The Good (Jojoba), The Bad (Jatropha) And The Ugly (Chinese Tallow)

Using Weed Risk Assessment To Select Non-Invasive Biofuel Crops in the Hawaiian Islands.

Chuck Chimera & Chris Buddenhagen
What are biofuels

- Plant-derived substitutes for petroleum
- Two categories of liquid biofuels
  - First generation
    - Ethanol (from plant starch, sugar)
    - Biodiesel (from plant & animal oils)
  - Second generation
    - Cellulose (Schubert 2006)
Hawaii’s Biofuel Goals

• 1994: Act 199
  – 10% ethanol content required in gasoline
• 2004: Act 95, Renewable Portfolio Standard
  – 20% net electric sales from renewable energy by 2020
• 2006: Act 240, Alternate Fuel Standard goals
  – 20% highway fuels from alternate fuels by 2020
Purported Benefits of Biofuels

• Renewable
• Reduced greenhouse gas emissions
• Energy security & independence
• Support of agricultural industries
• Diversified economy

www.bendbiofuels.com/
Problems With Biofuels

- Technology & Markets
- Land & water use
- Soil depletion
- Chemical use
- Food vs energy
- Limited greenhouse benefits
- Biodiversity impacts
- Weed risks

Top Image: http://www.greenpeace.org.uk
Bottom Image: www.mygreenelement.com
• “traits deemed ideal in a bioenergy crop are also commonly found among invasive species”
  – Hardiness, water thrift, pest/disease resistance, ability to outcompete other plants

Invasive plants in natural areas

Purposeful introductions 91%

Crop/other use 56 52%
Ornamental 41 39%

Accidental Introductions 10 9%

Smith, C. W. 1985

• The plants that pose the greatest threats are ones that we brought in on purpose.

Photo by Forest & Kim Starr
Methods: Species Evaluation

BIODIESEL

Biodiesel Crop Implementation in Hawaii

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BIOMASS

Physicochemical Analysis of Selected Biomass Materials in Hawaii

Prepared for:
State of Hawaii
Department of Business, Economic Development and Tourism

by
University of Hawaii
Hawaii Natural Energy Institute
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Methods: Invasion Process

- transport from abroad
- release
- establishment
- spread
- "tens rule"
- pest / impacts
  - ecological
  - economic
  - human health

Williamson and Fitter 1996
Hawaii Weed Risk Assessment System

49 questions
- climate/distribution
- domestication
- weed elsewhere
- undesirable traits
- plant type
- reproduction
- dispersal
- persistence attributes

Prediction
- Score 1-6
  - < 1: Low Risk
  - 1-6: Evaluate
  - > 6: High Risk

second screening

High Risk
Low Risk
Results

• 32 Species Evaluated

• 21 High Risk
  – 66%

• 3 Evaluate
  – 9%

• 8 Low Risk
  – 25%
Results

• 30 of 32 Introduced

• 18 Naturalized
  – 60% (e.g. Avocado)
  – 10% = ca. 3 spp.

• 12 Invasive
  – 40% (Strawberry Guava)
  – 10% = <1

Photos by Forest & Kim Starr
Results

• WRA Analysis (n=32)

• 27 Naturalized Somewhere (84%)

• 20 Weeds (66%)
  – Disturbance, Agriculture, Environmental

Photo by Forest & Kim Starr
Results

- **“Weedy” Attributes**
  - Viable Seed Production (100%)
  - Broad climate suitability (81%)
  - Tolerates mutilation, cultivation, fire (75%)
  - Reproductive ≤ 3 Years (69%)
  - Tolerates wide range of soils (69%)
  - Self-compatible (56%)
  - Form dense thickets (53%)
The Good

• 8 Species
  – Low Risk (WRA)

• *Simmondsia chinensis*
  – Not naturalized or weedy anywhere
  – Slow to reproductive maturity
  – Seeds not easily dispersed
The Bad

• 15 Species
  – High Risk (WRA)
  – Already naturalized

• *Jatropha curcas*
  – “Weedy” elsewhere
  – Toxicity
  – Forms dense stands
  – Reproduces quickly
  – Seeds water-dispersed
  – Non-weedy traits
    • Large seeds
The Ugly

- 5 species
  - High Risk
  - Weeds Elsewhere
  - Not Naturalized in Hawaii

- **Triadica sebifera**
  - Environmental weed
  - Toxic
  - Shade tolerant
  - Forms dense stands
  - Prolific seed production
  - Bird-dispersed
  - Resprouts after cutting
“Each tree produces up to 100,000 seeds a year, which are dispersed by birds and water and can remain viable for decades.” (Low and Booth 2007)
The ???

• 4 Species
  – Not weedy elsewhere
  – Not naturalized in HI

• 3 of 4 Species
  – Evaluate (WRA)
  – Little information

• 1 of 4 Species
  – High Risk (WRA)

Photos by Forest & Kim Starr
Algae as Biofuel

• Higher energy yield
• Smaller ecological footprint
• Currently more expensive
• Non-native algae can become invasive\(^1\)

\(^1\)Smith et al. 2002

Photo: Reuters – Cindy Fernandez
Discussion

• Biofuels are high risk species

• Exceptions to “Tens Rule”
  – 21 of 32 High Risk (WRA)
  – 12 of 32 invasive in Hawaii
  – 21 of 32 weeds elsewhere

• Crop plants
  – “strongly selected to grow where they are cultivated”¹

¹Williamson and Fitter 1996
Discussion

• Propagule Pressure
  - “A single consistent correlate of establishment success”¹

• Lag Time
  - “long periods of seemingly consistent behavior can be poor predictors of what invaders will do in the future”²

Conclusions

• Don’t assume biofuel production is benign.
• Use low-risk species
• Proven technology prior to planting
• Employ “polluter pays” policy
• No planting near or conversion of important biological areas
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