Do weather extremes and intensive field traffic affect soil functions and yield?

Comparison of different agricultural fields based on management and wheat yield

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Introduction and background

- Coincidence of heavy rainfall in autumn 2017 and continuing drought in spring/summer 2018
- Moist and unfavorable soil conditions during sugar beet harvest and drilling of winter wheat in 2017 and drought in 2018 led to an impairment of root growth in winter wheat
- Especially under moist soil conditions, high wheel loads cause major concern regarding the risk of soil compaction
- Sugar beet harvesters and drills are characterized by high wheel loads

These conditions have led to a decline in yields of winter wheat

Study site

Adenstedt, Lower Saxony
Source: Google Maps

Methods and experimental design

- Study site is located in Adenstedt in southern Lower Saxony
- Soil type is Stagnic Luvisol from deeply weathered loess
- Favorable and unfavorable driving conditions (trafficability) during harvest of sugar beet and drilling of winter wheat in 2017
- Different fields (A1-A7) with different management (cultivator/plough)
- Farmers were asked to assess the trafficability during harvest and drilling
- Manual harvest of winter wheat on different agricultural fields
- Wheat yield, grain bulk density (hectoliter weight), and number of wheat ears
- Threshing of wheat after harvest and drying and weighing of threshed wheat grain
- Soil sampling and soil investigation was not possible due to very dry and firm soil

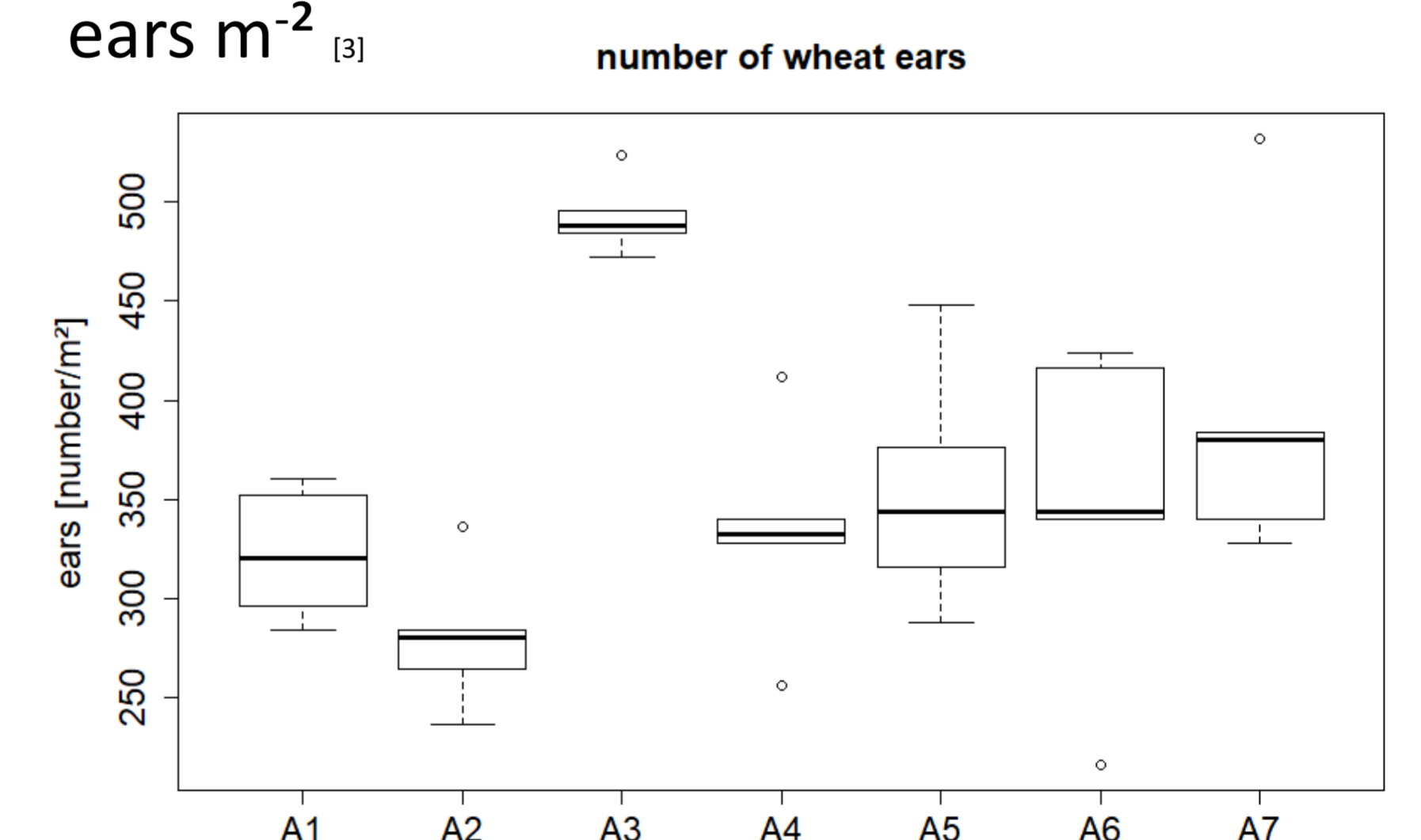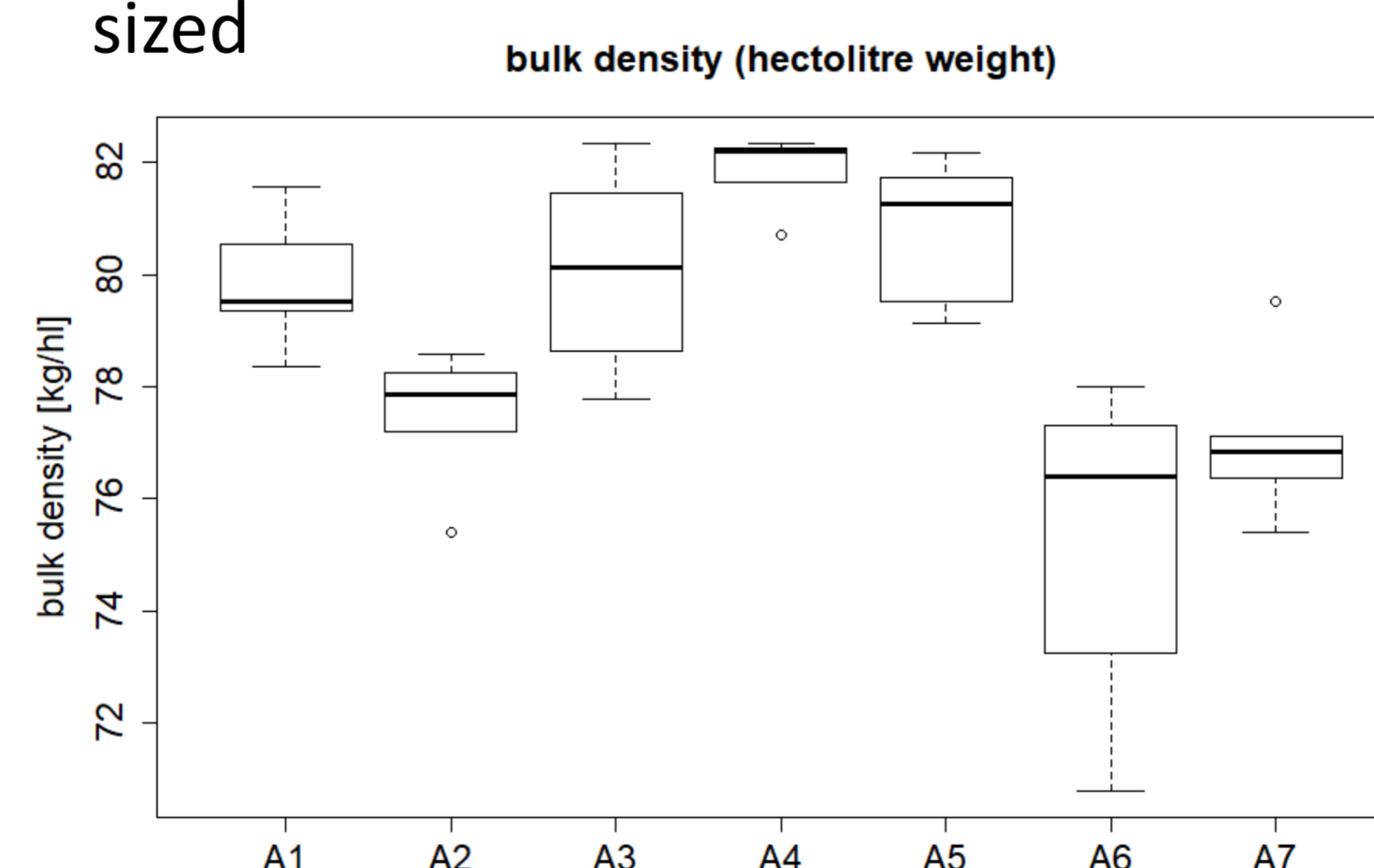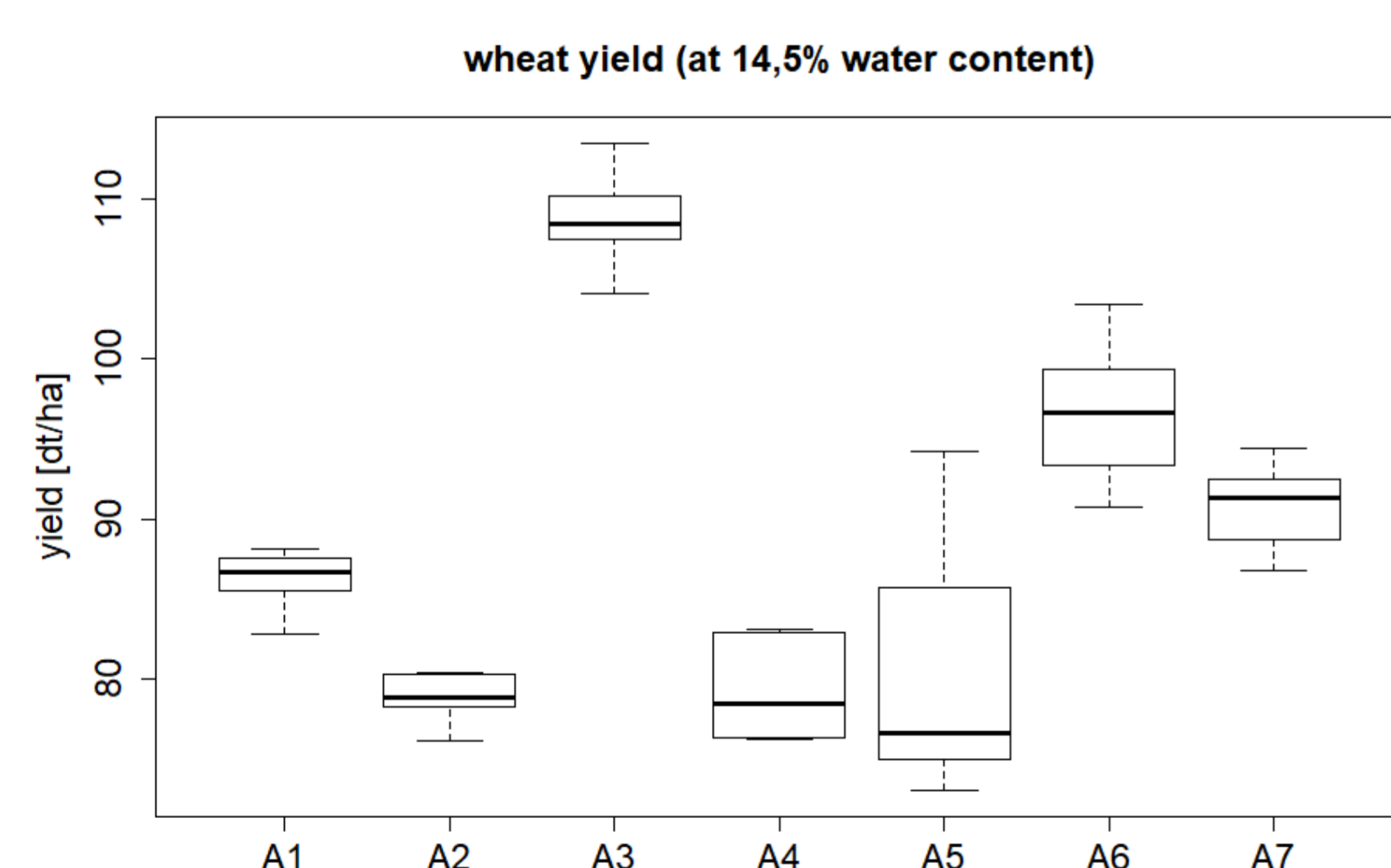| Field-no.	Soil tillage	Field location	Wheat varieties	Driving conditions (trafficability) during harvest and drilling of winter wheat
A1	Chisel plough	Inner field	Kredo	Favorable conditions
A2	Chisel plough	Inner field	Kredo	Unfavorable conditions, moist soil conditions
A3	Chisel plough	Inner field	Tobak	Favorable conditions, one week after heavy rainfall
A4	Chisel plough	Inner field	Tobak	Unfavorable conditions, moist soil conditions, heavy rainfall before harvest
A5	Chisel plough	Headlands of A4	Tobak	Unfavorable conditions, moist soil conditions, heavy rainfall before harvest
A6	Plough	Inner field	Tobak	Unfavorable conditions, moist soil conditions
A7	Chisel plough	Inner field	Tobak	Favorable conditions

Results

Wheat yield
- Wide variations of wheat yield (79-108 dt ha^{-1})
- Mean value Lower Saxony 2018: 70,5 dt ha^{-1} [1]
- Highest yield on field A3 (108 dt ha^{-1})
- Lowest yields on A4/A5 (78/77 dt ha^{-1}) and A2 (79 dt ha^{-1})

- Evaluation of trafficability by farmers is often subjective (see fields A6 and A7)

Grain bulk density (hectoliter weight)
- Wide variations of grain bulk density
- A4 had small grains and highest value of grain bulk density (82 kg hl^{-1})
- Mean value Germany 2018: 79,1 kg hl^{-1} [2]
- Wheat grains of the fields were differently sized

Number of wheat ears
- Highest number of ears per square meter on field A3 (488 ears m^{-2})
- Lowest number per square meter on A2 (280 ears m^{-2})
- Mean value in the study area (loess soil): 600 ears m^{-2} [3]

[1] Max Rubner-Institut: Qualitätsuntersuchungen im Rahmen der Besonderen Ernte- und Qualitätsermittlung (BEE) 2018.
[2] BEE 2018. Landesamt für Statistik Niedersachsen 2018.
[3] Information of farmers of the study area

Conclusions

- Differences in wheat yield were due to the fact that farmer of A4/A5 used heavy agricultural machinery when soil was moist and thus susceptible to compaction, so soil structure and soil functions were affected
- Farmer of A3 harvested when soil was drier/more stable and thus less susceptible to compaction
- Under these weather conditions, different management of the farmers and the short-term adjustment of the management are responsible for the yield differences
- Traffic effects of 2017 and drought of 2018 resulted in a decline of wheat yield in 2018
- Due to the increasing variability of the weather and thus the increase of extreme weather events, the farmers have to adapt their management to the weather and the soil conditions in the short term in order to achieve stable yields and maximum soil protection, as well

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