

# Biofuel Feedstocks: The Risk of Future Invasions

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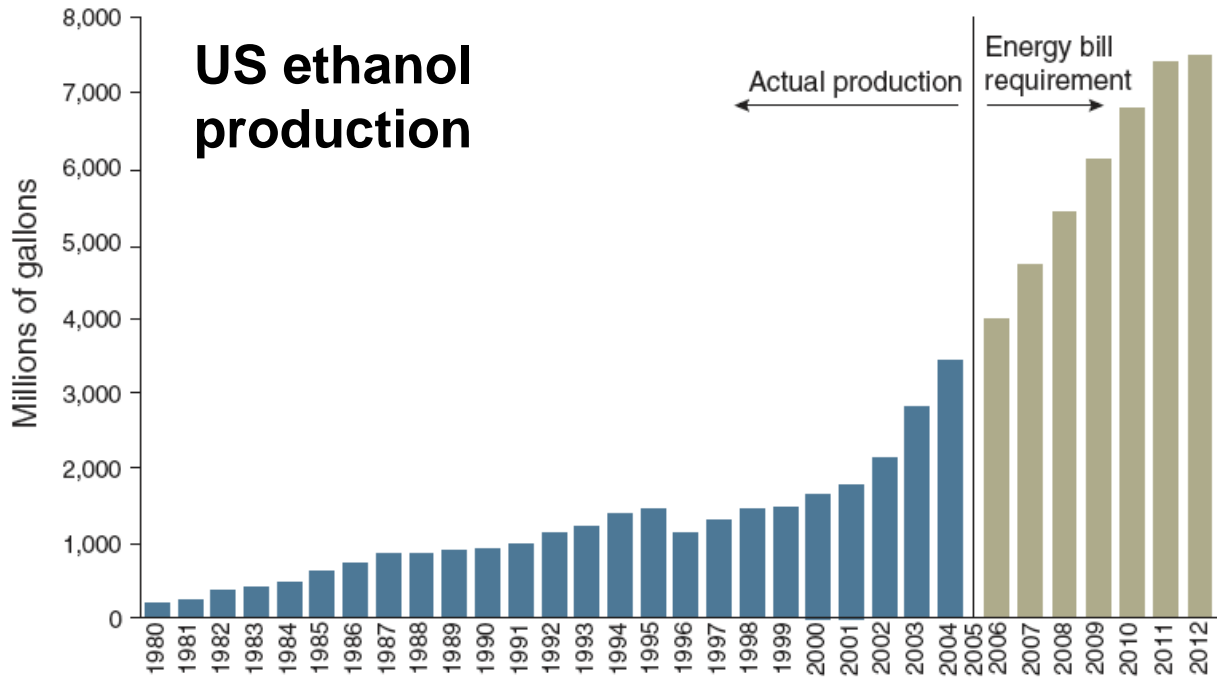
**University of Florida**



# 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%

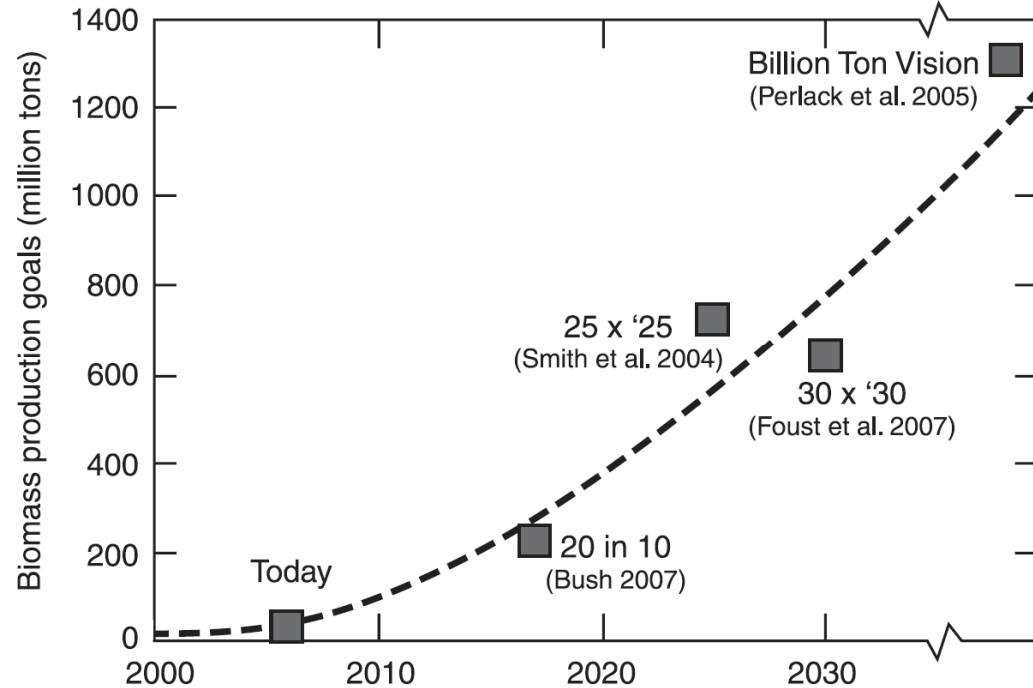


Increased to 35 billion gallons under “20 in 10”

Herrera 2006 Nature



Fales et al. 2007 CAST



Hybrid Poplars  
Switchgrass

Miscanthus  
Reed Canarygrass  
Switchgrass

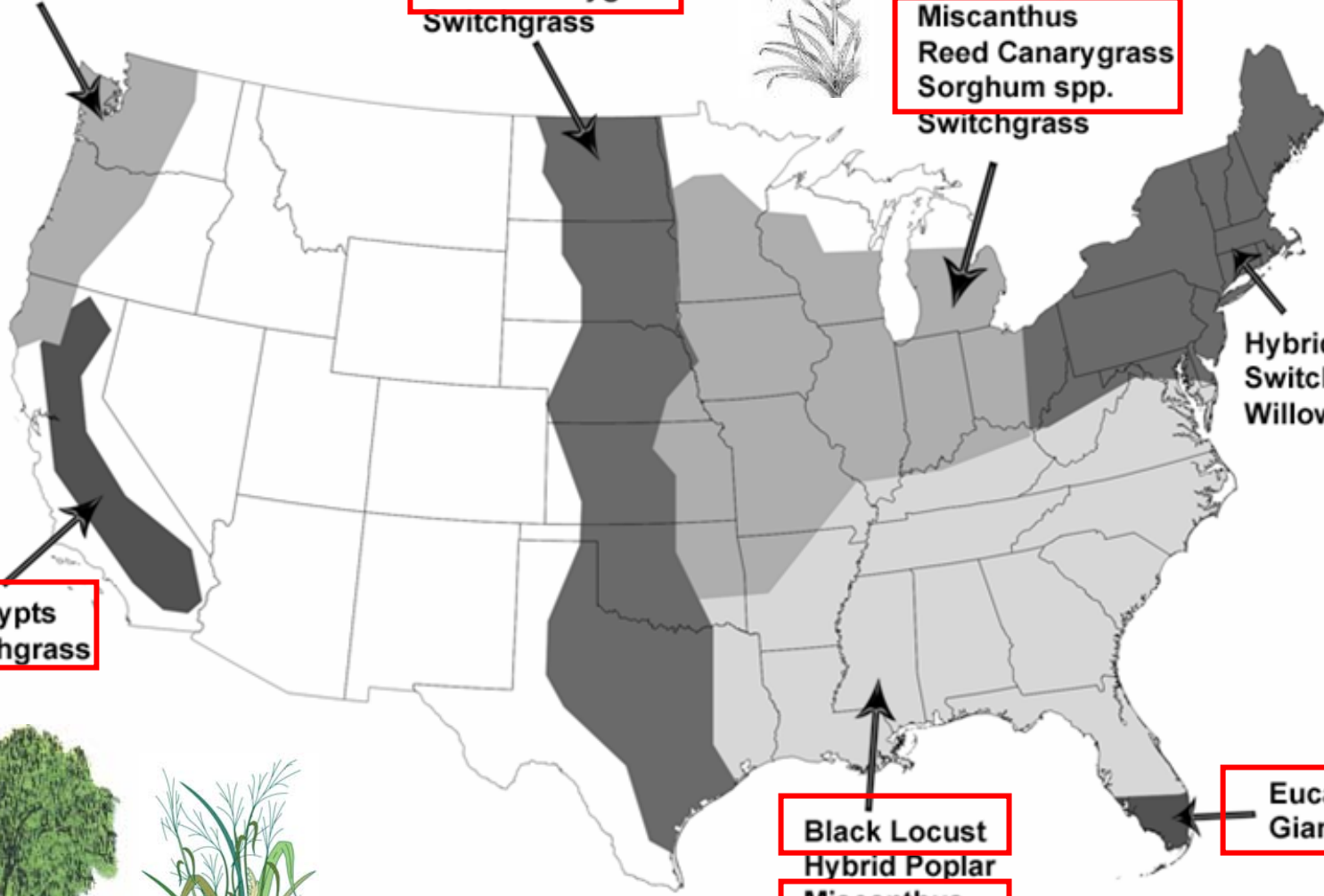
Hybrid Poplar  
Miscanthus  
Reed Canarygrass  
Sorghum spp.  
Switchgrass

Hybrid Poplars  
Switchgrass  
Willows

Eucalypts  
Switchgrass

Black Locust  
Hybrid Poplar  
Miscanthus  
Sorghum spp.  
Switchgrass

Eucalypts  
Giant Reed



# What is an invasive species?

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- Executive Order 13112 (1999)
  - Defined as a species that is
    1. Non-native (or alien) to the ecosystem under consideration **AND**
    2. Whose introduction causes or is likely to cause economic or environmental harm or harm to human health **AND**
    3. Introduced accidentally or intentionally by human agency
  - Invasive species can be plants, animals, & other organisms (eg. microbes)



# Impacts of invasive plants

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- 2<sup>nd</sup> contributing threat to animal and plant diversity
  - 42% of Threatened & Endangered species at risk from invaders
- Increased fire threat (number & intensity)
- Impacts human, livestock, and wildlife health
- Exacerbates erosion and drought
- Alterations in water flows and availability
- Reduced access/utilization to recreation
- Reduces property value

**\$34.7 billion in costs/losses/damages from plants**



# Origin of invasive plants

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- 85% of invasive woody species from landscaping
- 63% of Cal-IPC's most invasive species have horticultural origin
- 69% of FL-EPPC's list have horticultural origin
- Invasive species with agronomic/soil stabilization origin:
  - Johnsongrass (*Sorghum halepense*)
  - Kudzu (*Pueraria montana* var. *lobata*)



**switchgrass**  
*Panicum virgatum*



***Miscanthus* × *giganteus***

**Giant reed**  
*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<sub>4</sub> photosynthetic pathway
- High water/nutrient use efficiency

- **Other**

- Highly competitive (reduces herbicide use)
- Few residents pests (reduces pesticide use)
- Allelopathic
- Re-allocates nutrients to roots in fall



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	Agronomic crops		Potential biofuel feedstocks		Invasive species with agronomic origin
	Corn	Soybean	Switchgrass	Giant Reed	Johnsongrass
<b>Perennial</b>	-	-	X	X	X
<b>C<sub>4</sub> photosynthesis</b>	X	-	X	-	X
<b>Rapid establishment rate</b>	X	X	X	X	X
<b>Long canopy duration</b>	X	-	X	X	X
<b>Grows at high densities</b>	-	-	X	X	X
<b>Tolerates water stress</b>	-	-	X	-	-
<b>Tolerates low fertility soils</b>	-	-	X	X	X
<b>Tolerates saline soils</b>	-	-	*	*	-
<b>Re-allocates nutrients to perennating structures in fall</b>	-	-	X	X	X
<b>No major pests/diseases</b>	-	-	X	X	X

# How Will Genetic Modification Affect Potential Invasiveness?

- **Yield Improvement**
- **Crop adaptation to marginal lands**
- **Increase amenability to bio-processing**
- **Multi-product development**

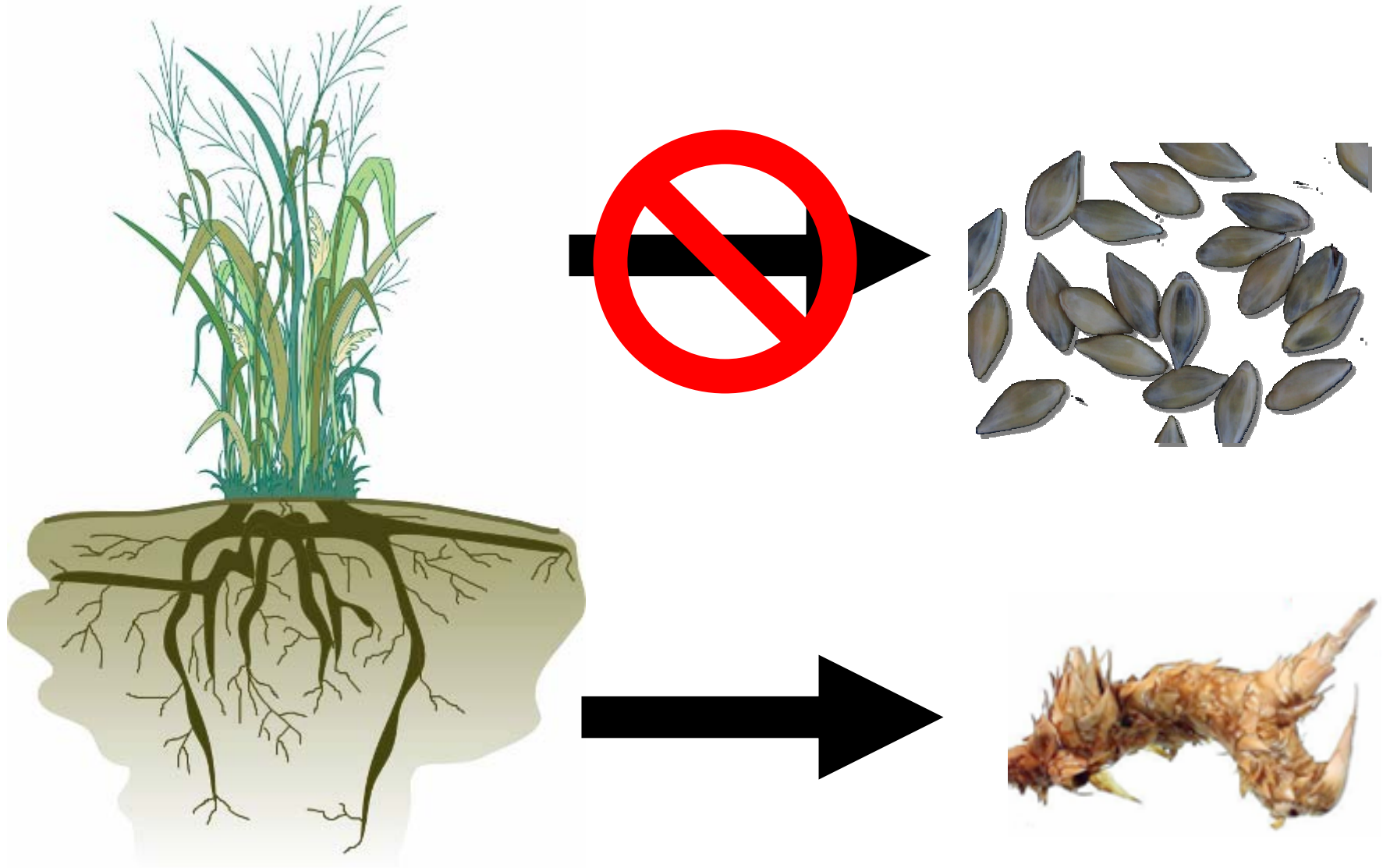
- **Drought tolerance**
- **Salt tolerance**
- **Herbicide resistance**
- **Increased cellulose content**
- **Increased yield**
- **Water-use-efficiency**
- **Nutrient-use-efficiency**



Drought tolerance

# Minimizing risk: sterilization

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# Policy Implications

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- 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

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## 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?

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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



CAST Commentary  
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## Biofuel Feedstocks: The Risk of Future Invasions

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### Introduction

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.

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.

From an agronomic perspective, certain native grasses are ideal for use as feedstock crops.

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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