

INNOVATING  
THE FUTURE OF  
FOOD SYSTEMS

Executive Summary

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# NOTE FROM GKI'S CHIEF OPERATING OFFICER SARA FARLEY

Dear Reader,

If, like me, you are equal parts inspired and overwhelmed by the magnitude of Sustainable Development Goal 2: *End hunger, achieve food security and improved nutrition, and promote sustainable agriculture*, then in January 2017 you received some mixed news. In that month the World Economic Forum released the results of a scenarios planning exercise that offered a glimpse into four possible futures for global food systems. Ranging from dire to promising, the scenarios provoked many questions. Among them: what must we do to stave off the most ill-fated future? What investments should we make? What long shots in research, technology, and innovation should we develop and scale? And how do these scenarios vary depending upon whether you live in a low-, middle-, or high-income country?

These unanswered questions were enticing in their criticality. And so my team at the [Global Knowledge Initiative](#) (GKI) initiated a "Scan for Transformational Innovations." Guiding our scan were a set of assumptions we'd developed through previous work in futures and innovation assessment, namely:

- The future isn't a fixed point in time. It is malleable and the very act of exploring it is a first step in shaping it.
- For any challenge substantial enough to be dubbed "pressing", "grand", or "complex" a multitude of innovations—likely straddling process, product, organizational, and market-based—will be required.
- The way in which innovation delivers impact is incredibly context-specific. Understanding systems is key to understanding whether and to what degree innovation will matter.

Guided by these ideas, we began our Transformational Innovation Scan by looking at innovation from two angles. First, we wanted to understand those innovations existing today that hold the most promise to transform food systems in emerging markets in the next five years. Second, we sought to make sense of those forces shaping our world, such as urbanization, wealth disparity, a changing climate, and nutrition and health inequities, to distill how they are transforming the context in which food systems will exist in 2035. We recognized that contending with these forces of change, and transforming food systems to be more environmentally, economically, and socially sustainable, demands unleashing innovation that is as transformational as the forces reshaping it.

To imagine, identify, and evaluate such transformational innovations were the motives behind this research effort. We paid special attention to innovations that address post-harvest loss. GKI currently serves as the [Innovation Partner for YieldWise](#)—The Rockefeller Foundation's \$130 million 7-year initiative to halve post-harvest food loss (PHL) in the developing world. However, we opened the aperture more broadly, scanning also for innovations germane across global food systems. Filtering these ideas through an expert-driven research process guided the design of our methodology. Through it, we succeeded in ushering 50 global experts through parallel processes to pinpoint likely matches between future scenarios and the innovations that can improve them on dimensions social, environmental, and economic. This report marks the conclusion of our research.

Whether you are an investor, policymaker, philanthropist, business leader, or development practitioner, we hope you'll find value in using the insights offered in this report to unleash innovations best poised to advance our planet toward a more sustainable and inclusive global food system. In doing so, we hope you'll find hope, inspiration, and fuel for your own innovation journey in these pages.

- **Sara E Farley**, Co-Founder & Chief Operating Officer, GKI

# EXECUTIVE SUMMARY

The future of global food systems hinge on how we respond to the challenges of today and prepare for the challenges of tomorrow. In its 2017 [Scenarios Analysis on Shaping the Future of Global Food Systems](#), the World Economic Forum foreshadowed global food systems in 2030 teetering between unsustainable production and consumption and torn between isolationism and collaboration. Called to action by these scenarios, the Global Knowledge Initiative (GKI) and The Rockefeller Foundation endeavored to identify the top immediately investible and emerging innovations that will be catalytic in reducing post-harvest food loss (PHL) and transforming food systems in emerging markets within the next 20 years. Thus, GKI conducted an Innovation Scan from April to October 2017 in its role as the Innovation Partner grantee for The Rockefeller Foundation's YieldWise Initiative, a \$130 million initiative to demonstrate 50% reduction in PHL in key value chains by 2030. [This report is the culmination of this effort.](#)

## THE GOAL OF THIS EFFORT WAS TO DEEPEN OUR COLLECTIVE UNDERSTANDING OF THOSE TRULY TRANSFORMATIONAL INNOVATIONS THAT WILL RESHAPE FOOD SYSTEMS IN EMERGING MARKETS FROM NOW TO 2035.

Through this Innovation Scan, we engaged global experts in the fields of agribusiness, academia, investment, innovation, international development, and Futures Foresight to examine the above challenge from two angles:

1. **What are the most promising innovations that exist today, or are just over the horizon, that merit investment?**
2. **How can next-generation innovations bridge the gap between the present state of the food system and the future system to which we aspire?**

Our findings to the first question live in Section 2: Investible Innovations of the full report, and our findings to the second live in Section 3 Emerging Innovations of the full report.

### WHO SHOULD READ THIS REPORT?

**Investors** can use these findings to identify those challenges or innovative solutions most likely to meet an existing or likely market demand, and which have untapped commercial potential.

**Policymakers** can use these findings to assess how high-priority innovations can be enabled through good governance, new regulations, targeted funding, infrastructure development, and cross-sectoral alignment.

**Innovators** can research, design, create, and test their own ideas that build upon the innovative solutions in this report.

**Business Leaders** can use these findings to expand into new markets and serve new consumers with new products that meet unaddressed needs.

# EXECUTIVE SUMMARY

## Investible Innovations for Impact Today

In Section 2, we present profiles of the top 22 investible innovations that should be further investigated, developed, and championed *today* to build resilient and prospering food systems in emerging markets over the next five years. This selection of innovations emerged through a rigorous process of divergence and convergence with an expert panel. Together, these experts helped to illuminate the transformational potential of each innovation, including the existing market opportunities, comparative advantage, critical risks, and performance across an array of evaluation criteria, explained in more detail on the next page and in Section 2.

The top 22 investible innovations for today can be found in the table below. Some innovations, such as evaporative cooling systems, offer quick wins. These low-hanging fruit are solutions that value chain actors can adopt quickly with minimal training and low up-front costs. Other innovations, such as modular factories, are believed to have the most potential to reduce PHL in the long run. Still other innovations yield benefits that primarily accrue to smallholder farmers, or would have the most positive environmental impact, or would face substantial systems barriers, such as data and transport infrastructure, before delivering impact. See Section 2 of the full report for detailed innovation profiles.

### INVESTIBLE INNOVATIONS FOR TODAY

- |   |   |  |
|---|---|--|
| 1. Cooperative packaging solutions      | 9. Micro cold transport                       | 17. Improved traceability technologies             |
| 2. Modular factories                    | 10. Adaptable reefer containers               | 18. Specialty marketing for PHL-prone crops        |
| 3. Near-farm mobile processing          | 11. Cold chain as a service                   | 19. Farm-to-fork virtual marketplace               |
| 4. Mobile packhouses & pre-cooling      | 12. Micro-warehousing and shipping            | 20. First-loss capital guarantee for PHL reduction |
| 5. Dehydration for smallholders         | 13. Evaporative cooling systems               | 21. Mobile education centers                       |
| 6. Battery technologies                 | 14. Biodegradable coatings                    | 22. Behavioral economics for agriculture           |
| 7. On-farm solar preservation           | 15. Microbes for agriculture                  |  |
| 8. Crates adapted for SHF supply chains | 16. Early warning system for diseases & pests |  |

#### QUICK WINS

- Evaporative cooling systems
- Cooperative packaging solutions
- Crates adapted to smallholder supply chains
- Biodegradable coatings
- First-loss capital guarantee for PHL reduction

#### GREATEST POTENTIAL TO REDUCE PHL

- Modular factories
- Near-farm mobile processing
- Dehydration for smallholders
- Micro-warehousing & shipping
- Specialty marketing for PHL-prone crops

#### BENEFITS ACCRUE TO SMALLHOLDERS

- Adaptable reefer containers
- Behavioral economics for agriculture
- Mobile pre-cooling & packhouses
- Specialty marketing for PHL-prone crops
- Mobile education centers

#### ENVIRONMENTAL SUSTAINABILITY

- Battery technologies
- On-farm solar preservation
- Evaporative cooling
- Early warning systems for plant disease and pests
- Microbes for agriculture

#### MOST SUBSTANTIAL SYSTEMS BARRIERS

- Cold chain as a service
- Early warning systems for plant diseases and pests
- Improved traceability technologies
- Farm-to-fork virtual marketplace
- Mobile education centers

# EXECUTIVE SUMMARY

## EVALUATION CRITERIA

To gain confidence in each innovation's estimated potential, our expert panel converged from 100 evaluation criteria to a suite of 8 to serve as an objective, intuitive, and comprehensive tool with which to better assess the potential of an innovation to achieve the goals of this effort. In the innovation profiles in Section 2, we include an estimate of how each innovation performs on each criterion, as projected by our expert panel. Absent rigorous field tests or primary research, these are just that – estimates.

Affordability	The income range of individuals and institutions who could afford the innovation
Usability	The amount of training required for the end-user to effectively use the innovation
Scalability	The point in the diffusion process at which the innovation could be scaled within 5 years
Smallholder benefits	The percentage of benefits that would likely accrue to smallholder farmers
PHL reduction potential	The innovation's potential to reduce current levels of post-harvest loss
Sustainability	The length of time that external support would be required before the innovation is accepted, adopted, and provides benefits
Energy considerations	The type of energy access required to deploy and operate the innovation
Environmental impact	The innovation's likely impact, either positive or negative, on the environment

## Supporting Emerging Innovations Now for Impact in 2035

### INVITATIONS FOR INNOVATION NEEDED TO TRANSFORM FOOD SYSTEMS BY 2035

1. How might we engineer production systems impervious to crop failure and spoilage?
2. How might we reimagine the relationship between consumers and producers?
3. How might we create closed-loop agricultural systems?
4. How might we assure that all food everywhere is priced to account for its true cost?
5. How might we create farm-free foods?
6. How might we open, share, and use data across the supply chain to eliminate information asymmetries?
7. How might we transform conventional agriculture into regenerative agriculture?
8. How might we scale hyper-adaptive, localized polyculture?
9. How might we build and scale a model of self-sufficient city-based agriculture?
10. How might we reposition rural areas as places of opportunity?

We also asked our expert panel to imagine how innovation could alter the course of the future as offered in WEF's four scenarios from its 2017 Scenarios Analysis. In some instances, our experts described specific applications for emerging innovations that could fundamentally rewrite the way our food systems work. Quantum computing, blockchain, Internet for All, and synthetic biology are but a few of the innovations indicated as promising in the pursuit of such transformation. Other times, experts offered ideas about the opportunities that exist for transformational innovation to reshape agricultural systems altogether. We view these opportunities as *Invitations for Innovation*. In Section 3, we issue 10 such invitations, each of which is meant to capture the imagination of investors, policymakers, innovators, researchers, and you to inspire bold efforts to reshape food systems in emerging markets.

# GKI

THIS REPORT WAS WRITTEN BY THE GLOBAL KNOWLEDGE INITIATIVE (GKI) IN ITS ROLE AS THE INNOVATION PARTNER FOR THE ROCKEFELLER FOUNDATION'S YIELDWISE INITIATIVE

## About the Global Knowledge Initiative

The Global Knowledge Initiative (GKI) is a non-profit organization based in Washington, D.C. GKI builds purpose-driven networks to deliver innovative solutions to pressing global challenges. It uses an integrated, systems approach to create the environment, mindset, and tools that enable problem-solvers to innovate and collaborate more effectively. As a grantee and Innovation Partner for The Rockefeller Foundation's YieldWise Initiative, GKI works to boost the degree to which innovation is used to improve the efficiency, effectiveness, and, ultimately, the impact of YieldWise.

## About the YieldWise Initiative

Launched in 2016, YieldWise is an initiative of The Rockefeller Foundation aimed at demonstrating how the world can halve post-harvest food loss by 2030. By taking a systemic approach to loss reduction, YieldWise aims to improve rural livelihoods, build less vulnerable ecosystems, and increase the availability of nutritious foods. YieldWise currently focuses on demonstrating loss reduction in four value chains in Sub-Saharan Africa: mangoes in Kenya, maize in Tanzania, and tomatoes and cassava in Nigeria.

Photo credit: Lukas Budimaier