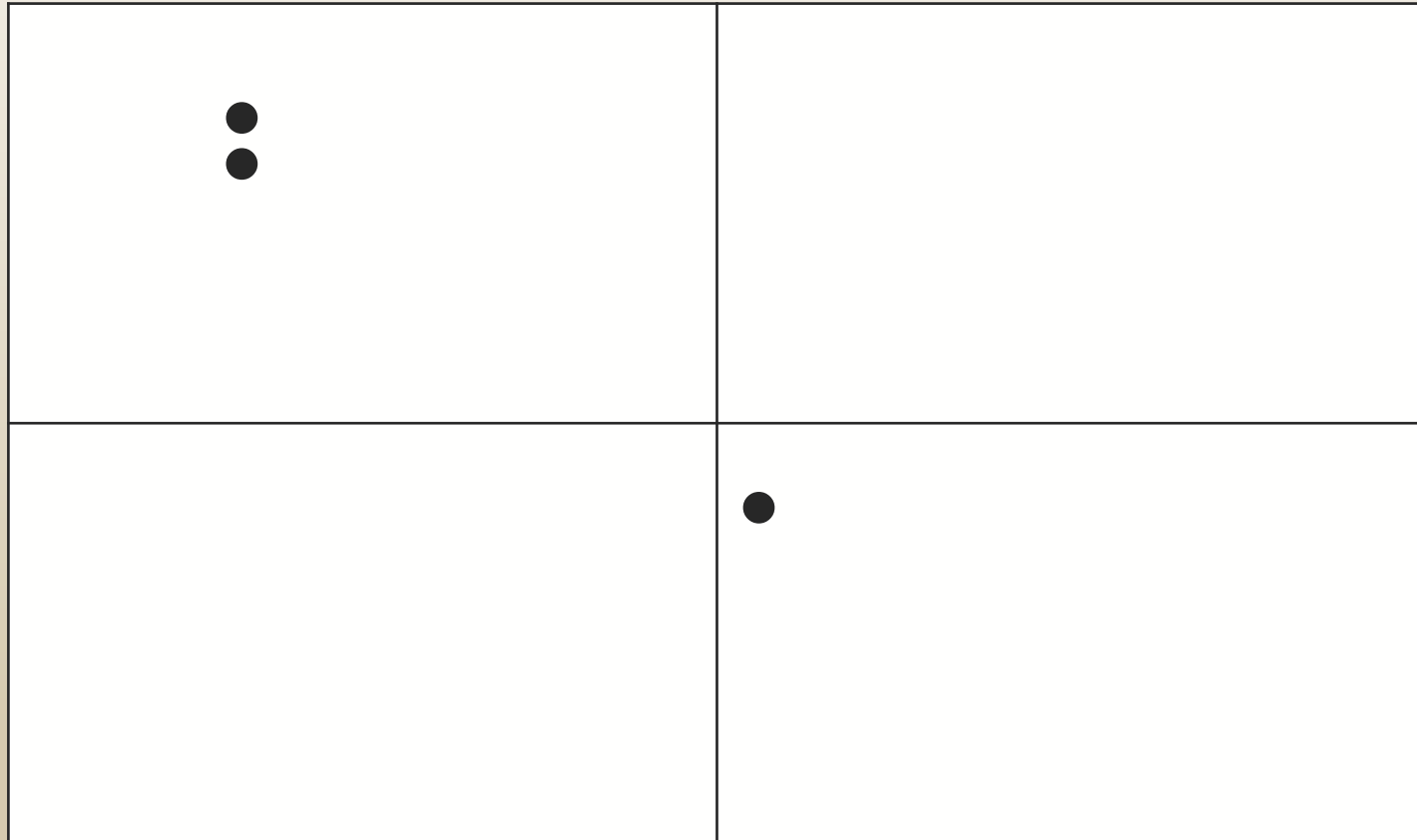




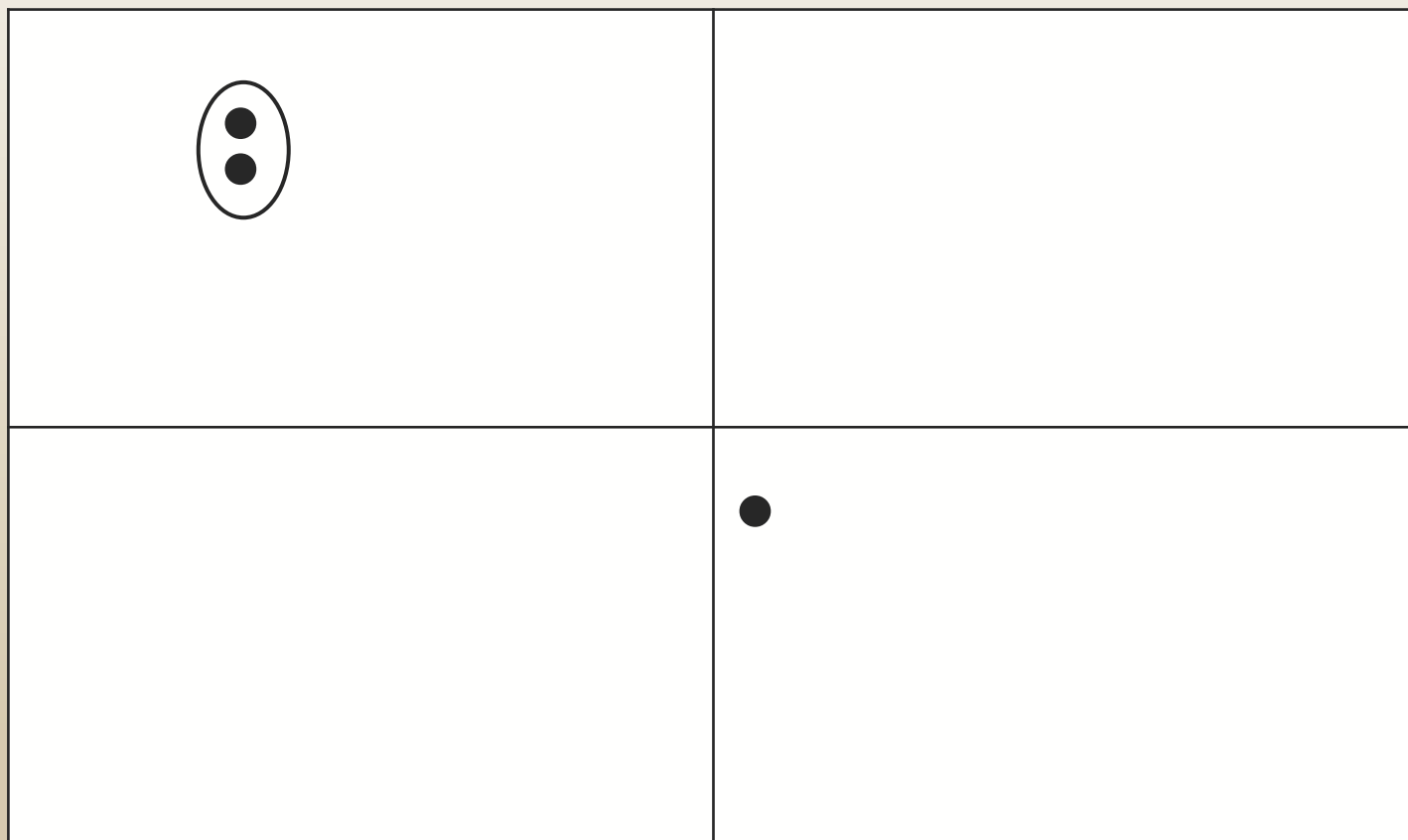




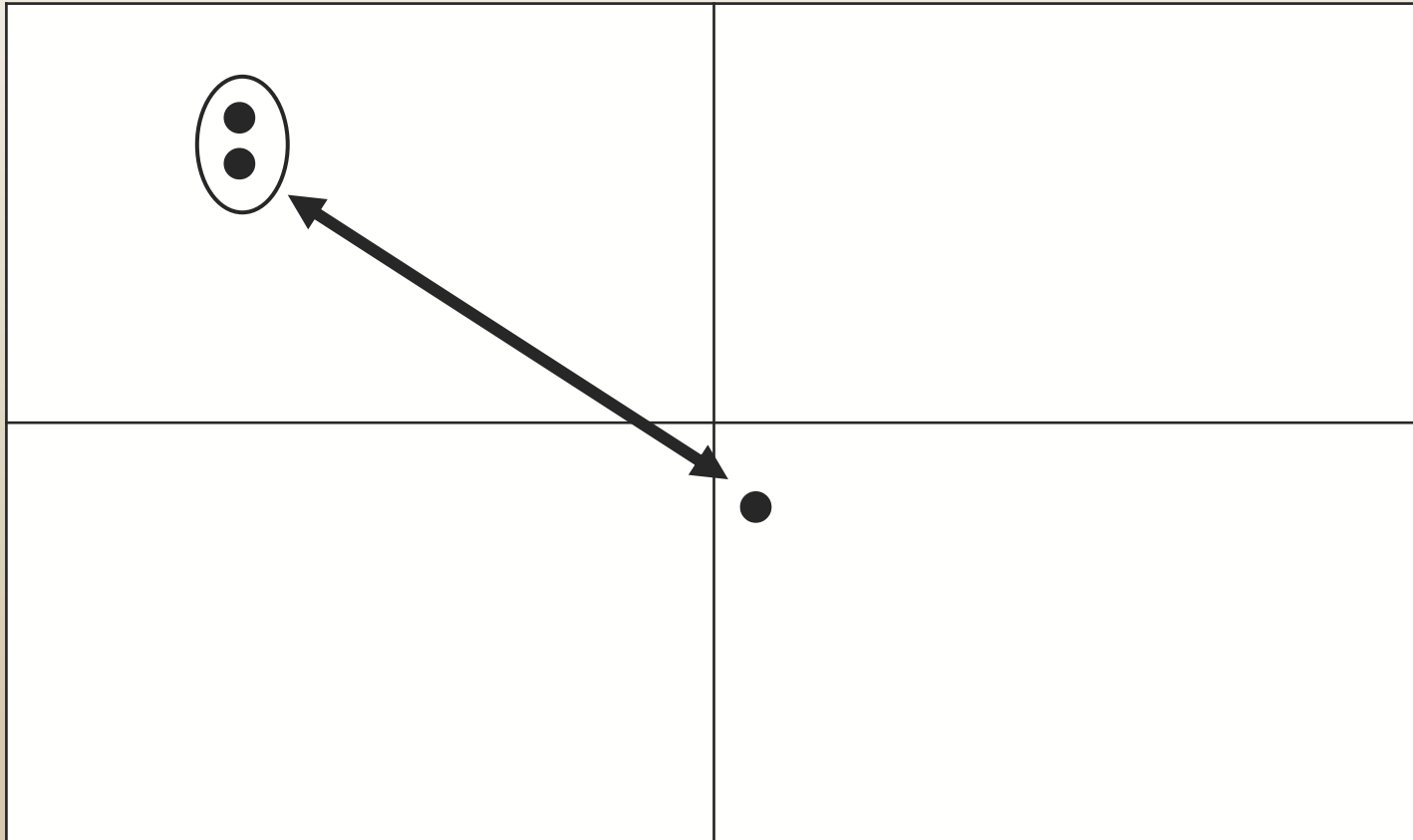
Partial least squares regression



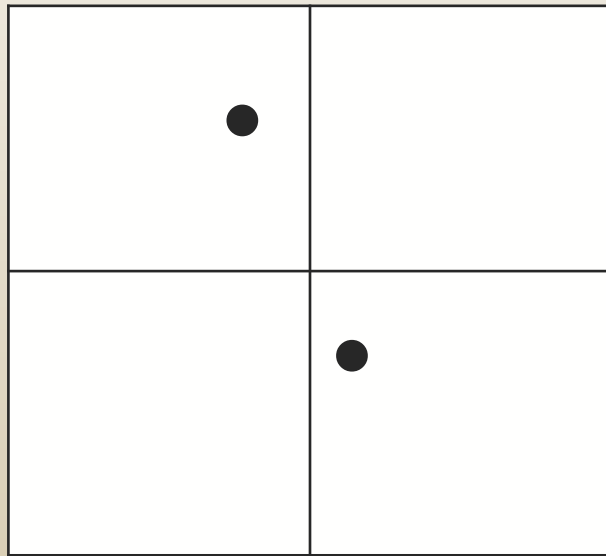
Partial least squares regression



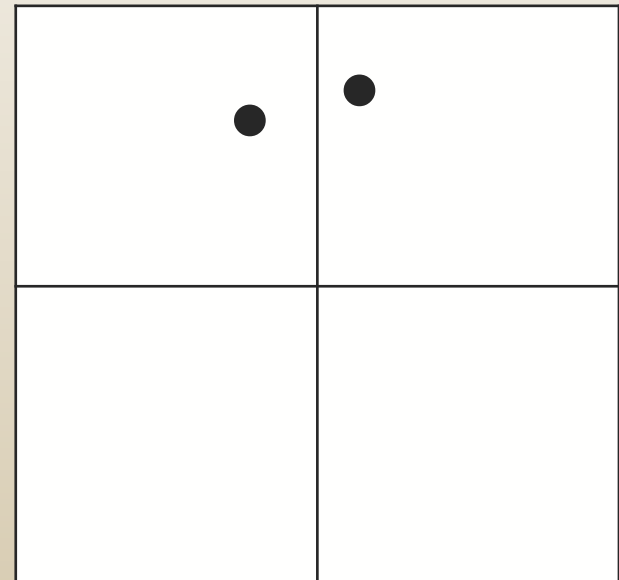
Partial least squares regression



Partial least squares regression



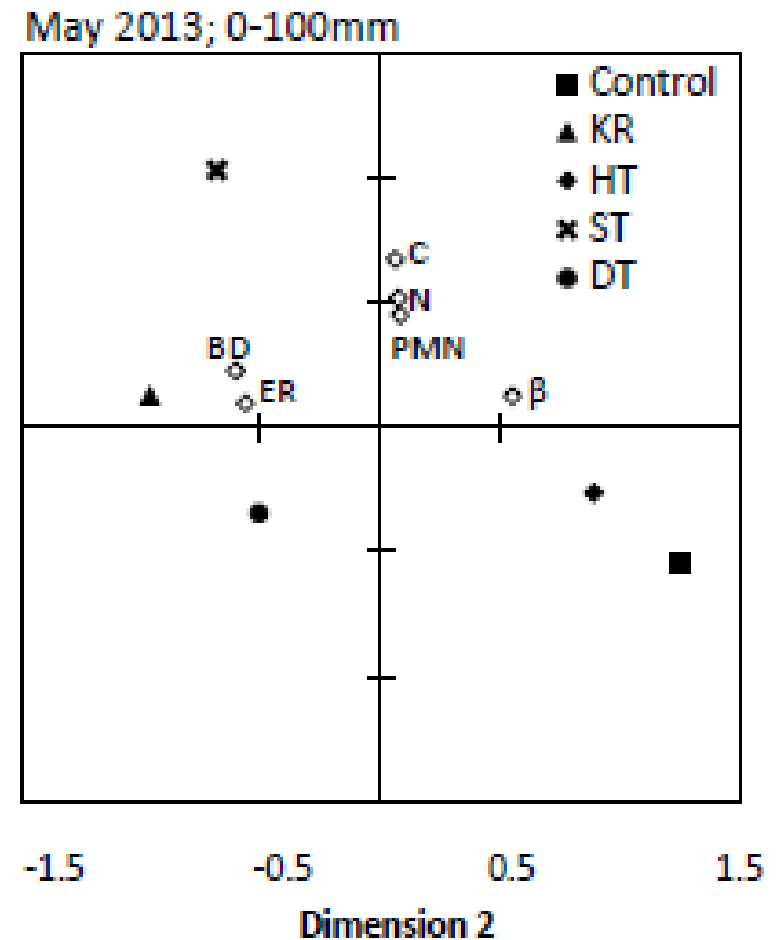
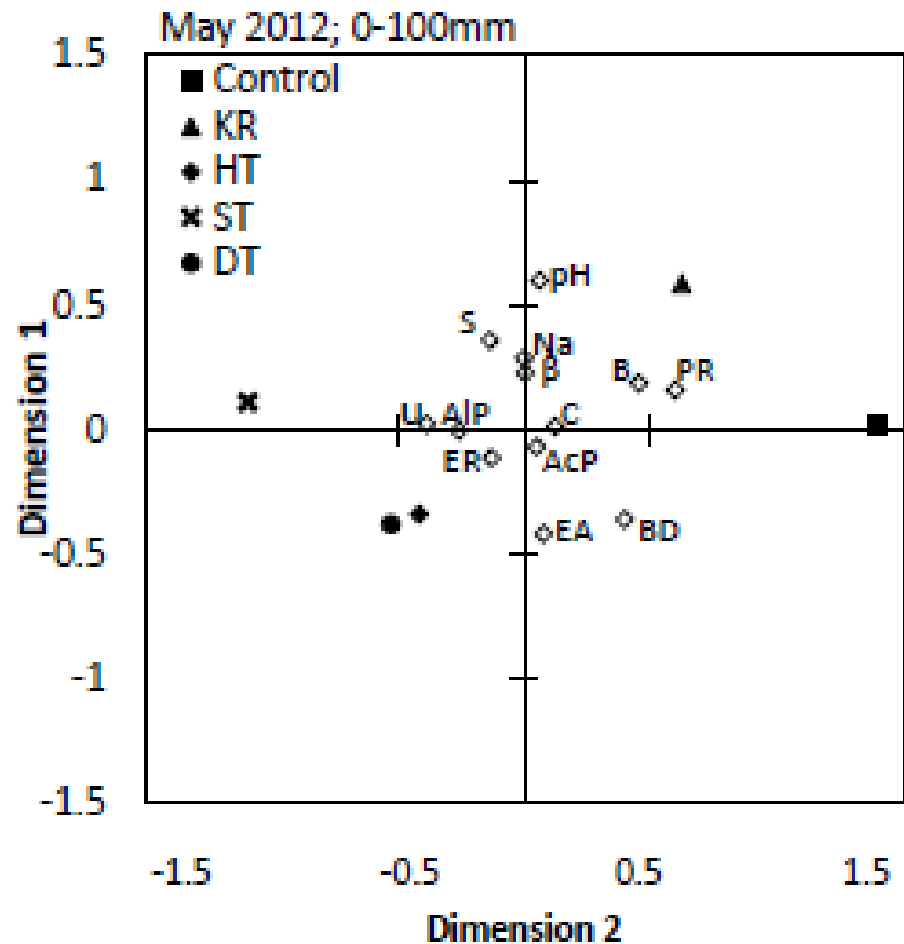
May 2012



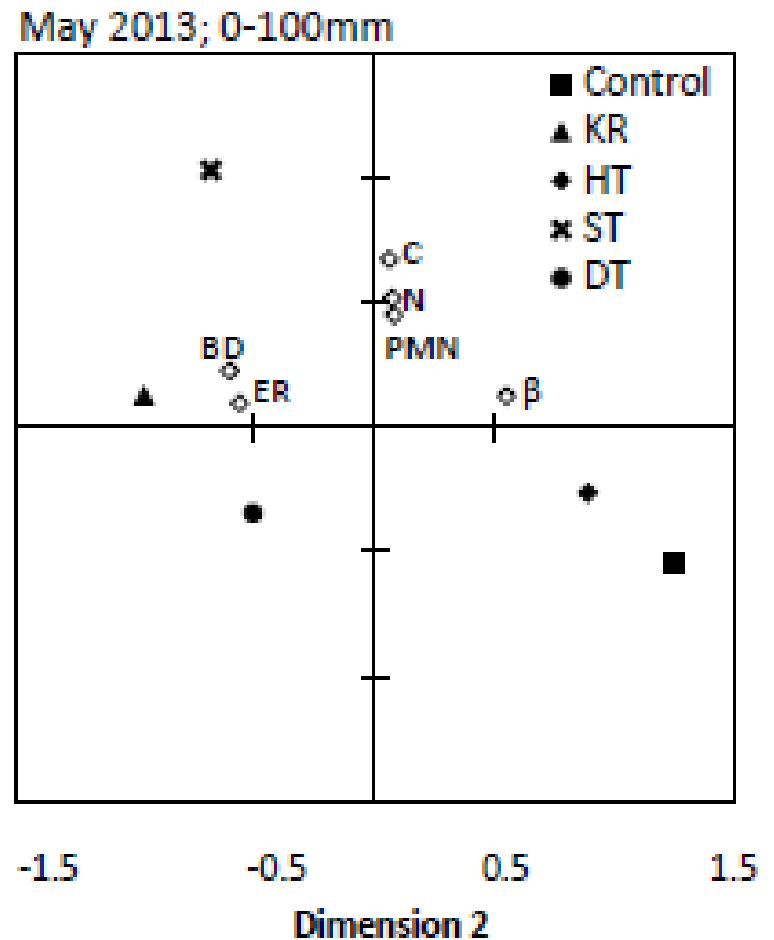
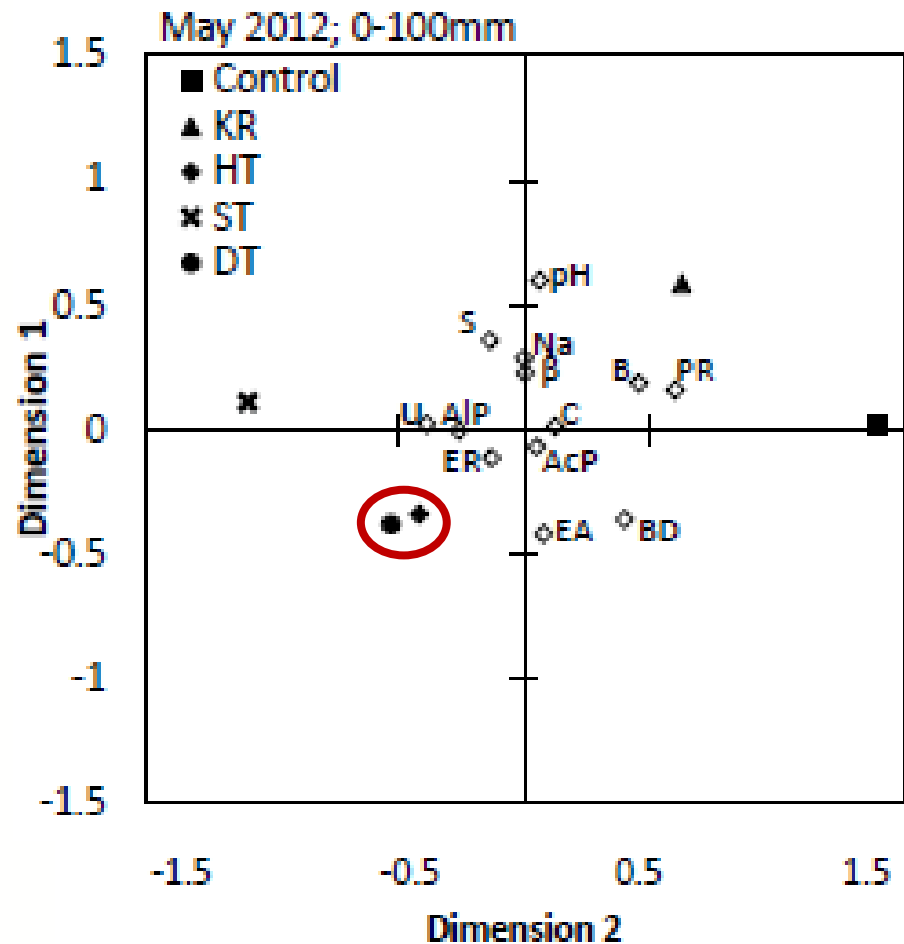
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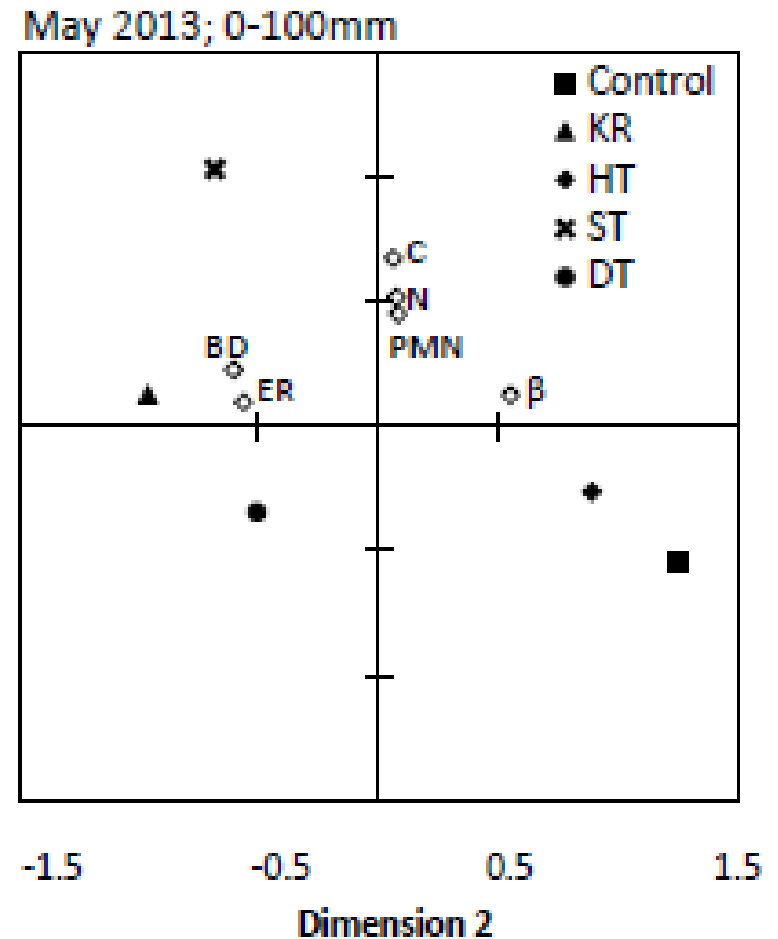
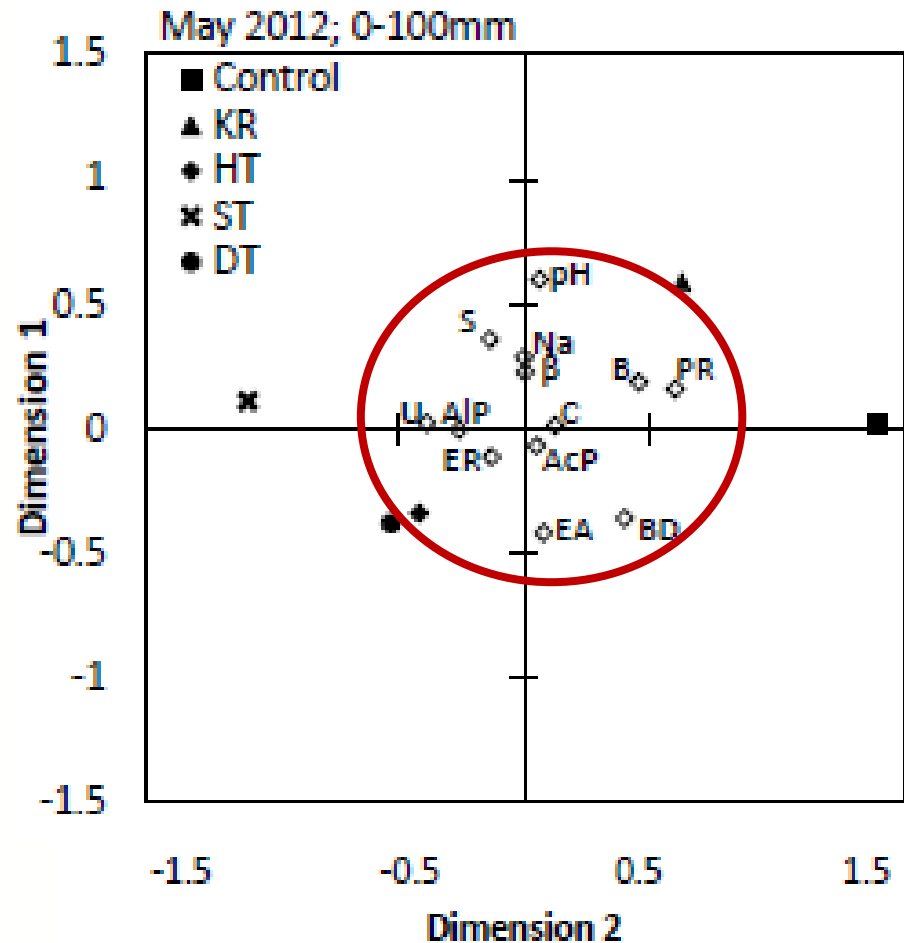
Partial least squares regression



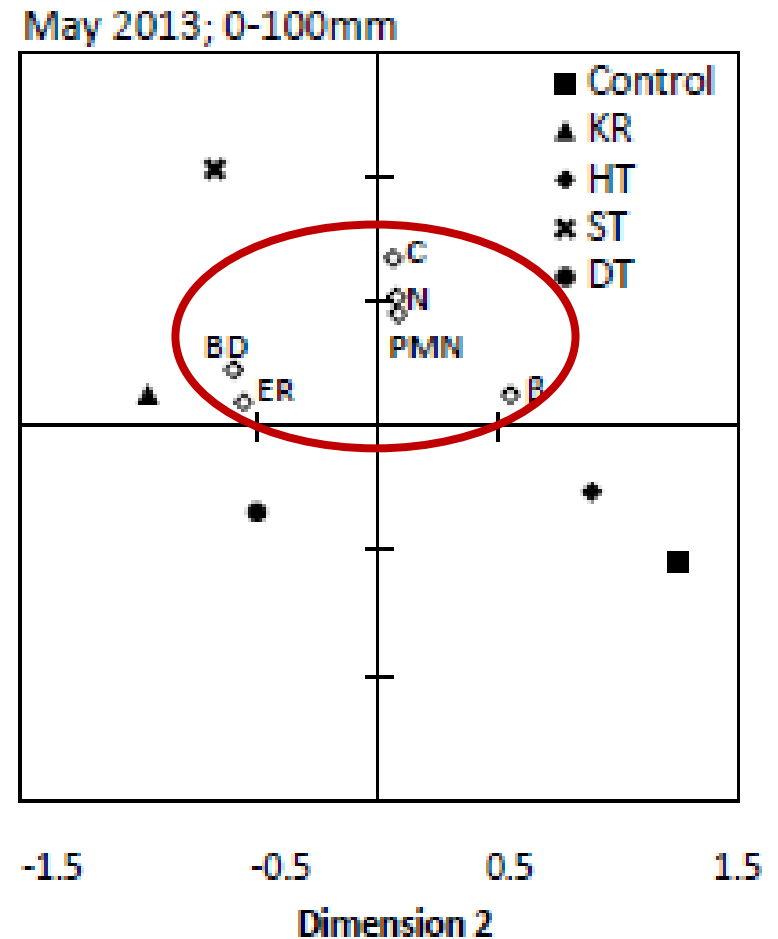
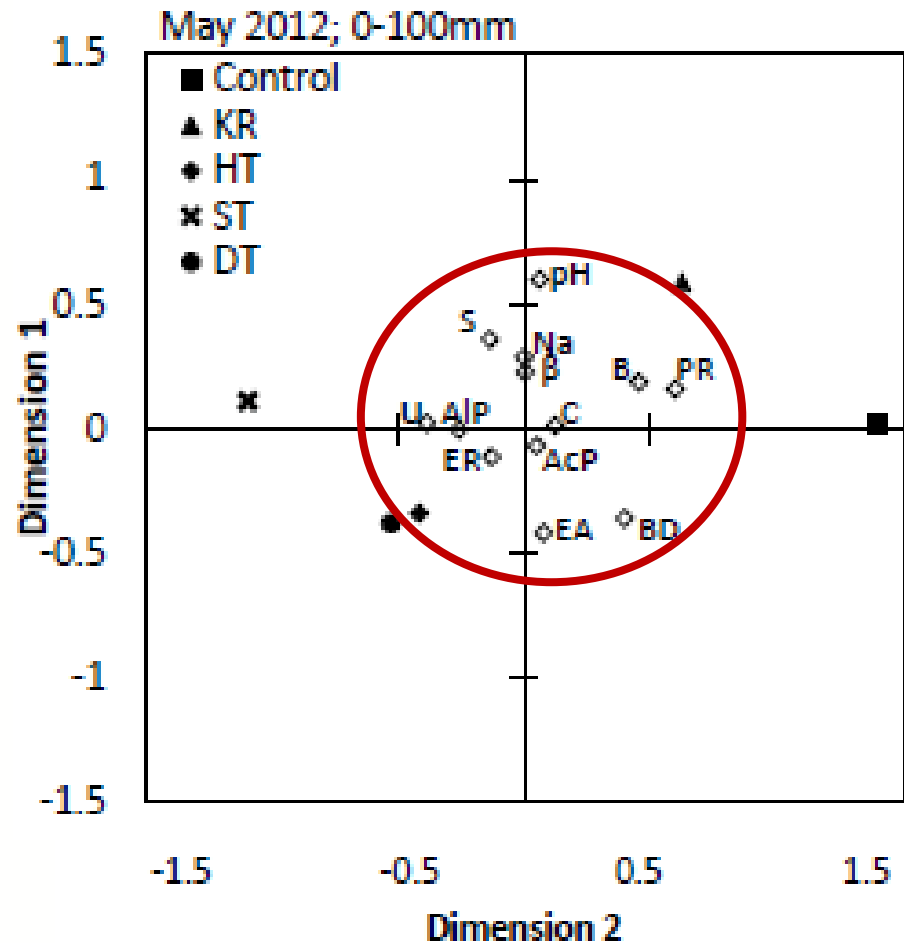
Partial least squares regression



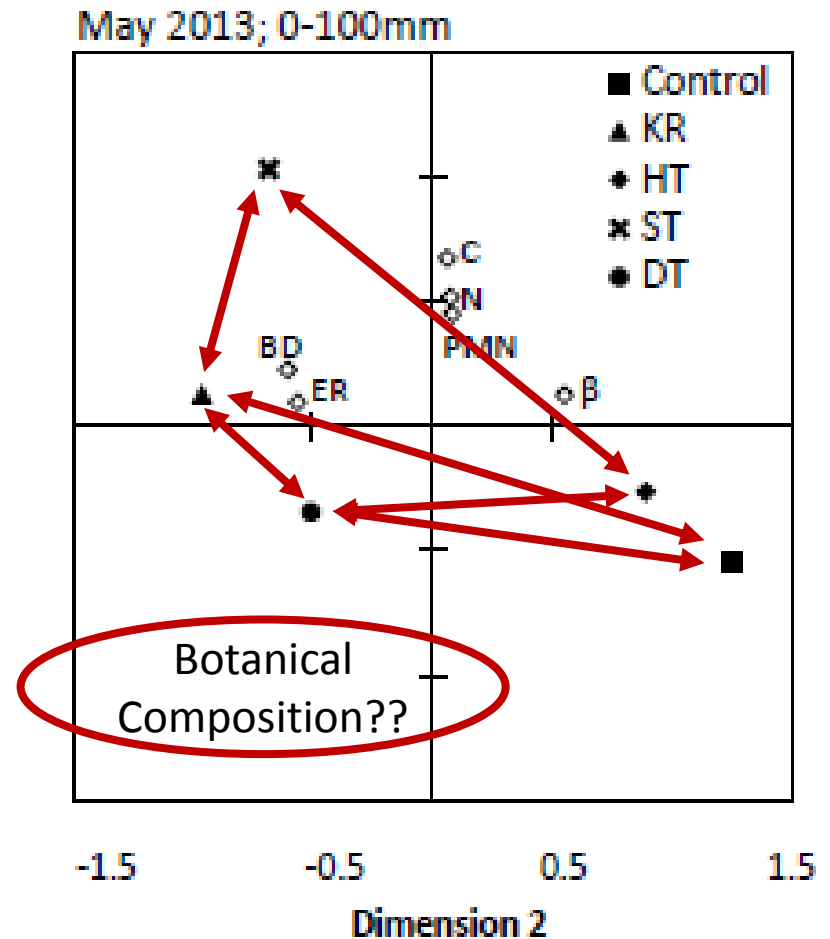
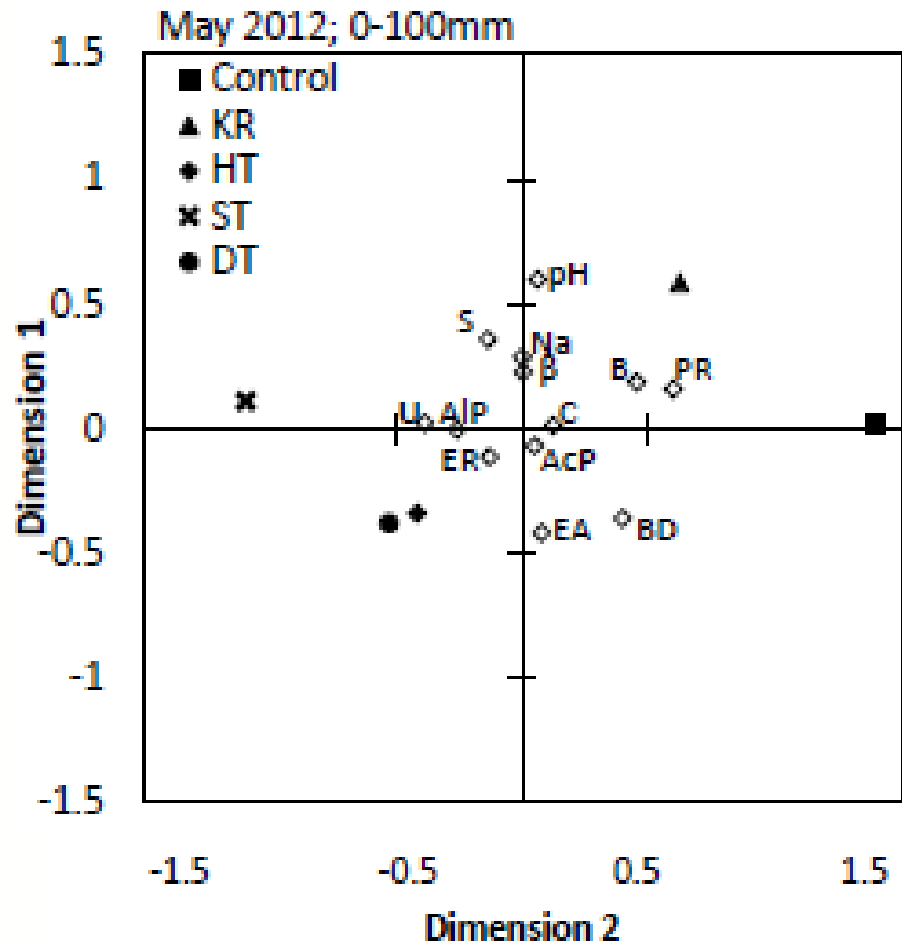
Partial least squares regression



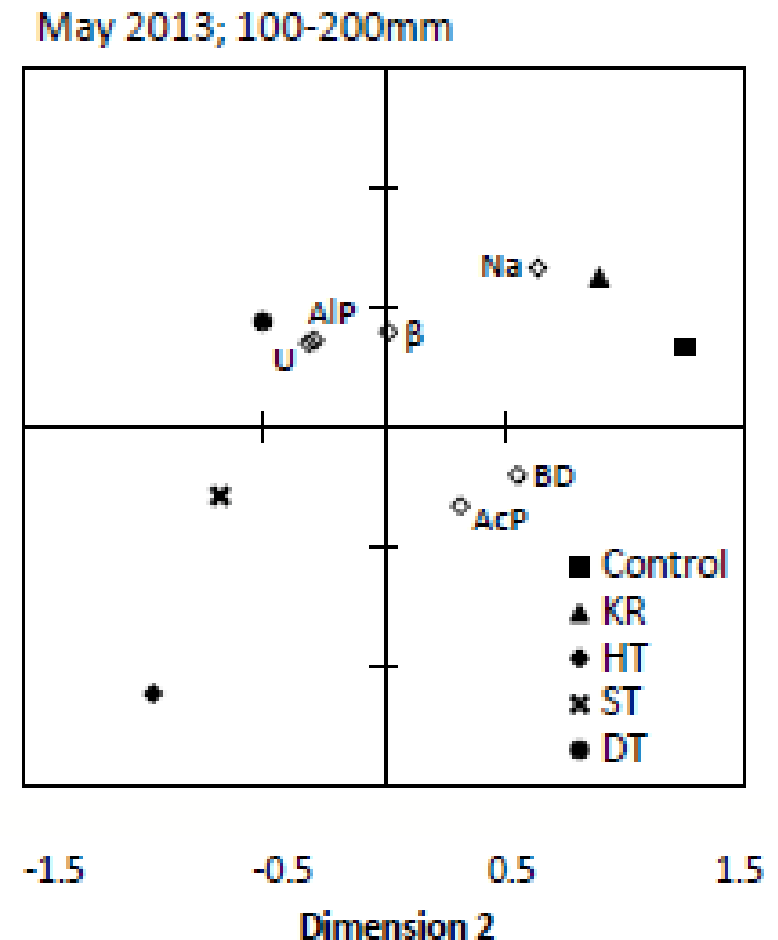
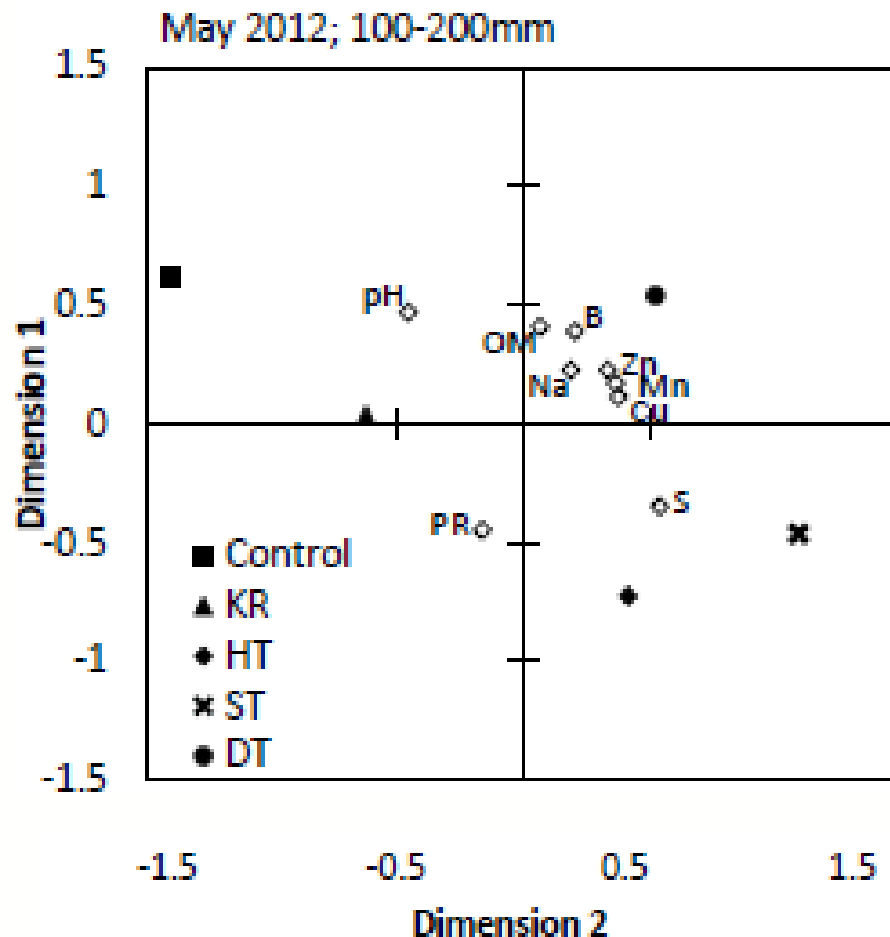
Partial least squares regression



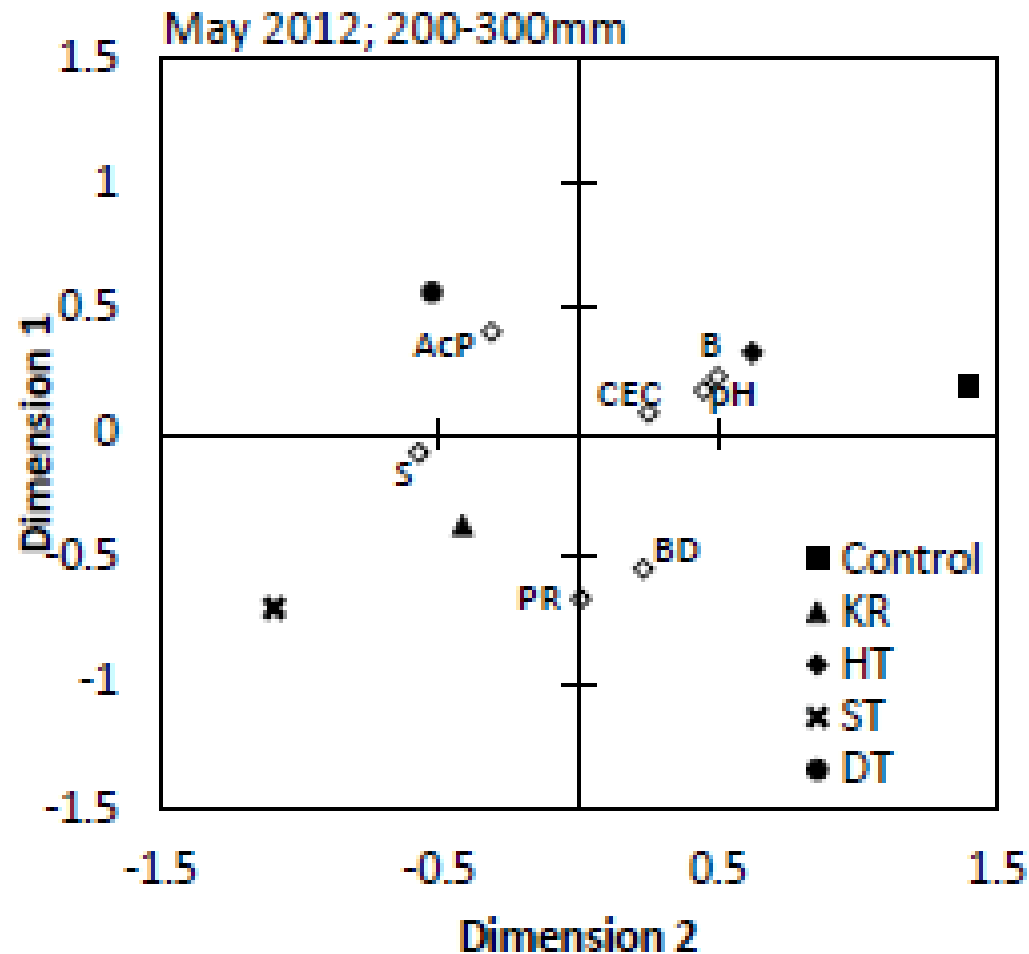
Partial least squares regression



Partial least squares regression



Partial least squares regression



Conclusion



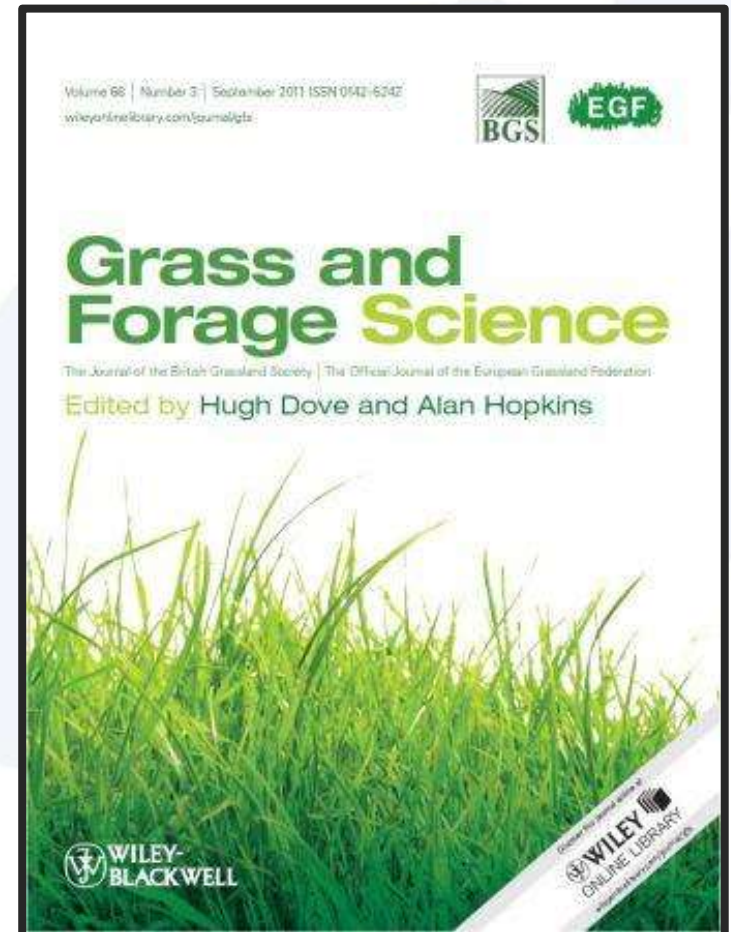
- Within 1 year after tillage physical and chemical condition reverted to the original state
- Microbiological indicators are sensitive to soil disturbance
 - Differences between tillage treatments were evident for 1 year
- Association between herbage yield and soil quality?
- Further research is required - mechanisms
 - Is it only botanical composition that played a role?
- Recommendation: Include yield in soil quality assessments



Acknowledgements



- Western Cape Department of Agriculture
- Swanepoel PA, du Preez CC, Botha PR, Snyman HA, Habig J. (2016). Tillage effects, soil quality and production potential of kikuyu-ryegrass pastures in South Africa. **Grass and Forage Science** (*In Press*)



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