Advancing Animal Agriculture With Scarce Resources: An Economist’s Perspective

2012 NIAA Annual Conference

Presented by:
Terry Barr, Senior Director of Industry Research Knowledge Exchange Division, CoBank, ACB E-mail: tbarr@cobank.com
The 9 billion-people question
A special report on feeding the world | February 26th, 2011
Distribution of Population Growth Provides Unique Challenges

- 2010: 6+ billion
- 2050: 9+ billion

Percent of total population growth by region

Regions with the fastest growing income and middle class!

Among the poorest regions of the world

49%
41%
7%
-1%
4%
Rising Food Prices Have Generated Global Concerns

FAO food price index

Feb index was 10% below year earlier!

Data source: Food and Agriculture Organization of the United Nations
Chart source: Knowledge Exchange Division, CoBank, ACB (confidential and proprietary)
What are the Basic Factors Driving The Global Demand to 2050?

1. Population
2. Economic growth and income
3. Rising middle class
4. Urbanization

The next 40 years will represent one of the greatest economic and geopolitical shifts in history.
World Population Growth Is Largely in the Developing Regions

Billion people

Chart source: Knowledge Exchange Division, CoBank, ACB (confidential and proprietary)
The Pace of Population Growth Slows Dramatically After 2020

Million people (change per decade)

<table>
<thead>
<tr>
<th>Decade</th>
<th>Million People</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950 to 1960</td>
<td>494</td>
</tr>
<tr>
<td>1960 to 1970</td>
<td>663</td>
</tr>
<tr>
<td>1970 to 1980</td>
<td>752</td>
</tr>
<tr>
<td>1980 to 1990</td>
<td>852</td>
</tr>
<tr>
<td>1990 to 2000</td>
<td>825</td>
</tr>
<tr>
<td>2000 to 2010</td>
<td>794</td>
</tr>
<tr>
<td>2010 to 2020</td>
<td>766</td>
</tr>
<tr>
<td>2020 to 2030</td>
<td>634</td>
</tr>
<tr>
<td>2030 to 2040</td>
<td>492</td>
</tr>
<tr>
<td>2040 to 2050</td>
<td>349</td>
</tr>
</tbody>
</table>

Chart source: Knowledge Exchange Division, CoBank, ACB (confidential and proprietary)
U.S. Has Been Dominant Force in Driving the Global Economy

Distribution of GDP in 2009 (BRIC+M* is 26% of G-7 and contains 1 of 6 largest economies)

Chart source: Knowledge Exchange Division, CoBank, ACB (confidential and proprietary)
Over the Next 20 Years BRIC+M Countries Will Be Major Driver

Distribution of GDP in 2025
(BRIC+M* is 80% of G-7 and contains 2 of 6 largest economies)
By 2050 the Global Economy Will Be Heavily Reliant on BRIC

Distribution of GDP in 2050 (BRIC+M* is 120% of G-7 and contains 4 of 6 largest economies)
This Economic Transformation Will Create A Rising Middle Class

China’s Income Distribution

About 10% of population is now middle class.

By 2030 75% of population has entered middle class!
India's Income Distribution

About 10% of population is now middle class.

By 2025 75% of population has entered middle class!
The Rapidly Growing Middle Class Will Transform Global Marketplace

Millions of people

Source: World Bank, IMF, Goldman Sachs, Brookings

+2 to 3 billion depending on definition of middle class

+1.7 to 2.7 billion depending on definition of middle class
This Rising Income Will Also Lead to Dietary Shifts ... More Meat

FIGURE 3
Per capita GDP and meat consumption by country, 2005

Per capita meat consumption (kg/year)

Per capita GDP (US$ PPP)

United States of America

Brazil

China

Japan

India
Urbanization Facilitates Development of Cold Chains and Markets

UN population, Urban population growth

Percentage Urban
- 0-25%
- 25-50%
- 50-75%
- 75-100%

City Population
- 1-5 million
- 5-10 million
- 10 million or more

% of population in Urban Areas
- 1975 ...... 37.2%
- 2009 ...... 50.1%
- 2025 ...... 56.6%
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2005/07</td>
<td>2050</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1961/63-</td>
<td>2005/07-</td>
<td>2050</td>
<td>-- percent change --</td>
<td>-- percent change --</td>
<td>2050</td>
</tr>
<tr>
<td>World (146 countries)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Population (mil. people)</td>
<td>3,133</td>
<td>6,372</td>
<td>9,100</td>
<td>103</td>
<td>43</td>
<td>43</td>
</tr>
<tr>
<td>Cereal production (mil tons)</td>
<td>843</td>
<td>2,012</td>
<td>3,009</td>
<td>139</td>
<td>49</td>
<td>49</td>
</tr>
<tr>
<td>Meat production (mil tons)</td>
<td>94</td>
<td>249</td>
<td>461</td>
<td>165</td>
<td>85</td>
<td>85</td>
</tr>
<tr>
<td></td>
<td>279</td>
<td>389</td>
<td>624</td>
<td>149</td>
<td>149</td>
<td>149</td>
</tr>
<tr>
<td></td>
<td>803</td>
<td>1,332</td>
<td>2,057</td>
<td>639</td>
<td>639</td>
<td>639</td>
</tr>
<tr>
<td>Developing (93 countries)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Population (mil. people)</td>
<td>2,139</td>
<td>5,037</td>
<td>7,725</td>
<td>135</td>
<td>54</td>
<td>54</td>
</tr>
<tr>
<td>Cereal production (mil tons)</td>
<td>353</td>
<td>1,113</td>
<td>1,797</td>
<td>215</td>
<td>61</td>
<td>61</td>
</tr>
<tr>
<td>Meat production (mil tons)</td>
<td>42</td>
<td>141</td>
<td>328</td>
<td>236</td>
<td>132</td>
<td>132</td>
</tr>
<tr>
<td></td>
<td>558</td>
<td>1,437</td>
<td>2,229</td>
<td>281</td>
<td>75</td>
<td>75</td>
</tr>
<tr>
<td>Developed (53 countries)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Population (mil. people)</td>
<td>994</td>
<td>1,335</td>
<td>1,365</td>
<td>34</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Cereal production (mil tons)</td>
<td>590</td>
<td>900</td>
<td>1,212</td>
<td>84</td>
<td>35</td>
<td>35</td>
</tr>
<tr>
<td>Meat production (mil tons)</td>
<td>52</td>
<td>108</td>
<td>133</td>
<td>108</td>
<td>23</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>2,205</td>
<td>3,776</td>
<td>3,589</td>
<td>1,571</td>
<td>510</td>
<td>510</td>
</tr>
</tbody>
</table>

Meat Consumption Will Double in Developing World by 2050,

<table>
<thead>
<tr>
<th></th>
<th>2010</th>
<th>2020</th>
<th>2030</th>
<th>2050</th>
<th>2010 to 2050 % change</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>World</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All meat</td>
<td>268.7</td>
<td>319.3</td>
<td>380.8</td>
<td>463.8</td>
<td>73</td>
</tr>
<tr>
<td>Bovine meat</td>
<td>67.3</td>
<td>77.3</td>
<td>88.9</td>
<td>106.3</td>
<td>58</td>
</tr>
<tr>
<td>Ovine meat</td>
<td>13.2</td>
<td>15.7</td>
<td>18.5</td>
<td>23.5</td>
<td>78</td>
</tr>
<tr>
<td>Pig meat</td>
<td>102.3</td>
<td>115.3</td>
<td>129.9</td>
<td>140.7</td>
<td>37</td>
</tr>
<tr>
<td>Poultry meat</td>
<td>85.9</td>
<td>111.0</td>
<td>143.5</td>
<td>193.3</td>
<td>125</td>
</tr>
<tr>
<td>Dairy (not butter)</td>
<td>657.3</td>
<td>755.4</td>
<td>868.1</td>
<td>1038.4</td>
<td>58</td>
</tr>
<tr>
<td><strong>Developing countries</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All meat</td>
<td>158.3</td>
<td>200.8</td>
<td>256.1</td>
<td>330.4</td>
<td>109</td>
</tr>
<tr>
<td>Bovine meat</td>
<td>35.1</td>
<td>43.6</td>
<td>54.2</td>
<td>70.2</td>
<td>100</td>
</tr>
<tr>
<td>Ovine meat</td>
<td>10.1</td>
<td>12.5</td>
<td>15.6</td>
<td>20.6</td>
<td>104</td>
</tr>
<tr>
<td>Pig meat</td>
<td>62.8</td>
<td>74.3</td>
<td>88.0</td>
<td>99.2</td>
<td>58</td>
</tr>
<tr>
<td>Poultry meat</td>
<td>50.4</td>
<td>70.4</td>
<td>98.3</td>
<td>140.4</td>
<td>179</td>
</tr>
<tr>
<td>Dairy (not butter)</td>
<td>296.2</td>
<td>379.2</td>
<td>485.3</td>
<td>640.9</td>
<td>116</td>
</tr>
</tbody>
</table>

What are the Constraints to Satisfying This Emerging Demand?

1. Land availability
2. Water supply
3. Technology and efficiency
4. Climate variability
5. Energy availability and cost
6. Food waste and losses
7. Food safety
8. Government policy (domestic & trade)
Arable Land Available is Not in Areas of Major Population

Area (million ha)

<table>
<thead>
<tr>
<th>Area</th>
<th>Sub-Saharan Africa</th>
<th>Latin America and Caribbean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrial countries</td>
<td>1000</td>
<td>1000</td>
</tr>
<tr>
<td>Transition countries</td>
<td>800</td>
<td>800</td>
</tr>
<tr>
<td>East Asia</td>
<td>600</td>
<td>600</td>
</tr>
<tr>
<td>South Asia</td>
<td>400</td>
<td>400</td>
</tr>
<tr>
<td>Near East and North Africa</td>
<td>200</td>
<td>200</td>
</tr>
</tbody>
</table>

Arable land 1997-1999

Land suitable for rainfed crops

UNEP; The Environmental Food Crisis - The Environment’s Role in Averting Future Food Crises
Countries Will Employ Many Strategies to Ensure Food Security

UNEP; The Environmental Food Crisis - The Environment’s Role in Averting Future Food Crises
# Sources of Growth in Crop Output: Heavy Reliance on Yield Growth

## Table: Sources of Growth in Crop Output

<table>
<thead>
<tr>
<th>Region</th>
<th>Arable Land Expansion</th>
<th>Increases in Cropping Intensity</th>
<th>Yield Increases</th>
</tr>
</thead>
<tbody>
<tr>
<td>All developing countries</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sub-Saharan Africa</td>
<td>23</td>
<td>21</td>
<td>8</td>
</tr>
<tr>
<td>Near East/N. Africa</td>
<td>31</td>
<td>25</td>
<td>31</td>
</tr>
<tr>
<td>Latin America/Caribbean</td>
<td>17</td>
<td>-7</td>
<td>22</td>
</tr>
<tr>
<td>South Asia</td>
<td>40</td>
<td>30</td>
<td>7</td>
</tr>
<tr>
<td>East Asia</td>
<td>6</td>
<td>5</td>
<td>12</td>
</tr>
<tr>
<td>World</td>
<td>14</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>Developing countries with</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>less than 40% land in use</td>
<td>30</td>
<td></td>
<td>15</td>
</tr>
<tr>
<td>Developing countries with</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>80% land in use</td>
<td>2</td>
<td></td>
<td>9</td>
</tr>
</tbody>
</table>

Water Will Become the World’s Most Strategic Resource

Aggregated global gap between existing accessible, reliable supply¹ and 2030 water withdrawals, assuming no efficiency gains

Billion m³, 154 basins/regions

<table>
<thead>
<tr>
<th></th>
<th>Existing withdrawals²</th>
<th>2030 withdrawals³</th>
<th>Basins with deficits</th>
<th>Basins with surplus</th>
<th>Existing accessible, reliable, sustainable supply¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Municipal &amp; Domestic</td>
<td>4,500</td>
<td>6,900</td>
<td>900</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Industry</td>
<td>600</td>
<td>1,500</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agriculture</td>
<td>800</td>
<td></td>
<td>2,800</td>
<td>4,200</td>
<td>700</td>
</tr>
<tr>
<td></td>
<td>3,100</td>
<td>4,500</td>
<td></td>
<td></td>
<td>3,500</td>
</tr>
</tbody>
</table>

¹ Existing supply which can be provided at 90% reliability, based on historical hydrology and infrastructure investments scheduled through 2010; net of environmental requirements
² Based on 2010 agricultural production analyses from IFPRI
³ Based on GDP, population projections and agricultural production projections from IFPRI; considers no water productivity gains between 2005-2030

Chart source: Charting Our Water Future; 2030 Water resources Group
Areas With Fastest Growing Populations Have Water Deficits

Base-case demand, supply, corresponding and gaps for the regional case studies

<table>
<thead>
<tr>
<th>Region</th>
<th>Aggregate 2030 demand 100%, Billion m³</th>
<th>Demand growth %, CAGR</th>
<th>2030 supply Billion m³</th>
<th>Aggregate gap % of demand</th>
</tr>
</thead>
<tbody>
<tr>
<td>India</td>
<td>80 (Municipal and Domestic: 7, Industry: 13)</td>
<td>2.8</td>
<td>744</td>
<td>50</td>
</tr>
<tr>
<td>China</td>
<td>51 (Municipal and Domestic: 32, Industry: 16)</td>
<td>1.6</td>
<td>619</td>
<td>25</td>
</tr>
<tr>
<td>São Paulo state</td>
<td>33 (Municipal and Domestic: 31, Industry: 36)</td>
<td>1.4</td>
<td>19</td>
<td>14</td>
</tr>
<tr>
<td>South Africa</td>
<td>46 (Municipal and Domestic: 19, Industry: 35)</td>
<td>1.1</td>
<td>15</td>
<td>17</td>
</tr>
</tbody>
</table>

1 Gap greater than demand-supply difference due to mismatch between supply and demand at basin level
2 South Africa agricultural demand includes a 3% contribution from afforestation
SOURCE: 2030 Water Resources Group

Chart source: Charting Our Water Future; 2030 Water resources Group
Productivity Increases Will Be Challenging in the Future

“The projected increases in yields, land and irrigation expansion will not occur spontaneously from market forces. It will require huge public interventions and investments, particularly in agricultural research and in preventing and mitigating environmental damage.”

Challenges for Meat Sector Vary by Type of Systems Around the World

Required Increase in Meat Production by 2050

Achieving these increases with twice as many poultry, 80 percent more ruminants, 60 percent more cattle and 40 percent more pigs using the current level of natural resources is unrealistic. Increased efficiency and reduced food losses will be key.

Production Systems Must Improve to Minimize Waste in Value Chains

Pastoral and ranch systems – focus on pasture management, animal health, transport infrastructure and market systems.

Small scale farmers – focus on animal health, poor feeding and post harvest spoilage.

Intensive scale units – main driver in urban areas. Increase output per animal and per unit of land and time. Focus on balancing productivity, waste management, welfare, emission reductions and food safety.

Chart source: Knowledge Exchange Division, CoBank, ACB (confidential and proprietary)
No Consensus on Climate Variability But Potentially Big Wildcard!

Projected impacts of climate change

<table>
<thead>
<tr>
<th>Temperature Increase (°C)</th>
<th>Global Temperature Increase (relative to pre-industrial)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0°C</td>
<td>-</td>
</tr>
<tr>
<td>+1°C</td>
<td>+2°C</td>
</tr>
<tr>
<td>+2°C</td>
<td>+3°C</td>
</tr>
<tr>
<td>+3°C</td>
<td>+4°C</td>
</tr>
<tr>
<td>+4°C</td>
<td>+5°C</td>
</tr>
<tr>
<td>+5°C</td>
<td>+6°C</td>
</tr>
</tbody>
</table>

**Food**
- Falling crop yields in many areas, particularly developing regions
- Possible rising yields in some high latitude regions
- Falling yields in many developed regions

**Water**
- Small mountain glaciers disappear, impacting water supplies
- Significant decreases in water availability in many areas, including Mediterranean and Southern Africa
- Sea level rise threatens major cities

**Ecosystems**
- Extensive damage to coral reefs
- Rising number of species face extinction

**Extreme weather events**
- Rising intensity of storms, forest fires, droughts, flooding and heat waves

**Risk of abrupt and major irreversible changes**
- Increasing risk of dangerous feedbacks and abrupt, large-scale shifts in the climate system

UNEP; The Environmental Food Crisis - The Environment's Role in Averting Future Food Crises
Increases in World Energy Will Be Largely in the Emerging Markets

![World energy consumption, 1990-2035](chart)

- Non-OECD
- OECD

Chart source: EIA, U.S. Department of Energy
Oil is Still Major Energy Factor But Coal and Renewables Gain

Chart source: EIA, U.S. Department of Energy
Expanded U.S. Natural Gas and Oil Production Could Change Dynamics

Trillion cubic feet

- **China**
- **Canada**
- **United States**

**Unconventional** (tight gas, shale gas, coalbed methane)

**Conventional** (all other gas)

International Energy Outlook 2011
The Uncertainties in the Energy Markets Are Large

Figure 5. Average annual world oil prices in three cases, 1980-2035 (real 2010 dollars per barrel)

- **High Oil Price**: $315
- **AEO2012 Reference**: $230
- **Low Oil Price**: $100

Chart source: EIA, U.S. Department of Energy
Reducing Food Losses Could Add Substantially to Food Supply
*Food losses or waste are the masses of food lost or wasted in *the part of food chains leading to “edible products going to human consumption”.*
Food Safety Issues Need to be Focused on Sound Science

Chart source: Knowledge Exchange Division, CoBank, ACB (confidential and proprietary)
Domestic and Foreign Government Policies are Major Wild Cards
The 9 Billion-People Question

We can and will feed the world. The question is what the level of relative prices for land, water, and food will be required to achieve that goal in a sustainable manner and what will be the inherent volatility that will surround those relative prices.

That will tell us about the likely structure of the global and regional markets that will evolve. It will also indicate the size of the required balance sheet, the amount of liquidity, the risk management tools and the human capital that will be needed to be competitive.
Did We Get A Preview of the Future In the Last Few Years?
Global Economy Facing Crisis of Confidence Regarding U.S. and Europe

Advanced economies accounted for over half of world growth rate from 1970 to 2008. From 2010 to 2016 they will account for less than one-third. This will be a world with a 2-speed recovery reliant on emerging markets!
Slowing of Liquidation Phase of Cattle Cycle Signaling Less Beef Output

January 1 Cattle inventory

Beef production

lowest since 1952

Chart source: Knowledge Exchange Division, CoBank, ACB (confidential and proprietary)
Export Market Will Be Key to Positive Protein Returns Through 2012

Export share of 2012 U.S. production
- Broilers ..... 20%
- Beef ........ 11%
- Pork ........ 22%
- All meat ...... 17%

Billion pounds (red meat: carcass weight; poultry: ready-to-cook)
Meat Industry Cautious In Uncertain Global Market; Low Grain Supplies

Change in 2011 2012
Broilers  + 0.8 %  -2 to -3%
Beef - 0.4 % -4 to -5%
Pork + 1.4 % +2 to 3%

Percent change in total meat output
2008 2009 2010 2011 2012
+ 3% -3.2% 1.3 % 0.7 % -1 to -2 %

Chart source: Knowledge Exchange Division, CoBank, ACB (confidential and proprietary)
Dairy Export Market Will Be Key to Sustaining Returns Through 2012

Chart source: Knowledge Exchange Division, CoBank, ACB (confidential and proprietary)
Meat and Dairy Industries
Squeezed by Volatile Forces

Are balance sheets strong and flexible enough with sufficient liquidity among all segments to match risks?

Industry realignment will continue?
Advancing Animal Agriculture
With Scarce Resources:
An Economist’s Perspective

2012 NIAA Annual Conference

Presented by:
Terry Barr, Senior Director of Industry Research
Knowledge Exchange Division, CoBank, ACB
E-mail: tbarr@cobank.com