SUMMARY

This PhD dissertation explores multiple facets of mycotoxin risk management in Tanzanian maize production, integrating farmer practices, assessment of biocontrol in the field and biomonitoring approaches across Chemba and Kiteto districts. The research encompasses: (1) an assessment of the pre- and post-harvest management practices among smallholder farmers; (2) an evaluation of the capacity of atoxigenic *Aspergillus flavus* for suppressing secondary metabolite production; (3) multi-mycotoxin incidence profiling in maize subjected to aflatoxin biocontrol versus conventional practice; and (4) a human biomonitoring study to determine the effectiveness of biocontrol interventions in reducing dietary mycotoxin exposure.

Chapter 1 presents literature on analysis of mycotoxin risks in maize, focusing on its role as a staple crop, the types and global prevalence of mycotoxins, and the specific challenges faced in Tanzania. It explores the biology and ecology of key mycotoxigenic fungi, reviews major toxin types and their health impacts, and highlights agronomic and environmental factors influencing contamination. This chapter further synthesizes evidence on mycotoxin co-occurrence, regional case studies, and detection methodologies in both food and biological matrices. Central to this, are integrated mitigation strategies spanning pre-harvest, post-harvest, and regulatory approaches, alongside an emphasis on human biomonitoring, awareness, and the evolving regulatory landscape for food safety and security in Africa.

Chapter 2 provides an overview of the structure and specific aims of this PhD dissertation, detailing its key research objectives and outlining how each chapter contributes to addressing the core questions of the study.

In **Chapter 3**, a comprehensive assessment of pre- and post-harvest management practices in Chemba and Kiteto Districts was conducted by use of structured questionnaire from 334 smallholder farmers. Findings reveal that these practices are pivotal in shaping mycotoxin contamination risks and determining the success of biocontrol interventions among smallholder maize farmers. The majority of farmers have limited awareness or experience with biocontrol products such as Aflasafe® TZ01, with economic barriers further constraining adoption. These findings highlight critical gaps in knowledge and information that must be addressed through intensified farmer education, extension campaigns, and communication strategies, alongside supportive financing mechanisms. Importantly, those exposed to biocontrol interventions

showed greater awareness of aflatoxin hazards and demonstrated improvements in agronomic practices, suggesting that biocontrol can foster more informed crop management and reinforce a positive cycle of risk reduction.

In Chapter 4, multi-mycotoxin incidences were quantified in maize harvested from biocontrol and non-biocontrol fields, capturing co-occurrence patterns that matter for real-world risk. Results revealed that, although biocontrol interventions effectively reduced aflatoxin contamination in maize, a numerical rise in the intensity of *Fusarium* mycotoxins including trichothecenes was observed in treated samples. This increase appeared as greater toxin concentrations rather than wider prevalence, highlighting complex and sometimes competitive interactions among co-existing fungal species following ecological management. These findings emphasize that single-target strategies can shift mycotoxin profiles without eliminating total risk, underscoring the need for ongoing surveillance and the implementation of integrated, multi-species control approaches.

In **Chapter 5**, 28 *Aspergillus* metabolites were analyzed to compliment Chapter 4 in the co-occurrence of other metabolites from biocontrol and non-biocontrol maize. Results provide new insights into the regional diversity and clustering of *Aspergillus flavus* metabolites in Tanzanian maize.

In **Chapter 6**, the thesis extends from the crop level to human health by leveraging human biomonitoring of farming populations through blood volumetric absorptive microsampling and urine analysis. This evidence demonstrates that, despite the implementation of biocontrol and complementary practices, smallholder farmers in Tanzania continue to face a complex burden of mycotoxin exposure most notably from fumonisin B1 (FB1), tenuazonic acid (TeA), deoxynivalenol (DON), and ochratoxin A (OTA) with frequent detection of TeA. These results emphasize the urgent need for comprehensive, context-sensitive strategies that go beyond single-point interventions, integrating ongoing education, rigorous surveillance, improved postharvest handling, and robust community engagement.

In **Chapter 7** this PhD dissertation concludes with the general conclusions which restate the main research aims, synthesize the key findings in relation to those aims, and highlight the overall contribution and implications which cover the main findings. Lastly, **Chapter 8** situates the dissertation's findings within an international context, emphasizing their relevance to global

food safety, public health policy, and sustainable agriculture. It discusses how mycotoxin management strategies developed in Tanzania reflect and inform broader scientific, regulatory, and socio-economic trends, and considers the interconnected challenges faced by maize-producing regions worldwide. The chapter concludes by outlining future perspectives including the need for integrated, multidisciplinary approaches, innovations in monitoring and control, strengthened international collaboration, and adaptive policy frameworks to ensure resilient food systems and continued progress in mycotoxin risk reduction at both local and global scales.