Innovation in Food Production and Sustainable Intensification

AIARD Conference

Marc Sadler
Global Lead, Climate-Smart Agriculture
Global Agriculture Practice, The World Bank
WHAT IS AGRICULTURE GLOBALLY?

- WATER USE: 70%
- LAND USE: 34%
- GHG: 24%
- LABOUR: 37%
The Challenges
Where people *produce* is changing

Food Production by Region
1972-2050
(Constant 2004-06 US$)

CEA 2013 based on FAO 2012
Where people **consume** is changing

Percentage Increase 05/07 – 2050

- Sub-Saharan Africa: 183%
- South Asia: 81%
- Middle East North Africa: 79%
- Latin America Caribbean: 43%
- East Asia: 30%
- Developed: 11%

*Source: World Bank Group*
What people eat is changing

Food Demand By Commodities in 2050 relative to 2005-07 (Billion kg per year)
And sometimes “what” and “where” is changing - MEAT
The global meat story to date

China eats half as much meat as the U.S., but because two-thirds of its meat has traditionally been high-fat pork, it consumes more total meat calories. Now demand for leaner meat is rising.
Urbanization is Progressing Rapidly

Urban and rural population as proportion of total population, by region, 1950-2050

<table>
<thead>
<tr>
<th>Region</th>
<th>1950</th>
<th>2000</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>Africa</td>
<td>40%</td>
<td>47.5%</td>
<td></td>
</tr>
<tr>
<td>Asia</td>
<td>73.4%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Europe</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Latin America*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>North America</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oceania</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: UN World Urbanization Prospects: The 2014 Revision
*Includes Caribbean
© GRAPHIC NEWS
Increasing incomes in developing countries are playing a major role

Kharas, 2011
The Constraints
The Way We Meet Current Demand Is Already Unsustainable (green = safe space)
Degraded Soils are a Key Limiting Factor for Agricultural Yields

Average Dry Yield (Blue small, red big)

Low quality soils are a key driver behind food insecurity, for example in Africa.
Climate Change Impacts on Food Systems – Uncertain Future

Tomorrow (2030): Pressure on Cereal Yields

Maize
- China: -7%
- Brazil: -8%
- France: -3%
- Global: -4%

Wheat
- China: -2%
- Russia: -14%
- France: -5%
- Global: -5%

Future (2050 and beyond): Yield Collapse?

Percentage change in yields between present and 2050:

-55 to 55

No data

CIAT, World Bank
TOMORROW – The Food System could be THE Climate Change Problem

Projections of Global, Agriculture and Land Use Change Related Emissions towards 2050 (Gt CO$_2$e)

GHG EMISSIONS TODAY

OTHER EMISSIONS

~25% of Total

11% LULUCF

14% Agriculture

GHG BUDGET for 2 DEGREES 2050

~70% of Total

25% LULUCF Static

45% Agriculture BAU
Emissions in Agriculture Are Not Principally a Developed Country Problem

Agricultural Emissions in Mt CO₂e/y

North America (incl. The Caribbean and Central America) 530
South America 700
Europe (incl. Russia) 550
Asia (incl. Middle East and Indonesia) 2,170
Oceania 140

Enteric Fermentation
Manure Management
Manure Left on Pasture
Rice
Agricultural soils
So what do we need to do?

Produce better
Consume better
Waste less
The Opportunities for Integration and Efficiency

**P - Productivity**
- Livestock efficiency
- Agroforestry
- Rice (AWD+)
- Fertilizer management
- Zero tillage

**R - Resilience**
- Manure management
- Livestock efficiency
- Pasture management
- Zero tillage
- Water saving technology
- Solar irrigation

**E - Emissions**
- Biodigesters
- Fertilizer management
- Supply chain management

**NORTH AMERICA & EUROPE**
- Biodigesters
- Fertilizer management
- Supply chain management

**EUROPE AND CENTRAL ASIA**
- Manure management
- Livestock efficiency
- Pasture management
- Zero tillage
- Water saving technology
- Solar irrigation

**MIDDLE EAST AND NORTH AFRICA**
- Solar power irrigation
- Water saving technology
- Manure management
- Biodigesters
- High-value crops

**ASIA**
- Rice (AWD+)
- Livestock efficiency
- Biodigesters
- Fertilizer management
- Degraded land restoration

**LATIN AMERICA**
- Livestock efficiency
- Agroforestry
- Rice (AWD+)
- Pasture management
- Fertilizer management
- Zero tillage

**AFRICA**
- Agroforestry
- Pasture management
- Fertilizer application
Rice Is a Major Source of Methane, but there is the Potential to Reduce Emissions

**Distribution of potential mitigating effects from applying AWD+**
(red indicates high mitigation potential)

**AWD+ consists of:**
- Alternate wetting and drying of rice paddies during the growing period and
- Application of rice straw to the fields in the off season
Rice – Alternate Wetting and Drying (AWD)

Productivity

- +15% Yield

Resilience

- -30% Water Use

Emissions

- -40% Methane Emissions
Synthetic Nitrogen Fertilizer Application: 
Relocation from Over-Application to Under-Application?

Distribution of nitrogen fertilizer:
Under-application (red) / over-application (green)

Synthetic fertilizer application:
- Excessive fertilizer application in China: ~200+ pounds per acre
- Under-application of fertilizer in Africa: ~100+ pounds per acre leaves yields significantly below potential.

Nitrogen impacts:
- Excess fertilizer leaching to local watersheds can lead to algae blooms, harming ecosystems.
- Excess nitrogen on-farm can emit nitrogen oxide, a major source of emissions.
Synthetic Nitrogen Fertilizer – Efficient Regional Reallocation

**Productivity**
- +100% Yield

**Resilience**
- ~ +550 calories per day For 280 Million People

**Emissions**
- -400 Mt Co2e
Efficiency of Livestock Systems Varies Greatly

**Emissions Intensity of Livestock Production**
*Across Regions*
(Kg of CO$_2$e per edible unit of protein)

**Distribution of Producers along Emission Intensity**
*Within a Given Region*
(Emission intensity per unit of production)

There is ample potential to increase the efficiency and emissions intensity of livestock systems both across and within regions.

Based on results of the GLEAM Model, FAO 2013
LIVESTOCK – “Feed and Breed”

Productivity
GHG/litre or kg - 50%

Resilience
+ incomes
- mortality

Emissions
- 40% Ag GHGs
Envisioning a Sustainable Food System for 2030 (work in progress)