POST-CONFERENCE REPORT



Feeding a Climate-Changed World

MAXIMILIAN J. GEBAUER

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Introduction

<< The global food system—including agriculture and land-use change—accounts for roughly one-third of anthropogenic greenhouse gas emissions, making it a significant driver of climate change. >>

Climate change and global food security are inextricably linked. The global food system—including agriculture and land-use change—accounts for roughly one-third of anthropogenic greenhouse gas emissions, making it a significant driver of climate change. Paradoxically, this system is also highly vulnerable to the impacts of a warming climate. Rising temperatures disrupt hydrological cycles, weather patterns, and soil health essential for crop production. Under high-emissions scenarios, the Intergovernmental Panel on Climate Change (IPCC) warns that agricultural yields could decline by 10 to 25 percent by 2050, as severe droughts, floods, heatwaves, and wildfires become more frequent. Such declines would exacerbate global food insecurity-already, on the order of 750 million people faced hunger in 2023—and threaten the livelihoods of the 1.5 billion individuals who grow, harvest, process, and distribute the world's food. Currently, about half of the global population lives in households connected to agrifood systems, so disruptions to these systems, which encompass everything from agricultural production and processing to distribution, consumption, and waste management, can have widespread socioeconomic ramifications.

In the coming decades, policymakers face a dual challenge: feeding a growing, urbanizing population while also adapting to and mitigating climate change. Global population is <u>projected</u> to increase by about 2 billion people by 2050, with roughly 70 percent of humanity living in cities by mid-century. Meeting the food needs of 10 billion people will require producing as much as 50 percent more food by 2050 than we do today. Crucially, this must be achieved under increasingly uncertain conditions-higher temperatures, shifting precipitation patterns, and more extreme weather-without further accelerating climate change. Food production cannot simply expand at the expense of forests or via emissions-intensive methods, as this would undermine long-term sustainability. Thus, leaders must figure out how to produce more food for more people under inhospitable climatic conditions, while simultaneously reducing the carbon intensity of food systems. Failure to balance these goals could destabilize economies, exacerbate poverty and hunger, and threaten peace and security on many fronts.

To grapple with this conundrum at the nexus of climate and food, Perry World House convened a high-level conference, "Feeding a Climate-Changed World," on March 18, 2025. This conference brought together policymakers, practitioners, and academics from world-renowned institutions and diverse national contexts to develop policy insights and research solutions to these multifaceted challenges. Through a series of focused panel discussions, participants examined critical questions, including: How can we produce more food with less environmental impact? Is there a diet that is healthy for both people and the planet? And how might geopolitical dynamics shape food security in a warmer, more urbanized world? Over the course of the colloquium, expert panelists and keynote speakers outlined the stakes and explored a range of potential solutions. They highlighted how global needs will evolve in coming decades and showcased innovations—from the genetic engineering of climate-resilient crops to improved livestock management and regenerative agriculture practices—that could help meet future food demand sustainably. Discussions emphasized the importance of viewing food systems holistically: addressing climate change alongside other megatrends like population growth and urbanization and seeking co-benefits where possible. Participants also delved into the nexus of climate change, urbanization, and nutrition, examining global diet homogenization and what policies countries are adopting to ensure nutritional security under changing conditions. This report synthesizes the key themes and insights from those discussions, offering a descriptive account of the challenges and opportunities identified by conference participants.

Unpacking the Challenge: Climate Change and Food Security

The Triple Challenge: Increase Food Productivity, Improve Equitable Distribution and Access, and Improve Resiliency and Reduce Impact of Food Systems

Policy Recommendations

- Because extreme weather is lasting longer and happening more frequently, decisionmakers need to focus on planning for prolonged crises—not just shorter-term events that affect food security.
- 2. The tensions between household and commercial farms must be resolved with policymakers bringing all actors together to design bespoke solutions for varying types of production models.
- New technological progress is needed to overcome productivity that is on a curve of diminishing returns.
- 4. Countries should prioritize multilateralism, which can yield partnerships, resources, and globally beneficial outcomes.

5. To secure financial resources, stakeholders can make food security more prominent in climate finance discussions as well as in Nationally Determined Contributions. (NDCs); consider revising subsidies that promote production but do not address mitigation; and pursue locally tailored small-scale investments.

The conference opened with a high-level discussion on the key interactions between global food systems and climate change. Panelists conveyed how climate stressors are already straining food systems and surveyed the implications for vulnerable populations. They identified a host of key phenomena: more frequent <u>extreme weather events</u> (from intense droughts and heatwaves to storms and floods) are directly disrupting crop yields and livestock production, while slower-onset changes like desertification, soil degradation, and biodiversity loss undermine the environmental foundation of agriculture. These climate impacts are <u>already</u> <u>exacerbating</u> existing problems of poverty, hunger, and instability.

Panelists emphasized throughout that impoverished and marginalized communities, particularly in the Global South, are <u>most at risk</u>. Smallholder/ subsistence farmers and pastoralists in regions such as sub-Saharan Africa, South Asia, and parts of Latin America are <u>acutely vulnerable</u>. When crops fail or grazing lands wither, these communities face immediate food insecurity and economic devastation. The panel noted that humanitarian agencies are already observing <u>massive needs</u>—for example, a significant share of emergency aid today is directed to alleviating acute hunger and malnutrition. Panelists contended that such efforts are not a long-term solution, and that proactive intervention requires substantive capacity building.

A recurring theme was the feedback loop between climate change and food insecurity. Climate change drives food insecurity by diminishing production and disrupting supply chains, and unsustainable agricultural practices can worsen climate change through land-use changes and greenhouse gas (GHG) emissions. Panelists stressed that this feedback loop can be broken through the transformation of global food systems to reduce their associated emissions and increase the ability of agricultural systems to serve as carbon sinks. Despite the daunting challenges, panelists advocated for a sense of "optimistic urgency." They argued that while the threats are grave, there are opportunities to build resilience if we act swiftly and holistically. They surveyed some present examples of interventions showing success. In Kenya, for instance, community-scale water management projects have helped pastoralists and farmers bridge dry spells, thereby maintaining food production during droughts. However, participants cautioned that future climate variability may be far greater than historical experience. They noted the need to transition from short-term crisis interventions to prolonged crisis management to mitigate the risks and impacts of longer and more severe climate events.

The panelists also derived a framework for evaluating policy interventions that proved fruitful through the conference. The guiding idea is to evaluate policy on a multi-dimensional scale that integrates considerations about climate impact and << Climate change drives food insecurity by diminishing production and disrupting supply chains, and unsustainable agricultural practices can worsen climate change through land-use changes and greenhouse gas (GHG) emissions. >>

human well-being. They identified three key desiderata for proposals: 1) increase food production to feed a growing population, 2) improve the equity of food distribution and access, and 3) do both in ways that enhance climate resilience and reduce environmental impact. Using this framework requires holistic evaluation and deeply integrative approaches.

On the agricultural productivity front, panelists suggested that advances in crop breeding (including both conventional breeding and biotechnology) can potentially deliver crops that are more drought-tolerant, heat-resistant, or pest-resistant, thereby offsetting some climate-related losses. One speaker emphasized low-cost, traditional practices as well, noting that sometimes resilience can be improved by rediscovering indigenous techniques. For example, farmers in parts of the Sahel have restored degraded land through agroforestry and water-harvesting methods that were historically used in the region - an approach that boosts yields and sequesters carbon simultaneously. Removing barriers to adopting such practices could yield immediate benefits for climate adaptation.

Turning to distribution and transportation, panelists argued that major opportunities to strengthen resilience and cut emissions can be obtained through improved efficiency in packaging, transportation, and distribution. It was noted that as countries develop, <u>a greater proportion</u> of food system emissions and waste comes from the processing, transport, and distribution stages rather than just on-farm activities. In many developing regions, <u>inadequate infrastructure</u> leads to high food spoilage rates, undermining food security while also carrying significant environmental costs. One panelist cited the example of West African trucking regulations that historically forced trucks to return empty across borders (to protect domestic haulage industries), resulting in inefficient logistics and higher costs/carbon per unit of food moved. Policy reforms to improve transportation networks, cold chain logistics, and regional trade could thus reduce both food waste and greenhouse gases. Panelists mentioned that in some cases, outdated regulations or market structures incentivize wasteful practices (such as rules that prevent the sale of "ugly" produce, or institutional norms that favor oversupply at events to avoid running out). Tackling these systemic issues could make food systems leaner and more climate-smart.

The discussion also explored the role of livestock in climate-food systems, especially in communities where animals are integral to livelihoods. In parts of Africa and South Asia, livestock often serve as a store of value for smallholders—a buffer against crop failures. However, large herds can contribute to land degradation and are a source of methane emissions. To address this, some suggested strengthening financial services and improving their accessibility so that households are less reliant on holding livestock as their only safety net, which in turn could slow the growth of herd sizes and associated emissions. Others pointed out that improving animal health and productivity-for example, through veterinary services or better feed-can allow farmers to raise fewer animals while obtaining the same output, reducing the overall carbon footprint.

Notably, the conversation extended beyond terrestrial agriculture to include fisheries and oceans, which are central to food security for many coastal and island nations. Panelists stressed that an over-focus on terrestrial food systems risks giving inadequate attention to aquatic systems that are both central for coastal communities and small island states and highly coupled with terrestrial systems. Discussion centered on key issues facing costal/island communities, especially the <u>salini-</u> <u>zation of soils</u>. Moreover, <u>illegal and unregulated</u> <u>fishing</u> by large industrial vessels just outside small countries' waters was noted as a serious problem that undercuts local fisheries management. The need for better governance of global fisheries and support for small-scale fishers was flagged as an often-overlooked aspect of food security in a climate-changed world.

Panelists turned to the question of whether multilateral cooperation is sufficiently equipped to tackle the food-climate challenge(s) identified. Some expressed concern that food security has not received adequate attention in international climate finance-estimates suggest only a small fraction (on the order of 3 percent) of climate funding is directed toward agriculture and food systems. This was taken to indicate a siloed policy approach where climate and food initiatives are not sufficiently integrated. Panelists suggested that breaking down this siloing could bring greater efficiency in the pursuit of such goals. Setting global targets was deemed useful as a starting point—akin to how the Paris Agreement set temperature goals, there could be international targets for climate-resilient agriculture or food system emissions reductions. These can then guide multi-level action, from international organizations to national governments.

Panelists stressed, however, the limits of topdown approaches and the necessity of inclusive processes. Effective solutions must involve local knowledge and community engagement, as food systems are highly context-specific. One expert noted that strategies will differ vastly between, say, large-scale commercial farms in North America and smallholder plots in East Africa. Thus, any global framework needs flexibility to accommodate diverse systems and the voices of those on the front lines, including indigenous peoples and small-scale producers who possess valuable knowledge about sustainable practices. Panelists also cautioned against framing it as an either-or choice: both high-tech innovations and time-tested agro-ecological methods are needed and indeed

can complement each other. An artificial divide between "industrial" and "small-scale" agriculture could impede progress; instead, a hybrid approach that leverages the strengths of each will likely yield the best outcomes.

As the discussion wrapped up, the panelists emphasized that achieving the needed transformation requires overcoming several key barriers. They reiterated the misalignment of incentives—for example, short-term profits may favor practices that degrade land or emit heavily, whereas the societal interest is long-term sustainability. Correcting these incentive structures through high-level policy interventions is one lever for change. Mobilizing finance for climate-smart agriculture, whether via domestic budgets or international aid, was also

found to be crucial. Given the complexity and heterogeneity of food systems, panelists argued that no single solution will fit all; instead, a portfolio of interventions is needed-tailored to local conditions. This means pilots and experiments must be tested across different scales and geographies, and successful models scaled up. Building a strong evidence base-for instance, through medium-scale field trials that demonstrate an innovation's benefits in productivity and resilience-can help convince skeptical decision-makers to adopt new approaches. In summary, the first panel set the stage by clearly delineating the scale of the problem and the broad contours of what solutions must achieve: a climate-resilient, sustainable, and equitable global food system.

Doing More With Less: Innovations for Climate-Smart Food Systems

Policy Recommendations

Supply-side Technologies & Solutions

- 1. Use conventional breeding alongside gene editing, such as CRISPR, to accelerate the development of stress-tolerant crop strains
- 2. Encourage bio-diverse production and consumption, elevating underutilized crops, through research and market development
- 3. Employ regenerative agriculture practices, which are techniques like cover cropping, reduced tillage, agroforestry, and composting that rebuild soil organic matter and improve soil structure. Such practices can turn farms into carbon sinks rather than sources
- 4. Link clean energy with agriculture to power production sustainably. For instance, solarpowered irrigation and farm equipment that run on renewable fuels (like biomethanepowered tractors or electric tractors)

Demand-side Technologies & Solutions

 Invest in more efficient infrastructure to yield economic, health, and environmental benefits. For instance, upgrade rural roads and transportation networks to shorten food delivery times and fuel usage; and expand electrification and cold storage—ideally powered by renewable energy—to preserve food and prevent spoilage

- 2. Use data and analytics to reduce food waste in corporate, as well as other settings
- 3. Address cultural barriers like the "never run out" mindset in business operations or aversions to selling "ugly" produce
- 4. Convert food waste to animal feed, bioenergy or compost in ways that maintain or increase farm/livestock productivity

The second panel focused on concrete policies, technologies, and practices that could enable food systems to meet rising demand sustainably. Building on the framing discussion, this session examined interventions at multiple levels of the agrifood system, from agricultural production to the transportation and distribution of food. The panel took on the framework developed in the first panel: what concrete opportunities exist that can increase food productivity, improve distributional equity, and do so with lower impact and greater resiliency? On the production side, panelists highlighted a range of promising strategies to make agriculture more climate-proof and climate-friendly. One major area of discussion was the genetic modification of crops to develop varieties that can tolerate heat and drought, use nutrients more efficiently. or contribute to mitigation efforts through carbon sequestration in soils. For example, researchers are using conventional breeding alongside gene editing, such as CRISPR, to accelerate the development of stress-tolerant crop strains. Panelists cited successes in developing drought-resistant maize and flood-tolerant rice through international research networks. In the aggregate, the panel underscored that both new and existing technologies should be leveraged. Traditional breeding, informed by farmers' experiential knowledge, remains vital, especially to ensure locally adapted crops. Meanwhile, modern biotechnologies can significantly speed up the breeding cycle for certain traits. Together, these approaches can provide a pipeline of innovations to keep production and resilience gains ahead of climate losses.

Returning to the theme of holistic evaluation, participants noted that crop improvement shouldn't focus only on yield, and that nutritional quality and environmental robustness are equally important targets. For instance, breeding for traits like <u>deeper</u> <u>root systems</u> can improve drought resilience and enhance soil carbon storage. Likewise, selecting for pest- and disease-resistance reduces the need for chemical inputs. There was also discussion of "neglected" crops (such as certain millets, sorghum, or indigenous vegetables) that are naturally hardy and nutritious. Elevating these underutilized crops, through research and market development, could diversify food sources in a climate-resilient way.

Alongside crops, <u>maintaining soil health</u> was identified as an underemphasized path to sustainable agricultural production. Healthy soils rich in organic matter have better water retention, fertility, and carbon sequestration capacity, making farms more resilient to droughts and floods. However, intensive farming has depleted soil carbon in many regions. To address this, panelists advocated regenerative agriculture practices: techniques like cover cropping, reduced tillage, agroforestry, and composting that rebuild soil organic matter and improve soil structure. Such practices can turn farms into carbon sinks rather than sources. An example raised was the comparison between conventional feedlot systems and well-managed grazing systems. When accounting for soil carbon sequestration in grasslands, the climate impact calculus can change-one speaker argued that grass-fed beef could in some cases result in lower net emissions than feedlot beef, if grazing is done in a regenerative way that restores soil carbon. This nuanced point illustrated how the metrics of sustainability depend on system boundaries, and that integrating soil carbon accounting is important when evaluating agricultural emissions.

Another production-side innovation discussed was the push toward energy-efficient and low-carbon farming. As farms increasingly use machinery, irrigation pumps, and even indoor growing systems, there is an opportunity to power these with renewable energy. Panelists mentioned prototypes of solar-powered irrigation and even experiments with farm equipment running on renewable fuels (like biomethane-powered tractors or electric tractors). While these technologies are nascent, they represent the kind of cross-sector synergy-linking clean energy with agriculture-that could significantly cut emissions from the agricultural sector. Life-cycle analysis of farming systems was urged to spot such opportunities; for example, manufacturing synthetic fertilizer is energy-intensive and often fossil-fuel powered, so decarbonizing fertilizer production could make a big difference in the total agricultural carbon footprint.

Moving to the post-harvest stages, the panel stressed that transportation and storage are major leverage points for both reducing emissions and improving food security and accessibility. Currently, the food supply chain beyond the farm gate is responsible for a large share of food-system emissions. It is also where significant food loss occurs, especially in countries lacking robust storage. For example, without cold storage, perishable foods in tropical countries can spoil quickly, leading to lost income for farmers and less food availability for consumers. Panelists argued that investing in more efficient infrastructure can yield economic, health, and environmental benefits. Upgrading rural roads and transportation networks shortens delivery times and fuel usage. Expanding electrification and cold storage-ideally powered by renewable energy-can preserve food and prevent spoilage. One cited statistic was that worldwide, the expansion of the "cold chain" (refrigerated storage and transport) is responsible for about <u>5 percent of energy</u> use, but this figure could grow as cold chains expand in developing countries. Thus, there is a need to deploy refrigeration carefully and efficiently, using innovations like solar-powered coolers or energy-efficient refrigeration technologies to balance improved food preservation with climate goals.

Participants also identified food waste reduction as a key intervention point. One proposed approach to mitigating the problem is the use of data and analytics in hospitality and retail operations to track and analyze kitchen waste to make a business case for waste optimization. Software tools can allow cafeterias, restaurants, and grocery stores to log what food gets discarded and in what quantities, making the true costs of food waste visible. One example was a "track-scale-drive" model in institutional kitchens, where staff weigh and record waste, and the system projects the monetary loss over time, motivating adjustments in purchasing and preparation. Some large hotels and restaurants implementing such tech reportedly <u>cut food</u> waste by significant percentages, which also cut costs and emissions.

However, even with better tracking, there are cultural barriers to overcome. The panel noted that in catering and food retail, a <u>"never run out"</u> rule often prevails—businesses fear the reputational << There is a need to deploy refrigeration carefully and efficiently, using innovations like solar-powered coolers or energy-efficient refrigeration technologies to balance improved food preservation with climate goals. >>

or revenue risk of empty shelves or buffets, so they overstock and overproduce food as a buffer. Breaking this norm requires resetting incentives: one suggestion was to retrain managers to weigh the cost of waste against the cost of a potential stockout, finding a more optimal balance. Changing consumer expectations is also part of the equation. Some grocery chains have started marketing <u>"ugly produce"</u> at a discount to reduce rejection of imperfect-looking fruits and vegetables. Panelists applauded these steps but noted they need to become much more widespread.

Throughout the transport and distribution discussion, the idea of creating value from would-be waste came up repeatedly. For example, converting food waste and by-products into animal feed, bioenergy, or compost can close loops in the food system. One speaker shared that in the United States less than ten percent of food waste is currently diverted to animal feed, whereas in Japan that figure is nearly 60 percent. This shows considerable room for improvement by linking industries, e.g. connecting produce packers or food processors with pig and poultry farmers who can use trimmings and surpluses as feed. Similarly, investments in facilities that can process agricultural residues or sub-standard produce into useful products (like biogas or nutrient-rich compost) would reduce methane emissions from landfills and slash the climate impact of organic waste. The panelists identified policy incentivessuch as subsidies or mandates for waste-to-feed programs or removing regulatory hurdles-as ways to encourage these circular practices in the private sector.

Another key topic was scaling innovations globally and the challenges involved. Even when a new technology or practice has demonstrated success in one context, replicating it worldwide is rarely trivial. Panelists highlighted a few barriers to scaling: First, technologies often need adaptation to local conditions such as soil type, culture, or economics. Second, there can be knowledge and training gaps in the target population, confounding deployment. Third, access to finance can be a limiting factor, especially for small and medium enterprises that drive innovation in developing countries. The panel noted that public-private partnerships and philanthropic funding can play a role in bridging these gaps, providing the initial push to bring promising innovations to scale.

Importantly, panelists emphasized heterogeneity as a central challenge: the global food system ranges from subsistence farms to hyper-modern agribusinesses, so solutions must be tailored. They cautioned against one-size-fits-all approaches. Precision agriculture using sensors and AI might dramatically improve efficiency on large commercial farms, but a smallholder with two hectares might benefit more from a simple weather advisory text message service and a stress-tolerant seed variety. Thus, bespoke solutions—matching the right innovation to the right context—are likely essential for widespread change at scale.

The conversation turned to potential downsides or trade-offs of certain innovations. One audience question raised the issue of genetically modified crops and the social and economic concerns they carry. Historically, some genetically modified (GM) crops were commercialized in ways that gave a few multinational companies <u>significant</u>. <u>control</u> through patents and seed licensing, raising concerns about dependency and loss of seed sovereignty. A panelist responded that newer gene editing techniques like CRISPR could alleviate some concerns: they are faster, cheaper, and can be deployed by public sector scientists or local institutions, not just big corporations. Nonetheless, it was stressed that investing solely in improved seeds without improving farming practices—irrigation, fertilization, organic matter management—could yield suboptimal results.

By the end of this session, a more concrete vision began to emerge of a climate-smart food system. In this vision, production is enhanced by science (e.g. climate-resilient crops, precision farming, agroecology) yet also made sustainable by focusing on soil, water, and input efficiency. Supply chains are modernized and streamlined, reducing loss and waste and cutting emissions through improved logistics. The human element—training, knowledge exchange, and incentive alignment-is recognized as pivotal to tie these pieces together. Panelists reinforced that achieving "more with less" is feasible: numerous pilot projects and regional initiatives have shown productivity can be decoupled from environmental impact. The task ahead is scaling these successes and integrating them into mainstream agricultural development.

Food Security and Megatrends: Climate Change, Urbanization, and Population Growth

Policy Recommendations

- 1. Research the drivers and impacts of a globally homogenized diet of ultra-processed food.
- Foster local markets and the consumption of nutritious, locally grown foods, for instance the direct consumption of sardines in Peru, as opposed to exporting them for animal feed.
- Factor sustainability into dietary guidelines to build awareness and encourage environmentally friendly consumption, noting the policy models of Chile, Brazil, and Peru.
- Employ taxes and stark warning labels (sticks) as well as (carrots) like finance for locally sourced school meals to encourage healthy and environmentally friendly decision-making.
- Focus on consumer education and cultural change to support biodiverse and healthy diets, for instance a Pacific Island cooking show that prioritized local and healthy ingredients.

The third panel turned attention to the interplay of global megatrends—population growth, urbanization, and climate change—on nutrition, with a focus on how the forces reshaping our world are also reshaping what and how we eat and what that means for health and sustainability. Panelists advocated an integrative approach, noting that focusing on any single trend in isolation could lead to blind spots or unintended consequences in another domain. The goal, they suggested, is to find mutual reinforcement: interventions that improve nutrition, advance sustainability, and accommodate demographic realities all at once.

Panelists suggested an additional megatrend is essential-the globalization and homogenization of diets. As economies develop and urbanize, diets around the world have been converging toward a more similar profile: often heavy in calories, fats, and sugars, and reliant on a few staple crops. One panelist cited that just three crops (wheat, rice, and maize) now provide about <u>half of humanity's</u> dietary energy. This homogenization is driven by global food trade and the reach of multinational food companies. While increased trade can improve food availability, it also means local diets can be displaced by ultra-processed foods and Western-style convenience foods. In the United States and increasingly in middle-income countries, ultra-processed products (like packaged snacks,

sweetened drinks, instant noodles, etc.) make up a large share of caloric intake—one statistic mentioned was 60 to 70 percent of calories in the United States <u>come from ultra-processed foods</u>. This dietary shift is <u>linked to rising rates</u> of obesity, diabetes, and other non-communicable diseases worldwide.

Urbanization plays a big role in this nutritional transition. In cities, people are often more detached from food production and may lack the time, space, or knowledge to prepare fresh foods. The panel discussed how urban living can encourage greater consumption of processed and prepared foods: dense urban areas have abundant fast-food outlets and supermarkets stocked with packaged goods. but fewer people grow their own food or cook from basic ingredients. Additionally, urban housing may have limited kitchen facilities or storage, nudging residents toward ready-made meals. The result can be paradoxical: even as cities offer more food variety and ostensibly better access, many city dwellers end up with poor-quality diets lacking fresh, whole food. Low-income urban populations are particularly vulnerable.

Panelists pointed out that different age groups face distinct nutritional challenges, but that the nutritional transition toward sugary and fatty processed foods is affecting all ages. Alarming increases in childhood obesity and early-onset type 2 diabetes are being observed in many developing countries, mirroring patterns previously seen in wealthier nations. At the same time, undernutrition and micronutrient deficiencies persist in vulnerable groups, sometimes coexisting with obesity in the same population—a phenomenon known as the double burden of malnutrition. Panelists debated whether preserving elements of traditional diets centered on locally available ingredients could help stem the tide of diet-related disease. One panelist stressed that a key barrier to changing consumer preferences on this front is that people increasingly perceive packaged foods as safer or more convenient. This perception can undermine efforts to

promote traditional or home-cooked foods. The challenge is to demonstrate that traditional or minimally processed foods can be compatible with modern lifestyles in terms of safety, convenience, and status.

The panel also explored global inequities in nutrition by highlighting how resources flow in the global food system. A case was mentioned of Peruvian anchovies: a highly nutritious fish that is largely exported to be used as feed for pigs and poultry in China, rather than consumed by local populations who might benefit from its protein and micronutrients. This kind of commodity flow raises questions about efficiency and equity. Is it efficient, in a nutritional sense, to convert high-quality fish into animal feed and then into meat, instead of directly into human food? And who decides these allocations? It reflects how global market demand (here, for meat in Asia) can drive local resource use in ways that don't necessarily align with local nutritional needs or climate goals. Panelists argued for re-examining such supply chains to find a better balance, potentially by fostering local markets and encouraging domestic consumption of nutritious exports. They also noted that consumer preferences are not fixed-policies and education can shift preferences toward more sustainable and healthy choices. Thus, there is room to influence both ends of the chain: production decisions and consumption patterns.

Another megatrend discussed was the rapid advancement of digital technology, AI, and data, and how it intersects with food and nutrition. An audience question prompted the panel to consider whether tools like machine learning and big data could help address the topics of the day. Panelists responded with a mix of optimism and caution. Optimistically, digital technologies could greatly enhance <u>precision and personalization in nutrition</u>. For example, machine learning algorithms can analyze large datasets on diets, genetics, and health outcomes to identify optimal diets for individuals. Additionally, <u>drones and remote sensing</u> are being used in agriculture to monitor crops and optimize farming practices which stands to support nutrition via improved yields and food quality.

A central question the panel tackled was: What is a healthy diet for both people and planet? Are there cases where nutritional guidelines conflict with sustainability, and if so, how to resolve them? The emerging viewpoint was that healthy diets and sustainable diets can be aligned but careful consideration and intervention are needed. Diets rich in plant-based foods tend to be both healthier and have lower environmental footprints than diets heavy in red meats and ultra-processed products. However, there can be trade-offs. The key is an integrative approach that considers nutrition, environment, and cultural acceptability together. Panelists praised new holistic dietary guidelines that some countries are adopting. In Latin America, for instance, there's a trend of dietary guidelines explicitly factoring in sustainability-advising citizens not just on what is good for health but also what is good for the planet. Brazil, Peru, and Chile have pioneered food guides that encourage minimally processed, plant-forward diets and caution against foods that harm health or environment. Chile's guidelines, as noted, even include seasonal eating recommendations to reduce reliance on imports and encourage local produce consumption.

Policy measures to promote nutritious and sustainable diets were a major focus. Governments have a suite of tools at their disposal, from education and information (food guides and labeling) to economic incentives (taxes and subsidies) to regulation (restrictions on certain ingredients or marketing). Panelists shared several real-world examples. Sugar taxes—like the soda tax implemented in Mexico—have shown success in reducing consumption of sugary drinks and nudging companies to reformulate products with less sugar. Mexico's sugar-sweetened beverage tax led to a <u>measurable</u> <u>drop</u> in soda sales and an increase in water purchases, as well as prompting beverage companies to offer lower-sugar options. Such taxes not only << Governments often purchase or provide food for schools, hospitals, military, etc. By setting healthy and sustainable criteria for these purchases, they can create a market for better food and model good dietary practices. >>

discourage unhealthy products but can generate revenue that governments can reinvest in health programs, though panelists stressed that earmarking tax revenue in perpetuity for a given end can be politically tricky. Food labeling reforms were also highlighted—<u>Chile famously introduced</u> stark warning labels on foods high in sugar, salt, or fat, and banned marketing cartoon characters on unhealthy cereal boxes, to reduce children's exposure to junk food advertising.

Another area of policy is public food procurement. Governments often purchase or provide food for schools, hospitals, military, etc. By setting healthy and sustainable criteria for these purchases, they can create a market for better food and model good dietary practices. One panelist cited how some countries mandate school meal programs source a portion of food from local farmers or meet certain nutrition standards, which simultaneously supports local agriculture and improves children's diets. This kind of integrated policy can reinforce multiple goals at once.

However, the panel also recognized pushbacks and obstacles. Large food and beverage companies have at times resisted regulations that threaten their products or marketing practices. An example was given of a <u>common tactic</u>: a private company might voluntarily propose a watered-down health initiative to preempt or delay stricter government regulation on their product categories. Some panelists were accordingly wary of public-private partnerships, noting that they can lead to conflicts of interest or piecemeal actions that fall short of systemic change. Others suggested broadening the notion of private sector to include smaller enterprises and social entrepreneurs who are more mission-driven.

Several participants stressed the importance of consumer education and cultural change in achieving diversified, healthy diets. One innovative approach mentioned was leveraging media and popular culture to shift norms—for example, a Pacific Island nation sponsored a reality TV cooking competition featuring local, healthy ingredients to rekindle interest in traditional cuisine. Drawing parallels to tobacco control, panelists noted that a combination of regulations (taxes, marketing restrictions), public awareness campaigns, and support for quitting was what turned the tide on smoking in many countries. They suggested a similar multi-pronged strategy for unhealthy diets: making nutritious food appealing and accessible, while making unhealthy options less pervasive.

As the discussion coalesced, panelists identified priority actions for aligning diets with health and climate goals. They agreed on promoting dietary diversification—both in production and consumption. On the production side, this means moving away from over-reliance on a few major crops and instead supporting a broader array of foods which has the added benefit of building climate resilience by spreading risk and preserving agricultural biodiversity. On the consumption side, it means encouraging people to eat a wider variety of foods, especially plant-based ones, to ensure nutritional balance and reduce environmental pressure on any single resource.

In summary, the megatrends panel portrayed a world in dietary transition, with significant challenges but also clear avenues for action. Urbanization and income growth are transforming diets, often not for the better, but policy and consumer-driven movements are pushing back to reclaim healthy, sustainable eating patterns. Nutrition security was the term used to denote not just having enough calories, but having the right nutrients for all people, which in a climate-changed world will require resilient food systems and proactive public health measures. The experts underscored that achieving global nutrition security by mid-century involves managing demand as much as supply: encouraging healthier consumption (through education, incentives, and culture) while ensuring the food that people ought to eat is available, affordable, and aligned with climate resilience. This two-sided approach—working on both eating habits and food production—is essential given the mega-trends at play.

Geopolitics of Food Security in a Warming World

<< Food security is not just a technical or local issue, but also a geopolitical one – involving questions of national security, global governance, and strategic competition. >>

Policy Recommendations

- In an era of increasing big power competition, it will benefit all countries if agriculture markets remain open and integrated
- Maintaining peace among major powers will in itself be a contribution to global food security
- 3. Multilateral development bank (MDB) reform can prioritize food security, with the banks offering more grants or concessional finance for adaptation and mitigation action across the agro-food system
- Military recognition of the impacts of climate change on food security could bring additional support for planning for and averting food-related crises

The final panel examined how geopolitical forces and international dynamics influence action at the climate–food security nexus. It became clear that food security is not just a technical or local issue, but also a geopolitical one – involving questions of national security, global governance, and strategic competition. Panelists began by observing that the current moment is characterized by heightened geopolitical uncertainty and disruption. Shifting power balances, conflicts, and rivalries are challenging assumptions that have underpinned international cooperation on issues like trade, foreign aid, and climate. One speaker noted that recommendations made even a year ago might need revisiting in light of recent geopolitical shifts. For example, they cited how the <u>United States' evolving</u> <u>stance on multilateral engagement</u> (with periods of retrenchment or skepticism toward international institutions) and aggressive pullback from funding various NGOs and programs in this space can rapidly change the landscape for global climate and food initiatives.

A prominent case study discussed was the Russia–Ukraine war and the weaponization of food. Ukraine is a <u>major grain exporter</u>, and the conflict has disrupted exports of wheat, corn, and sunflower oil, contributing to global price spikes. Panelists described how Russia <u>leveraged these</u> <u>disruptions</u> for political gain: for instance, at times halting grain shipments and then offering grain, or misinformation about grain availability, to certain African countries, in effect using food access as a tool to influence international opinion and alliances. The war also illustrated vulnerabilities in the global food trade system—over-reliance on a few breadbasket regions can be a liability when those regions are in turmoil.

The war's fallout has driven many countries in the Global South to rethink their dependence on global markets and Western-aligned supply chains. Panelists mentioned <u>initiatives by BRICS nations</u> and others to pursue greater self-reliance or South–South cooperation on food and agriculture. While diversification can enhance resilience, it also has limits—not every country can be self-sufficient in food and attempts to do so at all costs could lead to inefficiencies and higher overall resource use, undercutting climate mitigation and adaptation initiatives.

Indeed, one expert cautioned that a trend toward agricultural autarky might undermine global food security in the long run. Take China as an example: China's leadership has long placed a premium on food security, often described as part of the national strategic agenda. Historically rooted in the Communist Party's agrarian beginnings, China's policies aim for high self-sufficiency in staple grains and pork, including maintaining large strategic food reserves. While understandable from a national security perspective, panelists noted that if every big player tries to maximize self-sufficiency, it could erode the global trade system that normally allows surplus in one region to offset shortages in another. International grain markets have traditionally buffered local crop failures—a country hit by drought can import to make up the gap. But if protectionism rises and the surplus is hoarded, those buffers shrink. Moreover, widespread protectionist policies can make price volatility worse, as seen in past food price crises. Thus, the panel highlighted a delicate balance: countries will understandably pursue strategies to secure their own food supply, especially given rising geopolitical tensions, yet the global community benefits if markets remain open and integrated.

Resource competition represents another key focus for panelists. Climate change stands to <u>increasing-</u> <u>ly strain critical resources</u> like water and arable land, and nations may compete for access to these through various means. Transboundary water was one example: many major rivers cross national boundaries, and as flows diminish or become erratic, upstream and downstream countries might clash over water allocation. The panel cited concerns that water scarcity could spark conflicts or be used as leverage in diplomatic disputes. Similarly, fertile land is being sought beyond borders—evidenced by land acquisitions where wealthy or resource-poor countries lease or buy land in other nations to secure food production. While such investments can bring capital and technology, they also raise questions about sovereignty and local benefits.

The discussion moved to how major powers' strategic priorities intersect with food and climate. The United States, for instance, has historically led global food aid and agricultural development efforts (such as the Green Revolution, or more recently the Feed the Future initiative to boost African agriculture). One panelist lamented that the momentum of such programs can waver with political changes, often with real and severe consequences for those at-risk. Recent reporting, for instance indicates that in Sudan, 600,000 people are already experiencing famine, with cutoffs of U.S. foreign assistance having serious impacts. In another stark example, the World Food Programme, for which the United States is the largest single donor, closed its southern Africa office. Participants noted that when major donors pull back, lives are lost. They also highlighted that with the United States stepping back, that other actors, possibly with different agendas, like China or Russia may step up their influence via agricultural investments and aid.

Europe's role was touched upon as well. With recent pullbacks from this space by the United States, the European Union could take on greater leadership in climate and food security arenas. Panelists mentioned that Europe, spurred by its own security considerations is investing heavily in clean energy and could link that with support for sustainable agriculture abroad. There's an opportunity for Europe to champion global cooperation on climate adaptation in agriculture, possibly stepping into a leadership void.

A particularly intriguing point was the influence of great power relations on avoiding worst-case scenarios. Panelists indicated that maintaining peace among major nations was itself a contribution to global food security, because war (especially between nuclear-armed states) disrupts food production and distribution. In worst case scenarios, access to food (or lack thereof) can be used as a weapon of war. It's a reminder, they noted, that at the highest level, geopolitical stability underpins the strength and function of global food systems.

The conversation then shifted to global institutions and whether they are equipped for current challenges. MDBs and agencies like the World Bank, IMF, and United Nations play a huge role in funding and coordinating food security efforts. An audience question on the fate of MDBs elicited concern about the signals being sent by big shareholders, especially the U.S. If major powers de-prioritize climate and food in these institutions, other countries might follow suit. Conversely, reforming MDBs to better address climate-food issues (for example, by offering more grants or concessional loans for adaptation projects in agriculture) could be transformative. Panelists floated the idea of multipolar leadership models: instead of one or two countries dominating, perhaps coalitions of middle powers or regional leaders could drive initiatives on climate-resilient agriculture, bringing in a variety of perspectives and resources. This aligns with the emergence of forums like the G20 in complementing the traditional G7, indicating broader leadership.

Military and security perspectives were also mentioned as potential vectors for changes in this space. In many countries, including the United States, military leaders have identified <u>climate change as a</u> <u>security threat</u>. An audience member noted the importance of military voices in galvanizing action. For example, if militaries begin planning for food crises as security issues (imagine contingencies for climate-driven mass migration or conflict over water), that might prompt governments to invest more in prevention – namely, in climate adaptation for food systems. However, reliance on security framings has downsides: it might sideline humanitarian perspectives or invite securitization that doesn't address root causes. The panel agreed that the framing of climate and food as national security issues can draw high-level attention and funding, but it should be coupled with efforts to ensure equitable and ethical policy responses.

The panelists were candid that global cooperation is at a crossroads. Climate change and food security are problems that demand cooperation, yet geopolitical trends are pulling in the opposite direction with rivalry and fragmentation. They warned that if major emitters and producers focus solely on narrow self-interest, the world could see a failure of collective action that makes everyone worse off in the long run. For instance, if each country fortifies itself but doesn't help others adapt, widespread crises could still destabilize the international system (through refugee flows, price shocks, conflicts) and eventually circle back. Some noted that perhaps only after witnessing the "failures" of the current approach (where climate impacts outpace adaptation efforts) will nations realize the need for deeper cooperation-albeit that is a risky path to take.

To conclude the panel, speakers listed geopolitical pressures to watch that could shape food security in a warming world. These included: rising protectionism and trade barriers, which threaten the free flow of agricultural commodities; intensifying water disputes in key river basins as water scarcity bites; ongoing and new conflicts in food-producing regions, and the growing technological dividewhere wealthy nations and large agribusinesses forge ahead with advanced climate-smart ag tech, but poorer farmers are left behind. This last point on tech disparities is crucial: if small farms in vulnerable regions cannot access innovations like drought-tolerant seeds or efficient irrigation, their productivity may lag further, worsening inequality and dependency. One panelist warned that inequitable access to climate adaptation tools could become a new facet of geopolitics, where those left behind might feel aggrieved, potentially fueling migration or conflict.

Appendix: Conference Survey Results

Experts responded to a survey eliciting their views on several key conference questions.

Q:		
	SOMEWHAT AGREE	STRONGLY AGREE
Through 2050, climate change will post a grave threat to global food security.	30%	70%

Q:

Substantially mitigating GHG emissions from food production systems will jeopardize global food security.

STRON	GLY	SOMEWHAT	NEITHER AGREE
DISAGI	REE	DISAGREE	NOR DISAGREE
50%	Ó	40%	10%

Q:

Food systems can be adapted to prevent climate change from seriously undermining global food security.

NEITHER AGE	EE
NOR DISAGRE	E

	SOMEWHAT AGREE	STRONGLY AGREE	
10%	50%	40%	

Q:

Q:		NEITHER AGREE NOR DISAGREE		
	SOMEWHAT DISAGREE	1	SOMEWHAT AGREE	STRONGLY AGREE
The technologies and practices needed to climate-proof food security largely exist.	20%	10%	60%	10%

Q:

Demand-side interventions (encouraging reduction of food waste, climate friendly dietary preferences) can substantially improve the climate impacts of food systems.

SOMEWHAT AGREE	STRONGLY AGREE
50%	50%

Q:

SOMEWHAT DISAGREE

National/subnational policies should promote climate-friendly dietary choices.

Climate change impacts what

	NEITHER AGREE	SOMEWHAT	STRONGLY
	NOR DISAGREE	AGREE	AGREE
10%	20%	40%	30%

Q:

people eat.

NEITHER AGREE	SOMEWHAT	STRONGLY
NOR DISAGREE	AGREE	AGREE
30%	60%	

Q:

The confluence of urbanization, climate change, and population growth are making people's diets less healthy.

	NEITHER AGREE	SOMEWHAT	STRONGLY
	NOR DISAGREE	AGREE	AGREE
10%	30%	40%	20%

Q:

NEITHER AGREE NOR DISAGREE

SOMEWHAT DISAGREE

SOMEWHAT AGREE Climate change will worsen geopolitical competition over the factors of food 70% 20% production (land, soil, water, seeds, etc.)

STRONGLY AGREE



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