# Precaution and emerging technologies

## The case of GMOs

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# GMOs – some basic background

- What is genetic engineering? Some basic terms:
  - Genes
  - Traits
  - Proteins
  - Recombinant DNA
- The starting assumption for regulation was that there were few risks associated with novel proteins.

## What kinds of GMOs are out there?

- Just two traits at this point – the technology is not as simple as they thought.
  - Insect resistance. Using Bt, a pesticidal protein
  - Herbicide tolerance. Incorporates a protein to detoxify or substitute for a protein disabled by an herbicide – Roundup or Liberty.

# Looking a little deeper into the unintended or unknown consequences of genetic engineering

- **At the genetic level**
  - Insertion site is random
  - Multiple inserts, sequence rearrangements, other aberrations at the genetic level are common
  - Strong promoters can turn neighboring genes on and off
- **At the molecular level**
  - Plants often add sugars that change the character of the inserted protein
  - Unintended secondary products can be formed
- **At the ecological level**
  - What exactly does the novel protein/plant do in the environment?

## What are some common concerns raised?

- Possible human allergenicity or other type of toxicity
- Impacts on non-target organisms that are of ecological or other significance
- Failure of the GE traits, leading to economic impacts for farmers

**Risk =**
**magnitude of harm x**
**probability of occurrence**

# Thinking a little more about the magnitude piece of the equation

## Two crucial and intractable features of risk

- Risk has multiple dimensions, many of which are irreducibly qualitative
  - reversibility
  - fairness
  - spatial distribution
  - gravity
  - and others noted by Stirling, 1999.
- The multiple dimensions are incommensurable.

# Assessing probabilities – the problems of uncertainty and ignorance

- Uncertainty: where you have confidence in the completeness of the set of possible outcomes but no way to assign probabilities to those outcomes
- Ignorance: where defining a complete set of outcomes is also problematic

# The state of scientific knowledge about possible effects of GMOs

- It's still rather poor.
- Uncertainty and ignorance are the norm. Little scientific data have been generated to date.
  - Companies won't pursue essential questions
  - US and other governments do not require/fund essential research
  - Failures usually aren't published
  - Data are slowly being generated
  - Critical scientists are often brutally attacked by industry and other scientists

# On uncertainty and GMOs

- **the imponderables** associated with global climate models, the sheer number of chemicals and the unpredictability of their behaviour in the environment and the unprecedented nature of genetic modification technology **are all such as to render ignorance and uncertainty** (in their formal senses) **the dominant conditions in the management of each of these types of risk**.
- the curious thing is that these and other sources of intractable uncertainty and ignorance are routinely treated in the regulatory appraisal of technology by using the probabilistic techniques of risk assessment. Given the manifest inapplicability of probabilistic techniques under uncertainty and ignorance, this is a quite remarkable phenomenon.
- it is precisely where the stakes are highest that the uncertainties (and ignorance) tend to be most understated.

(Stirling, 1999)

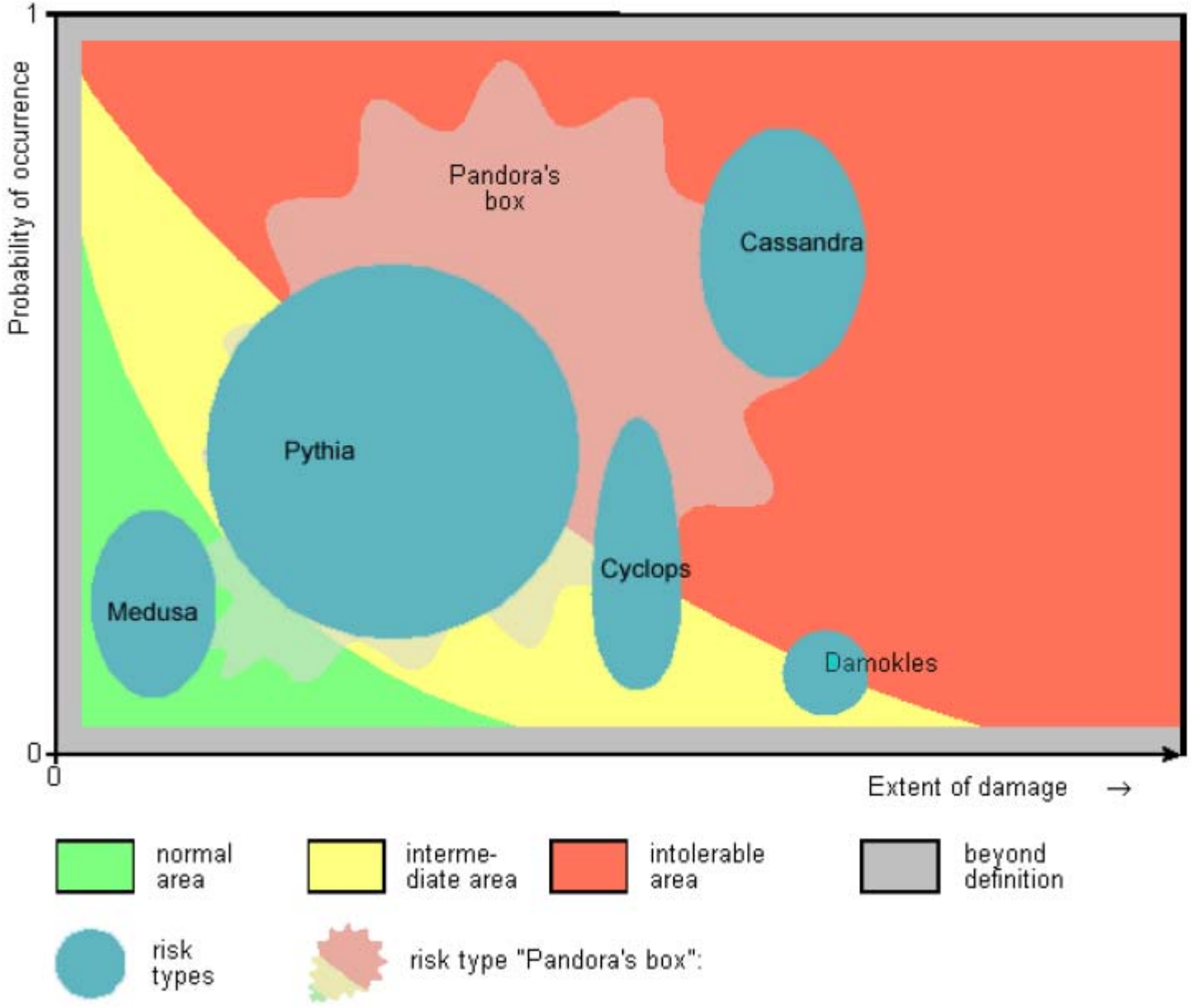
**What are characteristics of GMOs that make a strong precautionary approach appropriate in the face of enormous uncertainty?**

- They are living organisms that can reproduce and spread
  - Persistence
  - Possibility of global distribution
  - Possible irreversibility
- Potential for human and/or ecological harm

# Stirling's conclusions?

Conditions under which a more strongly precautionary strategy might be seen to be justified by the relatively high uncertainty: weapons of mass destruction, AIDS, BSE, POPs, endocrine disrupters, **GM crops** and continued growth in global warming. (Stirling, 1999)

**Figure 3: A Graphic Representation of the Heuristic Risk Taxonomy (after Renn and Klinke)**



# Essential components of precautionary action on GMOs?

- **Stakeholder engagement** as a matter of analytical rigor to address the multiple dimensionality of risk
- Significantly **more basic research** on possible ecological and human health impacts
- **Scientific rigor *and humility*** at the small-scale and large-scale experimental stages
- **Shift the burden of proof** onto the advocate
- System of **labelling** for GE foods to enable monitoring of food supply effects

In some cases, you want zero risk.