Risky Energy:
Biofuels and Invasive Species

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Policy Initiatives Related to Bioenergy

- **Federal:**
  - “20 in 10”
    - Reduce gasoline usage by 20% in 10 years
    - 35 billion gallons renewable/alternative fuels in 2017
  - “30 by ‘30” = “Billion Ton Report”
    - Replace 30% of petroleum with biofuels by 2030

- **California:**
  - AB 32 “Global Warming Solutions Act”
    - Reduce GHG emissions to 1990 levels by 2020
  - Executive Order S-06-06
    - 20% of electricity be biomass-derived by 2020
    - In-state biofuel production: 20% - 2010, 40% - 2020, 75% - 2050
  - Executive Order S-01-07
    - Low Carbon Fuel Standard - transportation fuels
    - “2020 Target” - reduce carbon intensity by 10%
*Miscanthus giganteus*

*Panicum virgatum*

*Arundo donax*
Crops grown for energy:

• **Life history**
  – Perennial
  – High aboveground biomass production
  – Flowers late / little allocation to seed production

• **Physiology**
  – Tolerates
    • Drought
    • Low fertility
    • Saline soils
  – $C_4$ photosynthetic pathway
  – High water/nutrient use efficiency

• **Other**
  – Few resident pests
  – Allelopathic
  – Re-allocates nutrients to roots in fall
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<table>
<thead>
<tr>
<th>Feature</th>
<th>Agronomic crops</th>
<th>Potential biofuel feedstocks</th>
<th>Invasive species with agronomic origin</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Corn</td>
<td>Soybean</td>
<td>Switchgrass</td>
</tr>
<tr>
<td>Perennial</td>
<td>-</td>
<td>-</td>
<td>X</td>
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<tr>
<td>C₄ photosynthesis</td>
<td>X</td>
<td>-</td>
<td>X</td>
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<tr>
<td>Rapid establishment rate</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Long canopy duration</td>
<td>X</td>
<td>-</td>
<td>X</td>
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<tr>
<td>Grows at high densities</td>
<td>-</td>
<td>-</td>
<td>X</td>
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<tr>
<td>Tolerates water stress</td>
<td>-</td>
<td>-</td>
<td>X</td>
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<tr>
<td>Tolerates low fertility soils</td>
<td>-</td>
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<td>X</td>
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<tr>
<td>Tolerates saline soils</td>
<td>-</td>
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<td>*</td>
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<tr>
<td>Re-allocates nutrients to perennating structures in fall</td>
<td>-</td>
<td>-</td>
<td>X</td>
</tr>
<tr>
<td>No major pests/diseases</td>
<td>-</td>
<td>-</td>
<td>X</td>
</tr>
</tbody>
</table>
How Will Genetic Modification Affect Potential Invasiveness?

- Yield Improvement
- Crop adaptation to marginal lands
- Increase amenability to bioprocessing
- Multi-product development

- Drought tolerance
- Salt tolerance
- Herbicide resistance
- Increased cellulose content
- Increased yield
- Water-use-efficiency
- Nutrient-use-efficiency

Drought tolerance
Minimizing risk: sterilization
Weed Risk Assessment

from Daehler et al. 2000
Policy Implications

- No restrictions unless state/federal noxious weed
- **Senate Bill 1242** - Jon Tester [D-MT]
  - Amend Federal Crop Insurance Act & Farm Security and Rural Investment Act of 2002
  - Crop insurance and loans
  - “*information [exists] to demonstrate that there are sufficient safeguards to prevent the spread of the crop as a noxious weed*”
Policy Implications

Horticulture - St. Louis Declaration 2001

1. Findings and Principles
2. Voluntary Codes of Conduct
   – Government
   – Nursery Professionals
   – The Gardening Public
   – Landscape Architects
   – Botanic Garden and Arboreta

“self-governance, self-regulation”

Meeting of researchers, nursery professionals, landscape architects, government officials, garden writers
How do we prevent cultivating the next invader?

1. Risk assessment
2. Climate-matching analysis
3. Cross-hybridization potential
4. Escape potential
   • Seed / rhizome
5. Ecological analyses
   • Disturbance tolerance
   • Community invasibility
6. Create eradication plan
Biofuel Feedstocks: The Risk of Future Invasions

In an effort to decrease greenhouse gas emissions, expand domestic energy production, and maintain economic growth, public and private investments are being used to pursue dedicated feedstock crops for biofuel production. Unlike food crops grown for grain-based ethanol (e.g., corn), which require high inputs of fertilizers and pesticides and typically are grown on prime agricultural land, proposed lignocellulose-based energy crops (e.g., switchgrass) typically have a neutral or negative carbon budget, require relatively few economic or environmental inputs, and can be cultivated on marginal, lower-productivity land. Thus, a rapidly growing industry related to crop selection, cultivar improvement, and conversion technologies is emerging.

A variety of plant species, including grasses, herbs, and trees, are being considered for use as dedicated biofuel crops across much of the United States (Figure 1). The leading candidates for lignocellulose-based energy, however, are primarily rhizomatous (i.e., having belowground vegetative reproductive structures) perennial grasses. Most of these grasses are not native to much of the region where production is proposed (Lewandowski et al. 2003). From an agronomic perspective, their life history characteristics, rapid growth rates, and tonnage of biomass produced by these nonnative grasses make them ideal feedstock crops.

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