Modelling invasion risk of plant pests using Self-Organising Maps to support pest risk assessment activities

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Motivation

CABI resources and tools to manage invasive species

www.cabi.org/HorizonScanningTool

- Decision support tool
- Uses information from CABI Compedium
- For identifying potential invasive species threats to a geographic area.

www.cabi.org/PRA-Tool

- Decision support tool
- Uses information from CABI Compedium
- Designed to make the job of conducting PRAs easier and more efficient.

Motivation

Query for Ghana

Results: 1741 species found

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- [x] Only show enhanced datasheets
- [x] Only show plant pests
- [ ] Only show known invasive species

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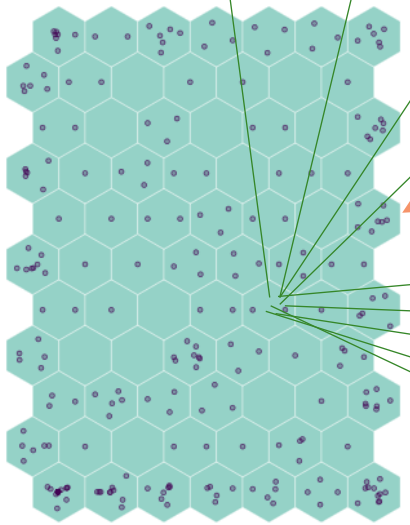
Preferred scientific name	International common name	Organism type	View datasheet
Acalymma vittatum	striped cucumber beetle	Invertebrates	Enhanced
Acanthiophilus helianthi	fly, capsule	Invertebrates	Enhanced
Acanthocoris scabrator	squash bug	Invertebrates	Enhanced
Acanthoscelides obtectus	bean bruchid	Invertebrates	Enhanced
Acarus siro	flour mite	Invertebrates	Enhanced

Methods - Self-Organising Maps

SOM classifies high-dimensional data into two-dimensional space represented by the map cells.

	Species 1	Species 2	Species 3	Species n
Region 1	0	0	1	0
Region 2	0	1	0	1
Region 3	1	0	0	0
Region *n*	1	1	1	0

Global occurrence matrix (input layer)



SOM map (output layer)

Rank	Species	SOM ranking
1	Species 38	0.945
2	Species 165	0.873
3	Species 2	0.825
4	Species 85	0.797
n	Species n	0.0

- The map size is determined according to the number of regions.
- In several iterations, the data points (regions) are distributed in a multidimensional space according to their similarity.
- Regions with a similar pest assemblage are located close together and are projected into the output layer.
- Each cell has a weight vector composed of as many elements as there are pest species which defines its position in the multidimensional space created by the algorithm.
- Creation of the **pest risk list**. Extract the weights vector of the neuron containing the region of interest. Pests are ranked according to their weight vector component.

Methods

Data

A global data set extracted from CABI's Distribution Database comprising:

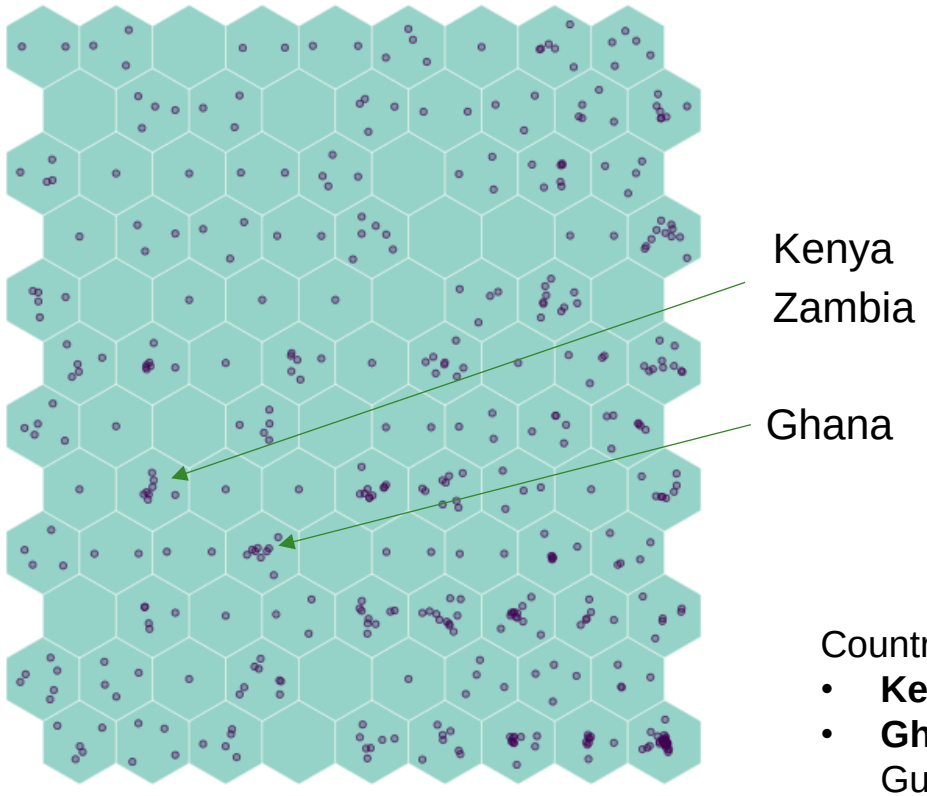
- **479** geographic areas
- **8,198** pests containing insects, fungi, microbes and other groups except weeds.

Methodology workflow:

- Comparison of SOM ranking with Horizon Scanning scores
- Focus on Ghana

Findings

How did SOM cluster the geographic regions according to their pest assemblages?



Countries grouped in the same cell:

- **Kenya**, **Zambia**, Ethiopia, Malawi, Nigeria, Tanzania, Uganda, Zimbabwe
- **Ghana**, Benin, Cameroon, Democratic Republic of the Congo, Côte d'Ivoire, Guinea, Senegal, Sierra Leone, Togo

Findings

SOM rankings for Ghana

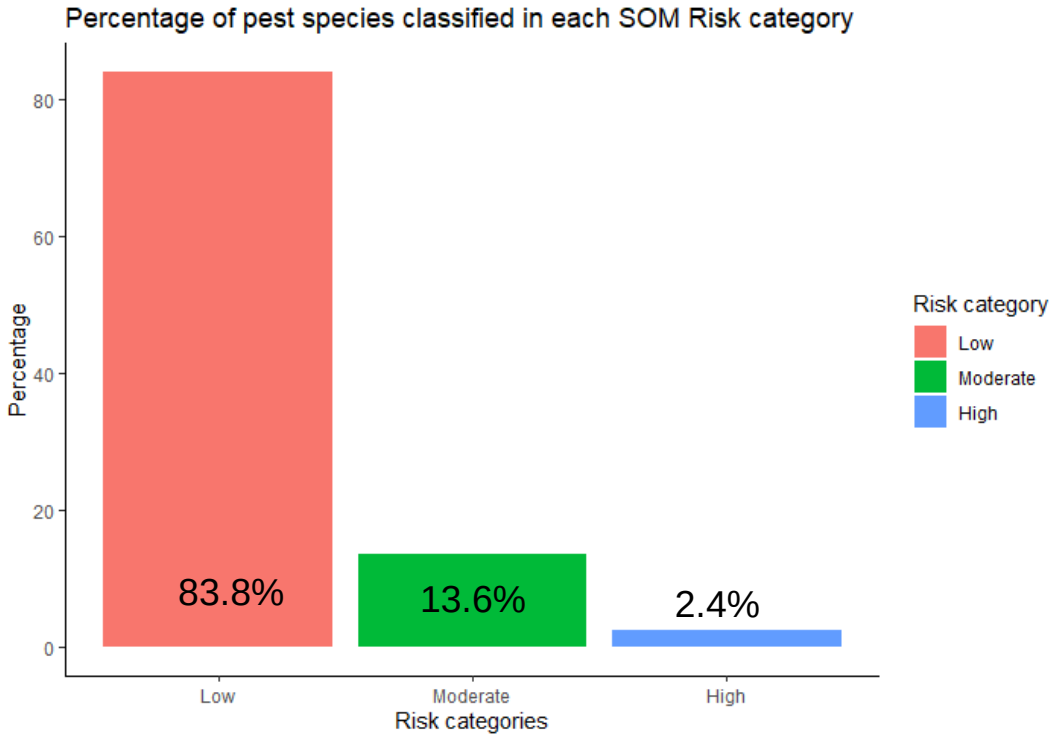
Scientific name	Common name	SOM Ranking	Risk category
Unaspis citri	citrus snow scale	0.88	High
Chrysomphalus dictyospermi	dictyospermum scale	0.88	High
Mononychellus tanajoa	cassava green mite	0.805	High
Orseolia oryzivora	African rice gall midge	0.795	High
Chrysodeixis chalcites	golden twin-spot moth	0.764	High
Diaphania indica	cucumber moth	0.764	High
Cylas puncticollis	sweet potato weevil	0.763	High
Melanaphis sacchari	yellow sugarcane aphid	0.74	High
Pinnaspis strachani	lesser snow scale	0.74	High
Helopeltis bergrothi	cacao-mosquito	0.73	High
Xiphinema ifacolum	dagger nematode	0.72	High
Erythricium salmonicolor	pink disease	0.648	Moderate
Phanerochaete salmonicolor		0.648	Moderate
Oryctes boas	rhinoceros beetle	0.635	Moderate
Pelopidas mathias	rice skipper	0.606	Moderate

Risk categories: 0-0.29 = Low, 0.3-0.60 = Moderate, 0.7-1.0 = High

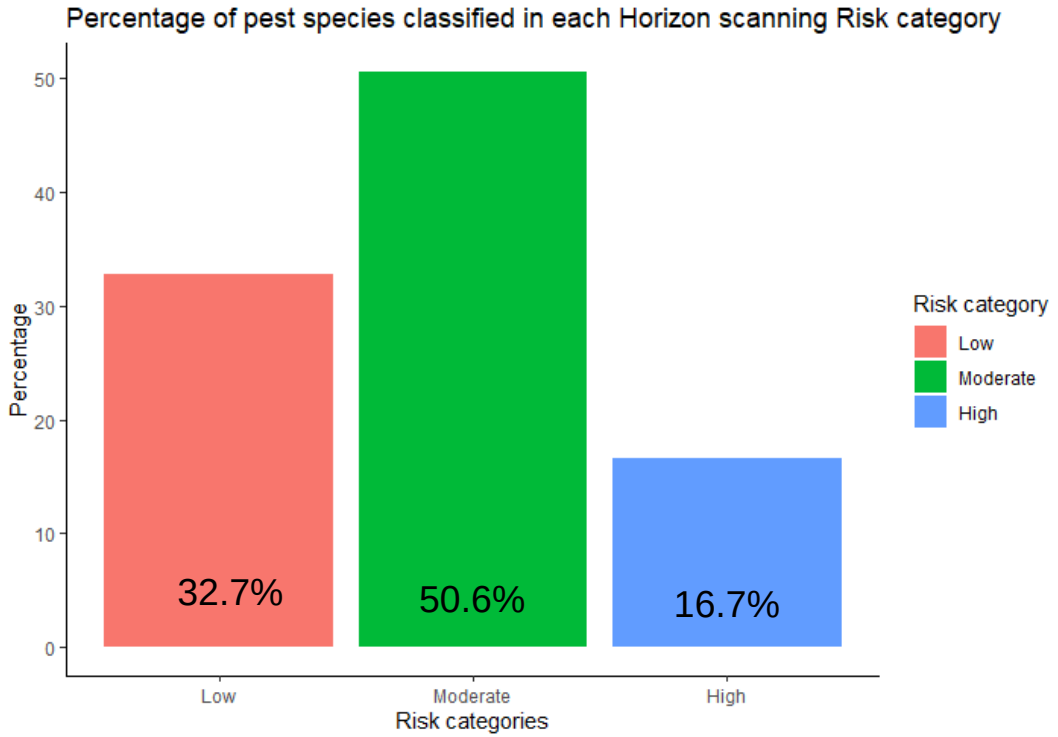
Findings

SOM rankings and HS scores for Ghana. A comparison

SOM: 7,124 pests recorded as absent or "no record" from Ghana in CABI DDB



HS: 174 pests included in the assessment



Findings

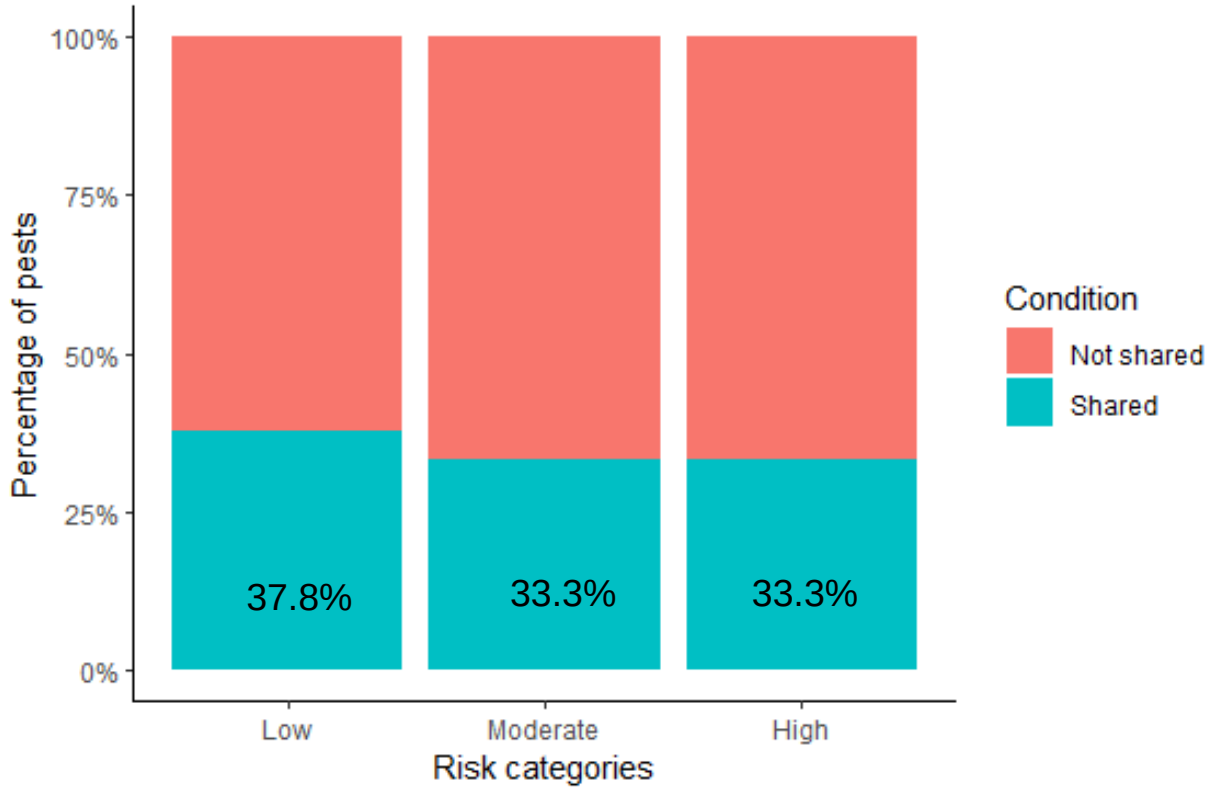
SOM rankings and HS scores for Ghana. Level of agreement

Low level of agreement: 0.042 Kappa value

Pest species that share categories in both methods: **37.2%**

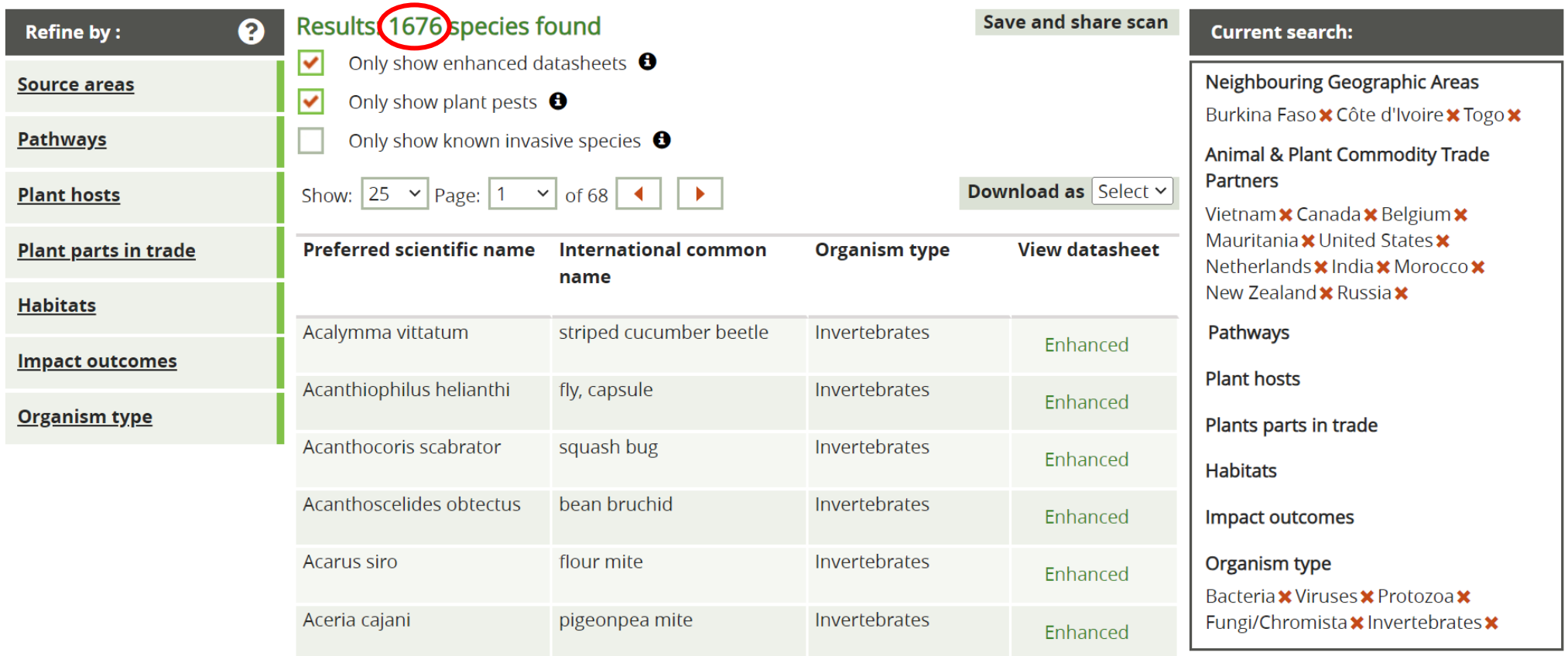
*Similar to Paini et al. 2010

Shared species in each category – SOMs vs HS



Applications

What is next? ⟶ Include the SOM ranking in PRA and Horizon Scanning Tool



Refine by :

- Source areas
- Pathways
- Plant hosts
- Plant parts in trade
- Habitats
- Impact outcomes
- Organism type

Results: 1676 species found

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Acanthoscelides obtectus	bean bruchid	Invertebrates	Enhanced
Acarus siro	flour mite	Invertebrates	Enhanced
Aceria cajani	pigeonpea mite	Invertebrates	Enhanced

Current search:

Neighbouring Geographic Areas

Burkina Faso ✖ Côte d'Ivoire ✖ Togo ✖

Animal & Plant Commodity Trade Partners

Vietnam ✖ Canada ✖ Belgium ✖ Mauritania ✖ United States ✖ Netherlands ✖ India ✖ Morocco ✖ New Zealand ✖ Russia ✖

Pathways

Plant hosts

Plants parts in trade

Habitats

Impact outcomes

Organism type

Bacteria ✖ Viruses ✖ Protozoa ✖ Fungi/Chromista ✖ Invertebrates ✖

Applications

Horizon Scanning Tool - search results

- Scientific name
- Common name
- Organism type
- Taxonomic information (Domain to Family)
- Total number of areas with presence records
- Number of neighbouring areas with presence records
- Number of areas with presence records matched to current climate
- Number of areas with presence records matched to future climate only
- Invasive somewhere
- Total Hosts
- Habitats
- Plant parts in trade
- Pathways
- Impact outcomes
- Datasheet URL

Applications

- Scientific name
- Common name
- Organism type
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- Total number of areas with presence records
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Scientific name	Common name	SOM Ranking	Risk Category
Sarocladium strictum	acremonium wilt	0.105	Low
Heteronychus arator	African black beetle	0.085	Low
Gryllotalpa africana	african mole cricket	0.232	Low
Orseolia oryzivora	African rice gall midge	0.794	High
Alfalfa mosaic virus	alfalfa yellow spot	1.975e-06	Low
Liriomyza trifolii	American serpentine leafminer	0.497	Moderate
Chaetomium globosum	antagonist of Venturia	0.0855	Low
Colletotrichum lindemuthianum	anthracnose of bean	0.160	Low
Armillaria mellea	armillaria root rot	0.085	Low
Ascochyta gossypii	ascochyta blight of cotton	0.242	Low

- Total Hosts
- Habitats
- Plant parts in trade
- Pathways
- Impact outcomes
- Datasheet URL

Limitations

Things to consider:

- A good dataset is important. SOM estimations are based on current species distributions.
- Does not take into account climate change and emerging trading routs that can affect distribution
- Use SOM as an approach aimed to support PRA rather than a stand-alone tool – use with other indicators and tools.

Take home message

- SOMs rankings can help prioritise long lists of pests.
- Tool to support risk assessors to prioritize pests and for more detailed PRAs.
- Horizon Scanning and PRA tool.

UX Research & Design

Caity Tanner (she/her)

What she will be doing

Caity will be taking notes to gain context from experts in the field (*that's you!*) by collecting your feedback, questions, and suggestions to improve CABI's HST and PRA tools in the future.

She will also be demo-ing some recent updates to CABI's Pest Risk Analysis Tool (PRA) and asking questions about decision support for our users in the PRA process.

CABI is an international intergovernmental organisation, and we gratefully acknowledge the core financial support from our member countries (and lead agencies) including:

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Agriculture and Agri-Food Canada

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Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra
Swiss Agency for Development and Cooperation SDC