Costs and Benefits of Plant Transfers and Bio-invasions in Historical Perspective with particular reference to Africa[1]

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Sequence and themes:

- Aspects of the history of plant transfers and bio-invasions with respect to Africa, especially South Africa.

- Deliberately including cultivated crops, weeds and plant invaders within the same frame of analysis.

- Draw on environmental history and on bio-invasion literature which emphasises environmental and economic costs.

- First section develops a critique of Alfred Crosby's idea of ecological imperialism.

- Second section discusses some costs and benefits of plant transfers and bio-invasions in South Africa. Suggest that demographically, economically, and socially, the benefits of introduced plants, including some invasives such as prickly pear and black wattle, have outweighed the costs. Ecological costs have been greater, but difficult to value.

Plant transfers have been central to world history. They have been fundamental in demographic growth, great agrarian complexes, and in the expansion of empires and settlement – not least European empires of the last 500 years. My paper touches on aspects of the history of plant transfers to Africa, especially South Africa. I'd like to raise some broad themes about their relationship to European empires, their benefits and their costs. I am deliberately including cultivated crops, weeds and plant invaders within the same frame of analysis, because it is sometimes difficult to define species within any one of these culturally constructed categories. My discussion will refer to two bodies of academic literature - on environmental history and on bio-invasions. The latter, which tends to emphasise the environmental and economic costs of transfers and invasions, is beginning to address the complexities of this issue.

The first section develops a critique of Alfred Crosby's idea of ecological imperialism. In a central text for the new environmental history, Crosby noted the significance of plant transfers from the 'old' world of Eurasia to the 'new' world of the Americas in facilitating settler colonialism, and the demographic transformation of the Americas. I argue that from the vantage point of Africa, part of the 'old' world, Crosby's discussion of asymmetrical

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plant exchange is problematic, and this conclusion has implications for the concept of ecological imperialism.

The second part of the paper discusses the costs and benefits of plant transfers and bio-invasions, mostly in South Africa. American plants have been a central feature of recent African history. This applies both to cultivated crops and some semi-invasive or invasive plants. I suggest that demographically, economically, and socially, the benefits have outweighed the costs, even in the case of some invasive plants, such as prickly pear from Mexico and black wattle from Australia. The ecological costs have been greater but they are difficult to value. The paper concludes with brief comments on the relevance of the argument for concepts of biodiversity, and how this might be adapted to cater for transferred plants.

Crosby and Ecological Imperialism

In Ecological Imperialism (1986), Crosby did not write much about Africa. But he has some interesting environmental arguments - in particular the role of disease in shaping the relative failure of settler colonialism in Africa and its success in the Americas and Australasia. He argued that it is difficult to conceptualise European imperialism, and settler colonialism in particular, without understanding the impact of environmental influences. In the Americas and Australasia, such forces helped to produce what he called neo-Europes – where Europeans dominated demographically as well as politically. In West Africa, by contrast, the disease environment, especially yellow fever and malaria, worked against European settlers; their attempts to start plantations also failed and their livestock were decimated by trypanosomosis (Crosby, 1986, 136). In Southern Africa, Europeans established a firmer foothold but Africans, unlike native Americans, had resistance to smallpox and sufficient demographic and military weight to defend some of their territory. Even at the height of settler power, Africans were demographically resurgent.

Historians writing on environment and empire are uneasy about assigning too much weight to environmental causation, and tend to concentrate more on the impact of European expansion, and on environmental policies, regulation and ideas. Crosby's work can lead in exciting and important directions; it can also lead to some potentially problematic propositions. And it is true that the failure, for the most part, of settler colonialism has been an absolutely central element in Africa's recent history. Perhaps in 1950, at the height of the colonial period, the picture looked a little different. But viewed over the longer term, and even in the context of the twentieth century as a whole, this was a relatively weak historical force.

With respect to plants, Crosby suggested that exported old world plant species, both domesticated and especially weeds, proved more powerful than those originating in the Americas and Australasia; and he sees a clear flow of plant species from the former to the latter, symbolised by the idea that after colonialism the sun never set on the dandelion. By contrast he argued that relatively few American species established themselves in the old world. He offers both botanical/ecological and socio-economic reasons for the success of old world weeds: the capacity to reproduce rapidly; and the degree of social and ecological disturbance in the new world.

We are left with a picture, in Ecological Imperialism, of an asymmetry of exchanges between the old and new worlds in respect of plants, as well as diseases and animals, and especially an asymmetry in regard to weeds and invaders. Does this hold with respect to the African part of the old world and what is the implication of such an analysis for the concept of ecological imperialism? My interest in these issues was stimulated by a project on the history of opuntia, or prickly pear, in South Africa. It is a good plant with which to think about these concepts. American in origin, it crossed continents, and crossed boundaries of race, of useful and invasive, of crop and weed

Certainly, if we take domesticated plants as a baseline, the evidence is of a counter movement or washback between the Americas and Africa. Over the last three centuries sub-saharan Africa came to depend increasingly on American domesticates: maize, cassava/manioc, sweet potatoes, bean varieties, some gourds, potatoes, tomatoes, tobacco, peanuts, cocoa, avocado, chili, peppers, cinchona, agave, guava, pineapple, passion fruit as well as prickly pear. True, sugar cane, plantains and bananas, tea, mango and citrus from the east are all major food or plantation crops. But collectively, plants of American origin, especially maize, are probably of greater importance.

Maize was introduced by Portuguese traders and slavers into Africa soon after it was brought back from the Americas (Miracle, 1966; Crosby, 1972; McCann, 2005). It served as a vegetable, after boiling or roasting, and as a grain, when dried and stored. Its yields in favourable conditions were relatively high, compared to the well established sorghums and millets. Its covered cob provided protection against voracious birds, and some insects. Maize was rapidly inserted into the agricultural repertoire of the Asante people, who later became perhaps the largest and most powerful kingdom in Africa. Its spread was uneven, but relentless. Despite its nutritional disadvantages – a lack of protein compared to sorghum or wheat - it became the major food-crop in Africa during the twentieth century.

The boundaries of maize production are still expanding. McCann (2005, 7) estimates that in southern Africa maize makes up 50 per cent of calory intake. South Africa, where - unusually in Africa - the bulk of production is on large commercial farms, has by far the highest output. But people in Lesotho, Malawi and Zambia consume a higher proportion of maize in their diets than anywhere else in the world. Maize seems to many of its consumers quintessentially part of African life and culture. A map of the world through its grains in a recent popular food book has Africa represented by maize.

The agro-ecological and ecological disadvantages of maize are well known. It is increasingly grown as a monocrop. It displaces older crops, and indigenous species where land is cleared, it prepares the ground for weeds, it can quickly exhaust soil, and precipitate soil erosion. McCann argues that it is associated with the spread of malaria in Ethiopia. Interestingly, maize does not become invasive, probably because the heavy cob and seeds are not easily spread and the reproductive capacity of the seed is destroyed when consumed by animals. That is in fact a massive advantage, not generally recognized. But maize cultivation is surely one of the major causes of environmental change in Africa, and also threats to biodiversity especially over the last century.

Any environmental critique must be tempered by recognition that it is the most important and preferred food source. Cassava, an American root crop, had some of the same advantages. Moreover, the spread of plants derived from American cultivars coincided with massive demographic growth in Africa .

Year	**1900**	**2000**
Global population	1.6 billion	6 billion
Africa's population	130 million	800 million
Africa's population as percentage of global population	8%	13%

Between 1900 and 2000 global population grew from roughly 1.6 billion to 6 billion (3.75 times); Africa's grew more rapidly from an estimated 130 to 800 million, or about sixfold. The relationship between production, food security and population is complex; food security does not explain rapid growth. But it is worth noting that the period of most rapid African population increase, perhaps the most dramatic population surge in world history, c.1960-1990, coincided with a doubling, or more of maize production.

Year	**1960**	**1990**
Africa's population	274 million	617 million
Ethiopia's population	23 million	49 million

Even in Ethiopia, which probably experienced the greatest loss of life from famine in the 1980s, population increased from 23 million in 1960 to 49 million in 1990. While maize took up a lower percentage of cropland in Ethiopia than in most African countries, production there expanded hugely (McCann, 2005, 220).

American domesticates also became increasingly important as cash crops. Cocoa underpinned the export revenue of Ghana for much of the colonial period and after; Ivory

Coast production rivaled it after independence. Peanuts played a similar role in Senegal; tobacco in Zimbabwe and Malawi.

Plants domesticated in Africa, such as millet and sorghum, are increasingly marginal in food supply in many countries. With relatively few exceptions, transfers of African useful plants have been less successful in a global context. West African rice had its moment in the coastal wetlands of the Americas (Carney, 2001). Sorghum is a minor crop in North America. West African palms have become a major plantation crop, for palm oil, in South East Asia. African grasses dominated, and were at first seen to enhance, some Brazilian coastal pastures.

What about weeds and invaders? Crosby cites as evidence for asymmetry that roughly 50 per cent of farmland weeds in the United States, out of about 500, and 60 per cent in Canada, were of Eurasian, largely European origin (Crosby, 1986, 164). But South Africa – the only country on which I have detailed information - shows exactly the opposite pattern (Henderson et.al., 1987)

Number of weeds in US farmland	**Number from Old World**	**Percentage from Old World**
500	258	Approx 50%
Number of declared weeds in South Africa	Number from the Americas	Percentage from New World
47	35	74%

Of the 47 main Declared Weeds in South Africa in a 1987 publication, at the time when Crosby wrote, 35 or 74 per cent were from the Americas, and a further four from Australia, making 83 per cent in all from the new world.
Of a further nine plants classified as alien invader plants, all of them trees, seven were acacia species from Australia, and one, prosopis or mesquite, was from America.

More thorough research and recording led to the identification of 161 important plant invaders ten years later. The current list of Declared Weeds is well over 200. The proportion from the Americas has declined somewhat, but 60 are from South America, 38 from Central America, and 27 from North America or about 60 per cent in all. (Zimmermann and Klein)

An estimated 750 tree species and around 8 000 shrubby, succulent and herbaceous species have been introduced in South Africa (van Wilgen and Richardson) so that more may become invaders in the future.

The plants from the Americas included some of the most difficult weeds such as burrweed (*Xanthium spinosum*) which was the first to be officially declared ‘noxious’ in the nineteenth

century. It stuck in the wool of sheep, then South Africa's most valuable export. Mexican marigold spread in cultivated land.
Lantana, a garden and hedge plant, colonized disturbed urban land. Five American water weeds, including water hyacinth (*Eichhornia crassipes*), and red water fern (*Azolla filiculoides*) have more recently proliferated in stored water and lakes to pose a major threat to the water resources of South Africa and Africa as a whole. (Martin P. Hill)

To conclude this section, if Africa is included as part of the old world, there is little basis for Crosby's model of asymmetrical plant transfer and weed invasion. (And I suspect it is problematic more generally.) South Africa's invasive plants are largely from the Americas and Australia. I would be cautious, however, about arguing for an inversion of Crosby's model, and suggesting that American plants are in some ways more powerful. Although you see echoes of such arguments about plant power blocs in the scientific literature, Williamson (1996) is sceptical of attempts to generalise about the botanical characteristics of successful invaders, or about the environments from which they originate. Much depends on climate, whether plants are hindered by natural enemies, whether they find suitable ground, disturbed or otherwise, and whether their spread is facilitated by human action, intentional and unintentional. Plants can travel in multiple directions.

Useful plants, cultivated or not, can flow against the routes of power. They can do so without direct colonialism, although seaborne transport was central to plant transfers in the age of imperialism. And Africans largely welcomed and absorbed many American cultivars. True, maize and some other American crops because the basis for large settler owned commercial farms in Southern Africa. But overall American crops and useful plants advantaged African people, helped underpin pre-colonial power in some contexts, and helped to bolster their economic and demographic strength in the twentieth century. We need to be cautious not only about asymmetrical flows but also the concept of ecological imperialism in respect of plants. This longer historical view, I will suggest, also has important implications for issues of intellectual property around plants.

Costs and Benefits of Plant transfer and invaders

Recent South African scientific literature on bioinvasions explores economic as well as ecological costs. Two key commentators, van Wilgen and Richardson argue:

Human communities and natural ecosystems worldwide are under siege from a growing number of destructive invasive alien species (including disease organisms, agricultural weeds, and insect pests). These species erode natural capital, compromise ecosystem stability, and threaten economic productivity. The problem is growing in severity and geographic extent as global trade and travel accelerate.

Their view, and that in the bulk of the literature, is negative concerning plant transfers, and generally pro-eradiction. There are however, some scientists and researchers who to some degree differ. I will suggest that if the issue of invaders is considered within the broader context of plant transfers, then the position becomes more complex. Part of the problem, as Perrings and others note, is the difficulty of assigning and quantifying genetic and ecological

value, as well as value in relation to production (after the application of knowledge and capital) and trade. Equally, the discussion of ecological costs, such as the loss of water supply through bio-invasions, is difficult.

As noted at the start, it is impossible to imagine the contemporary world without an understanding of the scale of plant transfers; they are the basis of many major agrarian systems and cultural landscapes. With respect to maize, especially in this bumper year for production and prices, and other plants contained largely within agriculture, it is difficult to overestimate the benefits. If we to start assigning value over the longer term of production in Africa based on plants transferred from the Americas, it would be extraordinary. It is very difficult to see this as part of any ecological imperialism.

I would like to concentrate on transferred plants which were not simply crops and which are now classified as invaders. There are many weeds or plant invaders that seem to have only costs, ecological and economic – I mentioned a few in South Africa, although it is possibly that they have some as yet undiscovered or forgotten genetic properties. Ecologists argue that their eradication is economically and ecologically justified.

A recent example in the South Africa is the red water fern, which has been countered by the American weevil, *Stenopelmus rufinasus*, collected in Florida and released in South Africa in 1997 after tests to ensure that it was restricted to this one species. Over 100 dam sites were tested and most were cleared within a year. The biological control agents developed in South Africa have been transferred elsewhere on the continent. The cost was low and scientists are claiming major economic gains of millions of rands through clearing of key water sources.

South Africa has, by the way, been at the forefront of biological control of plant invaders and weeds, targeting at least 35 different species in this way during the twentieth century, compared with 36 in the whole of the USA. Zimmermann and Klein (1999) estimated that existing invasions could be cleared for R600 million ($100 million) over 20 years and this would save R4 billion. These kinds of calculations are becoming more widespread in the scientific literature.

But some of the most successful invaders were not so much dangerous weeds but valuable self-spreaders: Crosby cites clover and Kentucky bluegrass in north America. These provided familiar pasture resources to livestock as they spread out, sometimes preceding the settlers, from the coast.

Mesquite was deliberately introduced in the late nineteenth century as a fodder and shade plant in the driest pastoral districts of South Africa. It's value was still praised in the mid-twentieth century, but by the 1990s it had spread rampantly in some areas displacing sparse indigenous vegetation (Hoffman et al, 1999, 143ff) It has also spread in the semi-arid zones of some other countries such as Namibia, Somalia and Sudan.

Australian Saltbush (atriplex species) is another case in point. It is now classified as a plant invader, but for most of the twentieth century it was cultivated as a fodder in the semi-arid districts of South Africa. Commercial livestock farmers and agricultural officials had a very

high regard for the fodder value of the plant. It was quite difficult to establish effectively and tended to spread by itself only to a limited degree. Some still feel that it enhances pastures.

Prickly pear

Perhaps the best example of a useful self-spreader in South Africa was *Opuntia ficus indica*, the common or sweet prickly pear, a cactus from Mexico and neighbouring areas of the Americas. Prickly pear, and especially a domesticated cultivar called spineless cactus, was planted but unlike maize, it spread largely through non-human agency. In some contexts, and in the eyes of different people, it could be a cultivated plant, a useful self-spreader, a weed, or a damaging invader. It had significant economic value in South Africa, and to some extent, it still does (Beinart, 2003; Beinart and Wotshela, 2003).

Opuntia species were deliberately brought back from the Americas in the sixteenth century. By the seventeenth century they had reached much of the Mediterranean littoral, the Canary Islands, the Cape, and India. One species became widespread in southern Madagascar from the late eighteenth century and another in Australia during the nineteenth century (Middleton, 2003). In the first it was a great boon – the basis of the cattle economy in the arid south of the island - and in the second a perceived pest.

At least 10 species became of some significance in South Africa of which the O. *ficus indica* was by far the most useful. They are also found in North Africa, in Ethiopia and Eritrea, in parts of Kenya, Tanzania, Mozambique, and Botswana. It has cultural significance: in Eritrea, expatriates are called Beles, after the fruit, because they return in the summer when it is widely harvested and sold.

Prickly pear served multiple purposes, especially for poor rural communities: as hedge and especially fodder and food. The spread of prickly pear in South Africa, in the nineteenth century, coincided with the intensification of white and black pastoralism in areas where water supplies were insecure. Although prickly pear cladodes were too low in nutrients to provide a complete fodder, they were particularly useful in droughts because of their high water content. Introduced livestock adapted to prickly pear in the Americas as well. Thorns were treated by chopping or burning. The spineless varieties were particularly valuable as a standing drought fodder because they needed no treatment. However, these had to be reproduced by cloning – that is planting from cladodes; if spread by seed, many of the thornless plants would revert to the thorny variety and this was the general pattern as the plant became invasive.

The sweet fruits were widely eaten by people, both white and black. They were traded – and are still sold in some quantity on the roadsides. Rural African people used the fruit, which does not keep well, to make beer. For over a century, prickly pear fruit beer was a major brew for poor black people in districts of the Eastern Cape where the plants thrived. The plant was also used for yeast, syrup, soap, and medicinal purposes.

Prickly pear can damage livestock, displace other vegetation, and take over the best riverine soil. By the early twentieth century, agricultural officials and commercial farmers turned

against it. In the 1930s, dense stands commanded about 1 million hectares. In Australia, an estimated 10 million hectares was densely infested. State-sponsored biological eradication campaigns were undertaken in both countries, initially with more success in Australia. In Madagascar, the unofficial introduction of cochineal insects decimated the plants, and the cattle, causing a famine. In South Africa, the eradication campaign proceeded more slowly – and cost a great deal - but by 1980, the main species of prickly pear was reduced by about 90 per cent.

In recent articles on plant invaders, prickly pear's apparent negative effects, particularly in reducing grazing capacity (van Wilgen et al.) are noted. In fact it almost certainly increased grazing capacity when effectively used and managed capacity (Beinart and Middleton, 2005). And the plant inserted itself into rural lives and remains part of the folklore; indigenous skills have been built up around it. The fruits are still gathered, eaten, sold and brewed on a smaller scale. I have been researching prickly pear brewing in one medium sized town in the eastern Cape. There are about 50 brewers and many more pickers. Most are poor African women. In 2005 the brewers could clear about R4,000 a year, say R200,000 as a whole, and they also created a market for a range of other suppliers – perhaps a R1million turnover in all. Multiply this 30 or 40 times for other towns and rural districts, and we can see that even at the tail end of the prickly pear era, selling and brewing of the fruits produces a substantial marketed commercial turnover. Non-marketed eating and brewing could be of even greater value.

Black wattle

Black wattle, (*Acacia mearnsii*) was introduced to Natal from Australia for tanning and timber in the 1830s. It was grown in plantations and later planted by Africans around their homesteads as a quick-growing source of timber and fuel in higher rainfall districts along the east coast. It could be pollarded, and also spread itself, diminishing the need for systematic planting. By the end of the twentieth century plantations covered about 130,000 ha. and an estimated 2.5 million ha had been partially invaded (Versfeld et al. 1998) It is one of the few invasive species for which scientists in South Africa have attempted a cost benefit analysis. They agree that it has significant negative impacts on water resources, biodiversity, and the stability and integrity of riparian ecosystems.

De Wit, Crookes and vanWilgen (2001) calculated the economic value of water flow lost to black wattle invasions in this region at $1.4 billion a year. It is an interesting calculation, because it assigns an opportunity cost to water, as suggested by Perrings et al and gives it value even if it is not used downstream. In some ways they are calculating a cost to the ecology, a cost to biodiversity – a more general loss to 'ecosystem services'. This focus on costing water loss is specifically related to South Africa's Working for Water programme, a major public works campaign to eradicate invasive species supported by ecological and economic arguments for which scientists have been highly effective protagonists. The ANC government has been sympathetic because it provides employment for poor people. I think that the sum arrived at by these authors is generous if it applied only to usable water and it does not allow for many other impacts on stream flow.

Costs	Benefits
Decline in water supply $1.4 billion US dollars	Plantation production $363 million
Ecological costs?	Building Materials $21 million – more?
	Firewood $143 million
Total: **$1.4 billion + ecological costs**	**Total:** **$525 million**
	Women's labour $350 million
	Saving of indigenous forest?

What of the benefits of black wattle? De Wit et al are aware of the value of plantation production of black wattle, and calculate it as $363 million. They were also well aware of is value to rural smallholders and sum they assign for firewood - $143 million a year - is generous. But that for wood use and building at $21 million may well be an underestimate. And these are real values as opposed to a hypothetical value assigned to waterflows which are affected by many other factors.

Even so I think they underestimate. I have roughly calculated the costs of getting such timber elsewhere, if it could be got, or replacing it with other materials such as concrete blocks, at about 5 times their value of wood. Black wattle and other exotics have a multitude of other uses for fencing, hurdles, grain containers, as well as building. Changes in building materials (see below) also have a significant aesthetic impact.

If we are talking about opportunity costs, we should include women's labour in gathering firewood. Black wattle is grown or gathered around the homesteads. If African women had to rely on a less convenient source of firewood, they would have to walk and carry loads further. If we take the South African minimum wage at R4,50 an hour at the time of their calculation, an added four hour firewood journey per week would cost R20 per household in labour or over R2 billion a year for KZN and Transkeian households ($350 million). Of course, many women do not have access to cash employment, so this would not in all cases be a real loss, but extra labour devoted to firewood gathering may have an impact on other household tasks.

De Wit et al display a certain insouciance in suggesting that electrification was an alternative to firewood. Until recently, it was not available for the great majority of rural homesteads

and the costs of electrical goods was beyond them. This is changing, although the recent hikes in fuel prices may delay the process.

An evaluation by de Neergaard (et al), 2005 of black wattle eradication in the Working for Water programme in KwaZulu/Natal noted that, 'Whilst the programme provides an income to thousands of families in rural areas, it may also be jeopardising the livelihoods of the same communities.

The wattle is an important resource for village households; virtually all households used it as their primary heat source and for building materials. Other uses included medicine extraction and 20% of the interviewed households gained income from selling firewood.

De Wit et al note the ecological costs of black wattle, and this is worth considering. But if it had not been available there would likely have been an even greater impact on what is left of indigenous forest. Black wattle has probably helped to save indigenous biodiversity in the pockets of indigenous forest remaining. How do we give this a value?

Lastly, I should raise the point of who benefits from the water apparently saved. As I understand the scenario presented considers this largely from the vantage point of downstream urban and industrial needs. These are certainly central in a country where the majority of people live in cities, towns, and dense settlements and where the great majority of people are dependent on wage income, government grants, or the informal sector. Yet the upstream rural communities in KwaZulu/Natal are amongst the poorest in the province. It is possible to conceptualise black wattle and other usable plants as storing water for them.

Discussion

I raise these points because I think that the historical economic and social value of prickly pear and black wattle, especially but not only to poor black people, may have been underestimated. Clearly such invasive plants can be environmentally damaging to indigenous biodiversity. And clearly it is difficult to calculate costs and benefits – de Wit et al should be applauded for trying do to so. But we need to be cautious about the political ecology of eradication, and to be clear about costs, and the winners and losers, in the process.

That said, it is important to note that the position is changing With respect to prickly pear, the relatively successful eradication in a biological campaign lasting from the 1930s to the 1950s has diminished accessibility, and the commodification of rural lifestyles diminishes the need for this all-purpose plant. Although the fruit is still very popular in parts of the country, and beer is still brewed, it is not as central to poor rural communities as it was. Manufactured beer and spirits are more widespread, and tastes in alcohol are changing. Few people still bother to process the fruit into jams and syrups and the plant is seldom used for hedging (Beinart and Wotshela, 2003). While all opuntia species are still declared weeds, and the object of eradication, some of the key scientists have argued since the 1980s that the *O. ficus indica*, at least (but not the dangerous *O. aurantiaca* or jointed cactus), is relatively stable and that its socio-economic value outweighs its ecological costs.

Similarly, building materials are changing. Concrete blocks, and metal roofs, are more common, even in the rural areas; wattle and mud walls and thatched roofing are fading, especially near rural towns. This is based on observation, and I do not know of any general attempt to quantify the process. Rural electrification is changing the demand for fuel. So eradication of black wattle may have less impact now and in fact one possible reason that this species, and some others, is spreading, is the decline in its harvesting. Nevertheless, recent rural surveys (de Wit et al and de Neergaard et al) do show that black wattle is still widely used in some of the more rural villages. The problem is that biological controls tend to be all-embracing and damage the useful, cultivated trees as well as the more troublesome invaders – this was the case with prickly pear and spineless cactus.

In sum, any discussion of the costs and benefits of such species should take into account the variety of uses of plants, their social context, and historical changes – plants can offer economic advantages for periods of time but their value can diminish (or increase) because of changes in usage and technology. Perceptions and tastes also change. This is certainly the case in relation to the aesthetic value of plants and their products. The American jacaranda was planted for a century along the streets of South African cities and hugely valued for its shade and flowers. Pretoria was called jacaranda city. Now the tree is cited as an invader. The rise of ideas of biodiversity, the championing of indigenous vegetation, and increasing ecotourism can result in a reconsideration of the cultural and aesthetic value of exotics. In turn some indigenous species are championed (around which new commercial interest can also develop)

An ideal scenario is for useful exotic species to be restricted to controlled spaces in agriculture and gardens, and to be eradicated elsewhere. But this is unlikely to happen, and biological eradication also makes selective eradication difficult. Mechanical and chemical eradication tend to be more expensive, not least because of labour costs, but they can also be more selective. Perhaps there is scope for Working for Water projects in rural villages to be calibrated according to local needs and to retain stands of black wattle around the homesteads and away from water courses.

Purist concepts of biodiversity often lack a historical dimension, and fail to cater for the actual diversity of plant species in most inhabited regions of the world, including agricultural and urban areas. We see everywhere in the literature claims that protecting biodiversity has economic benefits, but most people are dependent on introduced plants for their well-being. A purist approach does not always admit to longer term histories of human interaction with environments and the movement of plants that this implied. As I have argued, terms such as ecological imperialism in relation to plants might mask the degree to which these have been willingly absorbed and naturalized.

How do we resolve this problem? I am in favour or retaining distinctive protected biomes in particular areas, and of course concerned about extinctions that might result from exotic invasive plants and animal. But I wonder whether we should not deploy a more flexible approach to biodiversity, that recognizes intruders, and the impact of human culture, particularly in densely settled and agrarian areas (O'Riordan et al., 2002). There is an argument for gradations in the concept of biodiversity, especially in the formulation of

policy, as well as understanding of the social consequences of plant eradication, especially for poorer people. A range of cultural landscapes should also be acknowledged for their beauty and value - as recognised in world heritage sites - but these often have exotic vegetation.

And lastly, this discussion also has implications for an understanding of rights in plants and intellectual property. For example, San people have successfully claimed rights over the Hoodia plant, it seems both over its genetic properties and their knowledge of its medicinal properties. I am sure that they should get a share. And I can see the value, in many contemporary contexts, where power relations are very asymmetrical, of finding ways to transfer resources to marginalized and threatened communities. But given African absorption of American plants, any retrospective claims over plant properties, and knowledge of them, would be explosive and fraught with difficulties. Perhaps we should, in this case, separate species from their origins, rather in the same way that material objects are not generally trapped in the cultures and societies that originated them. Purist plant nativism, whether for scientific or economic reasons, could lead in complicated and unpredictable economic directions.

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