Management of invasive alien species for agricultural sustainability in Nepal

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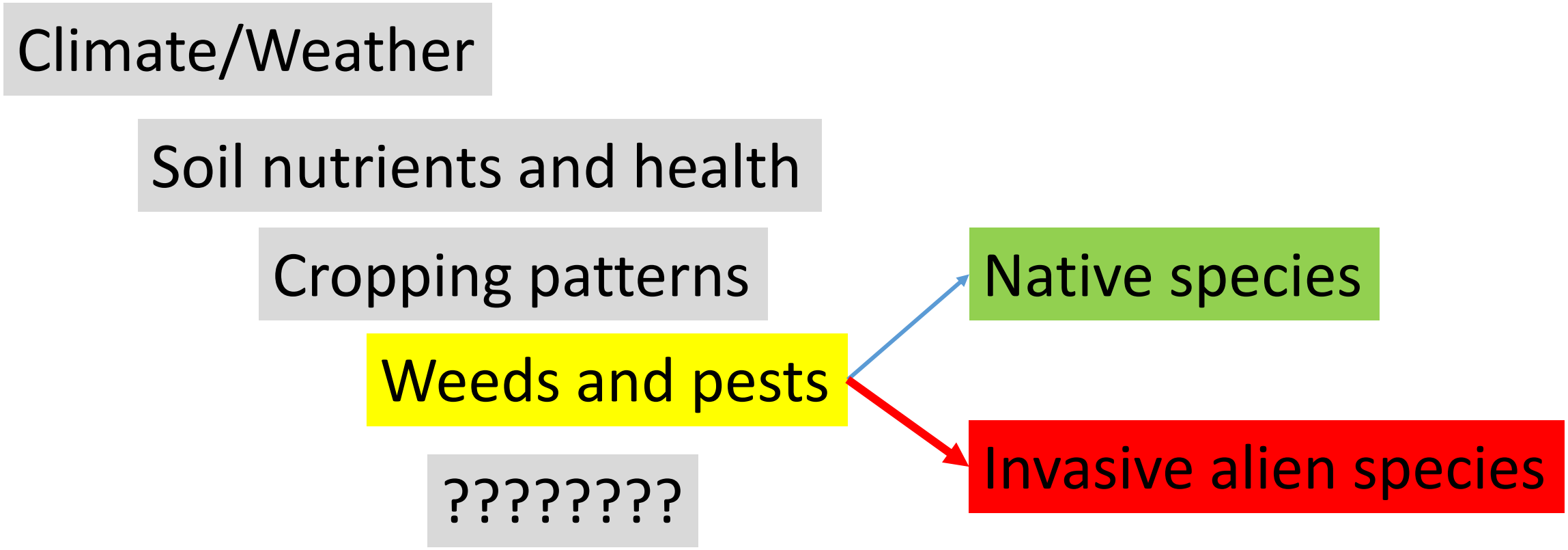
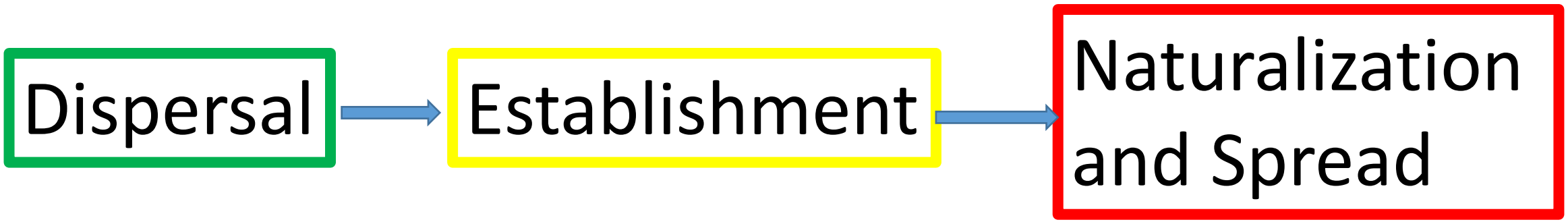
Factors affecting agriculture production per unit area



What is invasive alien species (IAS)?

Biological invasions:

- Human mediated dispersal (intentional or accidental) of organisms outside their current or past natural distribution range, often crossing the natural bio-geographic barriers (e.g. ocean, high mountains, desert).



What is invasive alien species…

Invasive alien species (IAS):

- **IPBES thematic assessment of invasive alien species:** “animals, plants or other organisms **introduced directly or indirectly by people** into places **out of their natural range of distribution**, where they have become **established and dispersed**, and may generate an **impact on local ecosystems and species**.”

Species

Native

Exotic

Casual

e.g. potato, poplar

Naturalized

Non invasive

e.g. white clover

Invasive

e.g. *Mikania*

Locust

Fall army worm

All ‘alien’ species are not ‘invasive’, but all ‘invasive’ species are ‘alien’.

What is invasive alien species…

Biological invasions

- **One of five** major components of global environmental changes (along with land use/sea use change, climate change, pollution, exploitation of biological resources) (IPBES 2019)
- **Second** most important driver of global biodiversity crisis (after land use change)
- High and **rising economic cost**: US $ 1.288 trillions in between 1970 and 2017 (Diagne et al 2021);
  - US $ 162.7 billion in 2017
  - **3 fold** increase per decade!

How many species are invasive in Nepal?

Date and References	#Naturalized species	#Invasive alien species
Flowering plants		
2005 (Tiwari et al)	166	**21**
2016 (Shrestha)	-	**25** (+ *Ageratum houstonianum, Erigeron karvinskianus, Galinsoga quadriradiata, Spermacoce alata*)
2017 (Shrestha et al)	-	**26** (+ *Spergula arvensis*)
2019 (Shrestha)	179	**26**
2021 (Shrestha and Shrestha)	182	**27** (+ *Mimosa diplotricha*)
2022	**184**	**30** (+ *Sphagneticola trilobata, Tithonia diversifolia, Leucaena leucocephala*)
Animals		
2015 (Budha)	64 (including captive animals)	?? (>10 species)

How many species are invasive in Nepal…

- More and more non-invasive alien species turned out to be invasive over the time.

Ageratum houstonianum (Nuwakot)

Tithonia diversifolia (Ilam)

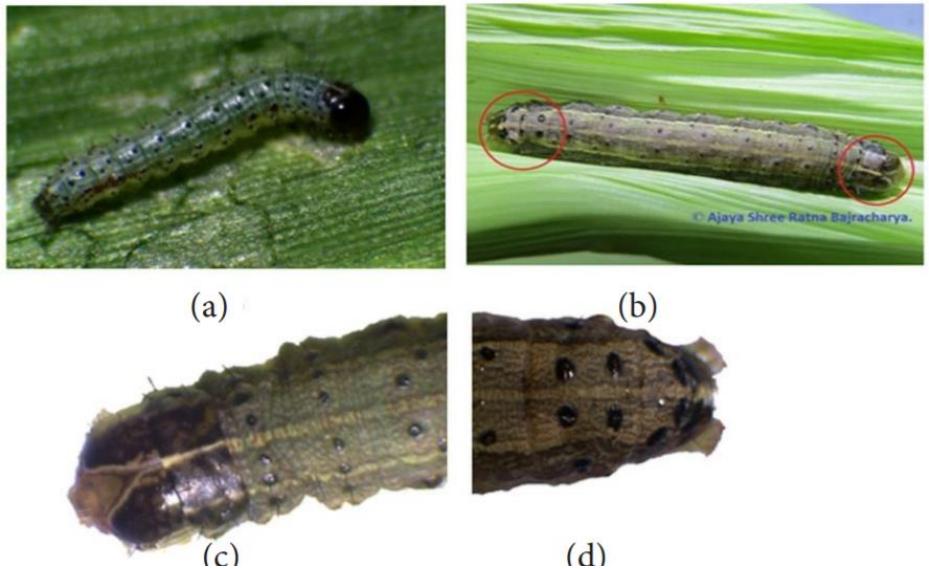
How many species are invasive in Nepal…

Important IAS reported after 2015

Mimosa diplotricha (2019)

Sphagneticola trilobata (2021)

Tuta absoluta (@Bajracharya et al 2016)



Spodoptera frugiperda (@Bajracharya et al 2019)

How many species are invasive in Nepal…

Among 100 of the world's worst IAS

Chromolaena odorata

Lantana camara

Mikania micrantha

Pontederia crassipes

Sphagneticola trilobata

How many species are invasive

Among 100 of the world's worst IA

***Leucaena leucocephala* (Ipil Ipil)**

- Introduced for **agroforestry** in Nepal and elsewhere
- In the process of **naturalization** in Nepal
- **Invasive** elsewhere including India and SE Asian countries
- A 'conflict species'

How many species are invasive in

Among 100 of the world's worst IAS…

Tilapia (*Oreochromis mossambicus*)
(Begnas lake – a Ramsar site)

Giant African snail (*Achatina fulica*)

How many species are invasive in Nepal…

Among 100 of the world's worst IAS…

(https://www.myholidaynepal.com/blog/category-Tour/Trout-Fish-at-Kakani/)

Might have established in Melamchi and Marsyangdi rivers

Rainbow trout (*Onchorhynchus mykiss*) farming in Melamchi valley, Kavrepalanchwok

How many species are invasive in Nepal…

- All these IAS affects agriculture, livestock and aquaculture productions directly and indirectly
- **Additional IAS are in our doorstep!**

Solidago canadensis

Hypoestes phyllostachya

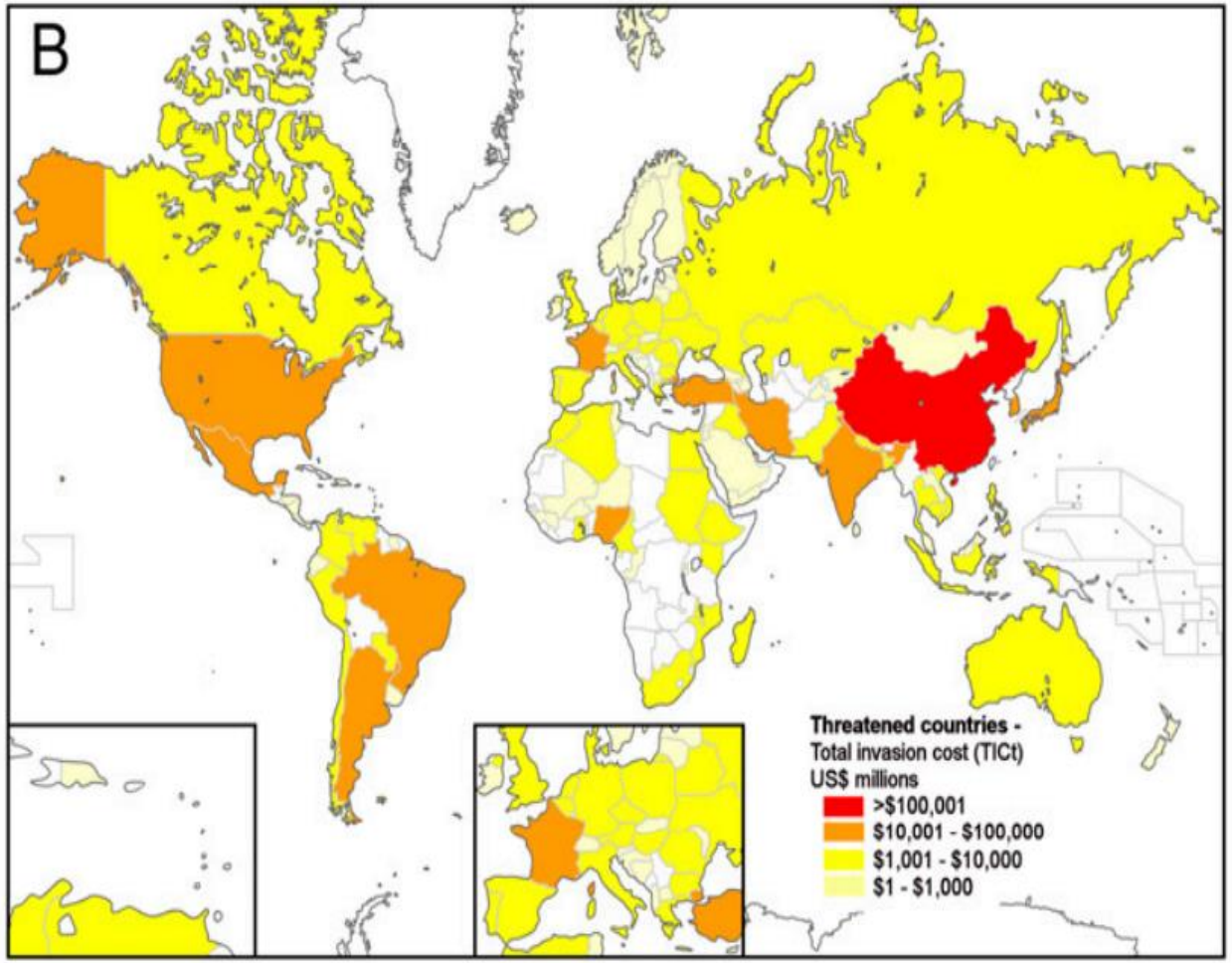
Anredera cordifolia

Impacts of IAS on agriculture productions

Rank	Country	OT_t
1	Mongolia	0.9922
2	Guinea-Bissau	0.9903
3	Nepal	0.9856
4	Bangladesh	0.9803
5	Cambodia	0.9688
6	Denmark	0.9659
7	Albania	0.9634
8	Chile	0.9611
9	Mauritius	0.9595
10	Vietnam	0.9542

Overall invasion threats

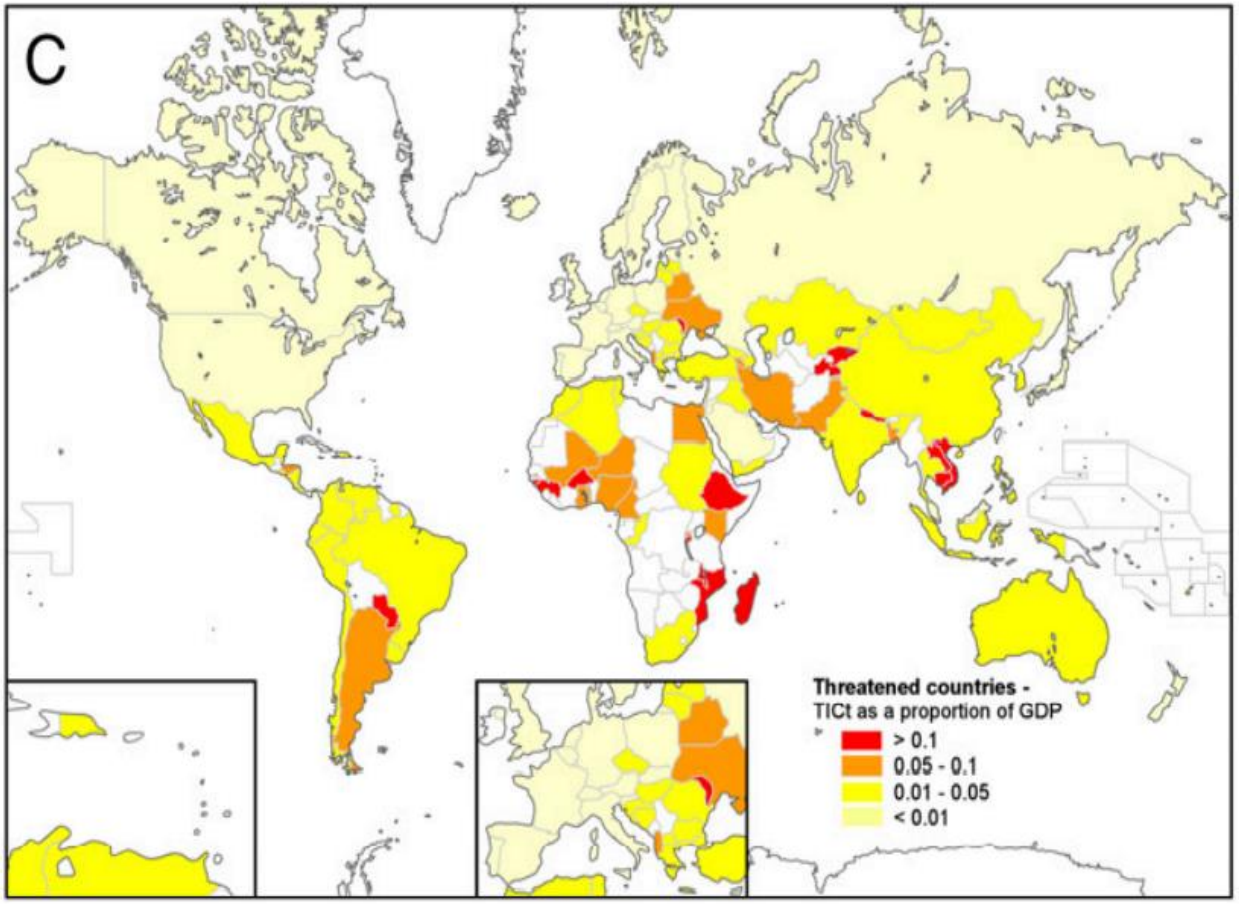
(124 countries; 1297 IAS; Paini et al 2016)



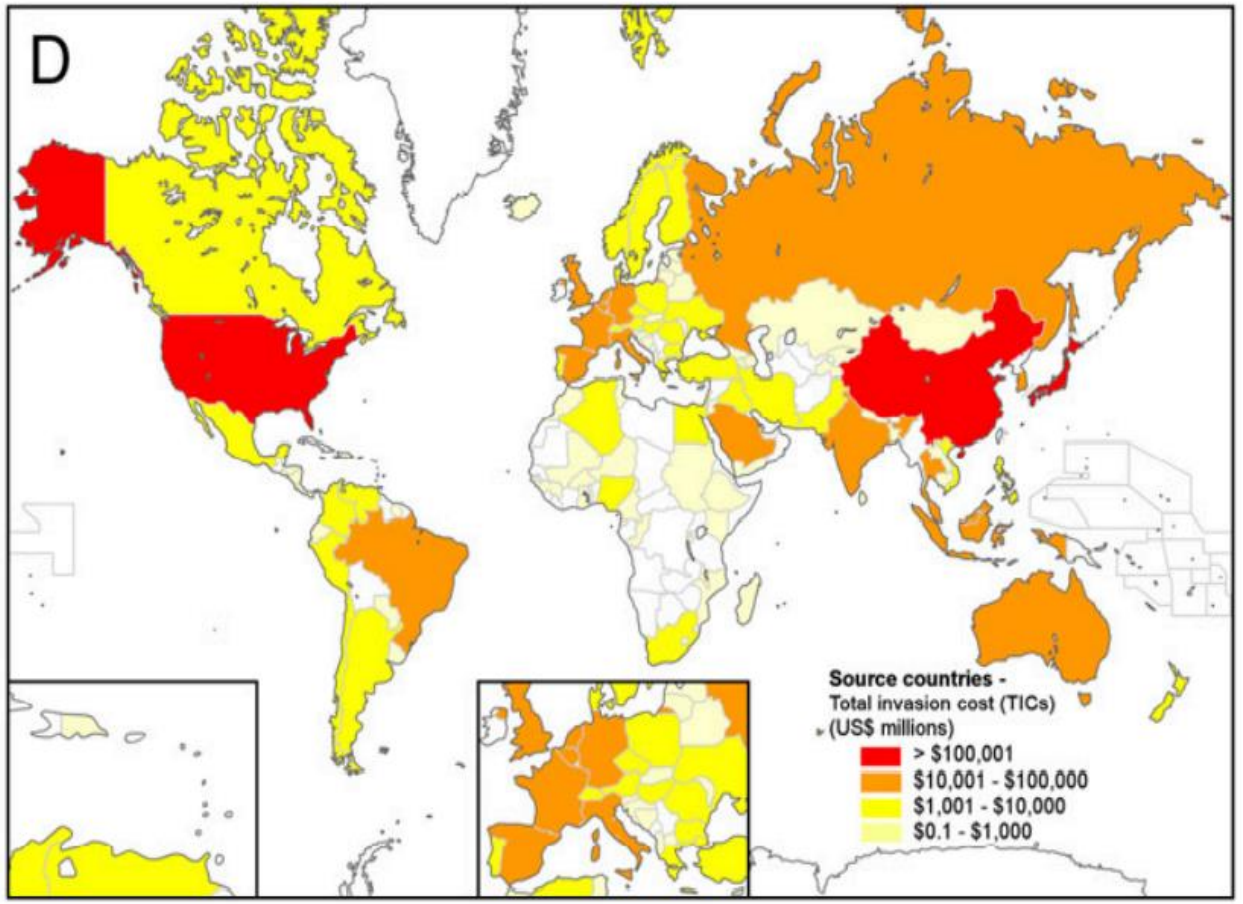
Total invasion cost

(Nepal: US $ 1.4 billion)

Impacts of IAS on agriculture productions…



Total invasion cost as a proportion of GDP



Total invasion cost

(124 countries; 1297 IAS; Paini et al 2016)

Impacts of IAS on agriculture productions…

Africa (Eschen *et al.* 2021):

- Total economic damage due to IAS: USD 3.66 trillions per year
- Most damaging species: *Phthorimaea (Tuta) absoluta* (USD 11.4 billions) and *Spodoptera frugiperda* (USD 9.4 billions).

Pakistan (Panjab province) (Bajwa *et al* .2019)

- Cost associated with *Parthenium*: USD 913/household/year

Nepal

- Not yet known; but can be substantial

कान्तिपुर

सतायो फौजीकिराले

कार्तिक २, २०७६ | डिल्लीराम खतिवडा, प्रदीप मेन्याङबो

उदयपुर/सुनसरी – धानबाली पाकेर काट्न लागेका बेला सुनसरी, उदयपु
कीराको प्रकोप बढेको छ । प्रदेश १ को बालीसंरक्षण प्रयोगशाला विरा
बढी फौजी किराको प्रकोप देखिएको छ । बाली संरक्षण अधिकृत मुके
सय २५ बिघा, उदयपुरमा ३ सय बिघा, सुनसरीमा ७५ बिघा र मोरङमा
देखिएको छ ।

कान्तिपुर 25

समाचार

बाह्र क्विन्टल शंखेकीरा संकलन

असार ३१, २०७५ | रासस

सल्यान — सल्यानको एउटै गाउँमा १२ क्विन्टल शंखेकीरा संकलन गरिएको छ । जिल्लाको शारदा नगरपालिका–६ बरलामा एउटै गाउँमा १२ क्विन्टल चार किलो शंखेकीरा संकलन गरिएको हो ।

पूर्वेली न्यूज़
आइतबार, माघ २५, २०७७

अचानक सबै खसी मरेपछि तुहियो कटुवालको घर बनाउने सपना

Impacts of IAS on agriculture productions…

Black gram field invaded by
Ageratum houstonianum (Kaski)

Oxalis latifolia in maize field (Dhankuta)

Reduced supply of livestock fodder

Parthenium invading rangeland in Hetaunda

Chromolaena invading rangeland in Panchthar

Impacts of IAS on agriculture productions…

Economic cost of IAS to Nepalese agriculture sector:

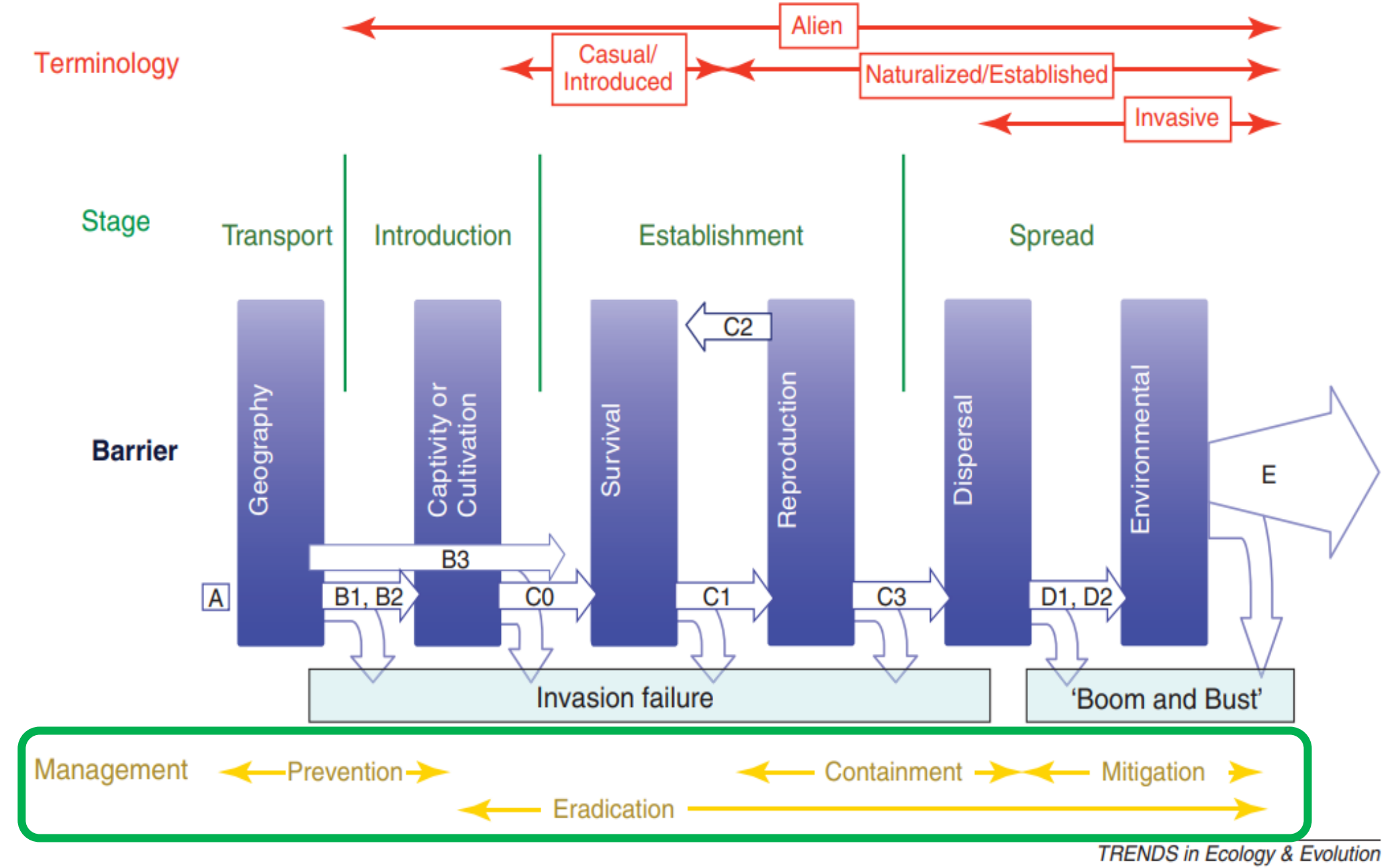
- A major data/research gap!
- Collaboration between resources/agriculture economists and invasion ecologists can address this data/research gap.

Management options

Depends on

- Stage of invasions
- Species in questions
- Habitats invaded

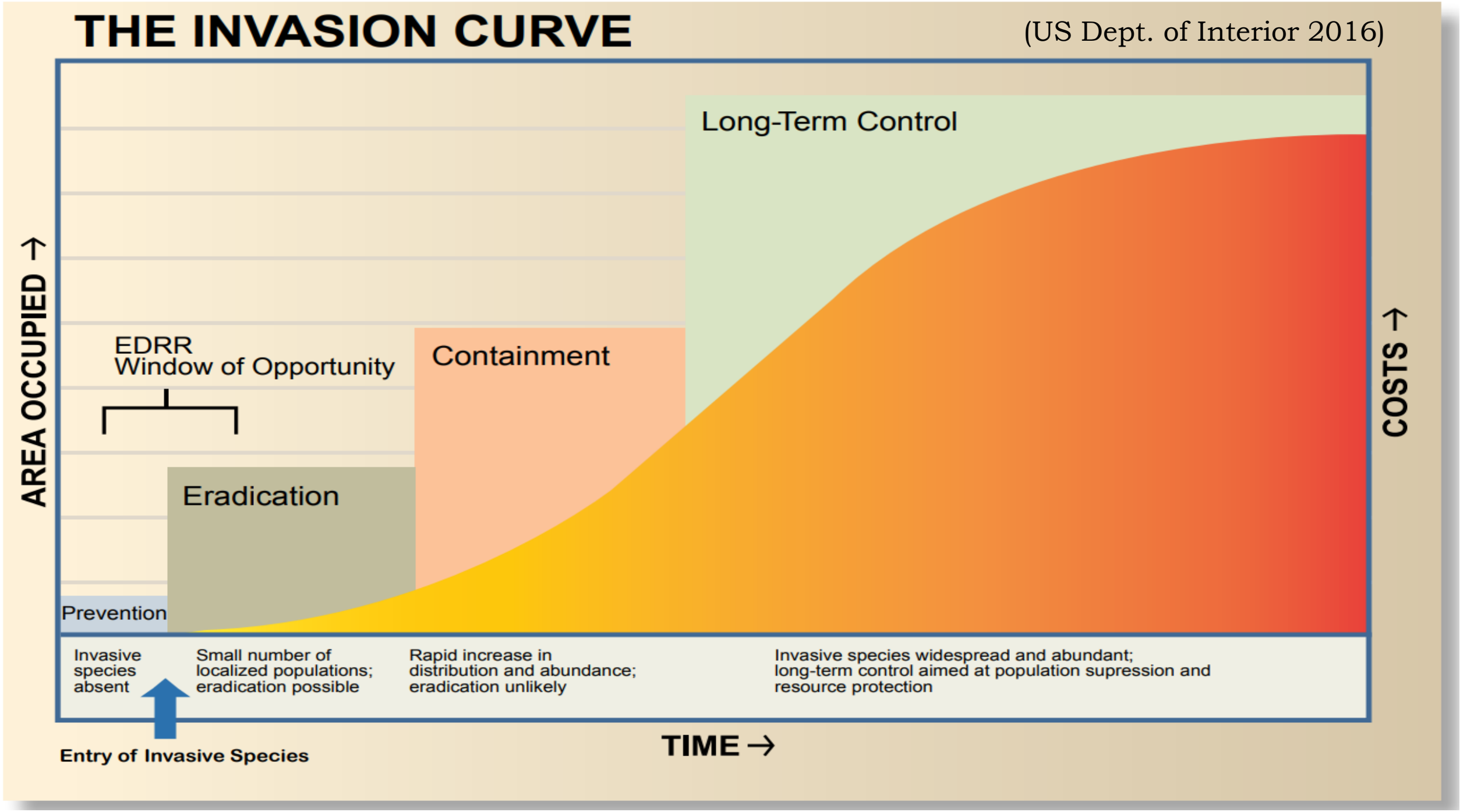
Cost of management **increase over time** and advancement in the invasion stage



(Blackburn et al 2011)

THE INVASION CURVE

(US Dept. of Interior 2016)



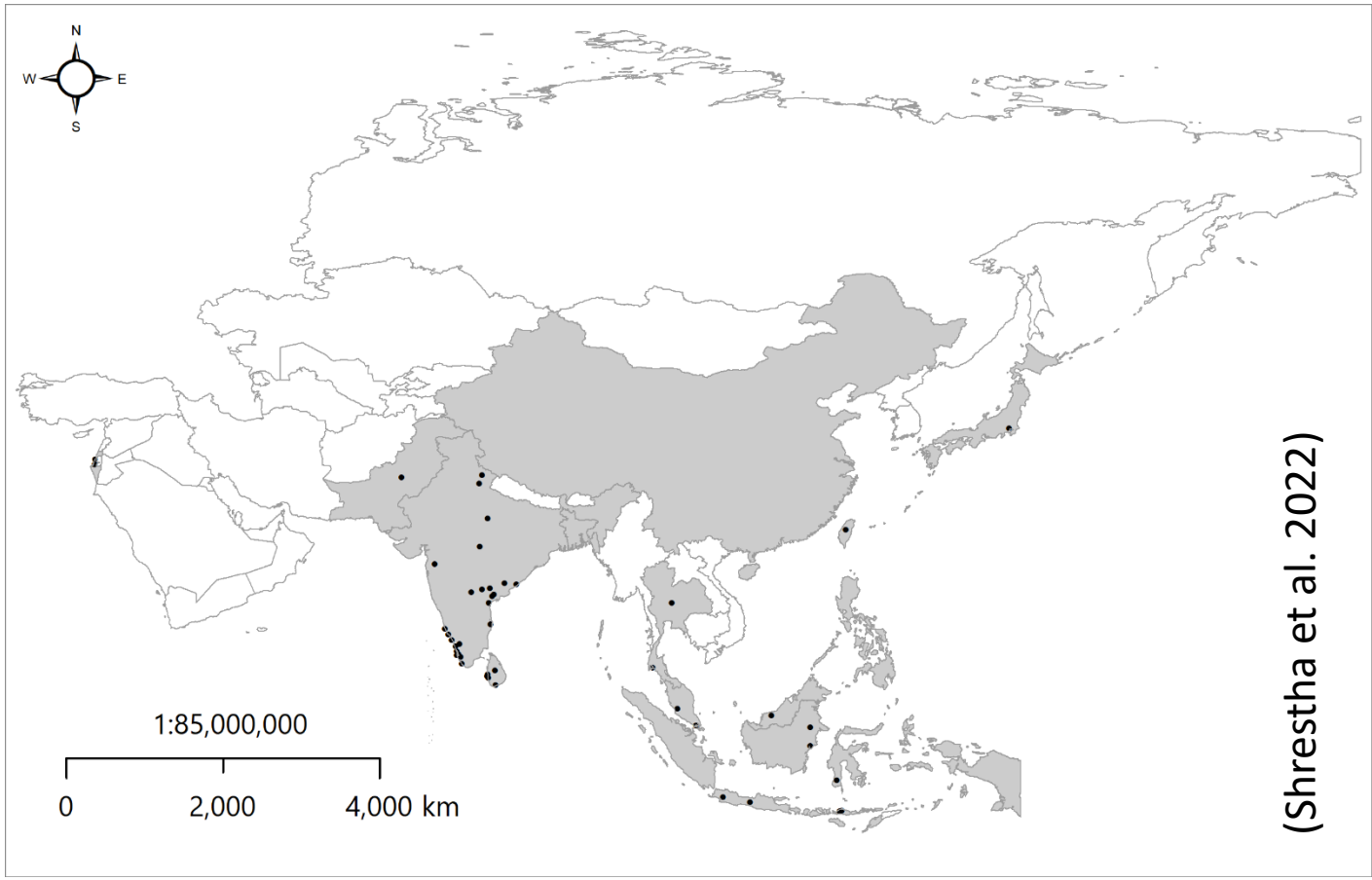
Management options…

- Prevention (Pre-border control): Quarantine; Risk assessment
- Early detection and rapid response (EDRR)
- Control (Physical/Mechanical/Chemical/Biological)
- Ecosystem based-approaches
- Adaptation

Species-specific management options for Nepal

- **Prevention**: E.g. *Salvinia molesta* (one of the globally worst invasive weed)

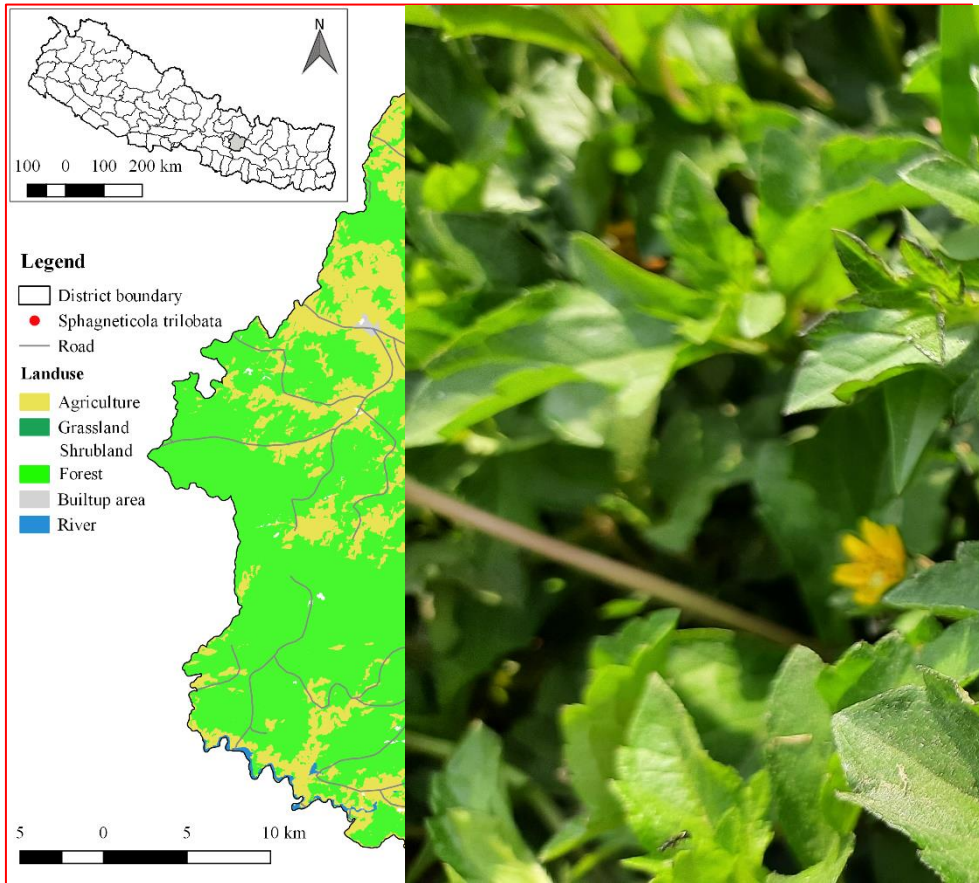
https://plants.ifas.ufl.edu/plant-directory/salvinia-molesta/



(Shrestha et al. 2022)

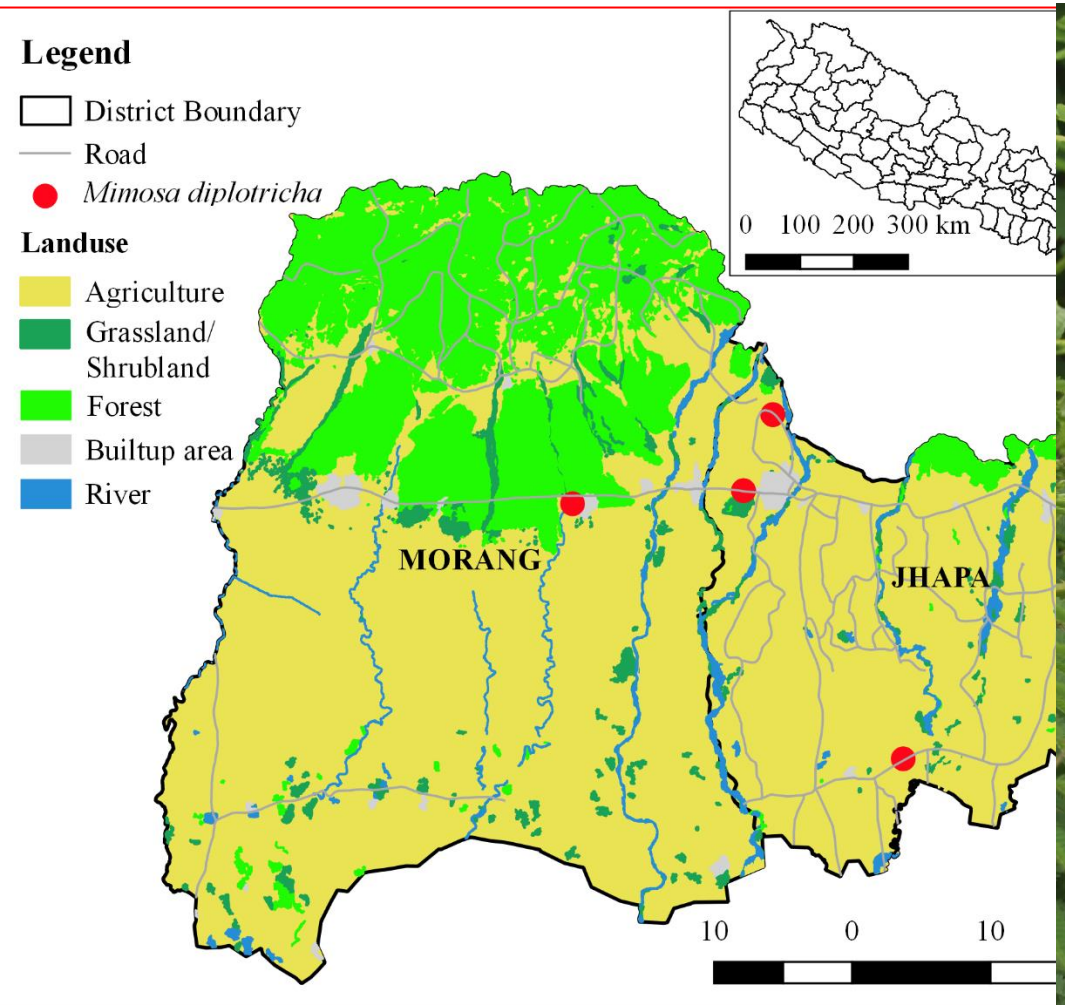
Species-specific management options…

- **Early Detection** and **Rapid Responses** (EDRR): Leading to **eradication** (e.g. *Sphagneticoloa trilobata, Solidago canadensis, Anredera cordifolia*) and **containment** (e.g. *Mimosa diplotricha)*



Species-specific management options…

- **Early Detection** and **Rapid Responses** (EDRR):….



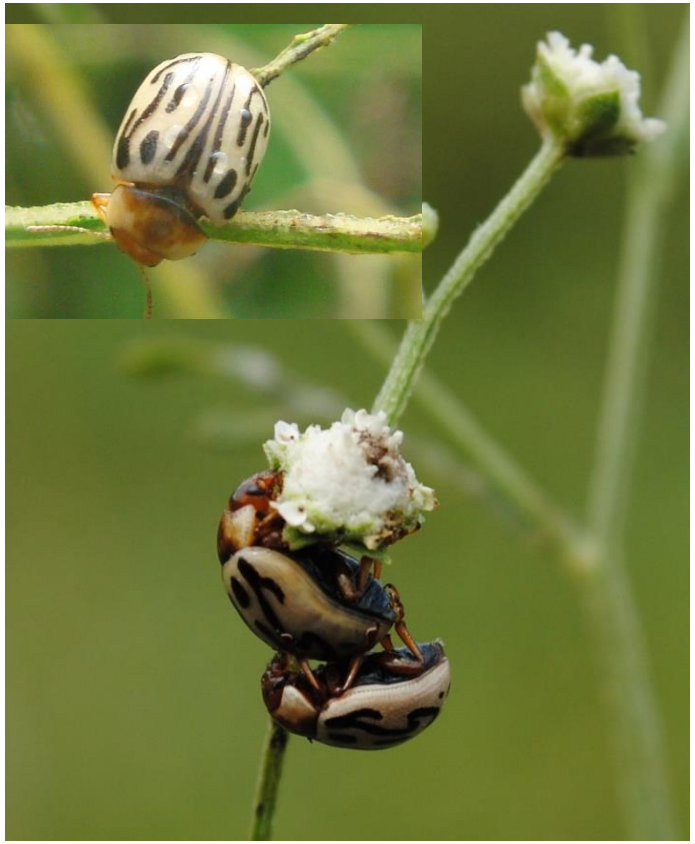
Species-specific management options…

Biological control:

- Sustainable and cost effective
- At least 11 invasive weeds of Nepal have effective biological control agents
- Formally not initiated yet, but some biological control agents have spread from the neighboring countries and established with some impacts
  - *Zygogramma bicolorata* and *Puccinia abrupta* for *Parthenium hysterophorus*
  - *Procecidochares utilis* for *Ageratina adenophora*
  - *Puccinia oxalidis* for *Oxalis latifolia* and *O. corymbosa*
  - *Neochatina bruchi* and *N. eichhorniae* for *Pontederia crassipes*

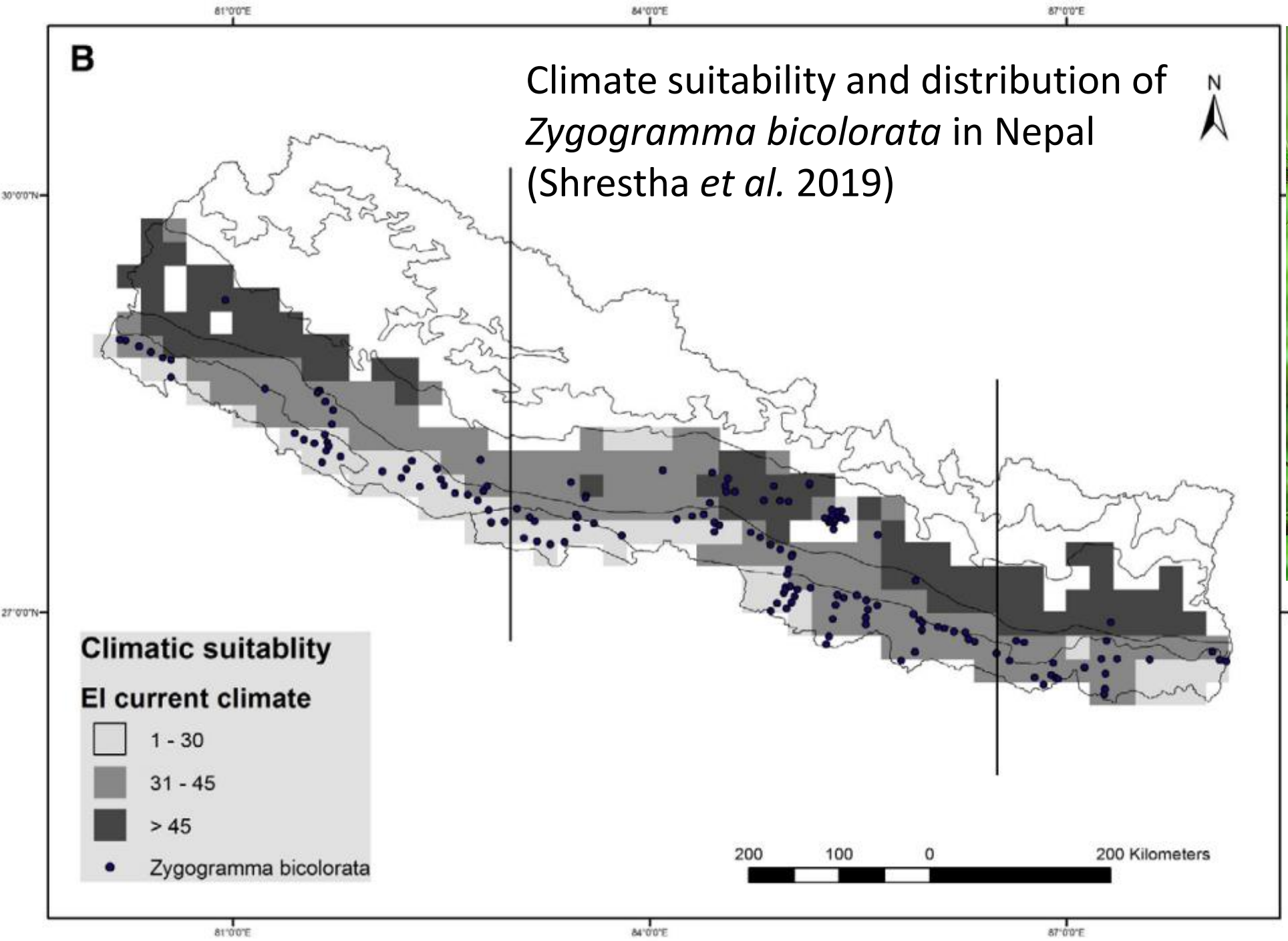
Biological control:…

Stem galling insect (*Procecidochares utilis*) against *Ageratina adenophora*



Leaf feeding beetle (*Zygogramma bicolorata*) against *Parthenium*

Winter rust (*Puccinia abrupta* var. *partheniicola*) against *Parthenium*


B
Climate suitability and distribution of *Zygogramma bicolorata* in Nepal (Shrestha *et al.* 2019)
N
81°0'0"E
84°0'0"E
87°0'0"E
30°0'0"N
27°0'0"N
Climatic suitablity
EI current climate
1 - 30
31 - 45
> 45
Zygogramma bicolorata
200
100
0
200 Kilometers

Biological control:…

- Two insects *Neochatina eichhorniae* and *N. bruchi* were released against water hyacinth in 2015 **without host-specificity test** (!?) by NARC
- Current status not known

(Project report by NARC in 2015 - unpublished)

Rearing NE and NB at rooftop of Entomology Division

Rearing NE and NB at laboratory of Entomology Division

Rearing of NE and NB in cut drum at glass house facilities of Entomology Division

Feeding puncture of the exotic beetle at glass house condition

Figure 7: Rearing of exotic beetle at Entomology Division, 2014/015

Puccinia oxalidis (?) against *Oxalis latifolia* and *O. corymbosa*

Species-specific management options…

Biological control:….

- None of them were introduced officially by Nepal
- No standard laboratory facilities for host range tests

- Search for native biological control agents against fall army worm (ongoing research?)

- Lack of awareness on the benefit and risk associated with biological control program

Data gap/requirements

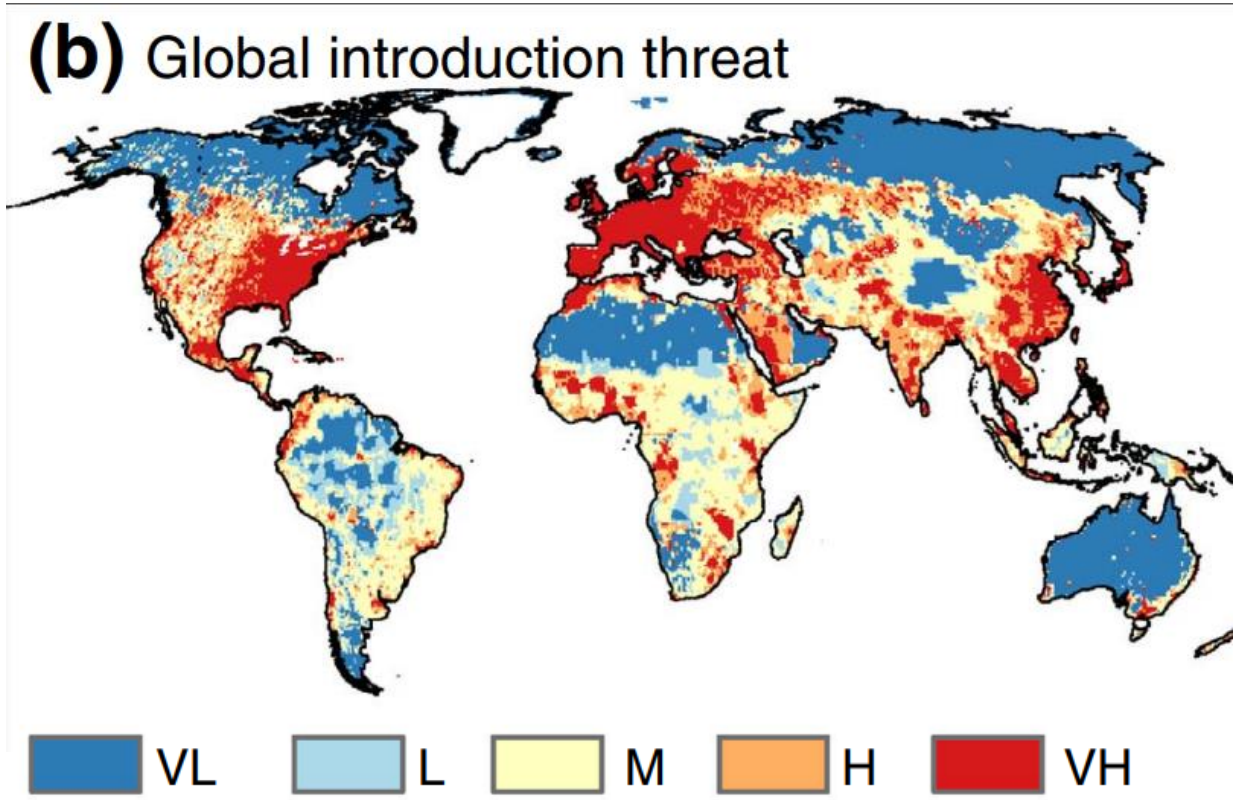
- **Interception** of potentially invasive alien species in the border
  - No data at all
- **Regional list** of IAS that are absent in Nepal: required for Prevention, Early detection and rapid response
- Potential **biological control** agents already established in Nepal and neighboring countries
- **Cost-benefit analysis**

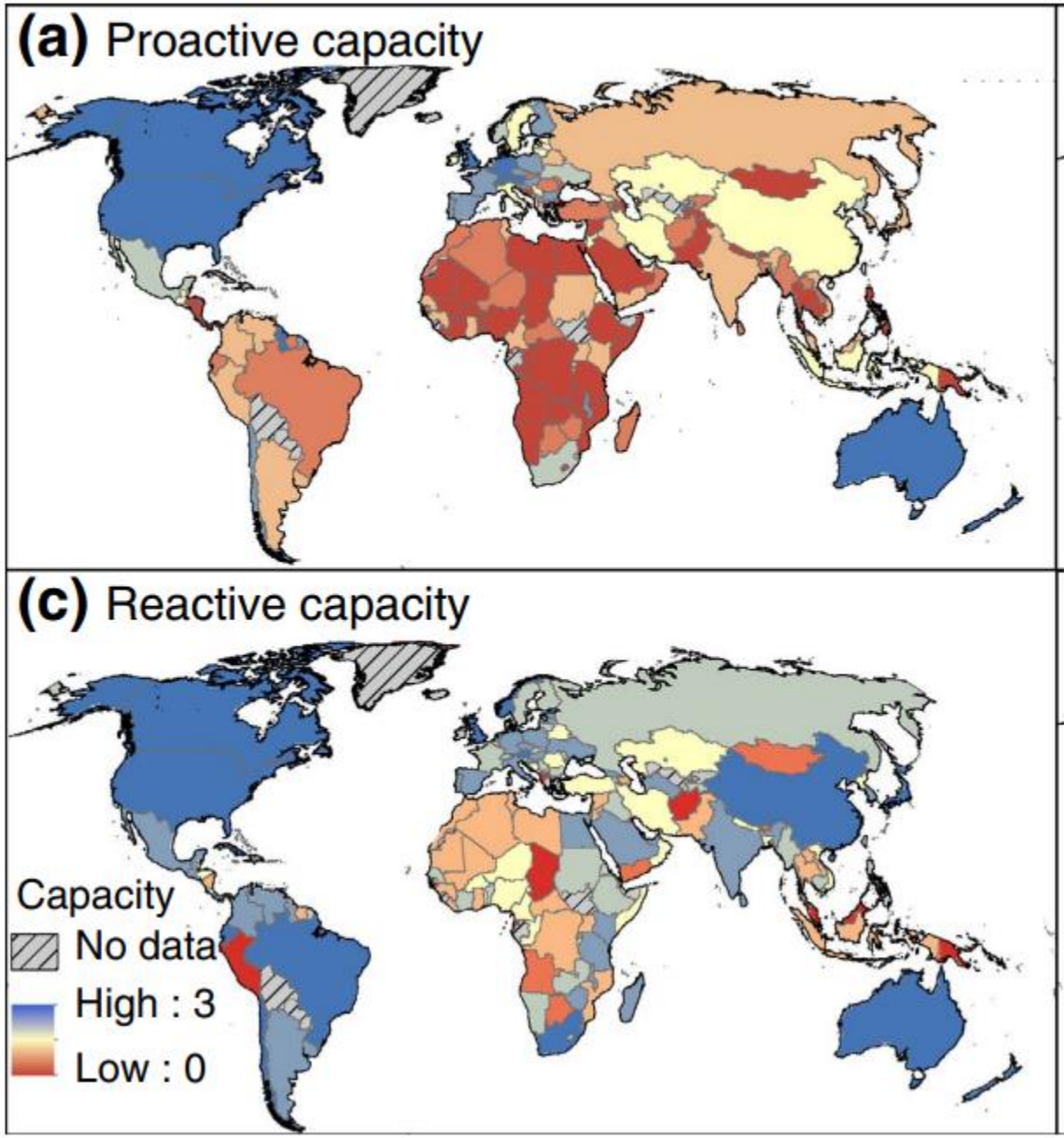
Post 2020 Global Biodiversity Framework of the CBD; Target 6 [Draft]: Reduce the impacts caused by IAS by managing **pathways** for the introduction of alien species, **preventing** the introduction and establishment of all priority IAS, **reducing the rate of introduction** of known or potential IAS by at least 50 per cent and **eradicating** or **controlling** IAS

Take home message

- Number of **IAS continue to increase** with the arrival of new IAS almost every year
- **Impacts of IAS on agriculture production** of Nepal is already substantial and highly likely to increase in future
- Improvement in **national proactive and reactive capacities** to prevent and control IAS needed for agriculture sustainability

Nepal: **High** introduction threats but **low** proactive and reactive national capacities





(Early et al 2016)

THANK YOU

Any queries and questions are welcome