Veterinary antibiotics (VAs) are integral to intensive livestock farming. Global VA consumption comprises approximately 75% of the total antibiotic production superseding the amounts used for the treatment of human infections. After administration, VAs vastly remain unmetabolized and are excreted from the animal through urine and faeces. Hence, soil organic fertilization with animal excreta, as manures, derived from intensive farming leads to systematic exposure of agricultural soils to VA residues and poses a threat to the environment and the public health due to potential: (i) VA toxicity on the soil microbial communities, affecting significant ecosystem functions and services; (ii) the dispersal of antibiotic resistance to microbial community members of soil and associated environments (e.g. plants). Furthermore, the continuous exposure of arable fields to VAs might lead to the enhancement of microbial growth-linked biodegradation, despite the inherent antimicrobial activity of VAs. Despite the copious efforts of the research community, current knowledge on the exposure route of VAs from livestock farms to agricultural settings and the impact of VAs on the microbial communities of soil and associated environments is still scarce, while the potential evolution of growth-linked biodegradation of VAs in agricultural soils is vastly understudied and limited to a few groups of VAs (e.g. sulfonamides).

For addressing these gaps this thesis aimed to: (i) explore the environmental fate of important for intensive livestock farming VAs like tiamulin (TIA) and tilmicosin (TLM), starting from livestock farm and animal excretion kinetics, to faecal material and eventually to agricultural soils; (ii) investigate the potential outcomes of the interactions of VAs and the soil microbial community (biodegradation, toxicity and antimicrobial resistance (AMR) stimulation), focusing on the two understudied VAs like TIA and TLM, in parallel with the relatively well-studied, regarding its soil behavior, VA like sulfamethoxazole (SMX); (iii) determine the efficiency of bioaugmentation using a TIA-degrading bacterial strain as a mitigation method for the decontamination of contaminated faecal material, comparatively to the commonly employed treatments of stockpiling and anaerobic digestion.

Firstly, we studied the persistence of TIA and TLM along their route from pig administration to fecal excretion and to agricultural soils. We administered TIA and TLM to pigs orally, through feed or water, and assessed: (i) the concentration of the VA residues; (ii) the effect of the administration methods on the excretion kinetics and the temporal excretion pattern of VAs; (iii) the persistence of the VA residues in the manures during downstream treatments of stockpiling and anaerobic digestion; (iv) the VA persistence in soils when applied directly or through VA-fortified manures. VA residues in animal excreta were quantified at levels of 0.55–5.99 mg kg-1 for TIA and 4.27–749.6 mg kg-1 for TLM. Different administration routes (feed/water) lead to different excretion patterns and residual levels for the two VAs. Both VAs showed high persistence during stockpiling (DT90= 19.4–119.3 days for TIA and 77.9–165 days for TLM) and anaerobic digestion (DT90 >365 days). Both antibiotics were very persistent when applied to soils with TLM being the most persistent. Fumigation or incorporation via manure increased their persistence suggesting microbial degradation and enhanced sorption respectively. Overall, the use of TIA- and TLM-contaminated feces as manures is expected to lead to VAs dispersal with unexplored consequences for the environment and human health.

We further investigated the consequences of the regular exposure of soils to VAs with particular focus on the interactions of the soil microbial community with the tested VAs. To address this, we employed a soil microcosm experiment where we repeatedly treated two soils with different pH and VA dissipation capacity (fast vs slow as determined in our earlier work) with the studied VAs (TIA, TLM and SMX), either directly or through fortified manures. This approach resulted in accelerated dissipation of TIA only in the “fast” soil and only upon direct application of the antibiotic. Whereas repeated application resulted in either no changes in the dissipation of SMX, and retardation of the dissipation of TLM. Ecotoxicological measurements showed that TIA and SMX inhibited potential nitrification rates (PNR), and the abundance of ammonia-oxidizing microorganism (AOM), while TLM presence lead to an overall increase. The presence of VA residues in soil imposes strong structural effects on the community of total prokaryotes and AOM, unlike the fungal and protists communities which were mostly responsive to manure incorporation rather than VAs. SMX stimulated sulfonamide resistance, while manure stimulated antibiotic resistance genes (ARGs) and horizontal gene transfer (HGT). Finally, we were able to identify opportunistic pathogens like *Clostridia*, *Burkholderia-Caballeronia-Paraburkholderia*, and *Nocardioides* as potential ARG reservoirs in soil. Overall, our findings provided unprecedented evidence about the effects of understudied VAs on soil microbiota and highlight risks posed by the application of VA-contaminated manures in agricultural soils.

Finally, in the last experimental section of the thesis, we assessed the performance of bioaugmentation as a remediation method for reducing the TIA content of faecal material and hence preventing the environmental dispersal of TIA residues. We tested the efficiency of bioaugmentation in pig faecal material fortified with TIA at two concentration levels (representative of the range obtained according to the initial experiment), 5 and 50 mg kg-1, using a previously isolated *Sphingomonas* strain, able to degrade TIA in liquid cultures. For achieving our goals we compared bioaugmentation with stockpiling and anaerobic digestion as the currently used methods for the pre-treatment of faecal material. Our results suggested an overall higher performance of bioaugmentation (DT50 = 32.3 and 66.2 days), compared to stockpiling (DT50 = 95.38 and 113.8 days), and anaerobic digestion (DT50 = 103 and 126.7 days). Interestingly, during anaerobic digestion we observed a hormesis-like low dose induced significant stimulatory effect in biomethanation, which was driven, as determined by amplicon sequencing analysis, by the increasing abundance of methanogens of the genus *Methanosarcina*.

On the whole, our results highlighted the dispersal potential and negative impact of important for intensive livestock farming antibiotics like SMX, TIA, and TLM, when they end up in agricultural soils through manure application, and, hence, the potential risks for public health. Nevertheless, we have reinforced environmental bioremediation strategies, by demonstrating the power of bioaugmentation for remediating persistent antibiotics in the environment like TIA. This work reinforces the basis set by a, yet, small body of contemporary research, for deeper understanding and problem solving in VA ecotoxicology.