Regulation of Genetically Modified Trees

A Position of the Society of American Foresters

Originally adopted on December 1, 2007 and revised and renewed on May 2, 2020. This position statement will expire in 2025, unless, after subsequent review, it is further extended by the SAF Board of Directors.

Purpose

In support of a science-based, proactive and adaptive approach to genetic engineering regulation and certification and supporting research.

Scope

Use of genetic modification in forest management and energy crops.

Position

The Society of American Foresters (SAF) supports and encourages research and scientific advancements in forest tree biotechnology and its use to improve forest productivity, wood quality, and forest health, including the use of appropriately regulated Genetically Modified Organisms (GMOs), specifically genetic engineering (GE). SAF believes that well-studied applications of appropriate biotechnology methods for forest tree improvement have the potential to enhance the quality, productivity, and value of plantation forests managed for wood, pulp, and bioenergy; protect tree species from serious insect and disease problems; and provide other social, economic, and environmental benefits (e.g., restoration). SAF also supports research on genetic engineering with appropriate management of produced genetic material. Further, SAF supports science-informed government regulatory oversight of biotechnology applications, including GE and newer genome editing (e.g., Crispr-Cas9) approaches, and encourages consideration of both the benefits and risks of forest biotechnology applications. SAF supports science-based GE regulation based on potential inherent threats of the novel organism, focused on the products' safety and environmental impact.

SAF urges government regulators to consider the cost of inaction on GE technology to society (restoration and preservation goals, economic impacts for companies and public-sector researchers). The US should diminish regulations that make field tests excessively costly, burdensome, or that limit duration of these tests. These sorts of excessive regulations impede the ability to complete economically and ecologically significant research and, thus, impede timely understanding or realization of the benefits or costs to society of this new technology.

Issue

The rapidly developing field of biotechnology, in particular GE and the creation of GMOs, is a source of ecological, social, and legal controversy (Strauss et al. 2017). While the use of biotechnology for tree improvement can bring economic, social, and environmental benefits, there are concerns regarding the safety of introduced genes and clonal varieties, and their impacts on natural ecosystems. Due to compliance with GE field study regulations and proposed trade/marketplace barriers for many GE products and public sector research, there are rapidly growing costs and risks to development of new products.

Background

Humans have intentionally engineered their environment, and the organisms therein, for millennia. Some of these activities resulted in the domestication of animals and plants, and some directly or indirectly affected the genetic make-up of forest tree populations. Early tree domestication began more than 5,000 years ago by propagating individuals that produced higher yields of fruits, nuts, and/or oils. Forest tree domestication accelerated during the latter half of the 20th century with the idea that traditional breeding methods applied to forest tree populations would enhance timber production and other important economic traits and could provide reliable quantities of well-adapted seed for planting (Burdon and Libby 2006). [Note: tree improvement through traditional breeding practices is not GM or GE.]

Forest tree biotechnology (including GM and GE) encompasses structural and functional studies of genes and genomes (including development and application of genetic markers); various methods of vegetative reproduction such as micropropagation, tissue culture, and somatic embryogenesis; and GE, which is the physical manipulation and asexual insertion of genes into organisms (FAO 2004). Currently, the environmental introduction of GMO plants produced through GE, which is a process (method) of genetic manipulation that can use native or foreign genes, and can affect all types of traits, is regulated by the government. We note that USDA has ruled that some of the new genome editing technologies (i.e., Crispr- Cas9), which do not introduce "foreign" genes, are not subject to regulation. These unregulated alternatives support the need to develop straightforward science-based risk and benefit assessments.

Enhanced Production and Value

The United States has led production of GE crops, with 70 million hectares of GE crops in production in the United States out of the 179.7 million hectares of global GE cropland in 2015 (FAO 2015, NAS 2016). Production of forest-based GE crops includes a blight-resistant American chestnut (*Castanea dentata*), poplar (*Populus* spp.), eucalyptus (*Eucalyptus* spp.) (NAS 2016), pine (*Pinus* spp.), sweet gum (*Liquidambar styraciflua*), American elm (*Ulmus Americana* spp.), and the white spruce (*Picea glauca*) for commercialization and conservation purposes (Häggman et al. 2013). A single-gene approach to GE reportedly produced a 20% biomass yield increase for eucalyptus (FuturaGene 2015). Additional potential for GE focuses on production of traits beyond yield improvements, including enhanced naturally produced hydrocarbons (e.g., terpenes) in trees, such as pine and eucalyptus (NAS 2016, Davis et al. 2020), or even enhancing the growing range, such as establishing cold-hardy varieties of eucalyptus (Wear et al. 2015, USDA 2016).

GE potentially allows for greater originality than traditional breeding techniques. Rather than simply applying regulations to the type of biotechnology used to achieve the modification, the originality of the GMO and the potential inherent threats of that novel organism should drive regulation. This is consistent with the recent National Academy report of GMOs in agriculture crops (NAS 2016), which suggests regulation based on comparisons of the molecular profiles of new and counterpart (baseline) plants. Further, the report recommends that while decisions should be informed by accurate scientific information, there should be transparency in regulation with broad societal participation in the decision-making process (NAS 2016). SAF recognizes that discovery, development and understanding the impacts of appropriate GE technologies can be accomplished only through both laboratory and field testing.

Potential Risks of GMOs

Application of new technologies frequently leads to concerns sparked by their novelty and initial uncertainties. The most frequently cited concerns associated with GE trees include: unintended consequences of inserted genes on tree biology; reliability of the newly encoded traits to produce the desired outcomes; effects of the new traits on forest ecosystem structure and function; and persistence and potential impacts of the introduced genes in native populations through the dispersal of pollen, seeds, or vegetative propagules (van Frankenhuyzen and Beardmore 2004). Other perceived risks from biotechnology/genetic modification are associated with loss of genetic diversity that may result in vulnerability to insect and microbial pests and to stressful climatic events.

Benefits

Initial applications of forest tree biotechnology targeted improved productivity and quality of intensively managed plantation forests. Such use, with appropriate social controls, can help reduce impacts on natural forest ecosystems from timber harvest-related stresses (Sedjo 2001). Other potential benefits of GE include enhancing the ability of trees to tolerate abiotic stress; restoring contaminated sites through phytoremediation; facilitating weed control using more environmentally benign treatments; producing new industrial products; modifying biomass chemistry to improve pulp and biofuels production; and improving carbon sequestration to mitigate greenhouse gas emissions. In addition, biotechnology, especially GE methods, offers unique and important tools to conduct research to identify the biological mechanisms for control of many ecologically and economically significant traits.

Trees genetically engineered for pest resistance may also promote plantation survival and yield, and lead to restoration of native tree species. For example, American chestnut and American elm have nearly vanished from the North American landscape as the result of exotic pathogens and are the subjects of intensive efforts to produce genetically resistant planting stock (Burdon and Libby 2006). However, GE chestnut remains limited despite some evidence (e.g., Delbourne et al. 2018) of public acceptance of GE for conservation and restoration. American forests, in particular, have been highly altered by the removal of several important species and several others are threatened (e.g., *Fraxinus Americana*, or American Ash). The importance of utilizing GE may increase as climate change causes additional abiotic stresses and shifts in forest composition. This may drive shifts in public perception of GE toward reduced barriers to GE plantings leveraging global sourcing trends.

Future Investment

GE may be able to provide solutions to several controversial components of widespread GMO plantings (e.g., gene propagation), but limitations to social science research and market and regulatory restrictions to field research (e.g., disinvestments by companies and governments (Strauss et al. 2017) continue to be a barrier. Lengthy regulatory processes also contribute to limiting the technology by making it prohibitively expensive. For example, the recent initiative by ArborGen to release a cold-hardy variety of eucalyptus included a lengthy public commenting period during the five-year permitting process, multiple studies, and finally an Environmental Assessment (EA) and Finding of No Significant Impact (FONSI), which resulted in Permit 11-052-101rm (USDA 2016).

In summary, despite this mounting evidence of the positive impacts on forest health, the leading global certification systems continue to ban the use and research of GM technologies, and the US is falling behind global adoption rates of GE. Justification for these limitations often cites a lack of adequate research on the long-term impacts of GE trees, yet the majority of the internationally endorsed certification standards follow a risk-avoidance approach that prohibits certified land managers from conducting research and field trials. Market obstacles resulting from these prohibitive forest certification standards, as well as cumbersome regulation, is limiting field plantings (Strauss et al. 2015). SAF does not support this current trend in certification, but rather SAF supports scientific research to advance innovation and sustainability. When forest certification follows science-based as well as stakeholder-driven processes, it can provide enhanced consumer confidence for the over 500 million hectares of certified forests.

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