Invasive Plants and Weed Biodiversity. **Jerry Doll.** University of Wisconsin, Department of Agronomy 1575 Linden Drive, Madison, WI 53706 USA.

ABSTRACT. Invasive plants often displace some or many other species, decreasing the biodiversity of infested areas. Most consider the loss of biodiversity as a serious human, ecological, environmental and human loss and efforts to curtail the spread of invasive plants should be encouraged world wide. The impacts of the loss of biodiversity are difficult at best to quantify but most people believe that biodiversity preservation is of great importance and any spatial, or worse, temporal loss of one or more indigenous species is detrimental to a healthy and holistic environment. Globalization of trade and tourism has increased the risk of exotic species reaching new territories. Weed scientists have much to offer in the fight to prevent, contain and control exotic species. We have well trained classroom and public educators, researchers and problem solvers for both natural and agricultural systems who can and are focusing attention on invasive plants. We can help those with great enthusiasm, concern and energy regarding invasive plants to make real-world plans and decisions that are practical, safe, economical and fruitful. We should strive to be engaged with others in this interesting dimension of weed science and management.

A Brief Review of and Comments on Invasive Plants and Weed Biodiversity. Invasive plants are non-native species that arrive in a new region, become established, adapt and spread into new areas, often displacing indigenous plant species. In addition to economic, environmental, health and aesthetic impacts, invasive plants can cause biodiversity losses. The USA has many thousand species of introduced plants. Of these, the great majority are used as food and fiber crops, ornamental and medicinal plants, forage species, etc. with great economic value. President Thomas Jefferson, our third president, was one of the early promoters of new plant introductions, saying “The greatest service which can be rendered to any country is to add a useful plant to its culture.” Parenthetically, does it then follow that the greatest disservice one could do is to introduce a non-useful (such as invasive plants) into a country? We have learned much about assessing risks and benefits of species introduction since the early 1800s and one of the newer risks it that of the loss of biodiversity.

The area of invasive plants is mew to many weed scientists. Anyone who wants an excellent presentation on the background, concepts, processes and impacts and more on

plant invasion should read the chapter by this title in the book, “Weed Ecology in Natural and Agricultural Systems” by Booth et al. (2003). It is comprehensive, current and very readable and gives an excellent backdrop to understanding the issues of plant invasiveness.

While many agricultural weeds are exotic, we generally tend not to associate the term “invasive” with the weeds found in agricultural systems but rather to those invading plants in forests, natural areas, roadsides, parks, preserves, wetlands, aquatic habitats, non-disturbed sites, etc. Invasive plants are not generally associated with cropland because the goal in these highly managed systems is the near elimination of all but one (grain, fiber, fuel) or a few (forages and rangelands) species. In other words, the goal of agricultural weed management is precisely to reduce biodiversity. For example, in glyphosate resistant soybean (*Glycine max*) or maize (*Zea mays*) the weed management goal is to eliminate all species except the crop (interestingly soybean and maize are non-native to both Brazil and the USA), regardless of whether they are indigenous or foreign to our region. The use of highly effective and often multiple control tactics over long periods of time by farmers will most likely reduce biodiversity within these fields. Froud-Williams (1997) clearly saw this when he stated “Arable ecosystems are more likely to suffer reduced biodiversity as a consequence of agricultural intensification rather than invasion per se.” Barlow (2007) is even more emphatic on this point. “The irony in the war on invasive plants is that agrarian civilization has done more to displace native species than any of the listed invasive plants could ever hope to do.”

Weed scientists have argued over the value, if any, of maintaining weed biodiversity in agricultural systems. On one extreme is the view that “the only good weed is a dead weed” which would strive to permanently eliminate all weedy species from fields. Others believe that maintaining a mixture of species via seed or vegetative propagules in arable land is desirable, not for agricultural purposed perhaps, but for larger ecological and wildlife benefits. To that end, Storkey and Cussans (2007) attempted to maintain low weed densities in winter wheat (*Triticum aestivum*) in the United Kingdom. Fifteen weed species were tested over two years in an attempt to achieve both in-field biodiversity (weeds and crop) and efficient wheat production. The risk of significant crop yield loss obviously increases with this strategy and farmer acceptance of increased risk is most unlikely unless the species with biodiversity value are also relatively poor competitors.

Another way to achieve the goal of biodiversity on the landscape is to balance intensive agricultural production with designated wildlife areas rich in native plant species (Storkey and Westbury, 2007). Government subsidized programs to promote and protect wildlife habitat (highly diverse habitats) are in place in several countries. In the USA, the Natural Resource Conservation Service of the US Department of Agriculture manages several programs that give financial payments to land managers to achieve conservation goals. In recent years, this includes subsidizing efforts to restore wildlife habitats. In Wisconsin (north central USA), a key targeted invasive species is reed canarygrass (*Phalaris arundinacea*), an introduced forage grass adapted to wet soils. In addition to being an important forage grass, this species now infests 1000s of hectares of stream bank and wetland habitats where it has displaced nearly all other plant species. State and Federal agencies are cooperating to develop comprehensive plans that incorporate cultural, mechanical and chemical approaches to greatly reduce the canarygrass infestations and then reestablish a mix of desired forbs, sedges and subsequently grasses that can regain their dominance in wetland habitats.

The impacts of the loss of biodiversity are difficult at best to quantify but most people believe that biodiversity preservation is of great importance and any spatial, or worse, temporal loss of one or more indigenous species is detrimental to a healthy and holistic environment. Biodiversity losses include species reductions in fauna as well as flora (Grice, 2006) and also encompass soil biota (Chen-Huili et al., 2005). We need to recognize that some of the associations between introduced plants and other organisms can be positive. A review and research by Altieri et al. (1977) noted numerous examples of beneficial interactions between cropland weeds and insects and proposed exploring ways to incorporate weeds into pest management strategies.

While Australian rangelands are extensive, they are also frequently monitored. Observations suggest than four native plant species are now extinct due to “environmental weed” invasion (Groves and Willis, 1999). These authors observed that “Of the various threats to native plant biodiversity, we conclude that increasing fragmentation of natural areas is a major factor that allows weeds to establish and dominate and thereby threaten still further the continued existence of native plant species and the Australian ecosystems in which they occur.”

How rapidly do new invaders appear? Of course this varies with a myriad of factors. Most believe that the globalization of world trade and tourism has enhanced the movement of exotic species (both by design and accident). Thankfully most countries no longer have an open door policy on plant introductions. However, Mother Nature has her own mechanisms to achieve benefits from species movement, regardless of the efforts of humans slow or halt the process.

An interesting review of new plant appearances in the state of Illinois, central USA, found that between 1803 and 1978, an average of 4.6 new species per year were reported (Henry and Scott, 1981). From 1956 to 1978, the average was 9.4 species per year, indicating an increase in the rate of exotic species introductions in modern times. Interestingly, 29% of the Illinois flora in 1980 was exotic and these species covered at least 80% of the land area, primarily as grain crops and pastures. On the Doll Family farm in southwestern Illinois, I observed the arrival of 10 new weed species during a 50-year period (Doll, 2007).

Can biodiversity be regained? The answer is “yes, but….” Yes, we can do it. But do we have the human, economic and other resources available? Careful site-by-site assessment is the starting point. When invasive species occupy large areas of land, complete recovery of biodiversity is unrealistic. However, reversal of species loss in small areas, particularly when the invasion is detected soon after it happens, can be accomplished. Those who desire more information on this should search the topic “restoration ecology” and similar terms.

In the North Central region of the USA, the European invader garlic mustard (*Alliaria petiolata*) is well beyond eradication in the vast shaded areas of forests and woodlands where it has displaced nearly all herbaceous species. However, dedicated volunteers working on public lands and diligent land owners have reclaimed many infested sites and reintroduced desired species. A personal example of converting land from an exotic species to native plants occurred in my lawn. We converted an area that was predominately Kentucky bluegrass (*Poa pratensis*) to wild flowers, forbs and native grasses. The site had been a well maintained lawn for more than 20 years. Nevertheless, the abundance and diversity of invasive weeds was amazing and required hours of manual labor to ensure the successful establishment and dominance of desired species. After four years, the prairie grass area is nearly stable and desired species now

predominate. The wild flower and forb area requires annual maintenance, suggesting either that we do not have the right mix of native species or that the invasive plant seedbank is still so large that more time is needed before the desired species will predominate without my help.

You will find some who seriously question the wisdom of trying to reverse the change from native to non-native species. For example, Harvard University landscape architecture lecturer Del Tredici (2004) questions whether restoration is wise. "What's striking about this so-called restoration process is that it looks an awful lot like gardening, with its ongoing need for planting and weeding. So the question becomes: Is "landscape restoration" really just gardening dressed up with jargon to simulate ecology, or is it based on scientific theories with testable hypotheses? To put it another way: Can we put the invasive species genie back in the bottle, or are we looking at a future in which nature itself becomes a cultivated entity?" As with any issue, a variety of opinions certainly exist.

It amazes me to see how rapidly the weed science community at large has embraced the issue of invasive plants. This is reflected in how often invasive plants are in the limelight today. Of course some have always fought "noxious" weeds and many countries have a long history of weed laws, prohibitions and quarantines. But now the issue is the center of attention in many circles. For example, the Weed Science Society of America (WSSA) recently teamed up with the Ecological Society of America and hosted a major symposium on invasive plants in natural and managed system (the proceedings are published in Weed Technology, vol. 18, p. 1180-1587, 2004). The WSSA will launch a new journal on Invasive Plant Science and Management in 2008 and the society's January 2008 newsletter contained the words "invasive" or "invasiveness" no less than 68 times. A similar search of the April 2005 Newsletter, found 22 occurrences of these words.

Some question whether the significant focus on exotic plants is justified. They point out that native plants can be invasive as well as imported species and that invasion is simply a normal aspect of nature. Perhaps the spread of not overly invasive exotic species actually enhances biodiversity and introduced plants might be better adapted in certain habitats to prevent erosion, provide wildlife habitat, recycle nutrients, etc. than native species.

Nevertheless, most people who ponder the impacts of exotic plants in new areas believe the risk of negative impacts far outweighs the likelihood of beneficial outcomes. For species known to degrade environmental, human or social quality of life, efforts should not only continue but increase to limit their spread and to regain lost territory. For species that still offer potentially significant benefits if introduced into new areas, a risk-benefit assessment, test plantings, detailed monitoring, and appropriate interpretation of and response to plant behavior must be carefully planned and implemented.

Weed scientists have much to offer in the fight to prevent, contain and control exotic species. We have well trained classroom and public educators, researchers and problem solvers for both natural and agricultural systems who can and are focusing their attention on invasive plants. We can help those with great enthusiasm, concern and energy regarding invasive plants to make real-world plans and decisions that are practical, safe, economical and fruitful. Funding opportunities are appearing to support active research and outreach programs on invasive plants. We should strive to be engaged with others in this interesting dimension of weed science and management.

Keywords: indigenous; native, non-native; restoration; weeds

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