Evaluating crop performance and productivity near High-Voltage Power Lines

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Introdution

Expansion of high-voltage power lines => concerns about potential impacts on crop productivity and ecosystem health.

Could electromagnetic fields (EMFs) alter plant growth or yield and quality?

- => literature review
- => Field study

Overview

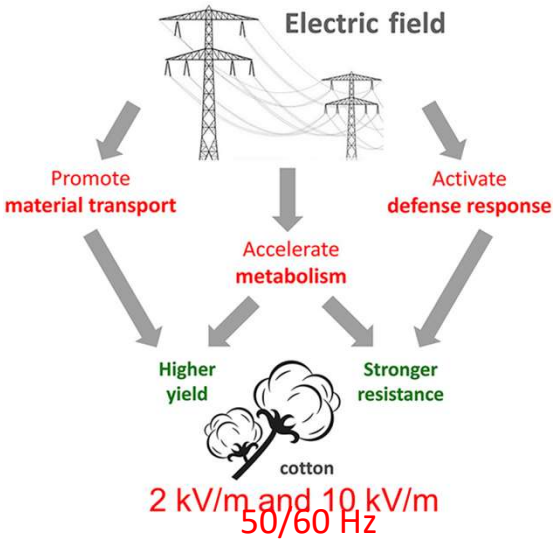
PART 1: Literature review

PART 2: Field Study

Literature review: Plant production

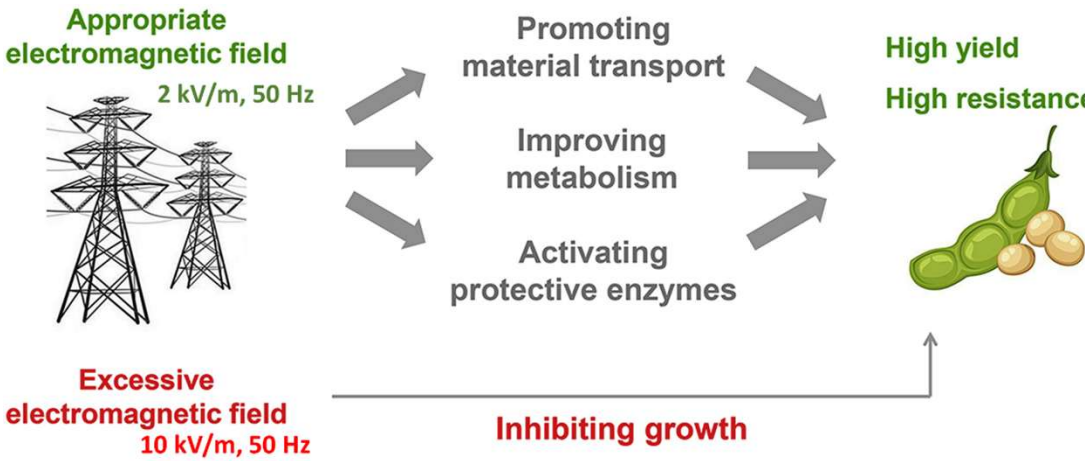
Responses vary depending on species, growth stage and exposure intensity/duration

- **Maize:** reduced carbon assimilation near HVPLs (35-275 kV; 0.7 – 2.7 µT) (Fătu et al. 2025)
- **Sunflower:** MVPLs (1-35 kV, 0.3 µT) increase carbon assimulation (Fătu et al. 2025)
- **Cotton** (Liu et al. 2021)



2 kV/m and 10 kV/m
50/60 Hz

- **Soybean** (Li et al. 2019)

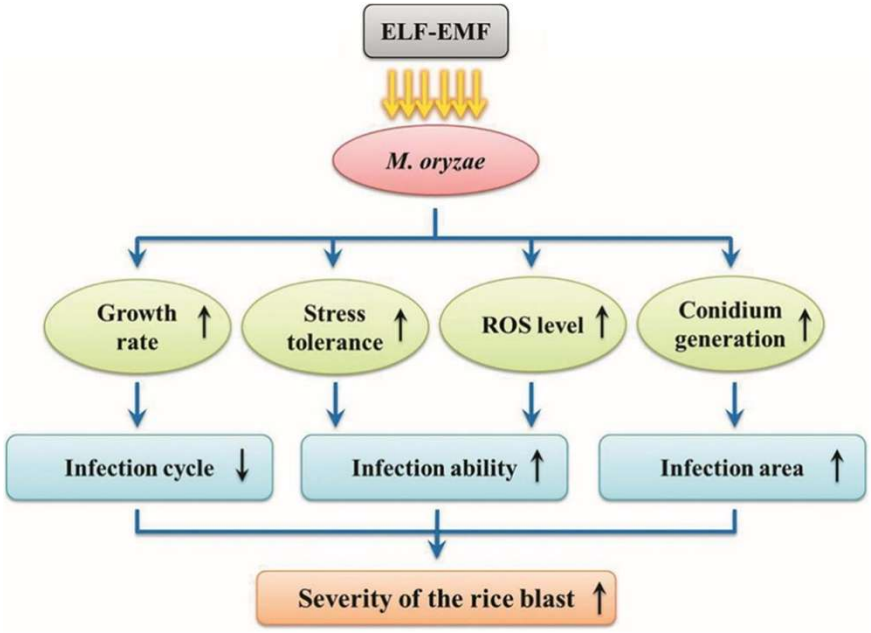


Literature review: Plant production

Responses vary depending on **species**, growth stage and exposure intensity/duration

- **Rice**: pathogenicity of *M. oryzae* spp. was enhanced (50 Hz, 3 mT) (Chen et al. 2023)

>> 2 – 10 µT
Under HVPL

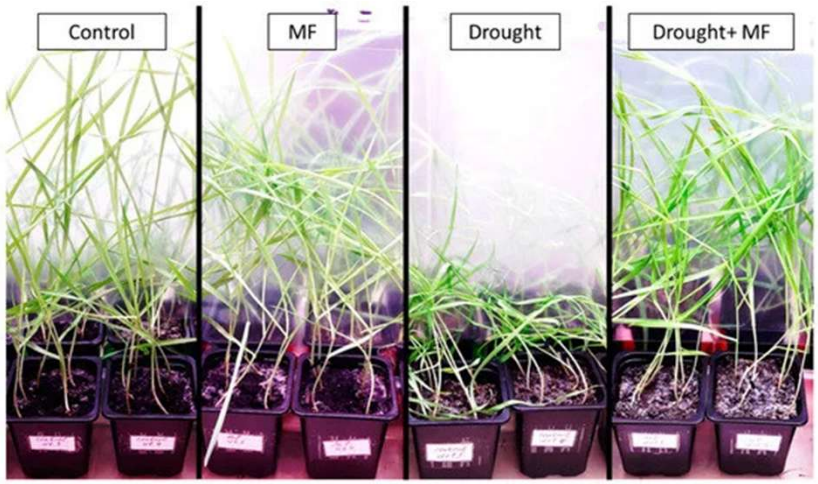


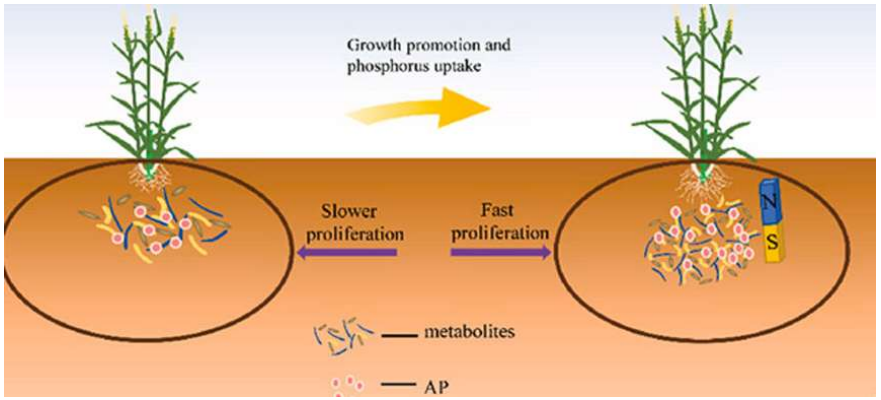
Literature review: Plant production

Responses vary depending on species, growth stage and exposure intensity/duration

>> 2 – 10 µT
Under HVPL

- **Wheat:** Increased drought resilience (frequency 14.3 Hz, magnetic induction 18 µT) (Mshenskaya et al. 2023)
- **Wheat**: Increased P uptake (60 mT) (Zhang et al. 2023); MF altered the wheat rhizosphere metabolites

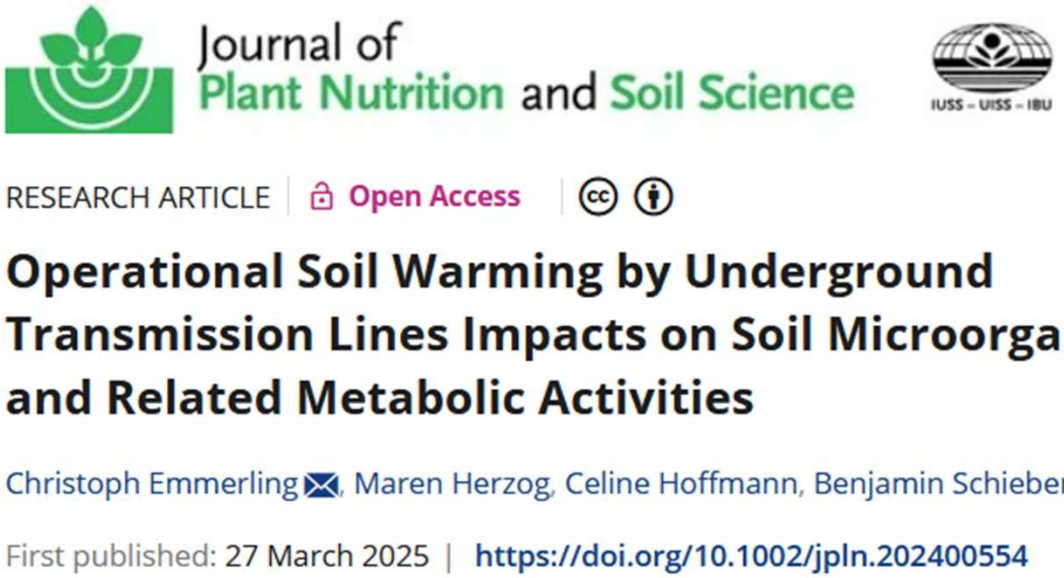




Literature review: Plant production

Under ground transmission lines

- Moderate soil warming from UTLs stimulates microbial activity
- No adverse effects detected on soil microbial health
- Grid expansion with underground cables is unlikely to critically impact soil ecosystems



Journal of Plant Nutrition and Soil Science

RESEARCH ARTICLE | Open Access

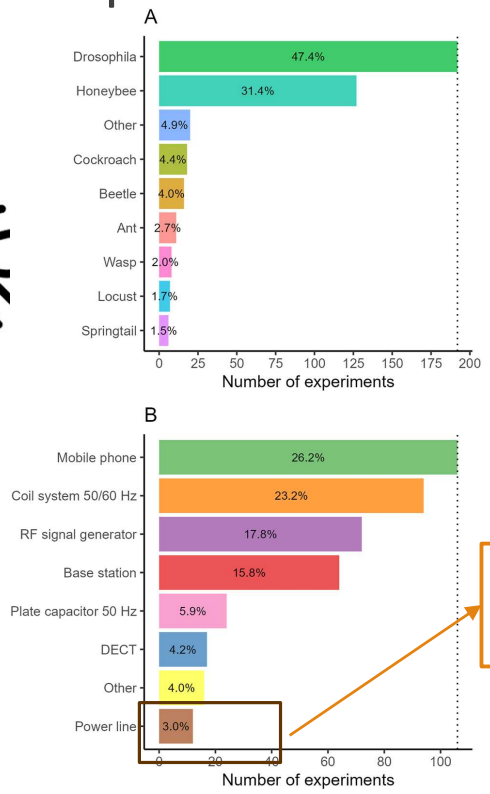
Operational Soil Warming by Underground Transmission Lines Impacts on Soil Microorganisms and Related Metabolic Activities

Christoph Emmerling, Maren Herzog, Celine Hoffmann, Benjamin Schieber

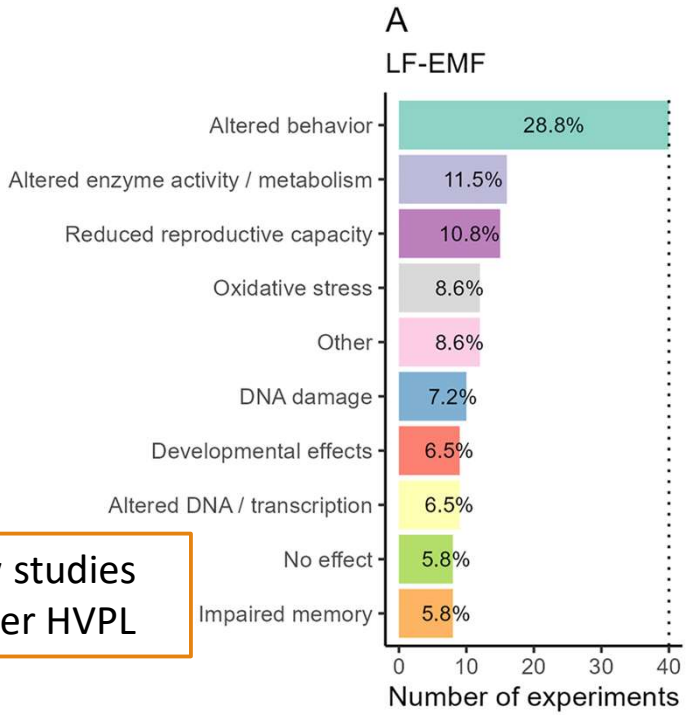
First published: 27 March 2025 | https://doi.org/10.1002/jpln.202400554

Literature review: Insects

Responses vary depending on species, growth stage and exposure intensity



Few studies under HVPL



Literature review: Pylons as Pillars of Biodiversity

High-voltage power pylons in intensively farmed fields provide *valuable wildlife habitat*.

Particularly on agricultural land, unfarmed patches under pylons can serve as high-quality habitat for insects, birds, and small mammals.

Selection of fields

Crops studied:

- 2022–2023: 1 wheat/barley field
- 2023–2024: 10 maize; 1 wheat field
- 2024–2025: 8 maize, 4 wheat,
  1 potato field

Measurements:

- Sentinel-2 satellite imagery
  (NDVI, 10 m resolution)
- Drone imagery
  (NDVI, VNDVI, 4 cm resolution)
- Yield mapping (location-specific sensors)

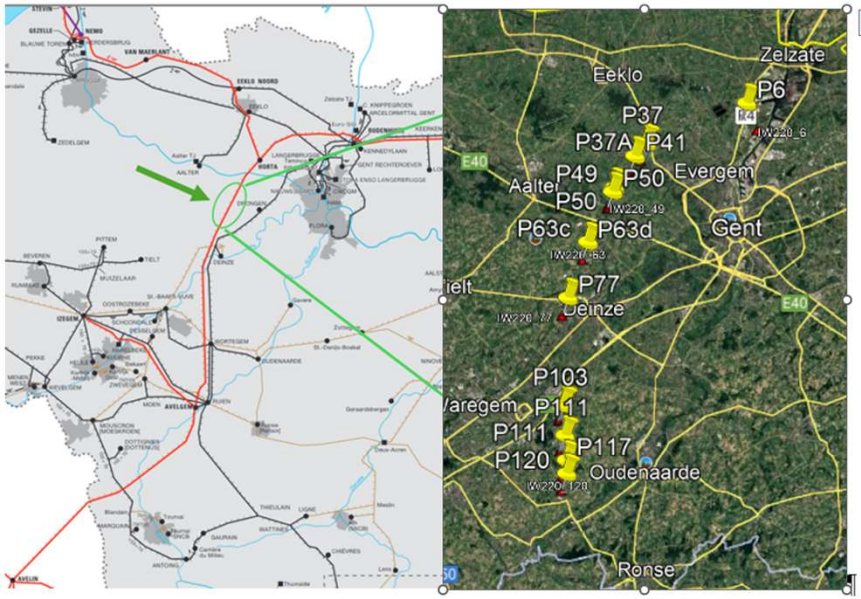


Figure 1: Location of the selected maize/wheat/potato fields along the high Voltage power line in Flanders.

Measure for plant health based on red and NIR reflection

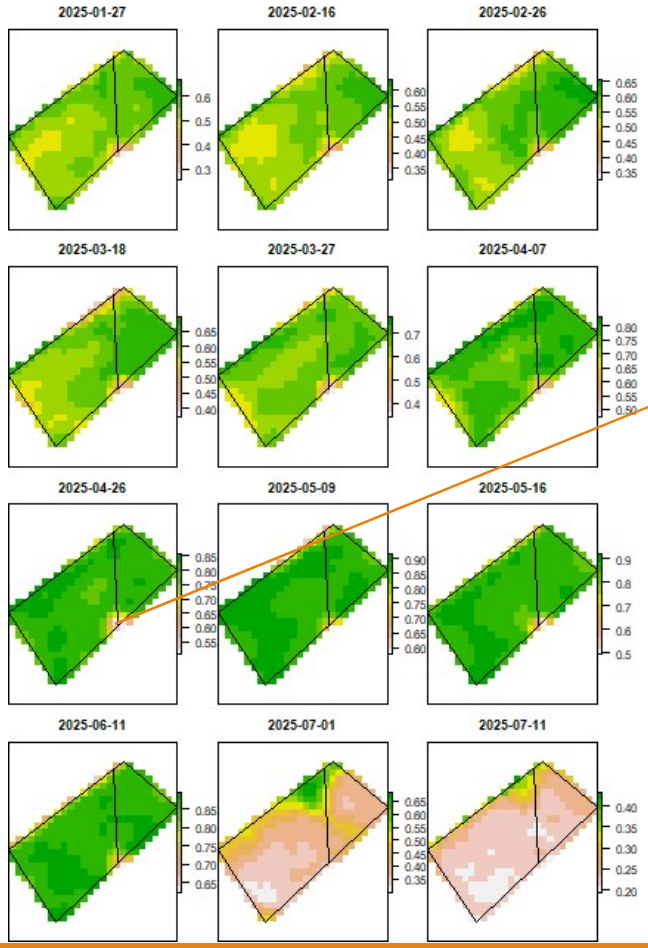
Focus: growth dynamics, yield, quality vs. distance to HVPLs

Overview

PART 1: Literature review

PART 2: Field Study

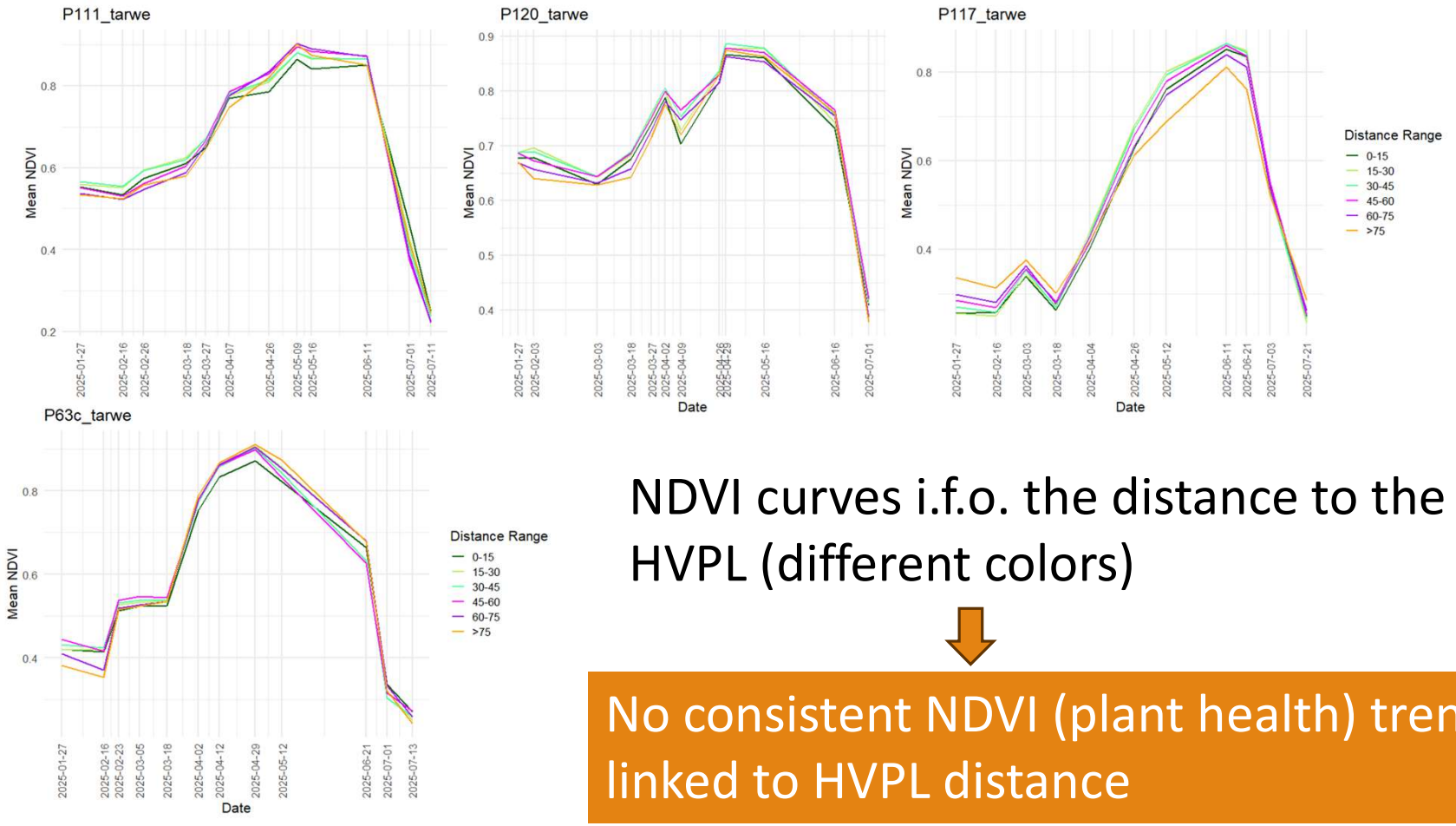
Wheat: NDVI based on Sentinel



For the different fields, the NDVI on different time points during the growing season was analysed

Spatial variation visible, spots with healther vegetation (higher NDVI), but not associated with the presence of the HVPL

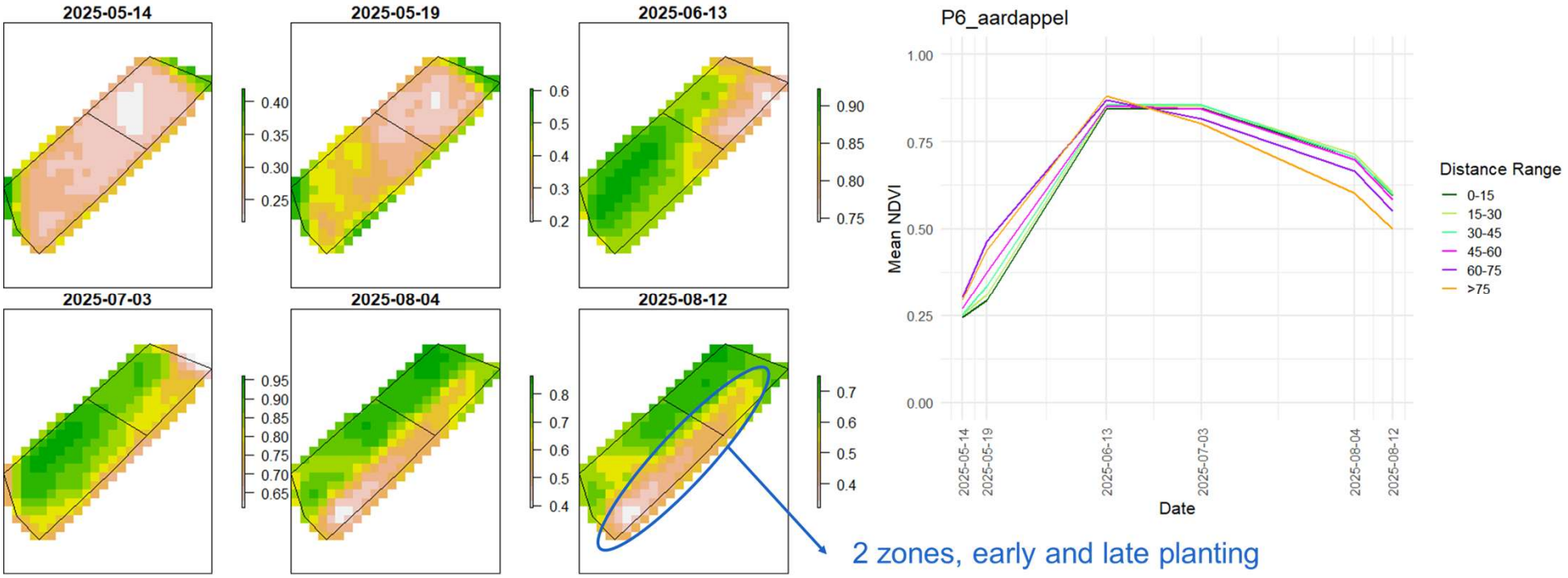
Wheat: NDVI based on Sentinel



NDVI curves i.f.o. the distance to the HVPL (different colors)

No consistent NDVI (plant health) trend linked to HVPL distance

Potato: NDVI based on Sentinel



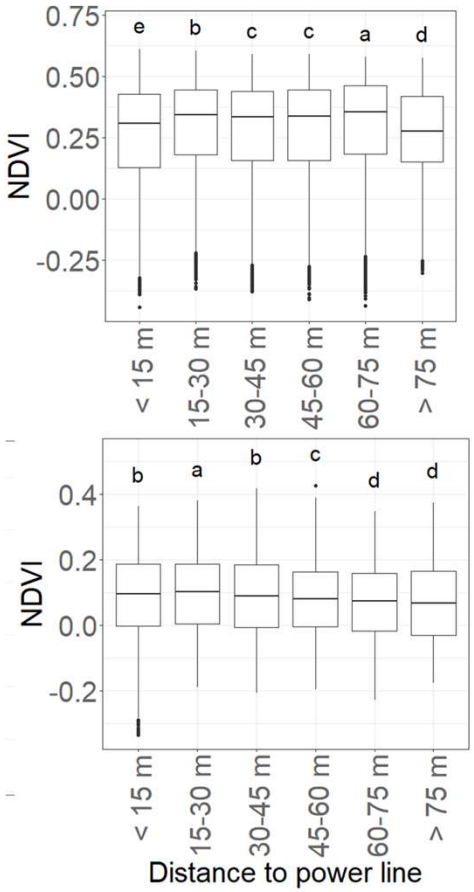
NDVI increased during growth, declined during senescence

Mixed patterns: early season → higher NDVI further from HVPL; later season → opposite trend **BUT: 1 Field; 1 Growing season**

Potato: Drone (14/7 & 6/8)

No visible differences in growth under or close to the HVPL

Potato: NDVI based on drone (14/7 & 6/8)

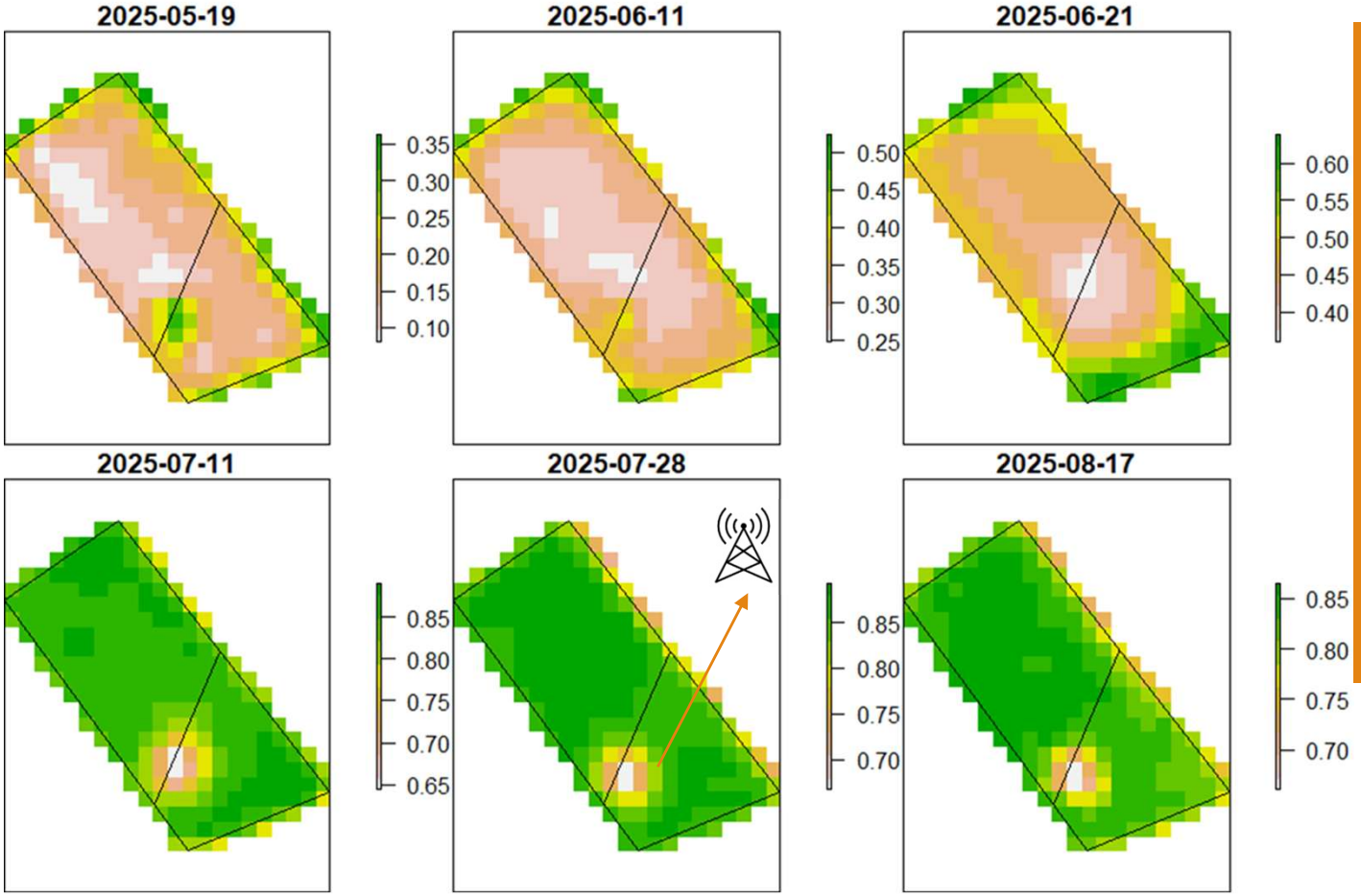


Statistical differences exist, but no trend

Slighlty lower NDVI further from HVPL

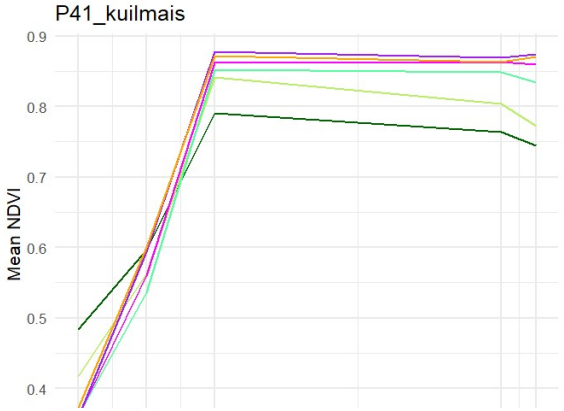
No consequent trend during the growing season

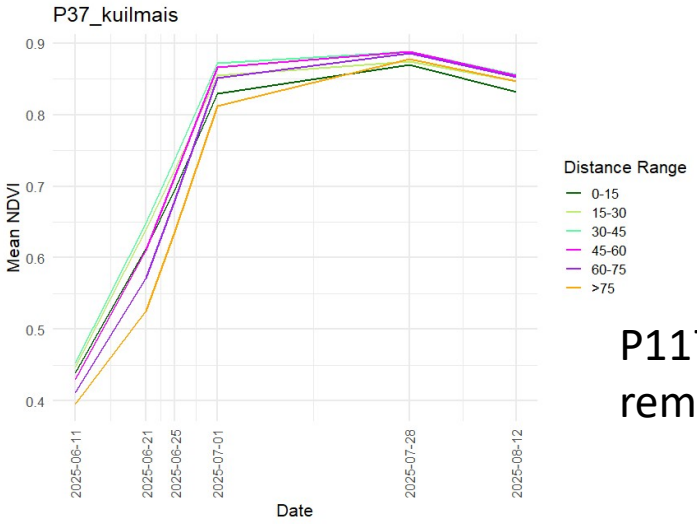
Maize: NDVI based Sentinel



Spatial variation visible, spots with healther vegeta-tion (higher NDVI), but not associated with the presence of the HVPL, only the pylon is clearly visible

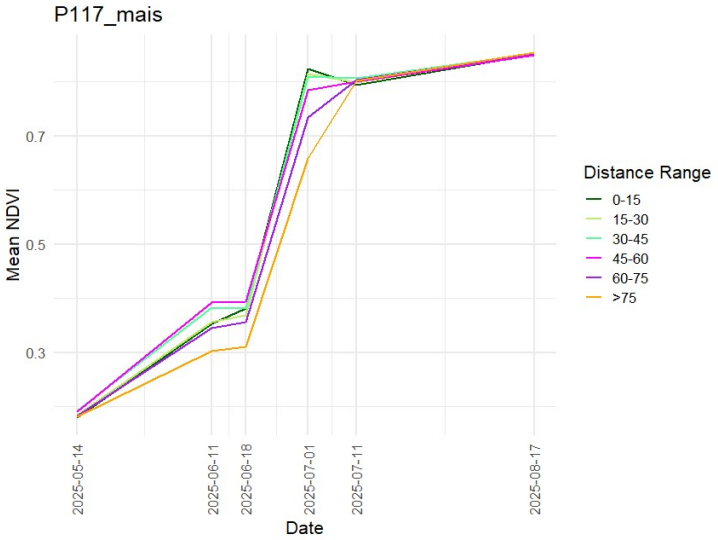
Maize: VNDVI based Sentinel





P41: First small differences which become bigger, with a trend of lower values near HVPL

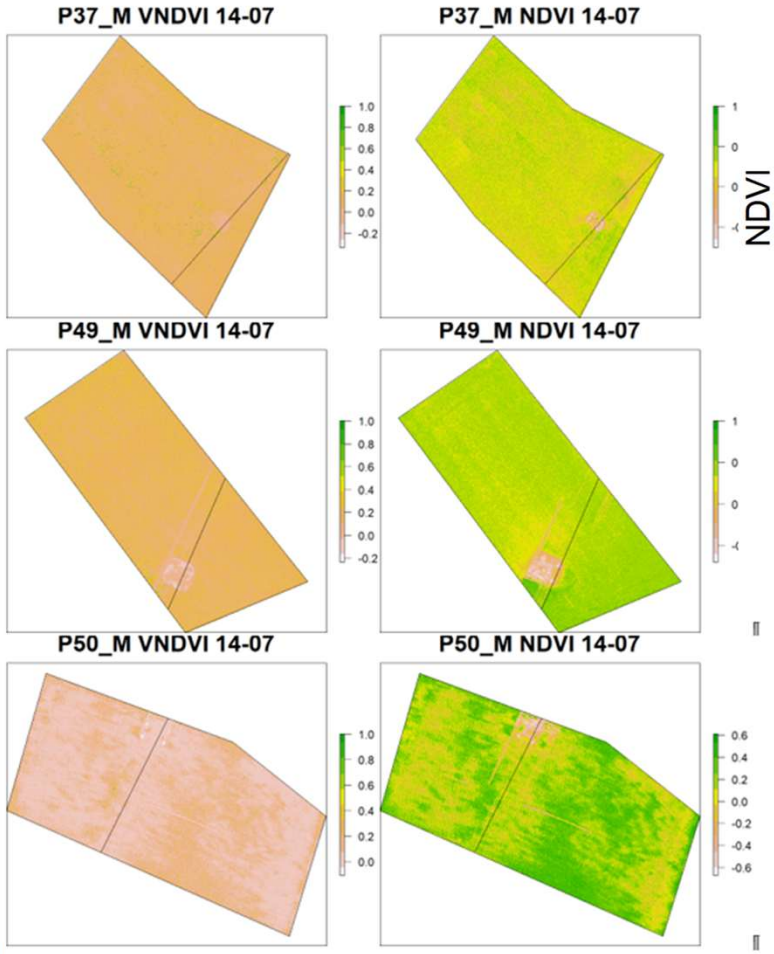
P117: Differences remain the same

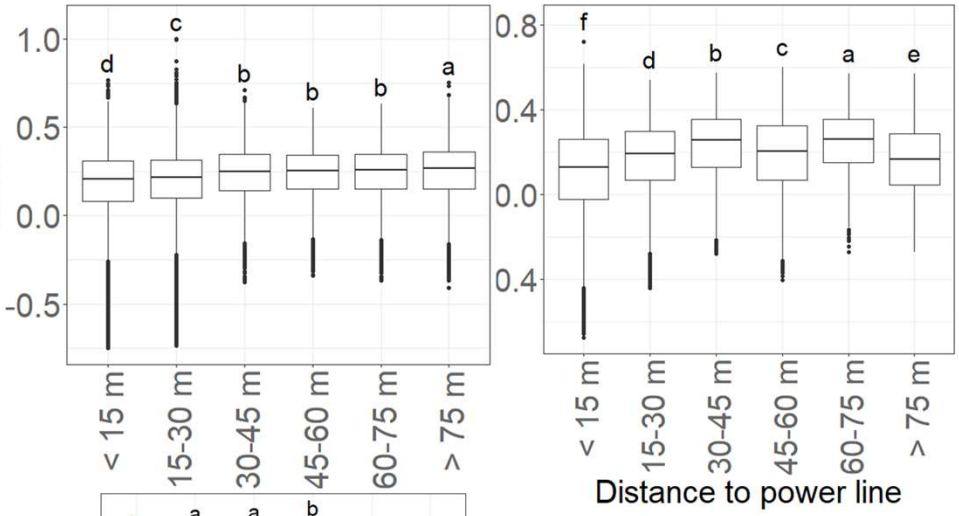


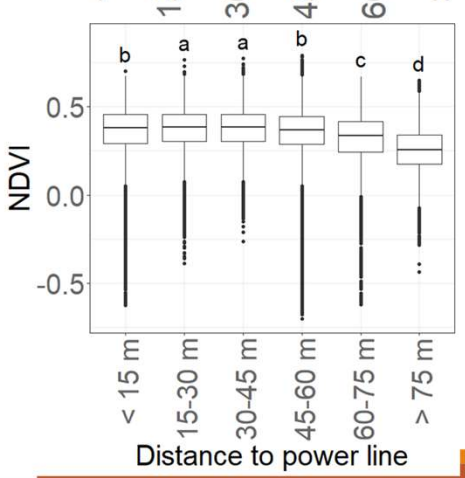
P117: First some differences which become smaller

Spatial variation in NDVI not associated to HVPL

Maize: NDVI based on drone (14/7 & 6/8)



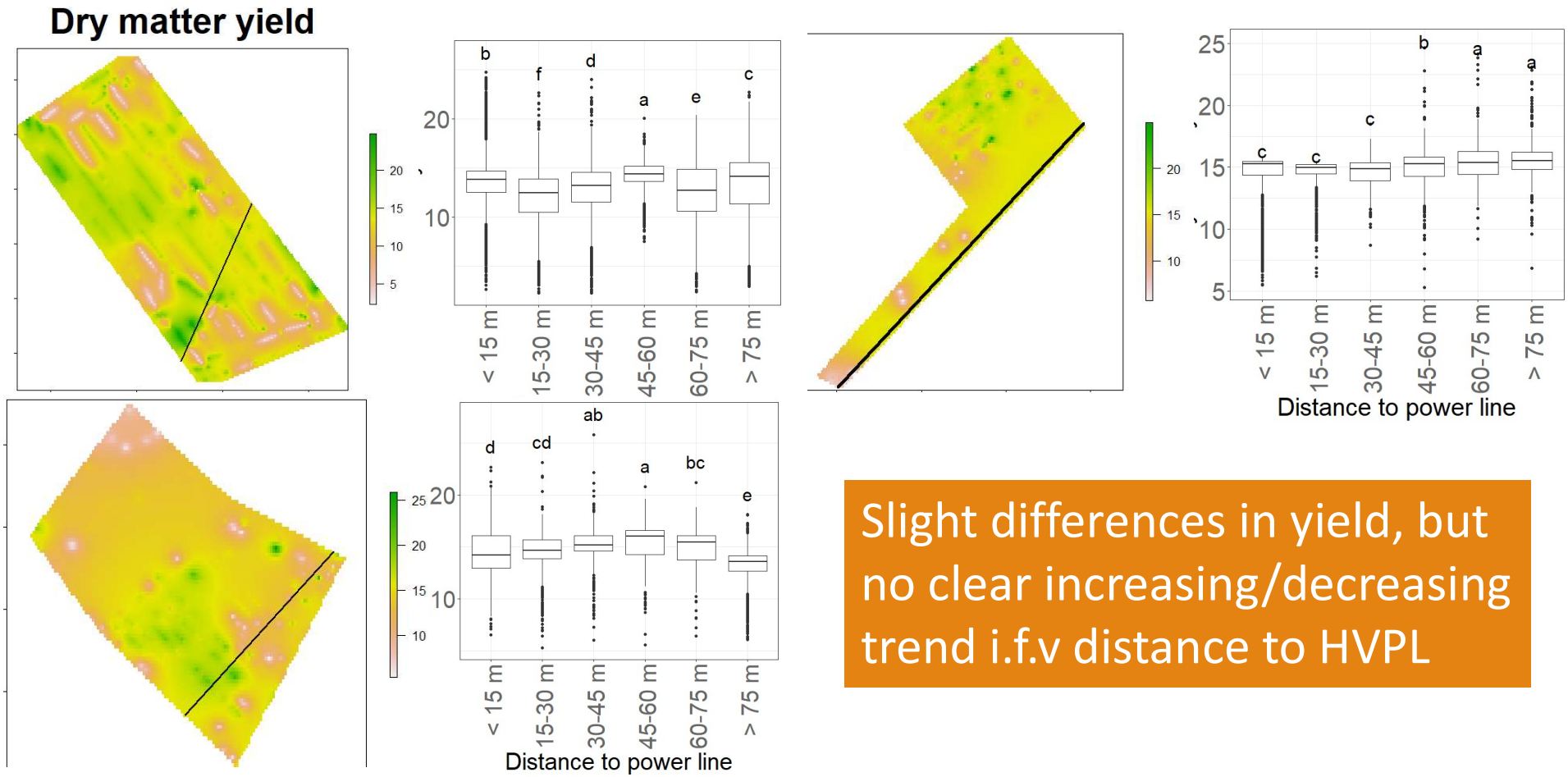




Sometimes increasing, fluctuating or increasing trend

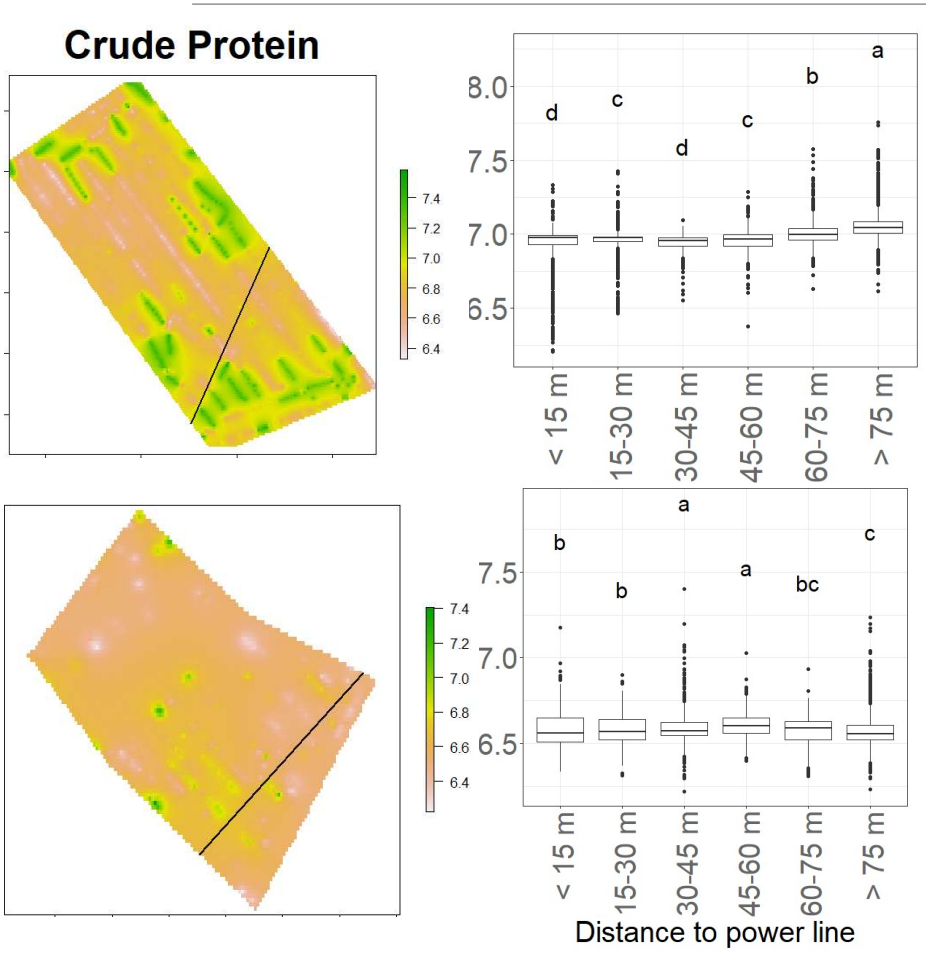
No consequent trend

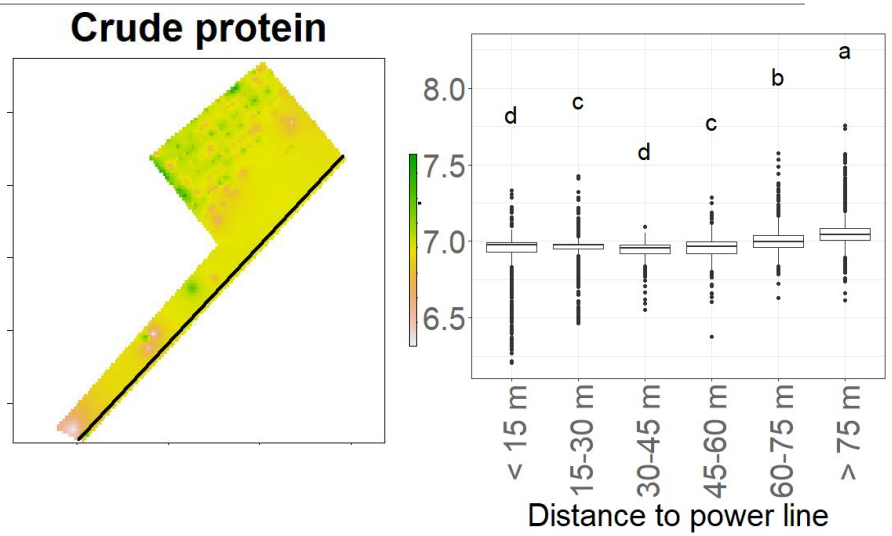
Maize: yield



Slight differences in yield, but no clear increasing/decreasing trend i.f.v distance to HVPL

Maize: composition/quality





Slight differences in protein %, but no clear increasing/ decreasing trend i.f.v distance to HVPL

Conclusion

- Crop responses to HVPL exposure are variable — no consistent trends across species, locations, or seasons.
- Maize and potato show some spatial yield and NDVI differences, but effects are small and inconsistent.
- No clear detrimental impact on overall productivity or crop quality detected so far.
- Environmental and management factors (e.g., soil type, microclimate) likely play a larger role than HVPL proximity.
- Next steps: expand multi-year, multi-crop field