Soils, Production, Prices, Food Inequality

Mark Swilling
Over 800 million people are underweight and malnourished, while changes in diet, the environment and lifestyle worldwide have resulted in 1.6 billion overweight adults.
Who grows our food?

- There are approximately 437 million farms in developing countries from which 1.5 billion people make a living.
- 40% have adopted western-style chemically intensive farming methods (Madeley, 2002: 21)
FAO Food price index (FFPI)

1917 Just before World War I

1951 Rebuilding after World War II

1974 Oil crisis

2008 forecast

Index reference: 1977-1979 = 100

Index of nominal prices, 2005 = 1

Index of real prices, 2005 = 1

(Source: OECD & FAO. 2010:29)
Yield growth of 1.5% pa, 68% increase in total output

120Mha more land needed

(FAO projections of output and land needs. Source: Erb et al 2009:15)
Urban development, food & diets

- 2\textsuperscript{nd} urbanisation wave: 6b – 9b by 2050
- Next 3b in Asian & African cities
- 15-20\% of cropland is peri-urban – expansion could remove 600Mha by 2050
- 1 billion new middle class consumers
- Increased demand for western diets
- Urbanisation & ‘supermarketisation’ go together
Table 1—Annual cereal crop yield growth rates, 1970s - 1990s

<table>
<thead>
<tr>
<th>Crop</th>
<th>Region</th>
<th>1970s</th>
<th>1980s</th>
<th>1990s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat</td>
<td>Asia</td>
<td>4.33</td>
<td>3.71</td>
<td>0.72</td>
</tr>
<tr>
<td></td>
<td>Latin America</td>
<td>0.60</td>
<td>3.40</td>
<td>2.36</td>
</tr>
<tr>
<td></td>
<td>Sub-Saharan Africa</td>
<td>3.54</td>
<td>0.92</td>
<td>-0.81</td>
</tr>
<tr>
<td></td>
<td>World</td>
<td>2.10</td>
<td>2.78</td>
<td>0.42</td>
</tr>
<tr>
<td>Rice</td>
<td>Asia</td>
<td>1.61</td>
<td>2.42</td>
<td>1.55</td>
</tr>
<tr>
<td></td>
<td>Latin America</td>
<td>0.70</td>
<td>2.97</td>
<td>3.71</td>
</tr>
<tr>
<td></td>
<td>Sub-Saharan Africa</td>
<td>0.02</td>
<td>2.51</td>
<td>-0.56</td>
</tr>
<tr>
<td></td>
<td>World</td>
<td>1.49</td>
<td>2.37</td>
<td>1.54</td>
</tr>
<tr>
<td>Maize</td>
<td>Asia</td>
<td>3.43</td>
<td>2.75</td>
<td>1.55</td>
</tr>
<tr>
<td></td>
<td>Latin America</td>
<td>1.49</td>
<td>0.61</td>
<td>3.82</td>
</tr>
<tr>
<td></td>
<td>Sub-Saharan Africa</td>
<td>2.26</td>
<td>1.72</td>
<td>2.09</td>
</tr>
<tr>
<td></td>
<td>World</td>
<td>3.19</td>
<td>0.60</td>
<td>1.76</td>
</tr>
<tr>
<td>Cereals</td>
<td>Asia</td>
<td>2.90</td>
<td>2.79</td>
<td>1.46</td>
</tr>
<tr>
<td></td>
<td>Latin America</td>
<td>1.69</td>
<td>1.28</td>
<td>3.12</td>
</tr>
<tr>
<td></td>
<td>Sub-Saharan Africa</td>
<td>1.90</td>
<td>0.56</td>
<td>0.66</td>
</tr>
<tr>
<td></td>
<td>World</td>
<td>2.18</td>
<td>1.79</td>
<td>1.12</td>
</tr>
</tbody>
</table>

Source: Computed by the authors using data from FAO 1998.
Note: The 1990s refer to the period 1990–97.
Yield growth estimates

- World Bank: 1.5% need to meet demand – no ecological constraints taken into account (World Bank 2009)
- UNEP: 0.87% until 2030, 0.5% from 2030-2050, taking into account ecological constraints (UNEP 2009)
- Hubert et. al. in *Crop Science* – yield growth for cereals will drop to 1.01% (Hubert et.al. 2010)
Global estimates of soil degradation

23% of total globally available land

- Asia: 2,787 million hectares
- South & Central America: 1,714 million hectares
- Africa: 1,663 million hectares
- North America: 1,131 million hectares
- Europe: 796 million hectares
- Oceania: 644 million hectares

Definitions

• "The key soil characteristics that affect yield are nutrient content, waterholding capacity, organic matter content, soil reaction (acidity), topsoil depth, salinity, and soil biomass. Change over time in these characteristics constitutes 'degradation' or 'improvement'. Degradation processes include erosion, compaction and hard setting, acidification, declining soil organic matter, soil fertility depletion, biological degradation, and soil pollution (Lal and Stewart 1995)." (p.5)

• The biggest determinants of degradation were water erosion (25%), wind erosion (18%), soil fertility decline (13%), waterlogging (2%), salinization (9%), and lowering of the water table (6%).
Therefore: 750Mha ‘lightly degraded’
"No developing country has in place a national monitoring system for soil quality." (Scherr, p. 7)
Average NPK application per Ha, 1961-2000
(Source: Tan et al 2005:139)
Global mean yield change per Ha since 1960s
(Source: Tan et al 2005:139)
### Ratio of cereal crop yield to NPK applied since 1960s

(Source: Tan et al 2005:140)

<table>
<thead>
<tr>
<th>Country category</th>
<th>Yield: NPK (kg kg(^{-1}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developed countries</td>
<td>110</td>
</tr>
<tr>
<td>Developing countries</td>
<td>494</td>
</tr>
<tr>
<td>Least developed countries</td>
<td>3,150</td>
</tr>
<tr>
<td>Global mean</td>
<td>161</td>
</tr>
</tbody>
</table>
Nutrient contributors since ‘70s

- **1970s**: soils provided 48% of nutrients, manures 13% and fertilizers 29%
- **1990s**: soils provided 30%, manures 10% and fertilizers 60%
- **2020**: soils will provide 21%, manures 9% and fertilizers 70%
NPK deficits for 562 Mha

- N: 56% of all cropland
- P: 80% of all cropland
- K: 56% of all cropland

Total deficit: 20 Tg across 562 Mha
Soils & yield decline

• Yield in 2000 was reduced by 27% due to nutrient deficits (Tan et. al 2005)

• 1998: global cropland production was 12.7% lower and pasture production 3.8% lower due to soil degradation (Scherr 1999)

• 1995: global production would have been 13% higher if 15% of strongly degraded soils were restored (Scherr 1999)
Soil degradation, productivity & prices

- Global soil degradation rates until 2030 will be 0.4% per annum, resulting in a total loss of 17% of cumulative global productivity by the year 2030 (Crosson 1997)
- 10% decline in soil productivity by 2020, then world food prices would increase by 17-30%, in particular for maize, rice, roots and tubers, and wheat (Agcaoili, Perez and Rosegrant 1995)
Nutrient loss/ha in SSA since 1970s across 100 m ha of cultivated land

- 700 kgs of N
- 100 Kg of P
- 450 Kg of K
- And nutrient mining may well be accelerating - about 86% of African countries lose more than 30 Kgs of NPK per ha per year (Henao and Baanante 1999)
Fertilizers in SSA

• 50% of fertilizer used in Africa is imported into Africa as aid
• 22 out of 40 SSA countries get ALL their fertilizer for free via aid
• To buy fertilizer in Africa, it costs 6 - 11 kgs of grain, compared to 2 - 3 kgs of grain in Asia (Henao & Baanante 1999)
So what’s going on in Africa?

- Nutrient imbalances, but overall yields in Africa have increased. How is this possible?
- Clue: 26 million ha were abandoned since 1970s
- Farmers have abandoned degraded soils and moved on to open new lands cultivated more intensively
- Woodland and forest cleared for newly cultivated fields
- But: there is a limit to this – as land availability for expansion declines, nutrient levels and yields decline, forcing people to leave the land and migrate to the urban areas (Gruhn et al., 2000: 1)
Top 5 challenges in order of priority

• densely populated marginal lands where population pressures and poor soils combine to accelerate degradation
• irrigated lands where salinization and water-logging takes place
• high-quality rain-fed lands suffer mainly due to climate change and nutrient mining
• urban and peri-urban agric lands where land is lost to urbanization (Scherr, 42/3)
Key choice

- Extend conventional HEI farming by intensifying on existing land and opening up 120 Mha of virgin land? Or
- Finding a farming system that can increase outputs by restoring the soils
Agroecological solution

- Recycle and re-use all available biomass
- Build the soils, esp. SOM, soil biotic activity, etc
- Minimizes losses from radiation, wind & erosion – planting, contouring, wind protection
- Maximise biodiversity above & below
- Enhance beneficial synergies
Can agroecological farming feed the world?


Assumptions

• Michigan: organic output in developed world is 92% of conventional, and in developing world it is 180% of conventional – no diet change

• ISE: organic output in developed world is 60% of conventional, and same in developing world – with diet change
Conclusion

unless we can find a farming system that increases output by restoring the soils, price rises and greater hunger are likely

if urbanisation means destroying the peri-urban farming systems, long-distance transportation of food will result in the same outcome.