Long-term Field Experiments in Germany: Classification and spatial Representation

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Abstract. The collective analysis of long-term field experiments (LTFE), here defined as agricultural experiments with a minumum duration of 20 years and research in the context of sustainable soil use and yield, can be used for detecting changes in soil properties and yield such as induced by climate change. However, information about existing LTFEs is scattered, and the research data are not easily accessible. In this study, meta-information on LTFEs in Germany is compiled and their spatial representation is analysed. The study is conducted within the framework of the BonaRes project, which, inter alia, has established a central access point for LTFE information and research data. A total of 205 LTFEs is identified ~~with a minimum duration of twenty years and research in the context of soil and yield~~which fit to the definition above. Of these, 140 LTFEs are ongoing. The land use in 168 LTFEs is arable field crops, in 34 trials grassland, in two trials vegetables and in one trial pomiculture. Field crops LTFEs are categorized into fertilization (n=158), tillage (n=38), and crop rotation (n=32; multiple nominations possible) experiments, while all grassland experiments (n=34) deal with fertilization. The spatial representation is analysed according to the climatic water balance of the growing season (1 May to 31 October) (CWBg),~~ and~~ the Müncheberg~~er~~ Soil Quality Rating (MSQR) and clay content. The results show that, in general, the LTFEs well represent the area shares of both the CWBg and the MSQR classes. 89% of the arable land and 65% of the grassland in Germany is covered by the three driest CWBg classes, hosting 89% and 71% of the arable and grassland LTFEs, respectively. LTFEs cover all six MSQR classes, however with a bias towards the high and very high soil quality classes. LTFEs on arable land are present in all clay content classes according to ESDAC, however with a bias towards the clay content class 4. Grassland LTFEs show a bias towards the clay content classes 5, 6 and 7, while well representing the other clay content classes, besides clay content class 3, where grassland LTFEs are completetly missing. The results confirm the very high potential of LTFE data for spatially differentiated analyses and modelling. However, reuse is restricted by the difficult access to LTFE research data. The common database is an important step in overcoming this restriction.

1 Introduction

~~Agricultural l~~Long-term field experiments (LTFEs) are a valuable research infrastructure for terrestrial research in general and agricultural research in particular. They are here defined as agricultural field experiments with a minimum duration of 20 years and research in the context of sustainable soil use and yield. Changes in soil properties tend to occur slowly; thus, for the identification of long-term trends, experiments with a long duration are needed. However, a single LTFE allows the drawing of conclusions only for its specific site. The collective analysis of research data from different LTFEs at different locations leads to more generalizable results. On the one hand, similar experiments on similar sites will lead to better validated conclusions when analysed in combination. On the other hand, LTFEs in different experimental conditions may lead to broader implementable results by their collective analysis. Furthermore, LTFEs are expensive; a comprehensive and coordinated evaluation is also required to prove that they are worth the expense (Körschens, 2006; Berti et al., 2016). Historically, LTFEs were mainly established to answer questions regarding plant nutrition in the sense of achieving the highest possible yield (Merbach and Deubel, 2008). Later, they were used to reveal the effects of agricultural management practices (~~e.g.,~~besides fertilization mainly~~,~~ tillage~~,~~ and crop rotation) on crop yield ~~and~~but also soil characteristics. LTFEs have been very helpful for research on soil organic carbon content or composition (Ellerbrock and Gerke, 2016; Kaiser et al., 2014; Körschens et al., 2014). LTFEs are further important for research related to questions regarding the inter annual variability of crop yield (i.e., yield stability) that can be associated with climate change (Berti et al., 2016; Reckling et al., 2018; Macholdt et al., 2019) and respective adaptation options (Hamidov et al., 2018). Valuable data can also be delivered for the validation of models (Franko et al., 2011; Ellerbrock et al., 2005) and for concepts used to evaluate soil functions (Vogel et al., 2019; Techen et al., 2020).

The ~~common~~ joint analysis of LTFEs can go beyond the original research question of each LTFE, e.g., to answer questions about climate change, ecosystem services, nutrient cycles, or yield stability. This research could be done through the common assessment of the ~~so-called~~ ‘control’ treatment of each LTFE, which is here defined as a treatment with customary tillage and fertilization and is present in most LTFEs. The combined analysis of control treatments is irrespective of ~~its~~the LTFE’s original research theme. ~~The control treatment is here defined as a treatment with customary tillage and fertilization and is present in most LTFEs. A meta-analysis of control treatments~~This would allow us to reveal changes in soil properties independently of the original questions for which the experiments were set up, e.g., overall trends in carbon content development. Although that would be a similar analysis to what can be done with soil monitoring sites (“Bodendauerbeobachtungsflächen”), it would be a reasonable approach. It can be assumed, that LTFEs have fewer breaks during the experimental period than soil monitoring sites, as soil monitoring sites are always a "window" in real agriculture. Further on, access to data from soil monitoring sites is not neccessarily easier than that to LTFE. Of course, the strengths of the collective analysis of LTFEs is the analysis of LTFEs with similar treatments in the form of a meta- analysis.

~~In addition~~The ~~,~~meta-analyses of similar ~~experiments~~ LTFE~~are reasonable~~, e.g., of fertilizer experiments with similar factors (e.g., with/without organic manure) or tillage experiments (e.g., conventional tillage vs. reduced tillage~~)~~) ~~. The analysis of similar experiments~~ has the opportunity to make use of the original research question of the LTFE. The effects and sustainability of measures can be revealed in a broader context and in different ~~landscapes~~soils. This can be done with pairwise comparisons of alternative and reference management practices, such as that by Bai et al. (2018) and Sandén et al.

(2018). However, because of the site specificity of soil-plant interactions and their responses to agricultural management practices, the upscaling and generalization of results requires information about the spatial representation of LTFE sites.

The statistical analysis of LTFEs poses several challenges and requires careful statistical modelling. We would recommend a mixed-model based analysis that accounts for the randomization layout of the trial (see Onofri et al., 2016, for review and some case studies). A general strategy starts out from the analysis model that would be used for a single year of data and then extend the model to account for variation across years. A specific challenge here is that during the course of the experiment, several observations are made on the same experimental units, and this serial correlation needs to be taken into account (Payne et al., 2015; Richter and Kroschewski, 2006; Singh und Jones, 2002). Also, there may be heterogeneity of variance between years, which may be related to changes in stability of the investigates systems (Macholdt et al. 2019a,b). For a recent account of several statistical issues in the design and analysis of LTFEs see Reckling et al. (2020).

A common issue with several LTFEs in Germany is that they were not properly randomized. This is mainly due to the fact that Fisher's principles of randomization and blocking were not widely known or accepted at the time when these trials were established. Instead, the systematic design originally proposed by Mitscherlich about a hundred years ago was very popular, and several LTFEs were established according to such systematic designs. For these unrandomized trials, a randomization-based analysis is obviously not available. One option then is to try spatial modelling, though it must be stressed that fitting of a spatial covariance structure cannot make up for lack of randomization. But such a modelling is perhaps the best way forward, if a sensible analysis is to be conducted for such trials. For a review of the connection between systematic designs as proposed by Mitscherlich and certain spatial covariance structures, see Piepho and Vo-Thanh (2020).

Important compilations of German LTFEs have been performed by Körschens (1994, 1997) and Debreczeni and Körschens (2003). In Körschens (1994), 97 German LTFEs with a duration of more than 20 years were listed. The starting year, the kind of factors, the cultivated crops, the size of the plots and experiments, the soil texture, the average annual air temperature and the average annual precipitation of the site are presented if available. In Körschens (1997), 50 German LTFEs with a duration of more than 30 years are listed, and similar information is presented. In Debreczeni and Körschens (2003), 94 German LTFEs with a duration of more than 20 years are listed, and information about the start, experimental aspects, cropping system and soil is provided. Körschens (1994, 1997) indicates the following constraints for the compilation of a complete overview of all LTFEs in Germany: the multitude of experiments, discontinued experiments, new experiments, or experiments not at all documented in the literature. In Debreczeni and Körschens (2003), restricted resources for data collection are also mentioned. In addition, the heterogeneous setup and the scattered distribution of LTFEs make comparisons of data difficult or impossible (Bai, 2018). To cope with these problems, in the frame of the project ‘BonaRes’, funded by the German Federal Ministry for Education and Research (BMBF), there is the focus on a central database for metadata and research data from LTFEs (BonaRes, 2020). The research data from two LTFEs (V140, Müncheberg and Dikopshof, Bonn) are available for free reuse via the BonaRes data portal (https://maps.bonares.de/mapapps/) and the research data of nine other LTFEs are very close to publication. More LTFE holders will hopefully agree to upload research data within the third (and last) funding phase of BonaRes and take the great chance for support in data processing and storage.

No information is yet available regarding the spatial representation of LTFEs in Germany with regard to important agronomic factors such as climate and soil fertility. The aim of this paper was twofold: first, to ~~analyse and~~ classify the ~~experimental design of the~~ LTFEs in Germany with regard to land use, research themes and farming systems. Second, the aim was to conduct a~~n~~ descriptive analysis of the geospatial distribution of the experimental sites with regard to key factors of agricultural production: climate and soil fertility. ~~The database consisted of a dataset with meta-information on 205 LTFEs in Germany. The dataset has been compiled in the frame of the project 'BonaRes', funded by the German Federal Ministry for Education and Research (BMBF) and is uploaded for free utilization in the BonaRes data repository (Grosse and Hierold, 2019). It contains information about name of the LTFE, exact location, holding institution, land use categorie, participation in existing networks, research theme, start (and maybe end) of the trial, and research parameters. Besides the focus of this project on the acquisition of metadata there is a focus on research data from LTFEs. The aims are to make LTFEs more visible, to enhance networking among LTFEs and to simplify common analyses of LTFEs. In compiling the dataset, special attention was focused on LTFEs with a minimum duration of 20 years. This age can be seen as a threshold for the identification of long-term trends. Attention was given to LTFEs in the context of soil research, i.e., the objects of research should at least include soil properties and yield as an important soil function. The setup of each trial should allow for statistical analyses, i.e., have factors, treatments, replications and as much as possible a static design.~~

~~The geospatial analysis was performed by comparing the regional distribution of LTFEs to that of climatic water balance classes (CWB) and the Müncheberger Soil Quality Rating (MSQR) as two complex site classifications. The representativeness of LTFEs according to these site sizes was assessed. LTFEs are classified according to their land use and their research themes to simplify the identification of similar experiments. The identification of suitable LTFEs in similar (or different) landscapes shall be enhanced. Therefore, a table with the IDs of all experiments, their thematic classification, their CWB class and their MSQR class is provided in the attachment. More details for each LTFE can be identified in the published dataset (Grosse and Hierold, 2019) through the ID of the LTFE. Thus, cooperation with LTFE holders can be initiated more easily.~~

2 Material and Methods

A combination of three methods was applied: a literature review to identify LTFEs in Germany, a fact sheet-based addition of information to the identified LTFEs, and a geospatial analysis employing the CWBg and the MSQR (Figure 1).

An extensive literature review was conducted to identify LTFEs. The search ~~items~~ terms were 'long-term field experiment', 'long-term experiment', 'long-term field trial', and 'long-term trial', as well as the German items 'Dauerfeldversuch', 'Dauerdüngungsversuch', 'Dauerversuch', 'Langzeitfeldversuch' and 'Langzeitversuch'. Sources were scientific papers as well as other articles, books, trial guides and websites. The focus was on the exact position of the LTFE and the following metadata: name of the LTFE, website (if available), institution, land use category, participation in existing networks, research theme, size of the LTFE area, number of plots, size of the plots, crop rotation, start (and maybe end) of the trial, ~~research~~ measured parameters, and trial setup including factors, treatments and randomization. For the coordination and simplification of the trial description, the BonaRes Fact Sheet was established, which asks for all relevant trial information (Grosse et al., 2019). It was sent to the trial holders, and the fact sheet was completed for 40 trials. Trial holders also delivered important information as personal communication.

In compiling the dataset, special attention was paid to LTFEs with a minimum duration of 20 years. This age can be seen as a threshold for the identification of long-term trends. Attention was given to LTFEs in the context of soil research, i.e., the objects of research should at least include soil properties and yield as an important soil function. The setup of each trial should allow for statistical analyses, i.e., have clearly defined treatment factors, replications and as much as possible a static design. Lysimeter experiments were excluded because they were considered as an own category. Some reasons for this exclusion are that soils are often transferred and not undisturbed in lysimeter experiments and tillage has to be conducted by hand instead of machines, which can bias some results. Indeed, longterm lysimeter experiments exist in Germany as part of the TERENO network (TERENO, 2020).

The LTFEs were classified according to their research themes to simplify the identification of similar experiments. The field crops LTFEs could best be grouped into four clusters: fertilization, tillage, crop rotation, other. The fourth cluster "other" entails all themes that could not be grouped into the first three and appeared only in a few (maximum five) LTFE cases, so that a separate group was not justified. ~~following research themes were selected: fertilization, tillage, crop rotation or other research themes. LTFEs were considered to belong to one group if one factor was fertilization, tillage, crop rotation, or another theme.~~ Two or more factorial experiments were sorted in all relevant classes, i.e., multiple nominations were possible. ~~LTFEs on arable land are existent in all three classes, and~~ LTFEs on grassland exist only as fertilization trials.

~~94~~ 109 LTFEs are precisely known in their position, and for an additional 96 LTFE the trial area is approximately known, usually on the area of the holding institution~~an additional 87 LTFEs are located on the approximate trial area~~. In the latter case, either the exact position is not known or the former LTFEs are now overbuilt with streets, parking spaces or buildings.

The geospatial analysis was performed by comparing the regional distribution of LTFEs to that of (a) climatic water balance classes of the growing season (1 May to 31 October) (CWBg) and (b) the Müncheberg Soil Quality Rating (MSQR) as two complex site classifications. In addition, (c) clay content of the topsoil according to ESDAC (2020) was chosen. The representativeness of LTFEs according to the frequencies in the cells of this classification was assessed. LTFEs were classified according to their land use and their research themes to simplify the identification of similar experiments. The identification of suitable LTFEs in similar (or different) landscapes shall be facilitated. Therefore, a table with the IDs of all experiments, their thematic classification, their CWBg class and their MSQR class is provided in the attachment. More details for each LTFE can be identified in the published dataset (Grosse and Hierold, 2019), which is freely available in the BonaRes Repository, through the ID of the LTFE. Thus, cooperation with LTFE holders can be initiated more easily.~~For the geospatial analysis, 14~~Fourteen LTFEs were excluded from the geospatial analysis because they were dealing with research themes other than fertilization, tillage or crop rotation or did not include field crops or grassland experiments. The remaining 191 LTFEs were grouped into the ~~three~~four classes of fertilization experiments, tillage experiments, grassland experiments, and crop rotation experiments. ~~and were characterised according to the following site information: (a) CWB and (b) MSQR.~~ The shares of LTFEs in each class were compared to that of agricultural land in Germany. For that, approximately 17.9 million hectares of agricultural land were subdivided according to their land use as arable land (approximately 13.5 million hectares) or grassland (approximately 4.4 million hectares) (Umweltbundesamt, 2019). For the descriptive statistical analyses cross-tabulations and contingency tables were used.~~14 LTFE were excluded from the analysis because they were dealing with research themes other than fertilization, tillage or crop rotation or did not include field crops or grassland experiments.~~

The CWBg was chosen as a suitable parameter to represent the climatic conditions for agricultural land use and because of its huge relevance for vegetation growth. Its impact may be even larger than that of temperature (Crimmins et al., 2011), and it may determine the growing season (Sattar et al., 2019). We used data from the German Meteorological Service (DWD) for the period 1981-2010 for the main growing season, defined from 1 May to 31 October (Ad-hoc-AG Boden, 2005). The CWB data for the growing season instead of the whole year was chosen, because regional differentiation is bigger for CWBg compared to the annual balance. The data are available for the whole territory of Germany with a pixel resolution of 1 km (DWD, 2020). The CWB is defined in Formula (1) as the difference in precipitation (P) and potential evapotranspiration (PET). It is a quantitative measure of the water supply in a given time period and for a specific region. The PET depends on location factors such as crop cover, topographical effects, soil conditions and soil water storage. It can therefore only be determined selectively. However, for a better comparison for spatial calculations, the so-called grass reference evapotranspiration is considered, which indicates the evapotranspiration of a standardized grass cover in standardized soil with optimal water supply (Pereira et al., 2015).

$$CWB = P - PET \tag{1}$$

The classification of the climatic water balance in seven classes follows the Survey Guideline KA5 (Ad-hoc-AG Boden, 2005) (≤150; -150 to <-50;-50 to <50; 50 to <150; 150 to <300; 300 to <500; ≥500 mm), which are classified there from extremely low to extremely high (Ad-hoc-AG Boden, 2005).

To derive data for agricultural areas, either arable land or grassland intersections with the CORINE Land Cover (CLC, 2018) dataset were made.

For (b), a soil quality map (BGR, 2014) is used, which applies the Müncheberg~~er~~ Soil Quality Rating (MSQR). It has a pixel resolution of 250 m. The BGR had applied this complex assessment procedure (Mueller et al., 2010; Ad-hoc-AG Boden, 2010), which was developed as a visual procedure for estimating yield potential in the field, by modelling data from the soil overview map (BGR, 2007), but only for arable land. It takes soil structure and soil degradation threats into account and integrates eight basic soil indicators with 13 hazard indicators into a rating of soil quality. The rating is shown on an ordinal scale of 0 to 102 and clustered into six quality classes, with higher values indicating higher yield potential (Daedlow, 2018). The eight soil indicators are substrate, A-horizon depth, topsoil structure, subsoil structure, rooting depth, profile available water, wetness and ponding, slope, and relief. The 13 hazard indicators are contamination, salinization, sodification, acidification, low total nutrient status, shallow soil depth above hard rock, drought, flooding and extreme waterlogging, steep slope, rock and surface, high percentage of coarse texture fragments, a soil thermal regime unsuitable for crop production ~~soil thermal regime~~, and miscellaneous hazards (e.g., exposure to wind and water erosion). Most of the indicators are sensitive to agricultural management, which makes the MSQR most useful for studying the effects of agricultural management on soil. The MSQR has been proven useful in other studies of geo-spatial representation (Askari et al., 2013; Hanauer et al., 2017; Smolentseva et al., 2014). Since no MSQR is available for grassland areas, the LTFEs on grassland were excluded in this analysis.

Out of the 157 fertilization, tillage or crop rotation LTFEs on arable land, 26 could not be assigned to a class of MSQR because the fields are surrounded by buildings and are therefore not part of arable land. If an LTFE did not obtain an assignment at a GIS intersection, the value was determined ~~by~~ manually by plausibility examination of the nearest 5 to 7 grid cells. One LTFE could not be assigned to a class of MSQR because it compares three different soils in boxes.

For (c), clay content, data of the European Soil Data Centre (ESDAC) based on LUCAS topsoil data is used (ESDAC, 2020). Although clay content is included in the MSQR as part of substrate, we decided to analyse the area shares of clay content separately, as carbon content is often correlated with the clay content (Körschens, 1997). Moreover, clay content is needed to estimate the carbon balance in a model derived from the CANDY model (Franko et al., 2011). Further on, ESDAC offers international data, therefore clay content is suitable for international comparability. Due to the fact, that texture is part of the MSQR, we do not offer separate maps for clay content, but present data in tables.

Calculations always refer to utilized agricultural areas or parts thereof, arable land or grassland.

The information was analysed with Microsoft Excel. The geospatial analysis was performed using the ESRI software ArcMap 10.6.1 (ESRI, 2018).

The research on LTFEs is not completed but is ongoing. The information about LTFEs is continuously updated and expanded. New LTFEs are integrated, and the information about each LTFE is extended. The state of research is November 2019.

3 Results and Discussion

3.1 Overview of LTFEs in Germany

In total, 205 LTFEs across Germany with a minimum duration of 20 years were identified, of which 140 trials are ongoing and 65 are terminated (status: November 2019). Further LTFEs reaching the 20-year threshold within the next five years (until 2024) were also included (n=6; Figure 2~~a~~). Most of the trials have a duration between 20 and 49 years (n=124; Figure 2~~a~~). 50 trials have a duration between 50 and 99 years. Three trials have been running for more than 100 years (‘Ewiger Roggen’, Halle, 1878 - today; ‘Statischer Düngungsversuch V120’, Bad Lauchstaedt, 1902 – today; ‘Dauerdüngungsversuch Dikopshof’, Wesseling, 1904 - 2009). The age of 22 terminated trials is unknown since only the starting date of the trials is known but not the exact ending year. As these trials were mentioned in different important sources as being ongoing (Amberger and Gutser, 1976; Debreczeni and Körschens, 2003; Körschens, 1990, 1994, 1997, 2000), it is known that their duration was at least 20 years.

The land use in 168 LTFEs is arable field crops, in 34 trials grassland, in two trials vegetables and in one trial pomiculture ~~(Figure 2b)~~. There are more long-term grassland experiments in Germany; we have not included them in our research because they are dedicated to research themes other than questions of sustainable soil use and ~~bioeconomy~~yield.

The majority of LTFEs were established after 1947, when research was resumed after the Second World War (Figure 3). In 1996/1997, a series of grassland fertilization experiments was established by several German state authorities. This explains the high number of LTFEs established in these years (Figure 3).

The research themes of the LTFEs can be assigned to the following categories: fertilization, tillage, crop rotation, ‘other’ themes and combinations of these (Table 1). Due to trials with two or more treatment factor~~sial trials~~, multiple nominations of experiments for the different research themes were ~~made~~ assigned (n=251). Most LTFEs ~~are~~ were established for research on fertilization (Figure 3 and Table 1) (n=158). This result is coincident with the results from a study in the international context (Berti et al., 2016). In Germany, ~~the entity of~~ fertilization LTFEs can be subdivided into field crop experiments (n=124) and grassland experiments (n=34). Historically, questions regarding the effects of fertilization on plant growth were the focus of research, while~~ in~~ more recently~~ times,~~ the effects on the soil and the environment are investigated. In the focus of the experiments are either different kinds of fertilizers or different amounts of fertilizers or comparisons with/without a specific fertilizer or combinations of these. Most frequently, organic fertilization versus mineral N fertilization is examined. In fewer experiments, the effect of straw fertilization is the subject of research. Additionally, the effects of mineral K fertilization, mineral P fertilization, liming, green manure, mineral Mg fertilization, compost, or sludge are examined (Table 1). More rarely, different points in time of the fertilizing measure are compared.

~~In 1996/1997, a series of grassland fertilization experiments was established by several German state authorities. This explains the high number of LTFEs established in these years (Figure 3).~~

Thirty-eight ~~38~~ LTFEs address tillage variations (Table 1). Most of these tillage experiments compare different tillage intensities. Most often, reduced tillage depth or conservation tillage are the subjects of research. Also, inversion versus non-inversion tillage is compared. Further research themes are sowing methods, different forms of primary tillage, the effects of stubble tillage, and tillage frequency (Table 1). The oldest tillage experiment started in 1923 (Statischer Dauerversuch Bodennutzung, Berlin-Dahlem), but 25 tillage experiments started in 1990 or later (Figure 3). Therefore, most of the tillage experiments are ‘younger’ experiments, a result also congruent with the findings of ~~(~~Berti et al.~~,~~ (2016).

Thirty-two LTFEs have the research theme ‘crop rotation’. Mostly, the effect of crop rotation on soil properties and yield is investigated. Therefore, rotational cropping versus monoculture is compared. Additionally, plant health is the focus, e.g., compatibility of different cereal species or different percentages of cereals in crop rotation (Table 1). Most of the crop rotation experiments were established after 1950. 19 experiments of the 32 crop rotation experiments are still ongoing. The oldest crop rotation experiment, the ‘Eternal Rye’, was established in 1878 by the Martin Luther University of Halle.

Twenty-three~~23~~ trials address research themes other than fertilization, tillage or crop rotation. The ‘other’ research themes are highly diverse. ‘Environmentally friendly crop~~plant~~ protection’, mainly reduced pesticide intensity, is the most frequent research theme among the ‘other’ research themes (n=5). ‘Irrigation’ is the second most frequent (n=4). ‘Effects of different forms of fallow’ is within the focus of three LTFEs. ‘Frequency and start of utilization of grassland’, ‘Land use systems comparison’, ‘Monitoring of Organic Farming’ and ‘Use of biodynamic preparations’ are each within the focus of two LTFEs. Three other research themes are present in only one LTFE (Table 1).~~:~~

Many different parameters are measured in LTFEs. In Grosse et al. (2019) 46 different soil parameters and 29 plant parameters are listed, which were measured in LTFEs. The analysed parameters can be assigned to different soil functions. The following five soil functions were chosen as most relevant for BonaRes: biomass production, water storage and filtering, nutrient storage and recycling, carbon storage, and habitat for biological activity. In most LTFEs, parameters for biomass production were measured like yield and yield components. Nutrient storage and recycling is the second frequent soil function. Less research is conducted (in decreasing frequency) for carbon storage, habitat for biologic activity and water storage and filtering.

Archived samples are an important means of performing or repeating measurements. However, the information, if archived samples exist, is difficult to find in the literature. We have the information from a fact sheet query. Of 40 responses received, 32 LTFEs have archived samples.

A total of 184 trials are set up with conventional ~~agriculture~~management practices, 14 with organic ~~agriculture~~ management practices and five with so-called integrated agriculture. Two trials compare conventional ~~agriculture~~ with organic ~~agricultur~~management practices~~e (Figure 4a)~~.

The holding institution for 96 trials is a university or ~~technical college~~university of applied sciences, and for 61 trials, it is a state authority. 27 trials are in the responsibility of non-university scientific institutions such as research institutes. 21 trials are or were held by industry ~~(Figure 4b)~~.

Compared to LTFEs worldwide, there are a comparatively large number of LTFEs in Germany. Our research revealed up to now 177 LTFEs which match our definition in the following countries: Austria, Belarus, Belgium, Bulgaria, China, Czech Republik, Denmark, Estonia, Finnland, France, Hungary, Ireland, Italy, Moldova, Norway, Poland, Romania, Russia, Slovenia, Spain, Sweden, Switzerland, United Kingdom, Ukraine, and USA. They are comparable in age (the oldest ones started 1843) and research themes. There are international networks such as the working group IOSDV (Internationale Organische Stickstoffdauerdüngungsversuche, Körschens, 2000), the GLTEN (Global Long-Term Experiment Network, GLTEN, 2020), which was launched in 2018, and networks of organic LTFEs like RetiBio in Italy and RotAB network in France (Ciaccia et al., 2020). In order to make the best use of the great efforts and costs that are behind every single LTFE, international networks should cooperate more intensively in future and possibly also use data infrastructures jointly. We would like to point out that the BonaRes data repository can also be used by international data holders.

All information about the LTFEs in Germany is published in an online overview map (https://ltfe-map.bonares.de). The aims of the overview map are to make LTFEs more visible, to enhance networking among LTFEs and to simplify joint analyses of

LTFEs. It is available in German and English. The map content can be displayed according to different categories, e.g., the research themes, land use, or duration of the LTFEs. In addition to~~,~~ the overview information, details about every single LTFE are provided in a pop-up window,~~. Therefore, it~~ offerings~~s~~ valuable information for potential users for orientation and initiation of cooperation.

As limitations of existing LTFEs it can be mentioned, that erosion and compaction are typically not analysed in LTFEs and they are not designed for such questions up to now. Grassland experiments are in fact meadow experiments, whereas grazing experiments are completely missing.

3.2 Geospatial Analyses

~~In the following analyses, the number of LTFEs is compared to the proportion of classes of CWB and MSQR, separately, according to their research topics (fertilization, tillage, crop rotation). Fertilization experiments are subdivided into field crops (including two vegetable experiments) or grassland experiments. In tillage and crop rotation experiments, no grassland experiments exist. While the CWB is available for the whole territory and can be evaluated separately for arable land and grassland, the MSQR soil quality is available only for arable land.~~

~~The total numbers of experiments in these analyses are 158 fertilization experiments (124 field crops and 34 grassland experiments), 38 tillage experiments and 32 crop rotation experiments (multiple nominations possible).~~

3.2.1 Geospatial Analysis of LTFEs in Relation to the Climatic Water Balance of the growing season (CWBg) Distribution

~~For the analysis, the CWB of the vegetation period (1 May to 31 October) was used according to Survey Guideline KA5 (Ad-hoc-AG Boden, 2005).~~ An overview of the distribution of these CWBg classes and of LTFEs in Germany is given in Figure ~~5~~4. ~~For the analyses, approximately 17.9 million hectares of agricultural land are subdivided according to their land use as arable land (approximately 13.5 million hectares) or grassland (approximately 4.4 million hectares) (Umweltbundesamt, 2019).~~ According to Table 2 and Figure ~~5~~4, arable land is distributed among classes 1-7 of the CWBg (Table 2; Figure ~~5~~4): the largest shares of 33% each are classified as CWBg classes 2 (from -150 mm to <-50 mm) or 3 (from -50 mm to <50 mm), respectively. The area of CWBg class 2 is mainly located in the lowlands of Germany: in the western and northern Rhine-Main Valley, in a majority of the north-eastern lowland and the Loess Boerde. The area of CWBg class 3 is mainly distributed in the north-eastern part of Germany and in parts of the Southern German Escarpment Landscape, the northern foothills of the Alps (lower Bavarian upland) and the lower uplands, ~~as there are~~such as the Lower Saxon and Hessian lowlands, the Vogtland district and the Erzgebirge foreland. 23% of the arable land is allotted to CWBg class 1 (<-150 mm). This extremely low CWBg is located almost exclusively in eastern Germany, especially in the rain shadow of the Harz: the Fläming, the plates and lowlands of mid Brandenburg and the heathland of Brandenburg. Minor shares of 7% and 4% are allotted to CWBg classes 4 (from 50 mm to <150 mm) and 5 (from 150 mm to <300 mm), respectively. CWBg class 4 is located mainly in the foothills of the Alps and around the secondary mountains and in the western Schleswig-Holstein (moraines of Schleswig-Holstein). CWBg 5 is mainly located in Germany's southern foothills of the Alps. CWBg class 6 (from 300 mm to <500 mm) is not present in Germany's arable land, and CWBg class 7 (>500 mm) is not present in Germany's agricultural land (arable and grassland).

Among the grassland, the largest share of 33% is classified as CWBg class 3 (Table 3). 23% of grassland are classified as CWBg class 5. 18% are classified as CWBg class 2, 14% as CWBg class 1 and 9% as CWBg class 4. CWBg class 6 is present in a small share (3%) of Germany's grassland at higher altitudes in the Alpine region.

To analyse sites in every CWBg class, each class would have to be represented through LTFEs. Ideally, the shares of LTFEs in each class would correspond to the agricultural area. This is, of course, not the case (Table 2), as LTFEs were not established systematically in the landscape. Each CWBg class present in the arable land is represented by LTFEs, but they are not found in the same shares. CWBg class 1 is overrepresented by all LTFE types, CWBg class 2 is underrepresented by crop rotation LTFEs, class 3 is underrepresented by fertilization LTFEs and crop rotation LTFEs, class 4 is underrepresented by tillage LTFEs and overrepresented by crop rotation LTFEs (although in number, there are only 4 crop rotation LTFEs), and class 5 again is overrepresented by crop rotation LTFEs (although in number, there are only 6 crop rotation LTFEs) (Table 2; Figure ~~5~~4) Overall, the three CWBg classes 1-3 representing 89% of the arable land area also host 89% of the LTFEs with a certain bias towards the driest CWBg class 1. Given that no spatial planning was considered during the allocation of LTFEs, this is a remarkably good distribution.

Among grassland LTFEs, not every CWBg class is represented by LTFEs (Table 3). Thus, CWBg class 6 is present in a small share of grassland (3%) but is not represented by any grassland LTFEs. CWBg classes 2 and 5 are underrepresented by grassland LTFEs, while CWBg classes 3 and 4 are overrepresented by grassland LTFEs. Overall and compared to the arable land area, the three driest CWBg classes 1-3 represent only 65% of the grassland area and host 71% of the grassland LTFEs.

3.2.2 Geospatial Analysis of LTFEs in Relation to the Müncheberg~~er~~ Soil Quality Rating (MSQR) Distribution

An overview of the distribution of the MSQR classes and of LTFEs in Germany is given in Figure 5~~6~~. Soils classified as 'very high' are located mainly in the central part of Germany. Soils classified as 'high' exist in the central part and in the south of Germany as well as in some smaller areas in the north-western region of Germany, including the coast~~al ~~lines. Soils classified as 'low' and 'medium' are predominant in the northern part of Germany but also exist in some areas in the middle and south of Germany. Soils classified as 'very low' mainly exist in north-eastern Germany. Soils classified as 'extremely low' exist mainly in small areas of mid-east and mid-west and north-west Germany (Figure 5~~6~~).

The classification of the agricultural area into the six MSQR classes (Table 4) is as follows: The largest share (28%) of agricultural area is classified as 'medium'. The smallest shares are classified as 'extremely low' (6%) and 'very high' (10%). Medium shares are classified as 'very low' (17%), 'low' (21%) and 'high' (18%). LTFE sites exist in all MSQR classes, and overall, the distribution of the LTFE sites follows a similar pattern as that of the MSQR classes, with the exception of a bias towards the 'high' MSQR class.

3.2.3 Geospatial Analysis of LTFEs in Relation to the combined CWBg and MSQR Distribution

The share of the arable area in Germany and the share of LTFEs on arable land in every CWBg-MSQR intersection are compared (Figure ~~7~~6). According to this analysis, in the MSQR class 'extremely low', the share of LTFEs matches the share of arable land area in each CWBg class. In the other MSQR classes, CWBg 1 is overrepresented by LTFEs compared to the respective land area. Thus, regarding climate, the distribution of LTFEs is biased towards dry areas with very low CWBg class 1. The reason for this bias is probably because most of these LTFEs are located in the region surrounding Berlin and the region Bad Lauchstädt/Halle/Seehausen, which are both historical agricultural research areas.

In CWBg class 2, the distribution of LTFEs is biased towards high and very high MSQR classes. This result is mainly caused by the sites Bonn, Braunschweig, Gießen and Göttingen.

CWBg class 3 is underrepresented by LTFEs in the MSQR classes of very low, low, medium and high.

CWBg classes 4 and 5 are rather adequately represented by LTFEs in every MSQR class. However, these CWBg classes rarely exist in Germany.

~~Franko et al. (2011) identified in their analysis of 40 LTFEs for the validation of a C-Model that more experimental results on clay soils would be required. However, for~~For the landscape approach proposed in this paper, more LTFEs would be required in areas with CWBg class 3 on soils classified as MSQR 'very low', 'low', 'medium' and 'high' and in areas with CWBg class 2 on soils classified as MSQR 'very low', 'low' and 'medium'~~ would be required~~.

3.2.4 Geospatial Analysis of LTFE in Relation to the clay content Distribution

According to Table 5, every clay content class is represented by LTFEs on arable land. Clay content class 4 (17% to 19% clay content) is overrepresented by LTFE, while the high clay content classes 7 (25% to 27% clay content) and 8 (28% to 98% clay content) are underrepresented, especially by fertilization and crop rotation LTFEs.

Among grassland, LTFEs in clay content class 3 (11% to 16% clay content) are completely missing (Table 6). The clay content classes 5 (20% to 21% clay content), 6 (22% to 24% clay content) and 7 (25% to 27% clay content) are overrepresented by grassland LTFEs, while the other clay content classes are rather equally represented.

Franko et al. (2011) found in their analysis of 40 LTFEs for the validation of a C-Model that more experimental results on clay soils would be required. This could be confirmed for LTFEs on arable land in this study.

4 Conclusions

To obtain adequate information about each CWBg,~~ and~~ MSQR and clay content class through LTFEs, more LTFEs would have to be established. However, nearly every class is represented by at least some LTFEs. For the joint~~common~~ analysis, there are other, more important constraints: data are not easy to access, and sometimes the older data are not digitized. Here, BonaRes offers great opportunities through the provision of support for data preparation and through the establishment of a common database. We hope that this great opportunity will be frequently used by LFTE holders in future.~~This opportunity should be used more by LTFE holders in the future.~~

Data availability

The LTFE metadata are available in the BonaRes Respository: Grosse, M., and Hierold, W.: Long-term Field Experiments in Germany [Data set], BonaRes, http://doi.org/10.20387/BonaRes-3tr6-mg8r, 2019.

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Declaration of Interest Statement

The authors declare that they have no conflict of interest.

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Figures and Tables

(In the order of their appearance)

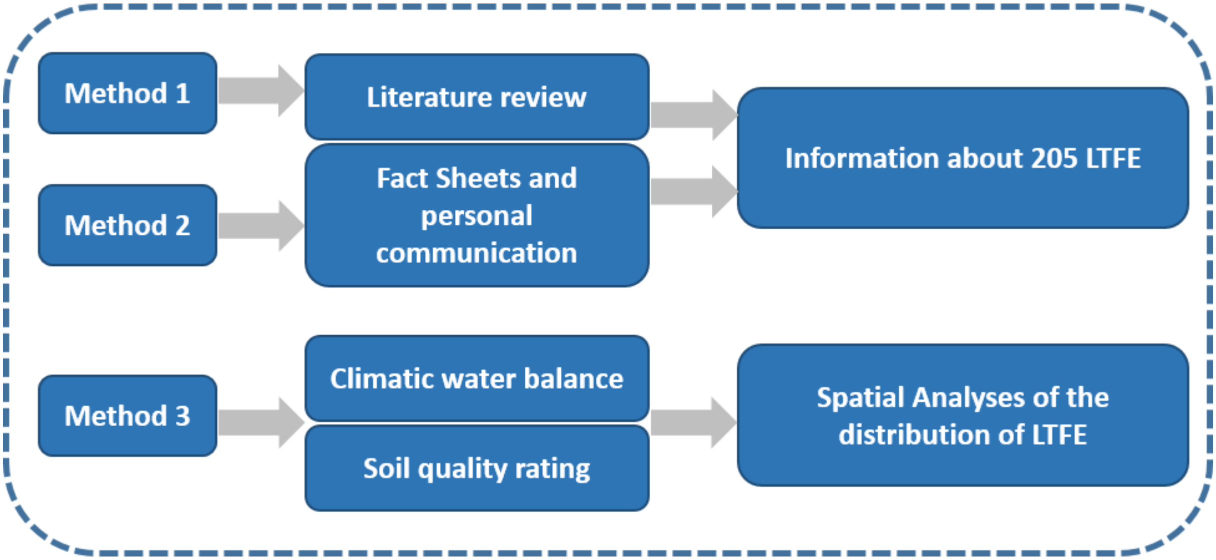
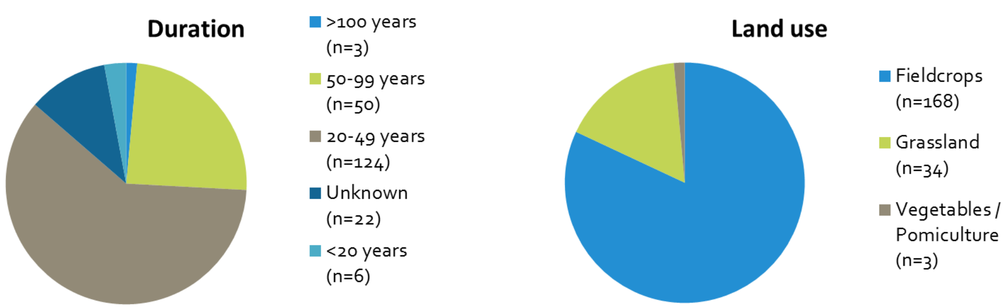


Figure 1: Methods used for assessing the representativeness of the LTFE distribution in Germany.



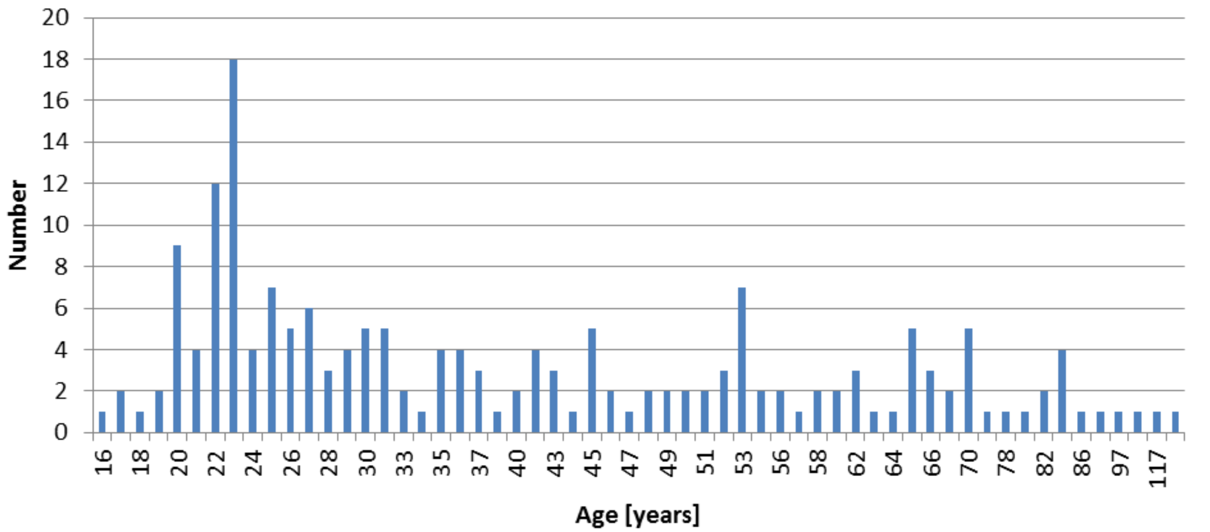
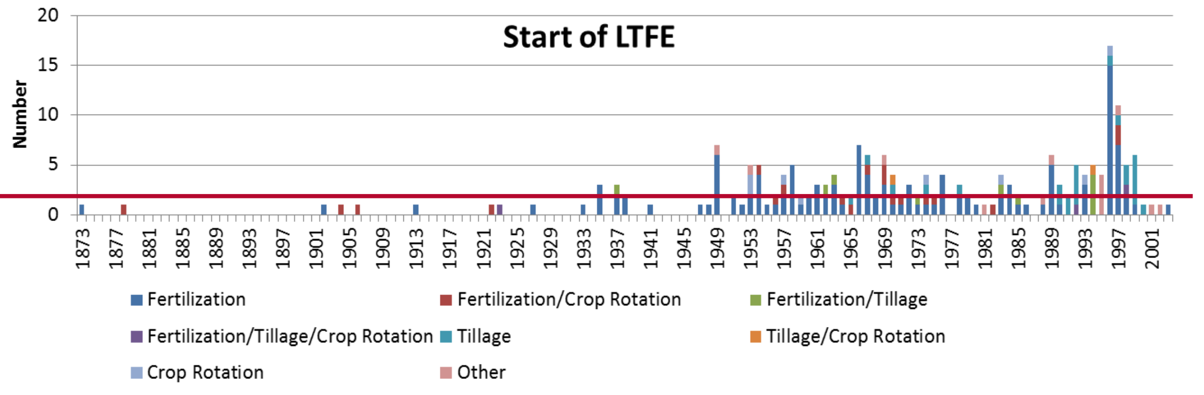


Figure 2: Number of LTFEs per age in 2019 (n=183; age of 22 LTFEs unknown) ~~Results of the literature research (I) (n=205).~~



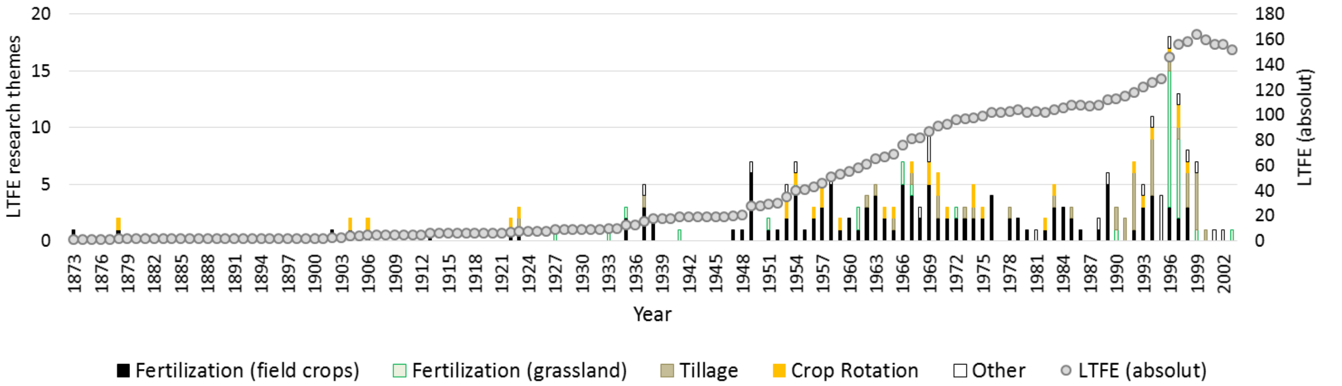
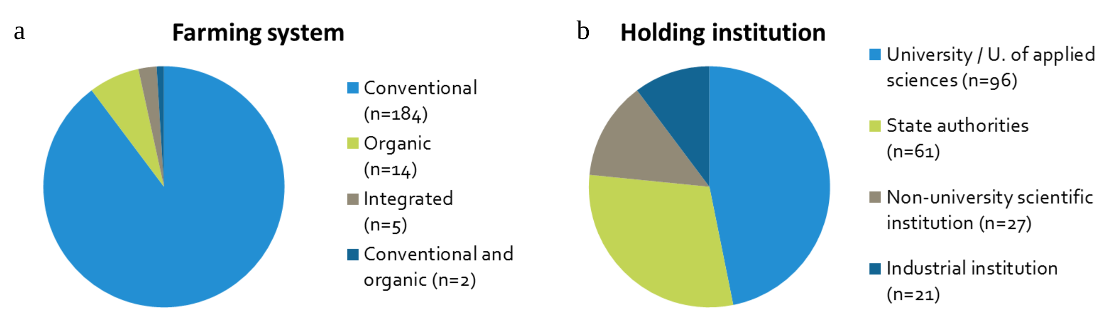


Figure 3: Number of LTFEs’ set up per year according to the research themes of the experiments (~~total number of LTFEs=205~~multiple nominations possible, n=251) and total number of LTFEs per year (= established LTFE minus terminated LTFE).

Table 1: Research themes in LTFEs (multiple nominations possible, sorted by frequency).

Theme	Number of trials
Fertilization – field crops experiments	**124**
Manure~~Organic~~ fertilization	58
Mineral N-fertilization	55
Straw fertilization	24
Mineral K-fertilization	15
Mineral P-fertilization	14
Liming	10
Green manure (with *vs*. without)	8
Mineral fertilization (not specified)	6
Mineral Mg-fertilization	4
Compost	3
Sludge	2
Tillage – field crops experiments	**38**
Reduced depth or conservation tillage	24
Inversion *vs*. non-inversion tillage	12
Sowing methods	10
Different forms of primary tillage	7
Stubble tillage (with *vs*. without)	3
Tillage frequency	3
Other	2

Fertilization – grassland experiments	**34**
Mineral P-fertilization	11
Mineral K-fertilization	10
Mineral N-fertilization	6
Liming	4
~~Organic~~ Manure fertilization	2
Sludge	2
Mineral fertilization (not specified)	1
Acid *vs*. alkaline fertilization	1
Crop rotation – field crops experiments	**32**
Crop rotation (not specified)	23
Rotational cropping *vs*. monoculture	4
Effect of pre crop	2
Crop rotation organic *vs.* integrated	1
Different percentages of cereals	1
Different percentages of wheat	1
Other – field crops and grassland experiments	**23**
~~Plant~~ Crop protection	5
Irrigation	4
Effects of different forms of fallow	3
Frequency and start of utilization of grassland	2
Land use systems comparison	2
Monitoring of Organic Farming	2
Use of biodynamic preparations	2
Chopped woody plants for weed suppression	1
Effect of weather conditions	1
Thistle control	1



F~~igure 4: Results of the literature research (II) (n=205).~~

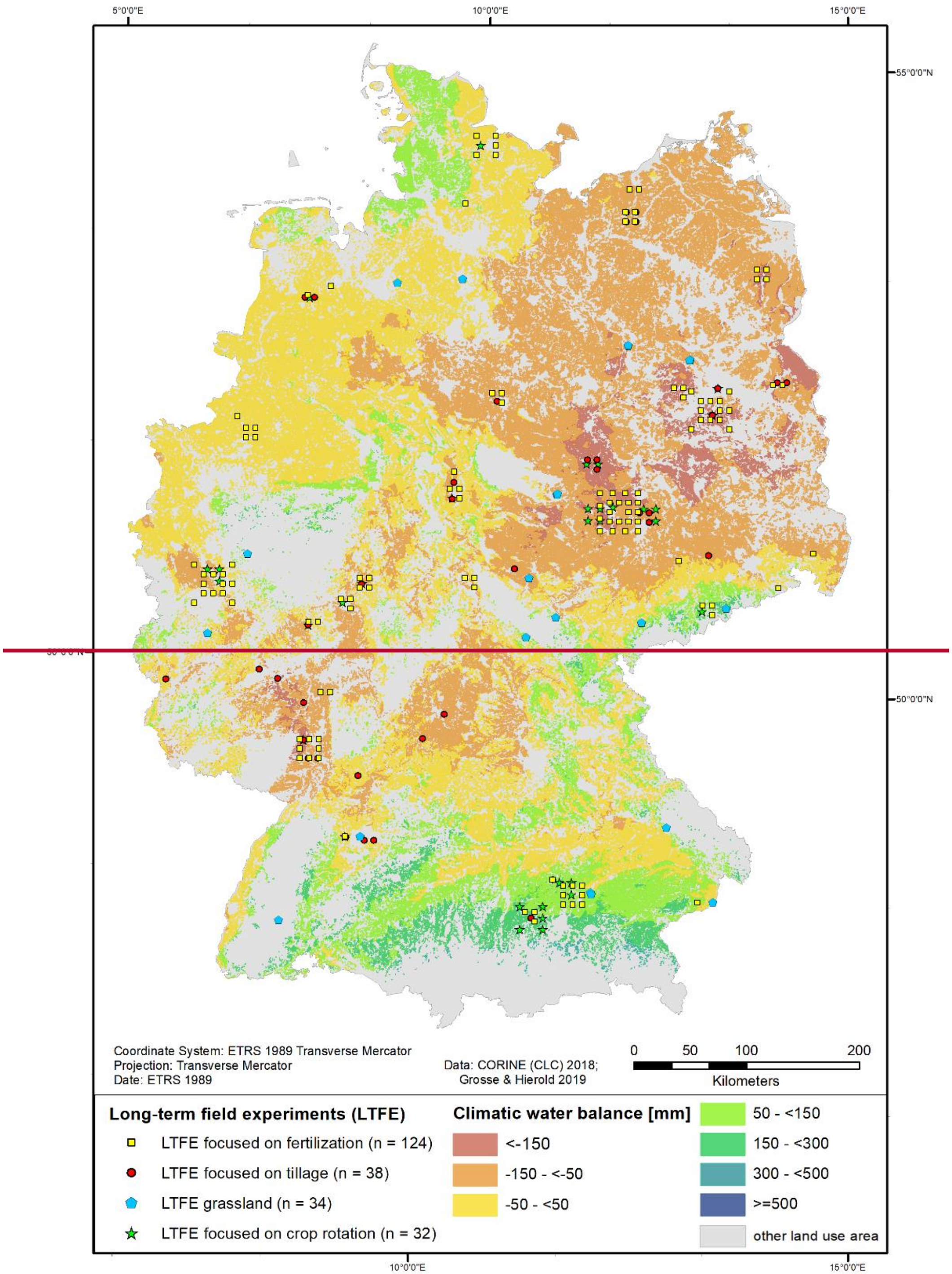
Table 2: Climatic water balance of the growing season (1 May to 31 October) (CWBg) classification of arable land in Germany and the number or share of the different LTFE types in each CWBg class.

CWBg class ~~vegetation period~~	Range [mm/yr]	Agricultural area (arable)		LTFE total (arable land) (n=169)		Fertilization LTFE* (n=124)		Tillage LTFE* (n=38)		Crop rotation LTFE* (n=32)	
		area [ha]	share [%]	number	share [%]	number	share [%]	number	share [%]	number	share [%]
1	<-150	3 135 676	23	66	39	49	40	13	34	13	41
2	-150 - <-50	4 473 111	33	49	29	39	31	12	32	6	19
3	-50 - <50	4 468 852	33	35	21	21	17	11	29	3	9
4	50 - <150	926 798	7	10	6	10	8	1	3	4	13
5	150 - <300	492 110	4	9	5	5	4	1	3	6	19
6	300 - <500	0	0	0	0	0	0	0	0	0	0
7	>500	0	0	0	0	0	0	0	0	0	0

*multiple nominations possible

Table 3: Climatic water balance of the growing season (CWBg) classification of agricultural ~~used~~ area used for grassland in Germany and the number or share of the LTFEs on grassland in each CWBg class.

CWBg class ~~vegetation period~~	Range [mm/yr]	Agricultural area (grassland)		Grassland LTFE (n=34)	
		area [ha]	share [%]	number	share [%]
1	<-150	599 247	14	6	18
2	-150 - <-50	792 064	18	3	9
3	-50 - <50	1 420 319	33	15	44
4	50 - <150	398 496	9	7	21
5	150 - <300	1 009 952	23	3	9
6	300 - <500	137 968	3	0	0
7	>500	0	0	0	0



5°0'0"E
10°0'0"E
15°0'0"E
55°0'0"N
50°0'0"N
Coordinate System: ETRS 1989 Transverse Mercator
Projection: Transverse Mercator
Date: ETRS 1989
Data: CORINE (CLC) 2018;
Grosse & Hierold 2019
0 50 100 200
Kilometers
Long-term field experiments (LTFE)
LTFE focused on fertilization (n = 124)
LTFE focused on tillage (n = 38)
LTFE grassland (n = 34)
LTFE focused on crop rotation (n = 32)
Climatic water balance [mm]
<-150
-150 - <-50
-50 - <50
50 - <150
150 - <300
300 - <500
>=500
other land use area
10°0'0"E
15°0'0"E

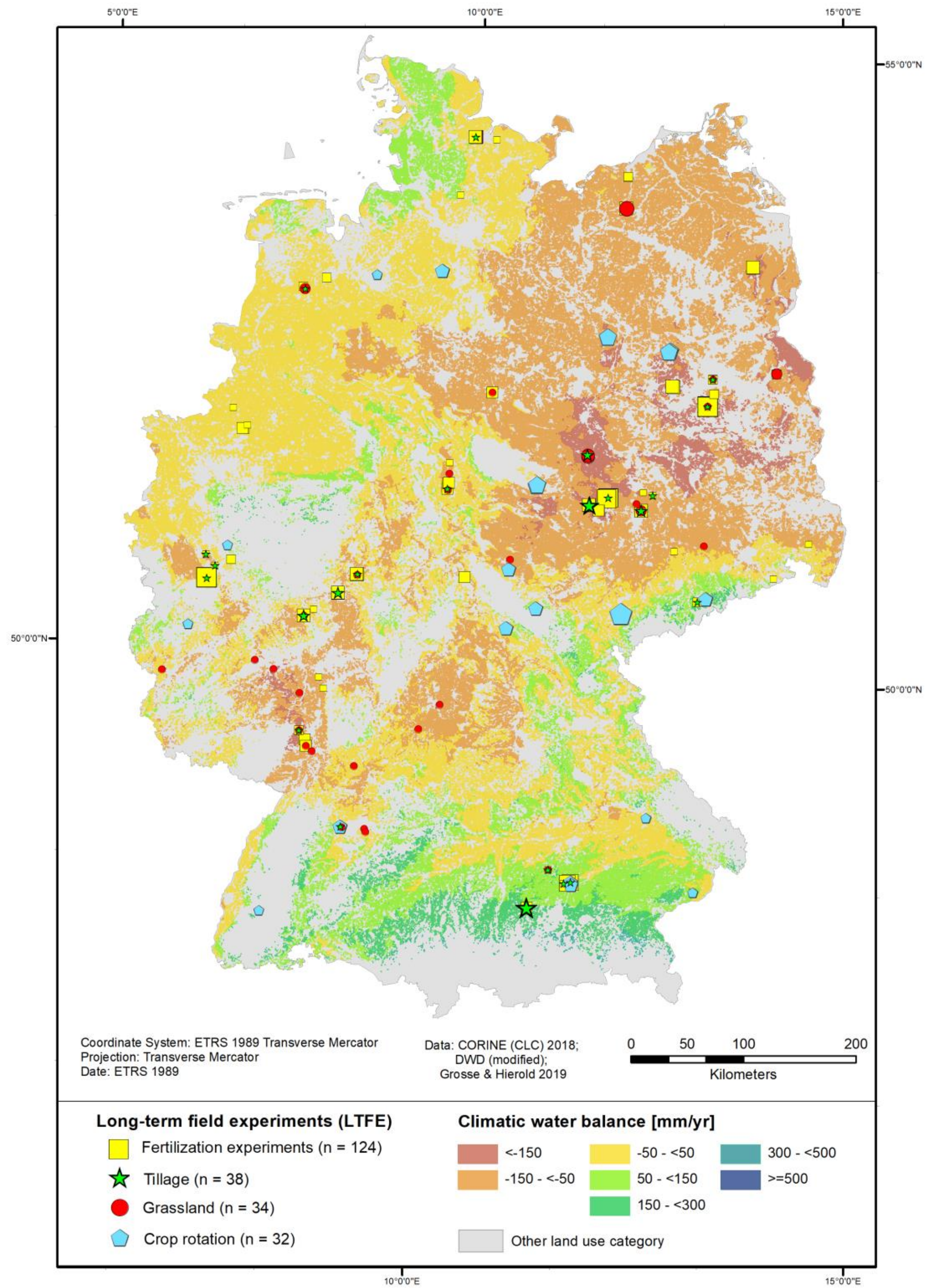
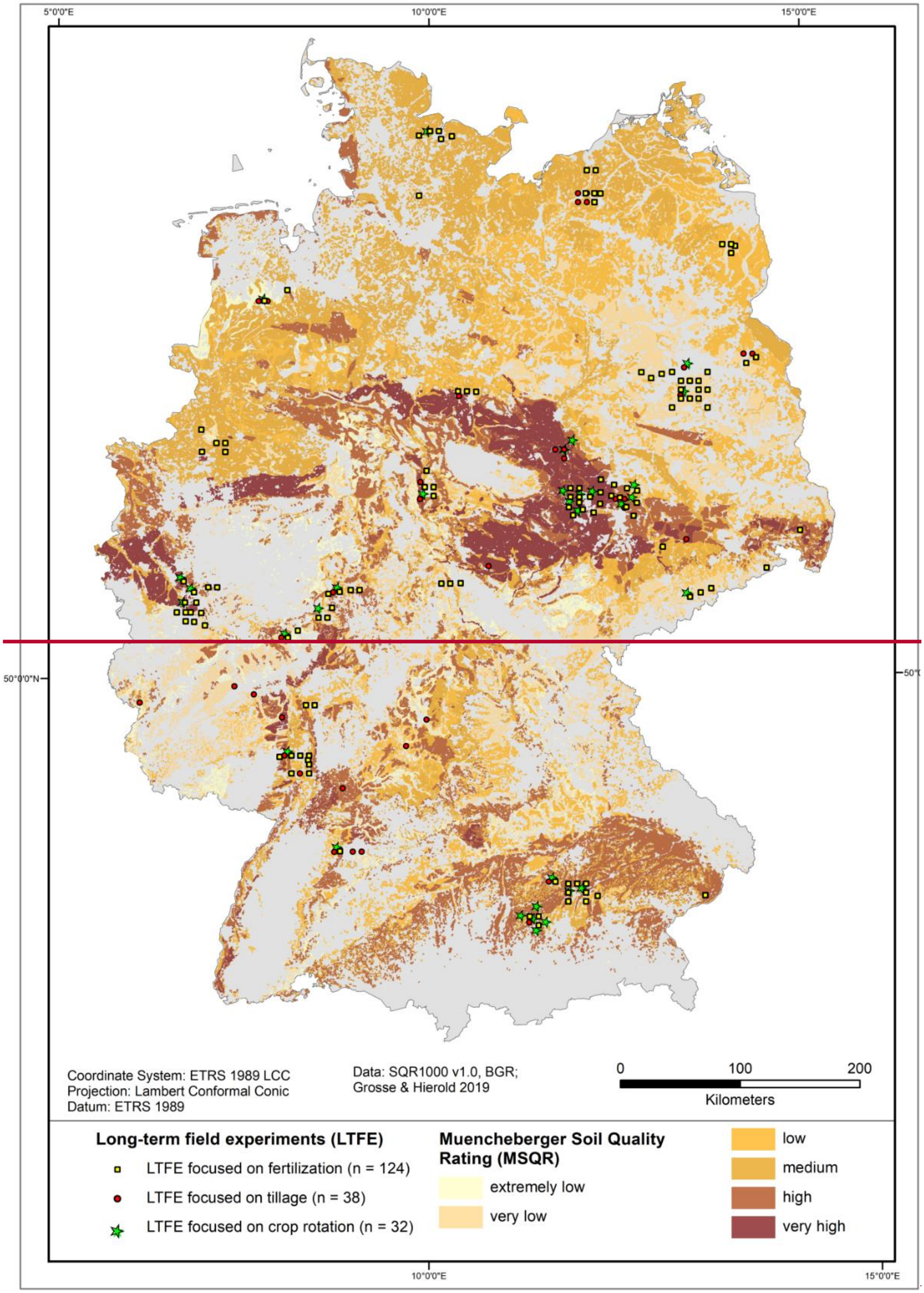

5°0'0"E
10°0'0"E
15°0'0"E
55°0'0"N
50°0'0"N
50°0'0"N
Coordinate System: ETRS 1989 Transverse Mercator
Projection: Transverse Mercator
Date: ETRS 1989
Data: CORINE (CLC) 2018;
DWD (modified);
Grosse & Hierold 2019
0 50 100 200
Kilometers
Long-term field experiments (LTFE)
Fertilization experiments (n = 124)
Tillage (n = 38)
Grassland (n = 34)
Crop rotation (n = 32)
Climatic water balance [mm/yr]
<-150
-150 - <-50
-50 - <50
50 - <150
150 - <300
300 - <500
>=500
Other land use category
10°0'0"E
15°0'0"E

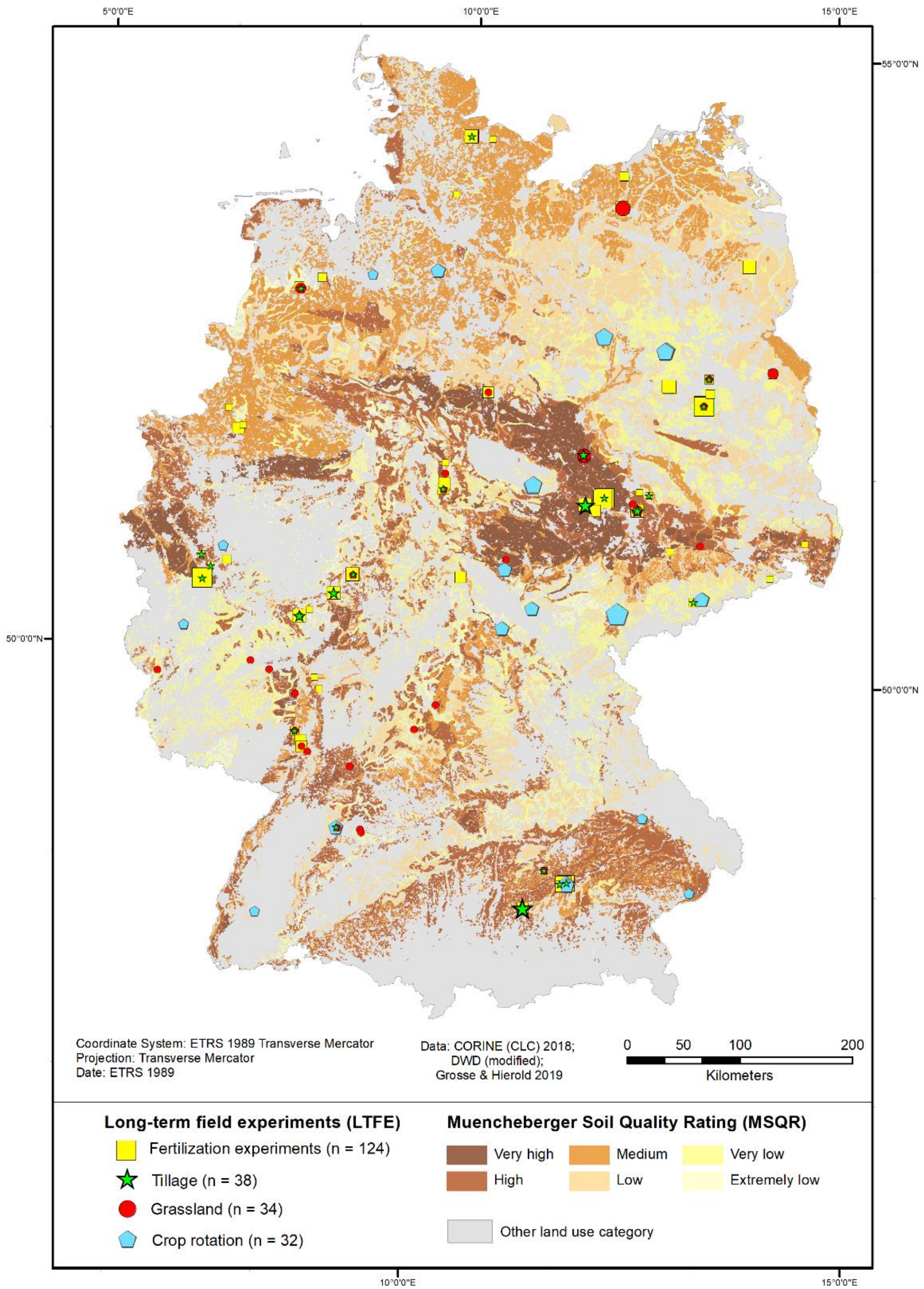
Figure ~~5~~4: Overview of the distribution of the different climatic water balance classes of the growing season and the different LTFE types in Germany. ~~The positions of the LTFEs are dispersed to avoid overlapping~~. The size of the symbols varies according to the amount of LTFEs at one place.

Table 4: Müncheberg~~er~~ Soil Quality Rating (MSQR) classification of arable land in Germany and the number or share of the different LTFE types in each MSQR class.

MSQR	Agricultural area		LTFEs total (arable land) (n=169)		Fertilization LTFEs* (n=123)		Tillage LTFEs* (n=38)		Crop rotation LTFEs* (n=32)	
	area [ha]	share [%]	number	share [%]	number	share [%]	number	share [%]	number	share [%]
extremely low	705 687	6	9	5	5	4	4	11	3	9
very low	2 149 584	17	29	17	22	18	5	13	5	16
low	2 656 535	21	18	11	13	11	3	8	1	3
medium	3 532 109	28	32	19	28	23	6	16	4	13
high	2 182 221	18	45	27	28	23	13	34	11	34
very high	1 181 237	10	36	21	27	22	7	18	8	25

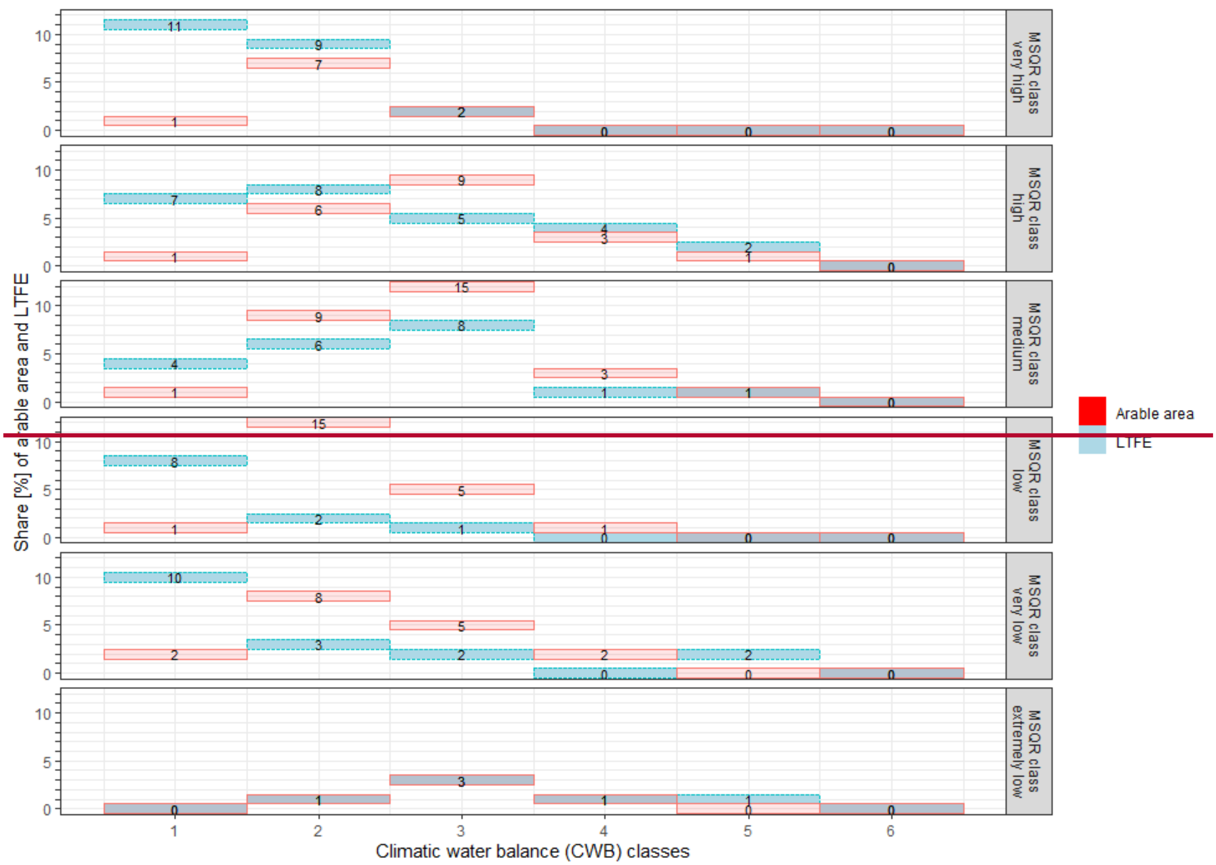
*multiple nominations possible


5°0'0"E
10°0'0"E
15°0'0"E
50°0'0"N
Coordinate System: ETRS 1989 LCC
Projection: Lambert Conformal Conic
Datum: ETRS 1989
Data: SQR1000 v1.0, BGR;
Grosse & Hierold 2019
0
100
200
Kilometers
Long-term field experiments (LTFE)
LTFE focused on fertilization (n = 124)
LTFE focused on tillage (n = 38)
LTFE focused on crop rotation (n = 32)
Muencheberger Soil Quality
Rating (MSQR)
extremely low
very low
low
medium
high
very high
10°0'0"E
15°0'0"E



5°0'0"E
10°0'0"E
15°0'0"E
55°0'0"N
50°0'0"N
Coordinate System: ETRS 1989 Transverse Mercator
Projection: Transverse Mercator
Date: ETRS 1989
Data: CORINE (CLC) 2018;
DWD (modified);
Grosse & Hierold 2019
0 50 100 200
Kilometers
Long-term field experiments (LTFE)
Fertilization experiments (n = 124)
Tillage (n = 38)
Grassland (n = 34)
Crop rotation (n = 32)
Muencheberger Soil Quality Rating (MSQR)
Very high
High
Medium
Low
Very low
Extremely low
Other land use category

Figure ~~6~~5: Overview of the distribution of the different Müncheberg~~er~~ Soil Quality Rating classes and the different LTFE types in Germany. ~~The positions of the LTFE are dispersed to avoid overlapping~~The size of the symbols varies according to the amount of LTFEs at one place.



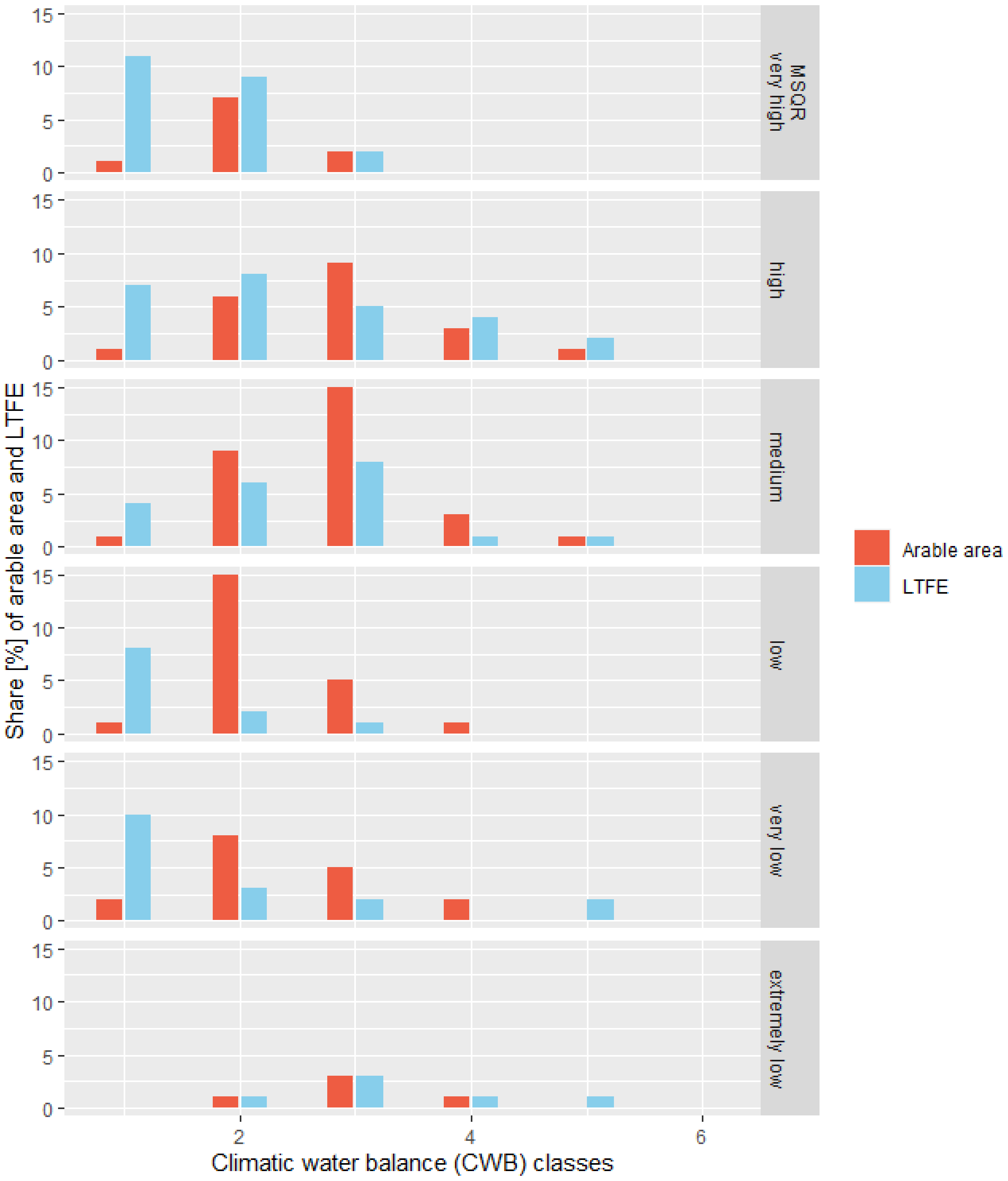

Share [%] of arable area and LTFE
Climatic water balance (CWB) classes
MSQR
very high
high
medium
low
very low
extremely low
Arable area
LTFE
0
5
10
15
2
4
6

Figure ~~7~~6: Share of arable area and ~~long-term field experiments~~LTFEs in every climatic water balance – Müncheberg~~er~~ Soil Quality Rating combination. ~~The numbers in the boxes indicate the percentages.~~

Table 5: Clay content classification according to ESDAC (2020) of arable land in Germany and the number or share of the different LTFE types in each clay content class.

Clay content class	Range [%]	Agricultural area (arable)		LTFEs total (arable land) (n=169)		Fertilization LTFEs* (n=124)		Tillage LTFEs* (n=38)		Crop rotation LTFEs* (n=32)	
		area [ha]	share [%]	number	share [%]	number	share [%]	number	share [%]	number	share [%]
1	0 to 5	1 748 393	14	25	15	19	15	6	16	3	9
2	6 to 10	2 404 798	19	24	14	19	15	6	16	3	9
3	11 to 16	2 265 517	18	29	17	20	16	5	13	4	13
4	17 to 19	1 523 493	12	42	25	37	30	6	16	6	19
5	20 to 21	1 179 602	9	15	9	12	10	2	5	8	25
6	22 to 24	1 553 463	12	20	12	11	9	5	13	6	19
7	25 to 27	1 097 725	9	4	2	1	1	3	8	1	3
8	28 to 98	1 082 066	8	10	6	5	4	5	13	1	3

Table 6: Clay content classification according to ESDAC (2020) of agricultural area used for grassland in Germany and the number or share of the LTFEs on grassland in each clay content class.

Clay content class	Range [%]	Agricultural area (grassland)		Grassland LTFEs (n=34)	
		area [ha]	share [%]	number	share [%]
1	0 to 5	715 137	11	3	9
2	6 to 10	941 166	15	5	15
3	11 to 16	952 126	15	0	0
4	17 to 19	821 432	13	4	12
5	20 to 21	710 826	11	6	18
6	22 to 24	978 366	15	5	15
7	25 to 27	651 066	10	8	24
8	28 to 98	639 561	10	3	9

Appendix

Table A 1: IDs of all long-term field experiments, their original name, their ~~holding institution~~place, their CWBg class (1 May to 31 October), their MSQR class, and their thematic classification. The institutional address is indicated by a number and given below the table. More details about the LTFEs can be found in the complete dataset (Grosse & Hierold, 2019).

~~ID~~	~~LTFE Name~~	~~Institution~~	~~CWB Class~~	~~MSQR Class~~	~~Thematic Classification~~
	~~Fieldcrops LTFE~~				
~~1~~	~~Bodenbearbeitungsversuch Dichtelbach~~	~~Landwirtschaftskammer Rheinland-Pfalz~~	~~3~~	~~very low~~	~~Tillage~~
~~2~~	~~Bodenbearbeitungsversuch Welschbillig~~	~~Landwirtschaftskammer Rheinland-Pfalz~~	~~3~~	~~very low~~	~~Tillage~~
~~3~~	~~Bodenbearbeitungsversuch Wintersheim~~	~~Landwirtschaftskammer Rheinland-Pfalz~~	~~1~~	~~very high~~	~~Tillage~~
~~4~~	~~Statischer Duengungsversuch V120~~	~~Helmholtz-Zentrum fuer Umweltforschung (UFZ), Leipzig~~	~~1~~	~~very high~~	~~Fertilization~~
~~5~~	~~Erweiterter Statischer Duengungsversuch V120a~~	~~Helmholtz-Zentrum fuer Umweltforschung (UFZ), Leipzig~~	~~1~~	~~very high~~	~~Fertilization~~
~~6~~	~~Modellversuch Stalldungsteigerung~~	~~Helmholtz-Zentrum fuer Umweltforschung (UFZ), Leipzig~~	~~1~~	~~very high~~	~~Fertilization~~
~~7~~	~~Bracheversuch V505a~~	~~Helmholtz-Zentrum fuer Umweltforschung (UFZ), Leipzig~~	~~1~~	~~very high~~	~~Other~~
~~8~~	~~Statischer Stickstoffduengungsversuch~~	~~Thueringer Landesamt fuer Landwirtschaft und Laendlichen Raum (TLLLR)~~	~~2~~	~~very low~~	~~Fertilization~~
~~9~~	~~Statischer Kalkduengungsversuch (M16)~~	~~Thueringer Landesamt fuer Landwirtschaft und Laendlichen Raum (TLLLR)~~	~~2~~	~~very low~~	~~Fertilization~~
~~11~~	~~Dauerduengungsversuch L28~~	~~Thueringer Landesamt fuer Landwirtschaft und Laendlichen Raum (TLLLR)~~	~~2~~	~~very low~~	~~Fertilization~~
~~13~~	~~Statischer Dauerversuch Bodennutzung (BDa_D3)~~	~~Humboldt-Universitaet zu Berlin~~	~~1~~	~~very low~~	~~Fertilization/Tillage/Crop rotation~~
~~14~~	~~Internationaler Organischer-Stickstoff-Dauerduengungsversuch (BDa_IOSDV)~~	~~Humboldt-Universitaet zu Berlin~~	~~1~~	~~very low~~	~~Fertilization~~
~~15~~	~~Agrarmeteorologisches Intensivmessfeld (BDa_E-Feld)~~	~~Humboldt-Universitaet zu Berlin~~	~~1~~	~~very low~~	~~Other~~
~~16~~	~~Bodenbearbeitungsversuch (Versuchsfeld Westerfeld)~~	~~Hochschule Anhalt, Bernburg-Strenzfeld~~	~~1~~	~~very high~~	~~Tillage~~
~~17~~	~~Anbausysteme-Vergleich~~	~~Landesanstalt fuer Landwirtschaft und Gartenbau Sachsen-Anhalt (LLG)~~	~~1~~	~~very high~~	~~Crop rotation/Other~~
~~18~~	~~Grundbodenbearbeitung und Distelbekaempfung, oekologisch viehlos~~	~~Landesanstalt fuer Landwirtschaft und Gartenbau Sachsen-Anhalt (LLG)~~	~~1~~	~~very high~~	~~Tillage/Crop rotation/Other~~

~~19~~	~~Bodenbearbeitung und Bestelltechnik in der Fruchtfolge~~	~~Landesanstalt fuer Landwirtschaft und Gartenbau Sachsen-Anhalt (LLG)~~	~~1~~	~~very high~~	~~Tillage/Other~~
~~20~~	~~Dauerduengungsversuch Dikopshof~~	~~Rheinische Friedrich-Wilhelms-Universitaet Bonn~~	~~2~~	~~very high~~	~~Fertilization/Crop rotation~~
~~21~~	~~Selektions-Dauerversuch SDV~~	~~Rheinische Friedrich-Wilhelms-Universitaet Bonn~~	~~3~~	~~very high~~	~~Crop rotation~~
~~22~~	~~Strohduengung zu Getreide~~	~~Rheinische Friedrich-Wilhelms-Universitaet Bonn~~	~~2~~	~~very high~~	~~Fertilization~~
~~23~~	~~Phosphatformenversuch~~	~~Rheinische Friedrich-Wilhelms-Universitaet Bonn~~	~~2~~	~~very high~~	~~Fertilization~~
~~24~~	~~Organische Duengung~~	~~Rheinische Friedrich-Wilhelms-Universitaet Bonn~~	~~2~~	~~very high~~	~~Fertilization~~
~~25~~	~~Strohduengung mit Faulschlamm~~	~~Rheinische Friedrich-Wilhelms-Universitaet Bonn~~	~~2~~	~~very high~~	~~Fertilization~~
~~26~~	~~Kaliformenversuch~~	~~Rheinische Friedrich-Wilhelms-Universitaet Bonn~~	~~2~~	~~very high~~	~~Fertilization~~
~~27~~	~~Strohduengung mit verschiedenen N-Formen~~	~~Rheinische Friedrich-Wilhelms-Universitaet Bonn~~	~~2~~	~~very high~~	~~Fertilization~~
~~28~~	~~Phosphatvorratsduengung~~	~~Rheinische Friedrich-Wilhelms-Universitaet Bonn~~	~~2~~	~~very high~~	~~Fertilization~~
~~29~~	~~Kalkversuch mit Spurenelementen~~	~~Rheinische Friedrich-Wilhelms-Universitaet Bonn~~	~~2~~	~~very high~~	~~Fertilization~~
~~30~~	~~Versuch mit Faulschlaemmen~~	~~Rheinische Friedrich-Wilhelms-Universitaet Bonn~~	~~2~~	~~very high~~	~~Fertilization~~
~~31~~	~~Dauerduengungsversuch~~	~~Rheinische Friedrich-Wilhelms-Universitaet Bonn~~	~~2~~	~~high~~	~~Fertilization/Crop rotation~~
~~33~~	~~Langzeit Duengungsversuch (FV4)~~	~~Julius Kuehn Institut, Braunschweig~~	~~2~~	~~very high~~	~~Fertilization/Tillage~~
~~34~~	~~C-Dauerfeldversuch (FV36)~~	~~Julius Kuehn Institut, Braunschweig~~	~~2~~	~~very high~~	~~Fertilization~~
~~35~~	~~Suedfeld-Duengungsversuch~~	~~Julius Kuehn Institut, Braunschweig~~	~~2~~	~~very high~~	~~Fertilization~~
~~36~~	~~Folgenabschaetzung der Wechselwirkung von Fruchtfolge, Duengung und Pflanzenschutz~~	~~Julius Kuehn Institut Dahnsdorf~~	~~1~~	~~high~~	~~Other~~
~~37~~	~~Langzeit-Duengungsversuch~~	~~Forschungsring fuer Biologisch-Dynamische Wirtschaftsweise e.V., Darmstadt~~	~~2~~	~~low~~	~~Fertilization~~
~~38~~	~~Klassischer DFV (4b2, organische und mineralische Duengung)~~	~~YARA GmbH & Co. KG, Duelmen~~	~~3~~	~~medium~~	~~Fertilization~~
~~39~~	~~Dauerduengungsversuch IOSDV~~	~~YARA GmbH & Co. KG, Duelmen~~	~~3~~	~~medium~~	~~Fertilization~~
~~40~~	~~Zuckerruebenfruchtfolgeversuch~~	~~Martin-Luther-Universitaet Halle~~	~~1~~	~~very high~~	~~Fertilization/Crop rotation/Other~~
~~41~~	~~Dauerduengungsversuch (Zuckerruebenmonokultur)~~	~~Martin-Luther-Universitaet Halle~~	~~1~~	~~very high~~	~~Fertilization/Crop rotation~~
~~42~~	~~Dauerduengungsversuch Getreide~~	~~Martin-Luther-Universitaet Halle~~	~~1~~	~~very high~~	~~Fertilization/Crop rotation~~
~~4~~	~~Dauerduengungsversuch Getreide~~	~~Martin-Luther-Universitaet Halle~~	~~1~~	~~very~~	~~Fertilization/Cr~~

~~3~~				~~high~~	~~op rotation~~
~~44~~	~~N-Formen-Versuch~~	~~Technische Universitaet Muenchen~~	~~4~~	~~high~~	~~Fertilization/Crop rotation~~
~~45~~	~~P-Duengung~~	~~Technische Universitaet Muenchen~~	~~4~~	~~high~~	~~Fertilization~~
~~47~~	~~Stroh/Stalldung-Fruchtfolge~~	~~Technische Universitaet Muenchen~~	~~4~~	~~high~~	~~Fertilization~~
~~48~~	~~N-Duengung/Fruchtfolge~~	~~Technische Universitaet Muenchen~~	~~4~~	~~high~~	~~Fertilization~~
~~49~~	~~N-Steigerung mit Kalkstickstoff~~	~~Technische Universitaet Muenchen~~	~~4~~	~~high~~	~~Fertilization~~
~~50~~	~~Versuch 020 N-Formen-Versuch~~	~~Technische Universitaet Muenchen~~	~~3~~	~~high~~	~~Fertilization~~
~~51~~	~~Bodenbearbeitungsversuch Suedzucker~~	~~Institut fuer Zuckerruebenforschung Goettingen~~	~~2~~	~~very high~~	~~Tillage~~
~~52~~	~~Erschoepfungsversuch (EV)~~	~~Justus-Liebig-Universitaet Gießen~~	~~2~~	~~low~~	~~Fertilization~~
~~53~~	~~Kalkduengungsversuch~~	~~Justus-Liebig-Universitaet Gießen~~	~~2~~	~~high~~	~~Fertilization~~
~~54~~	~~Dauerversuch Biologische Stickstofffixierung (BSG)~~	~~Justus-Liebig-Universitaet Gießen~~	~~2~~	~~high~~	~~Fertilization/Crop rotation~~
~~55~~	~~Oekologischer Ackerbauversuch Gladbacherhof~~	~~Justus-Liebig-Universitaet Gießen~~	~~2~~	~~extremely low~~	~~Fertilization/Tillage/Crop rotation~~
~~56~~	~~Bodenbearbeitungsversuch Hohes Feld~~	~~Georg-August-Universitaet Goettingen~~	~~3~~	~~high~~	~~Tillage~~
~~57~~	~~Garte-Sued-Bodenbearbeitung (Reinshof)~~	~~Georg-August-Universitaet Goettingen~~	~~2~~	~~very high~~	~~Tillage~~
~~58~~	~~Garte-Nord-Bodenbearbeitung (Reinshof)~~	~~Georg-August-Universitaet Goettingen~~	~~2~~	~~high~~	~~Crop rotation~~
~~59~~	~~Langzeitversuch zur P- und K-Duengung auf dem Reinshof~~	~~Georg-August-Universitaet Goettingen~~	~~2~~	~~high~~	~~Fertilization~~
~~60~~	~~Bodenbearbeitungsversuch Suedzucker~~	~~Institut fuer Zuckerruebenforschung Goettingen~~	~~3~~	~~high~~	~~Tillage~~
~~61~~	~~Kastenparzellenversuch Sandboden / Lehmboden / Tonboden~~	~~Leibniz-Institut fuer Gemuese- und Zierpflanzenbau, Großbeeren~~	~~1~~		~~Fertilization~~
~~62~~	~~PK-Mangelversuch~~	~~Justus-Liebig-Universitaet Gießen~~	~~1~~	~~very low~~	~~Fertilization~~
~~63~~	~~Dauerfeldversuch P60~~	~~Landesamt fuer Laendliche Entwicklung, Landwirtschaft und Flurneuordnung, Brandenburg~~	~~1~~	~~low~~	~~Fertilization~~
~~64~~	~~Dauerfeldversuch M4~~	~~Landesamt fuer Laendliche Entwicklung, Landwirtschaft und Flurneuordnung, Brandenburg~~	~~1~~	~~very low~~	~~Fertilization~~
~~65~~	~~Versuchsfeld der Versuchsstation Groß Luesewitz~~	~~Julius Kuehn Institut, Groß Luesewitz~~	~~2~~	~~very low~~	~~Other~~
~~66~~	~~Ewiger Roggen~~	~~Martin-Luther-Universitaet Halle~~	~~1~~	~~medium~~	~~Fertilization/Crop rotation~~
~~67~~	~~Schmalfuss'scher Dauerversuch, Feld A, Kalkduengung~~	~~Martin-Luther-Universitaet Halle~~	~~1~~	~~very high~~	~~Fertilization~~

~~68~~	~~Schmalfuss'scher Dauerversuch, Feld C, Kaliumduengung~~	~~Martin-Luther-Universitaet Halle~~	~~1~~	~~very high~~	~~Fertilization~~
~~69~~	~~Schmalfuss'scher Dauerversuch, Feld D, Phosphorduengung~~	~~Martin-Luther-Universitaet Halle~~	~~1~~	~~very high~~	~~Fertilization~~
~~70~~	~~Organische Duengung (Feld F)~~	~~Martin-Luther-Universitaet Halle~~	~~1~~	~~very high~~	~~Fertilization~~
~~71~~	~~Dauerfeldversuch "Bodenfruchtbarkeit"~~	~~Rheinische Friedrich-Wilhelms-Universitaet Bonn~~	~~3~~	~~very high~~	~~Fertilization~~
~~72~~	~~Dauerversuch Duengung-Fruchtfolge~~	~~Universitaet Hohenheim~~	~~4~~	~~medium~~	~~Fertilization/Crop rotation~~
~~73~~	~~Versuch zur Bodenbearbeitung~~	~~Universitaet Hohenheim~~	~~3~~	~~low~~	~~Tillage~~
~~74~~	~~Dauerduengungsversuch~~	~~Christian-Albrechts-Universitaet Kiel~~	~~3~~	~~high~~	~~Fertilization~~
~~75~~	~~Stickstoffversuch "Decline-Versuch"~~	~~Christian-Albrechts-Universitaet Kiel~~	~~3~~	~~medium~~	~~Fertilization~~
~~76~~	~~Fruchtfolgeversuch~~	~~Christian-Albrechts-Universitaet Kiel~~	~~3~~	~~medium~~	~~Fertilization/Crop rotation~~
~~77~~	~~N-Duengung zu Wintergerste~~	~~Christian-Albrechts-Universitaet Kiel~~	~~3~~	~~medium~~	~~Fertilization~~
~~78~~	~~Duengerartenvergleich (Versuch I)~~	~~Martin-Luther-Universitaet Halle~~	~~5~~	~~medium~~	~~Fertilization/Crop rotation~~
~~79~~	~~Kombinationswirkung (Versuch II)~~	~~Martin-Luther-Universitaet Halle~~	~~5~~	~~very low~~	~~Fertilization~~
~~80~~	~~Naehrstoffverhaeltnisversuch~~	~~Landwirtschaftliche Versuchsstation der BASF AG~~	~~1~~	~~very low~~	~~Fertilization~~
~~81~~	~~Feldwirtschaftsversuch~~	~~Landwirtschaftliche Versuchsstation der BASF AG~~	~~1~~	~~low~~	~~Fertilization~~
~~82~~	~~Naehrstoffmangelversuch~~	~~Landwirtschaftliche Versuchsstation der BASF AG~~	~~1~~	~~low~~	~~Fertilization~~
~~83~~	~~WW-Fruchtfolgeversuch~~	~~Landwirtschaftliche Versuchsstation der BASF AG~~	~~1~~	~~low~~	~~Fertilization/Crop rotation/Other~~
~~84~~	~~Bodenbearbeitungsversuch~~	~~Landwirtschaftliche Versuchsstation der BASF AG~~	~~1~~	~~high~~	~~Fertilization/Tillage~~
~~85~~	~~Bodenbearbeitungsversuch~~	~~Institut fuer Zuckerruebenforschung Goettingen~~	~~2~~	~~high~~	~~Tillage~~
~~86~~	~~Dauerduengungsversuch L28~~	~~Saechsisches Landesamt f. Umwelt, Landwirtschaft u. Geologie (LfULG)~~	~~3~~	~~high~~	~~Fertilization~~
~~87~~	~~Dauerduengungsversuch (V140)~~	~~Leibniz-Zentrum f. Agrarlandschaftsforschung (ZALF) e.V.~~	~~1~~	~~low~~	~~Fertilization~~
~~88~~	~~Bodenbearbeitung (V760)~~	~~Leibniz-Zentrum f. Agrarlandschaftsforschung (ZALF) e.V.~~	~~1~~	~~low~~	~~Tillage~~
~~89~~	~~Modellbetrieb Organischer Landbau, Felder 931 - 934~~	~~Leibniz-Zentrum f. Agrarlandschaftsforschung (ZALF) e.V.~~	~~1~~	~~low~~	~~Other~~
~~90~~	~~Kalium-Steigerungsversuch Hoeckelheim/Suedniedersachsen~~	~~Versuchsring Suedhannover, Landwirtschaftskammer Hannover~~	~~2~~	~~low~~	~~Fertilization~~
~~91~~	~~P-Duengung auf Sandmischkultur~~	~~Landwirtschaftskammer Niedersachsen~~	~~3~~	~~medium~~	~~Fertilization~~
~~9~~	~~Bodenbearbeitung/Fruchtfolge~~	~~Georg-August-Universitaet Goettingen~~	~~3~~	~~extrem~~	~~Tillage/Crop~~

~~2~~				~~ely low~~	~~rotation~~
~~93~~	~~Bodenbearbeitung~~	~~Georg-August-Universitaet Goettingen~~	~~3~~	~~extremely low~~	~~Tillage~~
~~94~~	~~Internationaler Organischer Stickstoffduengungs-Versuch (IOSDV)~~	~~unbekannt~~	~~3~~	~~extremely low~~	~~Fertilization~~
~~96~~	~~Dauerversuch 'Auswirkung von Daueranbau'~~	~~Bayerische Landesanstalt fuer Landwirtschaft (LfL)~~	~~5~~	~~extremely low~~	~~Crop rotation~~
~~97~~	~~Verbesserte Dreifelderwirtschaft~~	~~Bayerische Landesanstalt fuer Landwirtschaft (LfL)~~	~~5~~	~~high~~	~~Crop rotation~~
~~98~~	~~Getreide/Mais Fruchtfolge~~	~~Bayerische Landesanstalt fuer Landwirtschaft (LfL)~~	~~5~~	~~high~~	~~Crop rotation~~
~~99~~	~~Einfluss von Grundbodenbearbeitung~~	~~Bayerische Landesanstalt fuer Landwirtschaft (LfL)~~	~~5~~	~~high~~	~~Tillage~~
~~100~~	~~Internationaler Organischer Stickstoffduengungs-Versuch (IOSDV)~~	~~Bayerische Landesanstalt fuer Landwirtschaft (LfL)~~	~~5~~	~~high~~	~~Fertilization~~
~~101~~	~~Internationaler Organischer Stickstoffduengungs-Versuch (IOSDV)~~	~~Justus-Liebig-Universitaet Gießen~~	~~2~~	~~high~~	~~Fertilization~~
~~102~~	~~Organische Duengung / Stalldung Schafpferchversuch~~	~~Justus-Liebig-Universitaet Gießen~~	~~2~~	~~high~~	~~Fertilization~~
~~103~~	~~Gruenduengung / Strohduengungsversuch~~	~~Justus-Liebig-Universitaet Gießen~~	~~2~~	~~high~~	~~Fertilization~~
~~104~~	~~Bilanzversuch Kastenanlage~~	~~Justus-Liebig-Universitaet Gießen~~	~~2~~	~~high~~	~~Fertilization~~
~~105~~	~~Wirkungen differenzierter Bodenbearbeitungssysteme im Dauerversuch Scheyern~~	~~Technische Universitaet Muenchen~~	~~4~~	~~high~~	~~Fertilization/Tillage/Crop rotation~~
~~106~~	~~Fruchtfolgeduengungsversuch~~	~~Martin-Luther-Universitaet Halle~~	~~1~~	~~high~~	~~Fertilization/Crop rotation~~
~~107~~	~~Konzentrationsversuch~~	~~Martin-Luther-Universitaet Halle~~	~~1~~	~~high~~	~~Crop rotation~~
~~108~~	~~Duengungs-Kombinationsversuch Seehausen (F1-70)~~	~~Martin-Luther-Universitaet Halle~~	~~1~~	~~high~~	~~Fertilization~~
~~109~~	~~Bodenbearbeitungsversuch~~	~~Martin-Luther-Universitaet Halle~~	~~1~~	~~high~~	~~Tillage~~
~~110~~	~~Guelledauerversuch~~	~~Martin-Luther-Universitaet Halle~~	~~1~~	~~high~~	~~Fertilization~~

~~111~~	~~Bodenfruchtbarkeitsversuch~~	~~Martin-Luther-Universitaet Halle~~	~~1~~	~~high~~	~~Fertilization/Tillage~~
~~112~~	~~Internationaler Organischer Stickstoffduengungs-Versuch (IOSDV)~~	~~Landwirtschaftliche Untersuchungs- und Forschungsanstalt Speyer~~	~~2~~	~~high~~	~~Fertilization/Tillage~~
~~113~~	~~Humusversuch~~	~~Landwirtschaftliche Untersuchungs- und Forschungsanstalt Speyer~~	~~2~~	~~medium~~	~~Fertilization/Other~~
~~114~~	~~Kali-Magnesium-Kalk-Versuch~~	~~Landwirtschaftliche Untersuchungs- und Forschungsanstalt Speyer~~	~~2~~	~~medium~~	~~Fertilization~~
~~115~~	~~Klaerschlammversuch~~	~~Landwirtschaftliche Untersuchungs- und Forschungsanstalt Speyer~~	~~2~~	~~medium~~	~~Other~~
~~116~~	~~Bracheversuch~~	~~Landwirtschaftliche Untersuchungs- und Forschungsanstalt Speyer~~	~~2~~	~~medium~~	~~Other~~
~~117~~	~~Dauerduengungsversuch L28~~	~~Saechsisches Landesamt f. Umwelt, Landwirtschaft u. Geologie (LfULG)~~	~~1~~	~~medium~~	~~Fertilization~~
~~119~~	~~Duengungs- und Beregnungsversuch (Thy_D1)~~	~~Humboldt-Universitaet zu Berlin~~	~~1~~	~~high~~	~~Fertilization/Other~~
~~120~~	~~Stroh- und N-Duengung in Fruchtfolgen mit unterschiedlichem Getreideanteil (Thy_D5)~~	~~Humboldt-Universitaet zu Berlin~~	~~1~~	~~very low~~	~~Fertilization/Crop rotation~~
~~121~~	~~Statischer Naehrstoffmangelversuch (Thy_D41)~~	~~Humboldt-Universitaet zu Berlin~~	~~1~~	~~very low~~	~~Fertilization~~
~~122~~	~~Naehrstoffmangelversuch Winterroggen Monokultur (Thy_D42)~~	~~Humboldt-Universitaet zu Berlin~~	~~1~~	~~very low~~	~~Fertilization~~
~~123~~	~~Statischer Bodenfruchtbarkeitsversuch (Thy_D6)~~	~~Humboldt-Universitaet zu Berlin~~	~~1~~	~~very low~~	~~Fertilization~~
~~125~~	~~Strohduengungsversuch (Thy_D2)~~	~~Humboldt-Universitaet zu Berlin~~	~~1~~	~~very low~~	~~Fertilization~~
~~136~~	~~Modellbetrieb Organischer Landbau, Felder 901 - 904~~	~~Leibniz-Zentrum f. Agrarlandschaftsforschung (ZALF) e.V., Muencheberg~~	~~1~~	~~very low~~	~~Other~~
~~137~~	~~Statischer Dauerfeldversuch ""organisch-mineralische N-Duengung""~~	~~Leibniz-Institut fuer Gemuese- und Zierpflanzenbau, Großbeeren~~	~~1~~		~~Fertilization~~
~~138~~	~~Versuch zur Bodenbearbeitung~~	~~Universitaet Hohenheim~~	~~3~~	~~low~~	~~Tillage~~
~~13~~	~~Gehoelzhaeckselapplikation~~	~~Universitaet Hohenheim~~	~~3~~	~~very low~~	~~Other~~

~~9~~					
~~140~~	~~Versuch 700 (Reduzierte Bodenbearbeitung)~~	~~Universitaet Hohenheim~~	~~3~~	~~extremely low~~	~~Tillage~~
~~142~~	~~Effiziente Naehrstoffverwertung, K-Eichversuche~~	~~Saechsisches Landesamt f. Umwelt, Landwirtschaft u. Geologie (LfULG)~~	~~2~~	~~extremely low~~	~~Fertilization~~
~~143~~	~~Effiziente Naehrstoffverwertung, K-Eichversuche~~	~~Saechsisches Landesamt f. Umwelt, Landwirtschaft u. Geologie (LfULG)~~	~~4~~	~~extremely low~~	~~Fertilization~~
~~144~~	~~Referenzflaeche~~	~~Rheinische Friedrich-Wilhelms-Universitaet Bonn~~	~~3~~	~~medium~~	~~Fertilization~~
~~146~~	~~Statischer Versuch Bodennutzung (Thy_D3/1)~~	~~Humboldt-Universitaet zu Berlin~~	~~1~~	~~very low~~	~~Fertilization/Tillage~~
~~147~~	~~Statischer Dauerfeldversuch Organische Duengung und Humusreproduktion (Thy_D3/2)~~	~~Humboldt-Universitaet zu Berlin~~	~~1~~	~~medium~~	~~Fertilization~~
~~148~~	~~Statischer N-Duengungsversuch in Winterroggen-Monokultur (Thy_D7)~~	~~Humboldt-Universitaet zu Berlin~~	~~1~~	~~very low~~	~~Fertilization~~
~~149~~	~~Alte dreifeldrige Fruchtfolge~~	~~Bayerische Landesanstalt fuer Landwirtschaft (LfL)~~	~~5~~	~~very low~~	~~Fertilization/Crop rotation~~
~~150~~	~~Fruchtfolgen im oekologischen Landbau~~	~~Bayerische Landesanstalt fuer Landwirtschaft (LfL)~~	~~5~~	~~very low~~	~~Fertilization/Crop rotation~~
~~151~~	~~Fruchtfolgen im oekologischen Landbau~~	~~Bayerische Landesanstalt fuer Landwirtschaft (LfL)~~	~~4~~	~~high~~	~~Fertilization/Crop rotation~~
~~152~~	~~Fruchtfolgeversuch (FF)~~	~~Justus-Liebig-Universitaet Gießen~~	~~2~~	~~high~~	~~Crop rotation~~
~~153~~	~~Bodenbearbeitungs-Versuch (BB)~~	~~Justus-Liebig-Universitaet Gießen~~	~~3~~	~~high~~	~~Tillage~~
~~154~~	~~Bodenbearbeitungsversuch Suedzucker~~	~~Institut fuer Zuckerruebenforschung Goettingen~~	~~1~~	~~high~~	~~Tillage~~
~~155~~	~~Bodenbearbeitungsversuch Suedzucker~~	~~Institut fuer Zuckerruebenforschung Goettingen~~	~~2~~	~~high~~	~~Tillage~~
~~156~~	~~Bodenbearbeitungsversuch Suedzucker~~	~~Institut fuer Zuckerruebenforschung Goettingen~~	~~3~~	~~high~~	~~Tillage~~
~~157~~	~~Bodenbearbeitungsversuch Suedzucker~~	~~Institut fuer Zuckerruebenforschung Goettingen~~	~~2~~	~~medium~~	~~Tillage~~
~~1~~	~~Strategievergleich umweltschonender~~	~~Julius Kuehn Institut Dahnsdorf~~	~~1~~	~~low~~	~~Other~~

~~58~~	~~Pflanzenschutz (BS1)~~				
~~159~~	~~Oekologischer Landbau (oeko1)~~	~~Julius Kuehn Institut Dahnsdorf~~	~~1~~	~~high~~	~~Other~~
~~160~~	~~Strategien zur Minderung der Anwendung chemischer Pflanzenschutzmittel (BS4)~~	~~Julius Kuehn Institut Dahnsdorf~~	~~1~~	~~high~~	~~Other~~
~~161~~	~~Kalk-Duengungsversuch~~	~~FEhS-Institut fuer Baustoff-Forschung e.V.~~	~~3~~	~~high~~	~~Fertilization~~
~~162~~	~~Phosphorduengungsstrategien~~	~~Universitaet Rostock~~	~~2~~	~~high~~	~~Fertilization~~
~~165~~	~~Koernermais Daueranbau~~	~~Hoehere Landbauschule Rotthalmuenster~~	~~3~~	~~extremely low~~	~~Fertilization~~
~~166~~	~~Winterweizen Daueranbau~~	~~Hoehere Landbauschule Rotthalmuenster~~	~~3~~	~~medium~~	~~Other~~
~~167~~	~~E-Feld (bis 1957)~~	~~Georg-August-Universitaet Goettingen~~	~~3~~	~~medium~~	~~Fertilization~~
~~193~~	~~Dauerfeldversuch (DE-1b-F-1, Am Kotten)~~	~~YARA GmbH & Co. KG, Duelmen~~	~~3~~	~~medium~~	~~Fertilization~~
~~194~~	~~Dauerfeldversuch (DE-1b-F-2, Am Hof)~~	~~YARA GmbH & Co. KG, Duelmen~~	~~3~~	~~no data~~	~~Fertilization~~
~~195~~	~~Dauerfeldversuch (DE-1b-F-3, IPU Schlag 9)~~	~~YARA GmbH & Co. KG, Duelmen~~	~~3~~	~~medium~~	~~Fertilization~~
~~197~~	~~Feldmodellversuch ""Krumenaufbau""~~	~~Leibniz Zentrum f. Agrarlandschaftsforschung (ZALF) e.V., Muencheberg~~	~~1~~	~~medium~~	~~Fertilization/Tillage~~
~~203~~	~~Kalkformenversuch~~	~~SKW Stickstoffwerke Piesteritz~~	~~3~~	~~medium~~	~~Fertilization~~
~~205~~	~~Dauerduengungsversuch (M70)~~	~~Landesamt fuer Laendliche Entwicklung, Landwirtschaft und Flurneuordnung, Brandenburg~~	~~1~~	~~low~~	~~Fertilization~~
~~206~~	~~Getreidedauerversuch~~	~~Martin-Luther-Universitaet Halle~~	~~1~~	~~very low~~	~~Fertilization/Crop rotation/Other~~
~~207~~	~~Stroh-Stallmistversuch~~	~~Christian-Albrechts-Universitaet Kiel~~	~~3~~	~~very low~~	~~Fertilization~~
~~208~~	~~Phosphor-Steigerungsversuch~~	~~Christian-Albrechts-Universitaet Kiel~~	~~2~~	~~very low~~	~~Fertilization~~

~~209~~	~~Fruchtfolgeversuch Bodenbearbeitung/organische Duengung Winterraps (FF 1.1)~~	~~Landesforschungsanstalt fuer Landwirtschaft und Fischerei Mecklenburg-Vorpommern~~	~~2~~	~~medium~~	~~Fertilization/Tillage~~
~~210~~	~~Fruchtfolgeversuch Bodenbearbeitung/organische Duengung Sommerweizen (FF 1.2)~~	~~Landesforschungsanstalt fuer Landwirtschaft und Fischerei Mecklenburg-Vorpommern~~	~~2~~	~~medium~~	~~Fertilization/Tillage~~
~~211~~	~~Fruchtfolgeversuch Bodenbearbeitung/organische Duengung Winterweizen (FF 2.1)~~	~~Landesforschungsanstalt fuer Landwirtschaft und Fischerei Mecklenburg-Vorpommern~~	~~2~~	~~medium~~	~~Fertilization/Tillage~~
~~212~~	~~Fruchtfolgeversuch Bodenbearbeitung/organische Duengung Silomais (FF 2.2)~~	~~Landesforschungsanstalt fuer Landwirtschaft und Fischerei Mecklenburg-Vorpommern~~	~~2~~	~~medium~~	~~Fertilization/Tillage~~
~~213~~	~~Schmalfuss'scher Dauerversuch, Feld B (physiologischen Reaktion von Duengemitteln)~~	~~Martin-Luther-Universitaet Halle~~	~~1~~	~~medium~~	~~Fertilization~~
~~214~~	~~Schmalfuss'scher Dauerversuch, Feld E, Stickstoffduengung~~	~~Martin-Luther-Universitaet Halle~~	~~1~~	~~medium~~	~~Fertilization~~
~~217~~	~~E-Feld (ab 1957)~~	~~Georg-August-Universitaet Goettingen~~	~~3~~	~~very high~~	~~Fertilization~~
~~218~~	~~Modellversuch zur Bodenbildung~~	~~Martin-Luther-Universitaet Halle~~	~~1~~	~~very high~~	~~Fertilization~~
~~219~~	~~Weihenstephaner Kali-Formenversuch~~	~~unbekannt~~	~~4~~	~~no data~~	~~Fertilization~~
~~220~~	~~Kleinparzellenversuch Hu1 bzw. Hu1To9~~	~~Universitaet Rostock~~	~~2~~	~~no data~~	~~Fertilization~~
~~221~~	~~Organische Duengestoffe - Wirkung (V140/06)~~	~~Leibniz Zentrum f. Agrarlandschaftsforschung (ZALF) e.V., Muencheberg~~	~~1~~	~~low~~	~~Fertilization~~
~~222~~	~~Organische Duengestoffe - Wirkung (V140/07)~~	~~Leibniz Zentrum f. Agrarlandschaftsforschung (ZALF) e.V., Muencheberg~~	~~1~~	~~low~~	~~Fertilization~~
~~223~~	~~Organische Duengestoffe - Wirkung (V140/08)~~	~~Leibniz Zentrum f. Agrarlandschaftsforschung (ZALF) e.V., Muencheberg~~	~~1~~	~~low~~	~~Fertilization~~
~~224~~	~~Organische Duengestoffe - Wirkung (V140/09)~~	~~Leibniz Zentrum f. Agrarlandschaftsforschung (ZALF) e.V., Muencheberg~~	~~1~~	~~low~~	~~Fertilization~~
~~225~~	~~Bodenbearbeitungsversuch am Galgenberg~~	~~Technische Hochschule Bingen~~	~~1~~	~~very low~~	~~Tillage/Other~~
		~~Grassland LTFE~~			
~~10~~	~~Stickstoffduengung auf Gruenland~~	~~Landesanstalt fuer Landwirtschaft und Gartenbau Sachsen-Anhalt (LLG)~~	~~1~~		~~Fertilization~~
~~12~~	~~Stickstoffduengung auf Gruenland~~	~~Landesanstalt fuer Landwirtschaft und Gartenbau Sachsen-Anhalt (LLG)~~	~~3~~		~~Fertilization~~

~~32~~	~~Schachbrettversuch / Dauerduengungsversuch auf Gruenland~~	~~Rheinische Friedrich-Wilhelms-Universitaet Bonn~~	~~4~~	~~Fertilization~~
~~46~~	~~K-, P-, N-Steigerung zu Gruenland~~	~~Technische Universitaet Muenchen~~	~~4~~	~~Fertilization~~
~~95~~	~~Gruenlanddauerversuch (V102)~~	~~Leibniz-Zentrum f. Agrarlandschaftsforschung (ZALF) e.V.~~	~~1~~	~~Fertilization~~
~~118~~	~~P-Duengungsversuch~~	~~FEhS-Institut fuer Baustoff-Forschung e.V.~~	~~5~~	~~Fertilization~~
~~135~~	~~Gruenlandversuch Weiherwiese~~	~~Bayerische Landesanstalt fuer Landwirtschaft (LfL)~~	~~3~~	~~Fertilization~~
~~141~~	~~Kalk-Duengungsversuch~~	~~FEhS-Institut fuer Baustoff-Forschung e.V.~~	~~4~~	~~Fertilization~~
~~163~~	~~Gruenlandversuch Veitshof~~	~~Technische Universitaet Muenchen~~	~~3~~	~~Fertilization~~
~~164~~	~~Statischer Dauerduengungsversuch~~	~~Hoehere Landbauschule Rotthalmuenster~~	~~3~~	~~Fertilization~~
~~168~~	~~Phosphorduengung auf Gruenland~~	~~Saechsisches Landesamt f. Umwelt, Landwirtschaft u. Geologie (LfULG)~~	~~3~~	~~Fertilization~~
~~169~~	~~Kaliumduengung auf Gruenland~~	~~Saechsisches Landesamt f. Umwelt, Landwirtschaft u. Geologie (LfULG)~~	~~3~~	~~Fertilization~~
~~170~~	~~Phosphorduengung auf Gruenland~~	~~Saechsisches Landesamt f. Umwelt, Landwirtschaft u. Geologie (LfULG)~~	~~4~~	~~Fertilization~~
~~171~~	~~Kaliumduengung auf Gruenland~~	~~Saechsisches Landesamt f. Umwelt, Landwirtschaft u. Geologie (LfULG)~~	~~4~~	~~Fertilization~~
~~172~~	~~Phosphorduengung auf Gruenland~~	~~Landesanstalt fuer Landwirtschaft und Gartenbau Sachsen-Anhalt~~	~~3~~	~~Fertilization~~
~~173~~	~~Kaliumduengung auf Gruenland~~	~~Landesanstalt fuer Landwirtschaft und Gartenbau Sachsen-Anhalt~~	~~3~~	~~Fertilization~~
~~174~~	~~Phosphorduengung auf Gruenland~~	~~Landesanstalt fuer Landwirtschaft und Gartenbau Sachsen-Anhalt~~	~~1~~	~~Fertilization~~
~~175~~	~~Kaliumduengung auf Gruenland~~	~~Landesanstalt fuer Landwirtschaft und Gartenbau Sachsen-Anhalt~~	~~1~~	~~Fertilization~~
~~176~~	~~Phosphorduengung auf Gruenland~~	~~Thueringer Landesamt fuer Landwirtschaft und Laendlichen Raum (TLLLR)~~	~~5~~	~~Fertilization~~
~~17~~	~~Kaliumduengung auf Gruenland~~	~~Thueringer Landesamt fuer Landwirtschaft und Laendlichen Raum (TLLLR)~~	~~5~~	~~Fertilization~~

~~7~~				
~~178~~	~~Ueberpruefung der Kalkempfehlung fuer Gruenland~~	~~Saechsisches Landesamt f. Umwelt, Landwirtschaft u. Geologie (LfULG)~~	~~3~~	~~Fertilization~~
~~179~~	~~Umweltbewusste Gruenlandbewirtschaftung~~	~~Saechsisches Landesamt f. Umwelt, Landwirtschaft u. Geologie (LfULG)~~	~~3~~	~~Fertilization/Other~~
~~180~~	~~Grundduengung im Gruenland~~	~~Saechsisches Landesamt f. Umwelt, Landwirtschaft u. Geologie (LfULG)~~	~~3~~	~~Fertilization~~
~~181~~	~~Phosphorduengung auf Gruenland~~	~~Thueringer Landesamt fuer Landwirtschaft und Laendlichen Raum (TLLLR)~~	~~3~~	~~Fertilization~~
~~182~~	~~Kaliumduengung auf Gruenland~~	~~Thueringer Landesamt fuer Landwirtschaft und Laendlichen Raum (TLLLR)~~	~~3~~	~~Fertilization~~
~~183~~	~~Phosphorduengung auf Gruenland~~	~~Landesamt fuer Laendliche Entwicklung, Landwirtschaft und Flurneuordnung, Brandenburg~~	~~1~~	~~Fertilization~~
~~184~~	~~Kaliumduengung auf Gruenland~~	~~Landesamt fuer Laendliche Entwicklung, Landwirtschaft und Flurneuordnung, Brandenburg~~	~~1~~	~~Fertilization~~
~~185~~	~~Phosphorduengung auf Gruenland~~	~~Thueringer Landesamt fuer Landwirtschaft und Laendlichen Raum (TLLLR)~~	~~2~~	~~Fertilization~~
~~186~~	~~Kaliumduengung auf Gruenland~~	~~Thueringer Landesamt fuer Landwirtschaft und Laendlichen Raum (TLLLR)~~	~~2~~	~~Fertilization~~
~~187~~	~~Niederblockland~~	~~Niedersaechsisches Landesamt fuer Bodenforschung (NLfB)~~	~~2~~	~~Fertilization~~
~~188~~	~~Kalkbedarf der Hochmoorkulturen~~	~~Niedersaechsisches Landesamt fuer Bodenforschung (NLfB)~~	~~3~~	~~Fertilization~~
~~189~~	~~Koenigsmoor/Nordheide~~	~~Niedersaechsisches Landesamt fuer Bodenforschung (NLfB)~~	~~3~~	~~Fertilization~~
~~198~~	~~Versuch 250 (Naehrstoffmangelversuch)~~	~~Universitaet Hohenheim (Institut fuer Kulturpflanzenwissenschaften (340b))~~	~~4~~	~~Fertilization~~
~~199~~	~~Versuch 251 (Wechselduengungsversuch)~~	~~Universitaet Hohenheim (Fachgebiet Nachwachsende Rohstoffe und Bioenergiepflanzen)~~	~~4~~	~~Fertilization~~

ID	**LTFE Name**	**Place of LTFE**	**Address (see below)**	**CWBg Class**	**MSQR Class**	**Thematic Classification**

Fieldcrops LTFE

1	Bodenbearbeitungsversuch Dichtelbach	Dichtelbach (Hunsrück)	1	3	very low	Tillage
2	Bodenbearbeitungsversuch Welschbillig	Welschbillig (Eifel)	1	3	very low	Tillage
3	Bodenbearbeitungsversuch Wintersheim	Wintersheim (Rheinhessen)	1	1	very high	Tillage
4	Statischer Düngungsversuch V120	Bad Lauchstädt	2	1	very high	Fertilization
5	Erweiterter Statischer Düngungsversuch V120a	Bad Lauchstädt	2	1	very high	Fertilization
6	Modellversuch Stalldungsteigerung	Bad Lauchstädt	2	1	very high	Fertilization
7	Bracheversuch V505a	Bad Lauchstädt	2	1	very high	Other
8	Statischer Stickstoffdüngungsversuch	Bad Salzungen	3	2	very low	Fertilization
9	Statischer Kalkdüngungsversuch M16	Bad Salzungen	3	2	very low	Fertilization
11	Dauerdüngungsversuch L28	Bad Salzungen	3	2	very low	Fertilization
13	Statischer Dauerversuch Bodennutzung (BDa_D3)	Berlin-Dahlem	4	1	very low	Fertilization/Tillage/Cr rotation
14	Internationaler Organischer-Stickstoff-Dauerdüngungsversuch (BDa_IOSDV)	Berlin-Dahlem	4	1	very low	Fertilization
15	Agrarmeteorologisches Intensivmessfeld (BDa_E-Feld)	Berlin-Dahlem	4	1	very low	Other
16	Bodenbearbeitungsversuch (Versuchsfeld Westerfeld)	Bernburg-Strenzfeld	5	1	very high	Tillage

17	Anbausysteme-Vergleich	Bernburg-Strenzfeld	6	1	very high	Crop rotation/Other
18	Grundbodenbearbeitung und Distelbekämpfung, ö• kologisch viehlos	Bernburg-Strenzfeld	6	1	very high	Tillage/Crop rotation/Other
19	Bodenbearbeitung und Bestelltechnik in der Fruchtfolge	Bernburg-Strenzfeld	6	1	very high	Tillage/Other
20	Dauerdüngungsversuch Dikopshof	Wesseling-Dikopshof	7	2	very high	Fertilization/Crop rotation
21	Selektions-Dauerversuch SDV	Klein Altendorf	7	3	very high	Crop rotation
22	Strohdüngung zu Getreide	Meckenheim	7	2	very high	Fertilization
23	Phosphatformenversuch	Meckenheim	7	2	very high	Fertilization
24	Organische Düngung	Meckenheim	7	2	very high	Fertilization
25	Strohdüngung mit Faulschlamm	Meckenheim	7	2	very high	Fertilization
26	Kaliformenversuch	Meckenheim	7	2	very high	Fertilization
27	Strohdüngung mit verschiedenen N-Formen	Meckenheim	7	2	very high	Fertilization
28	Phosphatvorratsdüngung	Meckenheim	7	2	very high	Fertilization
29	Kalkversuch mit Spurenelementen	Meckenheim	7	2	very high	Fertilization
30	Versuch mit Faulschlämmen	Meckenheim	7	2	very high	Fertilization
31	Dauerdüngungsversuch	Bonn-Poppelsdorf	7	2	high	Fertilization/Crop rotation
33	Langzeit Düngungsversuch (FV4)	Völkenrode	8	2	very high	Fertilization/Tillage
34	C-Dauerfeldversuch (FV36)	Völkenrode	8	2	very high	Fertilization
35	Südfeld-Düngungsversuch	Völkenrode	9	2	very high	Fertilization
36	Folgenabschätzung der Wechselwirkung von	Dahnsdorf	10	1	high	Other

	Fruchtfolge, Düngung und Pflanzenschutz					
37	Langzeit-Düngungsversuch	Darmstadt	11	2	low	Fertilization
38	Klassischer DFV (4b2, organische und mineralische Düngung)	Dülmen	12	3	medium	Fertilization
39	Dauerdüngungsversuch IOSDV	Dülmen	12	3	medium	Fertilization
40	Zuckerrübenfruchtfolgeversuch	Etzdorf	13	1	very high	Fertilization/Crop rotation/Other
41	Dauerdüngungsversuch (Zuckerrübenmonokultur)	Etzdorf	13	1	very high	Fertilization/Crop rotation
42	Dauerdüngungsversuch Getreide (Getreidedauerversucht)	Etzdorf	13	1	very high	Fertilization/Crop rotation
43	Dauerdüngungsversuch Getreide (Getreidedauerversuch zur Bekämpfung der Halmbruchkrankheit)	Etzdorf	13	1	very high	Fertilization/Crop rotation
44	N-Formen-Versuch	Freising	14	4	high	Fertilization/Crop rotation
45	P-Düngung	Freising	14	4	high	Fertilization
47	Stroh/Stalldung-Fruchtfolge	Freising	14	4	high	Fertilization
48	N-Düngung/Fruchtfolge	Freising	14	4	high	Fertilization
49	N-Steigerung mit Kalkstickstoff	Freising	14	4	high	Fertilization
50	Versuch 020 N-Formen-Versuch	Freising	14	3	high	Fertilization
51	Bodenbearbeitungsversuch	Friemar	15	2	very high	Tillage

	Südzucker					
52	Erschöpfungsversuch (EV)	Gießen	16	2	low	Fertilization
53	Kalkdüngungsversuch	Gießen	16	2	high	Fertilization
54	Dauerversuch Biologische Stickstofffixierung (BSG)	Gießen	16	2	high	Fertilization/Crop rotation
55	Ökologischer Ackerbauversuch Gladbacherhof	Villmar	17	2	extremely low	Fertilization/Tillage/Cr rotation
56	Bodenbearbeitungsversuch Hohes Feld	Nörten-Hardenberg	18	3	high	Tillage
57	Garte-Süd-Bodenbearbeitung (Reinshof)	Göttingen	18	2	very high	Tillage
58	Garte-Nord-Bodenbearbeitung (Reinshof)	Göttingen	18	2	high	Crop rotation
59	Langzeitversuch zur P- und K-Düngung auf dem Reinshof	Nörten-Hardenberg	19	2	high	Fertilization
60	Bodenbearbeitungsversuch Südzucker	Grombach	15	3	high	Tillage
61	Kastenparzellenversuch Sandboden / Lehmboden / Tonboden	Großbeeren	20	1		Fertilization
62	PK-Mangelversuch	Groß Gerau	16	1	very low	Fertilization
63	Dauerfeldversuch P60	Groß Kreutz	21	1	low	Fertilization
64	Dauerfeldversuch M4	Groß Kreutz	21	1	very low	Fertilization
65	Versuchsfeld der Versuchsstation Groß Lüsewitz	Groß Lüsewitz	22	2	very low	Other
66	Ewiger Roggen	Halle	23	1	medium	Fertilization/Crop rotation
67	Schmalfuss'scher Dauerversuch, Feld A, Kalkdüngung	Halle	23	1	very high	Fertilization

68	Schmalfuss'scher Dauerversuch, Feld C, Kaliumdüngung	Halle	23	1	very high	Fertilization
69	Schmalfuss'scher Dauerversuch, Feld D, Phosphordüngung	Halle	23	1	very high	Fertilization
70	Organische Düngung (Feld F)	Halle	23	1	very high	Fertilization
71	Dauerfeldversuch "Bodenfruchtbarkeit"	Hennef	7	3	very high	Fertilization
72	Dauerversuch Düngung-Fruchtfolge	Renningen	24	4	medium	Fertilization/Crop rotation
73	Versuch zur Bodenbearbeitung	Renningen	24	3	low	Tillage
74	Dauerdüngungsversuch	Hohenschulen	25	3	high	Fertilization
75	Stickstoffversuch "Decline-Versuch"	Hohenschulen	25	3	medium	Fertilization
76	Fruchtfolgeversuch	Hohenschulen	25	3	medium	Fertilization/Crop rotation
77	N-Düngung zu Wintergerste	Hohenschulen	25	3	medium	Fertilization
78	Düngerartenvergleich (Versuch I)	Lauterbach	23	5	medium	Fertilization/Crop rotation
79	Kombinationswirkung (Versuch II)	Lauterbach	23	5	very low	Fertilization
80	Nährstoffverhältnisversuch	Limburgerhof/Bruch	26	1	very low	Fertilization
81	Feldwirtschaftsversuch	Limburgerhof/Bruch	26	1	low	Fertilization
82	Nährstoffmangelversuch	Limburgerhof	26	1	low	Fertilization
83	WW-Fruchtfolgeversuch	Ludwigshafen/Ruchheim	26	1	low	Fertilization/Crop rotation/Other
84	Bodenbearbeitungsversuch	Ludwigshafen/Ruchheim	26	1	high	Fertilization/Tillage
85	Bodenbearbeitungsversuch	Lüttewitz	15	2	high	Tillage
86	Dauerdüngungsversuch L28	Methau	27	3	high	Fertilization

87	Dauerdüngungsversuch (V140)	Müncheberg	28	1	low	Fertilization
88	Bodenbearbeitung (V760)	Müncheberg	28	1	low	Tillage
89	Modellbetrieb Organischer Landbau, Felder 931 - 934	Müncheberg	28	1	low	Other
90	Kalium-Steigerungsversuch Höckelheim/Südniedersachsen	Northeim/Höckelheim	29	2	low	Fertilization
91	P-Düngung auf Sandmischkultur	Oldenburg/Friesoythe	29	3	medium	Fertilization
92	Bodenbearbeitung/Fruchtfolge	Oldenburg/Friesoythe	18	3	extremely low	Tillage/Crop rotation
93	Bodenbearbeitung	Oldenburg/Friesoythe	18	3	extremely low	Tillage
94	Internationaler Organischer Stickstoffdüngungs-Versuch (IOSDV)	Oldenburg	30	3	extremely low	Fertilization
96	Dauerversuch 'Auswirkung von Daueranbau'	Puch	31	5	extremely low	Crop rotation
97	Verbesserte Dreifelderwirtschaft	Puch	31	5	high	Crop rotation
98	Getreide/Mais Fruchtfolge	Puch	31	5	high	Crop rotation
99	Einfluss von Grundbodenbearbeitung	Puch	31	5	high	Tillage
100	Internationaler Organischer Stickstoffdüngungs-Versuch (IOSDV)	Puch	31	5	high	Fertilization
101	Internationaler Organischer Stickstoffdüngungs-Versuch (IOSDV)	Rauischholzhausen	16	2	high	Fertilization
102	Organische Düngung / Stalldung Schafpferchversuch	Rauischholzhausen	16	2	high	Fertilization

103	Gründüngung / Strohdüngungsversuch	Rauischholzhausen	16	2	high	Fertilization
104	Bilanzversuch Kastenanlage	Rauischholzhausen	16	2	high	Fertilization
105	Wirkungen differenzierter Bodenbearbeitungssysteme im Dauerversuch Scheyern	Scheyern	32	4	high	Fertilization/Tillage/Cr rotation
106	Fruchtfolgedüngungsversuch	Seehausen	23	1	high	Fertilization/Crop rotation
107	Konzentrationsversuch	Seehausen	23	1	high	Crop rotation
108	Düngungs-Kombinationsversuch Seehausen (F1-70)	Seehausen	23	1	high	Fertilization
109	Bodenbearbeitungsversuch	Seehausen	23	1	high	Tillage
110	Gülledauerversuch	Seehausen	23	1	high	Fertilization
111	Bodenfruchtbarkeitsversuch	Seehausen	23	1	high	Fertilization/Tillage
112	Internationaler Organischer Stickstoffdüngungs-Versuch (IOSDV)	Speyer	33	2	high	Fertilization/Tillage
113	Humusversuch	Speyer	33	2	medium	Fertilization/Other
114	Kali-Magnesium-Kalk-Versuch	Speyer	33	2	medium	Fertilization
115	Klärschlammversuch	Speyer	33	2	medium	Other
116	Bracheversuch	Speyer	33	2	medium	Other
117	Dauerdüngungsversuch L28	Spröda	27	1	medium	Fertilization
119	Düngungs- und Beregnungsversuch (Thy_D1)	Thyrow	34	1	high	Fertilization/Other
120	Stroh- und N-Düngung in Fruchtfolgen mit unterschiedlichem Getreideanteil (Thy_D5)	Thyrow	34	1	very low	Fertilization/Crop rotation

121	Statischer Nährstoffmangelversuch (Thy_D41)	Thyrow	34	1	very low	Fertilization
122	Nährstoffmangelversuch Winterroggen Monokultur (Thy_D42)	Thyrow	34	1	very low	Fertilization
123	Statischer Bodenfruchtbarkeitsversuch (Thy_D6)	Thyrow	34	1	very low	Fertilization
125	Strohdüngungsversuch (Thy_D2)	Thyrow	34	1	very low	Fertilization
136	Modellbetrieb Organischer Landbau, Felder 901 - 904	Müncheberg	28	1	very low	Other
137	Statischer Dauerfeldversuch "organisch-mineralische N-Düngung"	Großbeeren	20	1		Fertilization
138	Versuch zur Bodenbearbeitung	Schönberg	35	3	low	Tillage
139	Gehölzhäckselapplikation	Schönberg	35	3	very low	Other
140	Versuch 700 (Reduzierte Bodenbearbeitung)	Schönberg	35	3	extremely low	Tillage
142	Effiziente Nährstoffverwertung, K-Eichversuche	Pommritz	27	2	extremely low	Fertilization
143	Effiziente Nährstoffverwertung, K-Eichversuche	Forchheim	27	4	extremely low	Fertilization
144	Referenzfläche	Hennef	7	3	medium	Fertilization
146	Statischer Versuch Bodennutzung (Thy_D3/1)	Thyrow	34	1	very low	Fertilization/Tillage
147	Statischer Dauerfeldversuch	Thyrow	34	1	medium	Fertilization

	Organische Düngung und Humusreproduktion (Thy_D3/2)					
148	Statischer N-Düngungsversuch in Winterroggen-Monokultur (Thy_D7)	Thyrow	34	1	very low	Fertilization
149	Alte dreifeldrige Fruchtfolge	Puch	31	5	very low	Fertilization/Crop rotation
150	Fruchtfolgen im ökologischen Landbau	Puch	31	5	very low	Fertilization/Crop rotation
151	Fruchtfolgen im ökologischen Landbau	Viehhausen	31	4	high	Fertilization/Crop rotation
152	Fruchtfolgeversuch (FF)	Rauischholzhausen	16	2	high	Crop rotation
153	Bodenbearbeitungs-Versuch (BB)	Rauischholzhausen	16	3	high	Tillage
154	Bodenbearbeitungsversuch Südzucker	Zschortau	15	1	high	Tillage
155	Bodenbearbeitungsversuch Südzucker	Insultheim	15	2	high	Tillage
156	Bodenbearbeitungsversuch Südzucker	Sailtheim	15	3	high	Tillage
157	Bodenbearbeitungsversuch Südzucker	Gieshügel	15	2	medium	Tillage
158	Strategievergleich umweltschonender Pflanzenschutz (BS1)	Dahnsdorf	10	1	low	Other
159	Ökologischer Landbau (öko1)	Dahnsdorf	10	1	high	Other
160	Strategien zur Minderung der Anwendung chemischer Pflanzenschutzmittel (BS4)	Dahnsdorf	10	1	high	Other

161	Kalk-Düngungsversuch	Weilmünster-Ernsthausen	36	3	high	Fertilization
162	Phosphordüngungsstrategien	Biestow	37	2	high	Fertilization
165	Körnermais Daueranbau	Rotthalmünster	38	3	extremely low	Fertilization
166	Winterweizen Daueranbau	Rotthalmünster	38	3	medium	Other
167	E-Feld (bis 1957)	Göttingen	18	3	medium	Fertilization
193	Dauerfeldversuch (DE-1b-F-1, Am Kotten)	Rosendahl Holtwick	12	3	medium	Fertilization
194	Dauerfeldversuch (DE-1b-F-2, Am Hof)	Dülmen Karthaus	12	3	no data	Fertilization
195	Dauerfeldversuch (DE-1b-F-3, IPU Schlag 9)	Dülmen	12	3	medium	Fertilization
197	Feldmodellversuch "Krumenaufbau"	Müncheberg	28	1	medium	Fertilization/Tillage
203	Kalkformenversuch	Cunnersdorf	39	3	medium	Fertilization
205	Dauerdüngungsversuch (M70)	Groß Kreuz	40	1	low	Fertilization
206	Getreidedauerversuch	Noitzsch	13	1	very low	Fertilization/Crop rotation/Other
207	Stroh-Stallmistversuch	Lentföhrden	25	3	very low	Fertilization
208	Phosphor-Steigerungsversuch	Schädtbek	25	2	very low	Fertilization
209	Fruchtfolgeversuch Bodenbearbeitung/organische Düngung Winterraps (FF 1.1)	Gülzow	41	2	medium	Fertilization/Tillage
210	Fruchtfolgeversuch Bodenbearbeitung/organische Düngung Sommerweizen (FF 1.2)	Gülzow	41	2	medium	Fertilization/Tillage
211	Fruchtfolgeversuch Bodenbearbeitung/organische	Gülzow	41	2	medium	Fertilization/Tillage

	Düngung Winterweizen (FF 2.1)					
212	Fruchtfolgeversuch Bodenbearbeitung/organische Düngung Silomais (FF 2.2)	Gülzow	41	2	medium	Fertilization/Tillage
213	Schmalfuss'scher Dauerversuch, Feld B (physiologischen Reaktion von Düngemitteln)	Halle	23	1	medium	Fertilization
214	Schmalfuss'scher Dauerversuch, Feld E, Stickstoffdüngung	Halle	23	1	medium	Fertilization
217	E-Feld (ab 1957)	Göttingen	18	3	very high	Fertilization
218	Modellversuch zur Bodenbildung	Halle	23	1	very high	Fertilization
219	Weihenstephaner Kali-Formenversuch	Weihenstephan	30	4	no data	Fertilization
220	Kleinparzellenversuch Hu1 bzw. Hu1To9	Rostock	37	2	no data	Fertilization
221	Organische Düngestoffe - Wirkung (V140/06)	Dedelow	28	1	low	Fertilization
222	Organische Düngestoffe - Wirkung (V140/07)	Dedelow	28	1	low	Fertilization
223	Organische Düngestoffe - Wirkung (V140/08)	Dedelow	28	1	low	Fertilization
224	Organische Düngestoffe - Wirkung (V140/09)	Dedelow	28	1	low	Fertilization
225	Bodenbearbeitungsversuch am Galgenberg	Bingen-Büdesheim	42	1	very low	Tillage/Other

Grassland LTFE

10	Stickstoffdüngung auf Grünland	Iden	6	1	Fertilization
12	Stickstoffdüngung auf Grünland	Hayn	6	3	Fertilization
32	Schachbrettversuch / Dauerdüngungsversuch auf Grünland	Daun	7	4	Fertilization
46	K-, P-, N-Steigerung zu Grünland	Freising	14	4	Fertilization
95	Grünlanddauerversuch (V102)	Paulinenaue	28	1	Fertilization
118	P-Düngungsversuch	St. Peter	36	5	Fertilization
135	Grünlandversuch Weiherwiese	Steinach	31	3	Fertilization
141	Kalk-Düngungsversuch	Rösrath	36	4	Fertilization
163	Grünlandversuch Veitshof	Veitshof	43	3	Fertilization
164	Statischer Dauerdüngungsversuch	Rotthalmünster	38	3	Fertilization
168	Phosphordüngung auf Grünland	Christgrün	27	3	Fertilization
169	Kaliumdüngung auf Grünland	Christgrün	27	3	Fertilization
170	Phosphordüngung auf Grünland	Forchheim	27	4	Fertilization
171	Kaliumdüngung auf Grünland	Forchheim	27	4	Fertilization
172	Phosphordüngung auf Grünland	Hayn	6	3	Fertilization
173	Kaliumdüngung auf Grünland	Hayn	6	3	Fertilization
174	Phosphordüngung auf Grünland	Iden	6	1	Fertilization
175	Kaliumdüngung auf Grünland	Iden	6	1	Fertilization
176	Phosphordüngung auf Grünland	Oberweißbach	44	5	Fertilization

177	Kaliumdüngung auf Grünland	Oberweißbach	44	5	Fertilization
178	Überprüfung der Kalkempfehlung für Grünland	Christgrün	27	3	Fertilization
179	Umweltbewusste Grünlandbewirtschaftung	Christgrün	27	3	Fertilization/Other
180	Grunddüngung im Grünland	Christgrün	27	3	Fertilization
181	Phosphordüngung auf Grünland	Heßberg	44	3	Fertilization
182	Kaliumdüngung auf Grünland	Heßberg	44	3	Fertilization
183	Phosphordüngung auf Grünland	Paulinenaue	21	1	Fertilization
184	Kaliumdüngung auf Grünland	Paulinenaue	21	1	Fertilization
185	Phosphordüngung auf Grünland	Wechmar	44	2	Fertilization
186	Kaliumdüngung auf Grünland	Wechmar	44	2	Fertilization
187	Niederblockland	Bremen	45	2	Fertilization
188	Kalkbedarf der Hochmoorkulturen	Bremen	45	3	Fertilization
189	Königsmoor/Nordheide	Bremen	45	3	Fertilization
198	Versuch 250 (Nährstoffmangelversuch)	Ihinger Hof	46	4	Fertilization
199	Versuch 251 (Wechseldüngungsversuch)	Ihinger Hof	46	4	Fertilization

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Author Response to Anonymous Referee #1

(Author Responses to Anonymous Referees #2 and #3 see below)

Review comment	**Author response**
For the international readership of SOIL it might be of limited interest, since all results are related to Germany without direct implications for outside Germany	This comment was already contradicted by reviewer 3. Indeed, the paper is exclusively about LTFE in Germany. But we expect the paper to be also interesting for an international readership because it provides a carefully developed example on how a large number of long-term field experiments can be comprehensively characterized with meta-information. On the other hand, the intersection of LTFE with spatial data is new and could also arise the interest of international readers, either with regard to the specific data usage of the German LTFE, or as inspiration for using their own LTFE.
More details need to be outlined how the access to data will be provided in the future. The one sentence in l. 68 ("There is a focus on reseach data from LTFEs") is not enough	We see this paper as a kind of vision or as motivation to make the LTFE data freely available. We expect that the comprehensive overview of meta-information will trigger motivation of LTFE holders to share their data for re-use and scientific cooperation. It facilitates the direct (bilateral) cooperation between interested scientists and LTFE holders for co-authorship. We entered some more details about the common database.
Maybe more abundant soil data, such as texture or soil type, can be used for classification and the representativeness analysis	We conducted a further analysis with clay data.
l. 6: Soil monitoring of climate impact can be performed much more cost efficient on permanent sampling sites (such as "Bodendauerbeobachtung"). Since LTFEs do not represent real practice field sites they might miss some trends that can only be monitored at farmers' field sites. The value of LTFEs is to provide data on management impacts (under changing climate).	We included a section about Bodendauerbeobachtungsflächen (lines 52 to 55).
L 16: The representation and distribution of management options in the LTFEs is missing as a result in the abstract. Since this is the main aim of LTFEs it would be worth to include one or two sentences on how management treatments are covered in LTFEs in Germany.	We are included that in the abstract.
l. 28: In agriculture, plant nutrition is linked to fertilisation. Thus, these are not two but one and the same aspect.	We expressed this more clearly

l. 39: The definition of "control treatments" is not clear. Is the control treatment defined by each LTFE or does it depend on the study? Customary or common management practices are changing over time e.g. the fraction of reduced tillage or fertilisation type and amount. Is the control treatment than also changing over time?	The definition we gave here is for the purpose of defining 'control treatment' for our study. The second point is a fundamental problem for long time series of LTFE, since the management changes repeatedly over time. This must be considered in individual time series to see how strong the breaks are and whether or not these time series can then be used.
l. 45: Change "landscapes to "soil" since LTFEs does not comprise landscapes.	We changed that.
l. 99 and 102: Why 191? 94+87=181	We corrected that.
l. 156: It is not comprehensible why many grassland LTFEs were excluded. This need to be explained and justified since grassland trials are under-represented in the compiled LTFE dataset. Above it is written that LTFEs are useful beyond the original scope or research theme. Here it is argued that the research theme of the grassland trials did not fit and were therefore excluded.	Most LTFE were originally implemented for agronomic purposes. Accordingly and particularly for grassland LTFE, most research questions are agronomic in nature and not closely related to the soil. In this paper, we intended to reveal the value of LTFE for soil related questions. We therefore only included those LTFE in our study, for which soil data are existing.
l. 192: What is a technical college? A university of applied sciences?	Sorry. Yes, university of applied sciences. We corrected that.
l. 200-206: This section is redundant and repetition from above an can be removed.	We removed that.
l. 214-l. 223: For an international readership of the journal, it would be good to provide a map with the names of the regions mentioned here or include the names in Fig 5.	We decided not to include the names in Fig. 5, as it would overload the figure. For an international readership we translated the names of the regions. We could provide a freely available map, but the names of the regions are in German language.
Fig. 3: The colours are not easy to distinguish, in particular that for tillage, fertilisation and crop rotation.	We changed the colours respectively changed the whole figure according to the comments of the other reviews.
Fig 5 and 6: The dispersion of points from only single experimental sites with different experiments results in biased impressions, e.g. that the whole region of Halle is covered with LTFEs even though there might be only one single experimental site. I propose to either strongly reduce the dispersal of the points from one site or completely avoid them since this map aims at illustrating the spatial distribution and representativeness of LTFEs and one site with many trails mostly does not contribute in achieve a higher representativeness of soils and climate.	We changed these illustrations, combined the points per location and subject, and adjusted the point size according to the number of LTFE at a location.
Fig 5: The map seems to be incomplete for German agricultural land (with is the reference for this study). Mostly grassland seem to be missing, e.g. in the pre Alps, the Sauerland or in North-Western Germany. Readers expect that the class "other land" comprise only non-	We think CORINE is a good basis because CORINE is also available for Europe. It is raised according to the same rules within Europe, uses a uniform legend and would therefore ensure connectivity. ATKIS is specific to Germany and is outside of Germany not relevant. CORINE

agricultural land. Maybe CORINE data are not appropriate but ATKIS Basis DLM data can be used.	provides data for a reference year. ATKIS has a permanent update cycle of 5 years. Each federal state does this on its own. Every year a fifth of every state is being photographed (aerial photos), preferably in spring, and updated on this basis. So there is not land use for one year but a mosaic of 5 years. For this reason and the fact that the aerial photos come from spring, the differentiation of arable and grassland is not so easy at ATKIS. For these reasons we would like to continue using CORINE.
Fig. 7: This illustration with boxes is unusual and thus difficult to read. Since the yaxis contains distinct values (no classes) a representation with points or lines would be more appropriate.	We changed the figure. Referee #2 also commented on this figure and suggested smaller column widths and larger row heights.

Author Response to Anonymous Referee #2

Review comment	Author response
All LTFE are situated in flat areas (a data evaluation in this respect would be nice and not too difficult to do). This means that they exclude major lateral processes (interflow, surface runoff) and differ largely from typical agricultural fields. This deficit may be especially pronounced for grassland experiments because grassland either occupies lowland areas that are too wet for arable use or areas that are too steep.	Indeed, lateral processes are typically not analysed in LTFE and they are not designed for such questions. Different design such as the 'Wishmeyer plots' are implemented for erosion studies. We wrote a section explicitely about deficits in the setup of LTFE (lines 283-285).
For grassland experiment, which in fact are meadow experiments (grazings seems to be missing; also a major deficit). Such critical assessment would be extremely helpful to guide the installation of future LTFEs and to show the limitations in the conclusions that can be drawn from the existing LTFEs.	We included grazing as example in the discussion of limitations of existing LTFEs.
Were lysimeter experiments included, which would allow assessing at least vertical water fluxes? Do long-term experiments with lysimeter exist at all in Germany?	We included two sentences about lysimeter experiments in lines 137-140.
Were experiments included that allow quantification of lateral processes (runoff, soil loss)? I could imagine that the measurements in Trier (Stehling and Schmidt 2017) or those by Jung and Brechtel (1980) qualify for LTFE. If they don't qualify, this would again illustrate a major deficit of present LTFEs.	Our response to the first review comments also holds here.
In the discussion I missed a wider view. Do similar compilations also exist in other countries? Are the German LTFE experiments similar to what was done and is done in other countries?	We included a section about the international situation (lines 272-278).
Furthermore, the authors give the impression that they still focus on the old questions of LTFEs (mainly yield) that became boring. I had this impression for two reasons. First, little examples are given how LTFEs can be used in fascinating modern research on urgent questions. Second, using LTFEs in modern research applying new techniques requires access to the experiments. Hence it makes a big difference whether an experiment is still ongoing or not. However, this information is given nowhere. Second, it often requires archived samples (as an example what can be done with modern techniques and archived	Information on whether an LTFE still exists or not can be found in the extensive data set, which can be found under the following DOI: http://doi.org/10.20387/BonaRes-3tr6-mg8r, 2019 We included some information about archived samples (lines 261-263) and which data can be obtained from LTFEs (lines 254-260).

samples, Köhler et al. 2012 comes to my mind but there are certainly more examples). This information, whether archived samples are available, should be included. Generally, I missed information about which data could be obtained from the LTFEs.	
Most of my other remarks are mainly editorial issues. The weakest part in this respect is the table in the Appendix, which is most important because it resolves the LTFEs and thus allows access (see below).	We enhanced the table in the Appendix according to your suggestions.
12: add "during the growing season"; I would even change the abbreviation to CWBg because usually an entire year is considered in a CWB. I was very surprised when suddenly somewhere in the manuscript the information ’growing season’ popped up	We did that.
13: Müncheberger Soil Quality Rating seems to be a combination of German and English. Shouldn’t it be ’Müncheberg’?	We changed that accordingly.
35: I welcome this definition of the control that is certainly better than the often used but wrong assignment of the strongest and most unrealistic intervention as control, namely the long-term nutrient removal. However, I did not find this definition to be used later in the manuscript.	Yes, we used this term only to give an example on how LTFE could be analysed collectively. We are wrote this part more detailed, also due to the comments of Referee #3.
46: Bai et al.	We changed accordingly.
116: Not clear how PET was derived. Was it taken from DWD? Is it Haude?	The PET was already included in the DWD data of CWB.
126: This is strange. Later only 6 classes of the MSQR are used, not 102. I wonder whether different properties like soil structure, wetness, relief, contaminations can be combined in one indicator of six classes. This may be possible for one specific target like yield but will fail for most other targets or require other classes. Is a better resolution than these six classes possible?	The soil quality rating is is performed on an ordinal scale of 0-102 and clustered into six quality classes. We added this information to clarify.
128: I guess this should read ’available water capacity’	The source says ‘profile available water’, just as Mueller 2010
130: What is unsuitable? This always requires the definition of a target.	We cited the source correctly, but we added “for crop production” here.
139: This leads to the question: Were lysimeter experiments included? If not, why not?	See above
155: The title does not have this restriction; also the Abstract does not. I wonder why it suddenly pops up in the results. I also wonder how this is defined (what is bioeconomy?) and whether these experiments really aim at sustainable soil use. They exclude many things that make soil use unsustainable (erosion, compaction) and	We included that in the abstract and avoided the term “bioeconomy”.

hence are unsuitable to test sustainability (in this general sense). I also wonder even more why the criterion sustainability excludes some grassland experiments. This is contrary to what I would expect.	
160: Establishment was in the past. Hence past tense would be appropriate. The question of correct tense is rather difficult to answer given that 30% of the experiments have come to an end already and others will come to an end in the future, I wonder whether the mostly used present tense is justified.	We changed to past tense.
171-172: One sentence is usually not a paragraph. Furthermore, temporal aspects were treated in the first paragraph of the results. I suggest moving this sentence.	We moved the sentence.
173: sentences usually do not start with a number; this also applies in other cases (e.g. L. 181, 184).	We wrote out the numbers with letters.
178 : Move opening parenthesis	done
208-209: This should be moved to the M & M section; this is the first time that growing period is mentioned although CWB appeared already several times. Furthermore, it would be good to explain the rationale behind this decision than let the reader speculate	We moved the sentence and explained, why we chose CWB of the growing season.
266-269: I would reverse the argument. In my view the critique by Franko is well justified and shows that 6 classes of the MSQR are insufficient. I do not suggest to include an assessment of the complexity of soil parameters but it is also not justified to say that the LTFEs are representative regarding soils just because they match the rather coarse and restricted (to yield) MSQR criterion.	We agree. We intended to say which CWB/MSQR combinations are less well represented in the existing LTFE having biomass production suitability in mind. For specific questions such as the representation of C-dynamics in simulation models other requirements to long term information exist. We included in addition to MSQR and CWB an assessment of the distribution of LTFE according to clay content with clay data from ESDAC.
References: The format varies among references. Please homogenize	We homogenized the references.
Fig. 2: The pie charts are an attempt to illustrate the manuscript. However, they do a poor job. They require a legend, which is difficult to read (because font size is smaller than that of ordinary text) and contain information that is better suited for a table or even could be given as plain test. For Fig. 2 a, a density graph would be more appropriate	We put this information into a bar chart respectively plain text.
Fig. 3: A graph usually has not a title but a caption. The colors are impossible to distinguish Are they necessary? Can they be simplified? Wouldn't the year when an LTFE was closed be equally interesting?	We changed the whole figure.
Table 1: It is not clear whether 'organic	We improved the table accordingly.

fertilization' also includes straw and compost (there is not an equivalent 'Mineral fertilization'). Furthermore, why are green manure, compost and sludge mentioned, but not the main type of organic manure? This classification appears inconsistent. It surprises me that only two of the grassland experiments have organic fertilizer although grassland use unavoidably produces manure. Have all except for two experiments used an unrealistic design that does not allow application of the results to typical situations? Better call 'plant protection' 'crop protection'	
Fig. 4: same remark as Fig. 2	done
Table 2 + 3: 'vegetation period' should not be in the column head but in the caption. Also the lines separating groups of variables are not consistent (why are CWB class and range separated by a line? Isn't the unit for CWB mm/ yr?	We changed the tables accordingly.
Fig. 5: Here four classes of LTFE are sufficient. Why does Fig. 3 require eight classes (that cannot be read anyhow)? LTFE should not be repeated five times in the legend. It is not necessary at all. CWB is in mm/yr	For the map we simplified the classes to avoid complexity. We simplified figure 3 also. We skipped LTFE from the legend. We changed the unit of CWB.
Fig. 6: Delete LTFE	done
Fig. 7: column widths could be much smaller while larger row heights would allow a larger font size. Presently the numbers hardly can be read. It is not necessary repeating 'MSQR class' six times. Better use a larger font size. The colors of the legend should agree with the colors in the graph.	We changed the figure.
Table A 1: This is likely the most important table because it allows access to the LTFEs. However, it is rather inconsistent and difficult to read. E.g., the IDs cannot be read; some institutions got abbreviations (why?) others not; some places are mentioned, others not (why?). Mentioning the main institution may be fine in hierarchical organizations but this is clearly insufficient for big universities. Whom should one ask there? I suggest replacing the information in column 3 by a number and the place and resolving the number below the table by reporting the full addresses. This would also create room for the other columns. Furthermore, I see no reason why umlauts are replaced. This is poor technology of the past century and again a waste of space.	We changed the table accordingly.

Author Response to Anonymous Referee #3

Review comment	Author response
The Material and Methods chapter explains how the geospatial analysis is done and also the classification criteria for the LTFEs. However, there is no information on how the experimental design should be analyzed as stated as one of the two main objectives of this study.	We wrote a section about the analysis of LTFE. This section is inserted in lines 63 to 78.
Do statistical methods come to use? Which ones? The pure assignment of LTFEs to four different classes without further statistical analyses (e.g. various types of discriminant analysis, contingency and cross tabulation, factor analysis) is not very appealing. The same holds true for the analysis of the data for climate (CWB) and soil fertility (MSQR) given as number of cases and percentage of share of classes (tables 2 and 3).	It is important to stress that our database comprises a complete repository of all LTFE with a duration of more than 20 years conducted in Germany. As such, our database constitutes a complete enumeration of the whole population of LTFE in Germany. Due to the complete enumeration, we believe that descriptive statistics (cross-tabulations, contingency tables) provide the best means of analysing our data. In line 148 the two used methods are written down. Methods of statistical inference, such as chi-squared tests for contingency tables, for example, are unecessary, precisely because of the complete enumeration. Such tests would only be helpful, if a random sample of LTFE were available out of a larger population. But such is not the structure of our data. The reviewer also suggests two multivariate methods, i.e., as factor analysis and discriminant analysis. Both methods would potentially use a large number of environmental covariates characterizing the LTFE. By contrast, our hypotheses relate to two clearly defined covariates that span a two-way classification, i.e. Müncheberg Soil Quality Rating and Climatic Water Balance. Moreover, we believe the two suggested multivariate techniques do not really match our objectives. The purpose of discriminant analysis it to provide a model-based decision rule that allows allocating new samples to known groups of units (LTFE in our case). This kind of application is clearly not what we need, as we already have a classification of all LTFE in our database. Moreover, there are no new LTFE to be classified. As regards factor-analysis, this is largely an exploratory method for a larger number of variates that allows exploring

	possible grouping in multivariate space. Again, this does not meet our needs; we already have the classification in hand that we are analysing, and this is based on just two well-defined covariates. Further on, we included Hans-Peter Piepho as a further author, who is an expert i.a. in spatial methods for field trials, design of comparative experiments, and network meta-analysis.
(There are) five (classes of LTFE) in table 1 and eight in figure 3?	We changed figure 3 so that it has also five classes of LTFE (with multiple nominations).
I am convinced that the manuscript would greatly benefit from a profound statistical analysis and that this would allow (i) a critical discussion of the value of the data that exist so far and (ii) to conclude how such laborious and expensive experiments could be designed in future.	See response to the 2nd statement.
A purely qualitative, merely descriptive analysis has certainly been carried out to a sufficient extent in the large number of papers already published on this subject, most of them mentioned generously.	Although various compilations of LTFE in Germany exist, this paper is new in the aspect, that it provides a carefully developed example on how a large number of long-term field experiments can be comprehensively characterized with meta-information. In addition, the geospatial analysis of LTFE sites is new.
A discussion of the results including international literature and experiences of long-term experiments, e.g. from England, China or the US, is missing to a large extent. I recommend that the discussion be significantly revised and expanded in these points.	We included a section about international LTFE in the lines 259 to 265.
Appropriate quantitative methods for the analysis of the experimental design and the spatial distribution of the experiments with regard to climate and soil fertility should be added.	What is meant by “experimental design” here? We have chosen a descriptive approach to classify the total population of LTFE in Germany. We believe that contingency and cross tabulation are stringent methods for this. If instead e.g. a factor analysis would have been chosen, that would be a completely different approach.
Line 49-55: the enumeration of the number of LTFEs published over the years by Körschens seems unnecessary in this way. If the details here are important I would recommend to present it as a table. And Line 83: after the explanations in the introduction regarding the work on the German LTFEs prepared by Koerschens et al., it seems incomprehensible why a new literature study should be made here and would require a	The numbers show, that our work was needed. We had the opportunity to carry out an extremely extensive search, which led to more than twice as many LTFE (205) being known as in Körschens' most extensive study (97). In addition, the setup of new LTFE with a planned duration of at least 20 years goes on and we have also recorded LTFE that were setup after Körschen's publications. In addition, we included grassland experiments. Also regarding the details to each of the

corresponding justification. This should also explain why the work of Koerschens et al. is obviously not adequate to follow the objectives of this study.	experiments we provide much more information in our dataset (http://doi.org/10.20387/BonaRes-3tr6-mg8r). Although most of the details are not needed for the spatial analyses of this paper, the precise coordinates of the LTFE are needed and could only be found out through our extensive search.
Lines 63-80: after the objectives of the work have been formulated in lines 61-63, the explanations given here seem like a description of material and methods. I recommend to shorten this part and to integrate it into the chapter Material and Methods.	We shortened it and enhanced the structure. Parts were integrated into Material and Methods, other parts in the results section.
Line 68: what is meant by research parameters? Please list.	By research parameter we mean everything that has ever been sampled and recorded in LTFE. Probably "measured parameters" is less misunderstanding. We changed that. An overview of the measured parameters known to us can be found on pages 9 to 11 of the fact sheet (Grosse, M., Heinrich, U., and Hierold, W.: Fact Sheet for the Description of Long-Term Field Experiments / Steckbrief zur Beschreibung von Dauerfeldversuchen, http://doi.org/10.20387/BonaRes-R56G-FGRW, 2019.). We referred to that.
Line 95: here, too, the technical justification for the selected research topics is missing. Especially with regard to the aspect of a meta-analysis of the research statements, which was prominently emphasized in the introduction, the research topics listed here appear incomplete.	We added "descriptive" and skipped "experimental design", which probably lead to the misunderstanding.
Lines 200-206: the description of the methodology belongs in the corresponding chapter and is superfluous here, as are lines 208 and 209. Similar mixtures of results and material and methods are also shown in the following chapters. I would recommend to check the results part and to concentrate all methodical information at the appropriate place.	We skipped lines 200 to 206 and enhanced the results part.
Figure 1 does not seem necessary to me, the content is very simple and directly repeats the statements in the text without a gain in information.	We would like to leave Figure 1, because we believe it improves the readability of the paper.
The core statements in figure 3 could certainly be presented much more clearly. At the moment most of the space is taken up by the legend. It also seems unusual to me that the figure itself contains a headline ('Start of LTFE').	We enhance Figure 3 and skipped the headline.