



# THE FUTURE OF FOOD

FEEDING THE WORLD – THE COMING FOOD REVOLUTION

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PREPARED BY:



AUTHORS:

David Beurle, Heather Branigin, Celine Beurle

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## INTRODUCTION



*Creating a sustainable and viable future scenario will require collaboration and effort at all levels and by all sectors - nothing short of a food revolution - and the outcome will be worth it.*

**The Future of Food** is presented by Future iQ Partners as a foresight research paper. It examines a range of critical catalysts of change related to our global food supply chain, and the potential impacts on human health.

Modern food production systems have delivered decades of significant benefits. Improved nutrition is extending life expectancy and reducing illness. Better plant varieties and farming practices have helped reduced famine, and alleviated the crushing impacts of hunger for millions.

However, with a growing global population, and the draining of many finite resources, it can be argued we are approaching a new point of crisis. We are faced with a range of converging powerful forces, that are fundamentally redefining how humanity lives. The same forces are reshaping what we eat, and where and how our food will be grown. **The Future of Food** examines what may occur if food production continues in the manner it has over the past decades. We explore how food production systems are impacting the environment, and how our diet choices are affecting human health on a global scale.

This paper also highlights a new era whereupon consumers are using their power, to instigate changes. These changes have never been more needed, in order to divert from possible catastrophe. Humans are at a point in time, where collectively we are able to direct the course of global food systems and avoid irreparable damage to the planet. This opportunity for stewardship is one we cannot pass up.

There are revolutionary technological developments in the food production and processing industries, which intend to halt the detrimental effects of producing food. Our research points to an approaching 'tipping point', that may well be the start of a new global system better suited to produce the food that people want and need, without the myriad of damaging effects upon the planet and human health.

**The Future of Food** poses some hard questions, and outlines some of our predictions of the future. Creating a sustainable and viable future scenario will require collaboration and effort at all levels and by all sectors - nothing short of a food revolution - and the outcome will be worth it: We will be able to sustain life and its necessary ecosystems, and future generations will survive to experience and enjoy it, in good health.



**David Beurle**

CEO

Future iQ Partners



## CATALYSTS OF CHANGE – A DISRUPTED WORLD

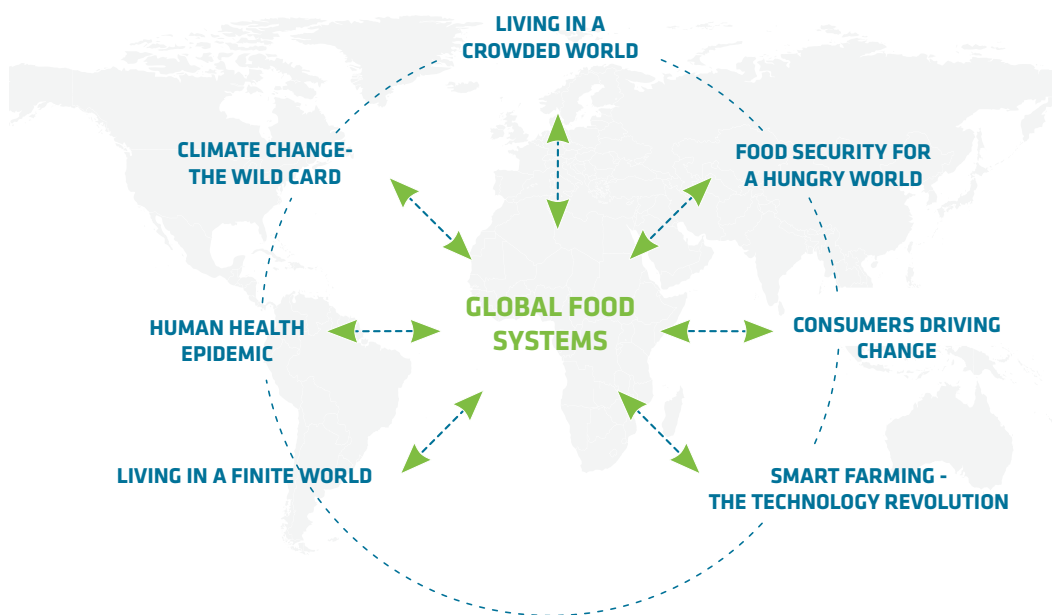


*We are faced with a range of converging powerful forces, that are fundamentally redefining how humanity lives. The same forces are reshaping what we eat, and where and how our food will be grown.*

### 2.0 CATALYSTS OF CHANGE – A DISRUPTED WORLD

There is no doubt that the world is being reshaped by a series of macro forces. This section of *The Future of Food* explores an array of catalysts of change, that we believe have the greatest disruptive potential to the global food systems, or offer the most significant opportunities and challenges. While the list is not exhaustive, individually each of these catalysts have the potential to cause a deep and lasting impact on the global food systems.

#### MAJOR CATALYSTS OF CHANGE – RESHAPING GLOBAL FOOD SYSTEMS



The Future of Food draws from a wide variety of contemporary research sources to explore the macro issues, and investigate emergent game-changing trends.



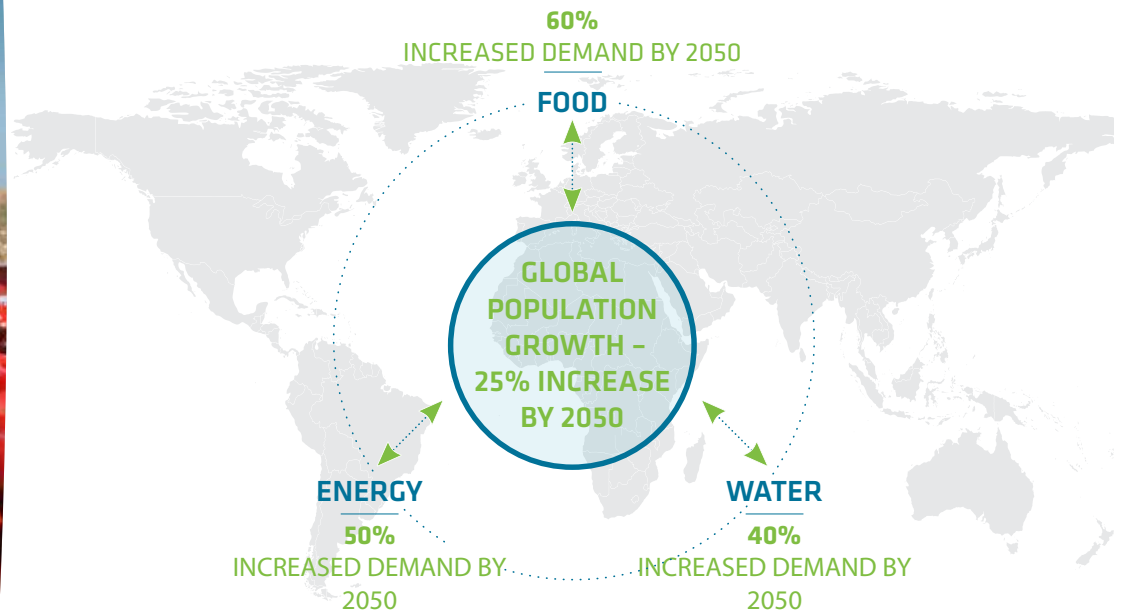
# LIVING IN A CROWDED WORLD



*How will we accommodate  
9 billion people in a  
sustainable way without  
exhausting or rendering  
unusable earth's finite  
resources?*

## 2.1 LIVING IN A CROWDED WORLD

Population growth is the most significant driver of the demand for food. As of July 2015, the world population stood at 7.3 billion and is estimated to grow to at least 9 billion by 2050. In the current 'business as usual' mode, feeding a population of 9 billion would mean a dramatic simultaneous increase in the need for food, energy and water in the next decades. 60% more food, 50% more energy and 40% more water by 2050.<sup>1</sup>



*Adapted from work by Prof. Nicholas Jordan, University of Minnesota (2015)*

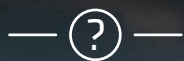
***"During 2016, it is estimated that 83,000,000 people will be added to the world's total population."***

*United Nations, Department of Economic and Social Affairs, Population Division. 2015. World Population Prospects: The 2015 Revision. Working Paper No. ESA/PWP.241.*





## LIVING IN A CROWDED WORLD



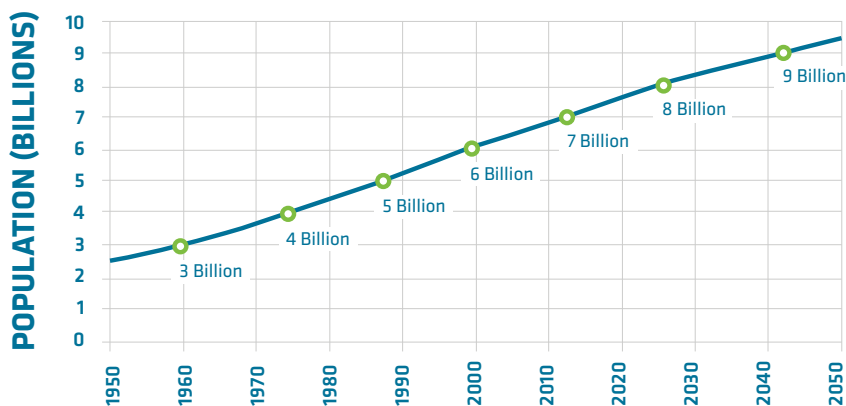
*Feeding a world of 9 plus billion people is going to require unparalleled innovation and ingenuity; and a lot of food – How will this be done?*



### 2.1.1 FEEDING MORE PEOPLE EVERY DAY

The world population increased from 3 billion in 1959 to 6 billion by 1999, a doubling that occurred over 40 years. The US Census Bureau's latest projections imply that population growth will continue well into the 21st century, although more slowly.<sup>2</sup>

#### WORLD POPULATION: 1950–2050



Source: U.S. Census Bureau, International Data Base, July 2015 Update

Throughout history, there have been efforts to curb population growth in order to reduce poverty and human suffering caused by the lack of food. China's former one-child policy, the Malthusian recommendation of "moral restraint", and family planning are examples of these efforts. The Green Revolution of the 1960's provided the world with the boost it needed to support a growing population without much thought to the effects on the environment or sustainability. Not until relatively recently have the consequences of this neglect been called to our attention with the impending need of a hungry world. These needs are not, and will not be uniform across the world.

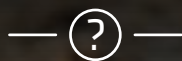
Population projections are split between the developed world and developing world. The majority of global population growth is forecast to occur in the already highly populated regions of Asia, India and Africa. As a function of numerous forces, there is going to be an increasing disconnect between where food is produced, and where food is consumed.

***"Even if all the people in the world adopted a policy of only two children per couple, it would take approximately 70 years before the world population would finally stabilize at about 12 billion, twice the current level."***

*Worldwatch Institute. 2016. World Population, Agriculture, and Malnutrition.*



## LIVING IN A CROWDED WORLD

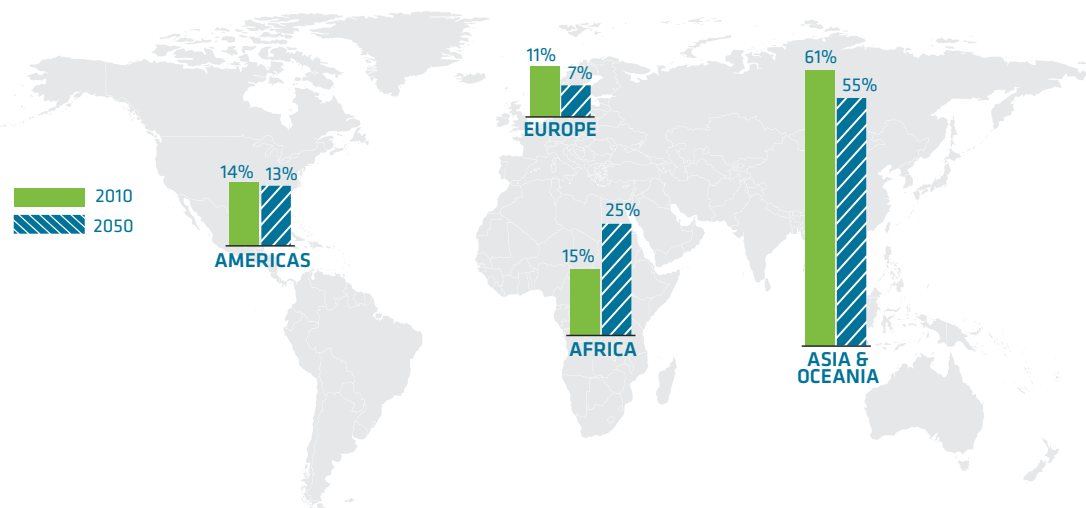


*The 'business as usual' approach will likely result in catastrophic consequences – how will diets and food production systems need to change?*

### 2.1.2 REPRODUCTION MATTERS - UNEVEN POPULATION GROWTH

Fertility rates and changes in reproduction behavior directly influence population growth patterns. Current global fertility rates are declining, yet we are nowhere near a rate that means an overall declining world population. A stable fertility replacement rate is 2.1 children per couple, however this is not uniform. For example, in North America, fertility has fallen to 1.86 in 2010-2015, but in less developed countries, fertility rates are 4.3 with a growing population rate of 2.4% per year.<sup>3</sup>

#### REGIONAL DISTRIBUTION OF GLOBAL POPULATION BY REGION, 2010 AND 2050



Source: United Nations Department of Economic and Social Affairs. 2013. World Population Prospects: 2012 Revision.

Africa's relative share of the global population is projected to increase the most and make up a greater relative share of the global population by 2050. The relative shares of Europe and Asia in the global population are expected to decrease, while the Americas will hold steady.

***“About nine out of 10 people between the ages 10 and 24 live in less developed countries.”***

*UNFPA State of the World Population 2014. The Power of 1.8 Billion: Adolescents, Youth and the Transformation of the Future.*



# LIVING IN A CROWDED WORLD

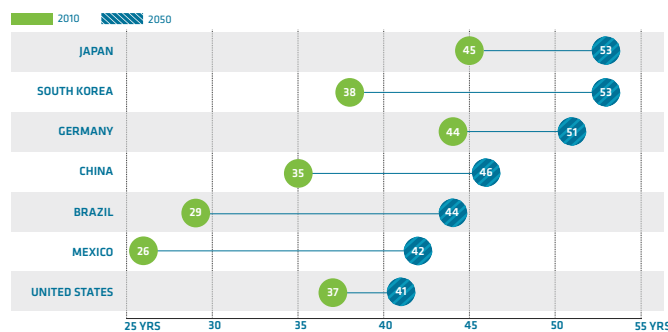


*An aging global population creates opportunities for innovation, but burdens the productive capability of countries. How will this impact food consumption and production systems?*

## 2.1.3 LONG LIVE THE PEOPLE

Global population growth is due, in part, to the rise in life expectancy rates. "The number of people 65 or older is projected to triple by mid-century, from 531 million in 2010 to 1.5 billion in 2050. In the U.S., the population of seniors is expected to slightly more than double, from 41 to 86 million.<sup>4</sup> Globally, life expectancy at birth has risen from 65 years for men and 69 years for women in 2000-2005 to 68 years for men and 73 years for women in 2010-2015. The highest levels of life expectancy at birth in 2010-2015 are to be found in Japan, Italy, Switzerland, Singapore, Iceland, Spain, Australia, and Israel.

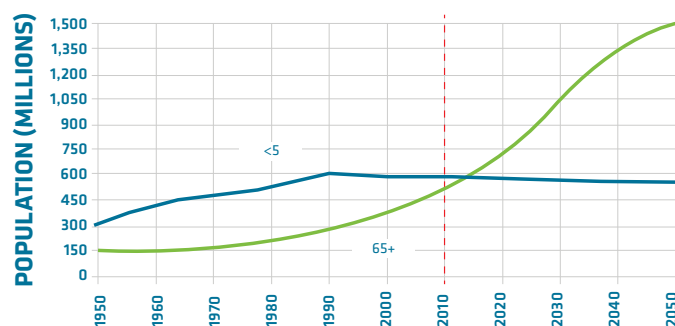
### ESTIMATED MEDIAN AGE IN SELECTED COUNTRIES, 2010 AND 2050



Source: United Nations Department of Economic and Social Affairs. 2013. *World Population Prospects: 2012 Revision*.

Globally, life expectancy is projected to rise to 77 years in 2045-2050 and to 83 years in 2095-2100. Life expectancy at birth has increased significantly in the least developed countries in recent years. The six-year average gain in life expectancy among the poorest countries, from 56 years in 2000-2005 to 62 years in 2010-2015, is roughly double the increase recorded in the rest of the world.<sup>5</sup> The total number of people aged over 65 is forecast to expand dramatically over the next decades. In the next few years, the total number of people on the planet who are over 65 will, for the first time in history, exceed the total number of people under 5 years of age.

### RAPIDLY EXPANDING PROPORTION OF PEOPLE WILL BE OVER 65



Source: Population Reference Bureau, National Institute on Aging, US Department of Health and Human Services.

With the growth of aging populations, food systems will need to adjust to changing demands in food consumption and preferences. This also creates a unique and growing market for foods offering specialized medicinal and nutritional benefits suited to elderly people. In addition, an aging population has significant implications for the productive workforce capacity and consumer activity, an issue now being confronted in numerous developed countries.



## LIVING IN A CROWDED WORLD

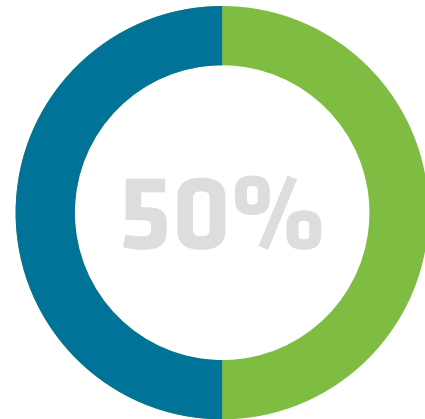


*Educated and connected young adults around the world will drive change in food preferences, diets and food processing. How quickly will this change occur?*

### 2.1.4 HERE COME THE 'MILLENNIALS'

Life expectancy rates for children under the age of five continued to improve over the past twenty-five years. Although the Millennium Development Goals (MDGs) Targets for reducing under-five mortality were not met by the end of 2015, efforts to accomplish these goals decreased under-five mortality by more than 20% in 156 countries, with widespread reductions of 20% or more recorded in Africa, Asia, Europe, Latin America and the Caribbean and Oceania.<sup>6</sup>

**IN 17 DEVELOPING COUNTRIES, HALF THE POPULATION IS UNDER AGE 18.**



Source: UNFPA State of the World Population 2014. *The Power of 1.8 Billion: Adolescents, Youth and the Transformation of the Future.*

In addition, the large cohort of young adults is beginning to reshape the world. At a current number of 1.8 billion worldwide, the population between 10 and 24 is becoming a growing economic power in its own right. "...the World Bank (2012) estimates that maintaining the 2005 levels of employment of the working-age population in 2020 will require generating an additional million jobs a month in South Asia and East Asia, and a 50 per cent increase in the number of jobs in sub-Saharan Africa (UNICEF, 2014)."<sup>7</sup>

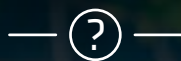
With increasing educational levels, and the rapidly increasing access to information technology, the youth of the millennial generation are a growing influence on the direction of food use and production. The values and behavior of this emerging consumer generation will have a direct future impact on our food systems and industries.

***"When millennials dine out, they're often in search of something exotic, adventuresome, memorable or new to explore during their dining experience."***

*Micah Solomon. 29 December 2014. 2015 Is the Year of the Millennial Customer: 5 Key Traits These 80 Million Consumers Share. Forbes.*



## LIVING IN A CROWDED WORLD



*The increased consumption of traditional animal protein is radically altering human health and global supply chains. Is this sustainable? What are the alternatives?*



### 2.1.5 THE EMERGENT MIDDLE-CLASS – CHANGING FOOD DEMAND

Economic development in the developing world is bolstering a rising middle-class of consumers able to afford different and more nutritious food. As an example, “increases in per capita consumption and changes in diets is leading to the consumption of more livestock products.”<sup>8</sup> “It is projected that by 2050, 2.3 times more poultry meat and between 1.4 and 1.8 times more of the meat of other livestock products will be consumed as in 2010 (FAO, 2009).”<sup>9</sup> Changing diets means more protein will be consumed by humans, however It is less clear that a continued reliance on animal protein presents the best sustainable health or environmental option.

The correlation between increasing wealth and changing diets is well documented, and has been described in a recent UN publication as the ‘Stages of Nutrition Transition’.

#### THE THREE STAGES OF NUTRITION TRANSITION



Source: Fanzo, Jessica, Carl Lachat, Thalia Sparling and Ted Olds, 2013. *The sensitivity of agriculture and food policies. A summary of eight country case studies. Changing Food Systems for Better Nutrition*, United Nations, SNC News, No 40.

The developing Asian middle class economy is having a dramatic impact on food consumption patterns, causing ripple-effects on the global supply chain. For example, the growth in Asian demand for animal proteins, mainly meat and dairy, has rapidly spurred growth of exports from New Zealand, and triggered ownership changes in meat supply chains in Australia. Such changes are likely to continue, as food production systems and supply chains adapt to meet demands from consumers seeking new and different food types. This picture will be further compounded as wealth increases in India, and then African countries, where dietary demands may cause different shifts.



# LIVING IN A CROWDED WORLD

— (?) —  
There is a growing disconnect between where food will be grown, and where food will be consumed – what are the implications at a global and regional scale?

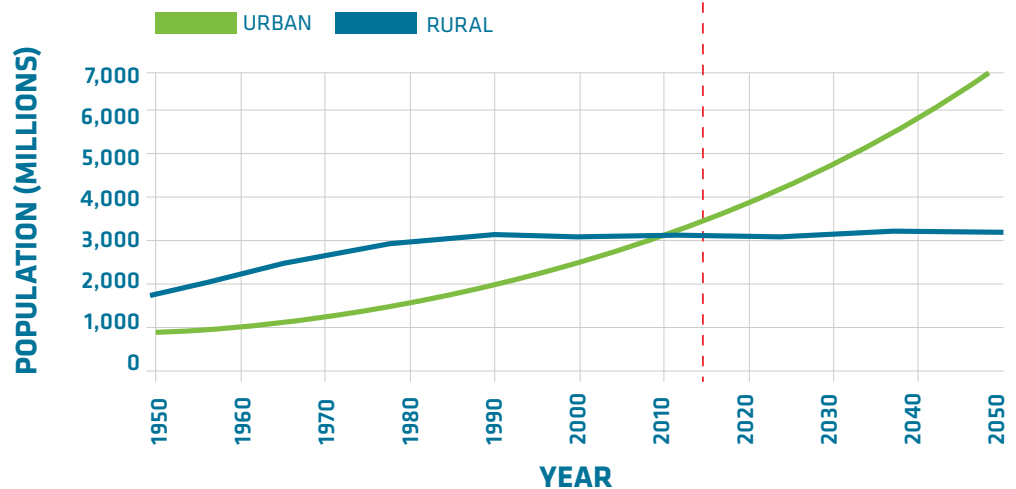
## 2.1.6 BIG CROWDED CITIES

In 2013, global urban population surpassed rural population. "The global urban population is expected to grow approximately 1.84% per year between 2015 and 2020, 1.63% per year between 2020 and 2025, and 1.44% per year between 2025 and 2030."<sup>10</sup> Much of the growth of urban areas is due to a shift in population from rural areas due to the availability of greater employment and educational opportunities. "Approximately 35% of current urban population growth is attributed to rural-urban migration."<sup>11</sup>

**"The urban population in 2014 accounted for 54% of the total global population, up from 34% in 1960, and continues to grow."**

*World Health Organization (2015)*

URBAN AND RURAL POPULATION OF THE WORLD, 1950-2050



Source: United Nations, Department of Economic and Social Affairs. *World Urbanization Prospects, The 2014 Revision*.

The increasing urbanization of people creates a potential further regional disconnect between where food is produced, and where it is consumed. In addition to greater total urbanization, we will see larger cities.

**"From 2010 to 2025, the GDP of the top 600 global cities will rise by over US\$30 trillion, or nearly 65% of global growth."**

*McKinsey Global Institute. 2012. Urban world: Cities and the rise of the consuming class.*

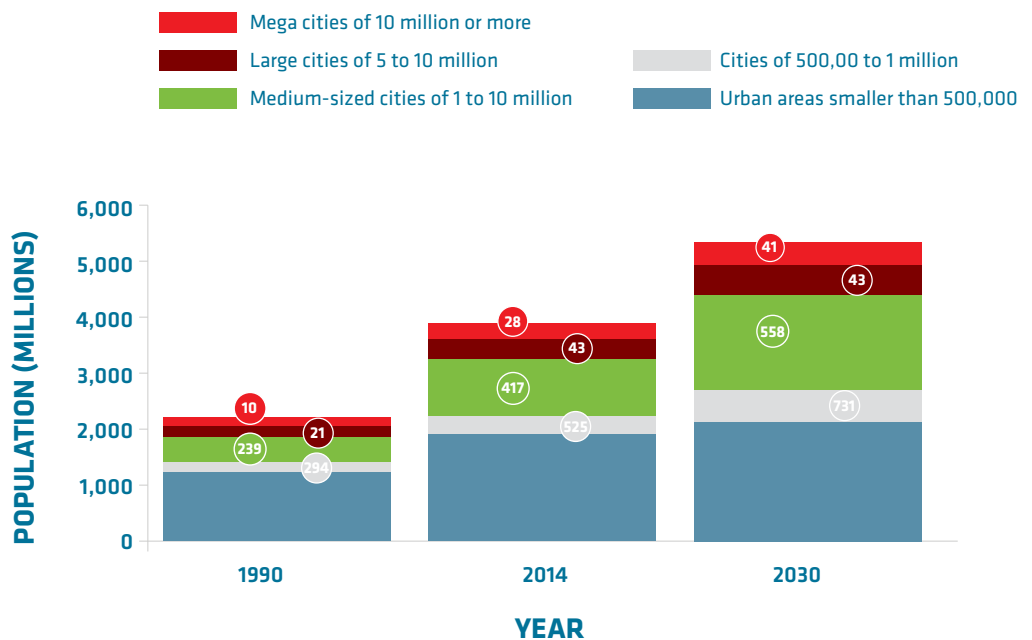


## LIVING IN A CROWDED WORLD



*Most people will live in big cities. How will food production and supply chains evolve to feed these huge urban populations? Who will own and control these vital supply chains?*

GLOBAL URBAN POPULATION GROWTH IS PROPELLED BY THE GROWTH OF CITIES OF ALL SIZES



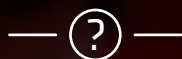
Source: United Nations, Dept of Economic and Social Affairs. World Urbanization Prospects, The 2014 Revision.

The added pressures on the resources needed to support enormous urban populations will challenge our food supply system in ways that must cause us to become more efficient and less wasteful. It is also likely to redefine the relationship between the relatively sparse rural food producing areas, and the high density urban locations. These changes in the distribution of population will require substantial infrastructural changes worldwide in order to get the food to people in urban areas.

***“Over 60% of new urban consumers will be in the top 440 emerging cities, with annual consumption set to rise by US\$10 trillion by 2025.”***

*McKinsey Global Institute. 2012. Urban world: Cities and the rise of the consuming class.*

# FOOD SECURITY FOR A HUNGRY WORLD

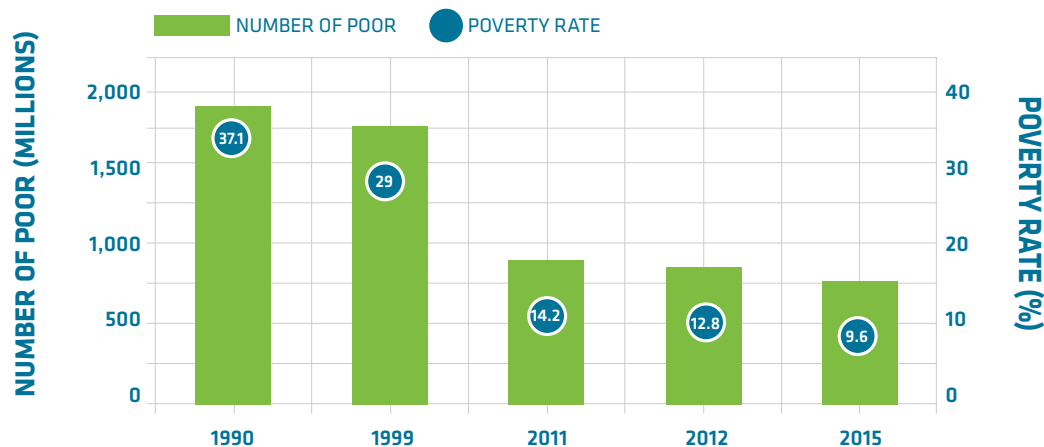


Today, there are a lot of hungry people in the world. What is the best way to provide greater food security worldwide?

## 2.2 FOOD SECURITY FOR A HUNGRY WORLD

Today, 795 million people in the world are malnourished and do not have access to consistent, dependable, healthy food (FAO 2015). Food availability, access, use (utilization) and stability are the four dimensions of food security.<sup>1</sup> Poverty is the primary cause of food insecurity and the reality of food insecurity is hunger. There are three types of food insecurity worldwide: chronic, seasonal and transitory.<sup>2</sup> Extreme poverty is defined by those who live on less than US\$1.90/day. Whether caused by infrastructural challenges, lack of education, employment opportunities or wealth, wars or natural disasters, poor people lack the resources needed to gain access to enough food to live healthy lives.

PROJECTIONS SHOW THAT THE GLOBAL POVERTY RATE MAY HAVE FALLEN TO SINGLE DIGITS IN 2015. YET, THE NUMBER OF POOR REMAINS HIGH.



Source: Cruz, Marcio, James Foster, Bryce Quillin, and Philip Schellekens. 2015. *Ending Extreme Poverty and Sharing Prosperity: Progress and Policies*, World Bank Group.

***“There is nothing inevitable about Africa, or any other region, remaining stuck in extreme poverty, yet it will take conscious public efforts in addition to the blind forces of the marketplace to end the poverty trap.”***

Jeffrey D. Sachs. 2008. *Common Wealth: Economics for a Crowded Planet*, The Penguin Press. New York.



# FOOD SECURITY FOR A HUNGRY WORLD



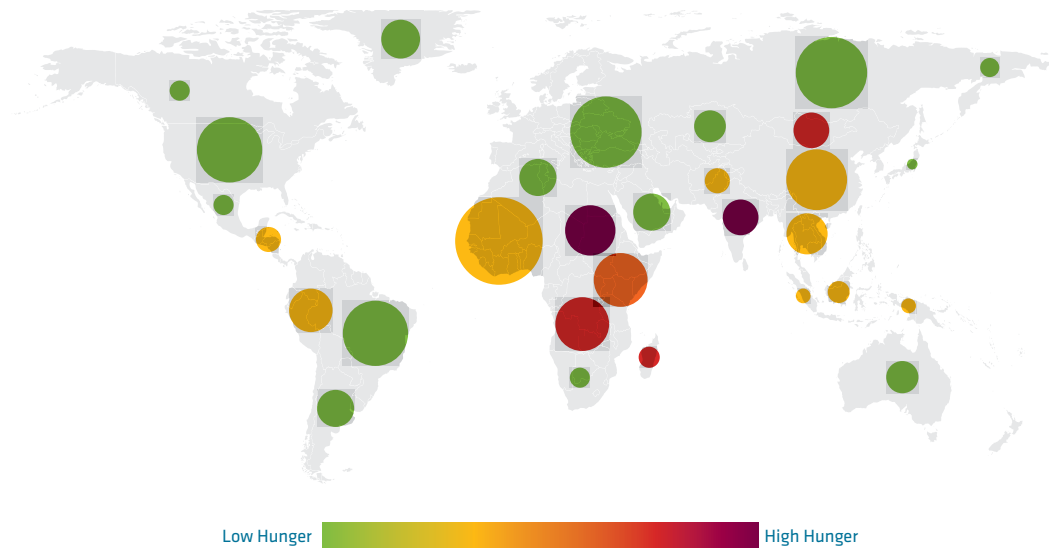
*Sub-Saharan Africa and Southern Asia is where people are hungry now; and where population growth will occur. How do we avoid a food crisis in these regions?*



## 2.2.1 WHERE THE HUNGRY PEOPLE LIVE

Although the number of undernourished people has decreased by 216 million since 1990-92, malnourishment continues to affect all areas of the world.<sup>3</sup> Areas of Southern Asia and sub-Saharan Africa have accounted for greater proportions of undernourishment since 1990-92. Just under one in every four people, about 220 million or 23.2% of the population in sub-Saharan Africa is estimated to be undernourished in 2014-16.<sup>4</sup> In Southern Asia, although there was a slight reduction in the number of people experiencing malnutrition (from 291 to 281 million people), that area still carries the highest burden of hunger in the world.<sup>5</sup>

### HUNGER MAP 2015



*“Even where policies have been successful in addressing large food-energy deficits, dietary quality remains a concern. Southern Asia and sub-Saharan Africa remain particularly exposed to what has become known as “hidden hunger” – the lack of, or inadequate, intake of micronutrients, resulting in different types of malnutrition, such as iron-deficiency anemia and vitamin A deficiency.”*

*FAO, IFAD and WFP. 2015. The State of Food Insecurity in the World. Meeting the 2015 international hunger targets: taking stock of uneven progress. Rome.*



# FOOD SECURITY FOR A HUNGRY WORLD

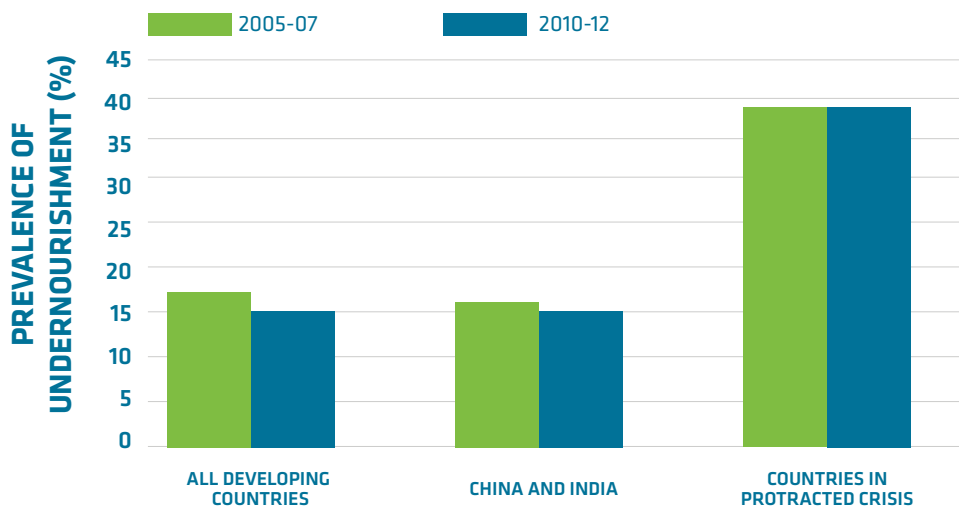


*Global population is growing; resources are being depleted. Are resource wars inevitable?*

## 2.2.2 WARS AND CONFLICT - HUMAN INFLICTED DESTRUCTION

Historically, food shortages and famine have been both the cause and result of war and conflict. Wars and conflict reduce the availability of food in several ways: By disrupting production and the flow of food through market channels; by reducing and in some cases eliminating public and private investment in food production and marketing activities, and finally, by causing outright loss through the destruction of food and food-producing assets.<sup>6</sup>

### FOOD INSECURITY: ARE PROTRACTED CRISES DIFFERENT?



Source: FAO, IFAD and WFP. 2015. *The State of Food Insecurity in the World. Meeting the 2015 international hunger targets: taking stock of uneven progress.* Rome.

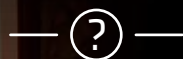
Wars and conflict destroy infrastructural systems providing basic transportation and physical access to food sources causing people to seek improved conditions elsewhere for their families. Lacking access to food, people are forced to flee conditions that threaten their health and wellbeing thus giving rise to migration and the increase of refugee situations. "...the number of displaced people at the end of 2013 was 51.2 million, more than at any point since the end of World War Two. The average length of displacement in major refugee situations is now 20 years."<sup>7</sup>

***"The 2008 world food crisis saw rapid increase in global prices for major grains and has been blamed for outbreaks of civil unrest in more than 40 countries."***

*Emmy Simmons. 2013. Harvesting Peace: Food Security, Conflict, and Cooperation (Environmental Change & Security Program Report Vol.14, Issue 3). Washington DC: Woodrow Wilson International Center for Scholars.*



# FOOD SECURITY FOR A HUNGRY WORLD



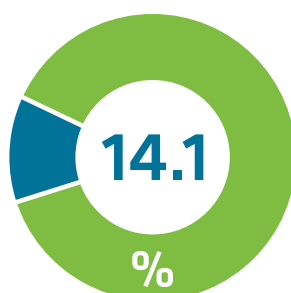
*The increased volatility in weather associated with climate change will lead to more natural disasters. How can our food systems develop more resilience and adaptability?*

## 2.2.3 NATURAL DISASTERS - THE NEW ERA OF CLIMATE CHANGE

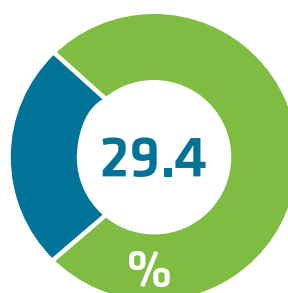
Natural disasters such as floods, drought, earthquakes, hurricanes and pestilence may affect the livelihoods of any community at any time. Not only do natural disasters affect local populations, but “when disasters strike, they have immediate repercussions on the livelihoods and food security of millions of family farmers and smallholders, pastoralists, fishers and forest-dependent communities in developing countries where agriculture employs from 30 to over 80 percent of the population.”<sup>8</sup>

Reducing the future vulnerability of communities to natural disasters will entail developing comprehensive risk management strategies for local regions with an eye to climate change as an increasing factor in the intensity of weather events.

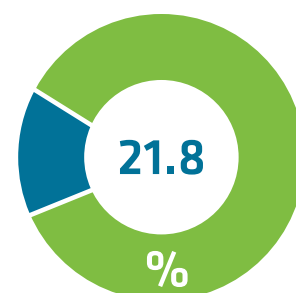
*DAMAGE, LOSSES AND DAMAGE PERCENTAGE LOSS TO THE AGRICULTURE SECTOR, PERCENTAGE SHARE OF TOTAL DAMAGE / LOSS TO ALL SECTORS.*



DAMAGE IN AGRICULTURE



LOSS IN AGRICULTURE



DAMAGE AND LOSS IN AGRICULTURE

Source: FAO. 2015. *The Impact of Natural Hazards and Disasters on Agriculture and Food Security and Nutrition*. Rome.

***“Agriculture and all that it encompasses is not only critical for our food supply, it also remains a main source of livelihoods across the planet. While it is a sector at risk, agriculture also can be the foundation upon which we build societies that are more resilient and better equipped to deal with disasters.”***

*José Graziano da Silva. 2015. FAO.*



# FOOD SECURITY FOR A HUNGRY WORLD



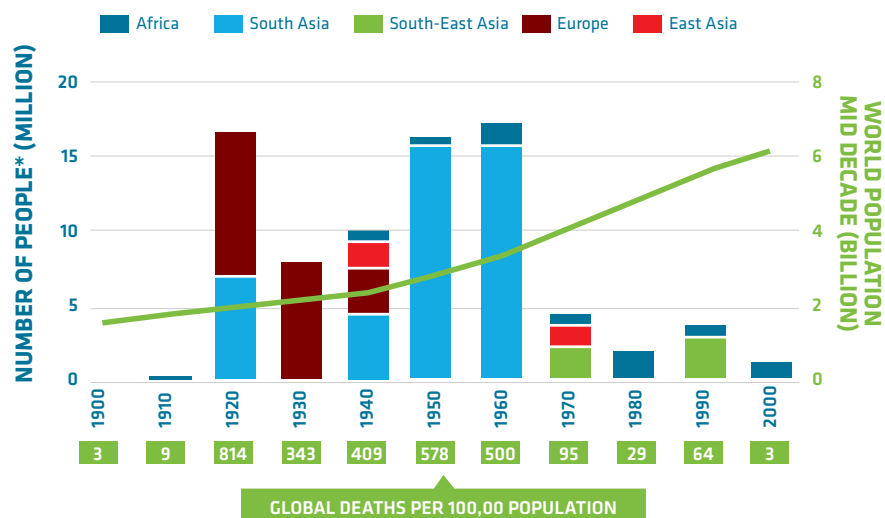
*Famine finds its roots  
in natural disasters and  
human-inflicted destruction.  
When and where will the  
next big famine strike?*

## 2.2.4 FAMINES – DEATH BY HUNGER

One of the most severe results of crises situations is famine. Famine is caused by an acute shortage of food and may result from conflict and human destruction and/or natural disasters.

Often a combination of government policy and severe weather will trigger famine such as the famine that took place in North Korea 1995-99. "Between 2.8 million and 3.5 million people died because of a combination of flooding and government policy."<sup>9</sup> Between October 2010 and April 2012, famine in Somalia killed approximately 258,000 people – roughly 4.6% of the population.<sup>10</sup> Where the frequency of famines now is lower than during other historical periods, more recently the potential effects of climate change have caused growing fears of the reoccurrence of famine.

### FAMINE DEATHS



Source: <http://www.economist.com/blogs/graphicdetail/2013/05/daily-chart-10>

***“When national governance fails, as in Somalia, recurrent food scarcity and famine become part of a vicious cycle of instability. Food insecurity both results from and contributes to repeated rounds of armed conflict in that country.”***

*Emmy Simmons. 2013. Harvesting Peace: Food Security, Conflict, and Cooperation (Environmental Change & Security Program Report Vol. 14, Issue 3). Washington DC: Woodrow Wilson International Center for Scholars.*



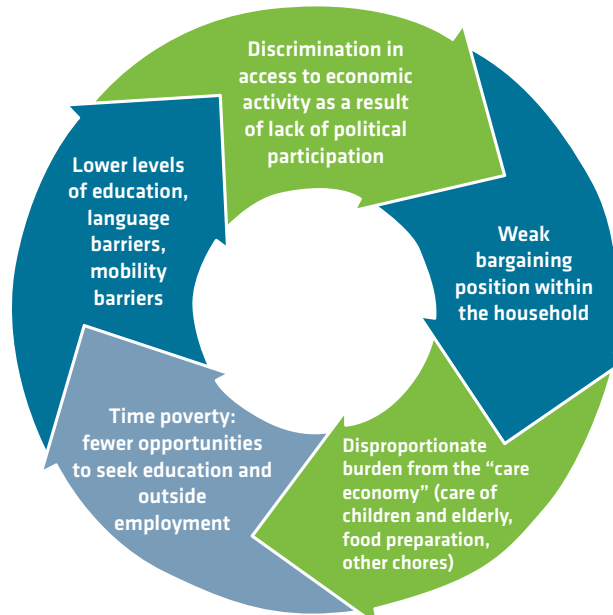
# FOOD SECURITY FOR A HUNGRY WORLD



*What efforts can the global community make to assist women in countries where they have limited rights in the areas of land tenure and agricultural production?*

## 2.2.5 PUTTING WOMAN IN POWER – BREAKING THE POVERTY CYCLE

Women are generally the primary caretakers in families and are the key to food security for their households.<sup>11</sup> The contributions that women make to family life and the acquisition of food often go unremunerated. Use of time for women in a “care economy” puts them at a distinct disadvantage when it comes to earning potential or employment opportunities outside of the home.<sup>12</sup> Education (not only formal but also in family planning) and social protection programs are key to enabling women to have more power over their ability to contribute to household economic stability.



Source: De Schutter, Olivier. 2013. *Gender and the right to food*. UN Special Rapporteur on the Right to Food. Executive Summary.

International efforts (in developing countries) to include women as instrumental players in a global food system requires education and literacy, health and breastfeeding support, extension programs that include women, legal rights to own and inherit lands where not permitted, and access to credit and agricultural inputs (such as tools, fertilizer and technology).<sup>13</sup>

***“Research shows that giving women greater control over household spending leads to greater expenditures on food, health, education, children’s clothing and nutrition.”***

FAO, IFAD and WFP. 2015. *The State of Food Insecurity in the World. Meeting the 2015 international hunger targets: taking stock of uneven progress*. Rome.



# FOOD SECURITY FOR A HUNGRY WORLD



*Will trade opening practices provide the security needed to protect smaller farm holders, or will it erode local sustainability?*

## 2.2.6 TRADE POLICY – OPENING THE DOOR TO GLOBAL FOOD SUPPLY

Growth in agricultural output has slowed, especially in developed countries. With this slowing of output, the issue at hand is whether the world will be able to increase global agricultural production to a level that will ensure food security to a growing world population. OECD analysis indicates that “trade openness improves each dimension of food security. Trade in food and agricultural products in particular increases the availability of food by enabling products to flow from surplus to deficit areas. Open trade can also improve utilization and nutrition by increasing the diversity of national diets. Finally, open markets generally improve the stability of availability of access, for the simple reason that international markets pool production risks across individual markets.”<sup>14</sup>

### *PRO-TRADE PERSPECTIVE ON COMPARATIVE ADVANTAGE, TRADE AND FOOD SECURITY.*

Open economy spurs competition and specialization based on comparative advantage

Specialization leads to greater production efficiencies

Efficiency increases food production and enhances economic growth

Greater food supply, freely traded, results in lower prices and greater access to food

Economic growth raises incomes and further improves access to food

Source: J. Clapp, 2015. Food security and international trade: unpacking disputed narratives. Background paper prepared for The State of Agricultural Commodity Markets 2016-16. Rome, FAO.

***“Global trade is undergoing rapid change through a fragmentation of production processes and the integration of emerging economies into the global market. These trends are affecting trade and industrial specialization, demand for skills and relative wages, bringing benefits and creating new policy challenges.”***

Å Johansson, and E. Olaberria. 2014. “Long-term Patterns of Trade and Specialisation”, OECD Economics Department Working Papers, No. 1136, OECD Publishing.



## HUMAN HEALTH EPIDEMIC

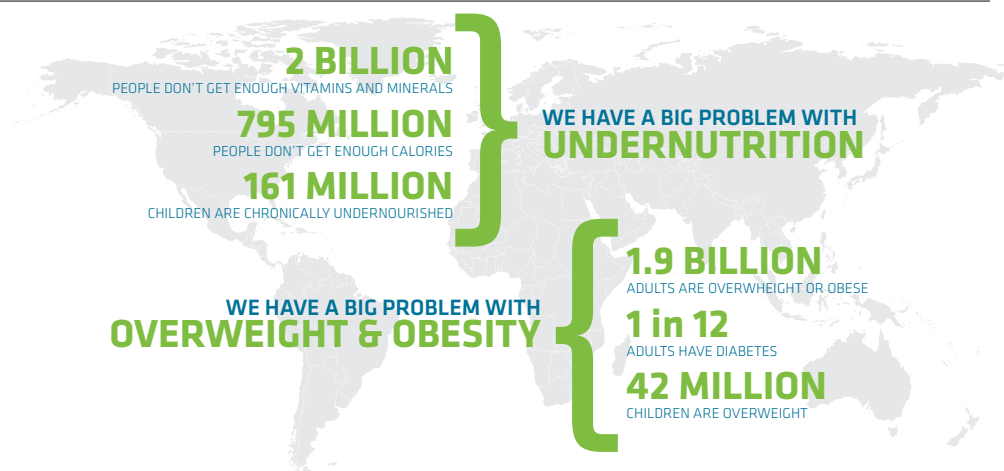


*"You are what you eat." Is this true about you?*



### 2.3 HUMAN HEALTH EPIDEMIC

Good health requires access to a nutritious, balanced diet that includes both sufficient quantities and quality of food. As populations improve their nutritional status, they have tended to transition from malnourishment to satiety to over-nutrition.<sup>1</sup> These extremes of food's effects on the human body have created a human health epidemic that reflects a narrowing of the inequalities in our world with respect to food access.<sup>2</sup>



Source: International Food Policy Research Institute. 2015. Global Nutrition Report 2015: Actions and Accountability to Advance Nutrition & Sustainable Development, Washington, DC. [http://www.shutterstock.com/subscribe?clicksrc=inline\\_thumb](http://www.shutterstock.com/subscribe?clicksrc=inline_thumb)

Today's food supply system is designed to maximize efficiency by reducing costs and increasing productivity, in many cases by use of preservatives and additives.<sup>3</sup> Toxins, antibiotics, hormones, processed foods and unhealthy additives threaten to derail our food system by causing irreparable harm to the environment and in some cases, to us.

***"Positive eating habits are created when informed people have access to food that is both nutritious and affordable....too many people lack the knowledge, confidence, or food environment to make healthier choices."***

*Jamie Oliver. (Chef and Campaigner) Global Nutrition Report 2015: Actions and Accountability to Advance Nutrition & Sustainable Development, International Food Policy Research Institute. Washington, DC.*



# HUMAN HEALTH EPIDEMIC

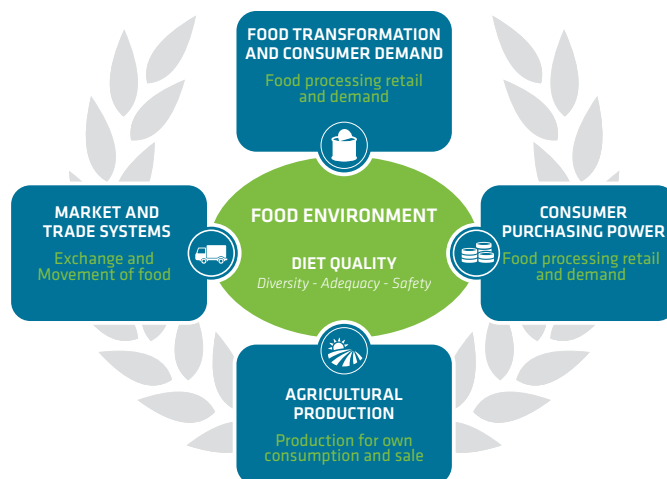


*Global population is growing and moving to cities. How can we create more vibrant and healthy urban 'Food Environments'?*

## 2.3.1 FOOD ENVIRONMENTS – WHY WE EAT THE WAY WE DO

Where we come from – our culture, living condition, and daily lives - determines the food we eat. "Food Environments" are the collective physical, economic, policy and socio-cultural surroundings, opportunities and conditions that influence people's food and drink choices, preferences, habits and nutritional status."<sup>4</sup>

*THE FOOD ENVIRONMENT FROM WHICH CONSUMERS SHOULD BE ABLE TO CREATE HEALTHY DIETS IS INFLUENCED BY FOUR DOMAINS OF ECONOMIC ACTIVITY.*



Source: Global Panel on Agriculture and Food Systems for Nutrition. February 2015. Biofortification: An Agricultural Investment for Nutrition, Policy Brief No. 1.

Factors such as affordability, proximity to supermarkets, urban and rural settings all influence food choice in food environments. An increasing proportion of food is eaten outside the home, in schools, at work or restaurants, often limiting the availability of healthy food options.<sup>5</sup> Both rural and poorer urban areas battle with "food deserts" – areas where there are no supermarkets or farm markets - and this lack of access to healthy food results in both hunger and obesity at increasingly high levels.

***"As people leave rural areas for opportunities in cities, rural areas have become poorer due to their isolation from schools, services, social interactions, and labor-market resources. Rates of both diet-related chronic disease and food insecurity have increased substantially in recent decades, and low-income and rural populations are disproportionately affected."***

*Amber Canto, Laura E. Brown, and Steven C. Deller. 2014. Rural Poverty, Food Access, and Public Health Outcomes.*

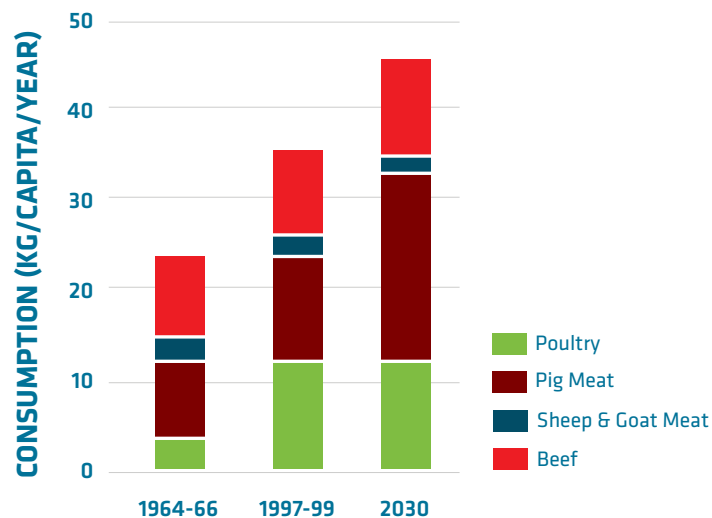
## HUMAN HEALTH EPIDEMIC

— (?) —  
*Our environment cannot support the western-world consumption rate of meat, if adopted by everyone. Can we curb our appetites?*

### 2.3.2 SEARCHING FOR PROTEIN

The Food and Agricultural Organization (FAO) of the United Nations projects a 60% increase in food consumption by the year 2050. This increase is driven not only by population growth, but also by a relevant increase in PC kcal consumption...with a clear tendency towards an increasing consumption of meat.<sup>6</sup> According to the U.S. Agriculture Department, worldwide meat consumption will rise 1.9% a year over the next decade as rising incomes in places like China, Mexico and Central America allow consumers to afford more pork, chicken and beef.<sup>7</sup>

WORLD AVERAGE MEAT CONSUMPTION PER PERSON, 1964-66 TO 2030



Source: FAO. 2002. *World agriculture towards 2015/2030. Summary report.*

Alternative protein-rich foods such as seitan, tofu, seafood, insects or simulated meats are gaining favor with protein-seekers. "Research carried out at the University of Oxford suggests that producing Cultured Beef could use as much as 99% less space than what is needed for current livestock farming methods. Research also points to greenhouse gas emissions and other environmental impacts for Cultured Beef being substantially lower than beef from modern farming."<sup>8</sup>

***"Production will have to far outpace population growth as the developing world grows prosperous enough to eat more meat."***

*David Tilman. May 2014. University of Minnesota - A World Demanding More. National Geographic.*



# HUMAN HEALTH EPIDEMIC

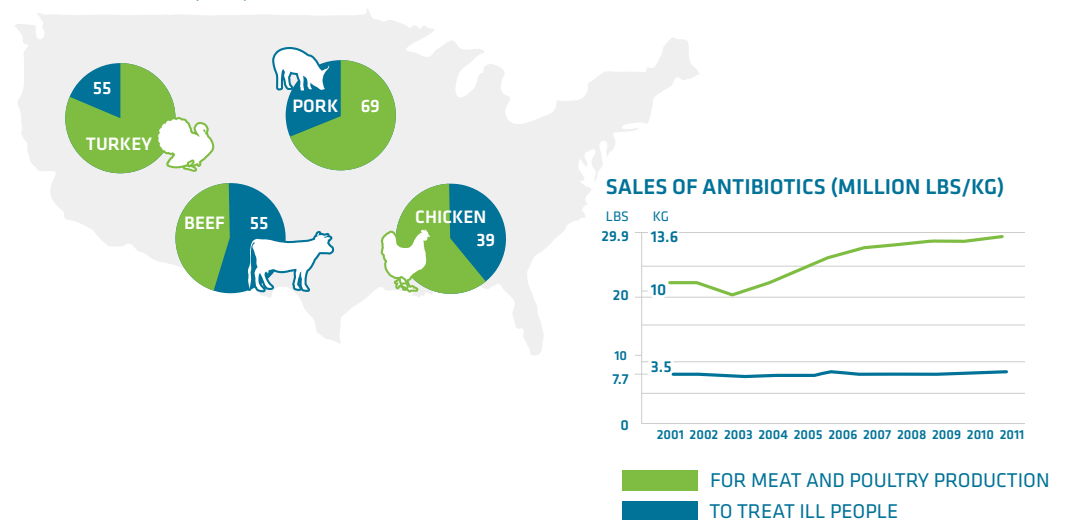
— (?) —  
Over decades, antibiotics have saved many human lives. Is widespread use of antibiotics to boost animal productivity worth the risks?

## 2.3.3 HOW TOXINS, ANTIBIOTICS AND HORMONES ARE MAKING US SICK

In the 1960s, the Green Revolution saw a tripling of pesticide use in farming from 1960-1990 and an increase in the global use of fertilizers by eight-fold between 1960-2000.<sup>9</sup> The long-term effects of this over-use are being felt across the world with the rise of cancers and health issues not only in humans but wildlife and ecosystems that depend on water and vegetation affected by industrialized farming techniques.

### HOW FAR WE ARE – DISTRIBUTION OF ANTIBIOTICS AND RESISTANT BACTERIA IN THE USA

ANTIBIOTIC-RESISTANT ENTEROCOCCUS FAECALIS DETECTED IN SUPERMARKETS, 2011, PERCENT OF ALL SAMPLES



Source: Stufung, Heinrich Boll. 2014. Meat Atlas: Facts and figures about the animals we eat, January 2014. Friends of the Earth Europe.

Since the 1950s, antibiotics have been used in intensive farming systems to increase the rate of growth in animals. An estimated 70 percent of the antibiotics used in the U.S. are given to farm animals for non-therapeutic purposes. Using antibiotics in this way can lead to drug-resistant bacteria causing certain bacterial infections that have become or are becoming untreatable in humans. Antibiotic resistant infections kill 90,000 Americans every year.

***“Without urgent, coordinated action, the world is heading towards a post-antibiotic era, in which common infections and minor injuries, which have been treatable for decades, can once again kill.”***

World Health Organisation. 2015. Antimicrobial resistance. Fact sheet Number 194.

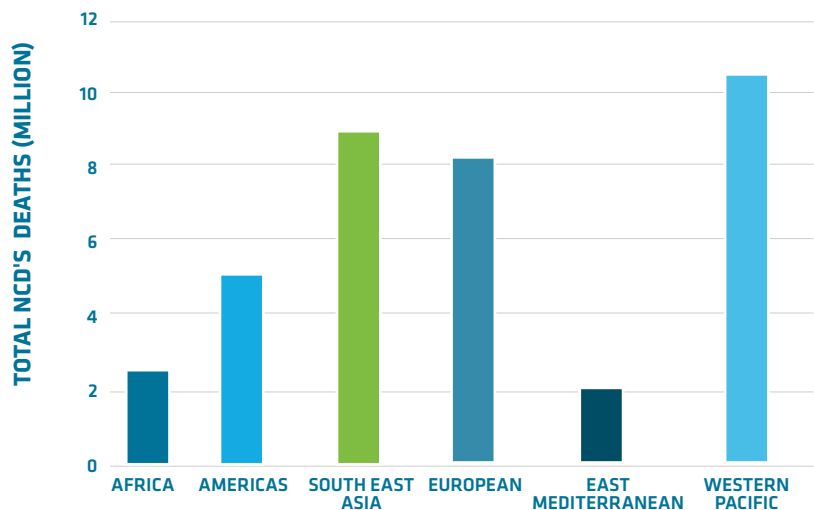
## HUMAN HEALTH EPIDEMIC

— (?) —  
*Diet matters when it comes to health. Should we regulate diets and ban 'killer diets'?*

### 2.3.4 FOOD QUALITY AND THE RISE OF NON-COMMUNICABLE DISEASE (NCD)

Food quality is paramount to good health. Consuming a healthy diet throughout life helps prevent malnutrition in all its forms as well as a range of non-communicable diseases (NCDs). The increased production of processed foods, rapid urbanization and changing lifestyles have led to a shift in dietary patterns. People are now consuming more foods high in energy, fats, free sugars or salt/sodium, and many do not eat enough fruit, vegetables and dietary fiber such as whole grains.<sup>10</sup>

*TOTAL NCD DEATHS, BY WHO REGION, COMPARABLE ESTIMATES, 2012*



Source: WHO. 2014. Global Status Report on Noncommunicable Diseases 2014.

The World Health Organization has determined that dietary factors account for at least 30 percent of all cancers in Western countries and up to 20 percent in developing countries.

***“As the leading cause of death globally, NCDs were responsible for 38 million (68%) of the world’s 56 million deaths in 2012. More than 40% of them (16 million) were premature deaths under age 70 years. Almost three quarters of all NCD deaths (28 million), and the majority of premature deaths (82%), occur in low- and middle-income countries.”***

*WHO. 2014. Global Status Report on Noncommunicable Diseases 2014.*



## HUMAN HEALTH EPIDEMIC

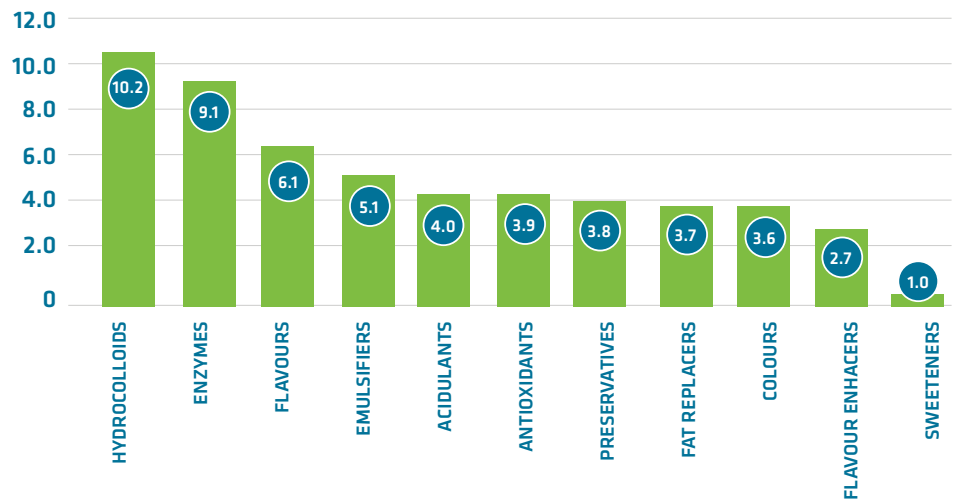


*Food processing is a vital part of our global food system. Can food processing be reinvented to actually make food better for us?*

### 2.3.5 PROCESSED FOODS AND UNHEALTHY ADDITIVES

Food processing is a series of operations by which unprocessed foods are converted into foodstuffs to prolong their duration, enable storage, and reduce time or effort spent in culinary procedures.<sup>11</sup> Whether for transportation or convenience' sake, the addition of additives and preservatives are meant to make fresh food last longer and taste better. Over time some additives have become serious threats to global health. Most people in developed countries consume too much sodium, fats (by means of oils), and sugars (high-fructose corn syrup).

*GLOBAL FOOD ADDITIVES MARKET GROWTH BY CATEGORY. 2009-2013 (AVERAGE % VALUE GROWTH PER ANNUM)*



**NB: EXCLUDES SALES OF VITAMINS, MINERALS AND FUNCTIONAL INGREDIENTS**

Source: Market Report. 2014. *The Global Food Additives Market* (6th ed.)Leatherhead Food Research, UK.

Efforts are underway to reduce these additives, but long-standing practices such as subsidies to corn growers have led to an oversupply of cheap high fructose corn syrup, which drives higher sweetener consumption,<sup>12</sup> especially in the beverage industry.

***“...the prevailing pattern of food and beverage marketing to children and youth in America represents, at best, a missed opportunity, and at worst, a direct threat to the health prospects of the next generation.”***

*Institute of Medicine. 2006. Food Marketing to Children and Youth: Threat or Opportunity?*

# HUMAN HEALTH EPIDEMIC

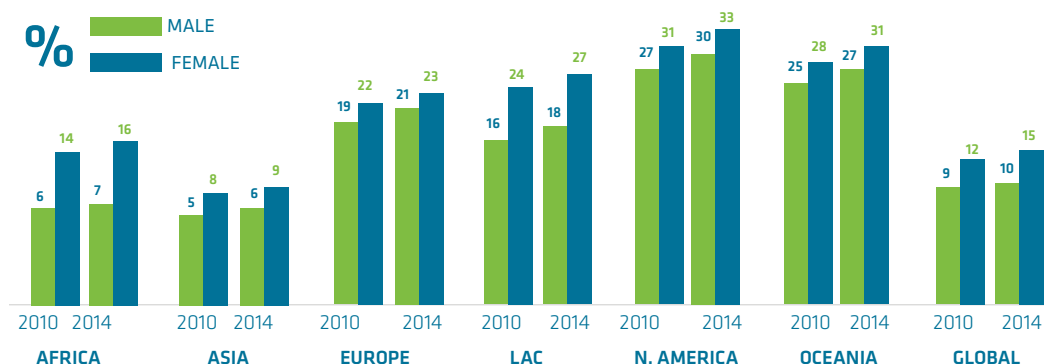


*Increased obesity rates mean rising health care costs, and productivity losses due to illness. Who is paying for these costs?*

## 2.3.6 THE OBESITY EPIDEMIC

Obesity and its associated diseases kills more than 2.8 million people in the world each year.<sup>13</sup> Common consequences of overweight and obesity are cardiovascular diseases, diabetes, musculoskeletal disorders and cancers.<sup>14</sup> In the United States, a 2013 study conducted by Columbia University and the Robert Wood Johnson Foundation examined death rates from obesity and found that one in five American deaths are now associated with obesity.

### MEAN PREVALENCE OF OBESITY FOR ADULT MALES AND FEMALES BY UN REGION, 2010 AND 2014



Source: International Food Policy Research Institute. 2015. *Global Nutrition Report 2015: Actions and Accountability to Advance Nutrition & Sustainable Development*, Washington, DC.

Worldwide, obesity has more than doubled since 1980 and is climbing.<sup>15</sup> Malnutrition is occurring due to the rise in more sedentary urban lifestyles and cheaper foods that provide the wrong nutritional content for healthy living. "In 2014, 39% of adults aged 18 years and older were overweight. The worldwide prevalence of obesity nearly doubled between 1980 and 2014. Thus, more than half a billion adults worldwide are classed as obese."<sup>16</sup>

***"Childhood obesity must be accepted as a significant and urgent threat to health that is relevant in all countries. Governments must take the lead."***

*Dr. Margaret Chan, WHO Director General. 22 June 2015.*



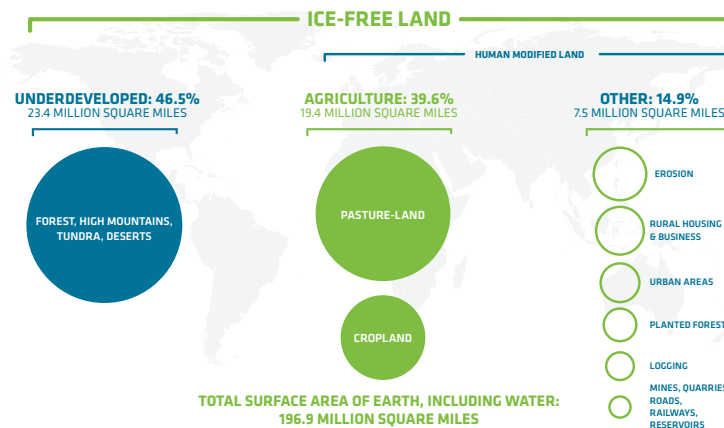
# LIVING IN A FINITE WORLD



We are depleting the land and fresh water needed to support global food production. Is it time to look at radical change and new innovative solutions?

## 2.4 LIVING IN A FINITE WORLD

Our current global food system is using many of our natural resources faster than they can be replenished. Shrinking agricultural land availability, growing water scarcity, higher energy demands including waste management, and the effects of climate change weigh heavily on our capacity to produce more food by 2050.



Source: Foley, Jonathan. May 2014. A Five-Step Plan to Feed the World. National Geographic.

One thing is clear, we cannot continue to indefinitely operate our food supply system in a depletion mode. The current global agricultural footprint takes up 38.6% of the world's ice-free surface leaving 46.5% undeveloped and 14.9% other landuse<sup>1</sup>. Of the 60-70% increase in agricultural production needed by 2050 to feed the growing population, it is estimated that approximately 46% will need to be in the form of staple grains and 76% will need to be in animal protein. Population growth is estimated to make up 70% of the total increase in food demand, while income growth will account for the remaining 30%<sup>2</sup>.

***“In 1968, Dr. Garrett Hardin introduced a principle called the Tragedy of the Commons. He claimed that if a community shares a common resource like a pasture owned by one and all, and if each farmer, motivated by enlightened self-interest, grazes his animals as much as possible to get the maximum benefit from this shared resource, other farmers will do the same. They will overgraze the commons until no grass is left.”***

*Douglas Gayeton. 2014. The New Face of Food and Farming in America. HarperCollins Publishers. New York.*



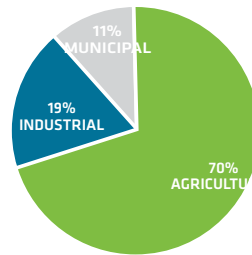
## LIVING IN A FINITE WORLD

— (?) —  
*Fresh water is critical to our food production capability. How can we reflect the embedded value of water in our food, and create incentives to preserve water resources?*

### 2.4.1 HITTING THE WALL - WHAT THIS MEANS FOR FRESH WATER RESOURCES

Water experts now calculate that humans are using half the available fresh water on the planet—leaving the other half to divide amongst a million or more species. By the year 2050, it is forecast there will be an 11% increase in irrigation demand accompanied by a 70-90% increase in water demand overall.<sup>3</sup> Seventy percent of water usage in the world is currently used for agricultural purposes and by 2025, 1.8 billion people will be living with absolute water scarcity.<sup>4</sup>

#### GLOBAL WATER USAGE



DEVELOPING COUNTRIES WILL INCREASE WATER WITHDRAWALS **50% BY 2025**

DEVELOPED COUNTRIES WILL INCREASE WATER WITHDRAWALS **18% BY 2025**

BY 2025, **1.8 BILLION PEOPLE** WILL BE LIVING WITH ABSOLUTE WATER SCARCITY AND TWO-THIRDS OF THE GLOBAL POPULATION MAY BE UNDER WATER STRESS CONDITION

#### FRESH WATER AVAILABILITY

**MORE THAN 66%** OF FRESHWATER IS HELD IN ICE CAPS AND GLACIERS



**ABOUT 30%** OF FRESHWATER IS GROUNDWATER



**LESS THAN 2%** OF FRESHWATER IS FOUND IN LAKES AND RIVERS



Source: FutureFood2050. 2015.

Growth in agriculture and industry is currently reported to be the main cause of surface water and groundwater quality deterioration (WWAP, 2006). Poor agricultural practices can lead to pollution of surface water and groundwater with pesticides, pollutants, nutrients and sediments. Impacts also include increased breeding grounds for disease and contamination of water supplies with pathogens from animal manure.<sup>5</sup> In order to preserve and replenish our fresh water supplies, we must continue to seek farming methods that focus on conservation and efficiency.

*While it is true that all aspects of social and economic development – often referred to as the food–energy–health–environment ‘nexus’ – depend on water, that is only half of the truth; the relationship is one of interdependency.*

UNESCO. 2012. *Managing Water under Uncertainty and Risk, World Water Development Report (WWDR4).*



# LIVING IN A FINITE WORLD

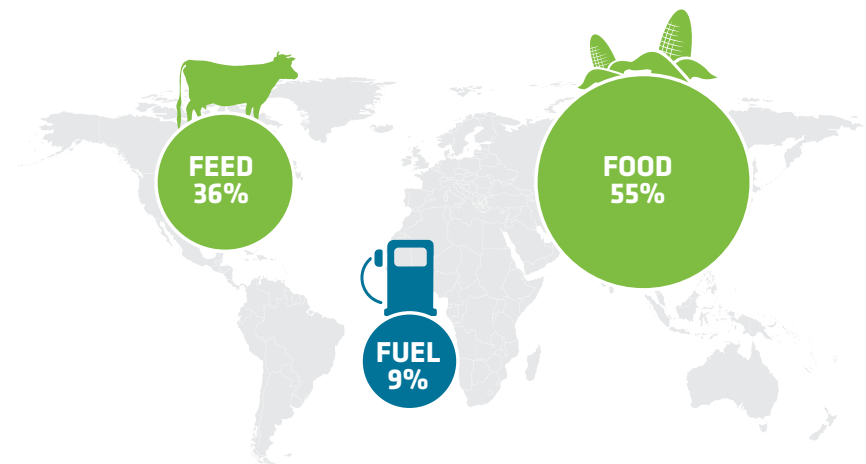


*There is a finite amount of arable land on the planet, and it is being degraded. How do we reinvent our approach to farming so we are continually improving farm land?*

## 2.4.2 LAND AND ITS LIMITATIONS

Today, we use approximately half of the planet's vegetated land to grow food. Worldwide, land used for agriculture has grown by more than 24 million acres per year since the 1960s, and expanding croplands and pasture lands are placing increasing pressure on tropical forests.<sup>6</sup> Crops are also used to feed animals and provide fuel. These needs are projected to climb as the impacts of increasing global incomes give rise to demands for more protein and the increased use of renewable energy sources requires farmed crops.

### HOW GLOBAL CROP CALORIES ARE USED



Source: Jonathan Foley. May 2014. *A Five-Step Plan to Feed the World*, National Geographic.

Land degradation caused by poor agricultural practices is the primary cause of the loss of arable soils. It is often caused by human activities such as overgrazing, over-cultivation, deforestation and poorly planned irrigation systems. Fifty two percent of the land used for agriculture is moderately or severely affected by soil degradation and the loss of arable land is estimated to be happening at 30-35 times the historical rate.<sup>7</sup> If we are to increase our food production to support the growing global population, we will need to come up with more sustainable ways of using our land resources or risk severely limiting their production use.

***“Desertification is the persistent degradation of dryland ecosystems by human activities and climatic variations. Because of its toll on human wellbeing and on the environment, desertification ranks among the greatest development challenges of our time.”***

*International Fund for Agricultural Development. 2010. Desertification*



## LIVING IN A FINITE WORLD

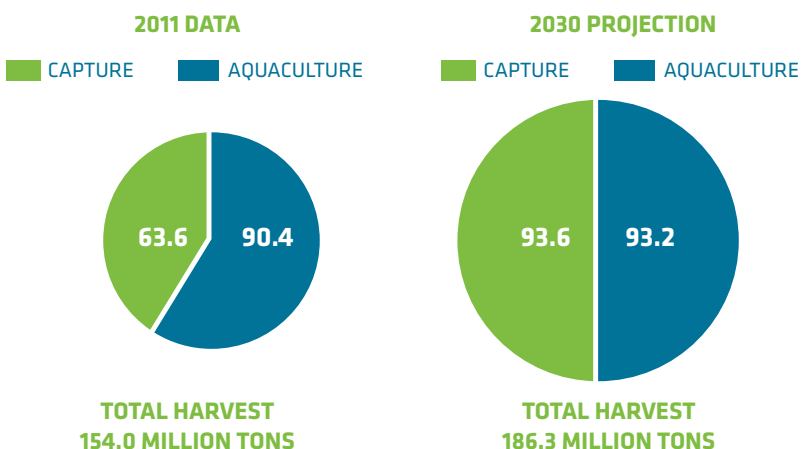


*We are reaching the limits of food producing land resources. Does the vast ocean resource become the farming landscape of the future?*

### 2.4.3 FISHERIES AND THE CRITICAL NEED FOR STEWARDSHIP

The growing fish industry is often called the new “blue revolution”. “During the last three decades, capture fisheries production increased from 69 million to 93 million tons; during the same time, world aquaculture production increased from 5 million to 63 million tons (FishStat). Globally, fish currently represent about 16.6 percent of animal protein supply and 6.5 percent of all protein for human consumption (FAO 2012).”<sup>8</sup>

#### VOLUME AND SHARE OF CAPTURE AND AQUACULTURE PRODUCTION IN GLOBAL HARVEST



Source: The World Bank. 2013. *Fish to 2030 Prospects for Fisheries and Aquaculture*.

Side effects of the capture industry such as by-catch (anything other than the target species which ends up getting caught in a fisherman's nets<sup>9</sup>), overfishing leading to collapse of stocks, and pollution have caused the fishing industry to turn to more intense fish farming (aquaculture and mariculture) as potentially more sustainable options. As with livestock, growth of the fish farming industry has given rise to the dangers of industrialized intensive farming practices, however the sector offers the potential for significant expansion.

***“Aquacultural pollution...is now a widespread hazard in Asia, where 90 percent of farmed fish are located. To keep fish alive in densely stocked pens, some Asian farmers resort to antibiotics and pesticides that are banned for use in the United States, Europe, and Japan.”<sup>10</sup>***

*Joel K. Bourne. June 2014. How to Farm a Better Fish, National Geographic.*



## LIVING IN A FINITE WORLD



*Forests are home to many new and undiscovered species of plants that have unique medicinal and flavor qualities. Is deforestation putting us at the risk of losing the 'spice of life'?*

### 2.4.4 SEEING THE FOREST FOR THE TREES

Forests play an essential role in mitigating climate change and providing products and ecosystem services that are essential to humankind. The latest estimate of the world's total forest area is more than 4 billion ha (9.85 billion acres), corresponding to about 30 percent of total land area or an average of 0.6 ha (1.48 acres) per capita of human population. Changes in land cover have caused the most pressing environmental issue in recent decades. Deforestation and land-use intensification, especially their impact on soil degradation, are most critical.<sup>11</sup>

#### DEFORESTATION FRONTS AND PROJECTIONS OF LOSS FROM 2010 TO 2030.

DEFORESTATION FRONT	PROJECTED LOSS (MILLION HA) 2010 TO 2030
AMAZON	23.48
ATLANTIC FOREST/GRAN CHACO	10
BORNEO	22
CERRADO	15
CHOCO-DRIEN	3
CONGO BASIN	12
EAST AFRICA	12
EASTERN AUSTRALIA	3-6
GREATER MEKONG	15-30
NEW GUINEA	7
SUMATRA	5
TOTAL FROM 11 DEFORESTATION	127-170

Source: World Wildlife Fund Living Forests Report. 2015. *Saving Forests at Risk*.

Agriculture is estimated to be the proximate driver for around 80% of deforestation worldwide.<sup>12</sup> Approximately 260 million acres of U.S. forest have historically been cleared to create cropland to produce feed for animals raised for food. Land degradation caused by deforestation, particularly in the rainforests of South America and the palm oil groves of Asia have more recently drawn the focus of public awareness campaigns. Looking forward, in order for our forest use to come into balance, it will be critical for sustainable forest management plans to include stricter standards around expanding agriculture.<sup>13</sup>

***"Deforestation has many negative effects on the environment. The most dramatic impact is a loss of habitat for millions of species. Seventy percent of Earth's land animals and plants live in forests, and many cannot survive the deforestation that destroys their homes."***

*Deforestation, National Geographic. 2016.*

# LIVING IN A FINITE WORLD

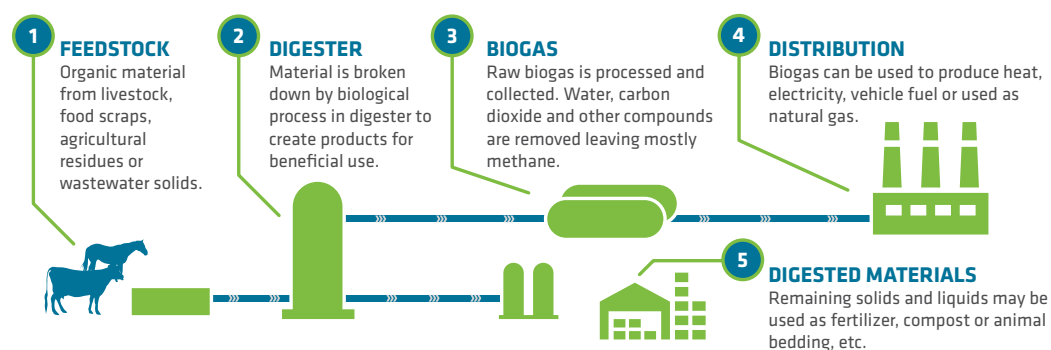


*Food production systems consume energy and resources. Can these systems be reinvented to create more closed loop beneficial impacts?*

## 2.4.5 ENERGY – NEW POWER SOURCES

Global energy consumption is forecast to rise by 40% by 2050. While fossil fuels are a finite resource, the revolution in renewable energy over the last decades offers clear solutions. Food production, processing, distribution and storage are all energy consuming steps. Livestock are a major source of methane emissions, which contribute to climate change. However, the food production industry, and farming in particular, can be part of innovative solutions. Currently, 9% of crop calories worldwide are used to produce biofuels. Corn is currently the primary feedstock used to produce ethanol, but other crops can also be used. Cellulosic biomass and switchgrass, hulless barley, hybrid poplars, algae, alfalfa and mixtures of native species are among others in experimental phases of development.<sup>14</sup>

### HOW BIO GAS IS PRODUCED



Source: Meersman, Tom, and Jim Spencer. 8 August 2015. Cow power – manure – seen as part of climate change strategy. Star Tribune.

Waste conversion to fuel is an innovative method that turns manure into methane-fueled heat and electricity, creating a closed-loop system. The process takes place in “anaerobic digesters” specifically build to create this alternative fuel source. The remaining waste may also be used to create a biomass product that can be used in bedding for cows and fertilizer for crops.

**“Bioenergy will be the biggest change in agriculture in our history.”**

*Gale Buchanan, USDA Undersecretary of Agriculture for Research, Education and Economics 2007.  
Clean Energy Farming.*





## LIVING IN A FINITE WORLD



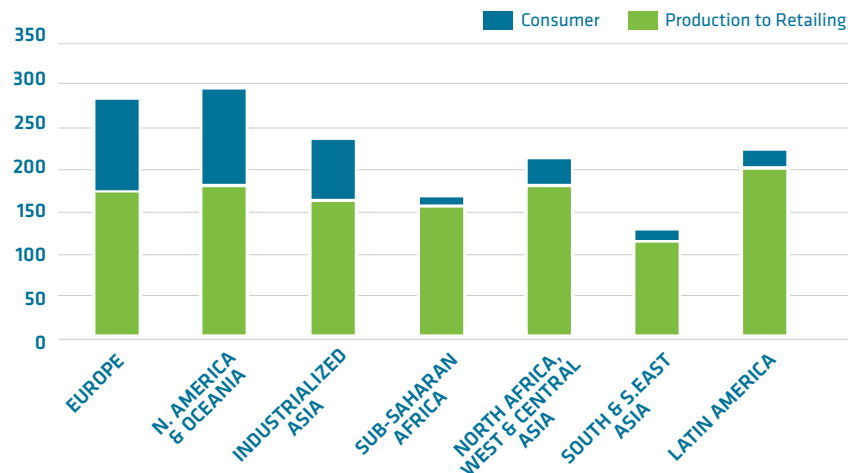
*We waste one third of food produced. What would a zero waste system look like?*



### 2.4.6 CLEANING UP WASTE AND USING WHAT WE HAVE

Food waste is a serious problem worldwide. Food waste occurs in supermarkets, homes, restaurants, and in transportation of food from farm to consumer. The UN FAO estimates that 1.3 billion tons of food is wasted annually, equating to approximately one third of the food the world produces. The FAO also notes that if just one fourth of lost or wasted food were saved, it could end global hunger.<sup>15</sup>

*PER CAPITA FOOD LOSSES AND WASTE, AT CONSUMPTION AND PRE-CONSUMPTION STAGES, IN DIFFERENT REGIONS*



Source: FAO. 2011. *Global Food Losses and Waste. Save Food! Study for the International Congress*, Dusseldorf, Germany.

Managing waste produced by current farming practices is a way to reduce pollution of our resources. China, like every other country that has adopted the western-developed, factory-farming model, generates more animal waste than it can manage. Some of it makes its way into the waterways and lakes. Industrial agriculture is now responsible for a larger share of China's water pollution than industrial factories.<sup>16</sup> In response to the growing concern about waste pollutions, the USDA recently announced the first-ever US national food waste reduction goal, calling for a 50-percent reduction by 2030.<sup>17</sup>

***“Consumers in the developed world could reduce waste by taking such simple steps as serving smaller portions, eating leftovers, and encouraging cafeterias, restaurants, and supermarkets to develop waste-reducing measures.”***

*Jonathan Foley. May 2014. A Five-Step Plan to Feed the World. National Geographic.*

## SMART FARMING - THE TECHNOLOGY REVOLUTION



*Technology has the potential to transform the food system. Will we listen when a robot tells us what we can and cannot eat?*

### 2.5 SMART FARMING - THE TECHNOLOGY REVOLUTION

*When Norman Borlaug won the Nobel Peace Prize in 1970 for selectively breeding high-yielding wheat and rice, he was called the person who, more than any one else of this age, helped to provide bread for a hungry world.<sup>1</sup> This was the beginning of the Green Revolution, and the push to make these discoveries was in response to the dual threats of an exploding world population and the increase of famine during the 1950s and 1960s. The pressures we face today are similar to Borlaug's era. Modern technology and access to information will play key roles; both high and low-tech solutions will be needed and no single answer will fit all communities of the world.*



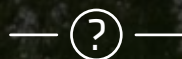
Advancements in technology have both saved us, literally, and created new problems. The centralization of production and the rapid rise in intensive farming have indeed fed more people to keep up with demand, but we have become desensitized as to where our food comes from and the pollution created by many of these practices is unsustainable. New technologies such as urban farming and precision agriculture, robots and 3D printing are leading the way to waste reduction, resource conservation and ultimately more sustainability.

***“New technologies will be needed to address the problem of rapidly increasing water scarcity, and also to reduce post-harvest losses. Addressing these challenges will require pushing the technology frontier outwards, including in marginal areas.”***

*FAO High Level Expert Forum. 2009. How to Feed the World in 2050: The technology challenge.*



# SMART FARMING - THE TECHNOLOGY REVOLUTION

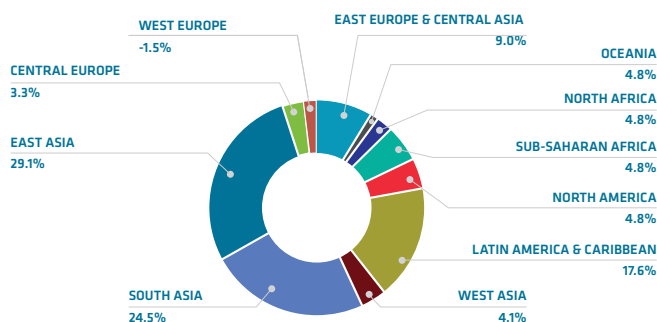


*Green lawns, golf courses and parks require large amounts of water and fertilizers. Why do we like green lawns so much?*

## 2.5.1 THE NEXT "GREEN REVOLUTION"

The Green Revolution resulted in a decrease in global malnourishment levels from 30% in 1950 to 12% in 2015.<sup>2</sup> However, pesticide use from 1960 to 1990 tripled and global use of fertilizer increased eightfold between 1960-2000.<sup>3</sup> A monoculture approach to growing crops in order to produce maximum yields brought a loss of seed diversity to industrialized farming and has encouraged high levels of nitrogen use. Calls for a new Green Revolution have produced a surge in the research and development of new growing techniques that hope to combine the goals of high productivity and sustainability for the environment.

### REGIONAL AND SUBREGIONAL SHARE OF WORLD INCREASE/DECREASE IN NITROGEN FERTILIZER CONSUMPTION, 2014-2018



Source: FAO, 2015. *World fertilizer trends and outlook to 2018*. Rome.

One noticeable red flag in our current farming system is the loss of wild pollinators in our environment. A recent study by the University of Vermont found that overall, wild bees declined across nearly one-fourth of the United States between 2008 and 2013, and that "where the study showed bees in precipitous decline, and amount of land tilled for corn spiked 200 percent in five years."<sup>4</sup> This is important because "of the hundred or so crops that make up most of the world's food supply, only 15% are pollinated by domestic bees, while at least 80% are pollinated by wild bees and other wildlife."<sup>5</sup> Reasons for the decline include habitat loss, parasitic mites, colony collapse disorder (CCD), and the use of neonicotinoids and other pesticides in the environment.

***"It's not really a mystery how to help pollinators. They need flowers, nesting sites, undisturbed soils and trees. And they need not to be poisoned by chemicals."***

*Prof. Taylor Ricketts, Univ. of VT (Josephine Marcotty, 22 December 2015. Wild bees losing out to corn in MN and Upper Midwest, says U of Vermont study. Star Tribune.)*

# SMART FARMING - THE TECHNOLOGY REVOLUTION

— (?) —  
*Technology is transforming  
traditional plant breeding.  
How long before we have  
'smart crops' that can  
manage themselves?*

## 2.5.2 PLANT BREEDING – CREATING SUPER PLANTS

Borlaug's plant breeding success set in motion an avalanche of international collaboration on plant breeding research. In the 1960's, the nonprofit IRRI (International Rice Research Institute), achieved a scientific breakthrough with the production of IR8, a rice that was fast-growing and high-yielding. Its success and use have been hailed with preventing famine in Asia.<sup>6</sup> In the face of climate change and an ecosystem depleted of natural resources, scientists today at IRRI are working on a rice that uses much less water to grow (C4 crops). They are doing this by manipulating its own genes and hope to achieve this within the next ten years....in theory yields could jump by 50 percent.<sup>7</sup>



Source: FAO. *Global Partnership Initiative for Plant Breeding Capacity Building: Harnessing plant genetic resources for development. Business Plan 2009-2013.*

With one third of the world's population suffering from malnutrition, plant breeding techniques such as biofortification, gene splicing and marker-assisted breeding could bring nutritious food to millions of people. "Biofortification is the process by which the nutritional quality of food crops is improved through agronomic practices, conventional plant breeding, or modern biotechnology."<sup>8</sup> Especially in Africa, this technology has contributed to providing higher quantities of nutrition on a significant scale.<sup>9</sup> Marker-assisted breeding uses genetic technology to identify gene markers in plants so as to eliminate the time it takes to experiment with plant seedlings.

***"The technology and new approaches that are transforming agriculture  
in other parts of the world can be applied in new ways and help Africa  
flourish as well. Now is the time."***

*Bill Gates. 15 October 2008. Keynote Presentation: Support for the World's Poorest Farmers, The World Food Prize 2009 Norman E. Borlaug International Symposium. Iowa.*



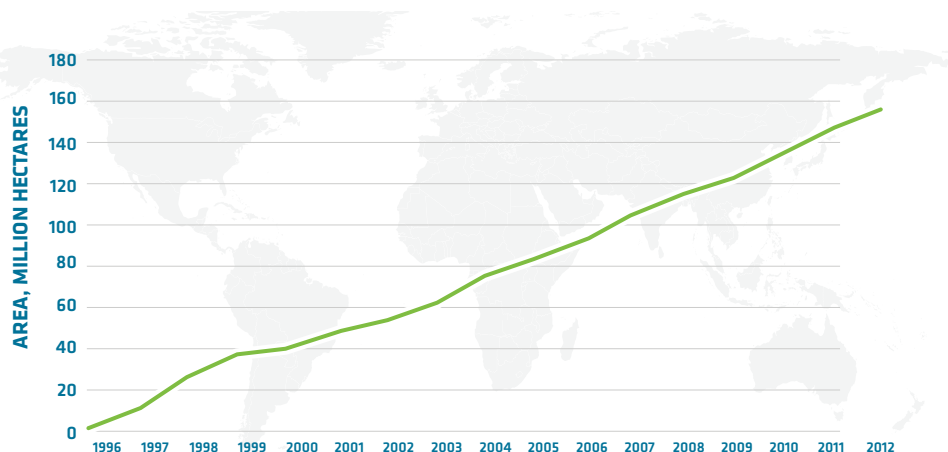
# SMART FARMING - THE TECHNOLOGY REVOLUTION

— (?) —  
*The concept of Genetic Modification evokes both fear and excitement. What if GM crops can stop millions of people starving to death?*

## 2.5.3 GENETICALLY MODIFIED FOODS

The development of Genetically Modified Organisms (GMOs), has brought significant controversy to the area of technology and food. "GMOs can be defined as organisms in which the genetic material (DNA) has been altered in a way that does not occur naturally by mating and/or natural recombination....It allows selected individual genes to be transferred from one organism to another, also between nonrelated species."<sup>10</sup> GMOs have been banned in many countries, but are used widely in North America and some developing countries. They have been created not only in crop production, but also in animals and are commonly referred to as GM foods. "A record 17.3 million farmers grew GM crops in 2012, up from 16.7 million farmers in 2011."<sup>11</sup>

### GLOBAL AREA OF GENERICALLY MODIFIED CROPS, 1996-2012



Source: FAO. 2014. *Technical Consultation on Low Levels of Genetically Modified (GM) Crops in International Food and Feed Trade*.

GM crops have revolutionized industrialized crop farming. Seeds genetically modified to be immune to the herbicide RoundUp, for example, means that farmers may spray herbicides freely to battle weeds and not kill the plant. Other GM crops bred with a particular bacterium Bt, have been found to require fewer pesticides because their genes ward off corn borers and other pests.<sup>12</sup> Production levels have increased dramatically and have fed the growing world demand for food, fuel and feed crops.

***"...we need to leave our doors open to ensure that we produce enough food in the future....that calls for different approaches. Agro-ecology and climate-smart agriculture are options. And so is biotechnology, including genetically modified organisms."***

*José Graziano da Silva, FAO Director-General. 29 September 2014. Opening statement, 24th Session of the Committee on Agriculture.*

# SMART FARMING - THE TECHNOLOGY REVOLUTION

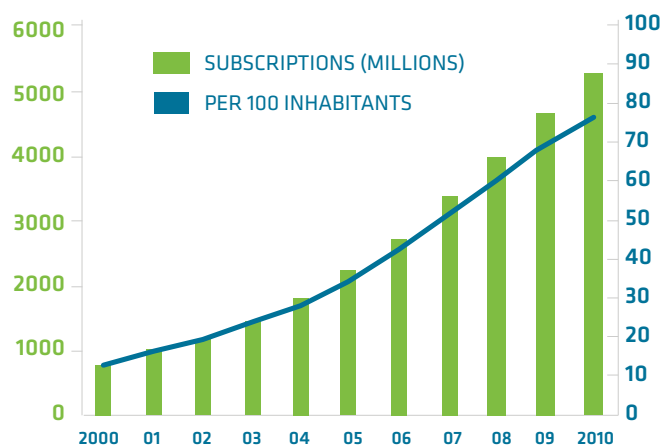


*Technology is shaping every aspect of the modern farming and food production system. How long before farming can be fully automated?*

## 2.5.4 THE AUTOMATION OF AGRICULTURE

The internet and computers have done more to democratize the global food system than any other technology. The number of mobile subscriptions worldwide has grown from 1 billion in 2000 to over 6 billion in 2012<sup>13</sup> and by 2018 it is estimated that over one-third of consumers worldwide will use smartphones.<sup>14</sup> Farmers using technology systems connected by the internet are able to access data and track items such as commodity prices and market information or pest and disease outbreaks<sup>15</sup> in real time and this helps with costs and decision making at all levels of farming.

*GLOBAL MOBILE CELLULAR SUBSCRIPTIONS, TOTAL AND PER 100 INHABITANTS, 2000-2010*



Source: Kevin Donovan. 2010. *Anytime, Anywhere: Mobile Devices and Services and their Impact on Agriculture and Rural Development*. InfoDev, World Bank Group.

Using a smartphone or similar device, a farmer may check the weather at any time or see what is happening on the farm without needing to be on site. GPS systems guide feed trucks to deliver exact amounts of food to livestock and sensors track where seeds are planted. Last year, a survey conducted by the American Farm Bureau Federation “found that 39 percent of respondents in major corn-and wheat-growing states were using sensor-driven technologies on their farms.”<sup>16</sup> Common technology involves inserting probes into the ground to measure water concentrations, enabling farmers to pinpoint areas that need more or less irrigation and thus promoting water conservation.

***“Today every John Deere tractor, sprayer, and combine comes equipped to wirelessly communicate information about where it is, what it has planted, and more.”***

*Nanette Byrnes. 26 May 2015. Food Technology for All, MIT Technology Review.*





## SMART FARMING - THE TECHNOLOGY REVOLUTION



*Urban farming and precision agriculture are innovative solutions to expand production and conserve resources. Can these solutions work in poor countries?*

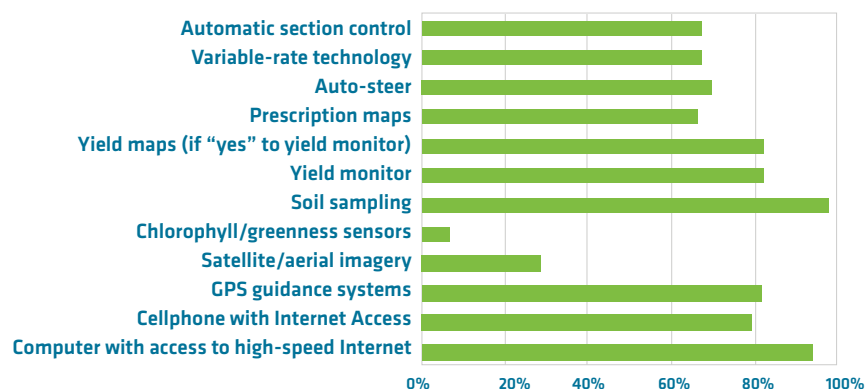
### 2.5.5 EXPANDING OUR OPTIONS - URBAN FARMING AND PRECISION AGRICULTURE

Urban farming has resulted due to the localized demand by city-dwellers for fresh, nutritious foods, especially in areas with “food deserts”. Types of urban farming ventures include rooftop gardens, rooftop greenhouses (both low tech and hydroponic), above-ground planting beds, the use of empty lots as farmland, and vertical farms that occupy tall buildings and abandoned warehouses.<sup>17</sup> Indoor urban farm options use advanced technology allowing them to escape the pollution associated with outdoor farming and provide extended growing seasons for the production of fresh foods.

***“On average, we’re growing in 16 days what otherwise takes 30 days in a field – using 95 percent less water, about 50 percent less fertilizers, zero pesticides, herbicides, fungicides,” said David Rosenberg, chief executive and co-founder of AeroFarms, NJ.***

*Morgan Brennan and Jodi Gralnick. 24 June 2015. Vertical farming: The next big thing for food – and tech. CNBC*

#### PRECISION AGRICULTURE TECHNOLOGY USAGE



**WHAT FARMERS ARE USING:** This table summarizes the adoption rates of numerous precision agriculture and AG data management tools currently available.

*Source: Mike Castle, Bradley D. Lubben and Joe Luck. July 2015. Precision agriculture usage. Nebraska Farmer.*

Precision agriculture involves the collection and analysis of data provided by Global Positioning Systems (GPS). Farmers use farm management software and GPS receivers to map their fields and track yields from every square meter.<sup>18</sup> Farmers are then able to calculate (among other things) where soils may be nutrient deficient, need irrigation, are infested with pests, etc. This technology provides efficiency and financial savings with respect to targeted treatments. It also saves the environment from unnecessary application of pesticides and herbicides and prevents the waste of water resources.

## SMART FARMING - THE TECHNOLOGY REVOLUTION

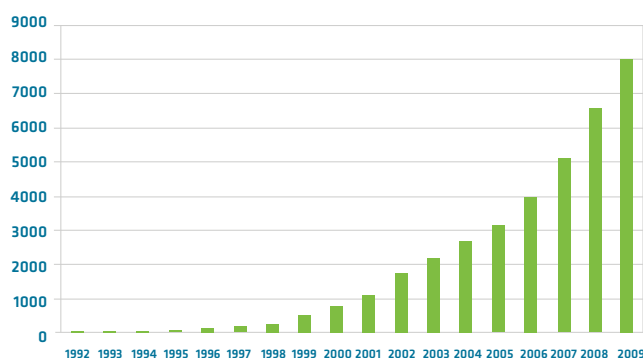


*Technological advances have progressively replaced humans for centuries. When will the farmer become obsolete?*

### 2.5.6 MACHINES OF THE FUTURE

The use of machines from farm to plate is nothing new. However robots and 3D printers give us a glimpse into what the future farm or kitchen may look like. Robots, autonomous machines, or “unmanned systems” are used in virtually all areas of modern farming. Their operations are efficient and predictable and they are able to withstand weather and adverse conditions. Using sensors, drones are able to measure the health of crops or herds from above. “On dairy farms, robotic milking machines are becoming increasingly common, essentially allowing the cows to milk themselves.”<sup>19</sup> Their use has even spread beyond earth where NASA scientists are working with Robots to grow food on space stations in anticipation of the potential for colonies in outer space.<sup>20</sup>

#### NUMBER OF AUTOMATIC MILKING FARMS WORLD-WIDE



Source: de Koning, C.J.A.M (Kees). 2010. Automatic Milking—Common Practice on Dairy Farms. The First North American Conference on Precision Dairy Management 2010.

3D printing, or multidimensional cooking of food is an ‘up and coming’ technology in the form of a printing machine that is able to form and cook raw foods into a variety of shapes. While still in the development stage, some are seeing this technology as a future tool in the efforts towards sustainability by incorporating alternative protein sources and nutritional elements into the food produced by the machine. This technique produces less waste than traditional cooking and may be programmed to produce foods containing exact nutritional components making it a potential aid in addressing malnutrition issues.

***“Interconnected smart appliances, 3-D printers, and touchscreen controls are just a few of the technological tools that the next generation of home cooks will use to simplify food preparation, create customized meal solutions, and produce far less waste.”***

*Melanie A. Bartelme, 2015. What's cooking in the Kitchen of the Future. Institute of Food Technologists.*



# CLIMATE CHANGE – THE WILD CARD



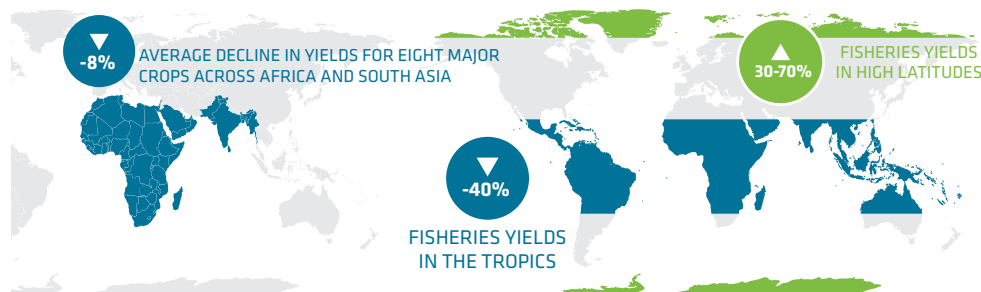
*Climate change is already radically changing the weather. How might it change what we eat?*

## 2.6 CLIMATE CHANGE – THE WILD CARD

*Climate change is real, and “scientific evidence for the warming of the climate system is unequivocal.”<sup>1</sup> On average, the Earth has warmed 1.5 degrees Fahrenheit since the late 19th century.<sup>2</sup> The recent rapid global warming of the Earth’s climate, the “greenhouse effect,” is mostly human-induced and results when the atmosphere traps heat radiating from Earth towards space.*

Gases that contribute to the greenhouse effect are water vapor, carbon dioxide (CO<sub>2</sub>), methane, and chlorofluorocarbons (CFCs).<sup>3</sup> Unless we reduce significant amounts of these gases flowing into our atmosphere, the International Food Policy Research Institute has projected that (crop) yields might fall by 13-50 percent by 2050, thereby jeopardizing the food security of more than 2 billion people in Asia alone.<sup>4</sup>

### WIDESPREAD IMPACTS ON FOOD AND FARMING ARE HIGHLY LIKELY



Source: CCAFS. 2014. *Climate change, food security and small-scale producers. Info Note.*

With a growing world population requiring a 60% increase in food production by 2050, the continued impacts of climate change are our wake-up call. One of the most disconcerting aspects of climate change is its unpredictability. “...as the Earth’s average temperature climbs, winds and ocean currents move heat around the globe in ways that can cool some areas, warm others, and change the amount of rain and snow falling. As a result, the climate changes differently in different areas.”<sup>5</sup> This volatility will require building resilience and efficiency into our global food supply system to be able to withstand not only the impacts of climate change but also the unrest that may result.

***“Climate change is THE problem, so it needs to be the filter through which we examine everything we do. When we’re designing policies in every area we should view them through that filter. Is this policy helping or hurting with climate change?”***

*Michael Pollan. 6 February 2015. Reforming Farming to Fight Climate Change: An Interview with Michael Pollan. Center for Ecoliteracy.*

# CLIMATE CHANGE — THE WILD CARD

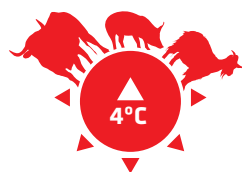


*Climate change is leading to a radical rethink in how we produce energy. What changes will it create in how and where we grow our food?*

## 2.6.1 KNOWN EFFECTS AND PREDICTIONS

Climate change is intricately tied to our food supply. Rising sea and temperature levels, warming oceans, extreme weather events, and ocean acidification are effects that have direct impacts on crops, livestock, fisheries and forests. Global awareness of climate change has grown as more people notice everyday changes in weather patterns across the world. The Intergovernmental Panel on Climate Change (IPCC) estimates that the average global temperature will most likely rise between 1 degree Celsius with strong emissions reductions and 4 degrees Celsius without them by 2100.<sup>6</sup>

### HEAT AND WATER MAY PASS CRITICAL THRESHOLDS



TEMPERATURE INCREASES OF MORE THAN 4°C WILL ENDANGER THE ABILITY OF FARMS AND ECOSYSTEMS TO ADAPT



CHANGES IN THE INTENSITY, FREQUENCY AND SEASONALITY OF PRECIPITATION



SEA LEVEL RISES AND MELTING GLACIERS



CHANGES IN GROUNDWATER AND RIVER FLOWS

Source: CCAFS. 2014. *Climate change, food security and small-scale producers. Info Note.*

Climate change has the potential to create an environment of scarcity and competition for our natural resources in the production of food. "More productive and more resilient agriculture requires a major shift in the way land, water, soil nutrients and genetic resources are managed to ensure that these resources are used more efficiently."<sup>7</sup> Now is a point in time where we may alter the course of climate change if we make the necessary changes to reduce global emissions and build resiliency through sustainable farming practices.

***"We have a choice: between an energy-efficient low carbon path and an energy-intensive high carbon path, which at an unknown point in time ends catastrophically. This doesn't seem like a very hard choice."***

*Michael Spence, William R. Berkley Professor in Economics and Business, NYU Stern School of Business, Italy (Davos 2015)*



# CLIMATE CHANGE – THE WILD CARD

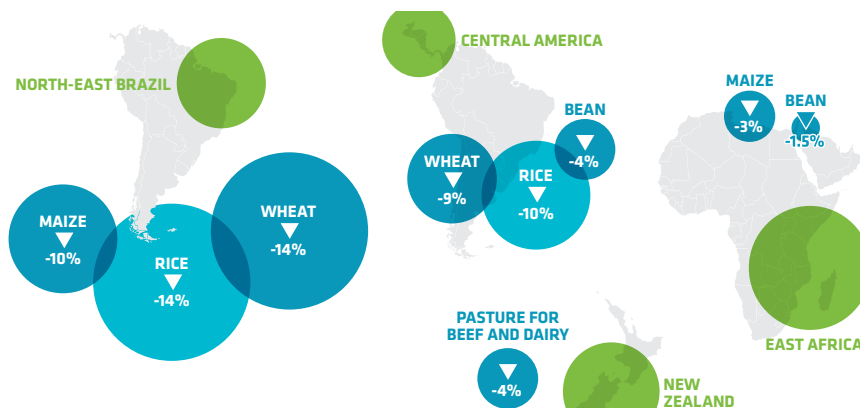


*Climate change is changing the political landscape. How will the balance of power and responsibility change in the global food systems?*

## 2.6.2 THE POLITICS OF CLIMATE CHANGE

The recent Paris summit on climate change, COP21, was recognized as a collaborative effort that brought together the world's leaders to determine how to address the effects of climate change going forward. The forum hosted over 750 attendees representing 43 countries and produced an agreement outlining anticipated benchmarks needed to alter the course of our current climate trajectory. Of particular interest to the agricultural sector is the Agreement's aim to hold the allowable increase in global average temperature to somewhere between 1.5 and 2 degrees. The half-degree will have a significant impact on agricultural production especially in crop yields, with higher temperatures meaning lower yields.

### CROP AND PASTURE YIELDS ARE LIKELY TO DECLINE IN MANY PLACES



Source: CCAFS. 2014. Climate change, food security and small-scale producers. Info Note.

This Agreement is also the first time ever that a global climate change accord recognized “the fundamental priority of safeguarding food security and ending hunger, and the particular vulnerabilities of food production systems to the impacts of climate change.”<sup>8</sup> The linking of food supply to climate change presents a great challenge and opportunity for policy makers. Thoughtful reorientation of our food supply will be key to long-term stability worldwide.

***“Providing food and nutrition for 9 billion people without compromising the global environment will be one of the greatest challenges our civilization has ever faced...It will require the imagination, determination and hard work of countless people from all over the world, embarked on one of the most important causes in history. So let's work together to make it happen. There is no time to lose.”***

*Jon Foley, Univ. of MN. 12 October 2011. Solutions for a cultivated planet.  
GLI Publications (Emily Dombeck).*

## CLIMATE CHANGE — THE WILD CARD

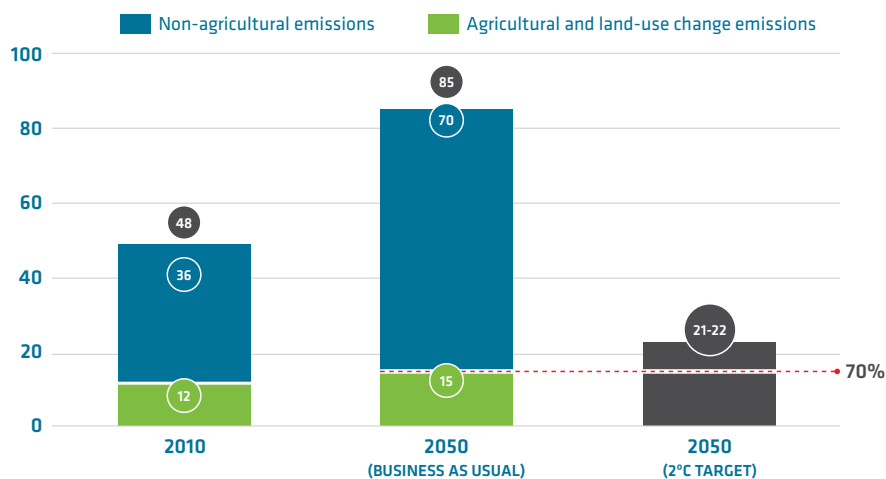


*Agriculture contributes to climate change. How do we reverse that equation?*

### 2.6.3 TAKING THE GAS OUT OF AGRICULTURE

Climate change impacts require us to adapt from the status quo of food production to more sustainable methods that will revitalize our environment. This transition will involve significantly reducing our greenhouse gas (GHG) footprint, as business as usual will only continue the depletion of our resources and exacerbate the effects of climate change.

*"BUSINESS AS USUAL" AGRICULTURE EMISSIONS WOULD COMPRISE 70 PERCENT OF ALLOWABLE EMISSIONS IN 2050 TO ACHIEVE A 2°C WARMER WORLD (GT CO<sub>2</sub> PER YEAR)*



Source: World Resources Institute. *Creating a Sustainable Future: A menu of solutions to sustainably feed more than 9 billion people by 2050.* World Resources Report 2013-14.

Reducing emissions may be accomplished in various ways, but ultimately we need to transfer our dependence from fossil fuels to renewables, reduce the amounts of methane produced by livestock and waste, and reduce the use of fertilizers involving nitrous oxide gases.<sup>9</sup> Significant progress has been made towards renewables, such as the EU's target of 20% final energy consumption from renewable sources by 2020.<sup>10</sup> Now is the time to continue these transitions towards a healthier, greener economy.

***"The great irony is that agriculture, as currently practiced, is one of the greatest offenders, pumping out a third of the world's annual greenhouse gas emissions. We are literally farming ourselves out of food."***

*Joel K. Bourne, Jr. 2015. The End of Plenty: The Race to Feed a Crowded World. W.W. Norton and Company, New York.*



## CLIMATE CHANGE – THE WILD CARD



*Our global food system consumes a lot of resources to process and distribute food. How might this change – Growing more local foods or more efficient industrial agriculture? Or both?*

### 2.6.4 GROWING LOCAL - GOING GLOBAL

Climate change is placing the spotlight on the real costs of getting food to where it needs to go. The distribution of food uses tremendous amounts of energy at all points of delivery and a transition to renewables will be crucial to lower its carbon footprint. Once produced, food needs to be cleaned, assembled, packaged, stored and transported. In rural areas, the infrastructure needs to be in place to prevent spoilage and contamination of food before it gets to markets.<sup>11</sup>



Source: U.S. Global Change Research Program. 2015. *Climate Change, Global Food Security and the U.S. Food System. Executive Summary.*

Changing climates caused by droughts or floods may cause a relocation of production areas for crops, livestock and fisheries. "The influence of climate change on which crops are grown where in the world affects the location of storage, processing, and packaging facilities, as well as that of the underlying transportation infrastructure for moving food from producer to consumers or to trade hubs."<sup>12</sup> Such shifting of food production will have a human toll that will need to be considered if climate change is allowed to worsen.

***"Today, the typical American prepared meal contains, on average, ingredients from at least five countries outside the United States."***

*Natural Resources Defense Council. 2007. Food miles: How far your food travels has serious consequences for your health and the climate.*

## CLIMATE CHANGE – THE WILD CARD



*Innovation requires time, resources and risk. How do we drive more innovation in the food production, processing and distribution systems?*

### 2.6.5 CLIMATE CHANGE AND ITS IMPACT ON INNOVATION

The effects of climate change have spurred rapid innovation efforts to build resiliency into our food supply system. Given the unpredictability of climate change, adaptation will be necessary, but not impossible. Global collaborative efforts such as “Mission Innovation” and “The Breakthrough Energy Coalition” will help lead the way to finding solutions to decrease our GHG emissions, support economic development, and strengthen energy security.<sup>13</sup>

*WE WILL NEED MAJOR INNOVATIONS IN HOW WE EAT AND FARM*



Source: CCAFS. 2014. *Climate change, food security and small-scale producers. Info Note.*

The increased burdens of growing populations and urbanization have created a global rush in food research and development. Stewardship of our natural resources in the face of climate change presents an opportunity that is unprecedented for humankind. “Food production on all the world’s farms can be increased through innovation, more sustainable practices, and reductions in food waste.”<sup>14</sup> Now we need to use our many skills to do so in ways that will reverse the growing effects of climate change and sustain our environment at the same time.

***“How the international community addresses climate change today will determine how well future generations will be fed and whether food security will be a reality for everyone.”***

*FAO. 2015. FAO’s Work on Climate Change: United Nations Climate Change Conference 2015.*



## CONSUMERS DRIVING CHANGE – RESHAPING THE FOOD INDUSTRY



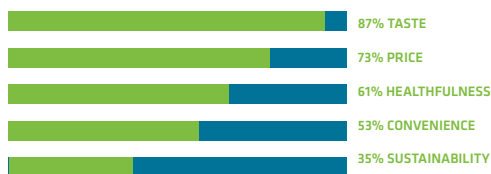
*There are increasing consumer sensitivities around an array of food related issues. Is this a developed world middle-class privilege, or part of a broader global trend?*

### 2.7 CONSUMERS DRIVING CHANGE – RESHAPING THE FOOD INDUSTRY

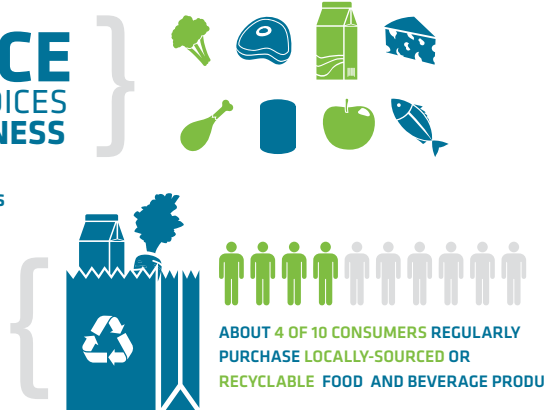
Through their purchase choices, consumers have the power to influence and drive changes in the food production, processing and supply chains. In developed markets, demands for safer and healthier foods are increasing. Responses such as local sourcing, improved animal welfare, fair trade and organic produce are also becoming more rapidly commonplace. Consumers with abundant food sources and the financial means have greater opportunities to make educated decisions about their purchasing power and food sources.

#### TASTE AND PRICE DRIVE FOOD AND BEVERAGE CHOICES MORE OFTEN THEN HEALTHFULNESS

HOW MUCH OF AN IMPACT THE FOLLOWING HAVE ON CONSUMERS  
DECISIONS TO BUY FOODS AND BEVERAGES



OUT OF 100%



Source: International Food Information Council Foundation. 2012.

**The FAO “identifies five important consumer trends and purchase drivers (in food consumption): food safety and health benefits; corporate social responsibility (CSR); production systems and innovations; sustainability; and food origin.”**

FAO. 2015. *Consumers' Concerns and External Drivers in Food Markets*. Rome.

## CONSUMERS DRIVING CHANGE – RESHAPING THE FOOD INDUSTRY

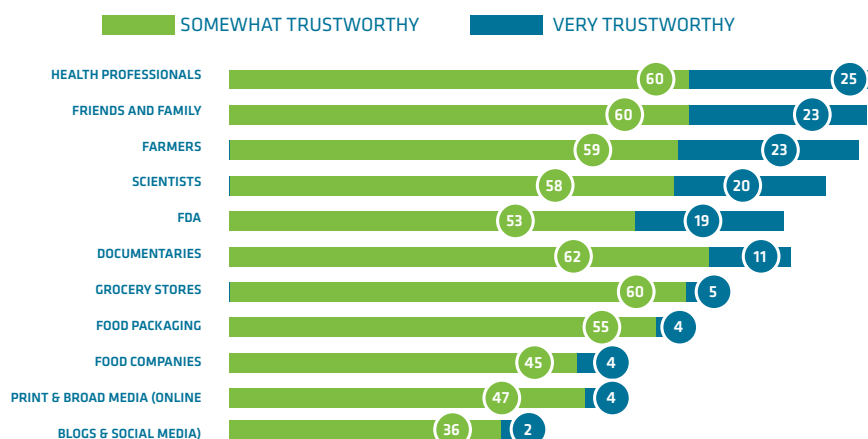


*Consumers are becoming more sensitized to health impacts from food they consume. Will better labeling reduce food related diseases and illnesses globally?*

### 2.7.1 HOW SAFE IS OUR FOOD? CLEAN FOOD LABELING

Food safety is a global concern. Every year, almost one in ten people fall ill due to a foodborne disease, and foodborne diseases cause 420,000 deaths worldwide, according to WHO Estimates of the Global Burden of Foodborne Diseases in 2015. Food labeling is a basic means with which to communicate information such as food origin or production to the consumer. Labeling provides immediate visual information to consumers.

*WHEN YOU GET INFORMATION ABOUT THE FOOD YOU BUY, HOW TRUSTWORTHY DO YOU FIND THE FOLLOWING SOURCES? (%)*



Source: The Chicago Council on Global Affairs. 2015. *Hungry for Information: Polling Americans on Their Trust in the Food System.*

In the wake of the past “mad cow” disease epidemic in Europe, and other major food safety scares, consumers have been asking for more transparency as “an important aspect of quality and safety assurance by allowing the tracing of products, ingredients, suppliers, retailers, processing operations or storage procedures throughout the food production chain.”<sup>1</sup> Non-GMO labeling is another area where consumer sentiment runs high. Many people appear to not particularly trust the food supply chain regarding the safety of their food, creating a pertinent reason for people to educate themselves and make their own informed choices.

***“In their broadest and most conventional application, food labeling policies have a dual purpose: to protect consumers and to ensure fair marketing. Food labeling is also becoming a policy tool for motivating change in consumer behavior and shifts in food production practices.”***

*Janet Albert. 2010. Innovations in Food Labeling.*



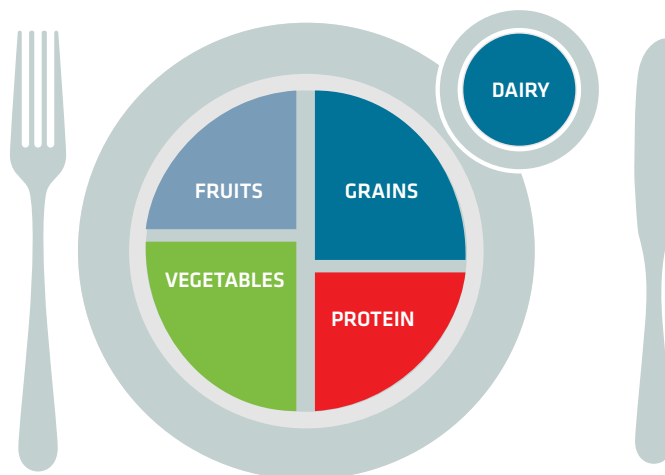
## CONSUMERS DRIVING CHANGE – RESHAPING THE FOOD INDUSTRY



*Huge amounts of public and private funds are invested to educate the public about healthy diets and lifestyle. But can people really be trusted to feed themselves properly?*

### 2.7.2 THE NEW FOOD 'PYRAMID' – RETHINKING DIETS

The overwhelming availability of less expensive, highly processed and convenience foods can make the choice to healthier and more ethical foods difficult, especially in rural and poorer urban areas. Concerted efforts are being made to educate and inform people on how to balance their diets and lifestyles because ultimately the long-term effects of unhealthy living not only cause increased health care costs, they may reverse the gains made in global longevity rates.



*ChooseMyPlate.org*

The World Health Organization (WHO) and many national governments have made relevant information available to the consumer, in support for the consumers' choice for a healthier diet. In 2010, the US Government announced a new health initiative, "MyPlate" replacing the former "food pyramid" advising consumers on the correct portions of foods to eat each day. These type of diet guidelines are believed to have the potential to reshape food consumption patterns, over time.

***"MyPlate' promotes fruits and vegetables, which cover half the circle. Grains occupy an additional quarter, as do proteins such as meat, fish and poultry. A glass of milk rests to the side. Desserts have been banished to the desert."***<sup>2</sup>

*The Washington Post. 3 June 2011. USDA replaces food pyramid with "MyPlate" in hopes to promote healthier eating.*

# CONSUMERS DRIVING CHANGE – RESHAPING THE FOOD INDUSTRY

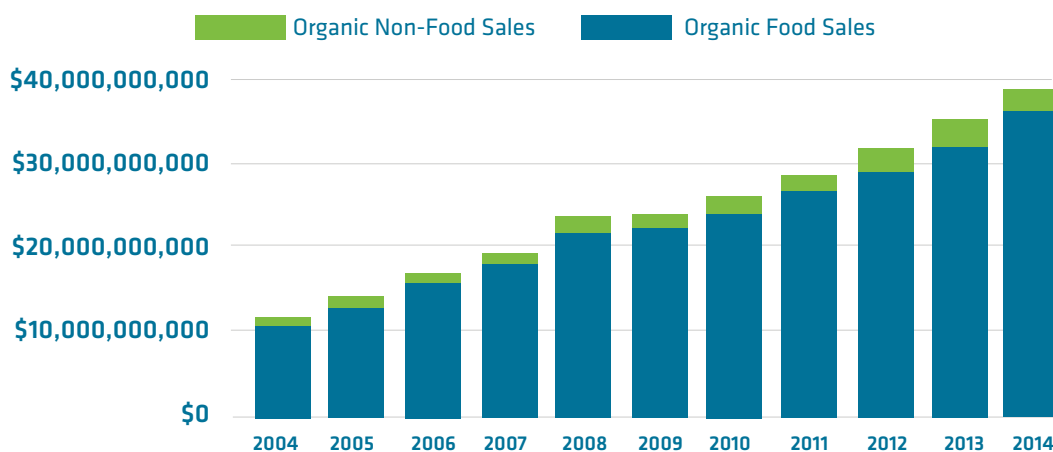


*In developed countries organic food and farming is gaining widespread interest. Is this a product for the privileged or is it a viable macro trend?*

## 2.7.3 'GOING GREEN' - DEMAND FOR ORGANIC FOOD

Organic farming and certification has exploded in recent years due to consumer demand for foods that are healthier, ethical and do not pollute the environment in their production. Organic farming uses more natural means of production such as inter-cropping, crop rotation, double digging, mulching or integration of crops and livestock.<sup>3</sup> The growth of organic farming worldwide is a reflection of the impact of consumer power on the food supply industry.

### TOTAL U.S. ORGANIC SALES AND GROWTH, 2004-2014



Source: Organic Trade Association. State of the Industry 2015.

Organic sales increased in the United States from \$3.6 billion in 1997 to over \$39 billion in 2014,<sup>4</sup> with a recent Consumer Reports survey showing that 84% of American consumers purchase organic food. Globally, organic sales have increased almost five-fold since 1999.<sup>5</sup> However, demand is outstripping supply, with limitations to growth including lack of land area under organic farming.

***“The informed consumer can effect change in the food system by choosing to purchase items that promote sustainability, equitability or other desirable goals. Clear labeling and information is essential for this to happen.”***

*Government Office for Science (UK) 2011. Foresight. The future of food and farming.*



## CONSUMERS DRIVING CHANGE – RESHAPING THE FOOD INDUSTRY

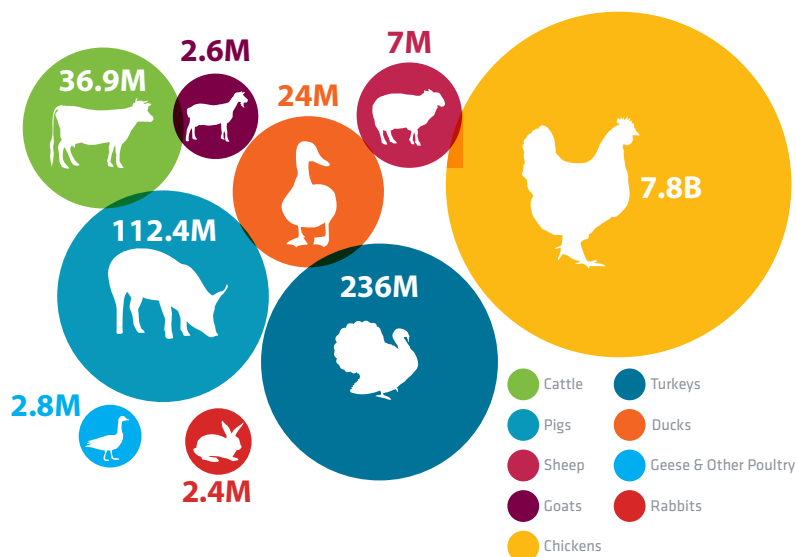


*Forecasts predict increased global consumption of animal proteins. Could animal welfare concerns create a major 'tipping-point' in the food industry?*

### 2.7.4 CONCERNS FOR ANIMAL WELFARE

The global food industry includes the breeding, rearing, transport and slaughter of large numbers of animals. The industrialized production of meat and animal products such as eggs and milk has also seen the emergence of unprecedentedly large farming systems, where animals are often confined.

#### MEAT CONSUMPTION IN USA – BY ANIMAL TYPE (2013)



Source: Heinrich Boell Foundation, Friends of the Earth Europe". Meat Atlas 2014

The growth of such intensive farming has alarmed many consumers with respect to animal welfare, the environment and human health. As a result of more knowledge, many consumers are now demanding transparency and insight into the reality of how animals are treated in the food industry.

***"In a survey conducted by market researcher The Hartman Group, 44% of respondents said they wanted to know more about how food companies treat the animals used in their products. Almost half of consumers (47%) said they support companies that avoid inhumane treatment of animals, a 6-point increase from a similar survey conducted in 2013. In addition, 65% of respondents indicated they want animals raised in as natural environment as possible."***

*The Hartman Group. 2015. Animal Proteins: The Consumer-Driven Demand for Transparency.*

## CONSUMERS DRIVING CHANGE – RESHAPING THE FOOD INDUSTRY



*Vegans and vegetarians are pioneering new meat free diets. Might this trend help solve the challenges of feeding the world?*

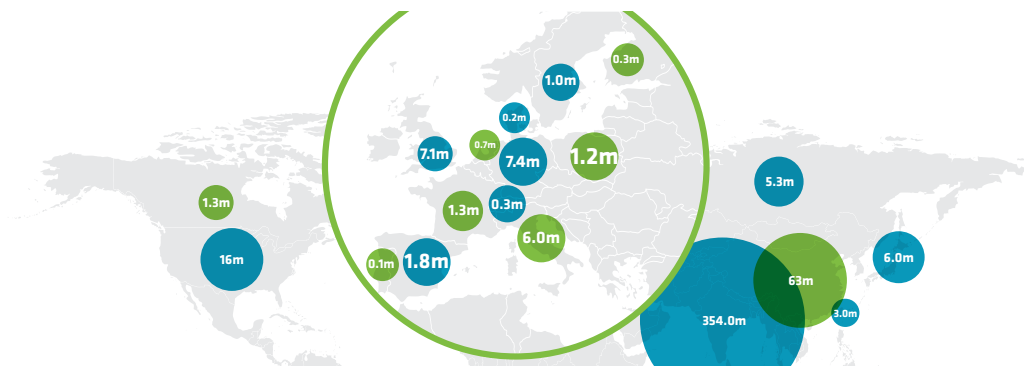
### 2.7.5 THE RISE OF VEGETARIAN AND VEGAN DIETS

Global consumer trends towards both healthier diets and alternative proteins have prompted an increase in vegetarianism and veganism worldwide. While animal welfare remains a primary motive for choosing a vegetarian diet, concern for the environment is a driving factor for many vegetarians.<sup>6</sup> Worldwide, vegetarians total 375 million. In India, where there are religious reasons guiding a meat-free diet, 31% of the population is considered vegetarian. In Europe, vegetarians are estimated to be approximately 10% of the population, and 5% in the USA.

***“Animal protein-rich food consumes five to 10 times more water than a vegetarian diet and one third of the world’s arable land is used to grow crops to feed animals.”***

*Anders Jaegerskog. 5 September 2012. Will we be restricted to a vegetarian diet by 2050? Science Illustrated.*

#### ESTIMATED NUMBER OF VEGETARIANS IN SELECT COUNTRIES



Source: Wikipedia 2015 – variety of sources including polls, census data and studies.

Vegetarianism excludes meat of any kind, be it red meat, poultry, birds, fish, shellfish or seafood. Veganism is the practice of abstaining from the use of animal products, particularly in diet, and an associated philosophy that rejects the commodity status of animals. Public interest in veganism seems to be on the rise. Google Trends has noticed an uptick in internet searches since 2004<sup>7</sup> and a 2012 study commissioned by the Vegetarian Resource Group and undertaken by Harris Interactive found that 2.5 percent of the United States identified themselves as “vegan,” up from 1 percent in 2009.<sup>8</sup>

***“Everyone recognizes the word vegan today. That’s a tremendous step forward. We have built our reputation on people who want to eat healthy.”***

*Pamela Elizabeth, founder of the New York vegan restaurant chain, Blossom in Chelsea Now, Oct 9 2014*





## CONSUMERS DRIVING CHANGE – RESHAPING THE FOOD INDUSTRY



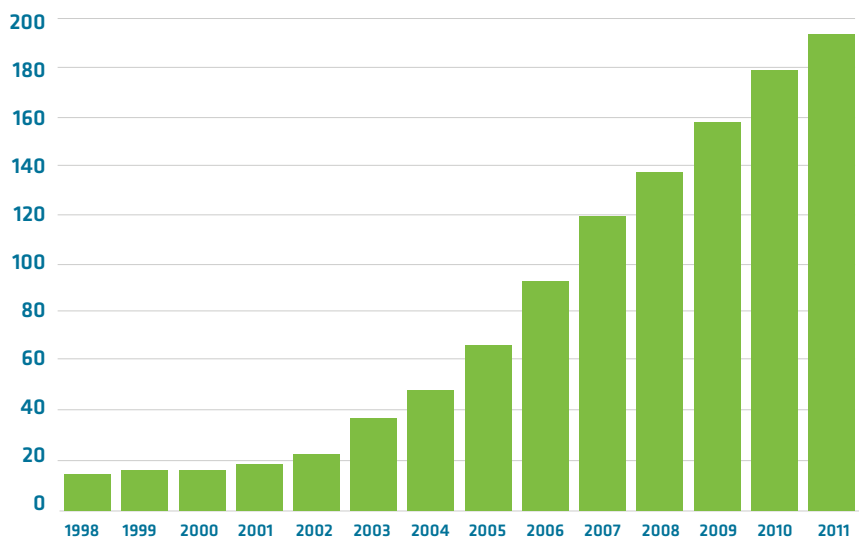
*Consumers are learning they have power to shape food supply chains. What will be their new demands over the next decade?*



### 2.7.6 CONSUMER POWER SHAPES NEW FOOD VALUE CHAINS

Consumer purchasing and choice has the potential to drive radical changes in the food industry. These changes are already occurring and cover issues including animal welfare, environmental sustainability, health and trade practices. These changes can reach across the world, encompassing entire supply chains. An example is consumers seeking out “Fair Trade” products. The largest fair trade product in the global market is coffee. Despite being slightly more expensive because of the so-called “fair trade premium”, sales have grown.<sup>9</sup>

#### HOW UK RETAIL SALES OF FAIRTRADE COFFEE HAVE GROWN (£M)



Source: Fairtrade Foundation

Corporations are expected to progressively change their practices by making them more socially responsible as a response to media, NGOs and consumer demands.”<sup>10</sup> Consumer demand in the United States for “cage-free” eggs is a case in point. McDonald’s recently followed the supply-line switches of other ‘fast food’ outlets to transition to “cage free” only eggs, and many farmers have build new facilities in order to accommodate the new regulations.<sup>11</sup> The move towards better conditions for chickens was a consumer demand and preference that set in motion changes to the food supply chain.

***“The McDonald’s announcement really settles the debate as to whether there will be a future for cage confinement in the egg industry – the answer is no, there won’t be.”***

*Paul Shapiro, VP of farm animal protection for the Humane Society of the U.S. (2015)*

# THE COMING FOOD REVOLUTION

## 3.0 THE COMING FOOD REVOLUTION

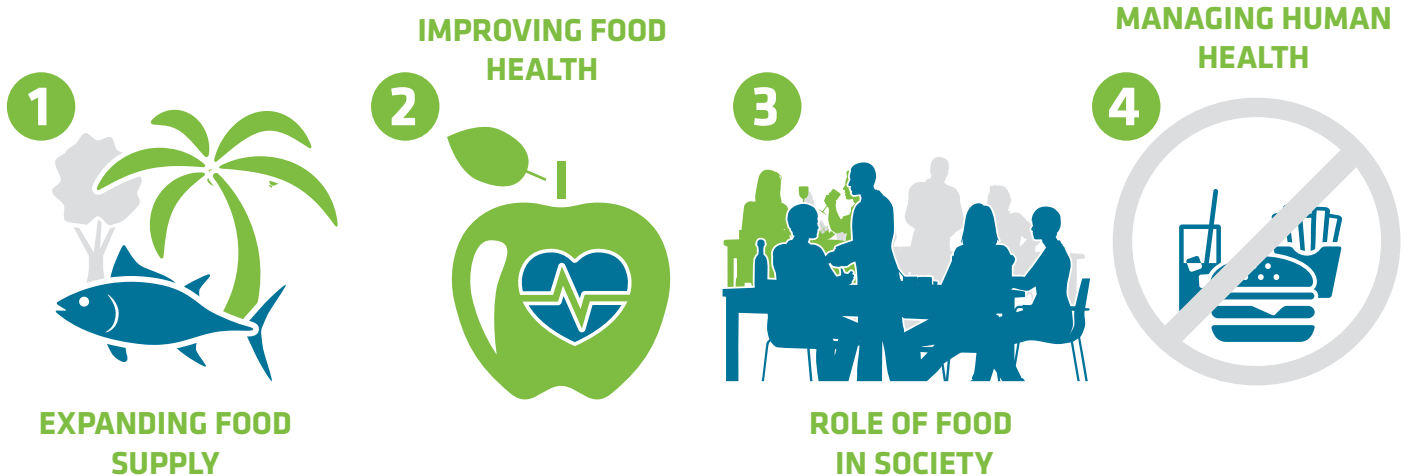
*There is a coming revolution in the food industry. How can we best apply our efforts, and transform global and local food systems?*

*There are a range of potent forces and trends that are converging upon and within the food industry. Macro threats such as supply capacity constraints, food safety, human health epidemics and growing consumer distrust, provide the basis and momentum to trigger a revolution across the entire scope of the food industry. Many would argue that this revolution is already underway, and is an essential next step to forge a path towards global and human sustainability.*

We don't have to look too far for comparable examples. Rising CO<sub>2</sub> levels have triggered climate change, which in response has triggered a global revolution in renewable energy. This is currently reshaping the very foundations of the energy industry; unraveling global power bases, forging new alliances and offering consumers new choices.

And, likely this renewable energy revolution will save us from the most catastrophic climatic change scenarios.

Reinventing our global and local food systems will offer similar disruptive opportunities. Our foresight work suggests that there will be four key dimensions to the food revolution story.



This section explores these dimensions in more detail. However, as important as they are individually, it is how they may intersect and interact that is likely to drive the depth of the food revolution we are predicting.

***“Let food be thy medicine, and medicine be thy food.”***

*Attributed to Hippocrates (460 – 370 BC)*



# THE COMING FOOD REVOLUTION

## 3.1 TURNING FINITE INTO INFINITE – FOOD SUPPLY

*Can we imagine a world where we have eliminated waste; produce abundant clean food; and take care of the ecosystems?*

Many of the challenges to global food supply are premised on the concept of limited resources. Whether this is caused by depleting fresh water supplies, declining areas of arable land or limited resources of fertilizers and other inputs; we are in a resource limited scarcity model.

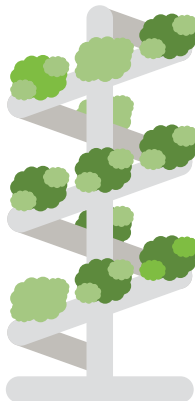
However, the shift from fossil fuels to renewable energy sources offers the prospect of a future with almost unlimited low cost energy. Could the same logic be applied to food production systems? Could we develop new closed loop farming systems that eliminate waste, purify water and produce abundant clean food? Cheap energy could allow water purification and desalination to occur on scales never previously imagined.

New innovations such as indoor vertical farming, hydroponics and aquaculture offer the opportunity to expand our food supply capacity in major new directions. Turning to new protein sources such as insects, cultured 'meats', algae and plants could rapidly expand the quantities without dramatic environmental costs. Developing the right scale in these systems could also mean we can help close the gap between where food is produced and where it is consumed, saving resources dedicated to transport and packaging.

### HYDROPONICS



### VERTICAL FARMS



### SMART FARMING



*“New ideas are by their very nature disruptive, but far less disruptive than a world running low on drinking water and productive land, set against the backdrop of climate change, extreme weather events and rising natural resource scarcities.”*

*UNEP. 2011. Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication.*

The challenge to some of these new food sources has been consumer resistance. However, as food science technology improves, the equation changes. The ability to be able to blend, 'manufacture' and engineer foods and flavors is improving. It may soon be readily possible to design and produce complex foods from basic food ingredients, by adding unique flavors, textures and characteristics.

*This opens the door to turning abundant low cost staple foods, such as plants and grains, into an almost infinite and enticing array of food and taste combinations.*

# THE COMING FOOD REVOLUTION

*What if every forkful of food had an increasingly positive impact on our lives? What would that level of health, taste like?*

## 3.2 THE NEW FRONTIER – ‘FOOD HEALTH’

Much is made of the health implications of processed food – both the positives and negatives. In recent years, intensive farming, processed foods, and the food processing industry have been the subject of intense public scrutiny. Food scares, food recalls, undercover documentaries, research studies and social media campaigns, all combine to create a strong voice demanding improvement in the healthiness, transparency and safety of processed food.

***Consumers’ concerns about health are closely related to food safety concerns. Consumers will demand more information about food products and the possibility to trace their movement through the supply chain.***

*FAO. 2015. Consumers’ Concerns and External Drivers in Food Markets.*

So how do we envisage the concept of ‘food health’? There is a significant opportunity for a radical shift in the way we approach the critical steps of food production, processing and preparation. How do we make sure that food processing makes food healthier for us? The ‘Cradle to Cradle’ concept explores how recycling materials could actually make those materials cleaner at each step. How could a similar ‘Fork to Fork’ approach ensure that food quality and value, and our environment, is improved at every step? This goes well beyond food safety aspects, and moves us into understanding, measuring and promoting a total health approach.

***“The solution to defining ‘food health’, lays in creating a system where the consumer can easily access and measure the health of their food, across multiple dimensions, such as:***

- Embedded content and impact of nutrients and toxins within food.
- Impact on the consumer, including effect on health and the joy of eating.
- Environmental cost and benefit of growing and getting the food to you.

*David Beurle. 2016. Future iQ Partners.*



Ready access to this type of information will drive consumer behavior, and reward production systems and supply chains that offer the best ‘food health’ profile.

*The ability to measure and predict ‘food health’ data will spur innovation, transparency and food safety within our food supply system.*



## THE COMING FOOD REVOLUTION

### 3.3 WHEN WE CAN'T BE TRUSTED

*Imagine if you could eat whatever you wanted; but your meals were uniquely customized to never exceed healthy thresholds?*

When given abundant food options, and the freedom to choose, the evidence suggests people 'tuck-in' with gusto. With 1.9 billion overweight or obese people on the planet today, it begs the question as to whether some people can actually be trusted to feed themselves properly. While many people exercise informed dietary choices and take responsibility for their own health; it appears many do not. The health implications of obesity are well understood, yet the numbers are on the increase. This has a significant cost on public and private health systems, yet this cost is not borne entirely by the individual.

***Specialization is undeniably a powerful social and economic force. And yet it is also debilitating. It breeds helplessness, dependence, and ignorance and, eventually, it undermines any sense of responsibility.***

*Michael Pollan. 2013. Cooked: A natural history of transformation. New York.*

In the case of smoking; public health policy, education, price disincentives, plain labeling, and insurance premium surcharges are all mechanisms designed to protect people from themselves. The issue of the public cost of individual choices in diet cannot be ignored, especially in the face of a relentless obesity epidemic. Is it not realistic to expect that at some point there will be a critical trigger of change in the food sector? This may be in the form of policy change, a legal case and precedent, or a groundswell of public opinion.



***As we look to 2050, when we'll need to feed 9 billion people, the question of which diet is best has taken on new urgency.***

*Ann Gibbons. September 2014. The Evolution of Diet, National Geographic.*

So – what happens then? Will we see diets regulated? Will unhealthy foods be banned? Will our Body Mass Index (BMI) influence our insurance premiums? Or will technology be our answer. Today, most of us are 'connected' to the world via smart phones and other devices. Does this technology provide the opportunity for people to have diet choices 'customized', thereby avoiding them doing dietary harm? Could we be presented with an abundance of choice, but incentivized to make the healthy choices for our unique metabolism, age and nutritional needs?

***Technology offers the opportunity for food and diet choices to be made for us, even if we don't know it. Just like driverless cars will save us from bad drivers, maybe technology will save us from bad diets.***

## THE COMING FOOD REVOLUTION

*The rapidly growing global food tourism sector is exposing people to new food experiences. What wonderful new flavors are yet to be discovered?*

### 3.4 FOR THE LOVE OF FOOD

People love food. It defines our cultures, it brings people together and it is an intrinsic part of our social fabric. As well as being essential to existence, food also brings us great pleasure. The experience and sensations of taste, aroma and texture ensures food provides some of our key experiential delights.

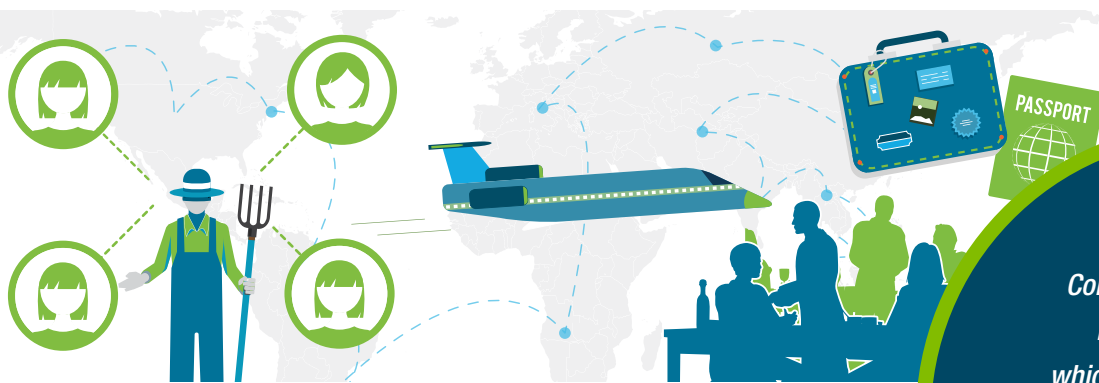
As discretionary incomes increase, people are able to purchase and access a greater array of food and diet choice. Eating experience is also broadened, as people can afford to 'dine out'. In addition, technology allows us greater amounts of leisure time, and gives us greater access to information flows. The emergence and popularity of blogs about healthy food and recipes demonstrates a strong appetite for new information.

Some of the observable recent trends include the increased popularity in cooking shows; competitions and home cooking experiences. Slow food movements have emerged and new food networks are forming. Food tourism is becoming increasingly significant in the global tourism market. These trends point to an underlying deep reconnection to food and food experiences, especially with more affluent consumers in developed countries.

***Food has an unmatched ability to communicate a unique sense of place. Local cuisine provides a direct connection to the history of a region, the soul of its people and the rhythm of daily life.***

*Greg Oates. 2016. The Bourdain Effect: Food is Now the Leading Hook in Travel. SKIFT magazine.*

People are seeking new tastes, flavors and are embracing the adventure of eating. This perhaps reflects an increasing sensitivity and interest in food, which could open the door for more rapid shifts in diets and tastes. Are we on the cusp of a new food taste and flavor revolution?



***It is significant, for example, that the Mediterranean diet of Spain, Greece, Italy and Morocco was included in UNESCO's list of Intangible Cultural Heritage of Humanity in November 2010.***

*José M. Puyuelo Arilla. 2012. Global Report on Food Tourism. UN World Tourism Organization.*

*The Dutch East India Company was built on the marvellous spice trade, which brought new aromas and tastes to the European palates. Which food cultures and influences will impact consumers over the next decade?*





## TASTE OF THE FUTURE

### 4.0 TASTE OF THE FUTURE

*The Future of Food lays out the key drivers of change, and concludes that the global food system is at a major tipping point. Triggered by disruptive catalysts of change, the predicted coming food revolution will be built on the key dimensions of expanding food supply, improved food health, the role of food in society and our need to manage human health across the globe.*

*Increasing demand for protein will drive ground-breaking innovation in alternative sources, such as plant-based and insect proteins.*

Food industry changes are occurring on a daily basis, and we foresee a major divergence of global food systems. We believe there will be an emergence of healthy 'local' or regional food systems; and simultaneously we will see the increasing emergence of massive industrialized global supply chains that produce, process, move and distribute huge quantities of highly engineered and manufactured healthy food. This is underpinned by an urgent need for relentless innovation to find ways to produce and supply healthy food to our growing world population.

Future iQ Partners is developing the next level of foresight research into the future of food, which will include more predictive elements of a diverging global food system. We are exploring the anticipated impact on food producing regions around the world, and stimulating important dialogue around future scenarios and options. Additional foresight research topics include **'The Future of Manufacturing'** and the **'The Future of Meat'**.

*The Future iQ team works with the food industry across North America, Europe and Australia, and our work spans across the continuum of food producing regions, processing sectors, major food suppliers and public health organizations. Our work helps stakeholders develop detailed strategic insights into the implications and impacts of the changes occurring within the global food system.*

*Within a decade, 3D printing of food will dominate customized meal assembly in hospitals, schools, institutions, and fast food outlets.*

*In the next two decades, there will be dramatic shifts in food producing zones around the world, and a realignment of global supply chains. There will be winners and losers.*



## ABOUT FUTURE IQ PARTNERS

### 5.0 ABOUT FUTURE IQ PARTNERS

#### GLOBAL PRESENCE – LOCAL SOLUTIONS

Future IQ is a market leader in the development and application of scenario planning; network analysis, industry and regional analysis, and stakeholder engagement. We specialize in applying innovative tools and approaches to assist organizations, regions and industries shape their futures.

To learn more about Future iQ Partners, and our recent projects visit [www.future-iq.com](http://www.future-iq.com) or by email at [info@future-iq.com](mailto:info@future-iq.com)



*Future iQ's customized foresight research consists of extensive global trend analysis to help identify emerging risks, new growth areas and to explore opportunities for disruptive innovation. Our foresight publications are aimed at providing stakeholders with the critical information needed to anticipate and adapt to emerging futures.*

#### AUTHORS



##### David Beurle, CEO

As CEO of Future iQ Partners, David specializes in creating future planning approaches for the use in regional, community and organizational settings. David has worked in the field of organizational, industry and regional planning for over 20 years. His work in community and economic development has earned his work international, national and state awards.



##### Heather Branigin, Research Analyst

Heather has a background in Political Science and International Relations and is committed to helping people understand global interconnectedness and collaboration. She is past President and a board member of the United Nations Association of Minnesota, and has worked for several years in the fields of international education and development.



##### Celine Beurle, COO

With an academic background in Sociology and Philosophy Celine is passionate about understanding society and this has led to her ongoing interest in pursuing societal change. She has drawn upon her research background, to write significant national policy papers and has published numerous technical and scientific papers.



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