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The Global Food Security Index

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Food systems today are under increasing strain from population pressures, high input prices, changing consumer patterns, dramatic weather, and price shocks. As DuPont talked to governments, NGOs, and farmer organizations around the world, we came to realize that while people shared a common goal of food security, not everyone shared a common language for understanding the drivers of food security or assessing vulnerabilities country by country. And, while literally billions of dollars were being spent to address global food challenges, there was no comprehensive way to measure food security and the impact of investments and collaborations at the local level. By creating a global index and providing open access to the data, we believe it will promote conversation and collaboration among all stakeholders across the food value chain, generate insights into how food security can be advanced and stimulate action to feed a growing population. In this context, the Index looks at the underlying factors and key risk areas affecting food security within a structured, rigorous framework.

"*Food security is defined as the state in which people at all times have physical, social and economic access to sufficient and nutritious food that meets their dietary needs for a healthy and active life*".

Using this definition adapted from the 1996 World Food Summit, the Global Food Security Index (GFSI) considers the core issues of affordability, availability, and quality across a set of 109 countries. The index is a dynamic quantitative and qualitative scoring model, constructed from 28 unique indicators, that measures these drivers of food security across both developing and developed countries. The overall goal of the study is to assess which countries are most and least vulnerable to food insecurity through the categories of Affordability, Availability, and Quality and Safety. The Economist Intelligence Unit (EIU) developed this tool in 2012 with sponsorship from DuPont.

2015 Update - Global food security has made a rapid improvement over the past year

We see a rapid improvement in global food security in the increased efficiency of food systems and improvements in the nutritional quality of the food to which populations have access.

We also see it in the outcomes: 805m people were estimated to be chronically undernourished in 2012-14, down by 4.4% from 842m in 2011-13. Of these 805m, around 791m live in developing countries, despite marked food security improvements in emerging markets and low-income countries over the past decades. The United Nations Food and Agricultural Organization (FAO) states that since the early 1990s the number of people in developing countries suffering from undernourishment has fallen by more than 200m; nevertheless, about one in eight people in these regions remains chronically undernourished[1]. Improvement is evident in almost all regions across the globe, but particularly in emerging markets (which have more food-insecure environments), as macroeconomic

improvements enable more countries to establish the structures necessary to enable food systems to operate effectively.

The 2015 Global Food Security Index (GFSI) displays these developments, revealing improvements in every region except Europe. Low-income and lower-middle-income countries around the world have led the way, recording the greatest overall increases in their scores and narrowing the gap between the most food-secure and least food-secure countries.

Such progress notwithstanding, global food insecurity remains a challenge. In particular, increased volatility of agricultural production, and also lower urban absorption capacity (as urban migration in many countries continues to rise and as GDP growth slows in over half the countries included in the index), are constraints on food security progress in almost every region. An overwhelmingly positive factor has been the fact that overall economic growth in the developing world over the past few years has led to improvements in the structural areas that are essential to improving people's access to a wider range of affordable, nutritious foods, including more extensive food safety-net programs, expanded crop storage capacity and dietary diversity.

Food security challenges for developed and developing countries differ considerably. Investment in infrastructure and food systems in low-income and lower-middle income countries is the key to narrowing the gap. Developing countries often lack basic infrastructure, including storage, road and port facilities, while smaller incomes inhibit access to and affordability of nutritious food. Political risk and corruption frequently compound structural difficulties in these countries. Advanced, rich-world countries generally outperform developing countries, but they too experience food security challenges. Lower economic growth rates in rich-world countries than in emerging markets have eroded affordability and have created challenges in adapting to urbanization. At the same time, a subsection of the developed world, notably Europe, has recently faced increased political stability risk.

Additionally, although advanced economies have more diverse diets and higher consumption of high-quality protein and micronutrients, they also have higher obesity levels. Obesity is a form of malnutrition, which is defined as the excessive consumption of macronutrients and/or micronutrients, and a food security concern.

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The Role of Innovation in Meeting Food Security Challenges

Innovation is crucial to meeting key challenges

Dramatically increasing the global food supply is a daunting enough challenge on its own, but several significant headwinds make the task even more complicated, underscoring the need for innovative solutions.

Climate Change: While a rapid rise in agricultural production is required to meet growing demand, other important factors -chiefly environmental issues- also come into play. Climate change has already begun to affect crop yields and threatens to cause greater damage as the century progresses[2]. Increased incidences of extreme weather associated with climate change -such as drought, consecutive days of extreme heat, and flooding- are issues that might be even harder to solve[3]. And the effects on developing countries will be even more severe.

Climate change is also restricting the means by which production can be ramped up. Because of the need to drastically reduce anthropogenic greenhouse gas emissions in order to avert the worst consequences of climate change, production gains must come

largely from intensification of existing lands rather than expansion into new ones, which usually results in the increased emission of greenhouse gases as a result of deforestation or the clearing of savannah[4]. This necessitates innovation along almost the entire agricultural value chain.

Soil Quality: The process of intensification is exacerbated by soil quality issues in critical production and consumption regions. In China, which relies on around 7% of global arable land to feed 20% of the world's population, the Ministry of Land Resources recently reported that 19% of such land is polluted, more than 40% is degraded due to "soil and water loss, soil impoverishment and Stalinization", and over half is severely deficient in total organic matter. High concentrations of heavy metals that have leached out of nearby mines and industrial sites are the most significant culprit, but excessive dependence on chemical fertilizers has also played a major role[5]. In most of Sub-Saharan Africa (SSA), the opposite problem has long limited yield growth: lack of fertilizer use is believed to be the principle reason African yields did not improve during the Green Revolution[6].

Water Depletion: Climate change is already affecting water availability in numerous ways, as precipitation patterns change or become more intense, major storm tracks such as El Nino shift, and extreme weather events become common. Areas that are currently subject to dry conditions will get drier, and those with already-high levels of rainfall will get wetter[7]. Underground water pollution is also a significant issue, notably in China[8]. In addition, the unsustainable use of critical aquifers in Asia and North America has resulted in extractions significantly above the natural ability of the aquifers -which serve 1.7 billion people- to replenish themselves[9].

Yield Plateaus: It is possible that key production regions for wheat and rice -northern Europe and China, respectively- have reached yield plateaus, which will require investments in new techniques to either increase yields in those regions or improve yields in regions that have more potential[10].

Every Sector Is Heeding the Call for Innovation

Governments, international institutions, NGOs, private companies and universities are all investing significant sums to develop innovative solutions to these problems. Government support, in the form of basic research funding and other incentives, frequently acts as an important catalyst for innovation in the private sector. But impact lenders, foundations and NGOs are also playing an ever-larger role, especially in efforts to help small farmers increase their productivity and in urban agriculture start -ups- thanks to innovative business models and a risk tolerance that governments generally cannot afford. Where these models have been successful, governments have often stepped in to scale up the projects. Several companies and institutions are also forging connections between sustainable agricultural technology providers and policymakers.

Smallholder Farmers: Crucial to Food Security

One size does not fit all. According to a 2013 report on smallholder farming by the Consultative Group to Assist the Poor (CGAP), an estimated 2.5bn people reside in about 500m small farmer households in the developing world[11]. Although there is no one definition for a such a farm, it generally applies to those where production "occurs on less than two hectares of land, is characterized by low yields, low quality, poor linkages and little access to finance"[12].

Small farmers must raise their yields…

Improving smallholder production is essential to raising global agricultural yields, but even more important for enhancing food security, as these farmers often are among the world's poorest and it is estimated that about 60% of them farm for subsistence[13]. Their ability to increase production will largely depend on improving their access to better inputs, particularly fertilizers and seeds, as well

as training to develop more efficient practices. In the context of the Maputo Declaration, many African governments have begun subsidizing fertilizer and seed costs and investing heavily in improved extension services and agricultural infrastructure. Private companies and NGOs have also entered this space, often making use of digital technologies, while policymakers are helping to scale up the number of farmers who can access them.

…*Which means raising cash.*

Techniques pioneered by impact lenders such as Root Capital and Oikos have opened up short-term financing to smallholders who generally belong to cooperatives and grow cash crops for export, for which there are large, consistent buyers whose contracts can serve as collateral. Their work eventually opened the door to local commercial lenders and policy banks, which have brought considerably more capital to the sector. While the model represents a major advance for millions of smallholders, those who qualify for such loans represent only about 10% of the total-mostly coffee bean farmers in Latin America, where there are long-standing traditions of cooperatives[14]. As of 2013, the "total amount of debt financing supplied by local banks to smallholder farmers in the developing world [was] approximately $9 billion", which meets less than 3% of the estimated total smallholder financing demand excluding China[15].

International partnerships to improve seed varietals. Improved seed varieties are an essential component of protecting yields on smallholder farms from crop diseases, pests and weeds, as well as from extreme weather events such as drought and flooding. With the exception of a few large middle-income countries, private-sector investment in agricultural R&D is largely absent in the developing world, and public-sector funding, while improving in many countries, remains too low to address the challenges. The flow of aid is still significantly below desired levels, but the Gates Foundation and USAID are funding projects to develop seed varieties that will benefit farmers in developing countries while also improving capacity building at national R&D agencies. With funding from UKAID and the Gates Foundation, Cornell University runs the Durable Rust Resistance in Wheat project to track the spread of wheat rust, a pathogen that has historically caused significant yield losses, and develop new varieties that resist the pathogen and endure high-stress weather events. Toward the end of the millennium, outbreaks began again in East Africa, and it is estimated that about two-thirds of global wheat production, including more than 80% of production in Sub-Saharan Africa (SSA), is climatically vulnerable to wheat rust. Cornell is coordinating research with 20 institutions around the globe[16]. The Water Efficient Maize for Africa (WEMA) project is developing new varieties of maize with better tolerance for drought. The project is a public-private partnership, with the Gates Foundation and USAID working with Monsanto, which supplied the genetic material. Coordinating with national agricultural research systems in five African countries, the project is developing drought-tolerant corn varietals using three different techniques -conventional breeding, marker-assisted selection and genetic modification- that fit the variety of regulatory approaches. In trials, the new seeds, set to be released in 2017, have yielded 20-30% higher production levels than those of conventional hybrids[17].

Genetically modified (GM) seeds: For the most part, these international partnerships are improving seed varieties via conventional breeding techniques, but some projects are developing GM seeds. One example is a Bt eggplant that is suitable for Bangladesh, which was developed by an Indian seed company and scientists from Cornell University, with funding from USAID. The eggplant has resistance to pests that often cause yields to drop by as much as 50%, forcing farmers to regularly apply high levels of dangerous pesticides[18]. Its commercialization in Bangladesh was approved in early 2015, but it continues to be prohibited in the Philippines

and India, which, as a top global producer of eggplant, could reap important economic, health and environmental benefits from its approval[19]. Researchers in Uganda are currently in field trials for a transgenic banana that has built-in resistance to a bacterial disease that, by causing discoloration and early ripening, costs the Great Lakes region around $500m annually. However, even if trials prove to be successful, farmers there will not benefit, as planting the crop would be prohibited in Uganda and Kenya[20]. Many scientists who argue in favor of more open regulatory frameworks for GM crops emphasize that developing countries, and particularly smallholder farmers who have limited access to agricultural inputs, are hurt the most by bans on such crops. Country restrictions on the planting of GM crops are based principally on the Cartagena Protocol on Biosafety under the UN Convention on Biological Diversity, which allows governments to "restrict the release of products into the environment or their consumption even if there is no scientific evidence that they are harmful" [21].23 Opponents of the crops have cited the potential development of super weeds, concerns over food sovereignty if companies are allowed to patent seeds, and possible health effects to humans. These concerns, however, have yet to be confirmed by evidence[22]. A report commissioned by the European Commission in 2010 "summarized the results of 130 research projects involving more than 500 independent research groups and concluded that biotechnology is not per se riskier than conventional plant breeding technologies[23]. Genetically modified crops have also brought significant benefits to farmers in the developing world. India's adoption of Bt cotton in 2002 has allowed it to jump from being a net importer of the fiber to the world's second-largest exporter, while also drastically reducing the application of dangerous pesticides and raising economic returns for farmers[24]. Similar results have been found in China, where it is estimated that Bt cotton accounts for half of the crop planted[25],[26]. There are indications that a number of developing countries that currently limit or prohibit the planting of GM crops are looking to reverse course and increase the capacity of their seed industries to develop and commercialise GM seeds. Since 2002, Bt cotton has been the only GM crop allowed to be grown in India[27], but Prime Minister Narendra Modi recently approved field tests for transgenic crops, which had been banned since 2010[28]. The regulatory environment in China is more complicated: the country is the sixth-largest producer of GM crops in the world by area, but currently allows the planting of only six such crops.47 The central government invested $3.5bn in basic research for biotechnology in 2008, but the current administration has sent mixed signals regarding the commercialization of GM crops.48 At the same time, past public investments in biotechnology are beginning to produce results.

Using genome editing, Chinese researchers recently bred a variety of wheat that is resistant to powdery mildew, a fungal pathogen. The regulatory decision on its commercialization is pending[29].

Urban Agriculture: There has been considerable interest in urban agriculture as a tool for improving food security for low-income city residents; the topic has become even more relevant in light of increasing urbanization in the developing world. Questions about scalability persist, and policy guidance is still hindered by a lack of data, but the sector is gaining acceptance in the developed world, including among policymakers. In the United States, the USDA's National Institute of Food and Agriculture (NIFA) supports urban agriculture projects as a tool in its multipronged approach to addressing food insecurity and nutrition in low-income areas, particularly for residents of food deserts where access to affordable and nutritious food is extremely limited. The institute, which offers competitive matching grants to urban agriculture projects that aim to increase food security while also providing nutritional education and job training, released $5 million in funds in 2014. To help develop more data on the sector, NIFA stipulates that grant recipients make their results available

to researchers[30]. Because scalability remains a major limitation for urban agriculture, NIFA also teams up with groups that provide significant amounts of nutritious food to low-income urban residents, such as food rescue operations, food banks and nutrition education programmers. Every day, City Harvest, a food rescue group that has operated in New York City for more than 30 years, picks up about 136,000 pounds of fresh food from restaurants, manufacturers, bakeries and farms and distributes it to 500 community kitchens that serve about 500,000 people.

Although not engaged in urban agriculture, City Harvest shares many of the same goals and initiatives: it prioritizes the delivery of nutritious foods, such as fresh produce, meat and dairy; offers nutrition and cooking classes; and hosts farmers' markets that distribute 20,000 pounds of fresh produce twice a month in eight locations around the city[31]. The NGO relies almost entirely on private donations, but NIFA recently awarded the group a five-year supplemental nutrition assistance program (SNAP) education grant to "motivate and mobilize" SNAP-eligible consumers to purchase more produce with their food stamps. The group will draw upon its background in community cooking courses, as well as its relationships with retailers, to offer shopping tips. For 2015, the USDA made $31.5 million in similar grants available through its Food Insecurity Nutrition Incentive (FINI) programmed, authorized by the 2014 Farm Bill[32]. Groups such as Growing Power, operating in Milwaukee and Chicago, have teamed up with city governments to train low-income residents in urban agriculture, and also help them obtain industry certifications, develop distribution plans for their products, and get their enterprises up and running[33]. Its Milwaukee farm -located across the street from a public housing project that is three miles from the nearest grocery store- provides $16 food packages for low-income customers that can feed a family of four for a week[34].

Urban agriculture in the developing world has generated policy support in a variety of forms. With funding from several international agencies, the Food and Agricultural Organization (FAO) of the UN has teamed up with municipalities in a number of Latin American and African countries on "micro-gardening" projects where low-income residents employ intensive vegetable production techniques on small urban plots[35]. Although these gardens benefit the participants, scalability remains an issue-none of the projects reached more than 11,000 households. The decision to support urban agriculture in the developing world is further hindered by a dearth of reliable data about its reach and effectiveness, as many countries can provide only limited, if any, household data[36]. One of the few studies on the topic was carried out using the World Bank's Rural Income Generating Activities (RIGA) database, which taps into a number of Living Standards Measurement Studies (LSMS) and other nationally representative household data sources for 15 low-income countries in Asia, Africa and Latin America. It determined, with some qualifications, that the number of households earning some income from urban agriculture was often high, "ranging from 11% in Indonesia to nearly 70% in Vietnam and Nicaragua", but in only five countries did it represent more than 10% of total income. The study's most important discovery, perhaps, was a clear association between participation in urban agriculture and improved dietary diversification, which is often used as a proxy for food security for low-income populations[37]. Its authors concluded the study on a cautionary note, urging policymakers in the developing world to think twice before deciding to shut down urban agriculture projects for public health reasons, as in the absence of a viable alternative food source, doing so could deprive low-income populations of a principal source of dietary diversity. However, they also stopped short of recommending policy support for it, as limited public resources might be better spent on employment promotion, which would improve purchasing power, or on enhancing the efficiency of urban food markets[38]. Evidence from rural areas suggests that the relationship between farming one's

own food and improved nutrition is stronger where there is inadequate market access. When access to more diverse foods is less of a problem, the difference in nutrition outcomes for farmers and non-farmers in rural areas is reduced, as non-farmers can purchase the same products farmers grow[39]. The availability of nationally representative household data in the developing world has improved over the past decade, but a critical element -sustained funding and capacity-building technical support for national statistical agencies- is still necessary to accurately measure the effects of urban agriculture. The LSMS-Integrated Surveys on Agriculture Program, funded by the Gates Foundation and the World Bank, is addressing this void for eight countries in Africa, focusing on issues such as the availability and quality of food consumption, crop production and livestock data[40]. Its survey data include georeference points within urban areas, thereby overcoming a major challenge: individual country definitions of urban, peri-urban and rural vary greatly, making it difficult to compare data and understand the true nature of urban agricultural operations.

Although a lack of data and research currently limits general policy recommendations on urban agriculture in the developing world, Dr. Alberto Zezza, a senior economist at the World Bank, recommends that policy decisions on whether to fund urban agriculture, and what type of projects to fund, be tailored specifically to each environment, relying on sound data. In China, for example, concerns over food safety and quality, coupled with a rising population, often generate a premium of 400-500% on organically grown food, versus an average of around 100-150% in the United States[41]. Such premiums could make investments in urban agriculture more viable-which would be especially helpful to low-income farmers.

NOTE

[1] The State of Food Insecurity in the World: Strengthening the enabling environment for food security and nutrition, UN Food and Agricultural Organisation (FAO), 2014 http://www.fao.org/3/a-4030e.pdf.

[2] A. Senthold et al., «Rising temperatures reduce global wheat production», Nature Climate Change, December 2014.

[3] W. Schlenker, «Nonlinear temperature effects indicate severe damages to U.S. crop yields under climate change». Proceedings of the National Academy of Sciences of the U.S.A., 2009.

[4] S. Asseng et al., Ibid.

[5] Y. Zhang, «Soil Quality in China-Policy Implications», Europe China Research and Advice Network (ECRAN), August 2014.

[6] G. Nziguheba et al., «The African Green Revolution: Results from the Millennium Villages Project». Advances in Agronomy, Vol. 109, 2010.

[7] S. Paige and Climatewire, «Climate change is altering rainfall patterns worldwide», November 12th 2013.

[8] U.N Water, «Water for a Sustainable World: the United Nations Water Development Report 2015», 2015.

[9] T. Gleeson et al., «Water Balance of Global Aquifers Revealed by Groundwater Footprint», Nature, August 8th 2012.

[10] P. Grassini et al., «Distinguishing between yield advances and yield plateaus in historical crop production trends», Nature Communications, December 2013.

[11] R. Peck et al., «Segmentation of Smallholder Households: Meeting the Range of Financial Needs in Agricultural Families», CGAP Focus Note: No 85, April 2013.

[12] T. Carroll et al., «Catalyzing Smallholder Agricultural Finance», Dalberg Global Development Advisers, 2012.

[13] R. Peck, *Ibid.*

[14] T. Carroll, *Ibid.*

[15] D. Zook et al., «Local Bank Financing for Smallholder Farmers: a $9 Billion Drop in the Ocean», Initiative for Smallholder Financing, Briefing 01, October 2013, 02.

[16] Cornell University, «Borlaug Global Rust Initiative», 2013.

[17] C. Juma, «Taking Root: Global Trends in Agricultural Biotechnology», Belfer Center for Science and International Affairs, January 2015, 12.

[18] USAID, «Pest Resistant Eggplant: India, Bangladesh, Philippines». Fact Sheet.

[19] Interview with Dr. P. Davies, International Professor of Plant Biology at Cornell University.

[20] C. Juma, «Taking Root: Global Trends in Agricultural Biotechnology», Belfer Center for Science and International Affairs, January 2015.

[21] C. Juma, New Harvest, Oxford University Press: 2011, 39.

[22] P. Ronald, «Lab to Farm: Applying Research on Plant Genetics and Genomics to Crop Improvement», PLOS Biology, June 2014.

[23] T. Fagerström et al., «Stop Worrying, Start Growing», EMBO Reports, Rep. 2012 Jun; 13(6).

[24] C. Juma, «Taking Root: Global Trends in Agricultural Biotechnology», Belfer Center for Science and International Affairs, January 2015.

[25] A. Anderson-Sprecher et al., «People's Republic of China: Agricultural Biotechnology Annual», USDA GAIN Report Number: 14032, December 31st 2014.

[26] P. Ronald, *Ibid.*

[27] USDA Foreign Agricultural Service, India: Agricultural Biotechnology Annual, 2014.

[28] K. N DAs et al, «Modi Bets on GM crops for India's Second Green Revolution», Reuters, February 21st 2015.

[29] D. Talbot, «Chinese Researchers Stop Wheat Disease with Gene Editing», MIT Technological Review, July 21st 2014.

[30] USDA National Institute of Food and Agriculture. «Community Food Projects Competitive Grant Program: 2014 Request for Applications», 2013.

[31] Interview with Leslie Gordon, City Harvest's Senior Director of Program Strategy and Operations.

[32] USDA. «USDA Awards $31 Million in Grants to Help SNAP Participants Afford Healthy Foods», News Release No. 0084.15.

[33] City of Chicago: Mayor's Press Office. «Mayor Emanuel Launches New 'Farmers For Chicago' Network For Chicago Urban Farmers». March 15th 2013.

[34] A. Hagey, «Growing Urban Agriculture», PolicyLink, 2012.

[35] FAO, «Urban and Peri-urban Horticulture», http://www.fao.org/ag/agp/greenercities/en/projects/index.html

[36] R. Stewart et al., «What are the impacts of urban agriculture programs on food security in low and middle-income countries?», Environmental Evidence, April 2013.

[37] A. Zezza et al., «Urban agriculture, poverty, and food security: Empirical evidence from a sample of developing countries», Food Policy, August 2010, 267.

[38] *Ibid.*

[39] Interview with Dr. A. Zezza, senior economist in the World Bank's Development Research Group. See also Carletto, Ruel, Winters, Zezza (eds.), forthcoming. «Farm-level pathways to improved nutritional status», Special Issue of the Journal of Development Studies, 2015.

[40] *Ibid.*

[41] Interview with M. Zoninsein, CEO and founder of Smart Agricultural Analytics.