Sustainable development: the role of agriculture

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University Professor Sustainable Development & Food Security
Chair of the CGIAR Science Council
…Sustainability …
Sustainable agriculture

- Water use, land use, food security, energy security and rural development are closely related.
- In this context, sustainable agriculture plays a pivotal role.
- Broad support for increased productivity.
- Broad political commitment for sustainable agriculture.
- No clear consensus on what sustainable agriculture is.
Sustainable agriculture

- Plant and animal production systems that in the long run make the most efficient use of limited resources to fulfill the needs of mankind

- Needs of mankind
  - Food security and bio-products
  - Economic viability
  - Environmental quality
  - Social equity

- Limited resources
  - Land
  - Water
  - Nutrients
  - Genetic resources
  - Labour
Agriculture in a dynamic environment

- Food security
  - Growing population
  - Shift in diets
- Climate change
  - Desertification
  - Invasive species and pathogens
- Biobased economy
  - Bio fuels
  - Bio products
…Food Security…
Global availability of food

Global Dietary Energy Consumption

<table>
<thead>
<tr>
<th>Year</th>
<th>kcal/person/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>1969-1971</td>
<td>2200</td>
</tr>
<tr>
<td>1979-1981</td>
<td>2300</td>
</tr>
<tr>
<td>1990-1992</td>
<td>2400</td>
</tr>
<tr>
<td>1995-1997</td>
<td>2500</td>
</tr>
<tr>
<td>2001-2003</td>
<td>2600</td>
</tr>
</tbody>
</table>

For quality of life
**Global availability of food**

![Bar chart showing food availability (kcal/person/day)](chart.png)

- **Food availability (kcal/person/day)**:
  - FAO: 2220 kcal/person/day
  - USA: 3760 kcal/person/day
  - Netherlands: 3490 kcal/person/day
  - China: 2930 kcal/person/day
  - India: 2470 kcal/person/day

- **World Need**:
  - Global availability of food compared to need.
Hunger in the world (data 2008)

Number undernourished persons

Developing Countries
Africa
Congo, Dem. Republic of
United States of America
The Netherlands
China
India

0 200 400 600 800 1000

WAGENINGEN UR
For quality of life
Hunger in the world (data 2008)

Percentage undernourished persons

- Developing Countries
- Congo, Dem. Republic of
- United States of America
- The Netherlands
- China
- India

The United States of America has the highest percentage of undernourished persons.
### Shifting diet

#### Dietary Energy Consumption (2001-2003) per person

<table>
<thead>
<tr>
<th>Population (billion)</th>
<th>Developed</th>
<th>%</th>
<th>Developing</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cereals</td>
<td>1020</td>
<td>31</td>
<td>1391</td>
<td>52</td>
</tr>
<tr>
<td>Oils &amp; Fat</td>
<td>566</td>
<td>17</td>
<td>267</td>
<td>10</td>
</tr>
<tr>
<td>Animal Products</td>
<td>712</td>
<td>21</td>
<td>311</td>
<td>12</td>
</tr>
<tr>
<td>Sugar</td>
<td>427</td>
<td>13</td>
<td>194</td>
<td>7</td>
</tr>
<tr>
<td>Pulses</td>
<td>286</td>
<td>9</td>
<td>198</td>
<td>7</td>
</tr>
<tr>
<td>Fruits, vegetables and roots</td>
<td>308</td>
<td>9</td>
<td>295</td>
<td>11</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>3319</strong></td>
<td><strong>100</strong></td>
<td><strong>2656</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>
Public spending on agriculture is lowest in the agriculture-based countries, while their share of agriculture in GDP is highest.

Source: Fan, forthcoming.

A central role of agriculture
Africa
Kofi Annan

“I request the IAC to present to me, within a year, a report providing a technological strategic plan for harnessing the best science and technology to provide substantial increase in agricultural productivity in Africa”

“I would also welcome specific action proposals that could contribute to food security in Africa through a global collaboration of governments, civil society and the corporate sectors”
Study Structure

**Co-chairs**
Speciosa Wandira Kazibwe
Rudy Rabbinge
M.S. Swaminathan

**Panel members**
Mohamed Besri
Maria Manuela Chaves
Avílio Antonio Franco
Oron Gideon
Jikun Huang
Ryuichi Ishii
Renald Lafond
Peter Matlon
Ahmadou Lamine Ndiaye
Bongiwe Njobe
Emmanuel Odigboh
Per Pinstrup-Andersen
E.N. Sabiiti
José Sarukhan
Jennifer Thomson

**Directorate**
Jim Ryan
Prem Bindraban
Huub Löffler
Process

4 Regional consultative workshops

Expert consultation

Proceedings

Resource documents

Study Panel meetings

Presentation, consultation, review
Diagnosis

1. Absence of dominating food crops
2. Multitude of farming systems
3. Weathered soils
4. Erratic rainfall
5. Endemic plant and animal diseases
6. Land / Labor productivity low
7. Dominant role for women – limited access to resources
8. Lack of investment in agricultural research
9. Lack of knowledge infrastructure
10. Lack of functioning academic institutions
11. Brain drain
12. Not functioning local and regional markets
13. Land entitlement inappropriate
14. No stimulating political and economic environment
15. Inadequate capacity to impact global policy formulation
Strategic recommendations – four domains

1. Technology options that can make a difference
2. Building impact-oriented research, knowledge and development institutions
3. Creating and retaining a new generation of agricultural scientists
4. Markets and policies to make the poor prosperous and food secure
Technology options that can make a difference

- Adopt a market-led productivity improvement strategy
- Adopt a production ecological approach with a primary focus on identified continental priority farming systems
- Pursue a strategy of integrated sustainable intensification
- Bridge the genetic divide
- Embrace information and communication technology at all levels
- Improve the coping strategies of farmers in response to environmental variability and climate change
Priority farming systems

- Irrigated system
- Maize mixed system
- Tree crop based system
- Cereal root crop mixed system
- Hunger Hotspot (CIESIN)
Discontinuities in production trends

Wheat Yields in the Netherlands from 1900 onwards

Wheat Yield (ton/ha)

Wheat Yield (ton/ha)

Yield of Paddy (Indonesia)

Green revolutions
Recognise the potential of rainfed agriculture and accord it priority

Reduce land degradation and replenish soil fertility

Explore higher scale integrated catchment strategies for natural resource management

Promote the conservation, sustainable and equitable use of biodiversity as a component of future biotechnology initiatives

Enhance use of mechanical energy and power
Mechanization

Labor productivity increase from 1960-2000 (%)

- World: 160
- Sub-Saharan Africa: 121
- East & Southeast: 203
- South Asia: 165
- Latin America & Caribbean: 246
- North America: 360
- Europe (15): 634

Actual maize yield (t/ha)
Building impact-oriented research, knowledge and development institutions

- Design and invest in national agricultural science systems that involve farmers in education, research and extension
- Encourage institutions and mechanisms to articulate S&T strategies and policies
- Cultivate African centres of agricultural research excellence
- Increase support for agricultural R&D
- Strengthen international agricultural research centres (IARCs)
Creating and retaining a new generation of agricultural scientists

- Focus on current and future generations of scientists in Africa
- Broaden and deepen political support for agricultural science
- Reform university curricula
- Mobilize increased and sustainable funding for higher education in S&T, minimizing dependence on external donor support
- Strengthen science education at primary and secondary school levels
Research Capacity

(a) Estimated number of full-time equivalent (FTE) agricultural researchers: 18700

North Africa
9%

Sub-Saharan Africa
55%

Egypt
36%
Markets and policies to make the poor income and food secure

- Increase investments in rural infrastructure
- Strengthen capacity to expand market opportunities
- Institute effective intellectual property rights (IPR) regimes to encourage the private sector and facilitate public-private partnerships
- Reduce barriers to increased African trade with OECD countries
- Improve data generation and analysis related to agriculture, food and nutrition security, and vulnerability
# Impact of investments

<table>
<thead>
<tr>
<th>Investment</th>
<th>Benefit/cost ratio</th>
<th>Reduction in numbers of poor per million Ush</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural research and extension</td>
<td>22.7</td>
<td>107.2</td>
</tr>
<tr>
<td>Education</td>
<td>2.7</td>
<td>12.8</td>
</tr>
<tr>
<td>Feeder roads</td>
<td>20.9</td>
<td>83.9</td>
</tr>
<tr>
<td>Murram roads</td>
<td>n.s.</td>
<td>40.0</td>
</tr>
<tr>
<td>Tarmac roads</td>
<td>n.s.</td>
<td>41.4</td>
</tr>
<tr>
<td>Health</td>
<td>0.6</td>
<td>2.6</td>
</tr>
</tbody>
</table>

*Source:* Fan et al. (2003).

*Note:* n.s. denotes effects were not statistically significant.

Conclusion

- There are ample opportunities for Science and Technology to increase food security and to alleviate hunger.
- Rainbow Evolutions rather than a Green Revolution is the best option for increased Agricultural Productivity in Africa,
- Technology on the shelf is not sufficient for the African situation
- Agricultural S&T is powerful but will only work in a conducive socio economic and political environment
Impact of the study

- Millenium Development Goals
  - MDG has eclipsed the IAC in most recommendation areas
- The global report of the Science Council of the CGIAR
- Sub-Saharan Africa Challenge Program
- The World Bank Report
- Programme for Dissemination of New Agricultural Technologies in Africa (DONATA)
- Multi-country Agricultural Productivity Program (MAPP)
- Comprehensive Africa Agricultural Development Program (CAADP)
Impact of the study

- African Centres of Agricultural Research Excellence (ACAREs): Biosciences East and Central Africa (BECA)
- Network of African Science Academies (NASAC)
- Building African Scientific and Institutional Capacity Building (BASIC)
- Regional Universities Forum for Capacity Building in Agriculture (RUFORUM)
- Global Open University
  - Economics of Agriculture and Natural Resources
  - Agro-ecology
…Unsustainability spirals …
Unsustainable development

- Desertification
- Deforestation
- Decreased production caused by
  - Wealth (Pollution)
  - Poverty (Outmining soils)
- Fertilizer consumption
  - phosphate
- Bio fuels
Unsustainable development

1. Due to *wealth*

2. Due to *poverty*

- Overgrazing: 35%
- Deforestation: 29%
- Over-exploitation: 7%
- Bio-Industry: 1%
- Mismanagement: 28%

Oldeman et al, ISRIC
Fig. 5: Lifetime of reserves

Bio-energy
Sustainable use of Phosphorus

**Recycling**

**Efficient application**

**Breeding**

**Phyto mining: algae from sea**

*Banksia* species (Proteaceae) from severely phosphorus-impoverished soils exhibit extreme efficiency in the use and re-mobilization of phosphorus

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doi: 10.1111/j.1365-3040.2007.01733.x
Energy: Competing claims

...Fuel for the Rich or Food for the Poor...
Jatropha on marginal soils
...A new paradigm ...
Sustainability: a new paradigm

- Long-term objectives are high production systems
- Optimize the use of scarce resources (land, water, labor, inputs and energy) for maximal productivity
- Stimulate agro-technological and ecological literacy
- Adopt the agro-ecological approach
- Jump start from just government to Public Private Partnerships
- Involve farmers (quadrangle approach)
Production Ecological Approach

- **POTENTIAL YIELD**
- **ATTAINABLE YIELD**
- **ACTUAL YIELD**
- **AVAILABLE FOOD**

**Temperature**
- Radiation
- Crop characteristics

**Nutrients**
- Water
- Labour

**Pests, diseases, weeds, pollutants**

**Post harvest losses**

NERICA
Modified (preliminary) calculations Africa

Calculated number of harvests per year

Bindraban, Conijn, Jongschaap, Uithol
Production potentials African continent

Total water limited biomass production (t/yr)

Bindraban, Conijn, Jongschaap, Uithol
Limiting factors
**Priority action points**

1. Leap frog to advanced agro-production systems
2. Focus on high-tech for smallholders
3. Public Private Partnerships
4. Address land use changes in view of competing claims
5. Specific attention for the bio fuel issue
Thank you