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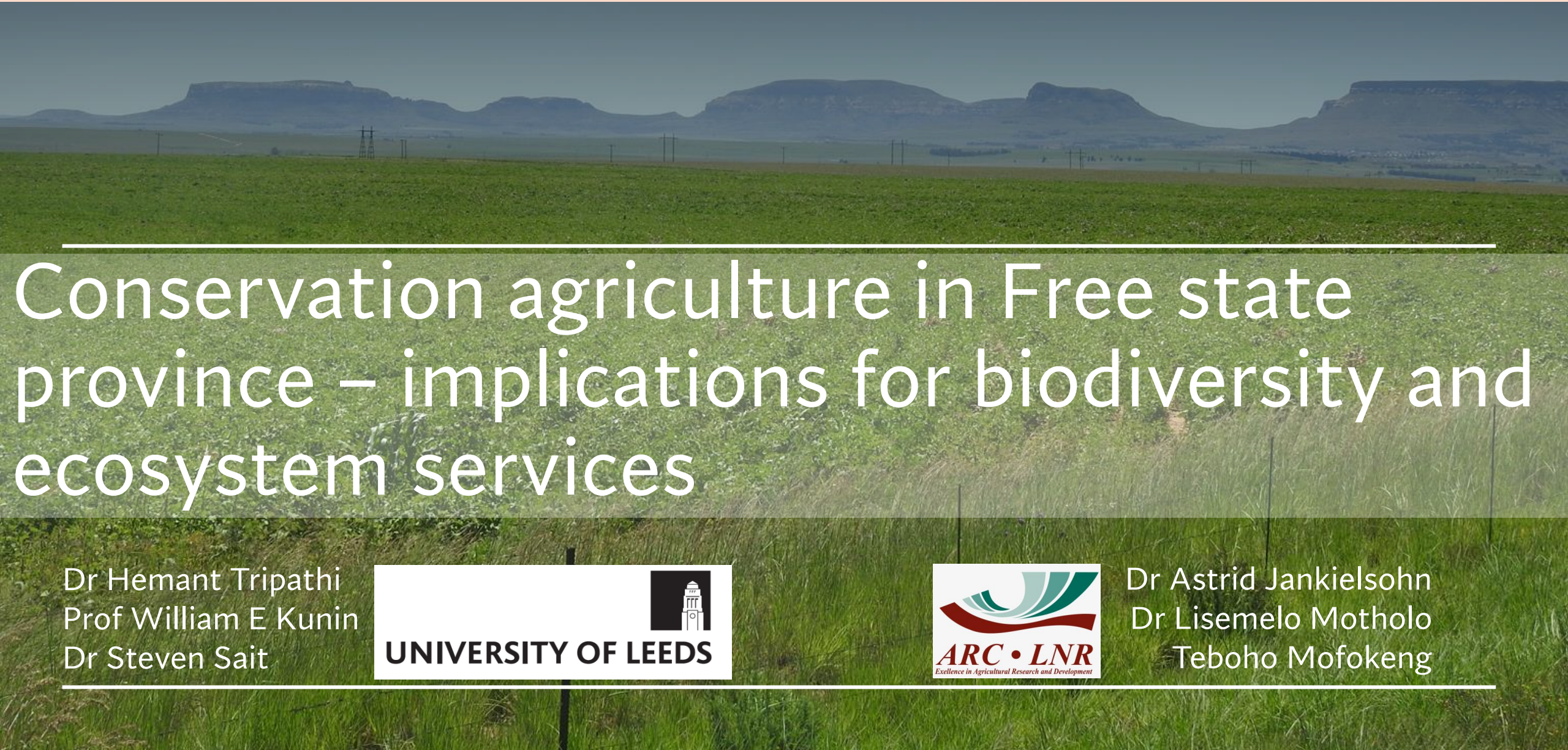

# Conservation agriculture in Free state province – implications for biodiversity and ecosystem services


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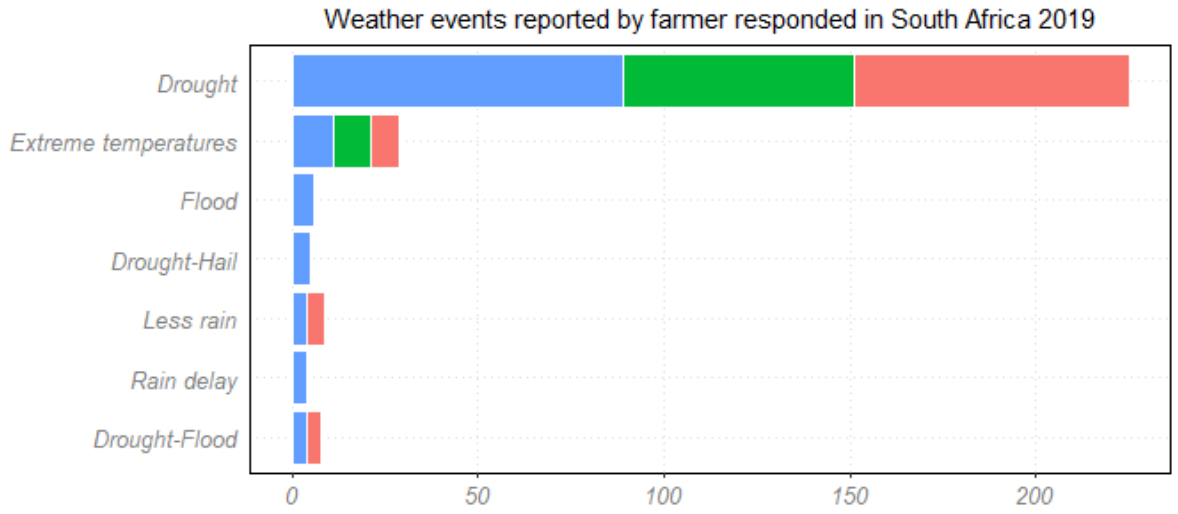
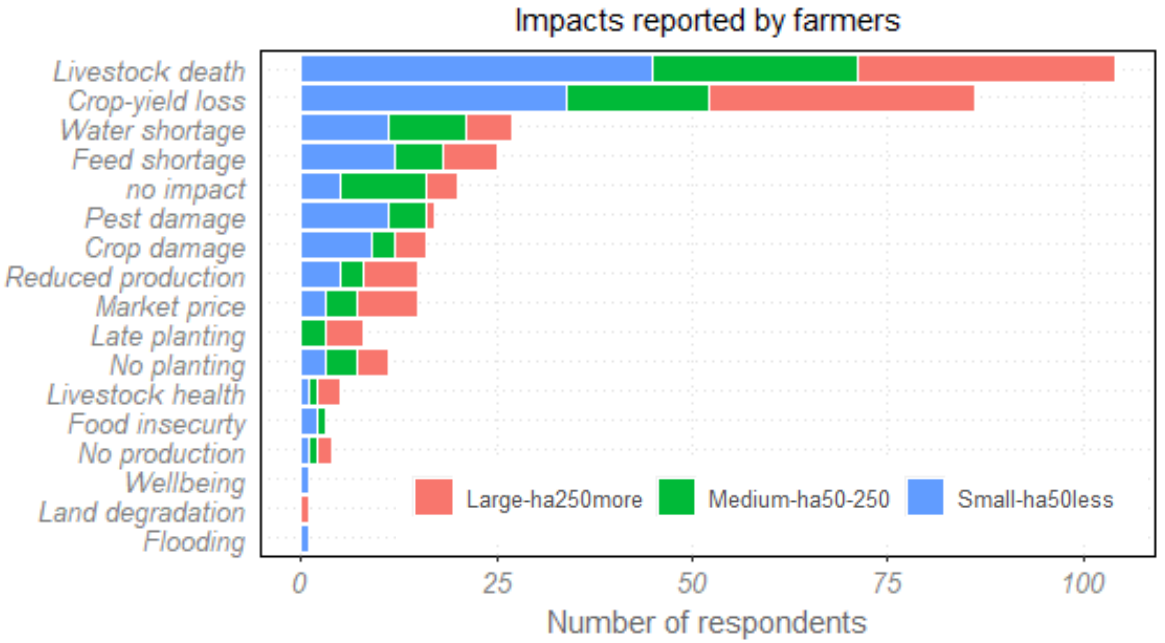
# Droughts

- Most common recurring weather-shock in the last 3-4 years
- Main impacts:
  a. Livestock health and death due to shortage of feed and water.
  b. Yield loss due to crop failure and pest damage, and delay in planting
  c. Reduced food security and wellbeing due to crop and livestock losses



# Coping and adaptation

## Small-scale farms

- Low till
- Intercropping with vegetables
- Cover crops for animal feed
- Reduce livestock
- Use of manure (from other farms)

## Large-scale farms

- Low till and cool season cover crops
  *Rye, brassica, vetch (hairy and grazing vetch), clovers*
- Livestock integration (mob grazing)
- Land expansion
- Soil management

## Land-reform farms

- Deep ripping/till
- Very few practice CA
- Land expansion
- Diversification

# Land reform

Land reform will change landscape structure – landscape heterogeneity

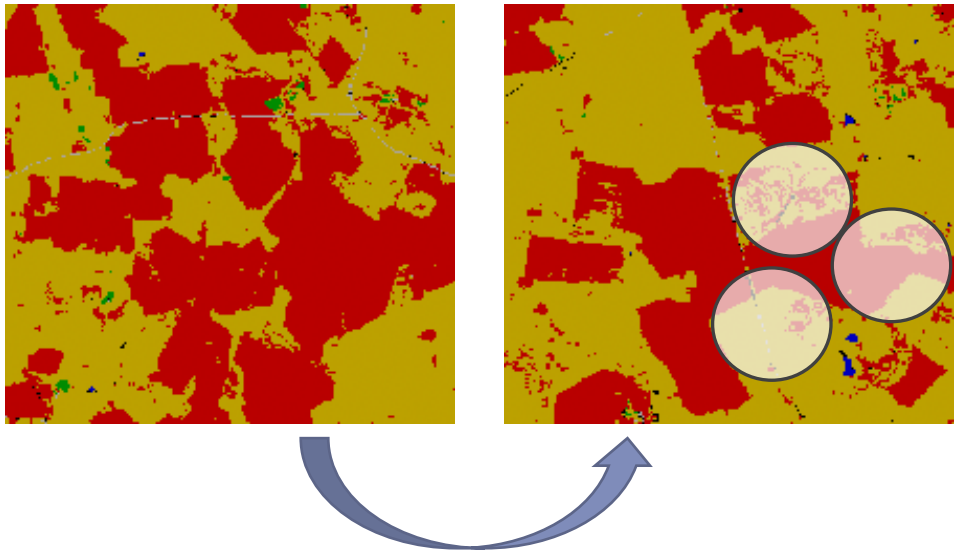
Future trajectories and implications depend on:

a. Type of land distributed – government-owned unused - 70% vs pre-existing enterprises - 30%

b. Beneficiaries' use of the land – farmers with capital, knowledge, and experience vs without

c. Technical and infrastructural support

**Re distribution of existing commercial farms + government support**



Loss of existing cultivated area and increase in non-crop habitat. Increase in landscape heterogeneity.

# Land reform

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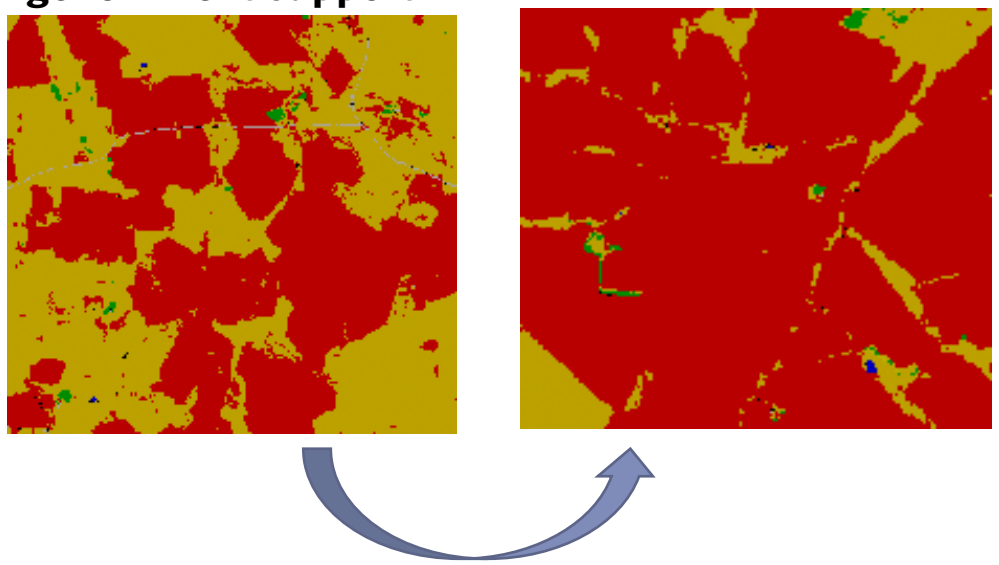
**Re distribution of unused lands – existing non-crop patches + mechanization / government support**



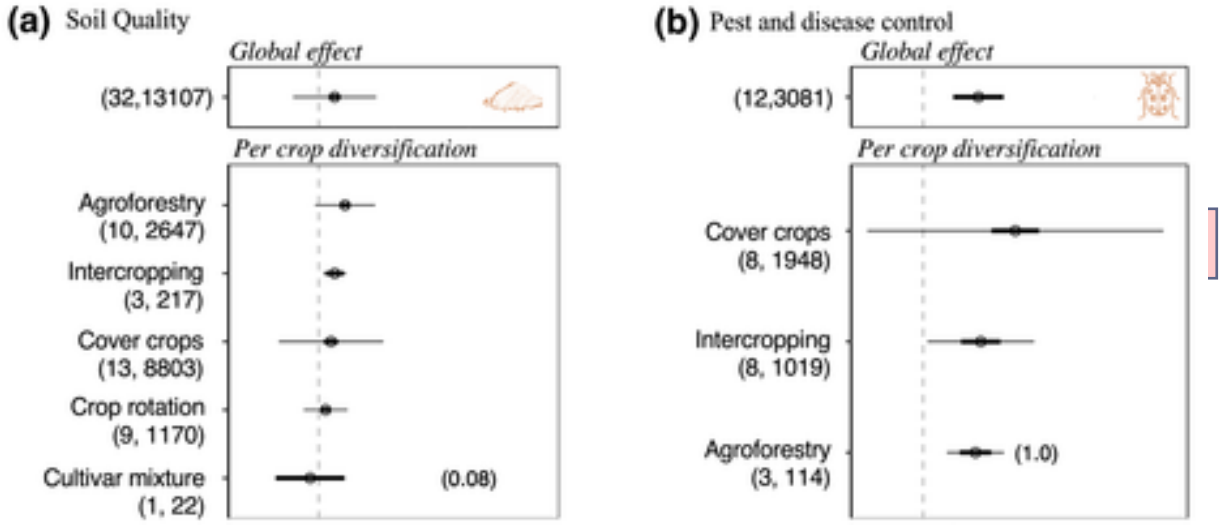
Reduction and patchiness of non-crop habitat. Decline in landscape heterogeneity. Landscape become homogenous with croplands.

# Effects on biodiversity and ecosystem services

1. Conservation agriculture practices
   *Low till, cover cropping (livestock integration in crop fields) , and use of organic manure, and Intercropping*
2. Landscape structure
   *Landcover richness – number of unique landcovers, and habitat quantity – area covered and number of patches (mainly grasses – grasses + herbs + fallow areas)*

Pest control by natural enemies – e.g., parasitoid wasps and spiders.

Nutrient recycling by decomposers - by e.g., dung beetles




*(Beillouin et al. 2021)*

*Beillouin, Damien et al. 2021. "Positive but Variable Effects of Crop Diversification on Biodiversity and Ecosystem Services." Global Change Biology.*

# Effects on biodiversity and ecosystem services

1. Conservation agriculture practices

   *Low till, cover cropping (livestock integration in crop fields) , and use of organic manure, and Intercropping*

2. Landscape structure

   *Landcover richness – number of unique landcovers, and habitat quantity – patch size and number of patches, and continuity – cohesion (mainly grasses – grasses + herbs + fallow areas)*

Pest control by natural enemies – e.g., parasitoid wasps and spiders.

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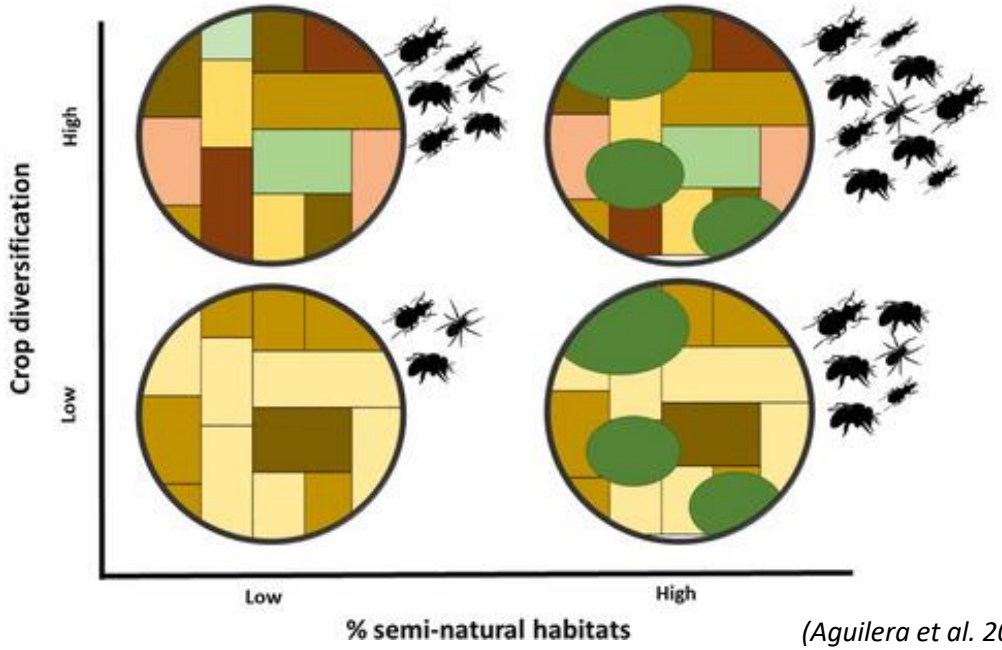



*(Aguilera et al. 2020)*

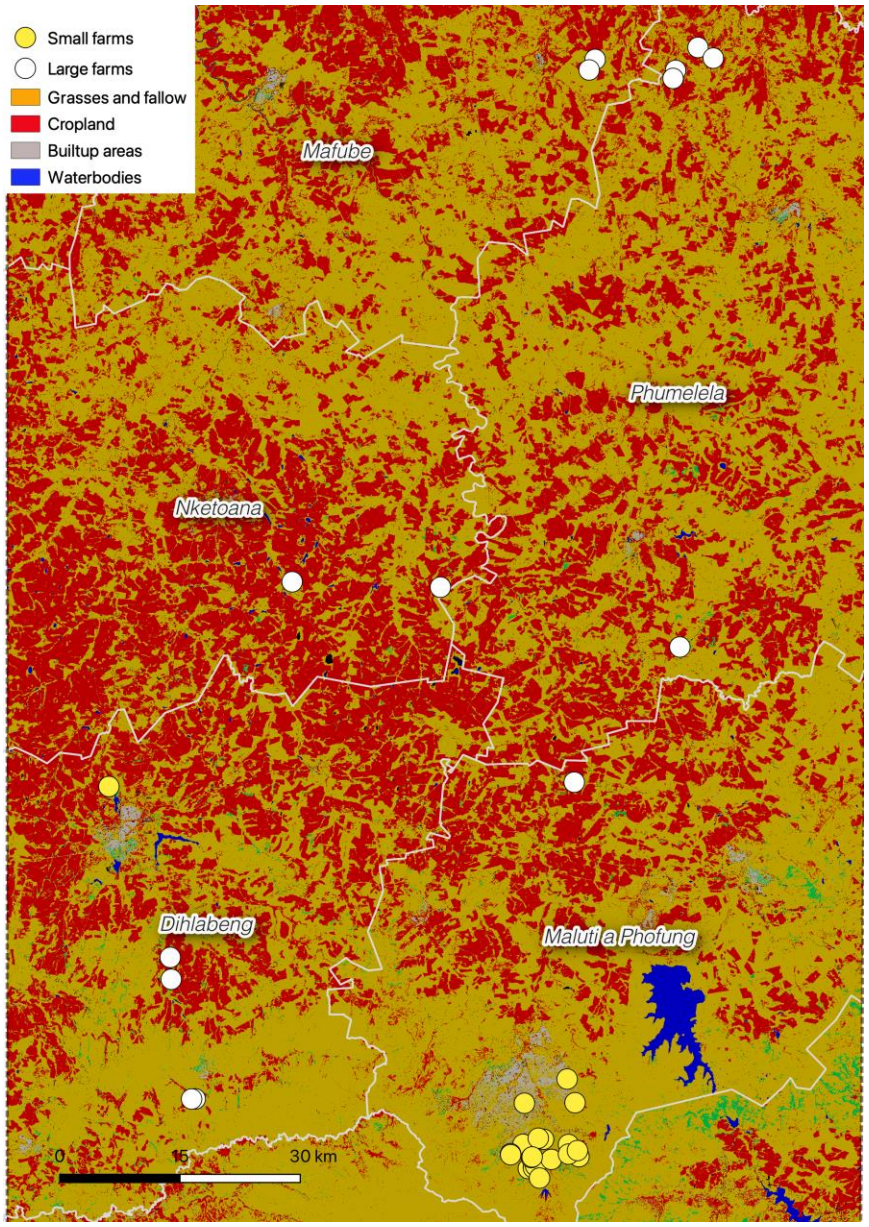
*Aguilera, Guillermo et al. 2020. "Crop Diversity Benefits Carabid and Pollinator Communities in Landscapes with Semi-Natural Habitats." Journal of Applied Ecology.*

# Survey in the Eastern Free State

Objectives:
Linking farming activities (Conservation vs Conventional) and landscape structure

Study area:
Thabo Mofutsanyane district (Qwaqwa, Bethlehem, Clarens, and Vrede)

Conservation farms neighboured conventional farms in the same areas

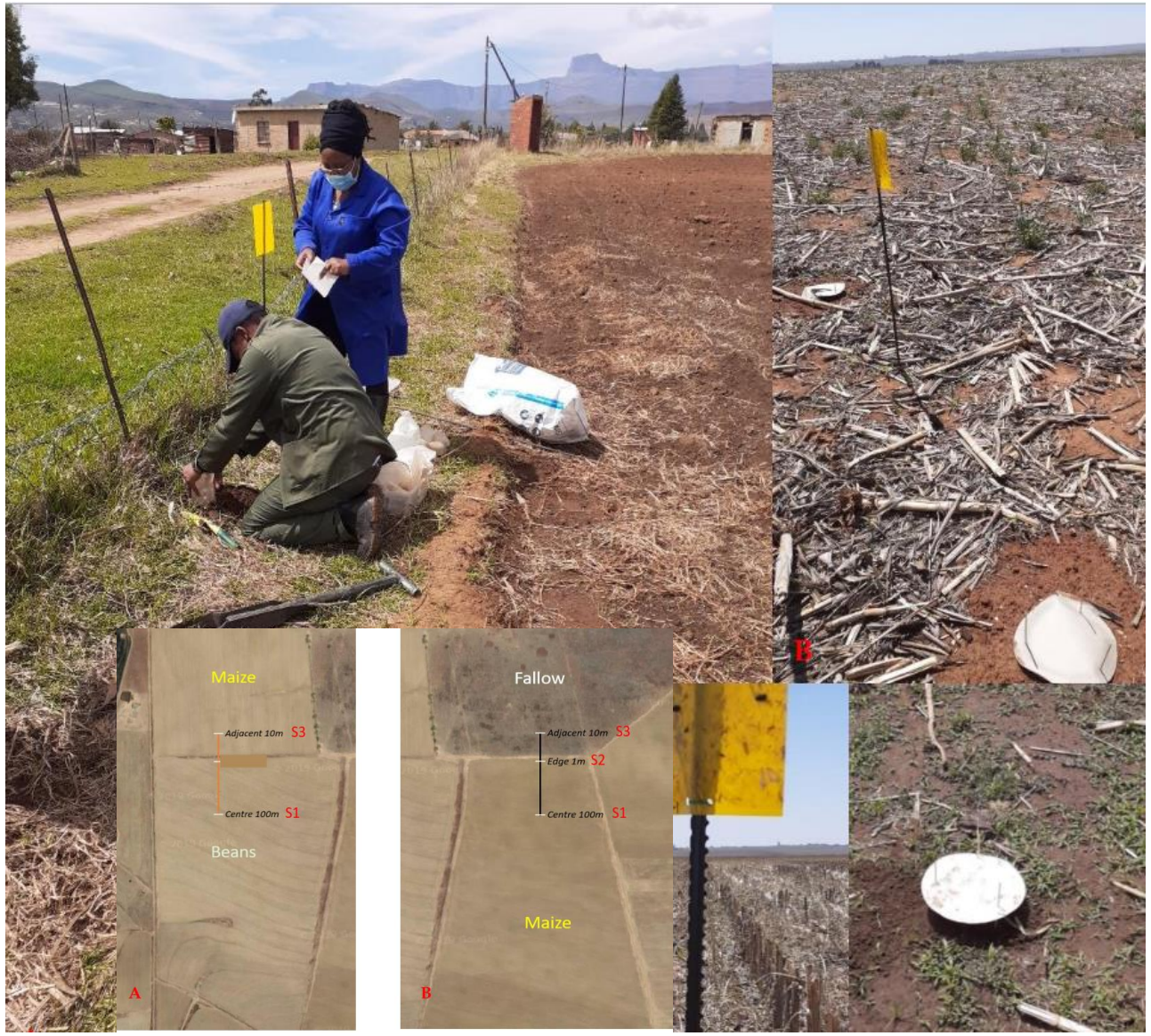
# Sampling

Sampled seasons:

a. **January 2021 :** Mid summer - seedling-jointing.
b. **May:** Late autumn – mature-harvest.
c. **November:** Late Spring - pre-seeding.
d. **Feb 2022:** Mid summer – seedling-jointing 2

Number of specimens: 60,000 individuals, 500 specimens, 259 species (OTUs), 102 families.

Soil: %C and NPK at 15 and 30 cm depths

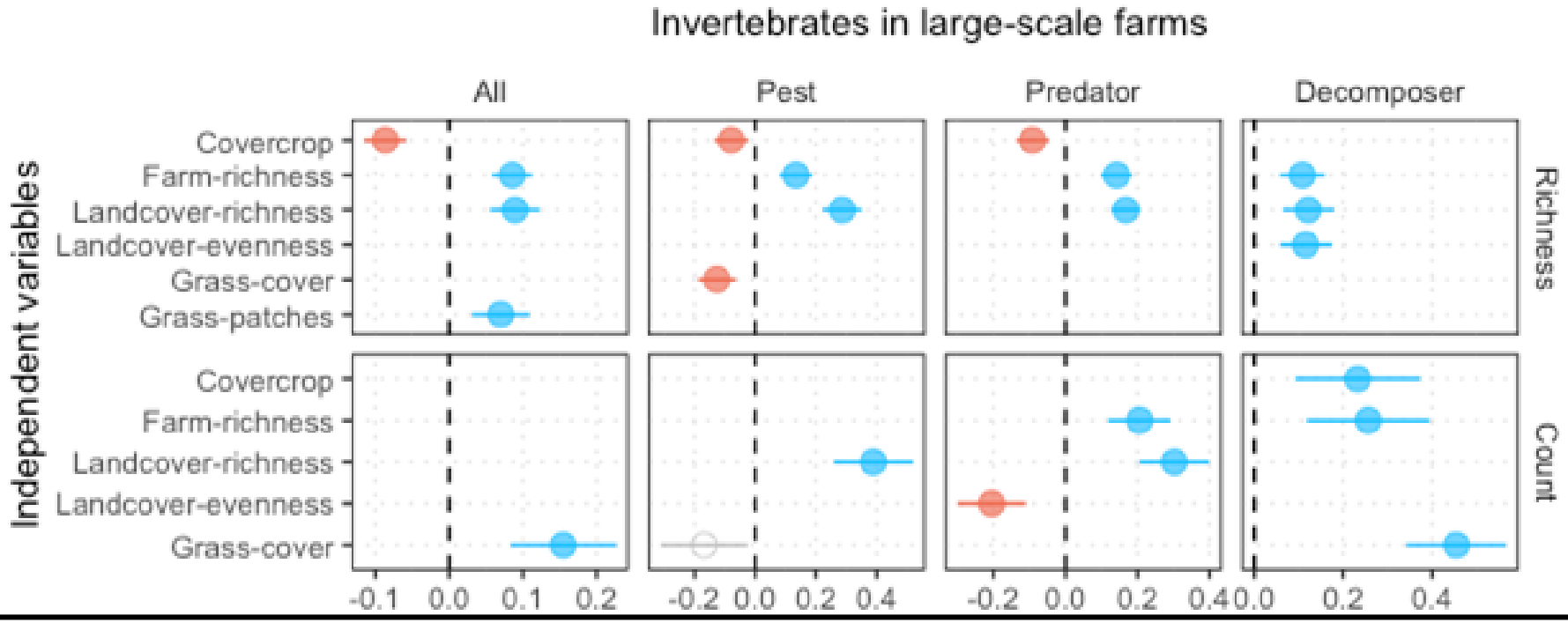


# Mixed effect of Cover crops

No difference between farms with and without cover crops when landscape-context is not considered

Farms with cover crops - lower pest and predator diversities

Significant effect on the abundance of ground-dwelling invertebrates – *carabid beetles, ground beetles and spiders*

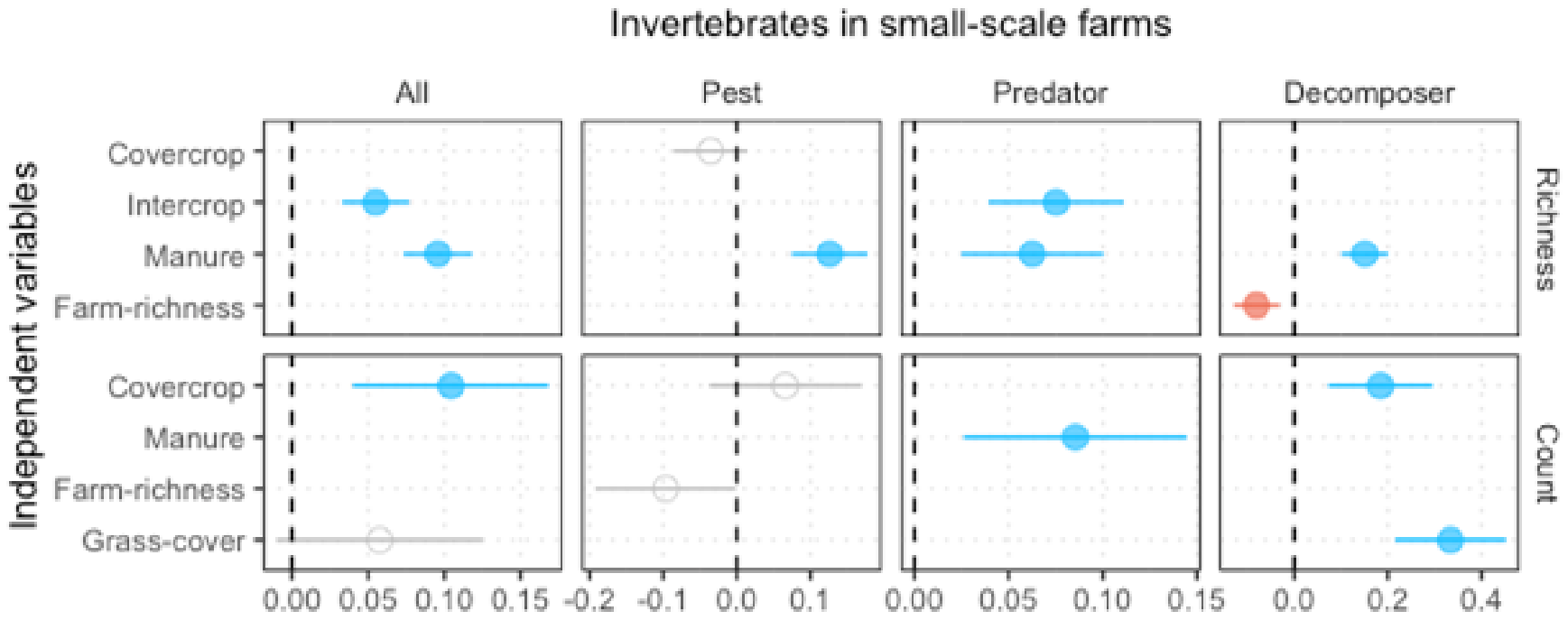


# Mixed effect of Cover crops

Significant effect on the abundance of ground-dwelling invertebrates, in **small-scale farms** too

No effect on diversity

Marginally significant reduction in pest richness.

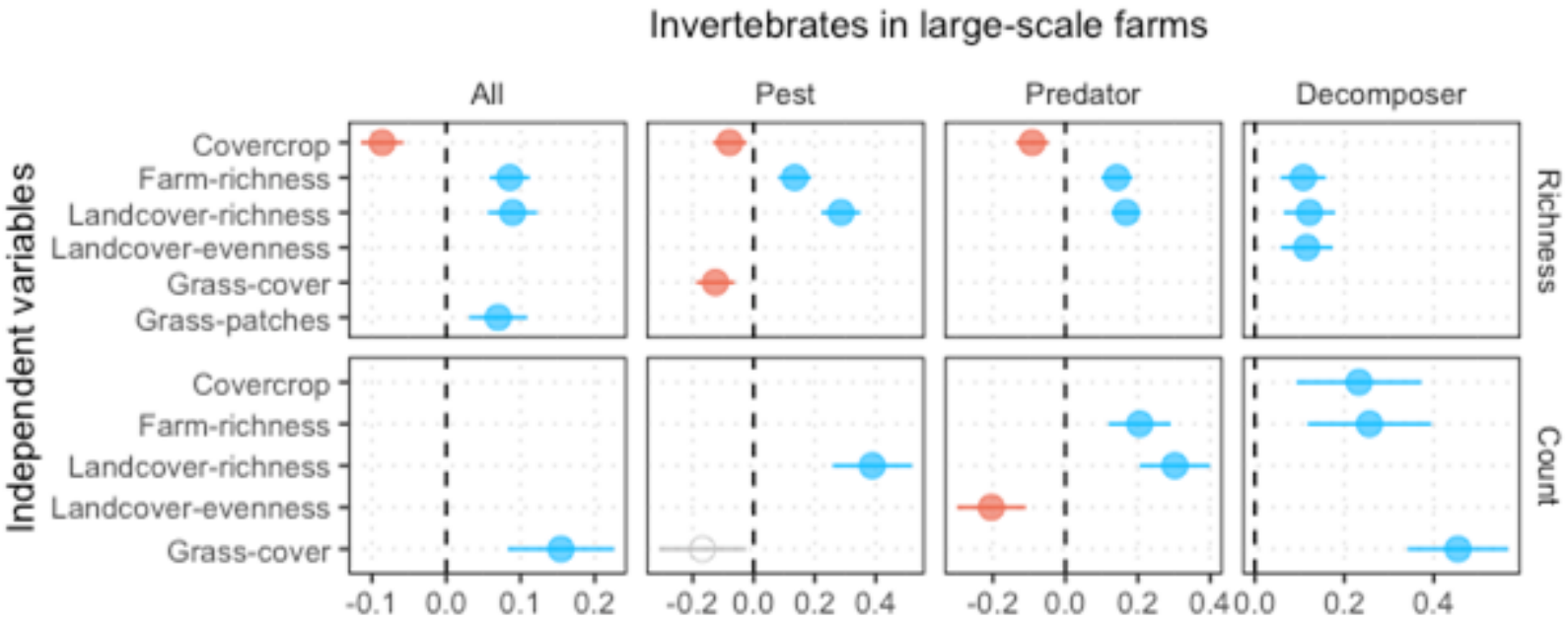


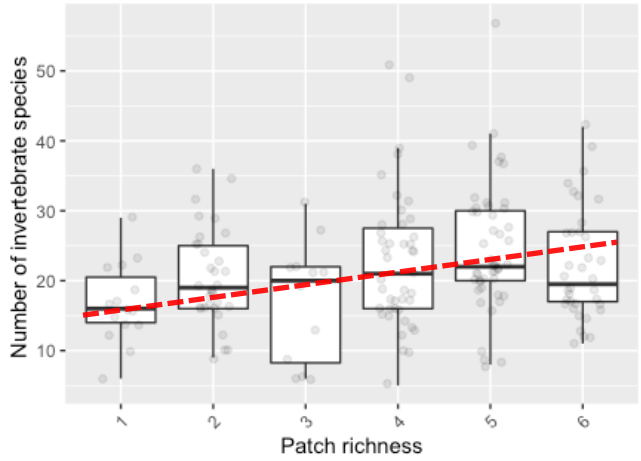
# Crop richness and landscape heterogeneity

Diversity increased with farm richness - positive effect on abundance of predator and decomposers

Non-crop habitat (grass cover and number of patches) increase overall biodiversity and abundance

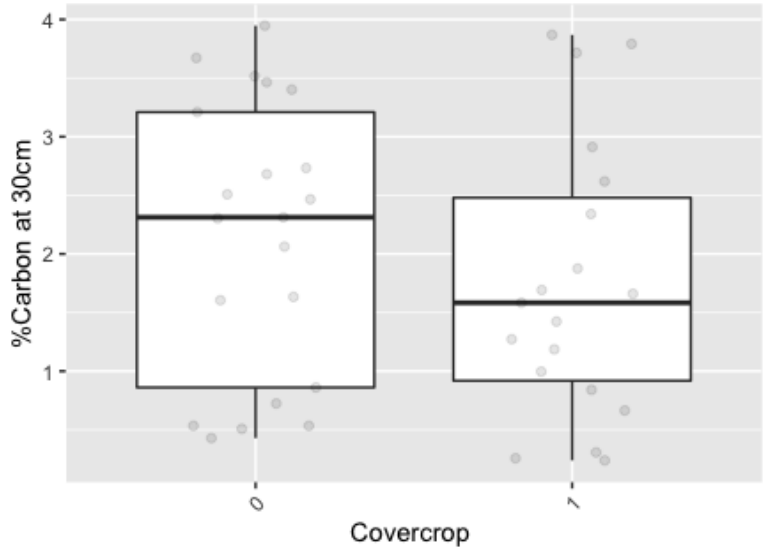
Greater effect of grass cover on ground dwelling invertebrates

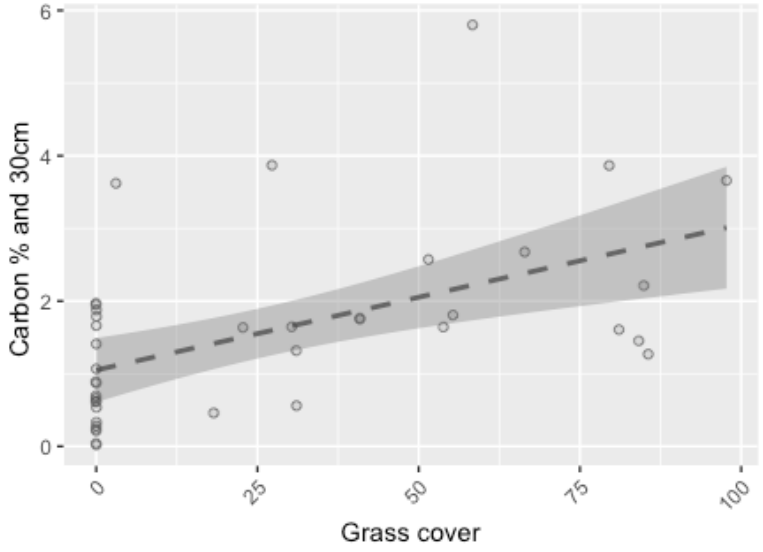


# Soil organic carbon

- Cover crop - No significant difference in soil carbon and bulk density.
- Carbon % increased with grass cover (40-75%) and landcover richness.
- No difference due to crop types



# Key lessons

Cover crops – no significant effect on biodiversity or soil organic carbon

Manure – positive effect on decomposers (may increase pest pressures)

Landcover richness – positive effect on biodiversity and ecosystem services

Intercrop – positive effect on predators and biocontrol

Farm richness – positive effect on biodiversity

Grass cover - increase in decomposers and decrease in pest richness

**Drought risk** and consequent changes in management practices will affect biodiversity and associated services

- Conservation agriculture practices (Cover crop + livestock integration) ***may*** have potential trade-offs with biodiversity
- Intercropping and crop rotation optimize pest control and biodiversity conservation
- Maintaining non-crop habitat patches may provide better outcomes for soil quality and biodiversity (than cover cropping with livestock integration)

**Land reform** caused changes in landscape structure will also impact biodiversity

- Land distribution causing conversion of existing in grass/non-crop habitat cover and patches – result in landscape homogeneity
- Loss of biodiversity, increase in pest pressures and reduction in soil regulation due to loss of decomposers.

# Further work

A need for longer-term monitoring to better understand trade-offs between expected outcomes – livestock fodder or grazing, soil conservation, and biodiversity (pests and biocontrol)

Cover crops with and for mob grazing needs more research - amount of biomass utilised and trampled by grazers will determine soil and biodiversity outcomes

More field-based case studies to better understand land reform impacts on landscape structure and local biodiversity and ecosystem services

# Policy and land management implications

Promote diversity within and between farms and among landscapes by encouraging crop and farm diversification and maintenance of non-crop habitat patches

Strategic spatial arrangement of agricultural practices increasing landscape-level landcover diversity to maximize beneficial effects on biodiversity and ecosystem services

# Thank you

Contributors:

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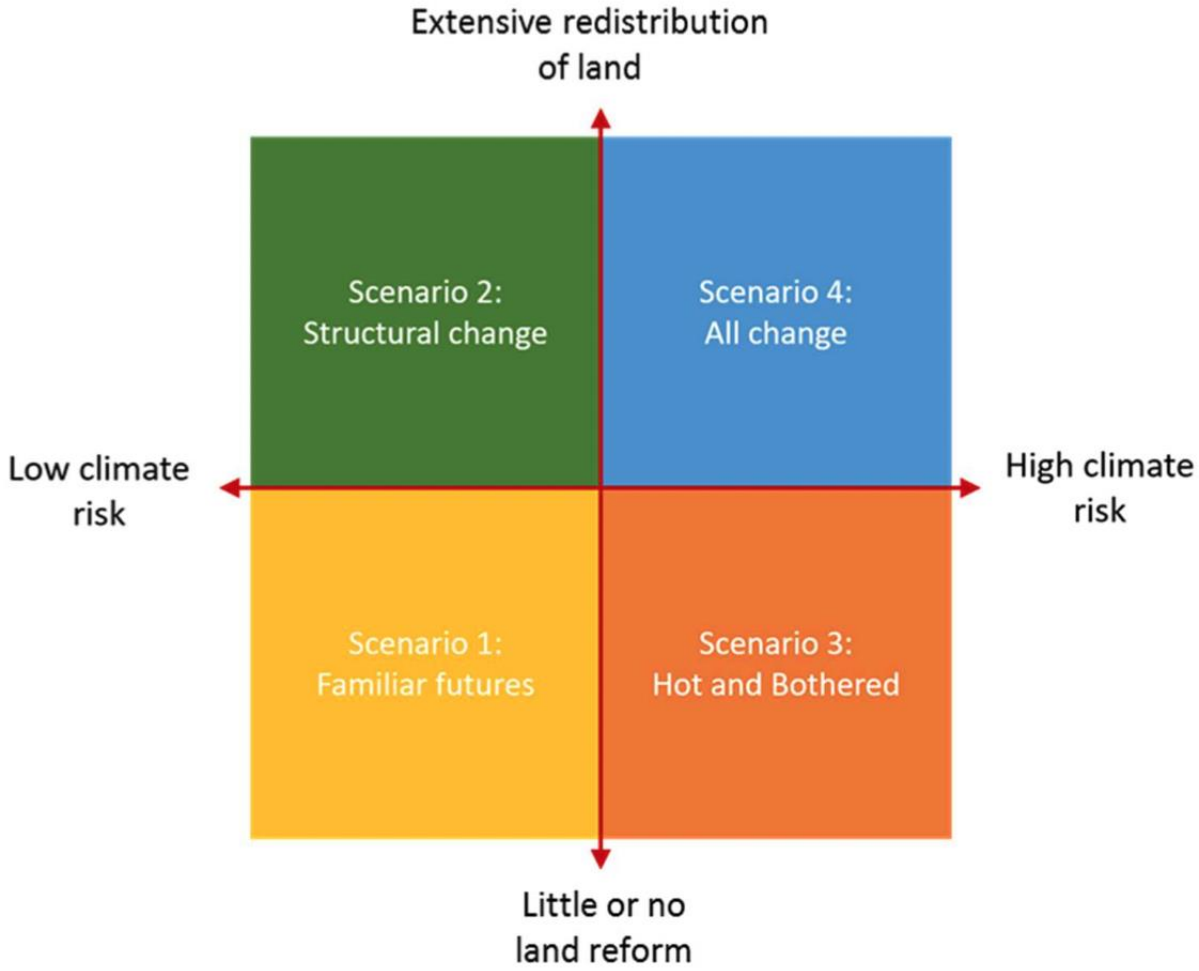
# Background

- Food production and food security
- Climate adaptation and resilience
- Land reform and equity
- Agricultural transformation with unknown ecological implications
- Free State province – contrasting production models, maize-bean and

| Production system | Number of farms (CT + CA) with 2-3 fields in each farm | Location |
|---|---|---|
| Small-scale | 20 (10 + 10) | Phuthaditjhaba |
| Commercial | 16 (8 + 8) | 4-Clarens, 2-Warden, 2-Reitz, 6-Vrede, 2-Bethlehem |



# Farm diversification improves resilience

**Diverse small-scale farming systems** and less dependent on international markets **least affected by COVID-19** measures.

Large-scale farmers were most able to access capital to buffer short-term impacts, whereas smaller-scale farms shared labour, diversified to subsistence produce and sold assets.

**Diversified mixed cropping systems offer yield stability and improve resilience**, and cope better under environmental and ecological shocks.

*sustainability*

MDPI

*Article*

## Impacts of COVID-19 on Diverse Farm Systems in Tanzania and South Africa

Hemant G. Tripathi [1,*], Harriet E. Smith [2,*], Steven M. Sait [1], Susannah M. Sallu [2], Stephen Whitfield [2], Astrid Jankielsohn [3], William E. Kunin [1], Ndumiso Mazibuko [4] and Bonani Nyhodo [4]