4 Final Remarks and Approaches to Continue the Long-Term Trials in Halle

4.1 Summary of the Results

From the originally eight long-term trials in Halle, six still exist today. Five of them are located at the experimental site *Julius-Kühn-Field*, which was started in 1866 by Julius Kühn and which has belonged to the Plant Nutrition department of the Agricultural Faculty of the Martin-Luther-University Halle-Wittenberg since 1948. They comprise the following trials: *Eternal Rye*, started in 1878, and the long-term trials investigating phosphorus, potassium, lime and organic fertilization, which were started by Karl Schmalfuß in 1949. In addition, this booklet also contains information about the discontinued long-term trials on nitrogen fertilization and the physiological reaction of fertilizers. Additionally there is another long-term trial in Halle (Adam-Kuckhoff-Straße 17b) investigating the effect of fertilization on soil development from loess substrate, which is also part of the evaluation presented here. The major important results achieved so far can be summarized as follows:

The *Eternal Rye* Trial

The *Eternal Rye* trial is one of the oldest experiments which have convincingly proved that the nutritive needs of crops can be met solely by mineral fertilization (NPK) without any restriction in yields. Fertilization with farmyard manure (FYM) has resulted in a considerable increase of humus, yet the small yield increase compared to NPK was due to the approximately 50% higher N amount applied with FYM until 1990. Due to increasing crop residues, mineral fertilization also contributed to a stable amount of humus. N deficiency (unfertilized, PK) resulted in a rapid yield reduction, whereas PK deficiency could be identified only after the third experimental decade due to the delivery of those nutrients by the soil. Fertilization specific steady state conditions of soil nutrient and C content appeared only after 30 to 50 years. The change of the N treatment into a NPK + farmyard manure (NPK+ FYM) fertilization in autumn 1990, combined with a single high PK fertilization, quickly restored the total crop growing capacity, whereas the changes in soil C and N contents still persist.
The continuous rye growth demonstrated the important impact of the weather, especially precipitation, on the yield at the experimental site, on the one hand directly by water supply to the plants, and on the other indirectly by organic matter turnover in soil. During rainy years, leaching caused N losses even in unfertilized areas. The transition to a potato – rye rotation in 1962 on one-third of the experimental area affected the rye yield very positively. The decrease of humus content, caused by decreased crop residues, occurred in this treatment as well as in the treatment with continuous maize growth, and as slowly as it happened on the second FYM plot (FYMII) when fertilization was stopped after 60 years.

At the same time also the composition of soil organic matter changed, measured with pyrolysis technology. The influence of the fertilization was greater than that of the cultivated crop species. Without fertilization a larger proportion of thermally stable SOM was found as in the farmyard manure treatment. The replacement of winter rye (C3-plant) by silage maize (C4-plant) in the section A offered further the possibility to determine the incorporation of C from plant residues into different SOM fractions using 13C-isotope analysis. It was shown that carbon derived from “young” maize was preferentially found in the DOC fraction or the respired CO2. It was calculated, that to reach a new steady state 49 years was required for the N-carboxylic acids, 60 years for N-alkanes and 250 years for bulk SOC. This demonstrates the very long duration of processes which determine the turnover of SOM. Under partial use of molecular-biological methods it could be recently shown that NPK and farmyard manure fertilization increased the biodiversity of C-autotrophic soil microorganisms. Using 14C analysis it was further found, that SOC in the location Halle was partly derived from external sources (lignite mining).

The Lime Fertilization Trial (Field A)

The omission of any supply of lime or alkaline materials to this slightly acidic soil resulted in a decreasing pH value in the topsoil of up to 4.5 after 50 experimental years. Apart from calcium uptake by the plants, the input of acid materials from the atmosphere plays an important but unquantifiable role. The same is valid for the input of alkaline materials. The presence of a considerable amount of gypsum refers to those inputs, and demonstrates the merely moderate moistening of the soil. Free Al3+ ions could be detected only in very low concentrations. To sustain the original pH value, a supply of approximately 250 kg CaO ha⁻¹ yr⁻¹ was necessary. Higher amounts have resulted in complete neutralization and accumulation of small amounts of CaCO3. Yet in the subsoil, which was not directly affected by cultivation, such processes have just begun. The supposed