

Theoretical Framework of “Hidden Hunger” in the Context of Climate Change: Global Governance Challenges of Micronutrient Deficiency

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ABSTRACT

In the era of climate change, the global food system not only faces the problem of calorie shortage, but also faces a more hidden and universal crisis: micronutrient deficiency, which is often called “hidden hunger”. This problem affects more than 2 billion people all over the world, weakening their immune system, cognitive development and working ability. Climate change has aggravated soil degradation, changed the nutrient composition of plants and disrupted the food supply chain. However, the existing rules and organizations are not strong enough to solve this problem well. This study uses the insights of nutrition science, climate economics and global governance theory to construct an analytical framework to study how climate change exacerbates hidden hunger and the obstacles in institutions that prevent us from taking action. Using evidence from different disciplines, we say that hidden hunger is a “thorny problem”: it has complex causes, its impact comes slowly, and the responsibility is shared among too many different groups. Our analysis shows that there are three interrelated ways of climate impact: the direct impact of increased carbon dioxide emissions on plant nutritional quality, the indirect impact of changes in diet and food supply, and the systematic impact of supply chain and economic access problems. We see that governance problems still exist, for example, the monitoring system is not strong enough, the coordination between different departments is not good enough, and funds are insufficient. This study provides a unified theoretical framework to link climate change with nutritional outcomes, and provides concrete ways to improve global governance, such as stronger monitoring systems, better cross-sectoral policy integration and new financing tools.

Keywords: Hidden hunger; Micronutrient deficiency; Climate change; Global governance; Food systems; Nutritional security

1. INTRODUCTION

In the past 50 years, the international community has made great progress in reducing calorie-related hunger. But a more subtle form of malnutrition still exists, even more serious in some areas: micronutrient deficiency, which is often called “hidden hunger”. Unlike acute hunger seen by very thin people, hidden hunger is invisible. It affects brain development, ability to resist diseases and long-term health, and has no obvious physical signs. The World Health Organization estimates that more than 2 billion people lack important vitamins and minerals, mainly iron, zinc, vitamin A and mercury.

Climate change has added new urgency to this problem. The Intergovernmental Panel on Climate Change (IPCC) shows that the more carbon dioxide in the air, the less protein, iron and zinc in rice, wheat and soybeans. These foods are very important to billions of people. At the same time, the climate disturbs the growing season, and water and insects can be used, making food production less abundant and not so good. All these make things more difficult, especially in poor countries that can't adapt to the environment well.

Although there is scientific evidence that there is a link between climate and nutrition, the response of governments around the world is still too weak and poorly organized. Existing institutions, such as the World Health Organization, FAO and the United Nations Framework Convention on Climate Change, work independently, with little coordination and insufficient consideration of the relationship between climate and nutrition. In 2021, the United Nations Food System Summit and other discussions began to discuss this issue, but the specific methods of joint action have not been fully developed ^[1].

This study raises an important theoretical and practical question: how can we rethink and strengthen global organizations to better solve the relationship between climate and hidden hunger? We believe that the hidden hunger and climate change is a “thorny problem”—a complex problem for several reasons. There is no single solution and no central organization can

solve this problem alone. To achieve this goal, we need a system that combines climate adaptation, agricultural policy, public health and trade, while paying attention to local conditions and vulnerable groups.

Section 2 focuses on the basic idea of hidden hunger and how it changes with climate change. Section 3 discusses how climate change can make micronutrient deficiency more serious. Section 4 discusses governance issues and institutional difficulties. Section 5 puts forward the governance plan and practical path. Section 6 concludes with policy suggestions and ideas for future research.

2. RESULTS AND DISCUSSIONS

2.1 The Origin and Conceptualization of Hidden Hunger

The term “hidden hunger” was first used to draw people's attention to a strange problem: people eat enough calories, but they lack important micronutrients. It's not like malnutrition causes weight loss or prevents growth. Implicit hunger is when people get sick more often, have difficulty in study and work less well, and when mothers and babies are at greater risk of death. This idea has changed our understanding of food safety: it is not only to have enough food, but also to have good, diversified food with all necessary nutrients.

2.2 Micronutrient Deficiency: Prevalence and Consequences

Micronutrient deficiency is one of the biggest health problems in the world. Iron deficiency affects about 1.6 billion people and is the main cause of anemia, which can lead to the death of mothers and prevent children from growing up healthily. Zinc deficiency affects one third of the world's population, weakens our immune system and makes us more susceptible to diseases. Lack of vitamin A is the main cause of blindness in children, which can be prevented. This also increases the risk of death from infection. Although some progress has been made in salt hydrogenation, there are still hundreds of millions of people who lack salt, which will lead to problems in learning and growth ^[2].

2.3 The Climate Change Dimension: Reframing Hidden Hunger

Incorporating climate change into the hidden hunger discourse represents a major change in concept. Climate change affects nutrition in many ways, which interact with existing problems. When there is more carbon dioxide, the basic plants have less nutrients, which makes food not so good for us. When the climate causes crop failure and the price changes constantly, it becomes more difficult to buy different foods. When the food chain is broken, you will find less fresh and healthy food. When people have to leave home because of the climate, their food safety is low and their food is poor.

3. PATHWAYS OF CLIMATE IMPACT ON MICRONUTRIENT STATUS

3.1 Direct Effects: Elevated CO₂ and Crop Nutrient Dilution

The most direct way for climate change to aggravate hidden hunger is the nutrient dilution effect caused by the high carbon dioxide content in the air. The research shows that C3 plants, such as rice, wheat and soybean, contain more carbon dioxide when growing, but the content of protein is lower, and the contents of minerals such as iron and zinc are lower. Why did it happen? Because the ratio between carbohydrate and protein has changed, the way plants absorb minerals has changed, which creates a paradox: more carbon dioxide sometimes produces more crops, but the food we get is not good for our health.

3.2 Indirect Effects: Altered Dietary Patterns and Food Availability

In addition to directly diluting nutrients, climate change has changed our eating habits in many ways. Changes in temperature and precipitation have changed the land suitable for different crops, which may reduce the output of nutritious foods such as fruits, vegetables, beans and animal feed. This reduces the diversity of our diet and forces people to eat more basic grains. Economic problems caused by climate, such as crop failure and rising prices, make it more difficult for families to buy food ^[3].

3.3 Systemic Effects: Disrupted Food Supply Chains and Economic Access

Climate change also undermines the food supply chain through extreme weather events, greater post-harvest losses and damage to roads and transportation. Small farmers are particularly at risk because they need predictable time and do not

have enough means to adapt. These problems lead to a decrease in the supply of nutritious food and income in the local market, which prevents people from buying diversified and healthy food.

4. GOVERNANCE CHALLENGES AND INSTITUTIONAL BARRIERS

4.1 Fragmented Institutional Architecture

The global governance landscape addressing hidden hunger in the climate context is characterized by a deeply fragmented institutional architecture. Multiple international organizations hold overlapping but partial mandates, yet none possesses comprehensive authority over the climate-nutrition nexus. The Food and Agriculture Organization (FAO) leads on agricultural systems and food security but has limited climate science capacity and relatively weak engagement with health outcomes. The World Health Organization (WHO) regards nutritional status as a health factor, but it has no power over agricultural production systems or trade policies that determine what people can eat ^[4]. The United Nations Framework Convention on Climate Change (UNFCCC) and its mechanism mainly focus on mitigating and adapting to climate change, but pay little attention to how climate changes our food. For them, food is mainly a source of gas to warm the earth, not a way to give us nutrition.

4.2 Weak Surveillance and Monitoring Systems

In order to solve the problem of hidden hunger in the climate era, it is necessary to establish a good monitoring system to find new nutritional risks, link them with climate-related causes, and help to take action quickly. But today, monitoring tools are not good enough. We don't collect data about plant food regularly, we don't use the same method, and we don't see many places. The changes of micronutrients due to the increase of carbon dioxide concentration were studied in the laboratory, but they were not included in the normal agricultural monitoring. Regarding the survey of what people eat, if any, it cannot be said whether people have enough micronutrients to help them make decisions. Medical signals of micronutrients, such as iron or zinc in blood, have almost never been measured in the population of most countries ^[5].

The integration of climate and nutrition data is particularly weak. Climate models predict temperature, rainfall and carbon dioxide concentration at different scales, but these predictions are rarely related to nutrition outcome models in a way that is helpful for policy planning. The monitoring system operates in an isolated island of institutions, similar to the broader governance fragmentation described above. Climate data are located in meteorological agencies and the Ministry of Environment, agricultural data of the Ministry of Agriculture and nutrition data of the Ministry of Health-each with its own reporting rules.

4.3 Insufficient Financing and Investment

The funding gap for eliminating climate hidden hunger is very large, and it is still expanding. Today, the global investment in nutrition action is about \$20 billion a year, which is far below the required level. In recent years, funds for climate adaptation have increased significantly, but only a small part has been used for actions to help nutrition. The Green Climate Fund and other international climate mechanisms support adaptive agriculture projects, but the nutritional quality of the results almost never becomes an important criterion for determining donations.

We see the same thing in the national budget. What the Ministry of Agriculture wants most is more output-more harvest, more irrigation and more fertilizer subsidies-rather than nutritional quality. The Ministry of Health mainly focuses on treating acute malnutrition and infectious diseases, rather than preventing chronic micronutrient deficiency. Climate adaptation plans often give priority to agriculture and food security, but they almost never say that micronutrients are important goals or indicators. This shows how people think: they believe that if we produce more food, the nutrition will improve automatically ^[6].

Private sector investment in climate adaptation with nutrition is also slow. Food processing and retail industries mainly deal with climate risks by strengthening the supply chain, focusing on the quantity of products rather than improving their nutritional quality. Investment in research and development of improved crops has always focused on yield, insect resistance and drought tolerance-these characteristics can bring immediate benefits-rather than nutritional improvement. Bioaugmentation programs (improving crops to get more nutrition) have proved to be technically feasible and inexpensive, but they don't have enough money compared with anything they may bring.

5. TOWARD AN INTEGRATED GOVERNANCE FRAMEWORK

5.1 Enhanced Surveillance and Data Integration

In view of the decentralized monitoring system we have seen above, the first thing to do is to establish a comprehensive monitoring system to track climate variables, agricultural production quality, eating habits and nutritional results in a coordinated manner. FAO and WHO will jointly develop standard programs for monitoring crop nutrition, evaluating diet and measuring micronutrient levels. These agreements must be made so that results can be compared between countries and over time. The Global Food Crisis Report and the Global Nutrition Report have become reporting tools, but their scope needs to be expanded to include the link between climate and nutrition.

Due to technical and institutional reasons, it is difficult to share and integrate data. The technical problem is the difference of data format among measurement methods, sample selection methods and institutions. Institutional issues are privacy issues, and data rights and institutional rules may hinder sharing. In order to solve all these problems, an inter-agency working group needs to be established, and its clear task is to help integrate data. The team will select the most important data sets, create sharing rules, and build a common platform for integrated analysis.

5.2 Cross-Sectoral Policy Integration and Coordination

As mentioned above, the organization of governance needs a new idea of joint efforts of different groups. Governments can set an example by setting up special groups, such as committees, to bring together people from agriculture, health, environment, planning and finance. These committees must make plans and help climate and nutrition at the same time. They should not just give advice, but they should have the right to make decisions and own their own money. They must also be responsible for achieving specific goals.

On a global scale, we can use existing groups. The review of national independent contributions of the United Nations Framework Convention on Climate Change provides an opportunity for countries to explain how their climate commitments can help nutrition. WHO's global nutrition goals and sustainable development goals are tools to measure the progress in climate and nutrition.

5.3 Innovative Financing Mechanisms

Lack of funds to solve the hidden hunger problem in the climate background requires new means to find resources from several places. Mixed financing, combining public funds and foundation funds with private investment, is a good idea; Public funds can first provide guarantees for risks or losses and encourage private investment in agriculture to help nutrition. Leap in social impact and results-based financing can promote real progress in nutrition ^[7].

International climate funds, such as the Green Climate Fund and the Global Environment Facility, must make it clear that nutrition is an important criterion for donations. At present, only a few projects that adapt to climate change have nutritional goals or indicators. Donating governments can ask their donations to help nutrition projects. This will tell the organization that nutrition is very important.

6. CONCLUSION

This study focuses on the relationship between climate change and hidden hunger, and finds direct, indirect and systematic ways for climate to aggravate micronutrient deficiency. Hidden hunger is a thorny problem in governance, and the current institutions are not fully prepared to solve this problem. Lack of coordination among institutions, weak supervision and insufficient funds hinder effective and collective action.

We put forward three important suggestions for improving global governance: (1) establishing a monitoring system linking climate and nutrition data; (2) Better cross-departmental cooperation with common plans and responsibilities; (3) Looking for new financing methods to help adapt to nutrition-sensitive climate change.

Finally, to solve the hidden hunger problem in the era of climate change, we need to rethink global governance. This is not a top-down thing, but a framework to help local people build a strong, diverse and nutritious food system. By linking climate and nutrition goals, we can move towards a future in which everyone can get enough, healthy and sustainably produced food.

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