Council for Agricultural Science and Technology
Linda M. Chimenti, Executive Vice President
What Is CAST?

• CAST is a 501(c)3 nonprofit organization
• Based in Ames, Iowa
• Composed of
  o scientific societies
  o individual and student members
  o company, nonprofit, and associate society members
• Has U.S. and international members
What Does CAST Do?

• CAST provides credible, understandable science-based information through
  o print materials
  o online sources
  o videos on website, YouTube, SchoolTube

• CAST uses volunteer scientific experts as authors and reviewers
CAST assembles, interprets, and communicates credible, science-based information

• regionally, nationally, and internationally to

  o legislators
  o regulators
  o policymakers
  o the media
  o the private sector, and
  o the public
Primary Objectives

• Publishing task force reports, commentaries, and issue papers written and peer reviewed by scientists from many disciplines

• Distributing CAST publications widely to nonscientists to enhance the education and understanding of the general public
Friday Notes

- Published 48 times each year
- Lead articles on current topics being discussed in agriculture
- More than 60 current agricultural news items selected from 100+ sources, including live links to the original articles
- Features an international section
- Washington, D.C., congressional updates

The Science Source for Food, Agricultural, and Environmental Issues
CAST expands its outreach through the active use of social media

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  [facebook.com](http://facebook.com)
- Twitter
  [twitter.com/CastAgScience](http://twitter.com/CastAgScience)
- YouTube
  [youtube.com/user/CASTagScience](http://youtube.com/user/CASTagScience)
- SchoolTube
  [schooltube.com/channel/cast/](http://schooltube.com/channel/cast/)
- Blog
  [cast-science.blogspot.com/](http://cast-science.blogspot.com/)
- Pinterest
  [pinterest.com/castagscience](http://pinterest.com/castagscience)
Newest Initiative

Ag quickCAST Publications

- 1-page documents
- Concise, easy-to-read format
- Excerpted from full-length CAST publications
- Links to content in original documents
- Available free on the CAST website
- Printable for distribution as handouts
Website

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Free access to all material for anyone having a “.gov” address

The map to the left depicts visits to the CAST website from every U.S. state and 181 countries.
The Contributions of Pesticides to Pest Management in Meeting the Global Need for Food Production by 2050

Presented by
Dr. Stephen C. Weller
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- USDA—Agricultural Research Service
CAST Paper on Pesticide Contributions to World Food Production:

- Paper provides use of pesticides since WW II.
- Pesticides became popular and widely used because they increased yields.
- Proper use of approved pesticides can have a major impact on food production in the developing world.
- “Intelligent use of pesticides has led to more efficient, sustainable and productive crop management and play a major role in crop yield increases to feed the world in 2050.”
Global Challenges for Agriculture

- Population increase = need for more food
- Poverty, hunger, malnutrition, and non-communicable diseases
- Climate change
- Water
- Environmental degradation
- Loss of diversity
- Pest management
- Agro-biodiversity critical to human survival but significantly undervalued and under-utilized

Sources: Nature 466 (2010); slide courtesy of Mary Abukutsa, JKUAT, Kenya
## Projected Population Growth

<table>
<thead>
<tr>
<th>Region</th>
<th>2011</th>
<th>2050</th>
<th>Change</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>World</td>
<td>6,987</td>
<td>9,587</td>
<td>+2,600</td>
<td>+ 38</td>
</tr>
<tr>
<td>High Income</td>
<td>1,242</td>
<td>1,333</td>
<td>+ 91</td>
<td>+ 7</td>
</tr>
<tr>
<td>Low Income</td>
<td>5,745</td>
<td>8,254</td>
<td>+2,509</td>
<td>+ 44</td>
</tr>
<tr>
<td>East &amp; S.E. Asia</td>
<td>2,183</td>
<td>2,308</td>
<td>+ 125</td>
<td>+ 6</td>
</tr>
<tr>
<td>South Central Asia</td>
<td>1,795</td>
<td>2,574</td>
<td>+ 779</td>
<td>+ 43</td>
</tr>
<tr>
<td>Sub-Saharan Africa</td>
<td>883</td>
<td>2,069</td>
<td>+1,186</td>
<td>+134</td>
</tr>
<tr>
<td>Lat. America/Carib</td>
<td>596</td>
<td>746</td>
<td>+ 150</td>
<td>+ 25</td>
</tr>
<tr>
<td>N. Africa &amp; W. Asia</td>
<td>451</td>
<td>725</td>
<td>+ 274</td>
<td>+ 61</td>
</tr>
</tbody>
</table>

Major Problems in Developing World

Poverty, Hunger, and Food Insecurity

• Food production by 2050 must increase by 70% to feed more people and increase food consumed per capita.

• More than 800 million people in the world are food insecure, and by 2050 the number may reach 1 billion.

• 130 million malnourished children exist, with the majority in sub-Saharan Africa.

• The daily intake of food averages 3,500 kilocalories (kcal), and a normal adult needs a minimum of 2,900 kcal/day to work productively.

• The poor and undernourished in the world consume less than 2,000 kcal/day; many of these are farmers.
Pesticide Benefits for Agriculture in the Developing and Developed World

• Lower crop yields are due in large part to uncontrolled pests during the cropping cycle and storage.

• Pesticide research in the developing world shows great potential to increase yields and has a favorable cost/benefit ratio.

• Pesticide use in the developing world promotes other sustainable practices and results in increased food production as in the developed world.
Pesticide Groupings

Insecticides  Fungicides  Herbicides
  • Rodenticides
  • Molluscicides
  • Nematicides
  • Plant Growth Regulators
  • Other materials that protect plants or usefully modify their physiology

• Pesticide use beyond agriculture includes managing undesirable insects, *pathogens*, weeds, and animals in households and landscape.
Key Concepts

- *Pesticide* use yields benefits in both the developing and developed world
- *Pathogen control and fungicide* use
- Weed control and *herbicide* use
- *Arthropod* management and *insecticide* use
- Pesticide use has led to increased yields and improved agronomic and agriculture practices including no till, conservation tillage, high plant densities, increased yields, efficient use of water and nutrients
- However, they must be applied in safe smart ways
Overall Message

• Authors are optimistic about developments occurring around the globe to minimize crop losses, and pesticides have and will play a role.

• Pesticides effectively applied and fully integrated in a comprehensive food production system will help the world produce food for the 9 billion humans of 2050. IPM approaches recognize that not all weeds, insects, and pathogens are necessarily bad.

• Good pest management integrates the best agronomic practices and the best crop germplasm to obtain high-quality crop yields.
Value of Pesticide Use in U.S.

• Data from field, vegetable, fruit, and nut crops showed crop protection products accounted for an additional $51 billion in value derived from their use.

• For field crops, 36% of the total value of production ($51 billion of the $141 billion) was attributed to the use of crop protection products.

• The direct effects of pesticide use include improved crop yields and quality, better shelf life, limitation of pest population expansion, and increased incomes, which lead to a multiplier effect within other commercial industries.
Pests Reduce Crop Yields

• 30% of yield and 20 to 50% of stored harvested crops are lost on a world basis to pests.

• IFPRI estimated global supply of wheat could be increased by 10% through increased use of fungicides and by 6 to 7% with insecticides and herbicides.

• IFPRI estimates maize production yield increases of 7% with pesticides, 12% for herbicides, 9% for insecticides, and 7% for fungicides.

• IFPRI estimates rice yield increases of 7% for insecticide, 8% for herbicide, and 9% for fungicide use.
Examples

- **Weed Management**
  - Farmers used alternative nonchemical methods of weed control for centuries until the late 1800s to early 1900s.
  - Synthetic herbicides became widespread after WW II.

- **Insect Management**
  - Cultural and mechanical practices were common prior to the late 1930s.
  - Development of resistance to insecticides by pests is a major problem.
  - IPM emphasizes sustainability of pest controls as well as maintaining the utility of insecticide use.

- **Disease Management**
  - For most crops, disease management is necessary.
  - Exclusion of pathogens from areas in which they are not established is the best way to prevent problems.
  - Spraying fungicides to kill plant fungal pathogens began in earnest in the 1800s.
Countries with High Use of Pesticides (wheat, rice, maize)

- USA, Canada
- Western Europe
- Brazil, Argentina
- China, Japan
- Australia
Production in Countries with High Pesticide Use

<table>
<thead>
<tr>
<th>Crop</th>
<th>% of World Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat</td>
<td>63</td>
</tr>
<tr>
<td>Rice</td>
<td>61</td>
</tr>
<tr>
<td>Maize</td>
<td>78</td>
</tr>
</tbody>
</table>
Crop Yields (t/ha) in Sub-Saharan Africa Compared to Global Averages

<table>
<thead>
<tr>
<th>Crop</th>
<th>Africa</th>
<th>Global</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize</td>
<td>1.6</td>
<td>4.5</td>
</tr>
<tr>
<td>Rice</td>
<td>1.9</td>
<td>3.8</td>
</tr>
<tr>
<td>Sorghum</td>
<td>0.9</td>
<td>1.3</td>
</tr>
<tr>
<td>Groundnuts</td>
<td>0.7</td>
<td>1.4</td>
</tr>
</tbody>
</table>
Fungicide Impact on Crop Yields

- Average yield increase in 50 crops from 16% to 100% in U.S. (Gianessi and Reigner 2006)
- Effective fungicides increased farm income in the U.S. by $13 billion per year
- Asian soybean rust reduced in Brazil by 59%, with yield increase of 44%
- Prevention of mycotoxin contamination of wheat
- Prevent rice blast epidemics in South Korea
- Scab in European apples reduced by 80%
Fungicide Contributions to Yield Increases in U.S.

<table>
<thead>
<tr>
<th>% Treated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carrots</td>
</tr>
<tr>
<td>Lettuce</td>
</tr>
<tr>
<td>Onions</td>
</tr>
<tr>
<td>Peaches</td>
</tr>
<tr>
<td>Peanuts</td>
</tr>
<tr>
<td>Potatoes</td>
</tr>
<tr>
<td>Tomatoes</td>
</tr>
<tr>
<td>Watermelons</td>
</tr>
</tbody>
</table>
Without Fungicides, U.S. Crop Production Is Lower

<table>
<thead>
<tr>
<th>Crop</th>
<th>% Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carrots</td>
<td>26</td>
</tr>
<tr>
<td>Lettuce</td>
<td>47</td>
</tr>
<tr>
<td>Onions</td>
<td>24</td>
</tr>
<tr>
<td>Peaches</td>
<td>54</td>
</tr>
<tr>
<td>Peanuts</td>
<td>66</td>
</tr>
<tr>
<td>Potatoes</td>
<td>43</td>
</tr>
<tr>
<td>Tomatoes</td>
<td>19</td>
</tr>
<tr>
<td>Watermelons</td>
<td>61</td>
</tr>
</tbody>
</table>
Fungicide Spraying to Control Wheat Rust

- Unsprayed Field: 80% incidence of wheat rust
- Sprayed Field: 2% incidence of wheat rust
Hops

- Hop cones infected with powdery mildew unsuitable for brewing
- First appeared in northwest U.S. in 1997
- 100% of U.S. hops fungicide treated
Maize: Africa, Fungicides

Fungicides increase maize yields 27 to 54%

Verma 2001
Insecticides

Most U.S. crops are attacked by 1-2 major insect species for which chemical insecticides provide the most cost-effective solution to prevent large crop losses.
30-100% of U.S. Agriculture Acres Treated with Insecticides Annually

Alfalfa
Artichokes
Asparagus
Avocados
Blueberries
Cranberries
Eggplant

Grapes
Green Peas
Hazelnuts
Hops
Nectarines
Peanuts
Pecans

Pistachios
Raspberries
Rice
Spinach
Strawberries
Sugarcane
Sunflowers
Sweet Corn
Insect Control Effectiveness

- Insecticide use on 50 U.S. crops was quantified, as were the impacts of this usage (Gianessi 2009).
- In 42 of the 50 crops, more than 50% of the acreage was annually treated with insecticides.
- Insecticides prevent crop loss from insects.
- If no treatment, 38 of the 50 surveyed crops suffer yield losses > 40-70%.
- Insecticides helped U.S. farmers produce an additional 144 billion lbs. of food and earn $23 billion.
- Every dollar spent on insecticides results in $19 of production value.
- U.S. agricultural producers use insecticides to protect their investments.
- Use is a response to pest populations and the risk of crop loss.
California Nectarine Production

(million pounds)

- DDT Introduced
- Insecticides Used

Herbicides

• Herbicide benefits are best understood by comparing their practicality, cost, effectiveness, and reliability to hand weeding.

• Experiments show if enough hand weeding or cultivation is done at the right time, crop yields can be equivalent to using herbicides.

• Shortage of workers for farm work makes hand weeding impractical.

• Reliability of cultivation can be compromised by weather and weeds continue to grow, causing yield loss.

• Herbicides offer a reliable and consistent option when available and affordable.
Is Hand Weeding the Solution?

There is a perfect nonchemical alternative to herbicides........
but it is totally impractical on a large scale.

In the U.S., 70 million workers would be required for weeding
to prevent yield losses without herbicides.
Herbicides

- Data from the 1960s indicate an increase in yields in major acreage of U.S. crops is due to herbicide use.
- Similar results have been obtained in the UK for cereals, in Australian grains, and in Canadian wheat.
- Improved weed control has resulted in less weed competition and fewer cultivations.
- The primary cause of expanded production and economic viability of soybean and maize production in Argentina was the adoption of herbicides for weed control.
<table>
<thead>
<tr>
<th>% Acres</th>
<th>Treated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asparagus</td>
<td>91</td>
</tr>
<tr>
<td>Carrots</td>
<td>98</td>
</tr>
<tr>
<td>Citrus</td>
<td>95</td>
</tr>
<tr>
<td>Corn</td>
<td>98</td>
</tr>
<tr>
<td>Cotton</td>
<td>95</td>
</tr>
<tr>
<td>Cranberries</td>
<td>95</td>
</tr>
<tr>
<td>Green Beans</td>
<td>96</td>
</tr>
<tr>
<td>Peanuts</td>
<td>97</td>
</tr>
<tr>
<td>Potatoes</td>
<td>93</td>
</tr>
<tr>
<td>Rice</td>
<td>98</td>
</tr>
<tr>
<td>Soybeans</td>
<td>96</td>
</tr>
<tr>
<td>Tomatoes</td>
<td>96</td>
</tr>
</tbody>
</table>
U.S. Crop Production without Herbicides

Less Production
Higher Food Prices
More Hand Weeding
Increased Cultivation
Fewer Farm Exports
More Food Imports
U.S. Corn Grain Yield

- Hybrids Introduced
- Fertilizers Introduced
- 2,4-D Introduced
- Alachlor/Metolachlor Introduced
- Atrazine Introduced
- Post-Emergence Grass Herbicides Introduced
- Roundup Ready Varieties Introduced

BU/Acre

Hand Weeding is the Predominant Weed Control Practice in Sub-Saharan Africa

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

Chikoye et al. 2007
Hours of Hand Weeding Required for Optimal Yields in Africa

<table>
<thead>
<tr>
<th>Crop</th>
<th>Hours/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groundnuts</td>
<td>378</td>
</tr>
<tr>
<td>Cassava</td>
<td>270</td>
</tr>
<tr>
<td>Maize</td>
<td>276</td>
</tr>
<tr>
<td>Sorghum</td>
<td>150</td>
</tr>
</tbody>
</table>

Akobundu 1987
Sorghum Weed Control Experiment: Nigeria

Yield (kg/ha)

- Weedy Check
- Hoe-Weeded Three Times
- Preemergence Herbicides

Ishaya et al. 2007
Just more than 3% of African smallholder farmers are using herbicides in their maize fields.

Overfield et al. 2001
Developing World

Farmers in Africa will not obtain the optimum from their crops, land, and other investments in crop production if there is no improvement in their traditional methods of weed control.

Akobundu 1991
Conclusions

- Pesticides are effective tools for managing pests.
- Yields are increased where pesticides are used.
- There are many examples to support pesticide use for effectively and economically managing pests.
- Achieving yields of crops necessary to meet the population and food requirements in 2050 will be best achieved using comprehensive integrated approaches that incorporate all tools available to sustainably meet the needs for food production to feed the 9 billion humans on the earth in 2050.
- Pesticides will play a major role in achieving this goal.
Conclusions

• Develop and label only safe pesticides that are as risk free as possible.

• Minimize undo exposure and decrease negative effects.

• Pesticide evaluation is based on benefits of use that far outweigh any risk.

• Emphasize pest management solutions with multiple tools in integrated approaches and don’t rely solely on pesticide use.

• Employ practices to avoid resistance development and reliance on one tool and offer a toolbox of management approaches.

• *Science Magazine*, 2013, discussed issues on “Smarter Pest Control” and impacts and techniques for discovery of new chemistries to ensure safer pesticides in the future.
Questions/Discussion

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