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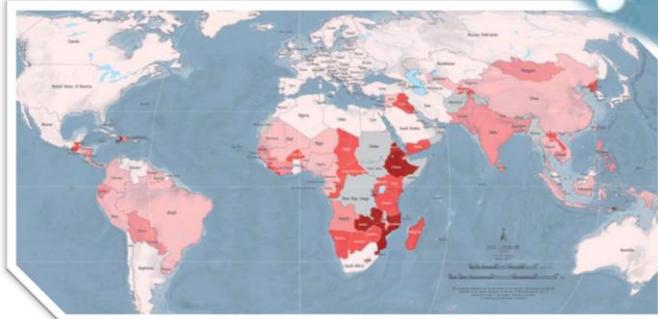
Feeding 9 Billion: Why Stewardship Matters

Charles Pearson, Ph.D., North America Head of Product Safety
The Pesticide Stewardship Alliance Annual Conference Keynote Address
5 February 2014

Food insecurity is abundant



2011-2013 FAO Hunger Map



Source: Food and Agriculture Organization of the United Nations



Last night 870 million people went to bed hungry; that is one in 8 people in the world today.

Three-quarters of these hungry people live in rural areas, mainly in Asia and Africa. Highly dependent on agriculture for their food, they have no alternative source of income or employment.

FAO calculates that approximate half of the world's hungry people are from smallholder farming communities, surviving off marginal lands prone to natural disasters like drought or flood or pestilence. As a result, these people live on the edge of crises and many are moving to cities in search of employment and a better life, a life that has enough food.

There is a sad paradox. When looking at global crop productivity, we find that – at least in theory - there is actually enough food produced to supply everyone in the world today ~2,700 kcal (FAO 2002). A major problem is that many people do not have sufficient land to grow enough food locally nor the income to purchase needed food.

A lot of food is wasted or lost



<http://www.biocycle.net/wp-content/uploads/2013/01/47.jpg>

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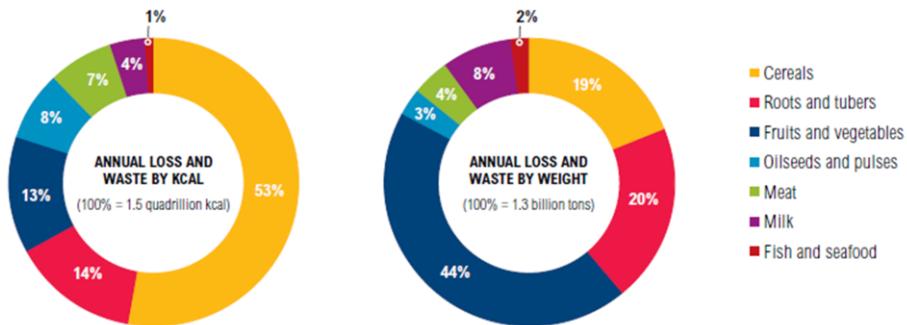
It is important to note that a lot of food that is produced is wasted or lost.

According to the World Resources Report 2013–14: Interim Findings (World Resources Institute), ~ 25% of food calories produced today are lost or wasted (~one-third losses by weight) and never reach the mouths of people.

“Loss” refers to food that spills, spoils, suffers from poor quality such as bruising or wilting, or otherwise gets lost before it reaches the consumer. “Waste” refers to food that is of good quality and fit for consumption, but is not consumed because it is discarded after it reaches consumers—either before or after it spoils.

In industrialized countries, consumer waste and loss are approximately 50:50. In developing countries, two-thirds of food loss occurs during harvesting, handling, and storage.

Reducing food loss and waste can help close the gap

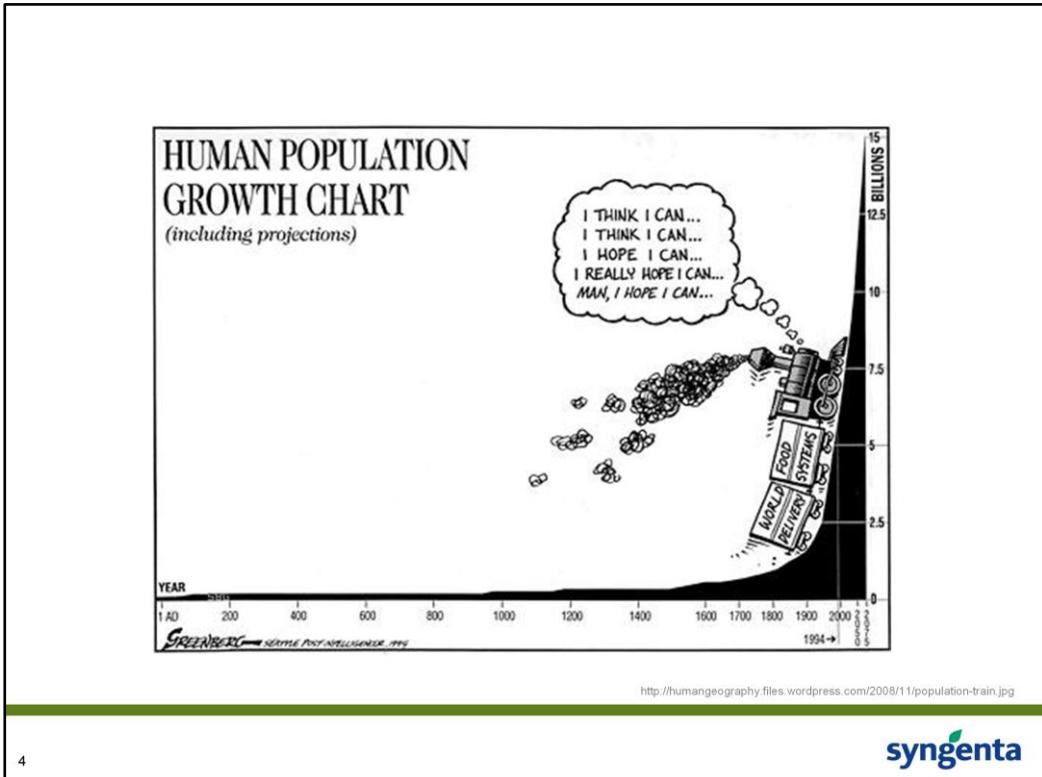


Cutting food loss and waste in half by 2050 could close 20 percent of the food gap.

Source: World Resources Report 2013-14: Interim Findings

On a calorie basis ~50% of the annual loss and waste come from cereals. On a weight basis over 40% loss and waste are from fruits and vegetables and another 20% from roots and tubers.

Cutting losses could have an immediate impact on food availability, particularly in sub-Saharan Africa. Globally, cutting losses and waste in half by 2050 would reduce the food gap by roughly 20 percent.



Let's talk more about the food gap.

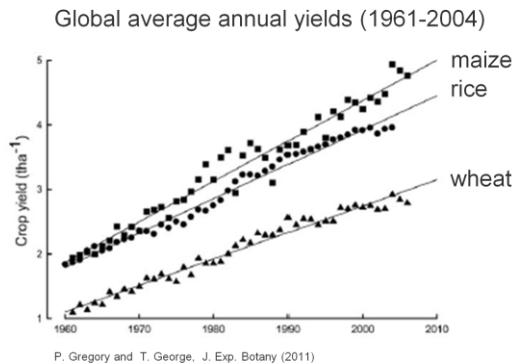
The human population has exploded in recent years. While it took the world until 1804 to reach one billion inhabitants, going from 6 to 7 billion took just 12 years (1999-2011). The world's population is currently increasing by 200,000 a day and by 2050 there will be an estimated 9.6 billion people on the planet.

Action is needed now to enable farmers to meet the challenge of providing a reliable food supply to this growing population. Productivity gains alone will not be enough – they must be part of a holistic, environmentally sustainable strategy.

Yields have increased over the last 4 decades

The tools

- Improved germplasm
- Fertilizer
- Crop Protection products
- Improved irrigation systems



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Over the past 4 decades (1962 -2006) global average yields of maize, rice, and wheat increased dramatically.

The technologies that contributed to these yield increases include:

1. improved germplasm - hybrids crops, disease resistance, and able to respond to fertilizers without lodging (dwarfing and semi-dwarfing genes)
2. Use of fertilizers - especially the availability of affordable nitrogen fertilizer
3. The development of crop protection chemicals for weed, insect and disease control
4. Improved irrigation systems, especially in rice-producing countries and for some previously rain-fed crops.

In 1960 average annual maize yields were just under 2 t/ha; by 2006 yields were pushing 5 t/ha. Similarly rice when from just under 2 t/ha to nearly 4 t/ha and wheat from 1 t/ha to nearly 3 t/ha. Continuous productivity gains were experienced for all the crops (linear growth) with a 2-3 fold increase in productivity over the past 4 decades.

More crop productivity is required

In 2050 the world will need ~70% more food

. . . will it come from using more land, more water, more labor, more inputs?

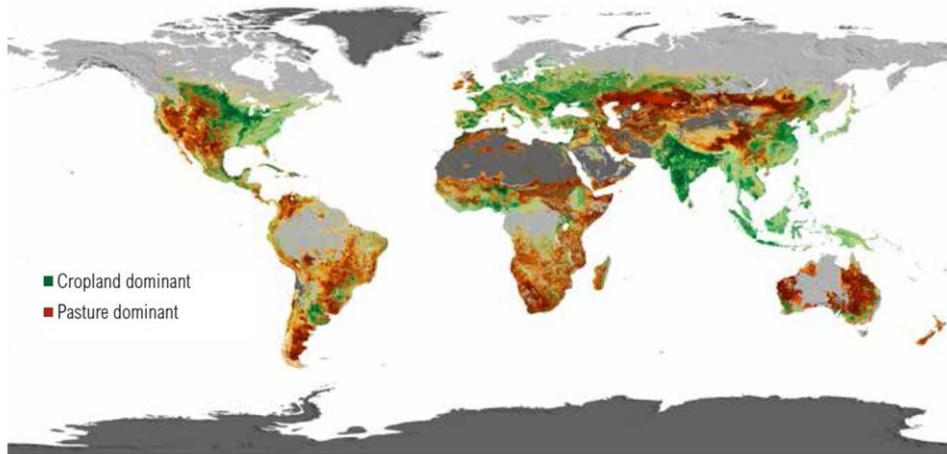
How can we sustainably feed the growing population?

➤ It will take a step change in productivity and resource efficiency

Source: World Resources Report 2013-14: Interim Findings

According to the World Resources Institute we will need ~70% more food, as measured by calories, to feed a global population of 9.6 billion people. To meet this increasing demand in production without expanding the annual unit area harvested, average crop yields would need to grow by 32 % more in the next 4 decades than over the last 4 decades. In other words we will need to increase the slope of yield gain significantly and boost yields at an even more rapid rate. This will be a very large challenge requiring a step change in productivity and resource efficiency for both the 8 million large scale farms (>250 ac) and the 450,000,000 smallholder farms (<5 ac). All of these farmers will have a role to play as we address productivity and food security.

Croplands and pasture occupy half of the world's vegetated lands

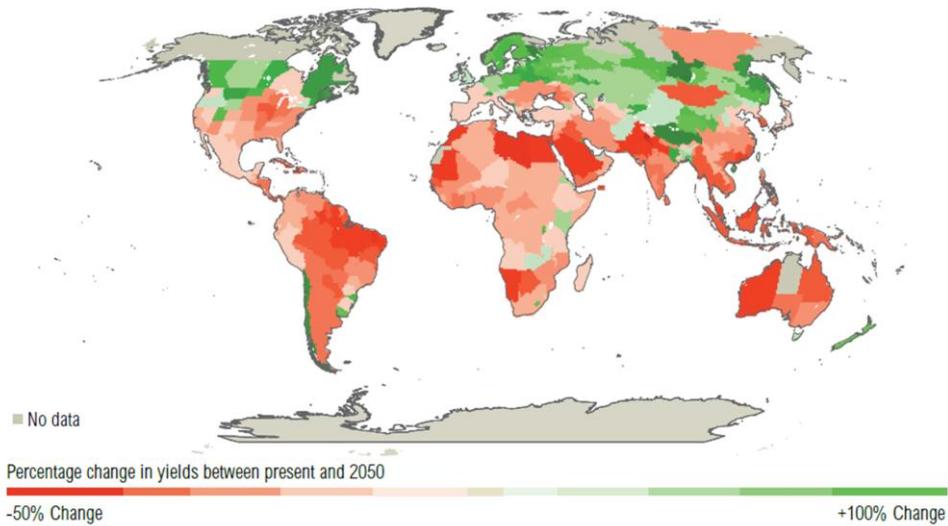


Data source: Ramankutty et al. (2008), Map source: Navin Ramankutty, McGill University.
Note: Areas in gray contain neither croplands nor pasture.

Source: World Resources Report 2013–14: Interim Findings

Can we cultivate more land? Crop land and pasture occupy half of the world's vegetated lands yet agriculture continues to expand and is the dominant driver of tropical deforestation and the conversion of carbon-rich peatlands. Between 1962 and 2006, cropland and pasture expanded by ca 500 million ha (Creating a Sustainable Food Future, interim report page 15). Converting natural ecosystems to cropland contributes to climate change and is one of the biggest threats to biodiversity. The question is how can we balance the need for food and the need for other types of vegetative lands. It is likely that if farmers can not increase productivity of current crop land they will be tempted to turn to other land (i.e. rain forest). That is why we need to act now to enable farmers to grow more food on they land they are using today.

Projected impacts on crop yields in a 3°C warmer world



Source: World Resources Report 2013-14; Interim Findings; World Development Report 2010: Development and Climate Change. Washington, DC: World Bank

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It is clear that feeding 9.6 billion will require higher productivity – that means more yield per unit area. Whether you subscribe to the notion of global warming or not, hopefully we can all agree that adverse weather conditions unfavorably affect yield. Failure to address environmental impacts will hinder food production in the coming decades – land degradation affects ~20% of the world's cultivated land, deforestation contributes to regional warming and drying.

You may recall that 2 years ago we saw hot, dry conditions decimate corn production in the mid-west. And then last year we saw many areas flood. . . and snow was falling during the optimal planting window in the corn belt. Abiotic stress can steal the yield potential desperately needed to feed a world of 9.6 billion.

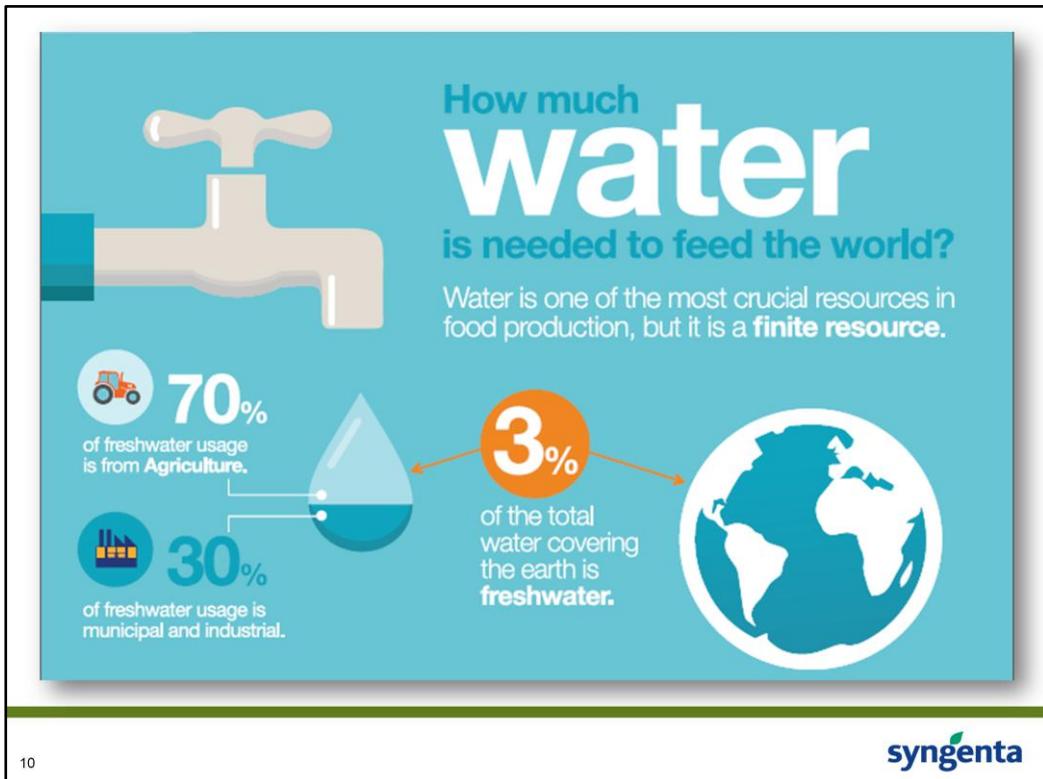
In this slide we see a scenario for increased temperature stress (+3 degrees Celsius = 5.4 degrees Fahrenheit). Climate change would lead to reduced rainfall in already dry areas, flooding in other areas, and to new combinations of diseases, weeds, and insects. Under such stress overall corn, wheat, and rice yields will be negatively impacted. Under such non-conducive environment the notion of producing more yield on the acre would be more challenging.

Climate change threatens agricultural productivity and, at the same time, about 14% of human-made carbon emissions are from agriculture. Another 18% from land use changes when natural ecosystems are converted to cropland.

Weed control solutions that support no-till practices, reduce fuel consumption from tilling, and aid in sequestration of carbon in the soil.



While land management and climate change are important considerations, Water is, and will continue to be, the biggest limiting factor in the world's ability to feed an increasing population.



We must find ways to use water more efficiently. Up to 40% of the water used in agriculture in some countries is lost due to inefficient crop and irrigation practices. Integrated approaches are required to help farmers use rain and irrigation water more efficiently.

Producing more food using less water will require public-private partnerships to address water use. The conversation must also include broad(er) acceptance for new technologies, e.g. solutions to help plants tolerate heat and drought through integrated approaches using improved varieties, growth regulators and other crop protection products.

Water is a precious commodity in California today

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California May Have Hit Its Driest Point In 500 Years, And The Effects Are Frightening



Running out of drinking water

Food Supply Threatened

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For California, 2013 was the driest year since the state started measuring rainfall in 1849. Paleoclimatologist B. Lynn Ingram says that, according to the width of old tree rings, California hasn't been this dry for about 500 years.

With only about seven inches of rain in California in 2013 -- far below the average of 22 inches -- wells are running dry and many reservoirs are about 30 percent full (including Folsom Lake, shown above).

California's \$45 billion agriculture business accounts for 15 percent of U.S. crop sales. But this year, farmers fear they may lose their entire crops. That could cause food prices to go up for most Americans. Some farmers are paying the expensive price of scarce water to irrigate crops. Others, unable to afford water, have been forced to leave fields fallow.

Ranchers are struggling to feed livestock, as there is much less grass. Some have been paying more for alternative feed. Others have had to sell portions of their herd. In California's vineyard capital, Napa Valley, wine grape growers said some vines are ripening early. Farmers are planning fewer crops to save water.

Water is running short in the center of the USA

The collage features several news snippets:

- JournalStar.com**:
 - Hot Topics: Pica: Westerkamp's amazing catch • Lewd bike ride • ...
 - Home / News - Lincoln Journal Star Online / Lincoln News
 - Study: Irrigation saved billion
 - NEWS NOW >> Morning Minutes: Nov. 4
- The New York Times**:
 - BREAKING NEWS
 - The Ogallala Aquifer, an important water resource, is in trouble
 - U.S. | WORLD | N.Y. / REGION | BUSINESS | TECHNOLOGY | SCIENCE | HEALTH | SPORTS | OPINION
 - POLITICS | EDUCATION | TEXAS
 - Wells Dry, Fertile Plains Turn to Dust
 - WRITERS ON THE RANGE
 - Southwest Kansas losing water suit
 - Water scarcity frightens Nebraska farmer
 - Nebraska fears for crops if Kansas wins water suit
 - Kansas lawsuit alleges Nebraska overuses from shared reservoir

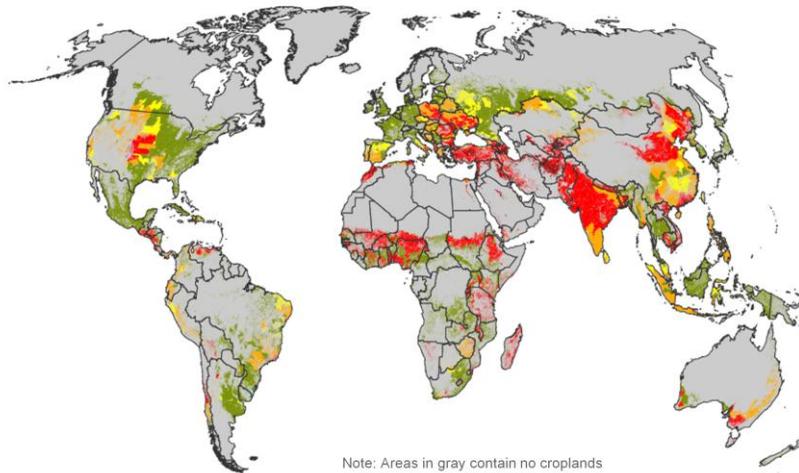
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The issue is also impacting the central USA. The Ogallala aquifer is in jeopardy. The aquifer yields 30 percent of the nation's irrigated groundwater. Kansas alone pumped 1.3 trillion gallons in 2011, more than enough to fill Lake Okeechobee, the huge lake in Florida (<http://www.kansascity.com/2013/09/01/4452173/the-ogallala-aquifer-an-important.html>). It is projected that under the current consumption of water in western Kansas, the aquifer could be pumped dry of economical water within the next 20 years. A recent report from Kansas State University indicates an 80% reduction of water use today would be required to ensure mid-to-longer term availability of water for the Ogallala (http://www.upi.com/Science_News/Blog/2013/08/28/Ogallala-Aquifer-could-dry-up-in-50-years).

No water, no crop – no crop . . . land prices fall . . . and town economies wither. This is serious stuff and we must find solutions for create a more sustainable situation.

Water stress will increase in many areas due to increasing water use and higher temperatures



Water Stress Condition

Lower

Near Normal

Higher

Source: World Resources Report 2013–14: Interim Findings

The shortage of water is not only an issue for the USA (you can see the red in the center of the country), but also a big issue for India, China and central Africa.

Water stewardship will be key to the future of agriculture and to the farmer's ability to feed a growing world population.

How can we sustainably feed a growing population?

Public acceptance of modern agriculture is divided and . . . yet integrated solutions that include technologies are needed to meet the productivity and sustainability challenges ahead



<http://audialtempartem.files.wordpress.com/2014/01/elephant-in-the-room-audialtempartem.jpg>

I would like to talk to you about an elephant in the room. If the elephant is not in this room today, it is certainly in the virtual room that includes the public. There is a divide in how the public accepts modern agriculture.

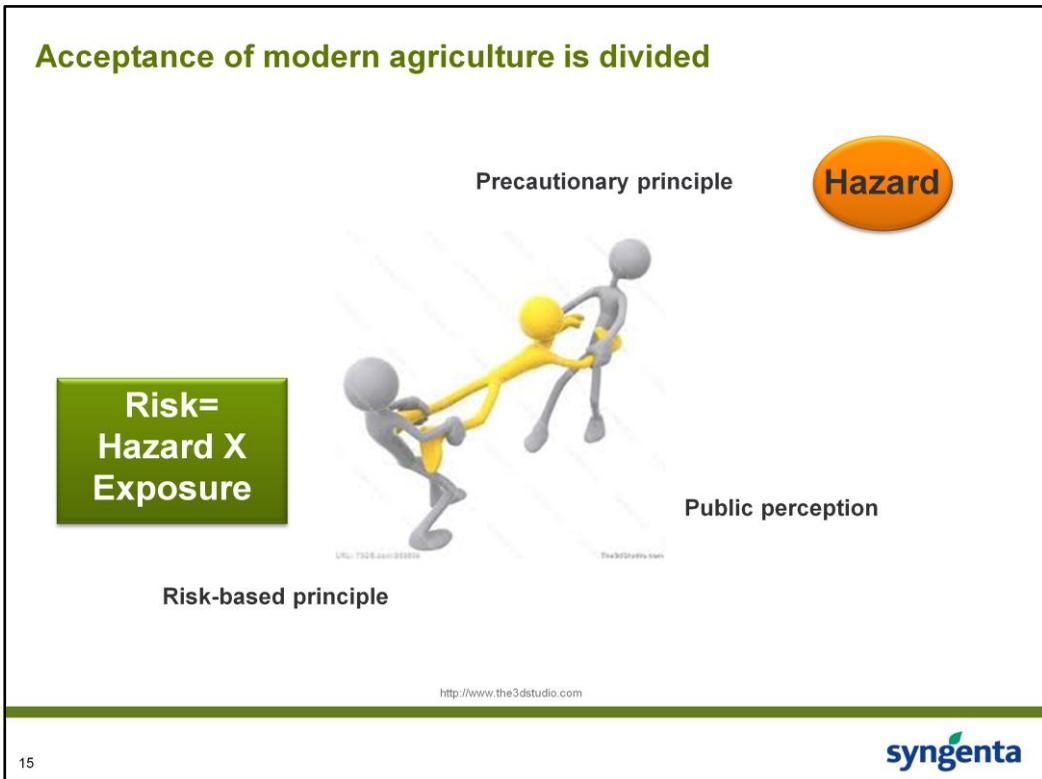
You see there is a segment of the world population with a strong desire to minimize or eliminate pesticide use, genetically engineered crops, and fertilizers. What some people do not realize is that without these tools the farmer's ability to grow food efficiently will be dramatically impeded.

Some advocates would suggest that the world should go completely organic. While organic production methods and food products represent a legitimate personal choice and occupy a valid position in the market there is the issue that organic agriculture by itself is not resource-efficient enough to meet the food demands of the future. A recent meta-analysis study by Seufert et al., *Nature* 229–232 (2012), shows that, overall, organic yields are typically lower than conventional yields – on average 25% lower.

In addition, despite popular believe, a recently published Stanford study by Dena Bravata (*Annals of Internal Medicine*, 2012) indicates there is little evidence of health benefits from organic foods. Analyzing data from 237 studies showed that fruits and vegetables grown "organic" were, on average, no more nutritious their conventionally grown counterparts.

As Missouri farmer Blake Hurst notes, "In the many places around the world where organic farming is the norm, a large proportion of the population is involved in farming. Not because they choose to do so, but because they must. Without pesticides, hand weeding is the only way to protect a crop."

While Organic production methods and organic food products represent a legitimate personal choice and occupy a valid position in the market, there is no evidence that organic agriculture is safer or more environmentally-friendly than other types of production, or that it is resource-efficient enough to meet the demands of the growing population.



To meet the challenge of feeding the increasing population farmers need full access to current and future farming technologies.

There are two views of how to address acceptability (and registerability) of modern agricultural technology and pulling at public perception. These are the precautionary principle and a risk-based approach.

In the case of the precautionary principle the focus is on hazard. Hazard can be defined as the intrinsic toxicity of a substance (www.pesticides.gov.uk)

Risk on the other hand is a function of the hazard AND exposure. Risk takes into account the likelihood of the hazard occurring (e.g. in relation to exposure through normal use).

What about biotech?

While biotechnology can improve productivity there is controversy over safety - particularly in the EU, Africa, and the Far East - where a highly conservative precautionary approach is often used. Controversy despite numerous international panels and Regulatory Authorities concluding that food derived from genetically engineered crops is as safe as food produced in other ways (DeFrancesco, Nature Biotechnology 2013). Scare stories continue to thrive questioning safety and ignoring the science. I heard a podcast over the weekend where a guest on talk radio said if you eat GMO food you will die. As scientists, as educators, as state and federal regulatory, as people who understand agriculture, how should we respond?

It is important to point out that transgenic crops are the most highly regulated food in the world (DeFrancesco, 2013). Under rigorous product development protocol and stringent regulatory approval paradigm, no incidence of harm from the consumption of genetically engineered foods has been ever documented. In contrast the US Center for Disease Control reported 128,000 cases of food-borne

illnesses leading to hospitalization, with 3000 deaths.

A question for all of us associated with agriculture: what should be done to provide a balanced view to the public and policy makers?

What about pesticides?

Without appropriate use of pesticides an estimated 35-40% of all crops would be lost to insect, weeds and diseases (Orke and Dehne, 2004).

Recently insecticides have been in the news and implicated by some in the global phenomenon of decreased bee populations. The cause of this trend is unknown but recent scientific reports indicate that the current questions around pollinator health have multiple causes. More on this in a few minutes.

Hawaii 2013



DENNIS ODA / DODA@STARADVERTISER.COM

Crowds opposed to genetically modified organisms gathered outside Kauai's Historic County Building Nov. 14 as Council members weighed the fate of Mayor Bernard Carvalho Jr.'s veto of Bill 2491, which placed new restrictions on major agribusinesses on the island. The lawmakers voted after a daylong delay to override Carvalho's veto.



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GMO supporters also came out in force Nov. 14 while the Kauai County Council considered whether to override Mayor Bernard Carvalho Jr.'s veto of Bill 2491. Fears of genetically modified organisms are misguided, advocates say. "We are regulated way more than the general public understands or knows," says Kirby Kester of the Hawaii Crop Improvement Association, which represents the agricultural seed industry.

Let me share a story about Hawaii.

Last summer companies came under attack as the Kauai County City council debated a law to impose pesticide buffer zones, halt transgenic crop work pending an impact assessment, and requiring 100% reporting for pesticide use and genetically engineered crops. Thousands of people, encouraged by mainland anti-GMO interests, marched to support a ban. Thousand of others rallied to support the agricultural industry. Here is the elephant; the dichotomy of acceptance for modern agriculture.

The City council voted for the ban, the Mayor vetoed the ban, and then the council overturned the veto. While the law is scheduled to go into effect in August 2014 the courts have been asked to review this action.

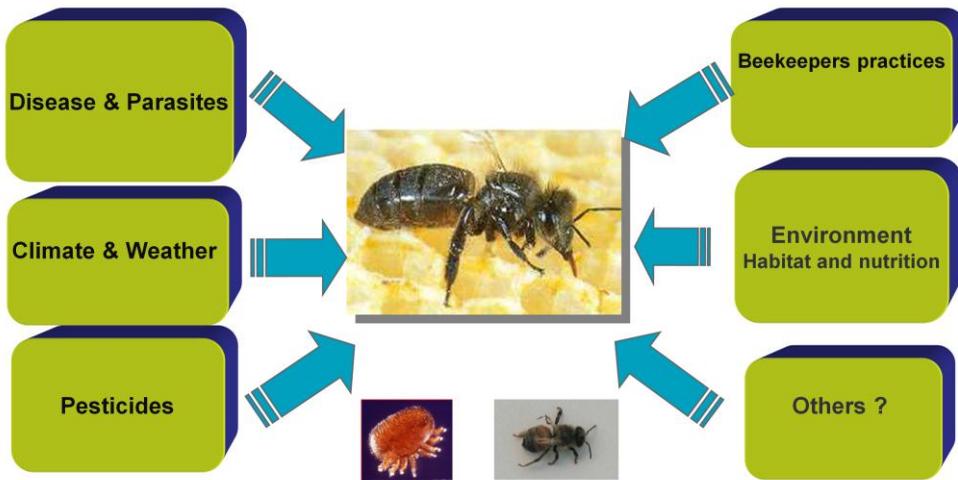
This example raises questions about where people get their information and how scientific information is developed, interpreted, and used in decision making. There is no doubt that people on both sides of the issue have genuine concerns, and these need to be addressed.

How do we help people understand that biotechnology supports integrated crop management practices and can improve productivity while minimizing the environmental impact of production? It appears that some people do appreciate or understand that transgenic crops are the most highly regulated food in the world and that numerous international expert panels and Regulatory Authorities have concluded food derived from GE crops is as safe as food produced in other ways. Unfortunately scare stories have many people concerned.

Pollinator Health



Bee Health Decline – Many Suggested Potential Causes



Experts view is losses caused by combination of stressors. In particular, *Varroa destructor* mites & associated viruses eg DWV (Deformed Wing Virus) are seen as a common & major threat.

Feeding 9.6 Billion: Why Stewardship Matters

Stewardship matters because

- The increasing world population will need food, a lot more food
- Growers will need to increase productivity using less land, water, and other inputs
- Farmers will need to adapt; they need access to modern technologies, education and training
- Solving the problem of food insecurity will require innovation, collaboration, and trust – we will only solve the problem by working together

The increasing population will need food , a lot more food, grown in a sustainable way

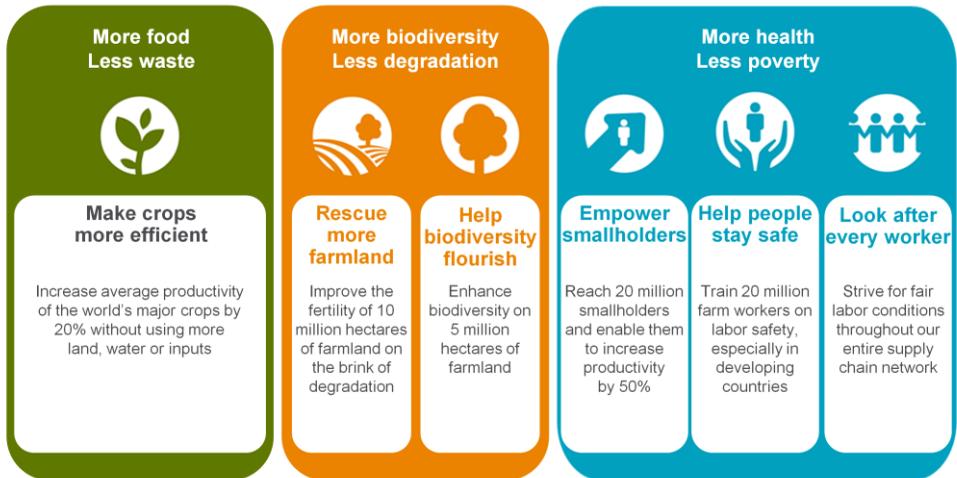
Crop productivity gains of 70% will be needed but without using more land, water, or other inputs. A step change in efficiency is required to achieve sustainable practices. Over the last 4 decades improved technology led to the green revolution, higher yields were experienced and many people were fed. In the future, technology will need to produce and deliver food that is nutritious and safe without eroding the environment. The world will need to achieve significantly more productivity over the next 4 decades through efficiencies in yield (bu/a), nutrient management (yield/lb nutrient), pesticide efficacy (bu/lb or per application), water (bu/gal) and land management.

Integrated crop management can aid in more biodiversity (less deforestation, reforestation, field margin management, new habitats); better soil management to reduce erosion and runoff (no-till, rotation, cover crops).

The 8 million large farmers and 450 million small holders must adapt to new technologies and production methods in order to keep up with food demands. This will also require stewardship activities to ensure safe useage of new approaches – training and adoption of approaches requires education.

If we are going to achieve growing more food with less resources we must find ways to engage beyond those that are involved in agriculture. Food touches everyone but agriculture does not. We must address people's concerns and build awareness and trust. Please consider the part you can play in sharing the challenge the world will face to produce enough food for 9+ billion, the importance and utility of agricultural technologies, and address questions of safety people may have. We need to share these messages with a wide range of stakeholders – the farmer, the NGOs, the policy makers, the Regulators, the food companies, and the public in our local communities.

The Good Growth Plan



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How will we feed 9.6 billion people in the world? Growers, Educators, Regulators, Policy Makers, industry and the public – we all have a role to play.

At Syngenta we are committed:

- to improving crop efficiency without using more land, water or other inputs
- to improve farmland and enhance biodiversity
- to support the health and safety of farmers and agricultural workers through training and education programs.

This is our Good Growth Plan

Thank you