京都大学	博士（工学）	氏名	JANSAKOO THANAPAT
論文題目	THE IMPACT OF AGRICULTURE ON GLOBAL AIR QUALITY: A COMPARATIVE ANALYSIS OF CLIMATE CHANGE MITIGATION SCENARIOS WITH CO-BENEFIT ON HUMAN HEALTH (世界を対象とした農業の大気質への影響 ： 人間の健康に対する共便益評価を含めた気候変動緩和シナリオの比較分析)		

（論文内容の要旨）

This dissertation efforts to examine the interconnections between climate change mitigation, agricultural practices, and air quality. The primary objective of this investigation is to delve into the intricacies of the policy pathways implicated in these domains, with a concerted effort to discern their individual impacts and potential co-benefits. The scope of our analysis will be concentrated on prominent air pollutants, specifically PM2.5 and O3.

Chapter 1 of this dissertation sets the stage by reviewing the intricate relationship between agricultural activities and future air quality, particularly in the context of changing dietary patterns to accommodate a growing global population, drawing insights from a literature of previous studies. The research question centers on understanding how agricultural practices influence air quality in the forthcoming era of dietary transformation. Emphasizing the significance of the study, it aims to contribute insights that inform sustainable agricultural practices and policies. The research objectives are delineated, focusing on the analysis of current agricultural practices, assessment of their impacts on air quality and human health, and an evaluation of the economic consequences.

In Chapter 2, the scope of this research is broadened by employing multiple models such as AIM/Hub and GEOS-Chem to assess the impact of agricultural activities on both air quality and human health. This approach allows for a comprehensive analysis, considering various facets and potential complexities involved in the relationship between agricultural practices and their consequences. The chapter provides a detailed exposition of the basic frameworks and underlying assumptions inherent in each model, offering a transparent overview of the methodology of this study. Furthermore, the initial section of the chapter outlines the overall research framework, providing readers with a cohesive understanding of the overarching structure guiding the investigation of this study.

Chapter 3 focuses on investigating the influence of horizontal resolution in the GEOS-Chem model by conducting a comprehensive analysis of its results in relation to ground monitoring station data. The examination delves into the impact of air pollution on both agriculture and public health. The findings reveal that augmenting resolution enhances the model's ability to reproduce observations at a regional level, though global results do not necessarily exhibit similar improvement. Despite minor differences, the changes in global agricultural and health effects prove comparable to uncertainties associated with emissions inventories and chemical transport models (CTMs). This nuanced exploration enhances our understanding of the model's performance and its implications for assessing the broader consequences of air pollution.

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In Chapter 4, a detailed investigation unfolds regarding the influence of ammonia emissions originating from the agricultural sector. This exploration involves the examination of diverse assumption reduction scenarios to evaluate their impact on PM2.5 and O3 concentrations. To achieve this, an integration of the GEOS-Chem model with meteorological parameters and a health exposure model is undertaken. Ammonia plays a pivotal role as the primary component of secondary particle matter (SNA), and consequently, reducing concentrations of NH3 can contribute to a decrease in PM2.5 concentrations. This connection underscores the importance of addressing ammonia emissions in efforts to mitigate particulate matter pollution, which is crucial for improving air quality and public health. On the other hand, while such reductions can lead to a decline in PM2.5 concentrations, they may also result in an increase in O3 concentrations, particularly in the northern hemisphere. This potential rise in ozone levels highlights the interconnected nature of air pollutants and the need for a comprehensive understanding of the consequences of emission reduction strategies.

Chapter 5 extensively explores the potential impacts of practical recommendations aimed at mitigating greenhouse gas emissions originating from agricultural activities. It places a strong emphasis on dietary changes recommended by the EAT-Lancet Commission as a key strategy for achieving emission reduction objectives. Furthermore, the chapter delves into the potential influence of future dietary patterns within the context of climate change mitigation policies, which aim to cap GHG emissions at 500 Gt-CO2 post-2020. This thorough examination seeks to uncover the intricate dynamics linking climate change mitigation policies, dietary choices, and strategies for reducing food loss, all contributing to the overarching goal of improving future air quality. The findings align with Chapter 4, emphasizing that implementing dietary changes can positively impact air quality and associated health outcomes. Regions such as Europe, Southeast Asia, and China exhibit significant potential for reducing PM2.5 levels and preventing premature deaths through dietary modifications. However, the study also underscores the limited impact of dietary changes on ozone concentrations, particularly when combined with climate change mitigation efforts. Implementing dietary modifications to enhance future air quality is projected to decrease the economic burden of health expenses. The convergence of climate change mitigation and dietary modification, based on the recommendations of the EAT-Lancet Commission, presents a viable path for achieving a sustainable and healthier future for both humans and the planet.

In Chapter 6, a summary of the dissertation will be presented, accompanied by an exploration of its limitations.

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（論文審査の結果の要旨）

本論文は、全球大気化学輸送モデル（CTM)、健康影響評価モデル、作物影響モデルの開発、及びその応用例として、農業起源の汚染物質排出に関する検討を行ったものである。得られた主な成果は以下のとおりである。

１）　低・高空間解像度の CTM の結果を比較して、モデルの精度に及ぼす空間解像度の影響を検討した。その結果、高空間解像度のシミュレーションに多大な時間とリソースを投入することが必ずしもモデル精度の向上につながらないことを示した。

２）　農業活動による大気質への影響の分析をシミュレートした。その結果、アンモニア（NH3）と窒素酸化物（NOx）の排出削減が PM2.5 汚染の緩和に効果的であることが明らかになったが、NOx 排出の削減は PM2.5 レベルに直接的な影響を及ぼさず、オゾン濃度を減少させる可能性を示した。さらに、アンモニアと NOx の排出削減戦略を組み合わせることで、大気汚染由来の死亡率の低下が著しく改善されることを示した。

３）　現在の国際的な共通目標となっている、全球平均気温を産業革命前と比べて 1.5℃上昇以内に抑える気候安定化に相当する気候変動緩和シナリオの下で、食生活の変更を追加的に考慮したときに大気環境に及ぼす影響を評価した。食生活の変更を気候変動緩和策と組み合わせることで大気質改善がより加速することを示した。PM2.5 は一定程度削減されたが、これらのシナリオによるオゾン濃度の変化はわずかで、特にアフリカではオゾン濃度に悪影響を及ぼす可能性があるため、慎重な検討が必要であることを示した。

以上の結果は脱炭素社会への移行に伴う農業の大気質への影響を、①一般的なモデル性能評価と、②食生活に着目して明らかにするものであり、昨今の脱炭素への社会の機運に対して科学的知見を提供する意味で非常に意義深い。また、既存の統合評価モデルと CTM の接続を行った点は学術上、実際上寄与するところが少なくない。よって、本論文は博士（工学）の学位論文として価値あるものと認める。また、令和 6 年 1 月 26 日、論文内容とそれに関連した事項について試問を行った結果、合格と認めた。

要旨公開可能日：　令和　６年　　３月　３１日以降