Micronutrient Resilience and Climate Change

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Summary

While much attention has been devoted to how climate change threatens food supplies and food security, there has been less focus on the effects of climate change on human nutrition. In the climate change-nutrition discourse, micronutrients play a core role. The impacts and disruptions associated with climate change—including the rise in atmospheric carbon dioxide, greater land degradation, more extreme weather, and rising sea levels, to name just a few—are jeopardizing people's micronutrient status. In addition, at the same time that climatic shocks and crises threaten individuals' nutrition security, climate change-induced rises in the prevalence of waterborne diseases may increase human micronutrient needs. Micronutrients are thus key to mitigating the impacts of climate change on human nutrition. Improving micronutrient resilience in the face of climate change will mean promoting context-specific, sustainable, diverse diets through both food production and connections to markets and trade. It will entail advancing large-scale food fortification as well as investing in the development of climate-resilient, more nutritious key crops (biofortification). And, importantly, it will call for ensuring access to micronutrient-rich foods at the heart of social protection systems and humanitarian activities.

Introduction

The world is in a climate emergency. Since the 1980s, each decade has grown successively warmer. The current mean global surface temperature is 1.1 degrees Celsius above that of the preindustrial period,[1] and it is more likely than not that global warming will reach or exceed 1.5 degrees Celsius by 2040. Atmospheric CO_2, already at 415 parts per million—the highest in human history—is on track to exceed 550 ppm in the next 30–80 years.[2]

The Paris Climate Agreement calls for limiting temperature rise to 2 degrees above the historical baseline. According to the Intergovernmental Panel on Climate Change, the only hope for meeting this goal will require the world to follow a very low greenhouse gas emissions pathway, a course of action that has not yet been taken. Other projected pathways will push us past—in some cases way past—the 2-degree threshold.[3]

Furthermore, as the world barrels toward the 2-degree Celsius threshold, there is evidence that even that threshold may be too high. Exceeding 1.5 degrees could actually trigger multiple tipping points, including the collapse of the Greenland and West Antarctic ice sheets, loss of boreal permafrost, loss of Barents Sea ice, and die-off of low-latitude coral reefs. The resulting sea-level rise, for example, could be catastrophic. And crossing these tipping points can generate feedback loops that make it more likely the world will cross additional climate tipping points.[4]

Much attention has been given to the ways that climate change is threatening food supplies and food security; less attention has gone to the effects of climate change on human nutrition. But the disruptions and emergencies that climate change will bring are likely to threaten people's micronutrient status in a whole range of ways (Figure 1). These threats will occur in a world where billions of people already suffer from micronutrient deficiencies that too often result in disability and death.

Climate Emergencies Are Nutrition Emergencies

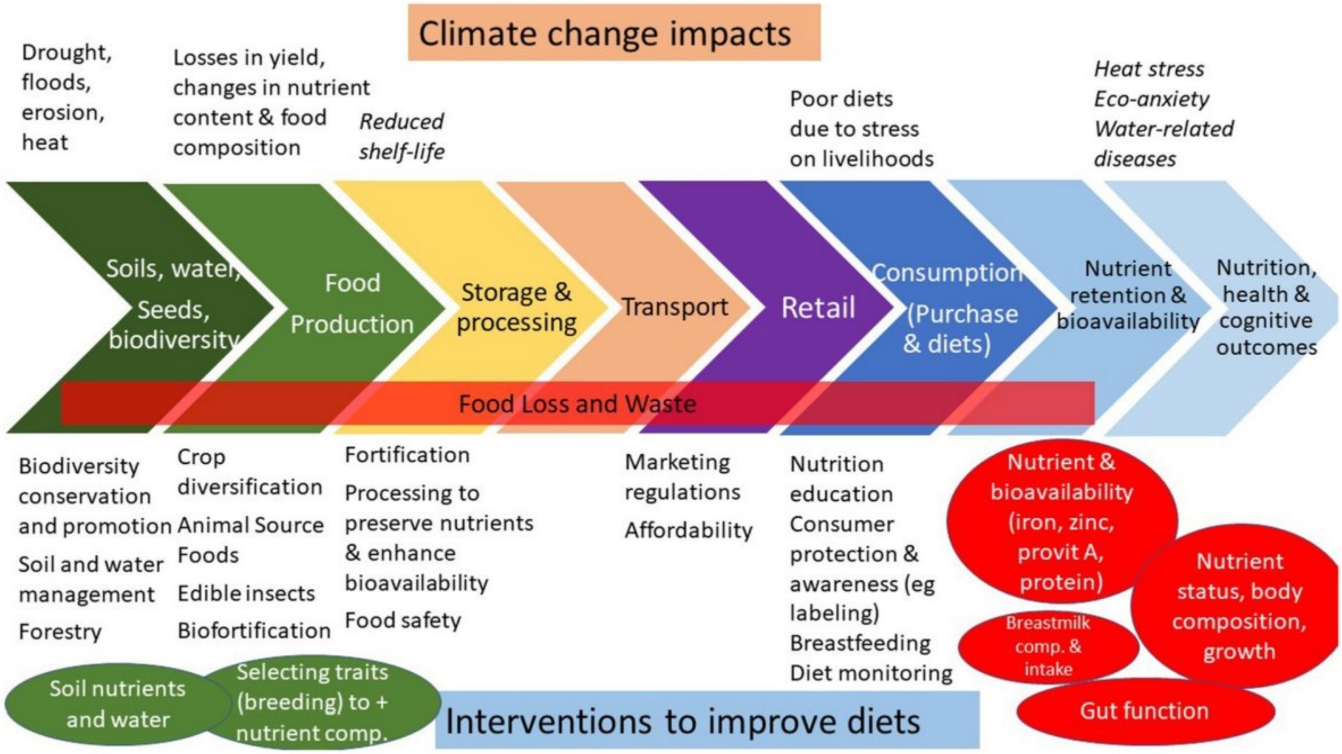
What we eat impacts climate change, and climate change impacts what we eat. Agriculture accounts for about 19–29 percent of greenhouse gas emissions, with livestock production making up more than half of emissions.[5] And climate change is already producing a litany of shocks that affect the production of plant and animal foods. These include the rise in atmospheric carbon dioxide that pushes up average temperature; increased ground-level ozone; greater land degradation; more extreme weather, including droughts, heat waves, and floods; rising sea level and associated flooding and loss of coastal land; ocean warming and destruction of coral reefs; threats to pollinators; and an increase in pathogens.[6]

These impacts reduce the yields of staples like wheat, rice, maize, barley, and soybeans; the yields of nutrient-rich foods like fruits, vegetables, legumes, and nuts; and ocean and inland fishery catches. For a number of crops, they have also been shown to reduce the micronutrient content, particularly of zinc, iron, and vitamin A. In rice grown under higher concentrations of CO_2, the average loss of major B vitamins (thiamin, riboflavin, and folate) was shown to be 17–30%.[7] The numbers of people that can be affected are staggering. One study finds that elevated CO_2 could cause an additional 175 million people to be zinc deficient. More than 1 billion women and children could lose much of their dietary iron intake, putting them at greater risk of anemia and other diseases.[8]

In addition, climate change has started to cause a decline in the diversity and population of pollinators, which are critical for the supply of nutrient-rich foods.[9] A model of the worst-case scenario—a complete loss of pollinators—finds that it would result in a 23 percent decline in the global fruit supply, a 16 percent decline in the global vegetable supply, and a 22 percent decline in the global nuts and seeds supply. For humans, these losses would cause an additional 173 million people to be folate deficient and an additional 71 million people to be vitamin A deficient.[10]

At the same time, the heavy rainfall, flooding, and hot weather associated with climate change are escalating the risk that waterborne diseases will become more prevalent, increasing the micronutrient needs of affected individuals.[11]

Figure 1: Climate change impacts on micronutrient status



Source: V. Owino, C. Kumwenda, B. Ekesa, et al., "The Impact of Climate Change on Food Systems, Diet Quality, Nutrition, and Health Outcomes: A Narrative Review," *Frontiers in Climate* 4 (2022): 941842, doi: 10.3389/fclim.2022.941842.

How Climate Change Threatens Micronutrient Status: Key Impacts

- **Climate change**—higher temperatures, atmospheric carbon dioxide, and ground-level ozone, among other factors—**will reduce the nutrient value of many nutritious crops** as well as staple crops and animal-source foods.
- An increasing number of **extreme weather events**—including droughts, floods, heat waves, and storms—**are reducing yields and pushing down food production**.
- **Climate change is decreasing the number and diversity of pollinators**, which are essential for production of nutritious foods like fruits, vegetables, nuts, and seeds.
- **Rising sea levels will threaten agricultural land** and reduce rice production in the low-elevation coastal zone.
- Ocean and freshwater warming, ocean hypoxia, destruction of coral reefs, and loss of mangrove forests are **reducing ocean and inland fisheries catch**.
- **Climate change-induced rises in the prevalence of waterborne diseases** and other health conditions will **increase the micronutrient needs of individuals**.

Improving Micronutrient Resilience in a World of Climate Shocks

The risks and impacts of climate change mean that we must urgently find ways to increase resilience—that is, the capacity to absorb, adapt to, and recover from shocks. One crucial aspect of this is micronutrient resilience—the ability of individuals, households, and communities to have stable and affordable access to all essential nutrients from diverse sources and to maintain their micronutrient nutrition even in the face of shocks.

The world's population already suffers from a heavy burden of micronutrient malnutrition. According to the latest data[12] reported in *Lancet Global Health* in October 2022, the burden of micronutrient deficiencies worldwide is likely far greater than the past global prevalence estimate of 2 billion. The new data indicates that one in two preschool-age children and two in three women of reproductive age suffer from at least one micronutrient deficiency.[13] As alarming as these new estimates already are, they may unfortunately be an underestimate when considering the current protracted global food crisis. Micronutrient-rich foods are more expensive and more vulnerable to price inflation than staple foods, and during economic crises households often cut back on purchasing these foods. Currently 3 billion people—about 40 percent of the world's population—cannot afford a healthy diet with sufficient nutritious, micronutrient-rich foods.[14] Furthermore, the most food-insecure countries are among those being hit hardest by climate change.[15]

Our food systems do not provide stable and affordable access to all nutrients. How then can we improve people's micronutrient resilience in a context of climate change?

Boosting Diet Diversity

A healthy, nutrient-rich diet relies on diverse food sources. The EAT-Lancet Commission took on the task of determining a universal healthy diet that could lie within planetary boundaries related to climate risk and environmental degradation. It concluded that moving to healthy diets by 2050 would require "doubling in the consumption of healthy foods such as fruits, vegetables, legumes and nuts, and a greater than 50% reduction in global consumption of less healthy foods such as added sugars and red meat (i.e. primarily by reducing excessive consumption in wealthier countries)."[16] This diet is currently largely out of reach for the world's poorest people, who often lack dietary diversity.

Research has shown, however, that simply getting farm households to grow a more diverse range of crops does not necessarily improve their diets or nutrition.[17] In contrast, commercialization of smallholder agriculture has been shown to significantly improve smallholders' dietary quality, particularly in terms of zinc and iron. Connecting smallholders to markets allows them to increase their incomes and in turn consume more nutrients from the foods they buy.[18] Because micronutrient-rich foods are often perishable, it is critical to improve infrastructure that will help these foods travel quickly and safely from the farm to the market to the consumer. This infrastructure should include roads, transport, and cold storage. It will also be helpful to promote light processing that can extend the shelf life of nutritious foods.

On a larger scale, as climate change shifts growing seasons and territories, evidence shows that providing equitable access to global food trade will be more important than ever in helping to improve people's access to nutrients in some poor countries.[19]

Untangling the Pros and Cons of Animal-Source Foods

Livestock production and meat consumption raise several thorny issues in relation to climate change. Animal-source foods—fish, meat, eggs, and dairy products—can be an important part of nutritious diets and may play an especially important role in meeting the nutritional needs of pregnant women and young children.[20] There is some evidence that smallholders can generate nutritional gains when they diversify their livestock production rather than just their crop production.[21] In some low-income countries, nutritious plant-based foods are not available or affordable throughout the year.[22] For poor households, livestock can be an important source of not only nutrients but also income. Yet industrial meat production is a major contributor to greenhouse gas emissions, and there is wide agreement that the average high rate of red meat consumption in high-income countries should be reduced for both health and environmental benefits.

At the same time, climate change will impose stresses on livestock production because of its impacts on, among others, the quality of feed crops and fodder and the availability of water.[23] Sustainable intensification of livestock production can help reduce the environmental footprint of livestock systems while also helping to meet the nutritional needs of current and future populations.

In light of these complex trade-offs, the EAT-Lancet Commission concluded, "The role of animal source foods in people's diets must be carefully considered in each context and within local and regional realities."[24]

Fortifying Crops and Foods

Billions of smallholder farmers rely mostly on staple crops in their diets. Biofortification—that is, breeding nutrients into crops themselves—is a promising way to increase the nutrient value of staples and other crops that can also be bred for their ability to resist or tolerate changing climatic conditions. This approach can help offset the declines in productivity and nutrient content that climate change may impose. Making staple foods more nutritious could help strengthen micronutrient resilience during times when other micronutrient-rich foods are either unavailable or unaffordable. Biofortification can also help promote the independence of subsistence farmers, who can keep part of each year's harvest to resow the following season.

Biofortification research has resulted in, among others, high-zinc varieties of rice and wheat, high-vitamin A varieties of maize, and high-iron varieties of pearl millet and beans—all with climate-smart traits.[25] Biofortified crops have been released in 40 countries. So far biofortification has added only one nutrient per crop, but new technologies could allow researchers to add multiple nutrients to a single crop and help preserve the nutritional value of crops when they are exposed to light or heat after harvest and in storage.[26]

Large-scale food fortification is already widely used in many countries to add key micronutrients—iodine, folate, and many others—to staple foods and condiments. In a context of climate change, fortification is a climate-friendly way of delivering micronutrients, as it requires no new agricultural land or infrastructure for crop production and distribution.[27]

Still, food fortification programs have not yet reached their full potential. More than 80 countries could benefit from fortification programs to add essential vitamins and minerals to additional food vehicles.[28] Evidence suggests that food producers in many countries are not meeting standards for fortification,[29] and populations in remote and rural areas may not have access to fortified products.

Prioritizing Micronutrients in Social Protection Systems

Climate change will bring increased shocks and crises, so it will be important to build micronutrient resilience into social protection systems and humanitarian activities. Provision of adequate vitamins and minerals should be a high priority. Social protection and humanitarian programs could include vouchers or other conditional transfers to ensure people's access to nutritious foods, or they could include targeted distribution of micronutrient supplements; fortified food rations such as fortified wheat or maize flour, oil, and salt; and specialized fortified foods for nutritionally vulnerable groups. Supplements and fortification are likely to be especially important to meet the special nutritional needs of, for example, young children and pregnant and lactating women during food emergencies. Social protection systems must also support breastfeeding—which offers both health and sustainability benefits—during emergencies as well as during normal circumstances.[30]

Ultimately, to create a micronutrient-resilient world, the challenge is to build food systems that are environmentally sustainable and can meet the nutritional needs of all people, even in the face of stresses and shocks that are sure to come.

Recommendations for Action

- **Strengthen markets for micronutrient-rich foods.** This means building better infrastructure for transporting, storing, and marketing perishable nutritious foods and using light processing to improve the shelf life of these foods.

- **Promote commercialization of smallholder agriculture.** Connecting smallholders to markets can help them increase their incomes so they can buy more and higher-quality foods.

- **Scale up food fortification and biofortification.** Large-scale fortification of foods is a climate-friendly way to deliver key micronutrients to large numbers of people. Biofortification of staple crops can help strengthen micronutrient resilience during times when other micronutrient-rich foods are either unavailable or unaffordable, and subsistence farmers can resow these crops year after year.

- **Prioritize micronutrients in social protection programs.** Humanitarian and social protection programs should go beyond providing calories to include micronutrient supplements, fortified food rations, specialized nutritious foods for nutritionally vulnerable groups, and vouchers or other conditional transfers to ensure people's access to nutritious foods.

- **Promote equitable global food trade to better distribute micronutrients.** Although trade improves the global distribution of micronutrients, more can be done to make distribution more equitable. With climate change, the importance of international trade for micronutrient equity will rise.

- **Strengthen data collection.** To guide programs and monitor progress, it is critical to create systems to collect high-frequency data on micronutrient production, market supply, dietary intakes, and nutritional outcomes across population subgroups.

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About the Nutrition for Resilience (N4R) White Paper Series

This white paper is part of a series designed to stimulate new thinking and discourse in advance of the Micronutrient Forum 6th Global Conference "Nutrition for Resilience (N4R): Ensuring Micronutrient Security in an Era of Complex Global Challenges," scheduled for 16–20 October 2023. This hybrid conference, with an in-person component in The Hague, Netherlands, will explore the interdependence of micronutrient nutrition and the resilience of individuals, communities and systems, within the context of a world where global crises are the new normal. **For more information, click here.**

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