Key Trends and Challenges for Global Agricultural Markets in the Presence of Disruptive Technologies

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Food and Agriculture Organization

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Part 1:
The big picture - a 2050 perspective
Global population growth to continue, but at a slower pace

Source: UNPD, 2016
Rapid urbanization to continue (global level)
Eastern Asia: Population structure 1950 to 2050

Age cohort:
- 100 + years
- 95-99 years
- 90-94 years
- 85-89 years
- 80-84 years
- 75-79 years
- 70-74 years
- 65-69 years
- 60-64 years
- 55-59 years
- 50-54 years
- 45-49 years
- 40-44 years
- 35-39 years
- 30-34 years
- 25-29 years
- 20-24 years
- 15-19 years
- 10-14 years
- 5-9 years
- 0-4 years

Percent of population

Italy: Population structure 1950 to 2050

Age cohort:
- 100+ years
- 95-99 years
- 90-94 years
- 85-89 years
- 80-84 years
- 75-79 years
- 70-74 years
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- 55-59 years
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- 35-39 years
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- 20-24 years
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- 0-4 years

Energy and Protein Content of the Diet, Total Availability (1961-2080)

Bubble size ~ population size

2500 kcal
3000 kcal
energy and protein rich

Energy [kcal/person/day]

Protein [in g/person/day]

Source: AT2050/80, Josef Schmidhuber, 2011
Commodity prices are expected to continue their long-term trend.
Part 2: Zooming in: the next 10 years
The price outlook

• Supply and demand fundamentals keep real international reference price trends slightly declining.

• The additional resources can be mobilized below current price levels.

• Most commodity group prices follow similar trends due to substitutability and complementarities.
Population growth
Population projections:
Slower growth overall, growth poles in Africa and South Asia

<table>
<thead>
<tr>
<th>Region</th>
<th>Annual growth rate in %</th>
<th>Millions 2017-2027</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2008-17</td>
<td>2018-27</td>
</tr>
<tr>
<td>World</td>
<td>1.19</td>
<td>0.98</td>
</tr>
<tr>
<td>Africa</td>
<td>2.61</td>
<td>2.39</td>
</tr>
<tr>
<td>Mena</td>
<td>2.04</td>
<td>1.61</td>
</tr>
<tr>
<td>Latin America &amp; Caribbean</td>
<td>1.14</td>
<td>0.85</td>
</tr>
<tr>
<td>North America</td>
<td>0.77</td>
<td>0.71</td>
</tr>
<tr>
<td>Europe</td>
<td>0.11</td>
<td>-0.02</td>
</tr>
<tr>
<td>Asia and Pacific</td>
<td>1.04</td>
<td>0.74</td>
</tr>
<tr>
<td>China</td>
<td>0.53</td>
<td>0.20</td>
</tr>
<tr>
<td>India</td>
<td>1.25</td>
<td>0.97</td>
</tr>
<tr>
<td>Oceania Developed</td>
<td>1.58</td>
<td>1.25</td>
</tr>
</tbody>
</table>

Source: UN-Statistics/population 2017 revision
Income growth
Large emerging economies still dominate income growth

Source: OECD Economic Outlook, IMF World Economic Outlook, related authorities, and OECD and FAO Secretariats.
... but at high and growing income inequality

- High income inequality in developing and emerging markets
- Not all consumers stand to benefit from income growth, slower growth for demand-responsive foods (meats, milk) in developing countries, the reverse holds for developed countries

Energy market and prices
Energy sector links

Maize prices in US$/t

Crude oil prices in US$/barrel

Corn (maize)  Crude oil
Saturated mandates and no market incentives

Crude oil no longer driving corn prices
Agricultural policies
China’s support to agriculture (TSE)

- Chinese agricultural subsidies (TSE) now equal those of all OECD countries combined.
- Policy measures aimed to ensure domestic food security.
- Main instruments are procurement prices, a temporary reserve system for maize, wheat and rice and respective TRQs.
- Policy reforms in the maize market are already in effect, further steps in rice and wheat markets are expected.
High initial grain stocks and low inventory demand
High cereal stocks dampen inventory demand over the medium term

Grain stocks at record levels

- Coarse Grains
- Rice
- Wheat
SDG challenges
Undernourishment

In developing regions the number of undernourished dropped by 211 million since 1990-92

- The **WFS goal was missed** by a large margin: it would have required some 265 million less than the current estimate.

- The baseline suggests that the SDG target of eliminating hunger will even be missed by a larger margin, i.e. by about 650 million
GHG emissions and Climate Change

World Greenhouse Gas Emissions from Agriculture (Co2 eq.)

Gigatonnes Co2 eq.


- Crop Residues
- Burning - Crop residues
- Enteric Fermentation
- Burning - Savanna
- Manure Management
- Manure left on Pasture
- Rice Cultivation
- Manure applied to Soils
- Cultivation of Organic Soils
- Synthetic Fertilizers
Part 3: Possible “disruptors”
Investment disruptors
Background: “pull and push” towards sustainability

1. SDGs ambitious agenda, requiring vast financial resources (e.g. $4.2tr v $0.14tr)
2. Public finance is insufficient, need to mobilize other sources; the private sector?
3. Equity investors are urging enterprises to move towards RBC, sustainable production, processing, distribution, i.e. sustainable supply chains.
4. Companies are discovering sustainability as a sales promoter, including in food and agriculture
5. No practical guide for the private sector to move towards RBC in food and agriculture
How can FAO be part of the solution?

1. Guidelines, conventions, soft-laws, “rights” developed by FAO/CFS
2. Guidelines, conventions, soft-laws, “rights” developed by other IOs
3. Take the various conventions and guidelines and
   • Focus on sustainability
   • Translate them into practice
   • Make them actionable by the private sector
4. Compile, in close cooperation with the OECD, the “Guidance for Sustainable Agricultural Supply Chains”
The guidance

1. A brief review of the various guidelines
2. A practical due diligence framework (5 steps)
3. A model enterprise policy
Creating the basis for innovative financing opportunities

How to mobilize private funding for development

• Sustainability seal
• Subsidized loans
• Blended finance
• Tax incentives
• De-risking strategies, VC for innovations and start-ups.
Amara’s law:
We tend to overestimate the effect of a technology in the short run and underestimate the effect in the long run.
Urban agriculture and its disruptors: “Controlled Production Environments”, “Smart farms”, “smart cities”
What are controlled environments?

- Come in many different forms: Vertical, semi-closed greenhouses, container agriculture, etc. often with hydroponics, aquaponics, etc.
- Become ever more important with urbanization: new opportunities for agriculture, delivering fresh, local, safe, traceable, healthy food.
- Control the growing conditions for unusual, uncontrolled environments: cold/hot/dry and harsh growing conditions
- Thrive on know-how, technologies, vicinity to consumers
- Favour high-price, premium produce: fruits and vegetables: tomatoes, egg-plants, peppers, micro-herbs, berries, even crop carriers for medical components.
- Very high yields at low resource needs (except for energy)!
- Combination of technology packages to make it a “disruptive technology”? 
Controlled environments: a “disruptive technology”?

- Not for food security, neither locally nor globally!
- Full integration of the technology packages (genetics, AI/ML/ robotics/IoT, full climate control, cooling, heating, LED, light programs), by far not fully exploited.
- Full integration into international supply chains, GVCs (genetics, seedlings, fertilizer, LEDs, etc.)
- Full integration into horizontal supply chains, just in time production, etc.
- High tech variants have made inroads in China (300 ha), Japan, South of France, the NL (Westland 400ha), UK, US (Maine, Arizona, California).
- Basic technologies are tried and tested under the harshest climatic conditions (Russia, GCCs).
Biological disruptors
Biological Disruptors

- Gene-editing: CRISPR CAS 9 and TALEN (Transcription activator-like effector nuclease)
- Will gene-editing be considered “GM”?
  - USDA: no (13 April 2018)
  - EU decision: yes, GMOs
- TR4 Banana wilt
- Personalised nutrition
Alternative proteins

• Finless food/fish
• “Clean meat”
• Faux meat: insect-based proteins
• “AgriProtein”: Organic waste ➔ insects (fly larvae) ➔ oil+protein+soil
• Faux meat: plant-based proteins
• https://www.future-meat.com/
## Alternative proteins:

3 basic options: cellular meat, **plant protein-based meat** and **insect-based meat**

<table>
<thead>
<tr>
<th>Company</th>
<th>Product</th>
<th>Cost</th>
<th>comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finless food/fish</td>
<td>Clean fish (“no catch”), cellular blue tuna</td>
<td>~ US$5000/kg</td>
<td>Start-up</td>
</tr>
<tr>
<td>Memphis meats</td>
<td>Cellular meat, meat balls</td>
<td>~ US$10,000/kg</td>
<td>2015, large investments by BGates, RBranson</td>
</tr>
<tr>
<td>JUST meat (former Hampton Creek)</td>
<td>Cellular meat</td>
<td>Unknown, not yet competitive</td>
<td></td>
</tr>
<tr>
<td>mosameat</td>
<td>Cellular meat</td>
<td>Unknown, not yet competitive</td>
<td></td>
</tr>
<tr>
<td>SuperMeat</td>
<td>Cellular meat</td>
<td>Unknown, not yet competitive</td>
<td>Start-up, partners w/ PHW Group</td>
</tr>
<tr>
<td>Bug Foundation</td>
<td>Insect based meats/burgers</td>
<td>US$12-15/burger</td>
<td>Operational</td>
</tr>
<tr>
<td>Umami Burger</td>
<td>Cheese and vegetables</td>
<td>US$13/burger</td>
<td>Operational</td>
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</table>
IT and Tech disruptors
Emerging Opportunities for the Application of Blockchain in the Agri-food Industry

Mischa Tripoli
Josef Schmidhuber
DLT/Blockchain

DBs for “disintermediation”
Applications:
Land and other registries
• Trade finance and facilitation (Maersk, IBM)
• Smart contracts, auto-execution
• Better statistics
• Traceability for food safety, speed and accuracy
  rules of origin, social and environmental attributes
• Anti-fraud, authenticity
• Platform technology
  for AI, ML and apps like crypto-anchors

→ Large efficiency gains in global supply chain management
→ 3 most important, remaining challenges: scalability, interoperability and process-product links.
→ Crypto-anchors address the process-product links >>>
Fixing process/product links with crypto-anchors

- DLT + crypto-anchors (e.g. edible shade of magnetic ink, $0.1$ RFID chips, digital fingerprints) embedded into food/drugs/pesticides to ensure traceable transactions of authentic products along a (global) supply chain
- IBM: first practical applications: 18 months, mainstream: 5 years
Big Data - ML - AI

FAO/AMIS Price sentiment
Subject scopes

Commodity
Market condition
Elections
Politics
Society
Energy
Agriculture infrastructure
Monetary policy
Finance & investment
Negotiations
Policy & Governance
Regulation
Environment
Price prediction

Topics & Sentiment

Market Sentiment and Price Prediction
Price Prediction in a nutshell

- Topics are extracted by the algorithm
- Using the topics and the sentiment of each article leads to a new metric: the topic sentiment
- Sentiments are continuously generated (by the machine) as new information arrives (it is a dynamic learning process)
- Machine makes price predictions but those predications are not published - for the time being!
Future work

- Improve the accuracy and consistency of our forecasts
- Feed it with Tweets
- Automated write-up (chatbot) – “Emma”
- Multilingual interpreter
- Projecting trade matrixes
Robots will cut pesticide usage by 90%
Roy Amara’s law reformulated in the context of Agriculture 4.0: “Be aware of the short-run hypes, but be ready to reap the long-term benefits”
Thanks
Political/trade disruptors
Political and trade disruptors

• US – EU/G7 trade conflict
• US - China trade conflict
• Multilateral structures in jeopardy: WTO, G7/G20, OECD, NAFTA, mega-regionals
• China debt crisis
Health, biosecurity and NCDs
The shape of things to come?

Rapid urbanization to continue (global level)

- Personalised nutrition
- Smart farms, smart cities
Health Disruptors

• NCDs
• Personalized nutrition
• Neutra-ceuticals
• 3-D printed foods
The most comprehensive genetic analysis on the market.

Analyzing 85+ clinically relevant genes.

WHAT OUR REPORT COVERS

- Personal Overview
- Digestion
- Methylation Cycle (B-Vitamin Cycle)
- Hormone Health
- Neurotransmitters & Mental Health
- Inflammation & Antioxidant Protection
- Detoxification
- DNA Damage, Protection & Repair
- Cardiovascular Health & Athletic Performance

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Personalised nutrition: Nutrigenomics

- Self-optimization and preventive health: optimize food to minimize risk of getting sick
- Biomarkers for interaction between food/LDL/HDL Cholesterol and genome, food/blood glucose and genome, prostate cancer, etc.
- Sciona: gene-testing of 19 genes to optimize personal diet
- Neutri-ceuticals
Automation potential by sector (% of time, with current technology)

Source: A Turner, 'Capitalism in an Age of Robots' (Institute for New Economic Thinking, 2018)
Consumption (kcal/person) and GDP per capita (62 Developing Countries)

\[ y = 310.25\ln(x) + 202.83 \]

\[ R^2 = 0.4742 \]
Post scriptum: some general thoughts

• A new “gilded age”?  
• Winner takes all (DTLs to break this)?  
• Growing monopolies, global, need for regulation (WTO)?!  
• Need to shift from Darwinian to Schumpeterian processes?  
• More disruption needed?!  
• Bounty, wealth longevity, but even more so dispersion and inequality.  
• Paradox: slower productivity growth (TFP) overall, high productivity growth concentrated in the hands of a few, huge differences across companies (not so much across countries)  
• First time that people move from higher to lower productivity jobs (education, not technology). German social contract as a role model? Livelong learning, social and societal inclusion, a case for UBIs?  