

POLICY ARTICLE

Native seed trade of herbaceous species for restoration: a European policy perspective with global implications

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With the need to meet ambitious restoration targets, an improved native seed sector for the production of herbaceous species with a practical and supportive policy framework is recognized. We evaluated the current “ready-made” policy frameworks in Europe regarding the native seed supply of herbaceous species and found them to be, generally, unsatisfactory for both producers and users. Initially, such policies were designed for fodder seed and relate to distinctness, uniformity, and stability, traits that do not reflect the genetic heterogeneity of native species required for ecological restoration. Until recently, more suitable certification standards were designed to multiply fodder seed for preservation of the natural environment; however, due to the disparateness of the seed market in Europe, this policy is rarely practical and fails to encompass all herbaceous native species often resulting in unregulated seed sales. We recommend a new or adapted native seed policy constructed through a participatory or bottom-up approach and supported through the formation of widely based trade associations. Such a policy could stimulate the native seed trade with concomitant impacts on the speed of improving ecosystem services.

Key words: bottom-up approach, certification, fodder seed, native seed production, seed policy, seed quality

Implications for Practice

- When multiple stakeholders are involved, a participatory or bottom-up approach should be used to adapt or devise a new native seed policy for restoration.
- Native seed policy should start by being applicable to all species to prevent the sale of seeds of unknown origin and quality.
- Member states can modify regulations based on the development of their seed market.
- Native seed regulations need to focus on protecting genetic integrity by applying certification procedures that are not agriculturally based (distinctness, uniformity, and stability).
- Quantitative restrictions in seed policies limit market expansion and do not facilitate the demand for large quantities of herbaceous native seed for ecological restoration.

Introduction

Policy steps to protect biodiversity ensure ecosystem resilience and combat environmental change is at the forefront of United Nations and other institutional initiatives. The connection between ecosystem services and society (Target 14), and the restoration of 15% of degraded ecosystems around the world (Target 15), has been emphasized in the UN Convention on Biological Diversity (CBD) Strategic Plan for Biodiversity 2011–2020 (CBD 2015; CBD 2016). However, insufficient progress toward the targets by European member states has occurred since the midterm assessment (Table 1; CBD 2012),

even after implementing the European Union (EU)’s Biodiversity Strategy to 2020 (EU Commission 2015a). Since the baseline assessment, grasslands, croplands, and urban ecosystems have continued to decline (EU Commission 2015b). The Global Strategy for Plant Conservation has ensured protection of approximately 10% in situ by area of terrestrial ecosystems, and 66 countries now have seed banks for native plant conservation (CBD 2014); however, the availability of seed material is limited for restoration efforts (Bekessy et al. 2010). Vast quantities of native seed are required for large-scale restoration and demands cannot be met by relying solely on wild resources (Merritt & Dixon 2014). Seed supply costs vary and can impose financial constraints on restoration practices

Author contributions: HA, CB conceived the purpose of the study reported; HA was the lead writer and designer; HA, MDV designed the figures and tables; and manuscript revision was given by SP, HWP, MDV, CB.

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doi: 10.1111/rec.12641

Table 1. International and European targets for ecological restoration to be implemented through national actions and reporting.

| Organizer | Strategy | Target |
|--------------------|---|---|
| United Nations CBD | Strategic Plan for Biodiversity 2011–2020 | <p><i>Target 14.</i> “By 2020, ecosystems that provide essential services, including services related to water, and contribute to health, livelihoods, and well-being, are restored and safeguarded, taking into account the needs of women, indigenous and local communities, and the poor and vulnerable.”</p> <p><i>Target 15.</i> “By 2020, ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced, through conservation and restoration, including restoration of at least 15% of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification.”</p> |
| United Nations CBD | Global Strategy for Plant Conservation | <p><i>Target 4.</i> “At least 15% of each ecological region or vegetation type secured through effective management and/or restoration.”</p> <p><i>Target 8.</i> “At least 75% of threatened plant species in ex situ collections, preferably in the country of origin, and at least 20% available for recovery and restoration programmes.”</p> |
| EU Commission | EU Biodiversity Strategy to 2020 | <p><i>Target 2.</i> “By 2020, ecosystems and their services are maintained and enhanced by establishing green infrastructure and restoring at least 15% of degraded ecosystems.”</p> |

(Broadhurst et al. 2016), since seed yield and quality (including dormancy) fluctuates with intervariability and intravariability in pollen flow, natural disturbances, and climate variability (Merritt & Dixon 2014; Broadhurst et al. 2016). Preference toward using a few core species and/or non-native seed mixtures (Tischew et al. 2011; Broadhurst et al. 2016), also increases the risk of hybridization with natural populations inducing changes in genetic diversity (Schröder & Prasse 2013). There is the need to identify “local” seed production areas or seed zones (Durka et al. 2016; Nevill et al. 2016) so that plant material is adapted to the site conditions (Bischoff et al. 2010; Tischew et al. 2011; Hufford & Mazer 2012; Broadhurst et al. 2016), since seeds multiplied in dissimilar environments from the restoration site may not be considered “restoration-ready” (Chivers et al. 2016).

However, much of the native seed market in Europe regarding herbaceous species is unregulated and poor seed quality is a common occurrence (Laverack et al. 2007; Ryan et al. 2008; Haslgrübler et al. 2013; Marin et al. 2017). In the United Kingdom, the native seed market is estimated to grow to 120–140 tons and be worth £9–17 million by 2019/2020 (UK Native Seed Hub 2011).

While the projected need globally to restore 150 million hectares of disturbed or degraded land by 2020 requires U.S. \$18 billion investment per year, the benefit to the global economy would be approximately U.S. \$84 billion (Menz et al. 2013). An analysis of more than 200 studies indicates that the cost–benefit ratio of ecological restoration is as high as 35:1 for grasslands (De Groot et al. 2013). While the economic case to intervene and restore native vegetation is strong, the current

policy environment in Europe appears insufficient to stimulate the expansion of native seed production of herbaceous species.

Our aim in this commentary has been to (1) evaluate the existing policies regulating the trade of native herbaceous seeds; (2) examine alternative seed directives; and (3) suggest how policy can evolve to better enable the native seed trade to adequately support internationally agreed ecological restoration targets.

Herbaceous Native Seed Policy in Europe

Historically, seed quality assurance policies were designed around the “truth in labeling” concept to protect the farmer from negative externalities (Copeland & McDonald 2001). These focus on the commercialization of a product, but can be influenced by international agreements on intellectual property, biosafety, and business regulations (Louwaars 2008). In Europe, seed policies in the agricultural sector (i.e. varieties) are based on the certification of minimum standards. Legislation that affects native seed in Europe includes the protection of habitats and species (EU Commission 1992) and fodder (EU Commission 1966; EU Commission 2010) with no specialized or comprehensive inclusion of native seed for restoration (Fig. 1).

The EU directive on the conservation of habitats and species (92/43/European Economic Community [EEC]) covers 502 species of vascular plants with conservation status (Table 2; EU Commission 1992). These species are prioritized for action under the Natura 2000 European ecological network implementing the goals of the EU Biodiversity Strategy and ultimately the CBDs Aichi Biodiversity Targets to restore 15%

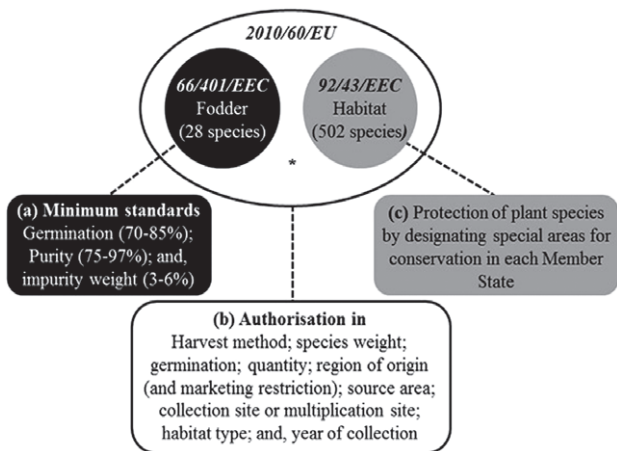


Figure 1. Seed quality policy requirements applicable to the marketing of native species in Europe. (A) Corresponds to the directive 66/401/EEC for fodder plant species certified as commercial seed (the lowest certification) using the minimum standards; (B) corresponds to the directive 2010/60/EU requiring authorization in fodder seed mixtures to preserve the natural environment; and (C) corresponds to the directive 92/43/EEC designating specific protected areas for at risk species. Asterisk indicates species not listed, but can be certified as commercial seeds in 66/401/EEC including conservation varieties from 2008/62/EC and other species under comparable source areas rules.

of degraded land. But in the EU, insufficient seeds of these species are commercially available, and germination data are not freely accessible in comparison to indicator and fodder species (Ladouceur et al. 2017). This may be due to economic reasons (hard to produce) and access (e.g. need for collection permits). Nonetheless, this convergence of factors has resulted in four times more restoration outside than within the Natura 2000 network (Dickie 2016).

The EU directive on the marketing of fodder plant seed (66/401/EEC) is the primary EU regulation applicable to native seeds (Table 2; EU Commission 1966). It covers 24 species and four genera (*Agrostis*, *Lolium*, *Poa*, *Vicia*) of grasses and legumes and requires minimum standards of seed germination (<75–85%), seed purity (<75–97%), and restrictions on the presence of weed seed. Of the species listed, 48% are native to

European grasslands (Ladouceur et al. 2017), provide important ecosystem services, and occur in extremely biodiverse habitats (Bischoff et al. 2006). The directive impacts the native seed industry even though it was designed for fodder quality assurance. Unlike crop varieties, the seeds of native species rarely reach minimum seed standards for germination and purity, due to their natural heterogeneity (Lesica & Allendorf 1999; Broadhurst et al. 2016) and do not easily conform to the agricultural sector requirements of distinctiveness, uniformity, and stability (DUS). Although no standardized definition of seed quality for native seeds exists, there is an agreement that seed for restoration purposes should be sourced locally to maintain genetic integrity (Fig. 2).

The EU directive on fodder plant seed mixtures (2010/60/EU) for the “conservation of genetic resources” is the first regulatory attempt to harmonize agricultural production and conservation/restoration needs (Table 2; EU Commission 2010). It includes fodder species listed under Directive (66/401/EEC), species with special habitat concerns (92/43/EEC), conservation varieties (2008/62/EC), and other species required for the preservation of natural and seminatural habitats (Fig. 1). Seed used must be from “source areas” listed in the Natura 2000 network or areas under comparable rules. A quantitative restriction limits the total yearly production of seed for preservation mixtures to not exceed 5% of the total weight of fodder seed certified from Council Directive 66/401/EEC per member state. This ceiling, originally set to protect the fodder variety industry from unfair competition, could severely limit the growth of the native seed market. This directive is not actively used in many European countries as most native species are not categorized as fodder or sourced exclusively from Natura 2000 areas. This directive does provide unique labeling requirements and, for the first time, labeling specifications of origin and provenance (Fig. 1). However, further labeling obligations that enable comparison with agricultural seed lots are often too demanding for a nascent industry, as knowledge of native seed quality (germination, dormancy breaking treatments, viability, purity), particularly of the most threatened species, may be lacking in many countries (Wade et al. 2016; Ladouceur et al. 2017). Today, one-third of Europe is without an herbaceous native seed industry. In more developed markets, independent native

Table 2. European directives applicable to the marketing of native seed.

| Legislation | Organizer | Number | Title | Website |
|-------------|-----------|------------|--|---|
| Directive | EEC | 66/401/EEC | Council Directive of 14 June 1966 on the marketing of fodder plant seed | http://eur-lex.europa.eu/legal-content/en/ALL/?uri=CELEX:31966L0401 |
| Directive | EEC | 92/43/EEC | Council Directive of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora | http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A31992L0043 |
| Directive | EU | 2010/60/EU | Commission Directive of 30 August 2010 providing certain derogations for marketing of fodder plant seed mixtures intended for use in the preservation of the natural environment | http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32010L0060 |

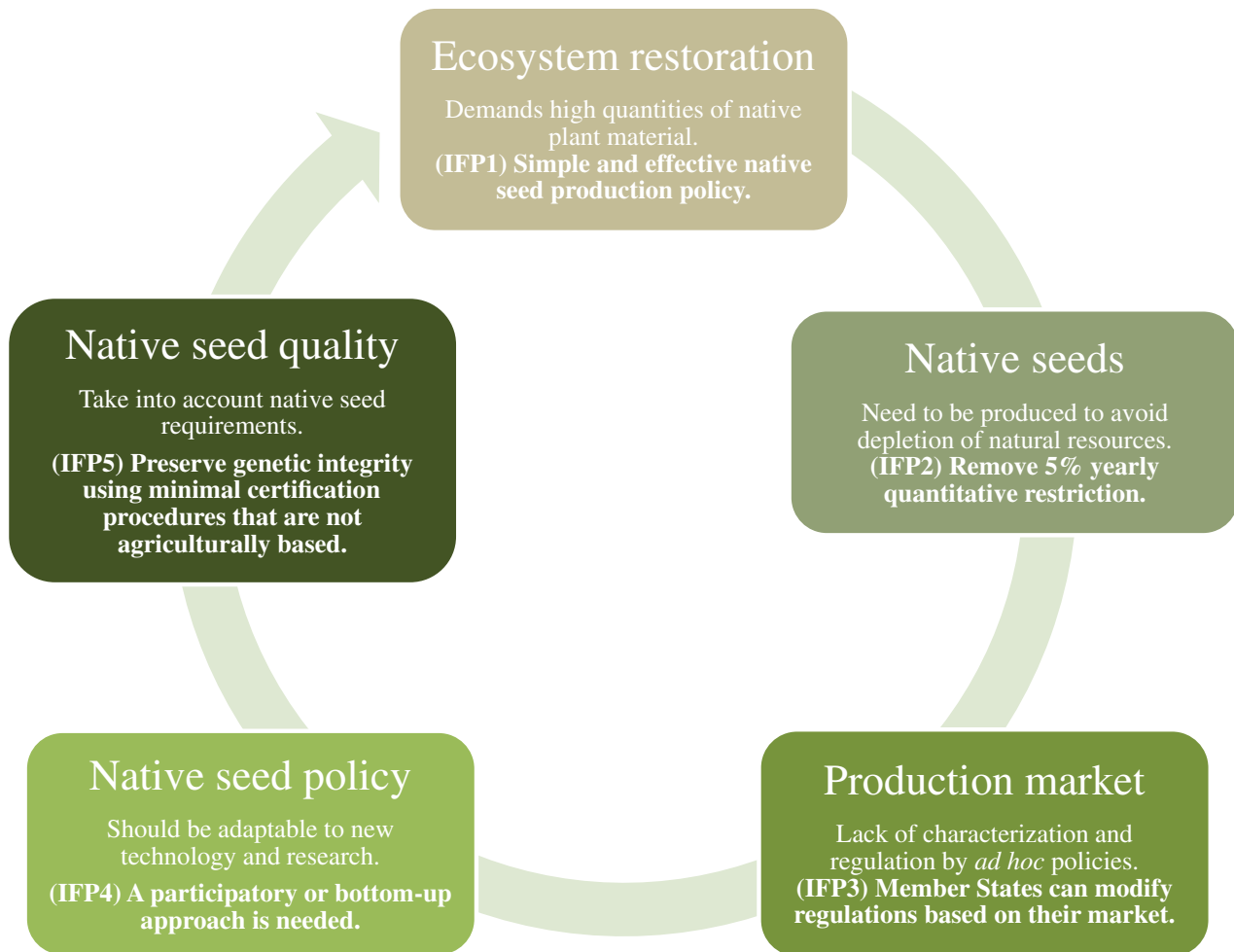


Figure 2. Implications for practice at-a-glance. (1) *Ecosystem restoration*. The need for a well-developed native seed industry stems from the urgent need to restore ecosystems on a large scale to protect ecosystem services and maintain biodiversity. (2) *Native seeds*. The need to use and multiply native herbaceous seeds to preserve genetic integrity, and maintain ecosystem resilience over the long term. (3) *Production market*. Is dynamic and unique in each member state; however, using a one-size-fits-all policy to regulate native seeds is not satisfactory while the market is still under-developed in many member states. (4) *Native seed policy*. Top-down policies that exclude users and follow agriculturally based standards (DUS) are problematic for the native seed industry. A revised or new flexible policy that considers the needs of the users and producers would be beneficial. (5) *Native seed quality*. To protect the buyer and seller, a simple product quality scheme needs to be determined for native seeds that is not agriculturally based and takes a user approach.

seed certification schemes exist, such as those operated in Austria, France, and Germany. However, the strict enforcement of regulations of native seed lots in less developed markets could stimulate unregulated seed sales of noncertified seeds.

Alternative Seed Policies With a Lighter Touch

With the EU's demonstrable interest in protecting genetic resources and biodiversity, it is recommendable to develop policies that support the sustainable trade of herbaceous native seeds for large-scale restoration. Certification and labeling requirements must be simple when a policy has an EU-wide application (Fig. 2), taking into account the relevant economic, political, and technological factors in each member state (Tripp 2002).

Closest in essence to the market needs for native seed supply and demand are the forestry and landraces directives which

have specialized procedures relating to the reproduction of plant material while still protecting biodiversity. For example, the EU Directive on the marketing of forest reproductive material (1999/105/EC) stresses the importance of genetic and phenotypic suitability, and external quality standards of reproductive material (EU Commission 1999). Source-identified tree seeds must be from a single region of provenance and identity must be labeled on the certificate. A national register for basic material is required by each member state and a supplier's label must also include purity, germination or viability, seed weight, and live seed. The OECD (2016) forest seed and plant scheme uses similar minimum requirements with approval on origin, population size, and adaptation and resistance for source-identified seed.

Conservation varieties or landraces (2008/62/EC) are considered to be plant genetic resources and biodiversity for varieties of agricultural species (EU Commission 2008). Member states

have the flexibility to decide DUS to be used for in situ conservation based on Directive 2003/90/EC and are exempt from official certification. This basic and limited form of regulation enables member states to decide species-specific quality criteria.

Even more liberal is the legislation for the marketing of ornamental plants (98/56/EC), requiring only the tracking of processes and materials, that is, an audit trail (European Commission 1998). However, these species may end up being used in restoration if other seeds are not available and, as evidenced recently, can contribute the spread of diseases, e.g. ash die back in the United Kingdom (Thomas 2016). In contrast, the International Seed Testing Association uses accredited laboratories to issue certificates of quality for agricultural, flower, and tree seed lots in the trade based on purity and viability (ISTA 2009).

Herbaceous native seeds should also be considered as genetic resources, and be assigned similar protection, particularly as temperate grasslands in continental Europe are considered conservation hotspots due to their high species richness (Wilson et al. 2012). The need for a lighter legislative framework is illustrated by Germany's ambition, under the Nature Protection and Landscape Conservation Act, to exclusively use native plant material for all restoration projects (BNatSchG 2010) by March 2020. The German native seed market is expecting a 10-fold growth and will likely exceed the 5% fodder quota (<http://ser-insr.org/webinars/2016/11/17/native-seed-production-in-germany>).

Closing the Gap Between Users and Producers

Our review of the policy arena suggests that a more pragmatic policy for native seed quality assurance is needed that does not follow the DUS principles, but accounts for the genetic diversity while still ensuring basic product quality to prevent negative externalities, such as disease or the loss of genetic biodiversity (Fig. 2). We see this to some degree in the United States, as the Federal Seed Act demands that all seed batches sold present a purity and germination label (Jones & Young 2005) and wild collected native seeds can be certified as source identified (i.e. with origin on the label) (Young et al. 2003). Furthermore, the Bureau of Land Management's National Seed Strategy for Rehabilitation and Restoration is currently characterizing federal policies, tools, and storage facilities aiming to "put the right seed in the right place at the right time" (Oldfield & Olwell 2015; PCA 2015). As noted, the (re)establishment of the plant community is critical to initiating ecosystem change toward the desired trajectory (SER 2004). Such an initiative falls squarely behind the new, 2015 sustainable development goals (<http://www.sustainabledevelopment2015.org/>), including actions to protect the planet. There is an urgent need for Europe to follow this lead.

Action can be taken at a number of levels, as current restoration activity supports about 10,000 jobs, although the potential is 25,000 jobs to meet the Natura 2000 15% target of restored land; however, this activity is not well documented (Dickie 2016). The Common Agricultural Policy is offering farmers additional payments conditional on landscape greening improvements (2013/1307/EU), an initiative that could greatly benefit

from an expanded herbaceous native seed industry. However, the full potential of these economic and environmental opportunities, including job creation, will only be realized through improved intersectoral efforts.

Policy development involving diverse stakeholder groups using a participatory approach helped the implementation process of Natura 2000 after a top-down approach was originally taken (Keulartz 2009). The European Commission is now looking to solve multiple land use concerns from the Natura 2000 sites by building a toolkit using member state experiences (Bouwma et al. 2010). More widely, recent successes in restoration planning and implementation have combined ecological, economic, and cultural considerations, including FAOs' Great Green Wall of Africa, the Satoyama initiative, and the Ecological Restoration Alliance of Botanic Gardens (Sharrock et al. 2014; IPSI 2016; Sacande & Berrahmouni 2016).

Finally, to improve or create a new policy that takes into account genetic diversity and product quality, there is a need to define herbaceous seed quality among users and determine what type and level of regulation is favored in this growing marketplace (Fig. 2). To provide ample policy support, the identification of key issues in supply and demand, linking communities, stakeholders, practitioners, and researchers is needed (Jalonen et al. 2014) and could be determined using a participatory or bottom-up approach. Most likely, this could be facilitated by the establishment of a native seed trade association that unites producers in Europe, commissions research, embraces public engagement, promotes education, and collectively negotiates legislations that address the needs of the native seed market. Emphasis on regulatory frameworks that include both landscape restoration and seed production goals will only be pertinent and effective if they are devised and implemented by both producers (farmers, retailers, etc.) and users (NGOs, government bodies, charities, researchers, etc.).

Conclusion

This commentary examined how EU-wide policies regulate the herbaceous native seed trade in Europe, primarily by considering herbaceous species for restoration as animal feed (fodder). While the recent fodder mixture directive (2010/60/EU) does consider the preservation of genetic resources, it is still not functional for native seed businesses, consequently limiting seed availability, and the capability to perform large-scale restoration. To regulate native seeds on an EU-wide level, a supportive policy is required that maintains genetic integrity and product quality, but does not strictly follow the agricultural model of DUS. We propose that the current policy directive (2010/60/EU) is either modified or replaced by an ad hoc policy underpinning the needs of the seed users and producers regarding seed quality and certification to facilitate both local and large-scale ecosystem restoration using herbaceous species in the coming years.

Acknowledgments

This research was funded by the People Programme (Marie Curie Actions) of the EU's Seventh Framework Programme

FP7/2007–2013/under REA grant agreement no. 607,785. The Royal Botanic Gardens, Kew receives grant-in-aid from Defra. We thank R. Fiegener for the opportunity to present this topic at the National Native Seed Conference in 2015 and 2017, and for the invaluable feedback from G. Laverack, T. Chapman, G. Rossi, and E. Ladouceur.

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Coordinating Editor: James Aronson

Received: 2 August, 2017; First decision: 11 October, 2017; Revised: 17 October, 2017; Accepted: 18 October, 2017; First published online: 10 December, 2017