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Issues, Trends, Tools & Surprises — 2024

The *Markets Institute at WWF* identifies global issues, trends, and tools around the most pressing challenges of our time related to the production of food and soft commodities. Each year we publish what we think were the biggest surprises of the previous year and release a list of what may be key emerging developments that will affect the global food system and will be important for producers, consumers, the private sector, and governments to consider as they anticipate issues and trends to respond more effectively at speed and scale.

The lists are identified through research, interviews, data analysis, gleanings from others, and especially through discussions with the Markets Institute's *Thought Leader Group*. As always, we welcome feedback and discussion, so please *get in touch*. We hope you are staying safe and healthy in 2024.

— *Jason Clay*, Executive Director, Markets Institute at WWF

Surprises in 2023

There were many surprises in 2023, an indication that the pace of change is increasing while our ability to anticipate, much less impact, change is not keeping pace. Identifying a single key change in 2023 doesn't do the year justice. In addition, some of the surprises are part of patterns that will continue in the coming years.

One such surprise was the rise of autocrats and demagogues that use "unexpected" change and global political ambiguity to right previous wrongs or even justify dreams of empire. This is accentuated globally through the use of social media and misinformation to inform foreign policy. Also employed are more conventional military tactics, e.g., the occupation of Ukraine and the displacement of Armenians from the Nagorno-Karabakh region of Azerbaijan. This will likely continue as global powers focus on more pressing issues and as climate change brings more uncertain weather that will affect food production.

AI itself wasn't a surprise; last year we identified it as a major influence. But the reach of AI into all aspects of life was shocking. We have barely scratched the surface of its impacts, positive and negative, on society, jobs, privacy, etc., or its ability to be divisive.

On a more positive note, there has been far more movement, more quickly to address global plastics than seemed

possible just a few years ago. While it is clear that there are a lot of issues that contributed to the change in will to address the issue, there are most likely many more with plastics than there are for climate change. There, the focus continues to be more on discussions and stalling rather than measuring, reporting, and sharing results and strategies to actually address climate change.

Other Key Surprises in 2023:

- **Chinese economy not doing well** — This will have consequences. The impact will be felt globally, but perhaps most keenly in export economies that benefit most from China (e.g., Latin America for food and Africa for minerals).

- **The recession in the US and elsewhere that hasn't happened** – While economies have an inertia of their own, the mood is preventing action on climate change and driving a general uneasiness globally.

- **Discussions about "equity" are pervasive** – These conversations are contributing to a rising sense about the importance of fairness, diversity, and equity. This has exploded as an issue in corporate investor calls since 2022 but is already producing backlash. We need a better definition of terms, as well as strategies. This isn't just an inter generational trend; it is also about equity and power in the global south.

- **Enormous success of CRISPR** – The EU and Japan will eat CRISPR bananas; and we are likely to see approval of a Sickle Cell Anemia treatment produced via CRISPR. While use of the technology is becoming more acceptable, the impacts of wider, more diverse use are less well understood.

- **Anxiety, particularly among young people** – Fueled by Covid and the two-year isolation, anxiety is increasingly amplified by social media. WHO says anxiety and depression will continue globally through the 2030s. Weather variability, extreme weather, the impacts of climate change and the changes that will be required to address it, will fuel additional anxiety and depression.

Issues

■ Seeing Opportunities

To effectively address a world in change, we need to start by changing how we see opportunities around us — simple to think about, hard to do. It's like a kaleidoscope — it is always the same number of pieces and mirrors, yet every time you twist it a single notch you see a different configuration. That is the kind of thinking we need to apply to the problems we seek to address going forward, as well as the strategies, tools, and solutions we use. We need to think differently about what already exists and how it might be used. The issue is more about how to think than what to think. We need to start by changing our mind set.

We do not have a lot of money to address the issue of climate change and its impacts and yet we know that huge sums need to be invested, in a timely way, to make a difference. Can we think differently about how we use existing tools? Government subsidies are often used to support the kinds of practices and crops that have the biggest impacts. Can we use the same funding to support the kinds of impacts, products, or markets that we need rather than support something from the past century that has continued out of inertia? Can we support marginal farmers to produce

environmental services and sequester carbon rather than produce crops inefficiently with impacts that are passed on to society?

In terms of global food systems, what are the stranded assets that can be used to produce more or different foods more efficiently? We can start with infrastructure — water, transport, energy, storage, and processing, but also brownfields, inner cities, caves, gas stations, garages, parking lots, etc., as well as repossessed properties, heirs' lands, and the like. Stranded assets come in all shapes and colors. Which can we rehabilitate for different use?

We need to look at opportunities differently. If we can't see the opportunities, we can't seize them.

■ Scope 3 Emissions

Scope 3 Greenhouse Gas (GHG) emissions are nothing new, but we are only now coming to grips with what they mean for supply chains as well as products produced with any raw materials or ingredients that have embedded impacts — the impacts that have not been accounted for and that are passed on to downstream buyers. Embedded Scope 3 GHG emissions are the focus of most of the concerns today, but embedded social impacts, like slave, bonded, or child labor, are also critical legal issues that must also be accounted for. How to monitor and measure emissions credibly is difficult but not impossible. We need common tools like life-cycle assessments as well as parameters and data sets. Today we do not have those.

At the heart of embedded issues like Scope 3 GHG emissions is the lack of traceability about where products were produced and transparency about how they were produced. The focus to date has been companies trying to get this information through their supply chain partners, but the information generally dries up when it comes to traders and commodities.

The creation of commodities has created a trading platform where such products are graded and aggregated based on physical characteristics. Specific information about where and how they were produced is lost. At this point, traders are dragging their feet at setting up the systems that are increasingly required not just by companies but by governments to trace these goods. The EU Deforestation Regulation is forcing deforestation-free commodity imports in 2024. China is also pushing Brazil and others to take deforestation out of imports like soy, and it is reducing GHG emissions by purchasing only younger animals. As countries weigh in on this issue it will tend to force exporters, traders, and buyers alike to address the issue. If we are to address climate targets and other metrics required for a more sustainable and resilient food system, then we need to measure critical impacts, set targets, and report results over time.

■ Blue Resources

The world is investing in the blue economy both in exploration and exploitation of harvesting natural resources from the oceans. Given the nascent level of knowledge about some of these materials as well as how to harvest them or how to reduce the impacts of exploiting them, we are likely to see increasing conflict over blue resources.

Rights and access have not been fully developed, much less implemented. As a result of climate change and the warming of oceans, seafood fisheries are shifting beyond traditional boundaries, often moving from one jurisdiction into others. Most of the world's fisheries are not managed today and don't even have good stock assessments. As they shift, it will be even more difficult to bring them into credible Fishery Improvement Programs (FIPs) much less make them legal and reduce the number that are Illegal, Unreported and Unregulated (IUU).

There is also a significant increase in both interest and investment in seaweed farming. Seaweed is on the path to being the next alt-protein-like investment. Seaweed is now seen as a great potential source of human food. It is also being used as a feed supplement to reduce enteric fermentation and methane emissions from ruminants, using delivery systems that are effective both for pasture-raised animals as well as beef and dairy stock that is fed. Seaweed extracts have successfully reduced enteric fermentation when added to cattle feed or introduced to water or mineral salts for animals that rely entirely on pasture for feed. Seaweed is also being explored for carbon sequestration — though a lot of work still needs to be done to determine how much carbon can be sequestered, how permanent it is, and what the impact is on benthic organisms in the most productive upwelling areas if seaweed is produced simply to drop onto the ocean floor. It is also possible that several different markets could be available to single seaweed production systems.

On a related issue, seabed mining is now gaining momentum, with Norway recently approving seabed exploration for minerals that are used for EV batteries. Climate modelers insist that the tradeoffs don't make sense from a climate perspective and the better pursuit might be on battery design, recycling batteries, or extracting the minerals on land. To date, information is scarce on the impacts of seabed mining on benthic biodiversity and the food chains of different trophic levels of marine organisms.

Impact of Climate Change on the Food System

The impact of climate change on food production has increased faster than projected. This reality is compounded in the food sector by governments, traders, producers, and others who want to stall as long as possible before addressing climate change. Most won't implement strategies to address climate change immediately because they don't have to, and because they are afraid that if they do, they will be at a competitive disadvantage.

In the near term, the impact of El Nino is expected to be accentuated by climate change and have a much more significant effect on food production, particularly in Latin America. This will affect the production and likely increase the price of several key globally traded agricultural commodities. Previous forecasting suggests that the 2030s will be a decade of considerable global drought with most major agricultural production regions expected to be affected.

Another likely impact of climate change is a reduction of the nutritional value of a range of different crops under climate change. A potential solution would be to reintroduce different varieties of commodities or to introduce new crops into regions as their suitability for continued production of existing crops declines. New varieties or entirely different crops could be more climate-resistant and screened for the nutritional impacts of climate change. To date, however, innovation has been focused on productivity, input efficiency, and even drought tolerance. Nutrition, however, hasn't been where innovation has been focused for 40 years.

Addressing the Impossible

Time and again when solutions are put forward for some of the most difficult, intransigent or complicated problems, they are deemed impossible — often by those who are best suited to design, approve, or otherwise implement a proposed solution. For example, politicians are quick to say that something can't be done because they know how hard it is to make change happen in their world. Farmers will tell you that something can't be done because they have not done it before, or they do not want to embrace the uncertainty required to transform their piece of the global food system.

Concerns are legitimate, but they can't just be excuses to do less or do nothing. We need transformational change. Climate change, population growth, and increased and different demands for food require systemic, global transformation. Piecemeal solutions won't do. We need to eliminate some previously acceptable practices, not just improve the better ones. We may need different interpretations of existing law or new laws; water and land rights are top of the list.

Trends

■ **Extreme Events (and Insurance)**

The number of extreme global weather events is increasing rapidly. In the US, there were 28 extreme events of $1B or more in 2023. Those included severe weather and hail, flooding, cyclones, tornado bursts, winter storms, drought, heat waves and wildfires. The number of events in 2023 increased by 40% over the average in the three previous years. From 1980 to 2019, the average number of events was eight, versus 22 this decade. El Nino is expected to increase the number of such events in the coming year.

This data only reflects the economic costs in the US, and it doesn't even acknowledge the other costs. Many people are uninsured or underinsured. It is not clear if the value of food loss in the field is reflected in these numbers or if that is all reported through the USDA. These numbers are often based on insurance value, excluding items that are uninsured. Also, losses may be better understood in the context of opportunity cost more than just replacement value. Most important, perhaps, is that one person's insurance does not cover another person's increased costs. If a farmer produces less food and a consumer has to pay more for food, is that included in the cost of climate change? Not normally.

To understand the global impact of extreme events linked to climate change, we need to be measuring the things that are most relevant and measure them in the same way. Today, we are not.

We are also going to need to rethink insurance, what it covers, and how it covers it. In California, insurance will no longer cover housing losses due to wildfires. They have just become too common. Similarly, more and more insurance companies are unwilling to cover flooding in coastal areas. In some cases, governments are stepping in to underwrite such policies.

However, as the data gets better and the impacts increase, we will need to make decisions that help us identify and then protect those goods and services that are important for everyone, e.g. food, water, infrastructure, etc. It is likely that we will need to start looking at long-term, affordable, up-front loans in key areas and sectors. Those should leverage additional investments in resilience in the face of climate change rather than simply be payouts to rebuild after a climate disaster event. It would be interesting to explore whether insurance companies could be rated based on how their investments reduce long-term impacts of climate change, rather than just how quickly and effectively they pay out to customers to rebuild . . . and then start the process all over again. It is not at all clear that the insurance industry, as we know it, will survive the latter strategy.

■ Extension to Farmers

Extension services for farmers globally are inadequate and decreasing in the face of change. As economies have slowed, infrastructure has aged and funding for COVID-related expenditures needs to be repaid. As a result, government support has waned just when farmers need access to more information, research and analysis, advice, and technologies to know what crops they should be planting or shifting to and when they should do it.

But most farmers, especially those with the biggest environmental impacts, need a different kind of extension. They need to measurably reduce their impacts, and in some cases become legal. Huge numbers of farmers do not have title to their land, so making long-term investments is difficult to finance. Given that farmers are living longer, they need help with succession plans and transitions. They also need advisers to help them anticipate future crops and their impacts on production and markets. They need support deciding which land they can rehabilitate profitably and which they can devote to new markets for carbon sequestration and other environmental services. Government extension services are not geared to provide such advice. Governments might think about more specialized technical assistance to meet these needs.

■ Awareness of Soil Microbiology

This year the awareness of soil health will finally begin to shift from discussions of regenerative agriculture and carbon sequestration models to the discussion that has been needed for decades — looking at and understanding soil as its own biome. While it will take years to fully make this pivot, it is important to build the discussion on the available science and research. In addition, we must expand awareness about the role that soil must play in credible strategies to reduce the impacts of food production on climate change — and vice versa.

Research suggests that underground mycorrhizal fungal networks are critical to plant health, access to nitrogen and phosphorous, carbon sequestration, and stored carbon. Scientists have also found that underground mycorrhizal networks in 1 km2 extended 660M km, or four times the distance from the earth to the sun. Some 90% of plants use symbiotic exchanges with such networks to extract carbon from the atmosphere, convert it to sugars and fats, and exchange them with mycorrhizal fungi for nitrogen and phosphorous.

This process started 450M years ago and is what allowed life, starting with plants, to move onto land. Today, 30-50% of living biomass is estimated to be in soil. And the areas of greatest carbon storage in soils are in tundra and boreal regions — far more than in rainforests. Recent research suggests these subterranean networks are responsible for sequestering a third of global emissions. Soil disturbance during habitat conversion and tillage over time destroy these complex mycorrhizal networks.

The FAO suggests that 90% of soils used to produce food will be degraded by 2050. Rebuilding them is essential and mycorrhizal networks will be critical. It is also the way to sequester increasing amounts of carbon. Adapting this science to rehabilitation and restoration will be critical, but it will take years. And, to date, soil microbiology startups have largely failed. However, once the issue is on the table and its importance is clear, others can begin to develop the tools and business models to deliver results on the ground. To integrate this process optimally into farming (excluding pasture and areas of perennial crops) will require no-till and rotations that do not disturb underground mycorrhizal networks.

■ Shifting Markets

Starting nearly a decade ago, companies began paying farmers to reduce GHG emissions or sequester carbon by shifting to more regenerative production practices. The purchases were based on calculations made with models. Several entities were created to bundle and create carbon-offset markets to sell this carbon at higher prices to much larger buyers. This is not generally considered credible carbon within the global food system. Credible carbon purchases need to be made within supply chains and then retired rather than sold to others on speculation. However, even in the last decade, it is clear that many of the assumptions about avoided GHG emissions or sequestering carbon have not held up, as a single year of drought can reduce the carbon sequestered for several years.

Shifting markets from those solely based on food to markets for avoided GHG emissions and carbon sequestration is necessary and important to make production more resilient and reduce emissions. But it is insufficient as an incentive, as most of the markets to date are paying farmers to do things that they are already doing or that are relatively easy to do. Reducing carbon absolutely by 80% will require increasingly significant investments. Carbon markets have taken hits a few times over the years due to questions about the credibility of carbon measurement, the use of models as proxies to measure sequestered carbon, and/or the permanence of any soil carbon sequestered.

It is already clear that carbon markets alone will not induce farmers globally to make the changes needed to reduce not just GHG emissions but also impacts that make food production less sustainable and resilient. Markets for methane are now being discussed because in the short term, reducing methane production has several times more impact than reducing CO_2 emissions. It will be even more significant if markets begin to be tested and created for water effluent and stream flow, reduced soil erosion, habitat protection, biodiversity or even nature.

Tools

■ AI and Machine Learning

The pace of invention, adaptation, and adoption of artificial intelligence (AI) and machine learning is exploding. It is affecting every aspect of life, generally, as well as all aspects of the global food system. In many instances, the horse has left the barn. While most of the impacts have been positive, the speed of change in the private sector suggests that the regulatory challenge is beyond the capacity of the public sector.

Excitement about the value of different applications notwithstanding, there are downsides. Not everyone can afford or have equal access to these technologies. While there are already proven positive impacts for many from AI, those who are creating or buying these technologies will tend to use them to further their own interests. As a result, deep fakes, misinformation, automated lobbying, collapse of trust, challenges to laws and contracts, confidentiality, blackmail, cyberweapons, etc., are becoming more common. In short, access could and should be open to everyone but in practice it is not. Even if it were, those involved would be only a small fraction of the global population because they have the education and experiences to see the advantages of such technologies. Most have not.

The issue is not just about regulating AI and machine learning in the private sector; it is also for the government to use the two more aggressively in ways that "raise all boats." Even a few companies moving considerably faster than the herd will not move the bottom or create the transformational change that is needed quickly and at scale. To cite one

example, better weather forecasting could do wonders for agriculture and food production while also reducing food loss and waste. We need to close the gap in accuracy between seven- to 10-day forecasts and annual trends. For food, the time frame of two weeks to four-to-five months is critical. Everyone would benefit.

Likewise, everyone on the planet would benefit from more transparent supply chains — if for no other reason than to reduce GHG emissions and other key impacts of food. While we have the tools to address this issue, transparency is blocked by a few companies that make money from mixing products or from charging additional fees for physically segregated commodities where transparency is maintained. Not only is this approach piecemeal, but pivotal companies create competing systems that are not interoperable. We need just one.

Agencies like DARPA in the US or EMBRAPA in Brazil need to identify the key impacts that AI and machine learning need to address both for humanity and the planet. In the coming years, the key problems and impacts in the global food system will become more apparent. And we will begin to see a greater allocation of funds and human energy to address them. AI and machine learning will certainly be tools used in these strategies. But to be effective, the focus will need to be on problem solving rather than tool development per se. Knowing what the key issues are, finding ways to collect data globally and using that data to provide information for improvement will be essential for addressing climate change and the global food system. But this will address the most pressing issues only if this is a shared enterprise and data set.

■ Certification

Within the global food system to date, certification systems have ensured legality (laws and regulations), product consistency (global commodity trading systems), health and safety (Codex Alimentarius), production processes (International Standards Organization) and better social or environmental impacts (various private voluntary standards).

These systems have generally accomplished their goals, but even collectively, and much less individually, they do not create the continuous improvement or the transformation that we need to see in the global food system. Each focuses on a piece of the system rather than the whole and on what we want to see more of rather than what we want to see less of or eliminated altogether.

As we try to measure where GHG emissions are along the value chain, how and why they are produced, who produces them, and what incentives it would take to reduce them, it is clear that the certification programs and the trading systems of today were neither created nor intended to address these issues. As such, they are not fit for the purposes needed going forward, i.e. credibly measured GHG emissions with 80% absolute reduction and 50% absolute reduction in other key environmental impacts from producing food. Today's certification and commodity trading programs are efficient at what they do — unfortunately what they do is to mix or blend product regardless of how it is produced. Yet, how a product is produced is now becoming one of the most important issues not just for more sustainable production, but also for a more resilient food system.

Going forward, we need global food systems that weed out the least efficient and most impactful production and credibly maintain product identity so that impacts are transparent for downstream buyers and not mixed and masked as they are today. In addition, trading systems should be based on shared public information that allows access to those who buy products or ingredients; consumers need to know that they are getting what they are paying for without

unwanted embedded qualities (e.g. key environmental impacts like deforestation and conversion or social impacts slave or child labor, etc.).

This year, draft language and the overall conceptual focus for Codex Planetarius, a proposed set of minimum environmental performance standards for select globally traded commodities, will be introduced and made available for public comment. Several global organizations are collaborating in the development of the concept. Public comment will be sought on the impacts to be addressed, as well as proposed metrics, commodities, geographies, and how the concept might be rolled out over time.

Market Mechanisms that Cover the True Cost of Food

To date, humanity has been drawing down the renewable natural resources of the planet by both converting and reducing natural habitats to produce food, and once converted, producing food in ways that degrade soil health. In the face of increased population and consumption (compounded by the impacts of climate change), we need to reduce the absolute environmental impacts of producing food. Increases in productivity and efficiency have not addressed this issue. In many ways, they have actually increased the gap between better and worse producers. Now, we need to mind that gap. We can start by addressing the most significant key environmental externalities from food production and rebuilding habitat and environmental services in production areas to ensure that food production maintains or improves soil health going forward.

Economists, environmentalists and even producers have long known that farmers are not paid the actual costs of addressing the key impacts of production. The 2023 UN FAO True Cost of Food report is the first global study to explore the actual costs of producing food globally. Now that we have a global baseline, we can find ways to ensure that producers are paid to address the actual costs of food production. In the next few years, we need to begin to develop and test different strategies as well as market mechanisms to address this issue. If we want plentiful food in the future, we need to ensure that production is more sustainable and resilient. We can start by agreeing on key impacts of global food production and testing market mechanisms and trade requirements that would help us get there.

Knowing the true cost of environmental externalities is one thing; addressing them is another. One proposal being floated to test a market mechanism is the 1% Solution. The idea is to add a 1% environmental premium on top of the FOB commercial price of key globally exported food items. All of the funds produced would be used within the country of export to help the poorest performers address and eliminate their most significant impacts. As global population and consumption has increased, global food trade has doubled every 20 years, to 30% of global production today. While food trade is essential for global food security, global consumers should be covering the true cost, including environmental ones, of producing food. Today, food exporting countries are subsidizing global consumers. That is not sustainable. Consumers should cover the actual costs of producing the food that they purchase. The 1% Solution may not be the right tool or delivery system but at the very least it can kick off the discussion that will get us where we need to go.

Next Gen Genetics

Recent discoveries show that biology can help producers address drought and weather variability as well as overall productivity. However, it is increasingly clear that biology will begin to replace chemistry as the source of other critical

production inputs like pesticides, fungicides, herbicides and even fertilizers. Biology is already being used to reduce the need for other inputs and in some cases will simply replace them altogether. That is good news as it could reduce some key environmental impacts, both direct and indirect, of producing food.

We are entering a period when many input issues will increasingly be addressed by traits in the seeds that farmers purchase. This is critical because the majority of global farmers have never had ready access to or been able to afford the different inputs individually, much less optimally, at a single point in time. All-in-one inputs like seeds with new genetics, however, while available, may not be affordable to most farmers globally. New business models could allow seed companies to sell their seeds at steeply discounted rates by retaining the avoided GHG emissions associated with the use of energy-intensive inputs. Seed companies could aggregate the credible individual GHG emissions reductions of smaller producers at a previously unheard-of scale. Through aggregation at scale, the individual tons of carbon would be much more valuable to buyers because the seed company would be a one-stop shop. It is this type of thinking that will allow seed companies to scale more quickly.

CRISPR and subsequent tools will be critical to this transformation from chemistry to biology. Products are in development that are even more drought-tolerant, that expand production ranges and reduce times to market. Seeds are being developed that will allow plants to tap increasing amounts of nitrogen and other fertilizers. Bio-based products are also available that help plants address pests. As these products increase, many farmers will be able to significantly reduce their absolute GHG emissions.

■ Knowledge-sharing Platforms

Several years ago, we first identified knowledge sharing as part of any credible response at speed and scale for addressing many of the issues that producers, companies, and supply chains are currently facing. We called such platforms pre-competitive platforms because they tended to focus on how commodities could be produced more efficiently, not about how they were marketed or sold. The first clear sector-wide success was the Global Salmon Initiative, where producers worked together to get production certified, reduce key impacts, and adopt proven management practices more quickly. The Dairy Marketing Institute (DMI) and the US dairy industry have also made considerable progress at reducing key impacts, sharing information and data, and evaluating new technologies more effectively.

Now a series of pre-competitive platforms are being established to allow companies to learn more about how long-term contracts can leverage change with suppliers. They do so by addressing key sustainability and resilience issues, learning from other sectors how ESG screens and databases can be used to address how feed is produced. That allows them to identify and track feed ingredients across animal proteins and create cloud-based databases that can be provided to buyers for credible transparency.

Governments are also beginning to create platforms for sharing knowledge. Open Data involves more than 70 countries that are part of the Open Government Partnership that are committed to sharing administrative and scientific research data. Not only does everyone learn faster, but the costs can be distributed more equitably. This will become a critical tool to ensure that less-developed countries get access to new models and technologies.

Unfortunately, neither producers nor governments are sharing information about how production and production practices are shifting due to the impacts of climate change. This is the next phase of precompetitive platforms. It will

be essential for pivoting away from some crops to others and identifying and addressing new impacts more quickly. It will also help producers make new mistakes and share the lessons so that everyone can learn more quickly about what works, what doesn't, what it costs, and how to sequence investments to make the best use of finance.

Many producers are focused on regenerative agriculture and bringing existing production back to a more productive state. This approach is appealing because it is generally interpreted as the adoption of a set of practices. What is needed, however, are systems and producers that can respond more quickly to external changes and still exist. That is the resilience that we need in our food production systems to best address the impacts of climate change. The challenge is that we need credible indicators, metrics, and systems that not only store the data but also are used to anticipate changes.