Guidelines on Biofuels and Invasive Species

This publication has been made possible in part by funding from The David & Lucile Packard Foundation.

Published by: IUCN, Gland, Switzerland

Citation: IUCN (2009). *Guidelines on Biofuels and Invasive Species*. Gland, Switzerland: IUCN. 20pp.

ISBN: 978-2-8317-1222-2

Editing: Sam Keam, Nadine McCormick, Geoffrey Howard and Andrea Athanas

Design & layout: L'IV Com Sàrl

Printing: MLfineArt, Geneva, Switzerland

Photo credits: Cover: David J. Moorhead, University of Georgia – An infestation of *Arundo donax*.
Page 7: Arne Wit – *Prosopis juliflora* densely covering extensive areas in Ethiopia.

Available from: IUCN (International Union for Conservation of Nature)
Publications Services
Rue Mauverney 28
1196 Gland
Switzerland
Tel +41 22 999 0000
Fax +41 22 999 0020
books@iucn.org
www.iucn.org/publications

A catalogue of IUCN publications is also available.

The text of this book was printed in limited numbers on Arctic FSC paper made from wood fibre from well-managed forests certified in accordance with the rules of the Forest Stewardship Council (FSC).

We encourage you to download it from www.iucn.org/energy or www.bioenergywiki.net.

Contents

1 Introduction and rationale

Many governments are actively encouraging private investment in biofuels developments to harness the perceived benefits of biofuels such as agricultural development, increased energy security and independence, improved balance of trade and reduced greenhouse gas emissions. However, in the rush to pursue the benefits of biofuels, the risks of invasion by introduced species have received little or no attention and are not being adequately prevented or managed. The situation is most acute in countries lacking the capacity and resources to adequately avoid and manage the risks of invasion. Lack of suitable pest and weed risk assessment and management regimes compromises the long-term viability of the biofuels sector and threatens local livelihoods and the environment.

Furthermore, many plant species currently being developed or considered for biofuels are potentially invasive. Whilst most current biofuels are produced from food crops that are well understood and have been domesticated for centuries; new and planned biofuels will be produced from a wider range of ligno-cellulosic feedstocks and inedible plant oils. Whilst these new biofuel feedstocks are potentially more productive and profitable, they also pose a greater risk of becoming invasive pests and causing widespread damage to ecosystems, livelihoods and the economy.

While many organisations work on invasive species issues and on biofuels, few have worked to address the two issues in tandem. The International Union for Conservation of Nature (IUCN) and the Global Invasive Species Programme (GISP) published a news story in 2008 entitled "Alien Alert"[1] in response to the growing threat of biological invasions posed by biofuels. The story received widespread media coverage. The resulting interest in the issue and acknowledgement of the seriousness of the risks posed by new biofuel developments prompted IUCN to develop these guidelines through an interactive process of consulting experts from regional government, plant protection organisations, research institutions, NGOs and the private sector. The guidelines were developed following two workshops[2] hosted by IUCN in Nairobi, Kenya and an extensive consultation. While the context and examples are from Eastern and Southern Africa, the guidelines are relevant globally, wherever biofuel developments are being considered. Given this area is evolving rapidly, the guidelines represent a "work in progress"; queries or comments are welcome and should be submitted to energy@iucn.org.

The biofuels context – opportunities and risks

These guidelines aim to highlight the risks of biological invasion by species introduced for biofuels production and to provide constructive recommendations on how to prevent the introduction, establishment and spread of invasive species resulting from biofuel developments. Whilst recognising the necessity of alternative fuels, the intent of these guidelines is neither to promote nor discourage the development of biofuels. Numerous factors other than biological invasion affect the sustainability of biofuels, which must be considered and addressed when promoting and implementing biofuels policies and projects.

Furthermore, a number of issues that cannot be fully covered in these guidelines affect the risk of an invasion by an introduced species. These include land tenure agreements, long term economic profitability, labour costs, the rule of law, and the relative prioritisation of biofuels for local development versus trade and export. These factors and many others will affect the likelihood of an invasion and the ability of a country or community to effectively manage the risk. However, these guidelines focus on the specific linkages between biofuel developments and risks of biological invasions, especially in the Eastern and Southern African Region, where risks are already apparent and likely to be exacerbated in the near future.

Target audience

The guidelines are intended to inform policies and practices of biofuel producers and decision makers, and ultimately provide guidance to importing companies and countries.

The guidelines have also been developed to support the development of an invasive criterion in the Roundtable on Sustainable Biofuels (see Box 1). It is also hoped that they can serve as a useful engagement tool for NGOs and communities seeking to raise awareness on the issue of biofuels and invasive species.

User guidance

Recognising the roles of many actors in managing the risks associated with invasive species, specific guidance is targeted to governments, private developers and NGOs at each stage of this document. And while the authors have attempted to be as thorough and specific as possible in the guidance, on the ground implementation is site specific, and that these guidelines are not able to capture all aspects of best practice for site level management.

Additionally, it should be noted that many knowledge gaps exist regarding the different risk factors of various species suggested as feedstocks and the ecosystems in which they will be grown.

The guidelines are likely to be of varying value to users depending on whether

1 http://www.iucn.org/media/materials/features/?1473/Alien-alert

2 Download background documents and presentations from http://www.iucn.org/about/work/initiatives/energy_welcome/energy_impacts/energy_bioenergy/biofuel_invasives/

Box 1 — ROUNDTABLE ON SUSTAINABLE BIOFUELS

The Roundtable on Sustainable Biofuels (RSB) is a multi-stakeholder initiative that has developed a Standard for sustainable biofuel production, which addresses environmental, social and economic issues related to biofuel production. The Version One of the RSB Standard, which was published in November 2009, includes a set of Principles & Criteria, compliance indicators, guidance documents and a complete certification system. Principle 7 on Conservation specifies criteria on biodiversity, ecosystem functioning, buffer zones, ecological corridors, and invasive species. Criterion 7.e on invasive species, which was developed in conjunction with these guidelines, currently states the following:

Biofuel operations shall prevent invasive species from invading areas outside the operation site.
Operators who must comply: **Feedstock Producer** and **Feedstock Processor**.

Minimum requirements:
Operators shall not use any species officially prohibited in the country of operation. Whenever the species of interest is not prohibited in the country of operation, operators shall seek adequate information about the invasiveness of the species to be used for feedstock production, e.g. in the Global Invasive Species Database (GISD).

If the species is recorded as highly invasive under similar conditions (similar climate, and similar local ecosystems, and similar soil types), this species shall not be used.

If the species has not been recorded as representing a high risk of invasiveness under similar conditions (climate, local ecosystems, soil type), Operators shall follow the specific steps:

1) **During the feedstock selection and development, operators shall conduct a Weed Risk Assessment (WRA) to identify the potential threat of invasion. If the species is deemed highly invasive after the Weed Risk Assessment, this species shall not be used.**

2) **During the potential importation of crops, operators shall comply with all related national regulations, including the gain of an official approval or a suitable import certificate.**

3) **During feedstock production, operators shall set up management plan, which includes cultivation practices that minimise the risks of invasion, immediate mitigation actions (eradication, containment or management) in case of escape of a plant species outside the operation site (possibly through the provision of a specific fund), as well as a monitoring system that checks for escapes and the presence of pests and pathogens outside the operation site.**

4) **During harvesting, processing, transport and trade, operators shall contain propagules in an appropriate manner on site and during transport.**

These guidelines are also explicitly referred to by the RSB in their guidance and indicators on invasive species.

Further information:
See RSB Website: www.rsb.org

they are being applied to new or existing developments. Existing developments should not be excluded since they can be adapted and improved in a number of ways by following the parts of these guidelines that are relevant to the production, transport and processing stages of projects.

Scale issues will greatly affect how the guidelines are used by different stakeholders. Small scale developments make implementing the guidelines and conducting more complex and costly requirements, such as weed risk assessments, less feasible. This presents a particular challenge since the risks from an invasion are not necessarily lower from small-scale production models.

Five key recommendations

1) Follow a precautionary approach when choosing feedstocks

Species should be chosen that minimize the risks to ecosystems and livelihoods from invasion, either by the feedstock species, or associated pests and diseases. Developers should also account for the possible costs of an invasion when choosing species.

2) Work with stakeholders to build capacity

Existing regulations are often robust enough in theory to reduce and contain risks of invasions. The main barrier to their effective enforcement and success comes from a lack of capacity and understanding for the need to follow best practices.

3) Comply with local, national and regional regulations

Regulations add an administrative and financial burden to developers, but they exist to safeguard the environment, the livelihoods of local communities, and the long-term financial sustainability of projects.

4) Develop and follow EMPs

Develop appropriate Environmental Management Plans (EMPs) that account for the full range of risks and specify actions to manage the site of production in such a way as to minimize the risk of escape and invasion of surrounding areas, and deal effectively with any potential or actual resulting invasion.

5) Extend planning, monitoring and assessments beyond the field

Consider developments within the wider context of the landscapes and ecosystems in which they are situated. Risks may extend beyond the site of production especially where adjacent areas may be more susceptible to invasion and the dispersal mechanism enables species to spread beyond the immediate site of a project. Thus, adopting an ecosystem approach when planning developments is preferable to only considering the risks posed by individual species.

Summary of the guidelines

The following section provides a short summary of the key points of the guidelines which have been split into four sections representing different intervention points along the supply chain.

1) Planning

All stakeholders should conduct a cost-benefit analysis that includes the potential costs of an invasion. Governments should develop strategic environmental assessments (SEAs) to plan biofuel production at national level and developers and investors should conduct environmental impact assessments (EIAs) at project level that include weed risk assessments (WRAs). These plans should be underpinned by a contingency fund as insurance for any necessary remedial actions in the future and a commitment from the outset to be vigilant to the invasion possibility, and take measures to prevent spread.

2) Importation

Importation of feedstocks and propagules should occur within a suitably robust quarantine system. Governments should strengthen their capacity to monitor and enforce phytosanitary regulations and base policies on sound ecological principles. Developers and investors should comply with all national regulations relating to the importation and introduction of live plants or propagules. This includes preventing the introduction of pests associated with biofuels.

3) Production

Feedstock plantations should only be developed subject to the development, submission and implementation of an Environmental Management Plan (EMP). EMPs should include:

- Specific best practices to be followed
- A contingency plan to be acted upon in the event of an “escape” of a plant species or pest organism that could cause an invasion.
- The provision of a contingency fund to pay for eradication, containment, management, or restoration.
- The development and implementation of a monitoring system that checks for escapes and the presence of pests and pathogens.

EMPs should ideally be audited by a neutral third party.

4) Transportation/Processing

Risks of invasion related to transportation and processing of feedstocks should be minimised by reducing the distances that viable feedstocks and propagules are transported, and, ideally, converting feedstocks on-site. Governments and developers should ensure adequate monitoring of transport vehicles for the presence of seeds, plant feedstock remnants and pests. Lastly, all stakeholders should promote awareness among transporters about the risks of invasive species and the need for a robust monitoring system.

Additional context

The guidelines in this paper outline a number of best practices for managing invasive species risks along the biofuel supply chain. In many cases the guidelines are aspirational; a number of limitations and challenges to their successful implementation beyond the immediate control of a government or developer should be recognised, including:

- Lack of public awareness about the risks of invasive species and the need to contain feedstocks on sites that are under adequate monitoring.
- Lack of funding to cover additional costs such as SEAs, extra administrative burdens for government departments, training and communication, quarantine facilities and sufficient staffing, especially for law enforcement.
- Lack of capacity, taxonomic databases, equipment, trained staff, robust environmental legal frameworks, etc.
- A profitable industry would lead to widespread adoption of the crops in question – concern about invasiveness may become secondary.

To address these issues and to successfully implement the guidelines, there are some pre-requisites that are urgently needed to support such measures such as clear communication strategies, sufficient funding mechanisms, and targeted capacity building efforts.

Cost recovery is a key limitation, and whilst there are a number of potential approaches such as fines, permitting fees, insurance schemes, refundable deposits, and taxes; there are understandable concerns about such measures undermining the economic competiveness of biofuels and deterring investments. As a minimum, we recommend the adoption of the ‘polluter pays’ principle when developing a framework for investments in biofuels in the region. This will help to clarify where responsibility lies for covering any costs related to an invasion and encourage the adoption of best practices to protect economic investments in biofuels in the region.

2 Background information

This section provides background information to clarify common misconceptions about invasive species and the process of invasion – more detailed information can be found in the IUCN biofuels and invasives workshop background paper[1].

Impacts of invasive species

Invasive species cause a wide range of environmental, societal and economic impacts. Invasion by introduced species is the second greatest threat to biodiversity after habitat destruction. Invasive species often out-compete native species and can irreversibly alter ecosystem functioning and hydrology. Invasive species may also introduce new pathogens that damage ecosystems and human health (see Box 4 on *Prosopis*).

The economic costs of invasive species are extremely high. The annual cost to the United States, United Kingdom, Australia, South Africa, India and Brazil has been calculated at over US$ 100 billion (CBD, 2006). Most of this cost is the result of reduced productivity of agriculture, forestry and other production systems, but other direct costs include damage to infrastructure, lost tourism revenue and costs related to eradication, containment and management. There are also indirect costs such as loss of ecosystem services, as well as cultural and social costs, for example from the loss of traditional livelihoods. While global calculations of the costs of invasive species are difficult and often subjective, it is likely that the cost of an invasion by a biofuel feedstock or associated pest would, in the long-run, outweigh any economic benefit offered by biofuel development. Thus, the cost associated with avoiding the introduction and spread of an invasive species should be viewed as a sound investment to insure against future economic and environmental costs and should be a logical prerequisite of any biofuel development.

Invasiveness and invasibility

While many plants have invasive traits, not all alien species become invasive in a given situation. Most alien species are relatively benign and may bring significant benefits such as food production, forestry, and biological pest control. There is a commonly used “rule of tens” which suggests that about 10% of introduced species will escape and survive in the wild, 10% of these will become established and 10% of established species will spread and become invasive. Thus, 0.1% of introduced species are likely to become invasive after introduction to a new

1 See http://cmsdata.iucn.org/downloads/biofuels_and_invasives_background_paper.pdf

Box 2 — KEY DEFINITIONS

INVASIVE SPECIES	**An alien species that causes (or has the potential to cause) harm to biodiversity, the environment, economies and/or human health. The term Invasive Species (IS) is often used interchangeably with Alien Invasive Species (AIS) or Invasive Alien Species (IAS). In this paper we use “invasive species”.**
ALIEN SPECIES	**A species that is introduced to a new location (ecosystem or area, rather than country – see Box 5 for further discussion) where it does not occur naturally (i.e. non-native, non-indigenous).**
BIOLOGICAL INVASIONS	**The phenomenon of invasions in which alien species cause harm to ecosystems into which they are introduced – this phenomenon is the result of the interaction between the alien species and the recipient ecosystem.**
PROPAGULE	**Any component of a species that can propagate a new individual whether sexually or asexually. Propagules include seeds, cuttings, rhizomes, bulbs, corms and clones.**
BIOFUEL	**Liquid or gaseous fuels produced from biomass that can be used to replace petrol, diesel and other fuels.**
FIRST GENERATION	**A biofuel produced using existing scalable technologies such as fermentation and distillation of starches and sugars to produce ethanol, or oil extraction and transesterification to produce biodiesel. First generation biofuels are normally produced from food crops such as corn (maize), sugar cane, soy, palm oil and rapeseed; or from inedible feedstocks such as *Jatropha curcas*.**
SECOND GENERATION	**Biofuels produced using more complex processes (than those of First Generation) that make better use of cellulosic biomass from plants. Two groups of approaches have developed – biochemical methods using enzymes and fermentation, and thermochemical methods that gasify biomass and re-synthesise fuels using catalysts. These new processes allow for the use of a broader range of feedstocks since the main requirement is high biomass yield.**

area or ecosystem. This figure may sound small but thousands of species are introduced into areas beyond their natural range every year and an invasion by just one species can have severe consequences for whole ecosystems. Introductions of non-native species are often the result of deliberate efforts by agriculture, aquaculture, forestry, agroforestry, horticulture, the pet trade, or for biological control of other pests, while accidental releases, particularly through transportation and trade can also occur.

Alien species are not invasive *per se* but can become invasive due to such factors as the local ecological conditions and the presence of vectors such as animals or flooding that can distribute propagules. Nevertheless, plant species that become invasive often share common traits which increase the risk of invasion such as:

- A lack of predators (or specific browsers, grazers) in their new environment
- Fast growth and ability to out-compete local vegetation
- Large and abundant seed production
- Tolerance to wide range of conditions
- Presence of thorns or toxins that make them inedible to animals.

Other issues to consider:

- One of the best indicators of invasiveness is whether the species under consideration is invasive elsewhere in regions with similar biotic and abiotic characteristics.
- Factors such as residence time and the number or extent of the introductions also affect the likelihood of invasion (increasing propagules pressure).
- Species may become invasive if their genotype is changed through breeding or genetic modification. Hybridisation can also 'invade' wild genotypes whereby introduced species may hybridize with close relatives within a recipient community, altering the genetics of the native population.
- Ecosystems can become more susceptible to invasion due to disturbances from land use change, agriculture or construction, changing availability of resources (light, nutrients, space, water), aiding establishment and spread.
- Ecosystems are likely to be more vulnerable to invasion if the receiving environments lack herbivores (predators), parasites or pathogens that would normally provide partial control of the introduced species.
- Climate change may change the invasiveness of species, either by providing a more suitable climatic envelope or through reduction of competitor species.

Many of the species that are being proposed as suitable second-generation biofuel feedstocks possess many of these traits and a study conducted by Buddenhagen *et al*. in 2009 found that potential biofuel feedstocks are two to four times more likely to become invasive in tropical regions than other alien plants.

The process of invasion

The means or route by which a species is spread is known as the invasion *pathway*. The pathway can involve physical elements such as transport by land, air and sea, and means such as international trade and tourism, which may result in the movement of species beyond their native range. The object or process that carries the species along the pathway is called a *vector*. Common vectors include people, soil, packaging, animals, vehicles such as trucks, cars, boats and aircraft, and natural forces such as wind and floods. Common pathways are roads and railways and international trade networks such as shipping lanes and air corridors.

Box 3 — WEED RISK ASSESSMENTS

Weed Risk Assessment (WRA) is a tool used to predict the likelihood of a plant species becoming invasive. WRAs offer a relatively rapid and simple system for approving or rejecting plants for importation and may contribute to decisions to plant a species or not. WRAs are usually based on a questionnaire that determines the invasive risk of the plant being assessed by asking whether the plant possesses a number of different attributes likely to increase the risk of an invasion. The answers to the questions are scored and the total score then determines whether a plant should be accepted, rejected or have further evaluation to reduce uncertainty. The assessment requires users to answer questions about a proposed plant species attributes such as:

- **Past history of invasiveness**
- **Environmental versatility**
- **Reproductive strategy**
- **Seed dispersal mechanisms**
- **Growth characteristics**

To be effective, WRAs should be carried out by a neutral body that is responsible for approval or rejection of species for import.

Further information:
Australian Quarantine and Inspection Service (AQIS) WRA site: http://www.daff.gov.au/ba/reviews/weeds/system

BOX 4 — THE CASE OF *PROSOPIS*

Prosopis spp. are a group of species that might initially appear to be ideal feedstocks for second-generation biofuels. Native to Central and South America, ***Prosopis*** are fast growing, have low nutrient requirements and are able to access deep sub-surface water sources in dry areas. They are also nitrogen fixing and can improve soil fertility. These characteristics led to a number of ***Prosopis*** species being introduced to Australia, Asia, and dryland Africa for fuelwood, fodder, shade, to improve soils and reduce soil erosion. However, it quickly became apparent that ***Prosopis*** was invasive due to traits such as rapid growth, abundant seed production, the tendency to form impenetrable thickets, the ability to thrive in dry, saline soils, and foliage that is unpalatable to livestock.

Following the collapse of demand for ***Prosopis***, many plantations were abandoned, without adequate management and eradication, ***Prosopis*** now covers millions of hectares in many countries in Africa and is severely impacting on grazing and traditional pastoralist livelihoods. The dense thickets have outcompeted local species and lowered ground and stream flow levels in many watersheds. Despite these negative effects, some positive benefits from ***Prosopis*** include wood and charcoal so there is often conflict over plans to control or eradicate it.

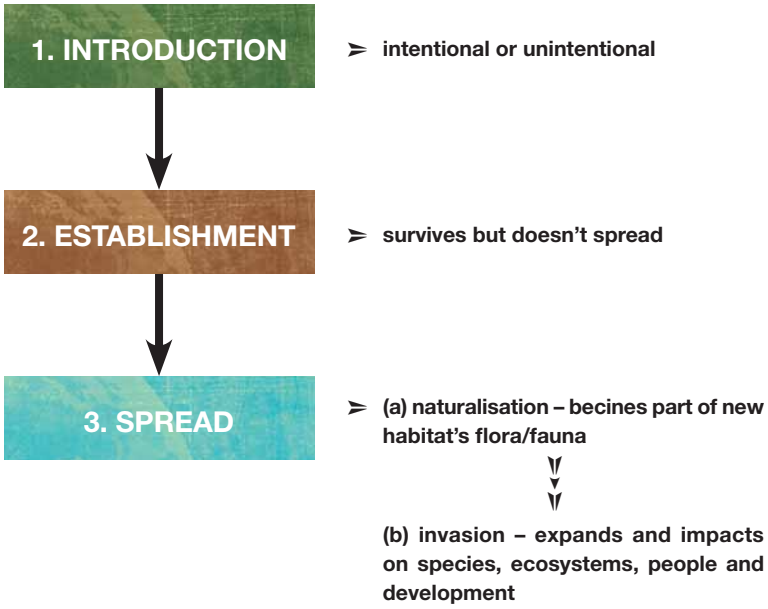
Based on the above, the introduction of ***Prosopis*** for biofuel production should be avoided, even though it has been proposed that the use of invasive species for biofuels may provide economic incentives for controlling their spread. It is highly unlikely that using ***Prosopis*** as a feedstock where it has become invasive will be an effective strategy for managing the invasion since creating a market for a fuel source would logically lead to more planting or farming of the species. For established populations, only accessible sites would be economic to harvest.

Furthermore, low-density areas of invasion in biodiverse areas should be a priority for control but harvesting in these areas would likely not be economic or have unintended impacts on other desirable species.

Current efforts to control ***Prosopis*** involve a mix of chemical, mechanical and biological control methods. Two biological control agents from the US (***Algarobius prosopis*** and ***Neltumius arizonensis***) have been used to reduce seed production with some success in South Africa, however more options such as fungi are being explored.

Further information:
GISP Case Studies http://www.gisp.org/casestudies/showcasestudy.asp?id=64&MyMenuItem=casestudies&worldmap=&country

Figure 1 – The process of invasion



Note: The term "naturalisation" implies "becoming part of the habitat or flora" but this isn't strictly true, it is a scientific term for that means "to form a self-sustaining population".

Biological invasion usually follows a common sequence beginning with introduction, and progressing to establishment, spread and invasion (see Figure 1). There can be a significant delay (lag phase) between introduction, establishment and spread. Some tree species have lag phases of hundreds of years while some herbs may take only weeks to go through these stages. Such delays are hard to predict and may be dependent upon irregular tipping points such as unusually extensive floods or droughts, irregular or unusual wildfires, adaptation to a new environment, biological invasions by other species and disappearance of predators or herbivores previously present.

Control of biological invasions

The best method for control is prevention. Other stages for control are recognised in the UN Convention on Biological Diversity[1] (CBD). Efforts to control invasions should be prioritised in the following order:

- **Prevention** – Avoiding the introduction of a potentially invasive species through appropriate risk assessments and enforcement of quarantine procedures. Where potentially invasive species have been introduced, management of plantations to prevent the escape of a potentially invasive species is critical.
- **Eradication** – Removal of the entire population of an invasive species and all propagules through mechanical harvesting, chemical treatment with herbicides, and the use of biological control agents such as host-specific parasites. Eradication is the preferable course of action if an introduced species has become established and is showing evidence of becoming invasive. However, once an invasion has begun, it is often already too late for complete eradication.
- **Containment** – this involves stopping the spread of a known invasive species, or potential invasive species by restricting further movement or spread.
- **Management & restoration** are the final tools for controlling an invasion and are the most expensive and time-consuming option. Management involves ongoing efforts to manage an established invasion once eradication and even containment are no longer possible. It is important to recognise that many plants produce seeds which can accumulate in the soils ("the seed bank") and germinate sequentially over many seasons or years. Restoration involves restoring an ecosystem to its pre-invasion state or to a preferred status – wherever possible.

1 CBD COP 6 Decision VI/23: https://www.cbd.int/decision/cop/?id=7197

3 Mitigating invasive species impacts along the biofuel supply chain

For the purpose of these guidelines, the biofuels supply chain has been divided into four stages: 1) selecting the biofuel feedstock and plantation site, 2) moving the feedstock to site, 3) production, and 4) harvest, transport, processing into biofuels, and transport to the point of sale. At each of these stages there are specific risks and options for avoiding or managing the risk of an invasion which may therefore require different interventions.

Figure 2 – Simplified supply chain showing potential intervention points

1) Feedstock selection and development, and feasibility assessments

Overview of the issues

At the stage of feedstock selection and development and feasibility assessments, governments and private investors are in the best position to avoid an invasion by screening potential feedstocks for invasive risk and conducting assessments on the suitable scale and location of feedstock production, processing and transport routes. These assessments should be done as early as possible before significant investments in project development predispose investors and developers to a potentially invasive feedstock.

Guidance for governments: Ideally national governments should conduct a Strategic Environmental Assessment (SEA) at this stage to identify suitable biofuel feedstock species and plan plantation zoning at a national scale so that biofuels production is sensibly sited, for example to minimise soil erosion and water stress, and to avoid areas of high conservation value.

If the biofuel is determined to be acceptable after a cost benefit analysis (including a consideration of its invasiveness) there may still be a need to mitigate its unintentional spread, if it is itself a potential invader. A related issue is the introduction of undesirable pests and diseases that may be associated with or the biofuel crop, causing impact to the feedstock or other species. Quarantine efforts should seek to reduce the introduction of pest species associated with feedstocks.

Lastly, international norms for species introduction need to be adhered to and governments should monitor the biofuel industry to ensure regulations are being complied with in terms of species used.

Guidance for developers and investors: The SEA should be accompanied by a project-specific Environmental Impact Assessment (EIA) funded by the developer, which must include a Weed Risk Assessment (WRA), of the potential feedstocks (see Box 3).

In cases where land has already been leased for biofuel development, developers should finance a strategic selection of the feedstock species and a WRA to identify the potential threat of invasion by the feedstock being considered. WRAs should be carried out by a neutral third party. Developers should also be required to include the possible costs of eradication, containment, management and restoration into their economic assessment of the project. A contingency fund should also be set up in some form at this stage that would go towards the cost of any remedial action required as a result of an invasion from a potentially invasive species.

2) Importation of feedstocks/propagules

Overview of the issues

The importation of species and transfer of live organisms or propagules across regional, national or sub-national boundaries is normally (or should be) regulated by national and regional governments. Some governments have adopted quarantine regulations that meet International Standards for Phytosanitary Measures (ISPM) requirements and these regulations, overseen by National Plant Protection Organisations (NPPOs), are adequate in principle. However, their effective enforcement is hampered by a lack of will, capacity or resources compared to the volume of trade.

Guidance for governments: Develop and strengthen quarantine regulations that meet ISPM requirements and allocate sufficient resources to NPPOs for monitoring and enforcement of regulations. Ensure that quarantine regulations are based on sound ecological principles (see Box 5).

Guidance for developers and investors: Comply with all national regulations relating to the introduction of live plants or propagules during the importation of feedstocks and propagules. These may include requirements for weed risk assessments and gaining official approval, for example by obtaining a suitable import certificate before embarking on production of biofuel feedstocks.

Risks associated with importation of feedstocks will be significantly reduced if industry can be persuaded to support and comply with voluntary standards for best practice. Ideally they support governmental agencies in an effort to enforce reasonable quarantine measures. There is an urgent need to clearly communicate to industry that such processes are beneficial to their long-term viability. Best practices may include full and timely compliance with appropriate regulations and perhaps future certification by a third party such as the RSB on criteria such as WRAs during the planning stage of developments.

Box 5 — BASING PLANT ASSESSMENTS ON ECOSYSTEMS RATHER THAN POLITICAL BOUNDARIES

It is commonly assumed that quarantine procedures at national borders are the most effective means of controlling the introduction and spread of pests and diseases. However, this can be misleading, since regional, national and sub-national boundaries are manmade constructs that often bear little relation to natural barriers between ecosystems, climatic zones and other natural factors that have a bearing on the likelihood of an introduced species being invasive. This is especially the case in large countries such as the USA or Australia where communities of species have long been separated by natural barriers such as mountain ranges and deserts. This separation has resulted in divergent evolution of species that may then become invasive if transferred to other, naturally isolated regions of the same country.

This issue can also affect smaller countries. In Africa, there are ongoing negotiations to create regional free trade blocs such as COMESA and ECOWAS, which will ease restrictions on the flow of goods and services between member states. If quarantine regulations are relaxed or waived for the trade of plant species between member states this will exacerbate the risk of introductions of invasive species since these large regional blocs span different ecosystems and climatic zones.

In response to this risk, it is preferable to take an ecosystem approach that adopts natural boundaries between ecosystems and climate zones in addition to the monitoring of political boundaries when determining the need for weed risk assessments and quarantine procedures. This more holistic approach would help ensure that assessments are carried out only where the movement of a species presents a realistic risk of invasion. Such an approach will require stronger regional co-operation within existing regional blocs, developing coherent quarantine measures that are aligned with the natural boundaries and vegetation zones within their borders.

One example of best practice comes from the state government of Western Australia, which requires a WRA to be carried out before any species that are native to other regions of the continent can be brought into the state. This precaution is in addition to the national requirement for a WRA for all species being considered for importation from overseas.

3) Feedstock production

Overview of the issues

This stage deals with managing the risks of invasion during feedstock production. Assuming the previous steps of these guidelines have been followed, the risk of an invasion by the feedstock itself should already have been significantly reduced. Nevertheless, it is possible that biofuels that are used in the future will become invasive or even that the invasion risk is deemed insufficient to stop using the feedstock. The following recommendations will help ensure that developers are in a strong position to deal with an unforeseen escape or spread of the feedstock, or any hitchhiking pests and pathogens that may be introduced as a result of the feedstock plantation.

Guidance for governments: In line with the "Polluter Pays" principle, government regulation should develop regulations that enable the polluter to be pursued for compensation in any case of negligence, thereby encouraging the developer or producer to follow best practices as outlined in their management plan.

Guidance for developers and investors: All developers should be required to submit an Environmental Management Plan (EMP) that will outline the actions to be taken to produce biofuel feedstocks in a sustainable manner. EMPs should include:

- A contingency plan to be acted upon in the event of an "escape" of a plant species or pest organism that could cause an invasion to contain the spread, and ascertain the suitable course of action such as eradication versus containment or management.
- The provision of a fund to pay for eradication, containment, management, or restoration. Where appropriate (funds should be external – held by government). Funding could also be guaranteed through a requirement for insurance or a licensing system that requires a deposit to be made into a centrally managed fund.
- The development and implementation of a monitoring system that checks for escapes and the presence of pests and pathogens.

The plan should specify that certain best practices will be followed that are well suited to the specific local conditions. Such practices may include:

- The use of buffer zones and wildlife corridors
- Zero-till planting to reduce exposed soil and "disturbed areas prone to invasion"
- Planting of indicator species that act as an early warning of pest problems
- Appropriate rotation or mixed cropping systems to maintain soil health
- Fencing and other barriers to prevent animal vectors entering farms
- Biological control agents to reduce the risk of spread
- Pre fruit/seed harvesting of biomass
- Educating farm employees about risks of taking propagules from the site and introduction of an appropriate system of checks
- Use and production of low fertility or sterile hybrids
- Control of seedlings that may establish outside of the crop area

Lastly, EMPs should be audited by a third party and it may also be appropriate to integrate invasive species risks into existing EIA requirements and agricultural regulations to further strengthen the system.

4) Transportation/processing

Overview of the issues

This stage includes all risks related to invasion after the feedstock has been harvested. This includes escape during transport from farm to processing facilities, and export of any propagules or pathogens during transport and trade by air, sea or land.

Guidance for governments:

- Promote projects that add value to feedstocks by converting them at or near the site of production (and thereby reduce risks of transporting propagules over long distances).
- Ensure that quarantine procedures monitor movement of any high-risk feedstocks within national borders
- Develop communication and education programmes for transport companies and other relevant stakeholders to highlight the risks of biological invasions and the need for monitoring systems.

Guidance for developers and investors:

- Propagules should be contained in an appropriate manner on site. Nurseries should ideally be sited alongside plantations to reduce transport distances and associated risk of escape.
- When feedstocks/propagules are transported efforts should be made to prevent the spread of seeds, pests etc. through adequate monitoring of vehicles.
- To reduce the risk of escape, feedstocks should ideally be converted on-site or as near to the farm as possible to an inert tradeable product (if not the finished biofuel). This has the benefit of containing propagules on site, but also adds value to the feedstock, which may then contribute to economic development in the communities where the feedstock is produced and processed.
- Awareness of transporters in relation to propagules and the risk of escape, as well as the risk of transfer of pathogens is extremely important. Developers should ensure that transporters are well informed about the need for a monitoring system that checks vehicles and packing materials for soil and seeds and includes regular cleaning at each end of the transport pathway.
- Transport corridors should be monitored for the escape and spread of species.

Acronyms

COMESA	Common Market for Eastern and Southern Africa
ECOWAS	Economic Community of West Africa States
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
GISP	Global Invasive Species Programme
ICRAF	World Agroforestry Centre
IPPC	International Plant Protection Convention
ISPM	International Standards for Phytosanitary Measures
IUCN	International Union for Conservation of Nature
NPPO	National Plant Protection Organisation
RSB	Roundtable on Sustainable Biofuels
SEA	Strategic Environmental Assessment
WRA	Weed Risk Assessment

Further resources

CABI – http://www.cabi.org/

CBD – https://www.cbd.int/decision/cop/?id=7197

GISP – http://www.gisp.org/

IPPC – https://www.ippc.int/IPP/En/default.jsp

IUCN Energy – www.iucn.org/energy

IUCN Invasive Species Specialist Group – http://www.issg.org/

Buddenhagen CE, Chimera C, Clifford P (2009) Assessing Biofuel Crop Invasiveness: A Case Study. PLoS ONE 4(4): e5261. doi:10.1371/journal.pone.0005261

Howard, G. & Ziller, S. (2008) Alien Alert – plants for biofuel may be invasive. July/August issue of Bioenergy Business http://cmsdata.iucn.org/downloads/alien_alert_g__howard_and_s_ziller_bioenergy_business_aug_2008.pdf

ICRAF policy on invasives - World Agroforestry Centre Policy Guidelines on Invasive Alien Species (2004) www.worldagroforestry.org/downloads/policies%20and%20guidelines/ICRAF_policy_invasives.pdf

CBD (2006) Global Biodiversity Outlook 2, http://www.cbd.int/gbo2/

IUCN (2008) Implementing Sustainable Bioenergy Production; A compilation of tools and Approaches. Gland, Switzerland: IUCN. 32pp http://cmsdata.iucn.org/downloads/biofuels____compilation_of_tools_final.pdf

IUCN (2009) Biofuels and Invasive Species: Exploring the links between biofuel production systems and invasive species – A background paper prepared by John Mauremootoo for the IUCN Workshop on Biofuels and Invasive Species – Nairobi, Kenya, 20th-22nd April, 2009 http://cmsdata.iucn.org/downloads/biofuels_and_invasives_background_paper.pdf

RSB Guidance on Principles & Criteria (version 1.0) 12/11/09 http://cgse.epfl.ch/webdav/site/cgse/shared/Biofuels/Version%20One/Version%201.0/RSB%20Guidance%20on%20PCs%20Version%201.pdf

Acknowledgements

These guidelines were developed and edited by Sam Keam, Nadine McCormick, Geoffrey Howard and Andrea Athanas. The basis of the guidelines came out of two workshops held at the IUCN ESARO office in Nairobi in April and October, 2009. Grateful acknowledgement is owed to the following participants who assisted in developing and refining this work: Sarah Simons, Francis Ogwal, Eva Kassara, Ryan Blanchard, Rezene Fessehaie, Seynou Oumarou, Brian Nkandu, Kirsten Roettcher, Abed Kagundu, Arne Witt, Lovemore Simwanda, Gadi Gumisiriza, Graham von Maltitz, Peter Sumbi, Abdulrahman S. Issa, Esther Abonyo, Sébastien Haye, Ayoub Francis Nchimbi, Emmanuel Sulle, Mkoma Masanyiwa, Fritjof Boerstler, Faith Odongo, Dick Lufafa, Alex Nabiswa. We would also like to thank the following for providing additional feedback on the draft versions: Doris Cellarius, Chris Buddenhagen, Piero Genovesi, and Christine Tibelius.

Financial support for the development of these guidelines was generously provided by the David and Lucile Packard Foundation.

About IUCN

IUCN, International Union for Conservation of Nature, helps the world find pragmatic solutions to our most pressing environment and development challenges.

IUCN works on biodiversity, climate change, energy, human livelihoods and greening the world economy by supporting scientific research, managing field projects all over the world, and bringing governments, NGOs, the UN and companies together to develop policy, laws and best practice.

IUCN is the world's oldest and largest global environmental organization, with more than 1,000 government and NGO members and almost 11,000 volunteer experts in some 160 countries. IUCN's work is supported by over 1,000 staff in 60 offices and hundreds of partners in public, NGO and private sectors around the world.

http://www.iucn.org

INTERNATIONAL UNION
FOR CONSERVATION OF NATURE

WORLD HEADQUARTERS
Rue Mauverney 28
1196 Gland, Switzerland
mail@iucn.org
Tel +41 22 999 0000
Fax +41 22 999 0002
www.iucn.org