The Worldwide Importance of Pesticides for Crop Production

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Tropical Export Crops

- Bananas, cocoa, coffee, tea
- Perennial trees/bushes that cannot survive freezes
- Diseases, insects, and weeds flourish in the tropics
- Without pesticides, production would decline significantly
Bananas

- 34 billion pounds exported annually
- Most popular fruit in the world
- Sigatoka fungal germ tube penetrating opening in banana leaf
Sigatoka-infected banana plants
Bananas: Sigatoka Disease

- Present in all banana growing countries
- In 1934, destroyed 22,000 acres of bananas in Central America
- Fungicide treatments began in 1936
Banana Export Plantations: Today

Fungicides are applied 25–35 times annually
Pesticide Use Markets

- **Highly developed (>90% acres treated)**
  - US, Europe, Japan, Australia, Canada

- **Developing**
  - China, India

- **Not Developing (<5% acres treated)**
  - Sub-Saharan Africa
Pesticide Use Driver: Developed Countries

- Consumer demand for picture-perfect produce
Consumers have zero tolerance for wormy apples
U.S. apples have been sprayed with insecticides for over 100 years
Cherry Fruit Fly
Cherry Fruit Fly Larvae
Two-thirds of respondents were willing to pay 5 – 10% higher prices for certified pesticide-free produce, yet were unwilling to accept any cosmetic defects or insect damage.
Herbicide Use Driver: Developed Countries

- Shortages of workers to weed fields starting around the 1950s-60s
- Herbicides greatly reduced the need for weeding by hand
California: Weeding Vegetable Crops 1940s – 1960s

Thousands of legal temporary workers from Mexico in the Bracero (Strong Arm) Program
Millions of people weeded U.S. cotton fields into the 1950s
Decline in Hand Weeding
1950s - 1960s

- Millions of Workers Left Southern States for Urban Factory Jobs
- The Bracero program ended in 1964
- Hand Weeding Was Replaced with Herbicides
Pesticide Use Drivers: Developed Countries

- Need to produce more food for growing populations
- Pesticides have effectively controlled pests leading to yield increases
U.S. Population, 1900 - 2000
U.S. Aggregate Farm Input Use

1950 = 100

- Land
- Labor
- Machinery
Potato Yield: US

Synthetic chemical pesticides introduced
U.S. Rice: Weeds Not Well Controlled Before Herbicides

- Hand Weeders Not Used
Herbicide Application: Rice
Pesticides are used widely in agriculture in the United States. Their application has improved crop yields and increased the quantity of fresh fruits and vegetables in the diet, thereby contributing to improvements in public health.

NAS, 1993
Feeding a Changing World

- Increased Population
- Rapid Economic Growth
- Increased Urbanization
- Increased Middle Class
- Changing Diets
Adequate weeding of rice requires 1 billion person days of labor
Hand Weeding in China

Millions of Farm Workers are Moving to Urban Areas
Herbicide Use: China

Million Hectares

Year


C X ZHANG
China: Rice Field
Weeding Rice in India

Labor is becoming scarce
Middle Class Households

<table>
<thead>
<tr>
<th>Country</th>
<th>2010</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>100</td>
<td>323</td>
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<tr>
<td>India</td>
<td>25</td>
<td>137</td>
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Dwyer, 2012
China: Beef Production

[Graph showing beef production in million tons from 1980 to 2010]
US Soybean Exports to China

• 895 million bushels/year
• 50% of all US soybean exports
• 25% of total US harvest
• 50% of China’s soybean imports
Since 1976, 95-98% of US soybean acres have been sprayed with herbicides for controlling weeds.

USDA, NASS.
Weeds in Soybean Field

Untreated

Herbicide Treated
Cultivation of organic soybeans with 30 inch row spacing
Cultivators

- Can’t be used in wet fields
- Weeds continue to grow
Wisconsin Research: Weeds and Yields

The frequency of weed control problems and subsequent reduced yields in low-input row crops is roughly 34 out of every 100 cases and the corresponding relative yield is approximately 74%.

In the U.S. there is a perfect non-chemical alternative to herbicides.
Weeding a community garden
In the U. S. 70 million workers would be required for weeding to prevent yield losses without herbicides.

Brazil: Soybean Production

Million Tons

Soybean Rust Pustules

- Brazil: First appeared 2001
- By 2003: Spread to entire country
- Yield losses up to 75%

Yorinori, 2005.
Brazil: Spraying Soybeans

Fungicides prevent losses of 44%

Brazil: Soybean Fungicide Market

<table>
<thead>
<tr>
<th>Year</th>
<th>Million US$</th>
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<tbody>
<tr>
<td>2001</td>
<td>25</td>
</tr>
<tr>
<td>2003</td>
<td>200</td>
</tr>
<tr>
<td>2005</td>
<td>600</td>
</tr>
<tr>
<td>2007</td>
<td>600</td>
</tr>
<tr>
<td>2009</td>
<td>800</td>
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Phillips McDougall
Africa: 
Maize as traditional food

- Main food for 50% of the population.
- 65% of farms have shortages before next harvest.
<table>
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<tr>
<th>Maize Yields (Tons/hectare)</th>
<th></th>
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<tbody>
<tr>
<td>Africa</td>
<td>1.6</td>
</tr>
<tr>
<td>Global</td>
<td>4.5</td>
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</tbody>
</table>

FAO
Gray Leaf Spot on Maize Leaf
Maize: Africa, Fungicides

Fungicides increase maize yields 27 to 54%

Africa Transformed

Rural to Urban
Sub-Saharan Africa: Urban Population

![Graph showing urban population growth in Sub-Saharan Africa from 1990 to 2050. The y-axis represents millions, with values ranging from 0 to 1200. The x-axis represents years from 1990 to 2050. The population shows a steady increase over time.](image-url)
Africa: Potato Consumption
Potato Production: Sub-Saharan Africa

Production
Area
Yield
1990=1.00

FAO
Fungicide spray increases yield by 224%

Namanda, et al., 2004.
Hand Weeding is the Predominant Weed Control Practice in Sub-Saharan Africa

50-70% of the labor in crop production is spent weeding

Constraints on Timely Hand Weeding

- Women can be too tired or sick (malaria)
- Fields can be muddy
- Competing time demands: child care
- Pregnancy
African Weed Control: Current Practice

- 100 million hectares, 100 million women
- 200 hours/hectare
  - 20 billion hours
  - 20-100% yield loss

Gianessi, 2009.
Crop Life Zambia Training Program

3,200 spray service providers were trained.

Hillowitz, 2010.
Spray Service Provider: Zambia

300% increase in herbicide sales in Zambia.

Hillowitz. 2010.
Maize yield increased from 1.5-2.0 tons per hectare to as much as 4.5 tons per hectare.

CARE Zambia, 2011
Adoption of herbicide technology among female farmers has also brought behavioral change as most of them have vowed never again to weed their crops using hand hoes.

CARE Zambia, 2011
China would “undergo famine if pesticides were not used”. The warning has come in a recent Chinese Ministry of Agriculture document…
Japanese Rice

- Famines due to rice blast
  - 1695, 1783, 1833–1837
- Last major rice blast outbreak: 1953
- Fungicides have prevented outbreaks since then

Rice blast

Monument to fungicides for rice blast control in Nankoku, Japan
Conclusion

- Pesticides are Essential for Feeding the World
- A significant increase in pesticide use would greatly improve international food security
Weedy Crop Field: Africa
Uncontrolled Weeds: A Major Cause of Hunger