

Adaptation and regional standardization of methodology for evaluating effects on non-target organism

Edison Ryoiti Sujii



Genetic Resources and Biotechnology

Convention on Biological Diversity



RIO+20
Conferência das
Nações Unidas
sobre
Desenvolvimento
Sustentável

- The green economy in the context of **sustainable development** and poverty eradication



Sustainability in Agriculture

- A goal for technical innovation in agriculture
 - Prudent use of renewable and/or recyclable resources
 - Protects the integrity of natural systems so that natural resources are continually regenerated
 - Improves the quality of life of individuals and communities
 - Profitable



Convention on Biological Diversity (Rio 92):

- **Biotechnology will provide maximum benefits if biosafety assessment protocols are available (Agenda 21)**

LAC-Biosafety



Biosafety Protocol of Cartagena

General principles for risk assessment

- Science-based
- Open, transparent and documented
- Case-by-case basis (trait-crop-receiving environment)
- Systematic – structured step-by-step approach
- Iterative
- Adverse effects (direct and indirect, immediate and delayed)



COLLECTION OF RESOURCES FOR BIOSAFETY ANALYSIS



Literature database (non-target organisms and methodologies)

References

Non-target (cotton): 66 References – 25 articles and documents

Non-target (maize): 131 References – 16 articles and documents

Non-target (potato): 16 References – 12 articles and documents

Non-target (rice): 24 References – 12 articles and documents

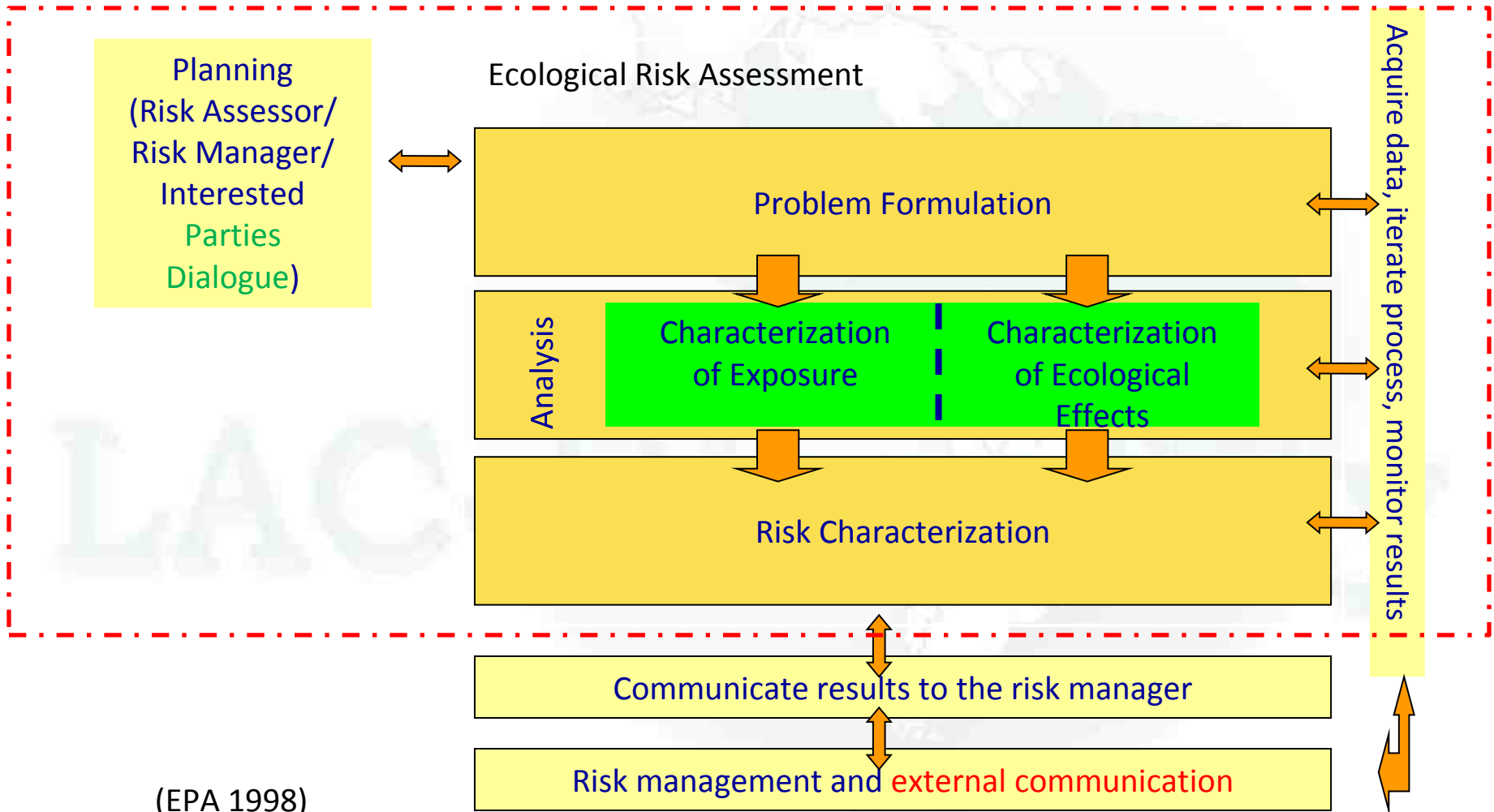
Methodologies 89 References - 16 articles and documents

Other related non-target: 274 References -44 articles and documents

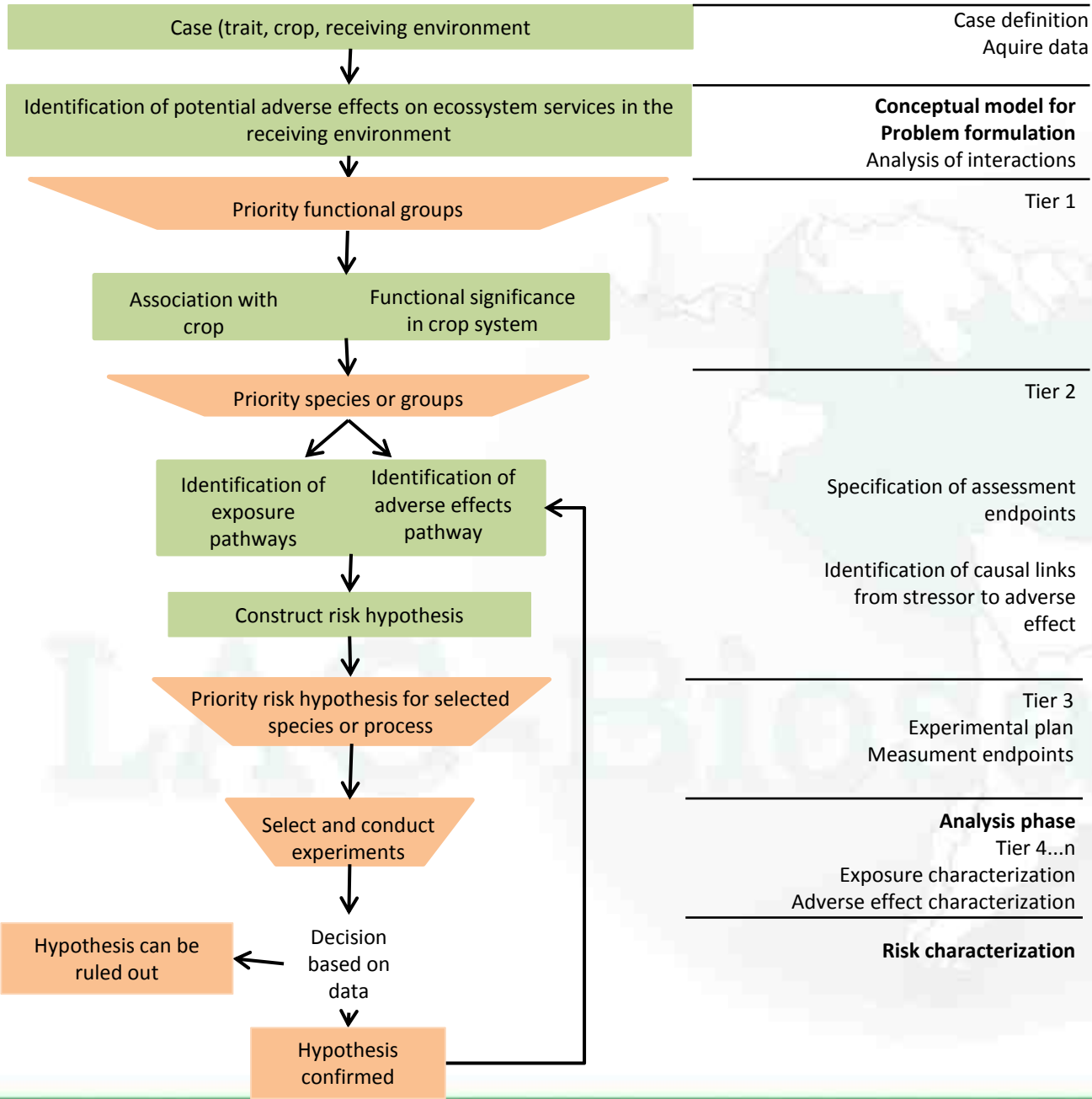
Total 600 References - 122 articles and documents available in PDF

Mendley e.address – www.mendley.com (sign in and search Laboratório de Ecologia)

Environmental Risk Assessment - General Framework



(EPA 1998)



LAC Biosafety Proposal

Methodology

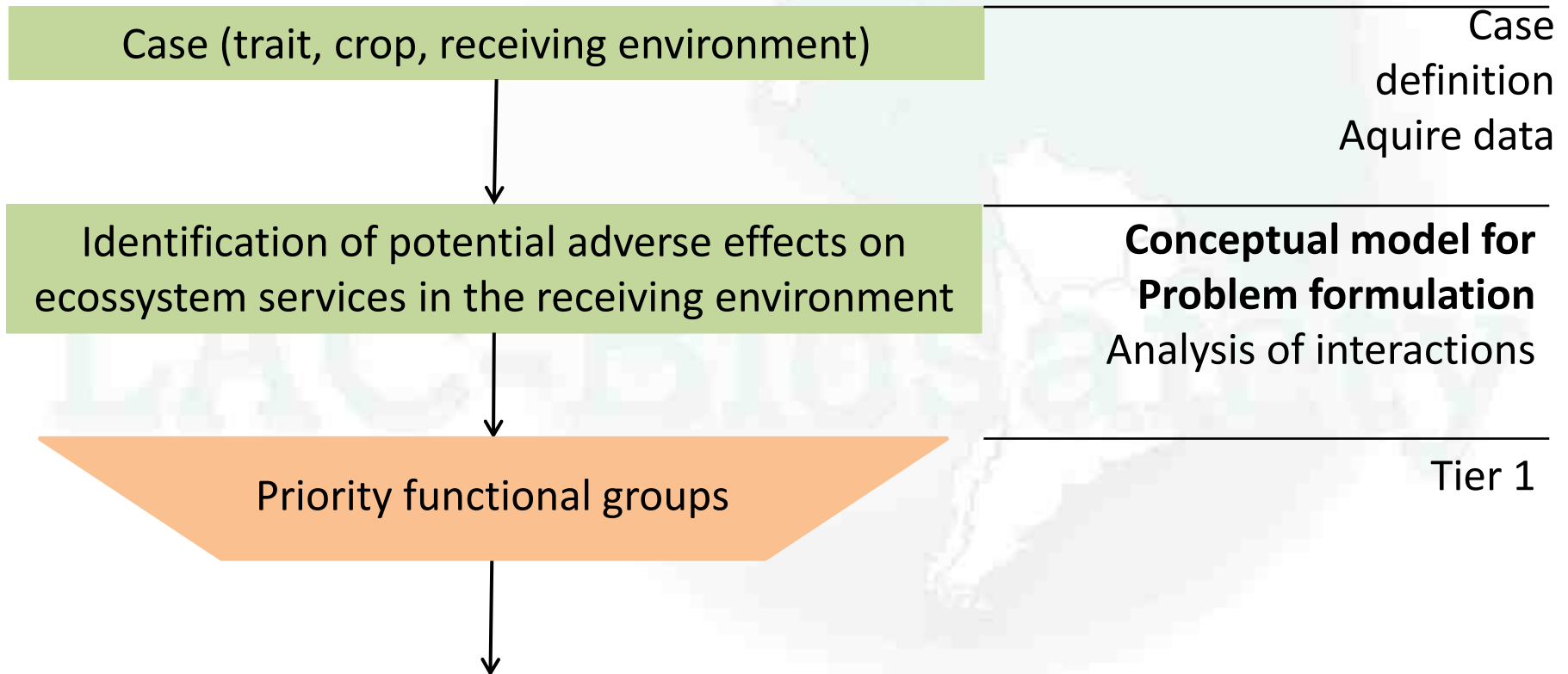
Risk assessment of GMO on non-target organisms

LAC Biosafety Proposal

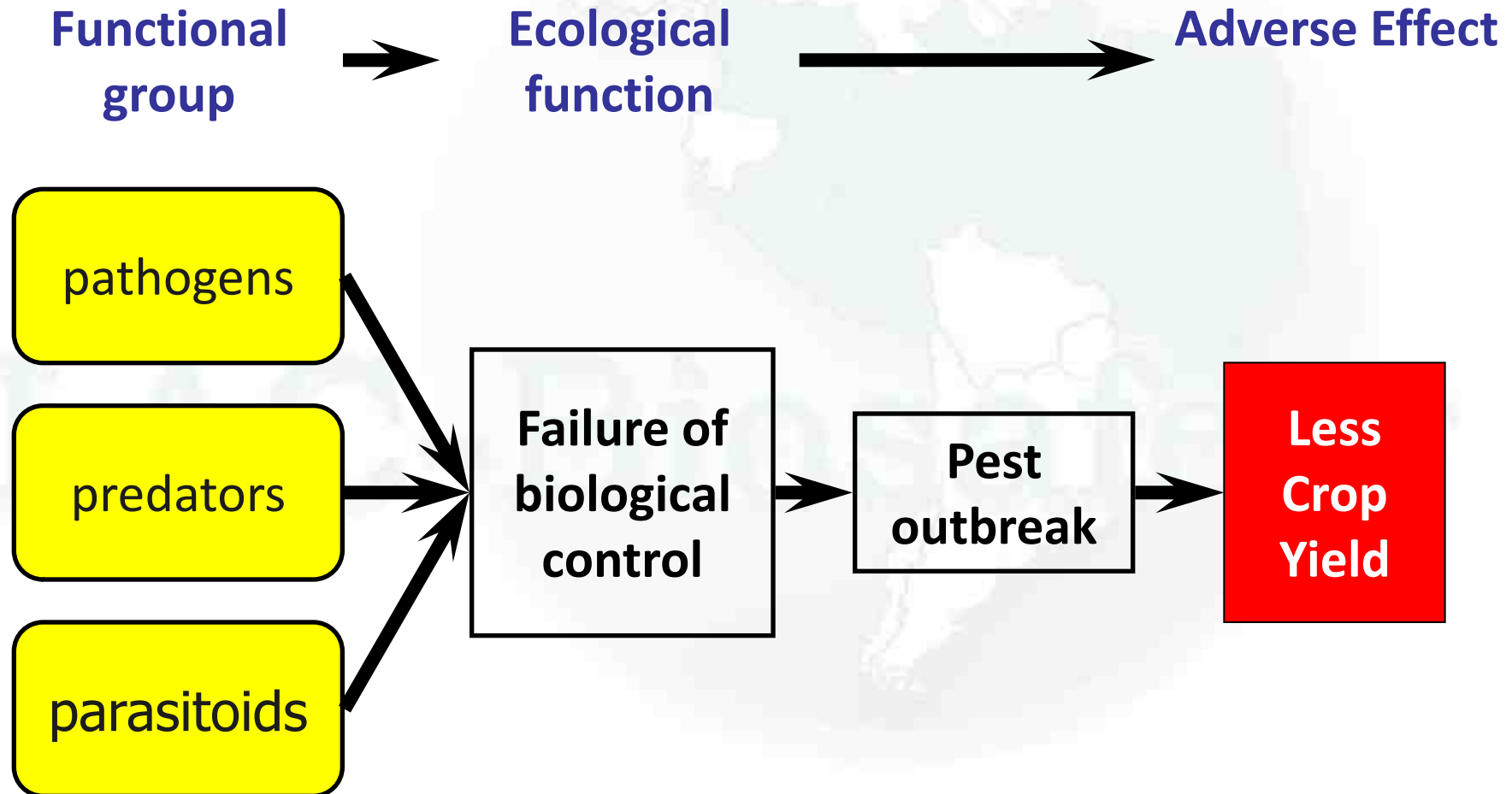


Methodology

Risk assessment of GMO on non-target organisms



Causal pathway to a potential adverse effect

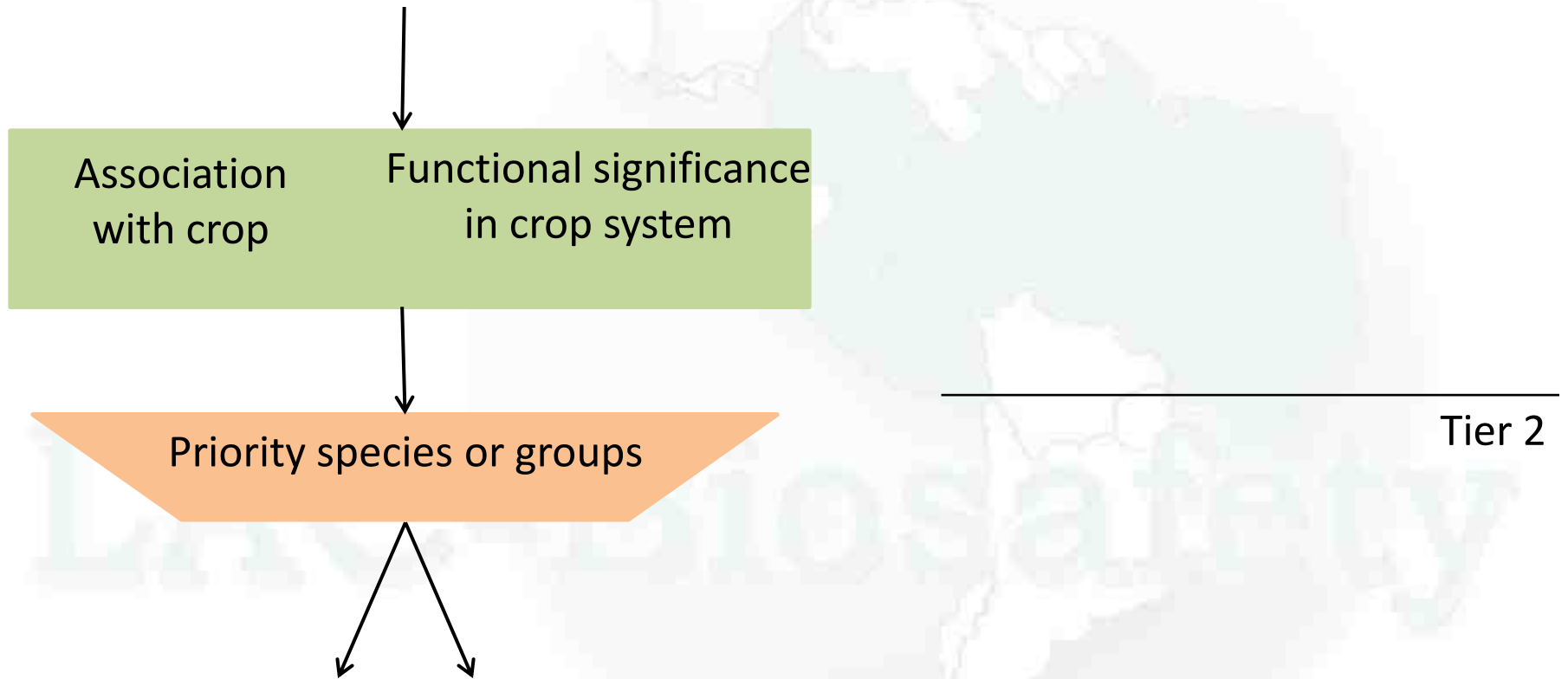


Bt cotton

Adverse Effects → Functional Groups	Crop ↓	Soil health ↓	Non-crop econ. ↓	Cultural value ↓	Conserv. concern ↑	Environ. quality ↓	Human disease ↑
Pest herbivores	X	X	X				
Predators/Parasitoids	X						
Pollinators of crop	X		X		X		
Soil decomposers	X	X				X	
Endangered species					X		
Plant disease	X						

Methodology

Risk assessment of GMO on non-target organisms



Selection Matrix

Functional group: predators	Association with crop					Functional significance				Overall rank
	GD	HS	P	A	TL	C	OC	NA	OF	
Wasp <i>Polistes</i> spp.	3	1	3	2	1	1	1	2	?	14
Stinkbugs <i>Podisus nigrispinus</i>	3	1	2	2	1	2	2	2	?	15
Ladybeetles <i>Cycloneda sanguinea</i>	3	1	3	3	2	3	3	2	?	20
Earwigs <i>Doru luteipes</i>	3	1	3	3	1	2	3	?	?	16
Lacewings <i>Chysoperla externa</i>	3	1	2	2	2	3	1	2	?	16
Spiders Thomisidae	3	1	3	3	1	?	2	2	?	15

Association with crop: selection criteria

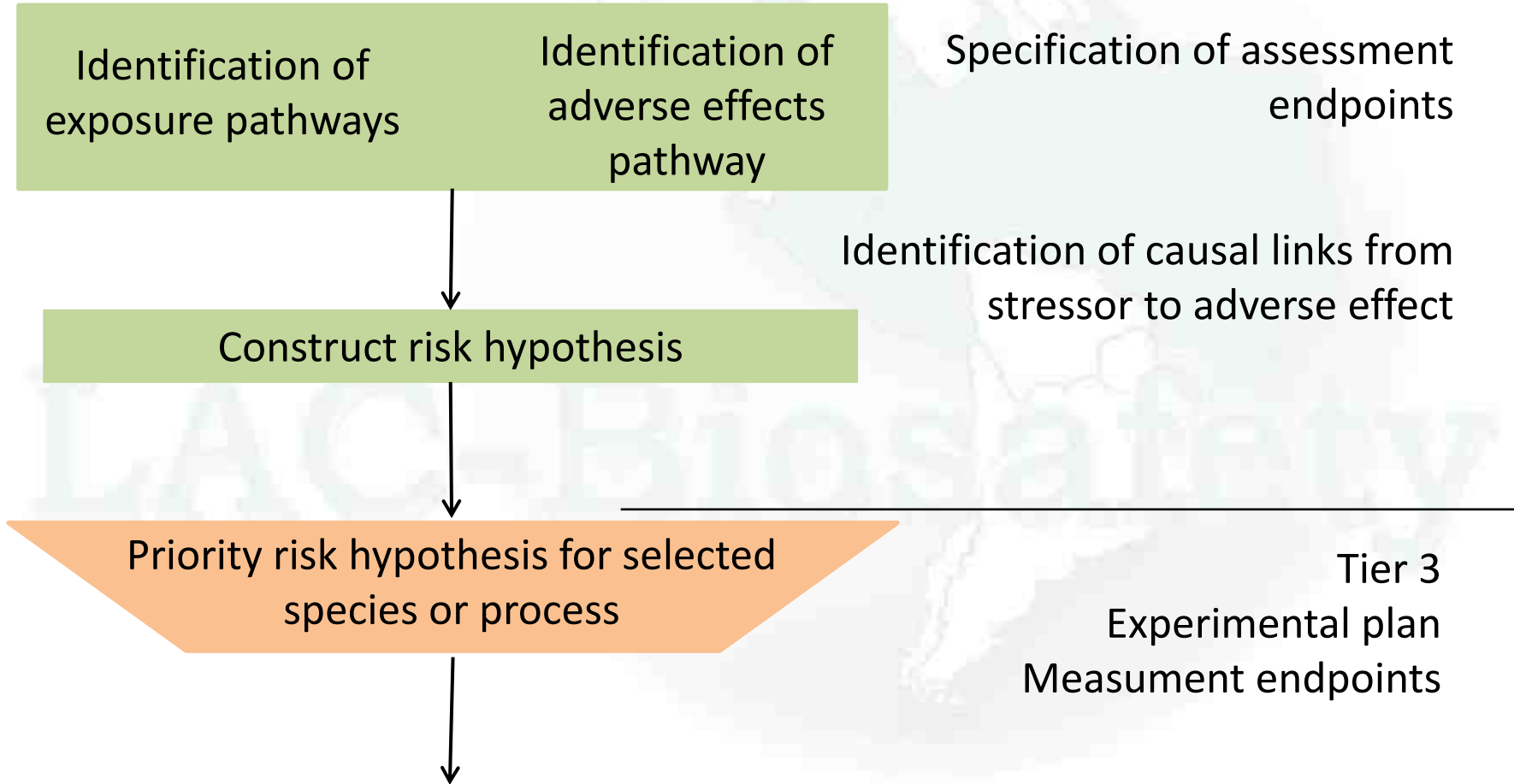
- 1. Geographic distribution**
- 2. Habitat specialization**
- 3. Prevalence**
- 4. Abundance**
- 5. Phenology**
 - a) crop growing season**
 - b) lifecycles of the species or taxon on the crop**
- 6. Trophic connection**

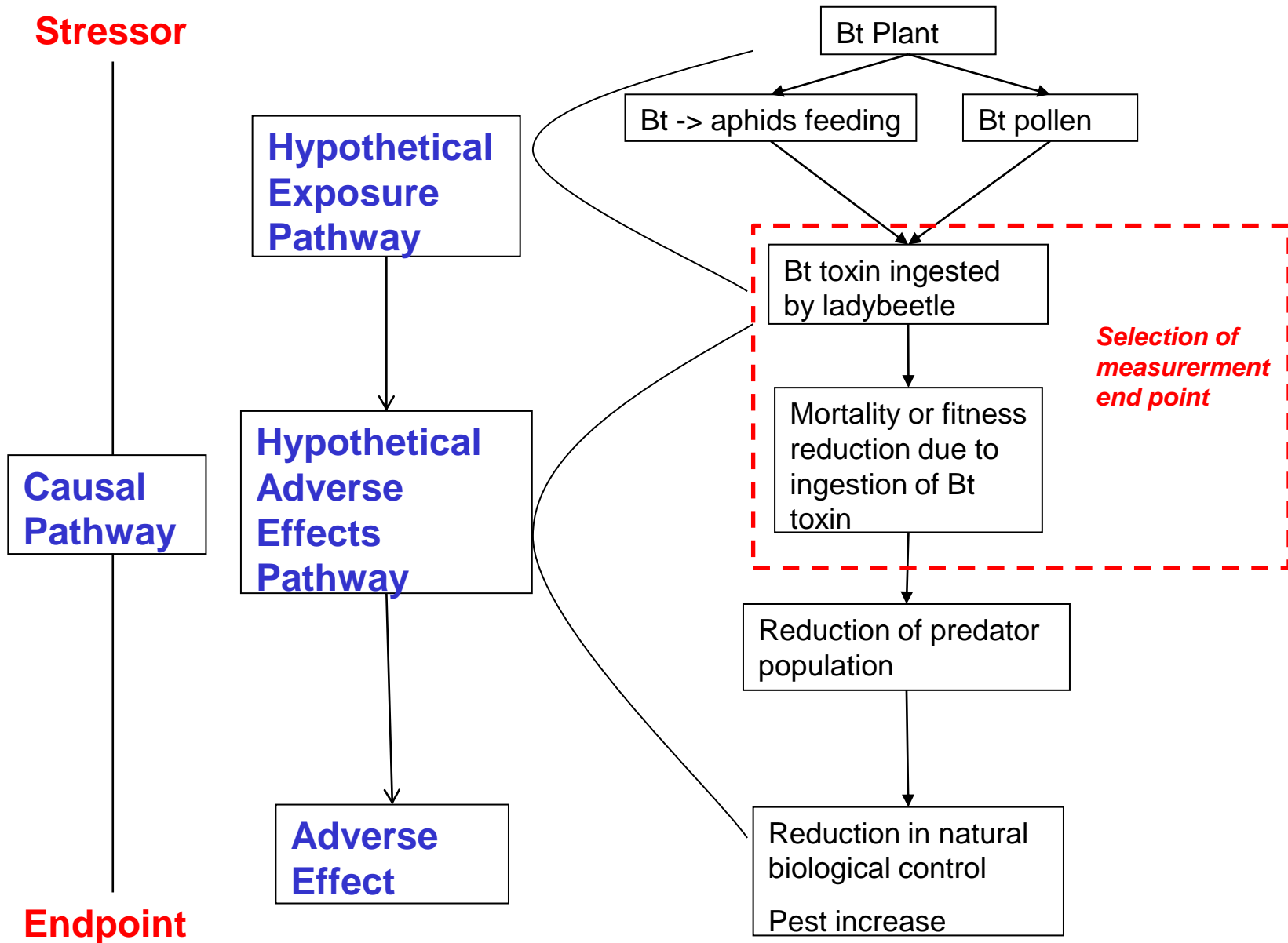
Functional significance: selection criteria

- Potential in Crop
- Potential in Other Crops
- Potential in Natural Areas
- Other ecological roles

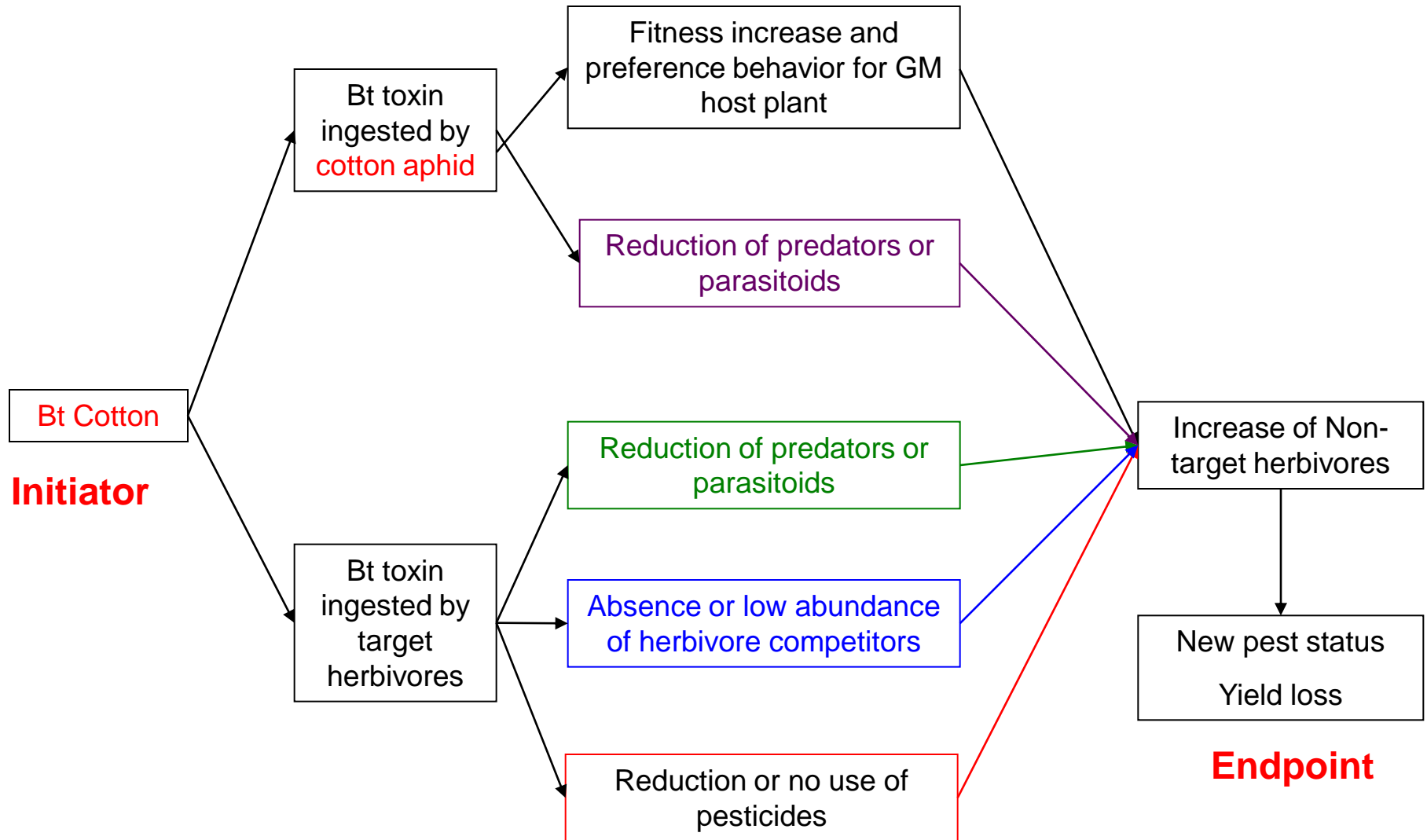
Methodology

Risk assessment of GMO on non-target organisms



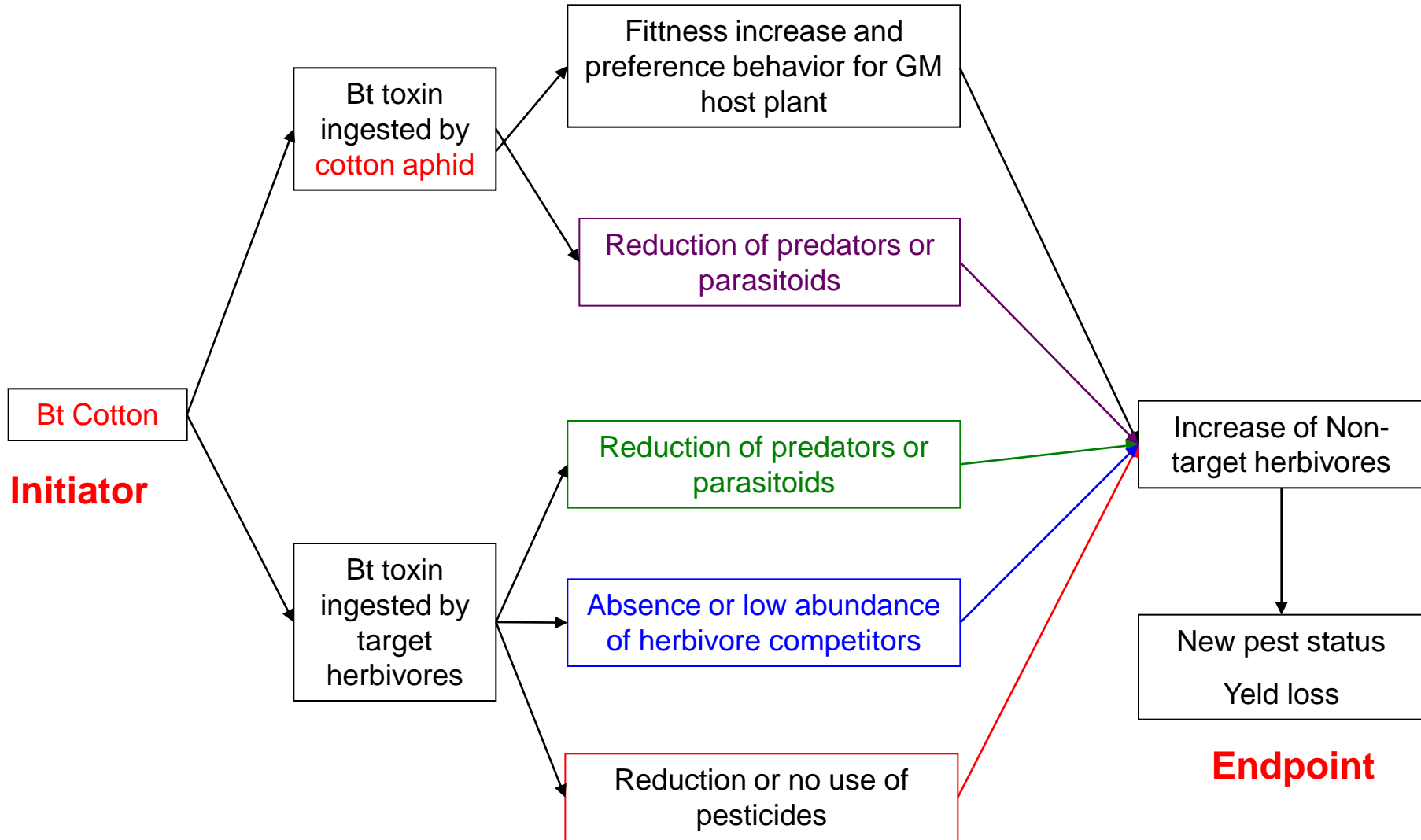


Ranking risk hypothesis



Likelihood: what is the chance for each one to happen?

Ranking risk hypothesis



Feasibility: can each one be tested?

Characterization and use

3. Strategy for testing a set of risk hypothesis

- Weak causal links
- Key causal links
- Easy and difficult experiments
- Staging the testing
- Experimental endpoints

COLLECTION OF RESOURCES FOR BIOSAFETY ANALYSIS



Literature database (non-target organisms and methodologies)

References

Non-target (cotton): 66 References – 25 articles and documents

Non-target (maize): 131 References – 16 articles and documents

Non-target (potato): 16 References – 12 articles and documents

Non-target (rice): 24 References – 12 articles and documents

Methodologies 89 References - 16 articles and documents

Other related non-target: 274 References -44 articles and documents

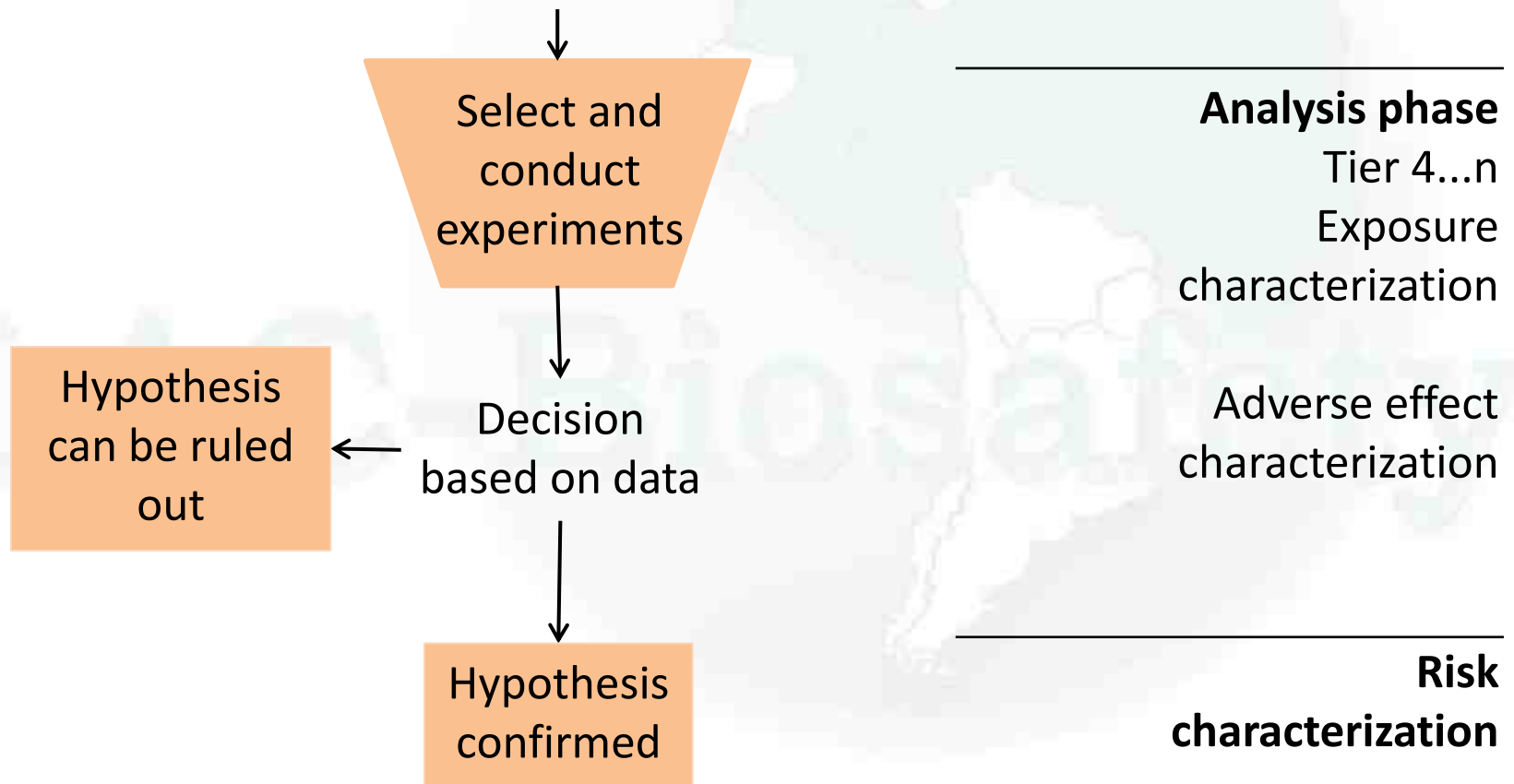
Total 600 References - 122 articles and documents available in PDF

Mendley e.address – www.mendley.com (sign in and search Laboratório de Ecologia)

LAC Biosafety Proposal



Methodology Risk assessment of GMO on non-target organisms



Analysis phase



Evaluates relationship between stressor levels and adverse ecological effects.

Exposure Characterization

Source of Stressor (transgene, product of the expression, crop)

Movement of Stressor

Transformation of Stressor

Concentration of the stressor

Adverse Effect Characterization

- Consequences: Magnitude of effect (severe)
 - Spatial scale of effect (large)
 - Reversibility of effect (irreversible)
- Likelihood: Relative ranking (high)
- Private/Social: Fully privatized (low)
 - Focus on socialized component

Risk characterization

Risk = Probability + Initiator/Source/Stressor/Hazard + Adverse effect

Combining the exposure and effects characterizations - the likelihood that an adverse effect of specified severity will occur.

Includes **three components**:

- Estimating risk– the process of integrating exposure and effects data
- Describing risk– what does the estimate mean?
- Uncertainty analysis– how certain is the risk?

Additional components

- Fairness: who is affected?
- Prevention: can the risk be avoided?
- Rights to make choices

Summary of Dossiers for Commercial Approval in Brazil of Cotton



Commercial Approvals: (2001-2011) 9 events (insect resistance - Cry1Ac, Cry2Ab2, Cry1F, Cry1Ab, Cry2A and herbicides -EPSPS, PAT)

List of non-target organisms for cotton - Direct exposure to the toxin/protein through artificial diet, seeds, soil, pollen, leaves, bran in Laboratory (Surrogate species from list of US EPA for ecotoxicological tests)

parasitoid: *Nasonia vitripennis* (Himenoptera)

pollinator: *Apis mellifera* (Hymenoptera)

predator: larv of *Chrysoperla carnea* (Neuroptera), *Hippodamia convergens* (Coleoptera)

soil - Collembola (*Folsomia candida*, *Xenilla grisea*) and earthworm *Esenia fetida* (Anellida:Lumbricidae), Mite (*Oppia nittens*)

Herbivores: Coleoptera: *Anthonomus grandis*, *Diabrotica undecipunctata*, *Leptinotarsa decemlineata*, Homoptera: *Myzus persicae*; Lepidoptera: *Ostrinia nubilalis*, *Manduca sexta*, *Helicoverpa zea*, *Heliothis virescens*; *Tetranychus* sp.; *Danaus plexippus*

Aquatic: Diptera: *Aedes aegypti*; channel catfish, *Daphnia magna*, *Onchoryncus miykiss*

Detritivores: Orthoptera: *Blatella germanica*;

Birds: Bobwhite quail; *Colinus virginianus*, chicken

Mamals: White mouse, Sprague-Dawley rat; rat,

Summary of Dossiers for Commercial Approval in Brazil of Cotton



Field evaluation of non-target organisms for cotton – Comparison of GM X Non-GM cotton (Brazil, Europe, Asia)

Acari: Acaridae, Euphthicaridae, Galumniade, Laelpidae, Lohmanniidae, Macrochelidae, Microzetiade, Oppioiade, Parasitiade, Phthicaridae, Scheloribatidae;

Aranea: Argiopidae, Philodromidae, Oxyopidae, Clubionidae, Lycosidae, Salticidae, Tetragnathidae, Therididae, Thomisidae; Blatodea: Blattidae; Coleoptera: Anthicidae, Carabidae, Ceramycidae, Chrysomelidae, Coccinelidae, Cucujidae, Curculionidae, Elateridae, Histeridae, Lagriidae, Latridiidae, Mordelidae, Nitidulidae, Phalacridae, Ptilodactylide, Scarabeidae, Scolutidae, Silvanidae, Staphylinidae, Tenebrionidae, ; Collembola; Dermaptera: Forficulidae, Labiduridae; Diptera: Agromyzidae, Asilidae, Calliphoridae, Cecidomyidae, Dolichopodidae, Drosophilidae, Heleomyzidae, Lonchaeidae, Muscidae, Mycetophilidae, Otitidae, Phoridae, Pipunculidae, Sarcophagidae, Sciaridae, Sciomyzidae, Stratomyidae, Syrphidae, Tachinidae, Therevidae, Tipulide, Xylophagidae; Hemiptera: Anthocoridae, Alydidae, Anthocoridae, Aphididae, Cicadellidae, Coreidae, Cydnidae, Lygaeidae, Miridae, Nabidae, Pentatomidae, Psyllidae, Pyrrhocoridae, Reduviidae, Tingidae; Isoptera: Termitidae;

Hymenoptera: Anthophoridae, Aphidiidae, Aphelinidae, Apidae, Bethyidae, Braconidae, Ceraphronidae, Chalcidae, Colletidae, Diapriidae, Encyrtidae, Eulophidae, Eupelmidae, Eurytomidae, Figitidae, Formicidae, Ichneumonidae, Megachilidae, Megaspilidae, Mutilidae, Mymaridae, Perilampidae, Platygastriidae, Pompilidae, Pteromalidae, Scelionidae, Sphecidae, Tiphidae, Trichogramma, Torymidae, Vespidae; Lepidoptera: Crambidae, Gelechiidae, Noctuidae, Pyralidae; Mantodea: Mantidae;

Neuroptera: Hemerobiidae; Orthoptera: Acrididae, Gryllidae; Psocoptera: Pseudocaecilidae;

Thysanoptera: Aleohipidae, Phlaeothripidae, Thripidae;

Non-target organisms for evaluation of GM Cotton in Brasil



List of Functional groups and species selected for Risk Hypothesis Formulation

1. Pollinators: *Apis mellifera*, *Trigona spinipes*, *Melissodes nigroaenea* and *Melissoptila pneucomola*
2. Herbívores: *Aphis gossypii*, *Spodoptera frugiperda* and *Anthonomus grandis*
3. Predators: *Chrisoperla externa* and *Cycloneda sanguinea*
4. Parasitoids: *Trichogramma pretiosum*, *Bracon vulgaris*, *Catolaccus grandis*
5. Soil organisms: Macrofauna (earthworms and Colembola) and Microorganisms (fungal and bacterial pathogens antagonists, arbuscular mycorrhizal fungi, decomposers, N-fixing)

Non-target organisms for evaluation of GM Cotton in Brasil



List of Adverse Effects for Risk Hypothesis Formulation

1. Reduction of pollination activity inside the crops and in the native vegetation due to the mortality or morbidity of immatures, impaired colony development or avoidance of transgenic crop fields
2. Selected herbivores outbreak leading to higher crop losses and increased use of broad-spectrum chemical insecticides
3. Reduction of natural biological control of pests by predation leading to higher crop losses and increased use of broad-spectrum chemical insecticides
4. Reduction of natural biological control of pests by parasitism leading to higher crop losses and increased use of broad-spectrum chemical insecticides
5. Reduction in the soil activity processes such as organic matter decomposition, nitrogen cycling (ammonification and nitrification), increase in the cotton pests attack or diseases transmission

CAPACITY BUILDING



2 COURSES: Risk evaluation of Genetically Modified Plants Training: Environmental Biosafety and Gene flow management

Place 1: ESALQ/USP Piracicaba SP – Organization: Embrapa/ ESALQ/USP Dep. Entomology

July, 25 to August 05 of 2011 - Participation: 20 graduated students

Place2. UFRPE CENAPESQ (Centro de Apoio a Pesquisa) Recife, PE - Organization: Embrapa/UFRPE Dep. Entomology

November, 23 to December, 04, 2010 - Participation: 10 graduated students

Lectures and practices from subproject members: Carmen S. S. Pires, Debora P. Paula, Celso Omoto, Eliana Fontes, Lucia Hoffman, Edison Ryoiti Sujii

1º Workshop Maíz Transgénico: Realidad y Perspectivas para el Brasil

(<http://www.cnpms.embrapa.br/milhotrans/>)

Place: Embrapa Milho e Sorgo Sete Lagoas – MG - Organization: Embrapa

07 a 09 de marzo de 2012 - Participation: 150 students, scientists, technicians from companies

Curso/Taller ORGANISMOS GENÉTICAMENTE MODIFICADOS Y BIOSEGURIDAD

Place: Universidad del Valle Cali – Colombia - Organization: UNIVALLE/ Corpoica/ Embrapa

20 a 23 de marzo de 2012 – Participation: 54 students, scientists, technicians

Workshop “Cómo Mejorar Los Beneficios Socioeconómicos De La Utilización De Algodón GM Entre Los Pequeños Agricultores Del Mercosur”

Place: FAEG - Goiânia – GO - Organization: Unicamp/ESURV/UEG

20 de abril de 2012 – Participation: 64 students and farmers

Training in Biosafety

Giselle de Araujo Chagas, biologist, BS, post-graduate student of environmental management

André Ricardo Bellinati, biologist BS, , post-graduate student of ecology

Gracias!

Carmen S. Soares Pires

Debora Pires

Simone Martins Mendes

José Magid Waquil

