Macro Statistics

◆ 1.3 Billion Tonnes/Year of Food Wasted out of 4 Billion tonnes Produced Globally = $750 Billion = 1/3 of Edible Food

◆ Losses along the Entire Food Supply Chain (FSC):
  ➢ 54% during production, post-harvest, storage; 46% at processing, distribution, consumption
  ➢ Developed Countries – Few Percentages to 40%-50%
  ➢ Developing Countries – 30%-50%

◆ Per Capita food losses as a percentage of production:
  ➢ Europe & N. America 280/300 kg/year vs. 900 kg/year ~ 33%;
  ➢ Sub-Saharan Africa & SE Asia 120-170 kg/year vs. 460 kg/year ~ 37%

◆ Consumers waste 95-115 kg/year in Europe & N. America, Equivalent to 748-1,520 calories lost/person/day; vs. 6-11 kg/year in Sub Sahara Africa & South East Asia, equivalent to 414-545 calories/person/day

◆ Food Loss occur at Production, Post-Harvest & Processing, before Consumption;
◆ Food Waste occurs at the Retail & Consumption

◆ 870 million People Go Hungry Every Day
Higher Demand with Limited Resources

Source: Agtech: Challenges & Opportunities for Sustainable Growth: Suren G. Dutia. E.M. Kauffman Foundation, April 2014
Losses Along the FSC: Developing vs. Developed Countries

Source: Global Food Losses & Food Waste – Extent, Causes & Prevention, FAO 2011
Developing Countries Waste 40% of Food at Production, Post-harvest and Processing; Developed 40% at Retail & Consumption

Source: Global Food Losses & Food Waste – Extent, Causes & Prevention, FAO 2011
Cereals: 40%-50% (i.e. wheat, rice) are lost at the Consumer Level in Industrialized Countries. In South East Asia, rice losses range between 37%-80% of total production ~ 180 million tonnes/year (China up to 45%, Vietnam up to 80%)

Source: Global Food Losses & Food Waste – Extent, Causes & Prevention, FAO 2011
Roots & Tubers: (potato, cassava, etc.), losses are high at production, post-harvest also in developed countries mainly due to handling, storage, quality standards – perishable products.
Oilseeds: (sunflower, rape seed, soybean) 6%-12% are lost at harvest in Developed Countries. Losses are

Source: Global Food Losses & Food Waste – Extent, Causes & Prevention, FAO 2011
Fruits & Vegetables: Developing Countries lose up to 50% from Production to Distribution due to Deterioration of Perishable Products and Seasonality. Globally, retailers generate 1.6 million tonnes of food waste annually at harvest because it does not meet standards.

Source: Global Food Losses & Food Waste – Extent, Causes & Prevention, FAO 2011
Meat: Loss in Developing Countries across the entire FSC due to high mortality rates, poor animal husbandry, transport to slaughter. Developed up to 50% of losses at retail/consumer level.

Source: Global Food Losses & Food Waste – Extent, Causes & Prevention, FAO 2011
Fish & Seafood: Developing 6%-8% of marine catches mostly at Distribution due to perishability. Developed 9%-15% discarded and at consumer level

Source: Global Food Losses & Food Waste – Extent, Causes & Prevention, FAO 2011
Milk: Developing countries waste mostly at post-harvest handling & storage compared to 40%-65% at consumer level for Developed countries

Source: Global Food Losses & Food Waste – Extent, Causes & Prevention, FAO 2011
Wasted Agricultural Inputs

◆ WATER: 550 billion cubic meters of WATER is wasted on growing crops than never reach the consumer. About 40% of global food supply comes from irrigated land on about 17% of available agricultural land. Inefficient systems/utilization in developing countries. Wasting water = wasting energy;

◆ LAND: Food Waste occupied 1.4 billion ha ~ 28% of world agricultural land in 2007. 1 ha of land can produce rice or potatoes for 19-22 people/year BUT only enough lamb/beef for 1 or 2 people. 78% of agricultural land is used for livestock production, either for direct grazing or feed crops;

◆ LAND DEGRADATION: 99% of food wasted at production stage comes from regions with medium-high degradation; 50% of wastage from low degradation;

◆ ENERGY: 7-10 calories of input required to produce 1 calorie of food: 3 calories of input to produce 1 calorie of edible plant, but 35 calories input per 1 calorie of beef. In the US alone 160 trillion BTU were embedded in wasted food. Biggest single energy input goes towards the production of agrochemicals (fertilizers, pesticides, growth agents, etc.)
Need Integrated Solutions applied by forward-thinking Technical Practitioners

“We have Paleolithic emotions, medieval institutions and God-like technologies”

Harvard biologist E.O. Wilson
Produce More OR Waste Less?

For Developing Countries the Choice Must Be to Produce More BUT Efficiently, Intelligently…Improving Use of Basic Agri Inputs: Land, Water, Energy…

◆ Opportunity: Provide 60%-100% more food by simply eliminating losses while freeing up land, water & energy resources for other uses:
  ➢ Improve transfer of technologies to developing countries to optimize produce handling at harvest and post-harvest where most food is lost;
  ➢ Minimize waste in food transport infrastructure and storage - cooling facilities at the farm;
  ➢ Closer control of fertilizer application, use improved high-yield seeds. Up-to-date engineering and agronomy has proven to triple cereal yield/ha in sub-Saharan Africa and same for maize in Malawi;
  ➢ GPS-controlled precision leveling systems can further enhance the performance of drip irrigation;
  ➢ More efficient watering systems, improved recycling can decrease the 13-64 tonnes of water consumed to process each tonne of vegetable;
…..in order to feed their growing population, requiring more protein

- Biotechnology, genetics to manipulate the growth process of crops and animals, mitigating disease;
- Technologies that monitor, measure and improve farm output and traceability;
- Automated farm technology & equipment to advance production;
- Harvesting non-food resources (algae, waste) to produce fuel that can be reused on the farm;
- Increase utilization of solar power to run drip irrigation, farm equipment, ambient storage and processing;
Need for Integrated Solutions

Integrated Farming Systems℠ Would Combine Advanced Seed Genetics, On-farm Agronomic Practices, Software and Hardware Innovations to Drive Yield

- **Database Backbone**: Expansive seed-by-environment testing makes on-farm prescriptions available for certified seed dealer sales and service.
- **Breeding**: Significant increases in data points collected per year to increase annual rate genetic gain.
- **Yield Monitor**: Advances in yield monitoring to deliver higher resolution data.
- **Fertility & Disease Management**: "Apps" for in-season custom application of supplemental late nitrogen and fungicides.
- **Variable-Rate Fertility**: Variable rate N, P & K "Apps" aligned with yield management zones.
- **Precision Seeding**: Planter systems enabling scripts for variable rate seeding with optimal row spacing of hybrids in a field by yield management zone.

Source: “Precision Planting/Monsanto Field Scripts program,” Precision Planting 2012.

Figure 13: An illustration of "Integrated Farming Systems," a vision of potential AgTech innovations.
Agritech Value Chain: E.M. Kauffman Foundation

Figure 14. Summary of Cultivian AgTech dataset.
Increasing Impact of Agritech: E. M. Kauffman Foundation

Sources of Growth in Global Agricultural Production


Figure 17. Relative contributions to growth in global agricultural production.
Demand Drivers & Supply Constraints:
E.M. Kauffman Foundation
Convert animal feed from grain & cereals to fruits & vegetables:

- World compound feed production is estimated at 1 billion tonnes annually, generates an estimated annual turnover of over US $370 billion;
- By 2050, developing countries expected to require 109% and 116% more meat and milk respectively (2010 base year);
- Shortage of feed availability in developing countries. Examples: China – deficit of 10, 30, and 20 million MT of protein feed, energy feed, and aquatic feed respectively. India = 25, 159, 117 million MT
- Area under fodder production cannot be increased due to increase in population, urbanization and intensive livestock production while increasing cost of fossil fuels and food-feed-fuel competition;
- About 60 million MT of fruits and vegetables are are wasted just in six countries: USA, China, India, Philippines, Malaysia, Thailand, composted or dumped in landfills or rivers, causing environmental hazards;
Why it is Important

<table>
<thead>
<tr>
<th>Protein Source</th>
<th>Number of kg of feed required for every kg of meat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beef</td>
<td>8</td>
</tr>
<tr>
<td>Lamb</td>
<td>5</td>
</tr>
<tr>
<td>Pork</td>
<td>2.5</td>
</tr>
<tr>
<td>Poultry</td>
<td>1.5</td>
</tr>
<tr>
<td>Fish</td>
<td>1.2</td>
</tr>
</tbody>
</table>


Figure 7. Animal feed requirements per kg of protein.*
Low Hanging Fruit.....

- Harness solar energy, (photovoltaic & miniature, battery-run) to run drip irrigation, farm equipment, ambient storage and processing:

- Developing countries consume on average 96 kg of oil equivalent/capita/ha (Kgoe) of arable land compared to 312 Kgoe/ha in industrialized countries, still almost 2 billion people in developing countries don’t have a reliable source of energy;

- Applications:
  - Control drip irrigation; 92% of global water usage is in agri production
  - Ambient field storage for fruits & vegetables to avoid field losses;
  - Operate greenhouses;
  - Operate small field & processing machinery;
  - Agricultural sensors: wireless sensors to monitor fertilizers & other agri inputs, traceability (livestock), run GPS for precision agriculture
  - EXAMPLES: Companies such as Solchip, Commonsensor (monitor water consumption for plants), Aquaspy (moisture sensors for irrigation)
External & Internal Barriers to Reduction in Food Waste in Developing Countries: Dissemination of New Technology to improve Best Practices especially post-harvest, Access to Market. Removing Obstacles to Free Trade. Financial Incentives

Figure 7: Barriers to reduction in value chain waste
Barriers include:

For Fruits & Vegetables as Animal Feed:

- Easier Access of fruits & vegetable waste to beef & pig farmers;
- Educating & Training Beef & Pig farmers on the merit of shifting feed to discarded Fruits & Vegetables: Composition of Feed Nutrients, Minerals, etc;
- Financial incentives on both ends;
- Cost/Benefit analysis

For Solar Energy & Other Technologies

- Access to the technology: price/value;
- Training in the application of technology: Promote Extension Services where most new agri technologies are tested;
- Market success: Replication
THANK YOU