Biofuel Crops: Invasive Weed Issues and Challenges for the U.S.

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To provide alternatives to petroleum-based energy, the United States (US) government has mandated a greater proportion of plant-based biofuels be integrated into its energy portfolio (e.g., 2007 Energy Independence and Security Act; EISA). However, many of these species that are either proposed or under consideration are invasive or have a high likelihood of becoming invasive.

Economic losses from invasive plants and the cost of control in the US are estimated to be $34 billion annually, and this number primarily considers managed row crop agricultural systems (Pimentel et al. 2005). The environmental and economic costs of invasive plants to natural areas are also extensive, though less well defined. Although the benefits of biofuel production may be great, the socio-economic and ecological costs of certain biofuel crops could ultimately exceed their benefits. Federal agencies must take coordinated action to avoid inadvertently facilitating the introduction (including cultivation escape) and spread of invasive species through its development, subsidization, funding for research, or other support of biofuels programs.

Although most of our food, fiber, and landscape plants are non-native species, relatively few have proven invasive. However, those that are harmful have caused substantial socio-economic and environmental impacts. Among the most well known of these are johnsongrass (*Sorghum halepense*) and kudzu (*Pueraria montana*). Kudzu is one of the species being considered for biofuel production, and there are other proposed energy crops, including reed canarygrass (*Phalaris arundinacea*), giant reed (*Arundo donax*), and miscanthus (*Miscanthus sinensis*), that are currently invasive in regions of the US or elsewhere in the world. In addition, a number of potentially harmful non-native algal species have been suggested for use in the production of biodiesel and jet fuel, which present an unknown risk to freshwater ecosystems.

In the absence of a strategic effort to develop mitigation procedures and policies, the risk of some biofuel crops escaping cultivation and causing substantial harm is greatly increased. The risks are particularly significant where biofuel crops are cultivated or transported among sensitive ecosystems that include forest, prairie, desert, and wetland areas, as well as rangelands and other agricultural croplands.

In response to this issue, the US Invasive Species Advisory Committee (ISAC) approved nine recommendations directed at the Federal government biofuel programs. The recommendation of the committee can be found at (http://www.invasivespecies.gov) and include the following.

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.

These recommendations require improved coordination and cooperation among agencies and scientists, research efforts to reduce the risk of invasion into natural environments or other cropping systems, and field-to-process facility mitigation protocols that minimize the potential for propagule escape. Although directed at the Federal government, many of the recommendations are also relevant to state agencies, tribes, scientific institutions, and the private sector. Implementation of the recommendations proposed by the US National Invasive Species Council will help to ensure that the US maximizes the benefits of its biofuel initiatives while minimizing the potential spread of invasive species.

Literature Cited

Pimentel, D., R. Zuniga, and D. Morrison. 2005. Update on the environmental and economic costs associated with alien-invasive species in the United States. Ecological Economics 52:273-288.