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Biofuels: Cultivating Energy, not Invasive Species

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ISSUE

To provide alternatives to petroleum-based energy, the United States (U.S.) government has mandated a greater proportion of plant-based biofuels be integrated into its energy portfolio. However, **certain plant species being proposed for biofuel production in the U.S. are invasive species or are likely to escape cultivation and become invasive**.

U.S. Executive Order (E.O.) 13112[1] defines invasive species as "alien [non-native] species whose introduction does or is likely to cause economic or environmental harm or harm to human health" and states:

> "Each Federal agency whose actions may affect the status of invasive species shall, to the extent practicable and permitted by law" "not authorize, fund, or carry out actions that it believes are likely to cause or promote the introduction or spread of invasive species in the United States or elsewhere unless, pursuant to guidelines that it has prescribed, the agency has determined and made public its determination that the benefits of such actions clearly outweigh the potential harm caused by invasive species; and that all feasible and prudent measures to minimize risk of harm will be taken in conjunction with the actions."

The socio-economic and ecological costs of certain biofuel crops could greatly exceed their benefits. Thus, the Federal government needs to take strategic action to avoid inadvertently facilitating the introduction and spread of invasive species through its development, encouragement, funding, or other support of biofuels programs.

ACTION

This briefing paper, adopted by the U.S. Invasive Species Advisory Committee (ISAC) on August 11, 2009, provides:

a) background information on the potential linkages between biofuels and invasive species and;

b) recommendations for Federal action to reduce the risk of invasive species introduction and spread through its biofuels programs. Implementation of these recommendations will help to ensure that the U.S. maximizes the benefits of its biofuel initiatives while preventing the spread of invasive species.

[1] www.invasivespecies.gov (see E.O. 13112 and the ISAC Definitions White Paper)

BACKGROUND

Agency Roles and Responsibilities

Depending on their mission, Federal agencies might engage in biofuel programs by:

- conducting biofuel research and development;
- introducing and producing biofuel crops for experimentation and/or use;
- subsidizing biofuel research, development, production, and marketing;
- purchasing biofuels to supplement their energy demands;
- establishing early detection and rapid response programs for escaped biofuel plants;
- implementing long-term management of biofuel crops that become invasive; and/or regulating various aspects of the biofuels pathway, when necessary.

Policy and Legal Responsibilities

Specific agency directives for biofuel programs are emerging in Federal legislation. For example, the 2007 Energy Independence and Security Act (EISA) mandates the production of 61 billion liters of plant cellulosic-based fuels. This cannot be met with current agricultural, forestry, and municipal residues alone. It necessitates large-scale planting of dedicated energy crops that do not compete with food or feed. This will require producing and promoting biofuel crops for experimentation and demonstration. The U.S. Department of Agriculture's (USDA) research effort is therefore focused on identifying crops that will maximize yield while allowing cultivation on less productive, marginal lands with minimal agricultural inputs. The Food, Conservation, and Energy Act of 2008 (i.e., 2008 US Farm Bill P.L. 110-234) also directs USDA to provide subsidies for growers to encourage adoption of dedicated energy crops which currently do not have a market. The 2008 Energy Act directs the U.S. Environmental Protection Agency (EPA), in consultation with USDA and the Department of Energy (DOE), to report to Congress on the environmental and resource conservation impacts of biofuels

Invasive Species Risk

This paper focuses on one potential negative impact of biofuels, namely the risk that they will escape cultivation and become invasive species. Although most of our food, fiber, and landscape plants are non-native species and relatively few have proven invasive, those that are harmful have caused substantial socio-economic and environmental impacts (e.g., johnsongrass [*Sorghum halepense*] and kudzu [*Pueraria montana*])(Box 1). A number of potentially harmful non-native algal species are being considered for use in the production of biodiesel, renewable biodiesel, and jet fuel (e.g., the toxic freshwater cyanobacteria, *Anabaena circinalis*). (first report due Dec.2010).

Box 1. Economic Impact of Invasive Plants in the U.S.[2]

Estimated losses and the cost of control is $34 billion annually.

- $26.4 billion on agricultural invasives
- $6 billion on pasture invasives
- $1.5 billion on turf and garden invasives
- $0.1 billion on aquatic invasives

[2] Pimentel et al. 2000. *BioScience* 50:53-65. Note: Paper largely addressed managed systems. Additional research is needed for natural areas.

Indications that some biofuel crops pose a particular risk of becoming invasive include:

Certain plant species proposed for biofuel production (e.g., reed canarygrass [*Phalaris arundinacea*], giant reed [*Arundo donax*], and miscanthus [*Miscanthus sinensis*]) are already invasive in regions of the U.S. and/or elsewhere in the world.

Several of the traits that could maximize biofuel crop yield and foster the ability for biofuels to be cultivated in marginal environments can also increase risk of invasiveness. Invasive plants share many of the traits desired in biofuel crops and these traits may allow them to grow on marginal lands (Box 2).

Box 2. Traits that maximize crop yield and increase risk of invasiveness

- Perennial growth form
- Rapid and high aboveground biomass production
- Tolerance of drought, low fertility, or saline soils
- Highly competitive with other vegetation
- Few resident pathogen or insect

The potential scale of biofuel cultivation (>61 million ha) suggests ample opportunity for biofuel crops to be introduced into environments in which they could thrive and interact with ecosystems.

Absent strategic mitigation efforts, there is substantial risk that some biofuel crops will escape cultivation and cause socio-economic and/or ecological harm. If invasion occurs, the costs associated with the damage may negate the economic benefits conveyed by cultivation of the particular species. The risks are particularly significant where biofuel crops are cultivated within ecosystems that include forest, prairie, desert, and wetland areas, as well as rangelands and other agricultural croplands.

RISK MITIGATION AND RECOMMENDATIONS

To minimize the risk of biofuel crop escape into the surrounding environment, the U.S. government needs to employ and promote ecological studies and scientific models that characterize the invasion risk of each biofuel species or cultivar (as appropriate) within a target region and identify ecosystems most susceptible to invasion. Information generated from biofuel crop ecological studies, risk analyses, bioeconomic and climate match modeling, and other methods can guide the government's risk mitigation plans. Depending on their authorities, Federal agencies can take strategic steps at appropriate points within research and development, crop production, harvest and transportation, conversion/refinery practices, and/or regulatory action to minimize the risk of biofuel crops becoming invasive. ISAC recommends that the Federal government apply the following recommendations to its own biofuels programs, as well as use them as a basis for standards of operation when engaging with the private sector and other partners.

Recommendation #1. Review/Strengthen Existing Authorities.

Identify Federal authorities relevant to biofuels. Determine their likely influence on biofuel invasiveness (i.e., prevention or facilitation). Identify gaps and inconsistencies in authorities within and among Federal Departments or Agencies. As appropriate, develop policies and programs to minimize invasion risk.

Recommendation #2. Reduce Escape Risks.

In order to determine potential biofuel benefits and risks, the invasive potential of each candidate biofuel crop needs to be evaluated in the context of each region proposed for its production. Use/promote species (including unique genotypes) that are not currently invasive and are unlikely to become invasive in the target region. Choose species or cultivars with a low potential for escape, establishment and negative impact. Where appropriate, implement mitigation strategies and plans to minimize escape and other risks.

Recommendation #3. Determine the Most Appropriate Areas for Cultivation.

Ideally, biofuel crops should be propagated in containable systems (e.g., terrestrial or aquatic sites constructed specifically to cultivate biofuel crops) and be unable to survive outside of cultivation. Use research findings to identify the most appropriate sites (e.g., unlikely to impact sensitive habitat or create disturbances that will foster invasion) for cultivation of biofuel crops within landscapes. Support for biofuel research and demonstration projects will require site selection that minimizes the potential escape of plant species or cultivars to sensitive areas and the loss of wildlife habitat.

Recommendation #4. Identify Plant Traits that Contribute to or Avoid Invasiveness.

Incorporate desirable traits (e.g., sterility or reduced seed production, inability to regenerate by stem fragments) into biofuel varieties to minimize their potential for invasiveness. Use information from plant research, agronomic models, and risk analyses to guide breeding, genetic engineering, and variety selection programs.

Recommendation #5. Prevent Dispersal.

Develop and coordinate dispersal mitigation protocols prior to cultivation of biofuel plants in each region or ecosystem of consideration. Implement a comprehensive plan, appropriate to the specific crop, throughout the cultivation period. Examples of dispersal mitigation measures include the use of sterile cultivars, species not likely to genetically mix with other plants (different species or cultivars), harvesting prior to seed maturity, cleaning equipment, and minimizing propagule dispersal throughout the biofuel production cycle.

Recommendation #6. Establish Eradication Protocols for Rotational Systems or Abandoned Populations.

Proactively develop multiple year eradication protocols to plan for the rapid removal of biofuel crops if they disperse into surrounding areas or become abandoned or unwanted populations (e.g., those which persist beyond desired crop rotation period).

Recommendation #7. Develop and Implement Early Detection and Rapid Response (EDRR) Plans and Rapid Response Funding.

Develop EDRR plans that cover multiple years to eliminate or prevent establishment and spread of escaped invasive populations. A flexible funding source needs to be in place to support EDRR efforts.

Recommendation #8. Minimize Harvest Disturbance.

Disturbed environments are especially prone to plant invasion. Minimize the soil disturbance resulting from biofuel harvest by rapidly replanting, using cover crops, or employing other methods that will prevent the potential for future invasion of non-native plants from the surrounding area into the harvested site.

Recommendation #9. Engage Stakeholders.

Identify and employ cooperative networks (e.g., working groups and councils), communication forums, and consultation processes through which the Federal agencies can work with state agencies, tribes, the private sector, and other stakeholders to reduce the risk of biological invasion via the biofuels pathway.