Technology and Innovation for Sustainable Agriculture

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Agriculture matters

- Provides livelihood for 40% of global population...
- ...including 70% of poor in developing countries
- Major influence on:
  - Clean water supply
  - Pollination
  - Pest and disease control
  - Carbon emissions
Smallholder farmers

- Majority of the chronically hungry
- Manage 80% of farmland in Asia and Africa
- Supply 80% of food consumed in developing world
- Lack access to:
  - Knowledge
  - Skills
  - Inputs
  - Credit
  - Markets
  - Infrastructure

<table>
<thead>
<tr>
<th>Region</th>
<th>Average Farm Size (ha)</th>
</tr>
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<tbody>
<tr>
<td>Africa</td>
<td>1.6</td>
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<tr>
<td>Asia</td>
<td>1.6</td>
</tr>
<tr>
<td>Latin America &amp; Caribbean</td>
<td>67.0</td>
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<tr>
<td>Western Europe</td>
<td>27.0</td>
</tr>
<tr>
<td>North America</td>
<td>121.0</td>
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</tbody>
</table>
STI applications & farming practices
Adequate water management

- Relatively large, sophisticated farming systems
  - Automated canal and piped water delivery systems
  - Laser land leveling for surface irrigation applications
  - Automated sprinkler irrigation
  - Microirrigation
  - Sophisticated control systems

- Smallholder farmers
  - Contour farming
  - Ridging
  - Increased soil organic matter
  - Water harvesting
  - No-till farming (aka zero tillage, direct seeding)
**STI applications & farming practices**

**Healthy, nutrient-rich soil: fertilizers**

**Inorganic fertilizers**
- Immediately supply nutrients to plants
- Very expensive
- Heavy application can build up toxic salt concentrations
- Inadequate supply infrastructure in remote areas
- Subject to leaching
- Can pollute water system

**Organic fertilizers**
- Must first be broken down
- Much cheaper
- Do not build up toxic salt concentrations
- Improve soil structure
- Soil better able to hold water and nutrients
- Increase carbon content and absorption of soil
Bio-fertilizers or plants that have symbiotic associations with other plants

- Plow between harvests
- Can increase crop yields without need for nitrogen-based fertilizers

Integrated soil fertility management

- Combines use of organic and inorganic nutrients with mineral nutrients
- Focuses on timing and placement of inputs

Mixed cropping

Microbiological techniques

- Suppress diseases
- Solubilize phosphorous
Traditional and participatory breeding with:
- Marker assisted selection
- Genomics
- Transgenic approaches

Genetic breeding and other modifications can improve:
- Crop yields
- Appearance
- Taste
- Nutritional quality
- Resistance (drought, insects, disease, herbicides)

Plant tissue culture
- Produce disease-free, high quality planting material
- Rapidly produce many uniform plants
Facilitate information exchange
More resource-efficient, site-specific agriculture from:
- Nanotechnology
- Remote sensing
- GIS
- GPS
- Mobile phones
- Internet
Example: pest and weed control
- GPS-enabled design of specific plans for herbicides and pesticides
- Infrared weed detectors
Obstacles
- Illiteracy
- Reluctance to pay for information
Reduce crop losses, increase food supply
Increase shelf life
Improve consumer acceptability of indigenous foods
Develop value-added, exportable products
Improve livelihoods of women
Greatest potential in primary processing technologies:
- Cleaning
- Drying
- Pre-cooling
- Grading
- Packaging
- Storage
STI applications & farming practices
Sustainable agriculture systems: organic

- Requires minimal external inputs
- Uses local, naturally available materials
- More diverse, stress-resistant approach
- Yields remain stable or increase upon conversion (for smallholder farmers in marginal conditions using low amounts of synthetic inputs)

**Soil benefits:**
- Increased water retention
- Reduced soil erosion
- Improved organic matter

**Environmental benefits:**
- Water table improvements
- Better carbon sequestration
- Increased agro-biodiversity

**Economic benefits**
- No need to purchase synthetic pesticides and fertilizers
- Obtain premium prices for certified produce
- Processing activities add value
Agricultural innovation
Elements of an agricultural innovation system

DEMAND DOMAIN
- Consumers of food, food products, and industrial raw materials
- Global commodity markets
- Policymakers and agencies

ENTERPRISE DOMAIN
- Farmers
- Commodity traders
- Input supply agents
- Companies and industries related to agriculture, particularly agro-processing
- Transporters

INTERMEDIARY DOMAIN
- Extension services
- Farmer and trade associations
- Seed banks, marketing boards, and cooperatives
- Private companies and entrepreneurs
- Journalists
- Consultants
- NGOs and donors

RESEARCH DOMAIN
- Agricultural research organizations
- Universities and technical colleges
- Private research foundations
- Sometimes: private companies and NGOs

SUPPORT STRUCTURES
- Banking and financial system including development banks and credit agencies
- Transport and marketing infrastructure
- Professional networks including trade and farmer associations
- Education systems
- Standards and certification agencies, frameworks, and procedures
Publicly funded agricultural R&D stalled or declined
- Nearly half of spending in US, Japan, China, India, Brazil
- Only 6% in 80 countries with 14% of agricultural land area

Declining development assistance to Africa
- Proportion of agriculture support fell 2/3 from peak
- Only 3% of STI aid destined for agriculture R&D in LDCs

Persistent problems
- Lack of competence in some fields
- Capacity movement to industrialized countries
- Lack of incentives to address social needs
Research institutes & education systems
Opportunities

- **Academic reforms**
  - Reward applied research, special R&D for local varieties
  - Improve attractiveness and social relevance
  - Increase access to tech education & farm management
  - Expand graduate training in certain fields
  - Establish and enforce codes of conduct

- **Capacity-building in the field**
  - Occupational education for farmers
  - On-line distance learning and education
  - Competitive grants for tertiary and post-doc training
  - Extension training in critical thinking & problem solving
Extension services
Success factors

- Personal contact
- Adequate resources
  - For extension service networks and hiring agents
  - For farmers to adopt technologies and practices
- Two-way information flow
- Client oriented
  - Include farmers and rural communities
  - Client trust
  - Minimal regulatory duties or non-advisory work
  - Services designed with gender issues in mind

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Financing agriculture & innovation

Methods

- Increase investments in knowledge, STI
- Increase investments in rural development
  - Infrastructure
  - Telecommunications
  - Processing facilities
- Specialized banks, microfinance, insurance
- Increased access to markets (extension, organic)
- Public-private partnerships
- Innovative procurement practices
- Brokered long-term contractual agreements
- Farmer groups, cooperatives, other partnerships
Governance

Key areas

- Greater democratic control
- Security of tenure and access to land
  - Land productivity improves
  - Farmers adopt technology and innovate
  - Investment increases
  - Transferability improves long-term creditworthiness
- Remove or modify tax or pricing incentives for:
  - Overuse of pesticides, fertilizers, water, fuel
  - Land degradation
- Intellectual property rights
Governance
Key areas (continued)

- Lower cost of inputs
  - Vouchers for smallholder farmers
  - Subsidies for bio-fertilizer & sustainable tech, practices

- Increase farm-gate prices
  - Reduce trade distorting subsidies
  - Encourage foreign direct investment
  - Streamline and improve anti-dumping measures
  - Provide temporary protection

- Improve global market access
  - Eliminate escalating tariffs for processed commodities
  - Generalized preferential access to developed markets
Governance
Key areas (continued)

- International trade policies for sustainability
  - Transboundary water
  - Emerging human and animal diseases
  - Agricultural pests
  - Climate change
  - Environmental pollution
  - Food safety
  - Occupational health
Questions

What special tariff reductions, rebates, or other policies, preferences, or tools can be implemented at the international level to assist smallholder farmers?

What new financial incentives and support can be provided to entrepreneurs and smallholder farmers?

What next steps should be taken and commitments made to revitalize and strengthen extension services?

How can the cost of organic fertilizer, seeds, and other inputs be reduced for smallholder farmers?

What can be done to promote aid harmonization and alignment with national structures and priorities?

What are suitable new or existing fora or other means to share ideas and approaches to fostering innovation and supporting smallholder farmers?