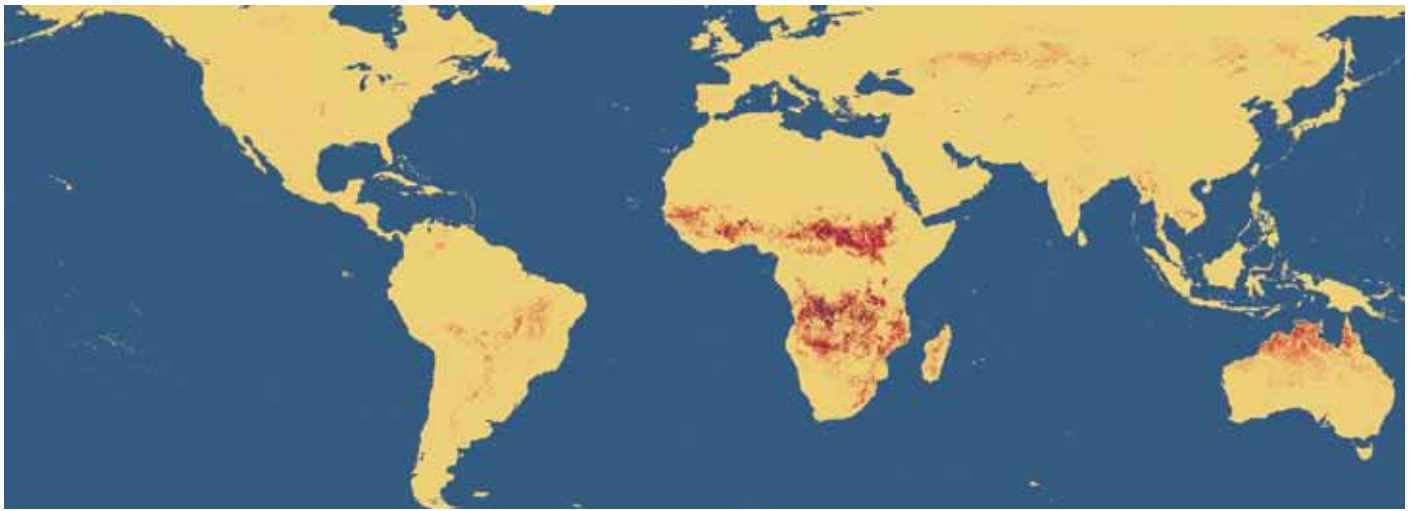




Invasive grasses:

Africa burns and why this matters for grasses

Above: Many ecosystems across the world experience fire, but the frequency with which they burn can vary from as often as once a year to as infrequently as once every few decades. The parts of the world that burn most often are the grass-dominated savannas. This picture shows that African savannas, in particular, burn very frequently (indicated by darker reds) and the area that burns frequently is much larger in Africa than on any other continent. Image: Vernon Visser

Box 1: The alien grass-fire cycle

The alien grass-fire cycle refers to the invasion of fire-adapted alien grasses into ecosystems that previously experienced few or no fires. These grasses tend to be tall bunch grasses that produce highly flammable aboveground biomass in the form of leaves and stems that have a high surface-to-volume ratio and thus rapidly dry out when they die back. These grasses are also able to rapidly recover after fires because their leaves are 'easy' to replace and the plant meristems are located below ground. Once these grasses are introduced into habitats that were previously fire-free (or at least experienced infrequent fires) they rapidly promote fires because of these features. Native vegetation is unable to survive this sudden increase in fire frequency and the fire-adapted alien grasses spread into habitat that is opened up by fire.

Classic examples of the alien grass-fire cycle include invasions of Gamba grass (*Andropogon gayanus*) in Australia, buffel grass (*Cenchrus ciliaris*) in the arid west of the USA, and molasses grass (*Melinis minutiflora*) in much of South and Central America. All three of these species are native to Africa.



Gamba grass invasion in Australia. On the left is an example of a native eucalypt woodland in northern Australia. The image on the right shows what an invaded woodland looks like after the eucalypt trees have been killed by fire. Image: Wikimedia Commons



Buffel grass invasion in Hawaii, USA. On the left is an example of native vegetation (Panoramio: <http://www.panoramio.com/photo/30980166>). The picture on the right shows part of the island completely overrun by buffel grass. Image: Wikimedia Commons

Vernon Visser and **Susan Canavan** describe the current situation with invasive grasses in South Africa and what fire has to do with this.

When most South Africans think about invasive species the first thing that comes to mind is a pine tree or a wattle tree. The idea that grasses can be problematic invasive species probably seems absurd. Yet if we venture beyond our shores we find that this is precisely the case in many other parts of the world. Grasses are among the most abundant and damaging invaders of natural areas in regions such as the Americas, Australasia and Pacific islands like Hawaii. They can radically increase fire severity and frequency, resulting in complete ecosystem change (Box 1).

Why African grasses?

What is perhaps of most interest is that many of the invasive grasses worldwide are African species. Africa appears to be relatively little affected by invasive grasses, but African grasses are causing problems elsewhere in the world. Why might this be the case?

The most obvious reason is perhaps that fewer grass species have been introduced into Africa than elsewhere in the world. Grasses are best known for their uses in agriculture (cereals, fodder for animals, etc.) and therefore we might expect that similar species and numbers of species have been introduced all around the world for agricultural purposes. Indeed, when we investigated the uses of alien grasses introduced into South Africa we found that most of these species are used in agriculture. This is no different to the situation in, for example, the USA, Australia and Chile. In fact, almost exactly the same set of species, and numbers of species, have been introduced into South Africa and these other countries for agricultural purposes. Many of these introduced grasses originate from Eurasia and include some



Avena barbata



Avena fatua



Brachypodium distachyon



Briza maxima



Briza minor



Bromus catharticus



Hordeum murinum



Poa annua



Vulpia myuros

Grasses invasive in the fynbos biome. Image: Wikimedia Commons

Box 2: Invasive grasses in South Africa

Probably the worst invasive grass in South Africa is the Spanish reed (*Arundo donax*), a plant which you most likely would not even recognise as a grass. This plant is largely restricted to rivers and wetlands, which might leave you thinking it is not that much of a problem. That would be incorrect because this species has spread to nearly every river system in South Africa and is choking out native vegetation for many thousands of kilometres along riverbanks.

Alien grasses are becoming increasingly problematic in the fynbos biome. Here grasses, mostly of European origin, dominate large areas of lowland fynbos, particularly in disturbed habitats (e.g. through too frequent fires or soil nutrient enrichment through air pollution or nitrogen fixation by alien legume plants).

Fountain grass (*Pennisetum setaceum*) is native to the arid mountains of northern Africa. It has pretty 'fluffy' inflorescences, which make it popular as a garden plant. It



Spanish reed (*Arundo donax*) invading along a riverbank. Image: Wikimedia Commons

has also been extensively planted for mine dump rehabilitation. However, this species is becoming increasingly abundant across much of the western parts of South Africa. In the arid Succulent and Nama Karoo it is frequently seen spreading along riverbanks and roadsides.



Fountain grass spreading along roadsides in the Western Cape. Image: Wikimedia Commons

It is thought that this species is being spread by mowing road verges. The biggest worry with fountain grass is that it starts to invade natural vegetation in the arid parts of the country and introduces fire into these biomes, which are not normally exposed to fire.

of our best-known crops, including wheat and rice. What does set South Africa apart from these countries though, is that many South African species have been moved around the world for use as pasture grasses. So what is it about African grasses that makes people want to use them as animal feed?

The main reason African grasses are so popular for animal feed seems to be that many of them respond very

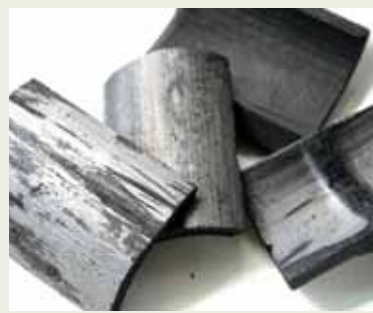
well to grazing. Unlike grasses in much of the Americas and Australia, African grasses have evolved with large herds of grazing animals. African grasses are so popular as pasture grasses that Australia even had a government-sponsored programme to introduce alien grasses, with most species originating from Africa. Although African grasses are such popular pasture species worldwide, their success as invasive species is probably for a different reason – fire!



Growing bamboo culms.



Collection of bamboo culms of different sizes ready for processing.



Charcoal made from bamboo culms.



Harvesting of sugar cane for uses such as biofuel production.

Emerging uses for grasses. Image: Wikimedia Commons

Box 3: Emerging uses for grasses

Agroforestry

With increasing rates of deforestation and rising prices for wood, statured grasses such as bamboos are becoming a good alternative to traditional hardwoods. The lignified stalk or culm has a similar texture to wood, but with the added benefit of being lighter and having higher tensile strength than steel. Rapid growth rates, some of the fastest in the plant kingdom, mean that some bamboo species can produce more cubic meters of material than any hardwood tree and almost all softwood trees. In Asia, where there are many native bamboo species, bamboos are commonly used instead of wood for building houses, making tools, utensils, etc. These useful qualities have meant that there is a growing demand for Asian bamboo species, which are being cultivated *en masse* around the world as a substitute for wood.

Carbon mitigation

Other emerging uses for statured grasses, for both bamboos and similar reeds and canes, include their use to offset carbon emissions through mass planting. This is done because many of these species sequester a

significant amount of carbon, while also serving as a valuable harvest crop.

Biofuels

Rapid growth, a perennial nature and low management requirements of many statured grasses such as *Arundo donax* (Spanish reed) have made them a popular choice for biofuel production. The production of biofuels is a growing industry that aims to replace traditional oil consumption with geologically-recent carbon energy to reduce greenhouse gas emissions. This is done by harvesting plants, algae or bacteria, which are processed and converted into a convenient energy form such as ethanol. Unfortunately, many of the species suited for biofuel production also have many weedy attributes such as rapid growth rates and high dispersal capacity. This conflict of interests has led to arguments about the feasibility of this industry: the environmental costs of invasion in the long term may outweigh the economic benefits in some cases.

Fire on the African savanna

African savannas are unique in that they burn frequently, as often as once a year (see title photo). The reason is partly to do with the monsoonal climates experienced over much of Africa and because grasses here are uniquely adapted to burn. Grasses here generally grow faster, produce more flammable biomass and survive fires better than grasses elsewhere in the world. When African fire-adapted grasses were introduced into the Americas and Australia they were able to outcompete the native grasses there because they encouraged more regular fires and were able to survive these fires, unlike the native species. Paradoxically, when grasses from elsewhere in the world were introduced into Africa, they were unable to cope with the regular fires that occur here.

You might now be thinking that we live on a continent that is immune to grass invasions. And yes, you are probably justified in thinking this, to a degree. It seems unlikely that African savannas and grasslands will experience the same radical vegetation changes that have occurred elsewhere in the world as a result of anything to do with fire. However, we do have reasons to be concerned (Box 2).

Summing up

Grasses are becoming increasingly popular as ornamental plants and people are growing an ever wider range of grasses in their gardens. Grasses are also being proposed as biofuel feedstocks, and for use in carbon mitigation schemes (Box 3). The grasses being used for these purposes are very different to those used for animal feed and few have been

introduced up until now.

We are also seeing an increasing number of grasses being introduced from regions such as Australia and South America, places which previously contributed very little to our introduced grass flora. These regions have very similar climates to South Africa and therefore the likelihood of a newly introduced grass species being able to survive in South Africa is all the greater.

The wildcard for predicting future grass invasions though is global environmental change. Rising carbon dioxide levels and changing temperature and rainfall regimes may tip the balance in favour of invasive grasses in South Africa, but exactly where and when is difficult to predict. It is with this in mind that recently a National Working Group on Alien Grasses was established whose purpose is to monitor the situation with invasive grasses in South Africa. The hope is that through the group's efforts we will be able to identify emerging grass invasions early enough, and thereby prevent grass invasions of the same magnitude as have occurred elsewhere in the world. **Q**

Vernon Visser is a postdoctoral researcher at the Centre for Invasion Biology. Among other research areas, he works on understanding and predicting alien grass distributions. He is also leader of the National Alien Grass Working Group, which was established to assess and monitor grass invasions in South Africa.

Susan Canavan completed her BSc and Hons in Ecology and Economics at the University of Guelph in Canada. She is currently working on her MSc in Botany at Stellenbosch University's Centre for Invasion Biology. Her research looks at the risks and benefits of introduced bamboo species.