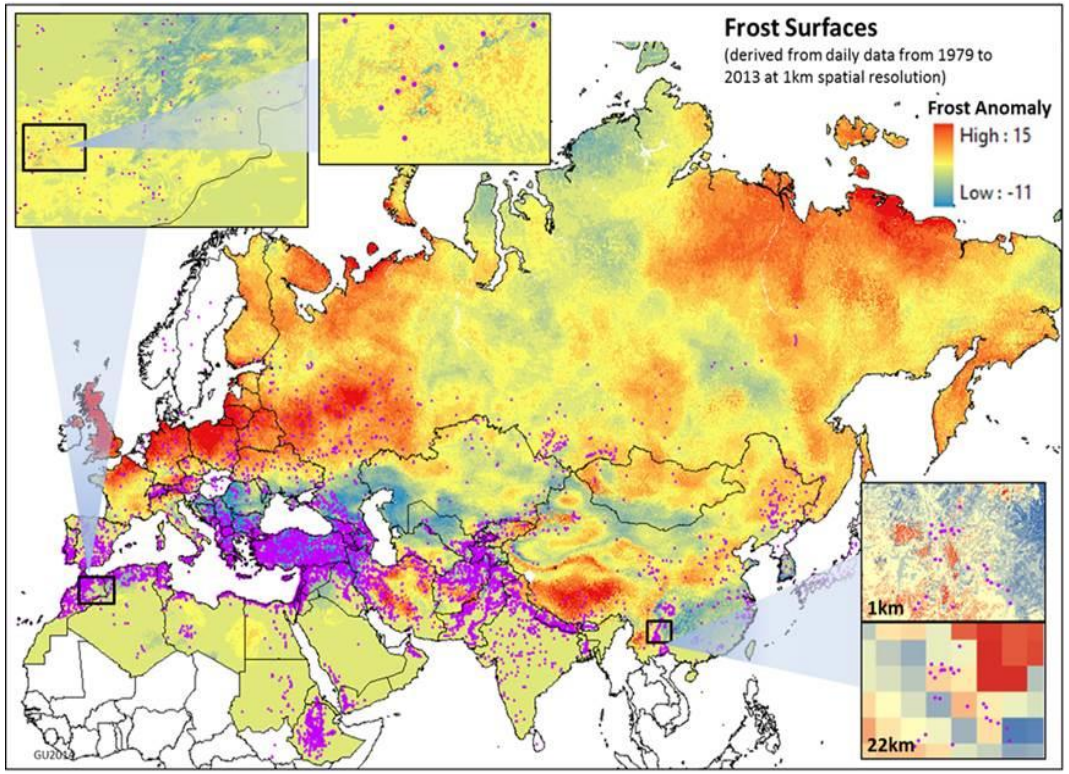
FIGS

Faster solutions for crops of tomorrow

Genebank mining with the Focused Identification of Germplasm Strategy




A perfect storm is approaching


Must grow more food on less land with fewer inputs under harsher conditions


We have to redefine the capabilities of our crop plants

A lot of innovative plant breeding is required

Genetic diversity is crucial


WORLD CONSPEX
COLLECTION


313,500
wheat accessions

FIGS

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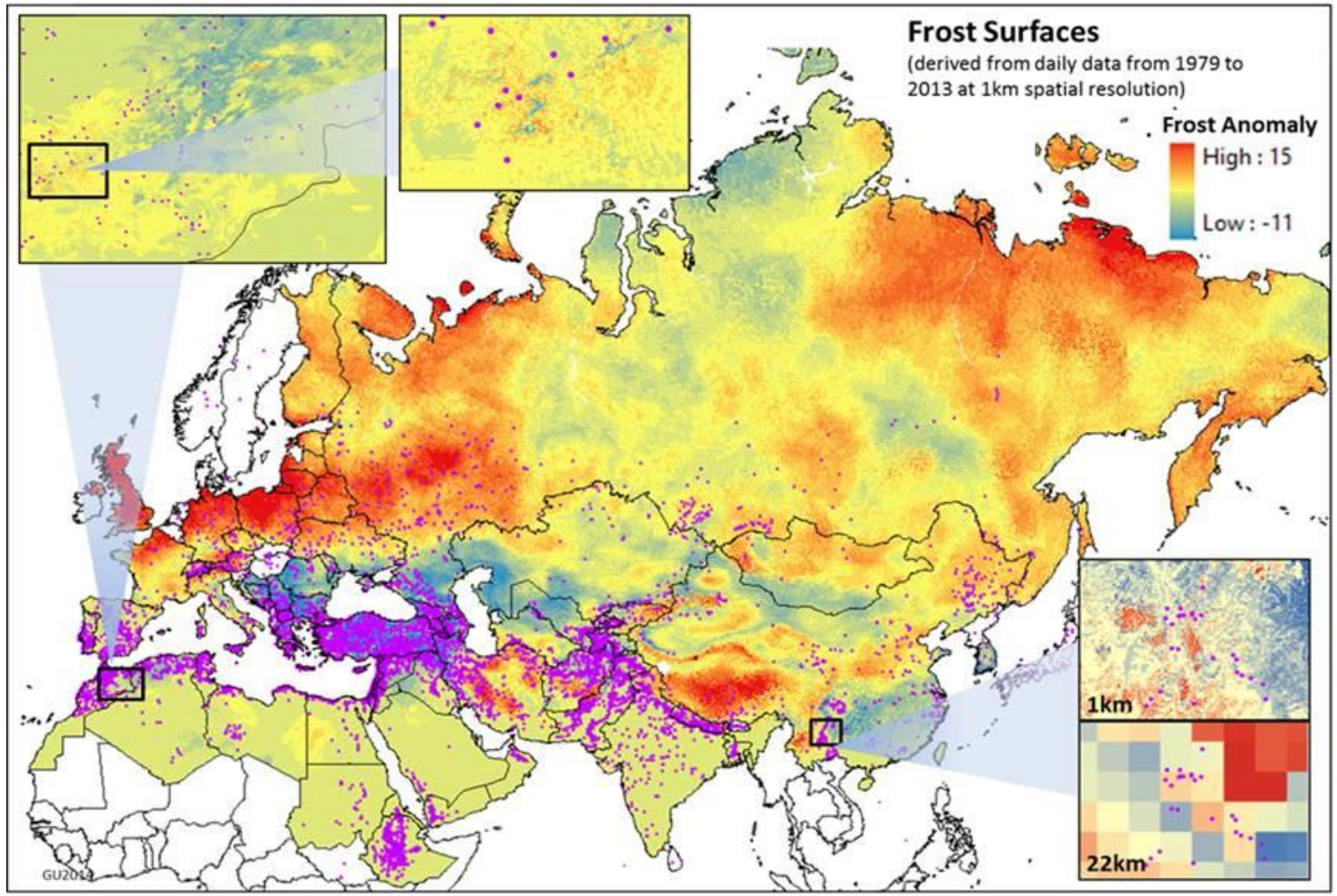
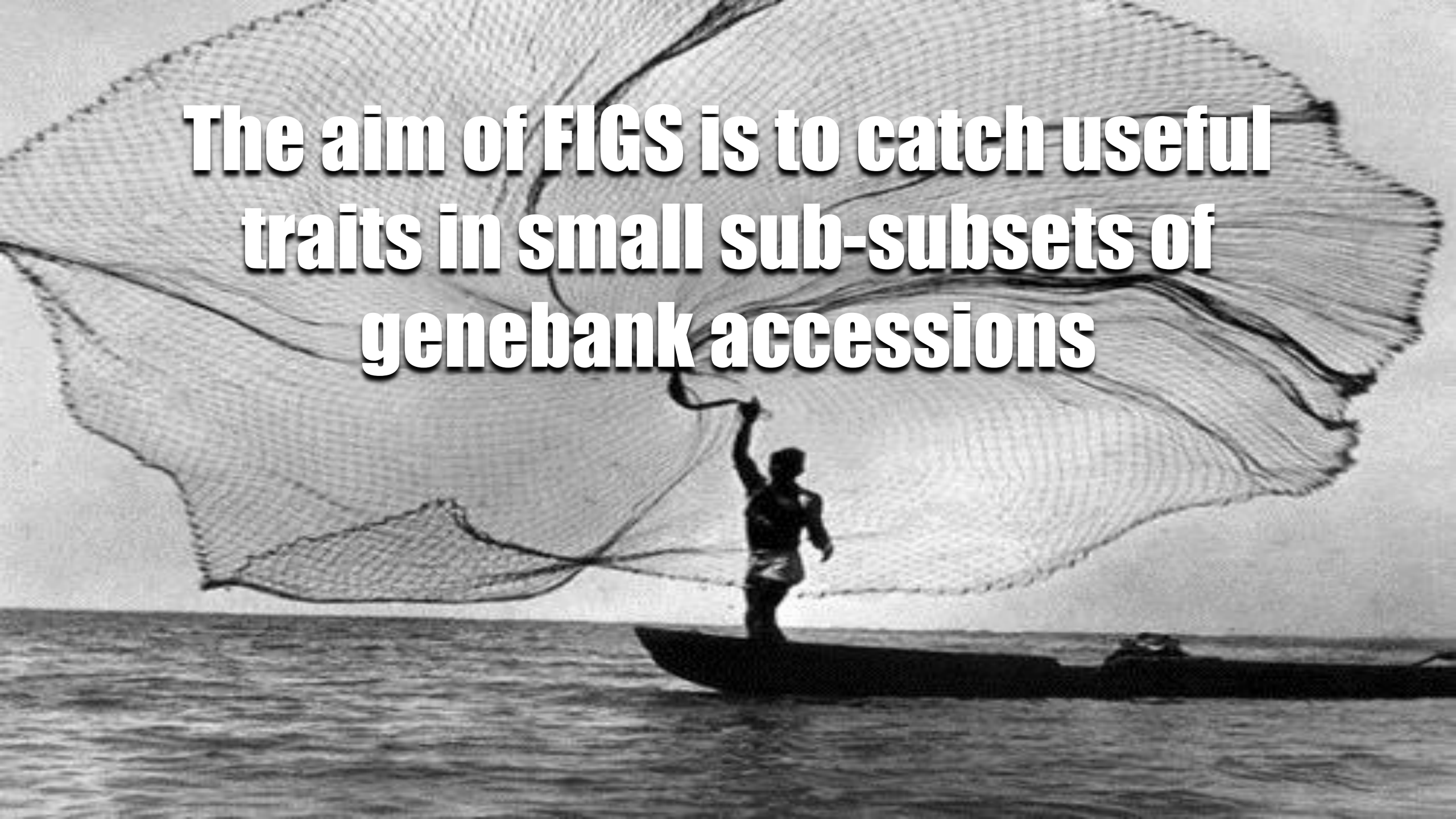
Focused identification of Germplasm Strategy




The aim of FIGS is to catch useful traits in small sub-subsets of genebank accessions

UNCLE CHARLES SAYS...

I WANT YOU
TO SUPPORT SCIENCE & REASON

THE CENTER FOR INQUIRY
CELEBRATES DARWIN DAY

FIGS: In a nutshell

Look to environments that are likely to impose a selection pressure for the required trait .

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OPEN ACCESS PEER-REVIEWED

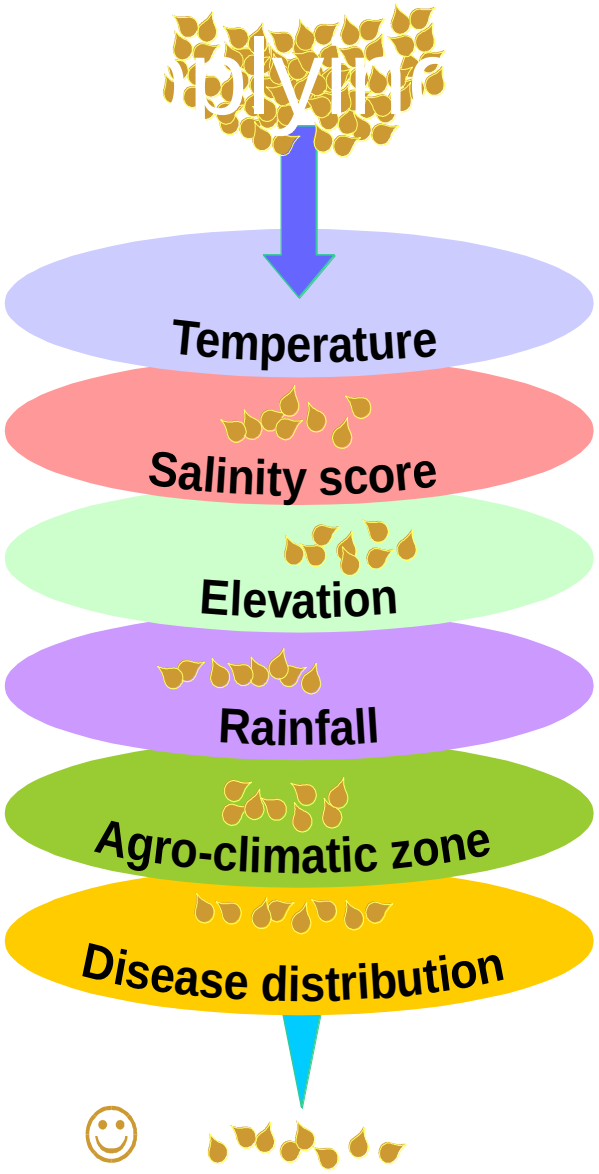
RESEARCH ARTICLE

Investigating the case of human nose shape and climate adaptation

Arslan A. Zaidi, Brooke C. Mattern, Peter Claes, Brian McEcoy, Cris Hughes, Mark D. Shriver

Published: March 16, 2017 • https://doi.org/10.1371/journal.pgen.1006616

OK, but does FIGS work?



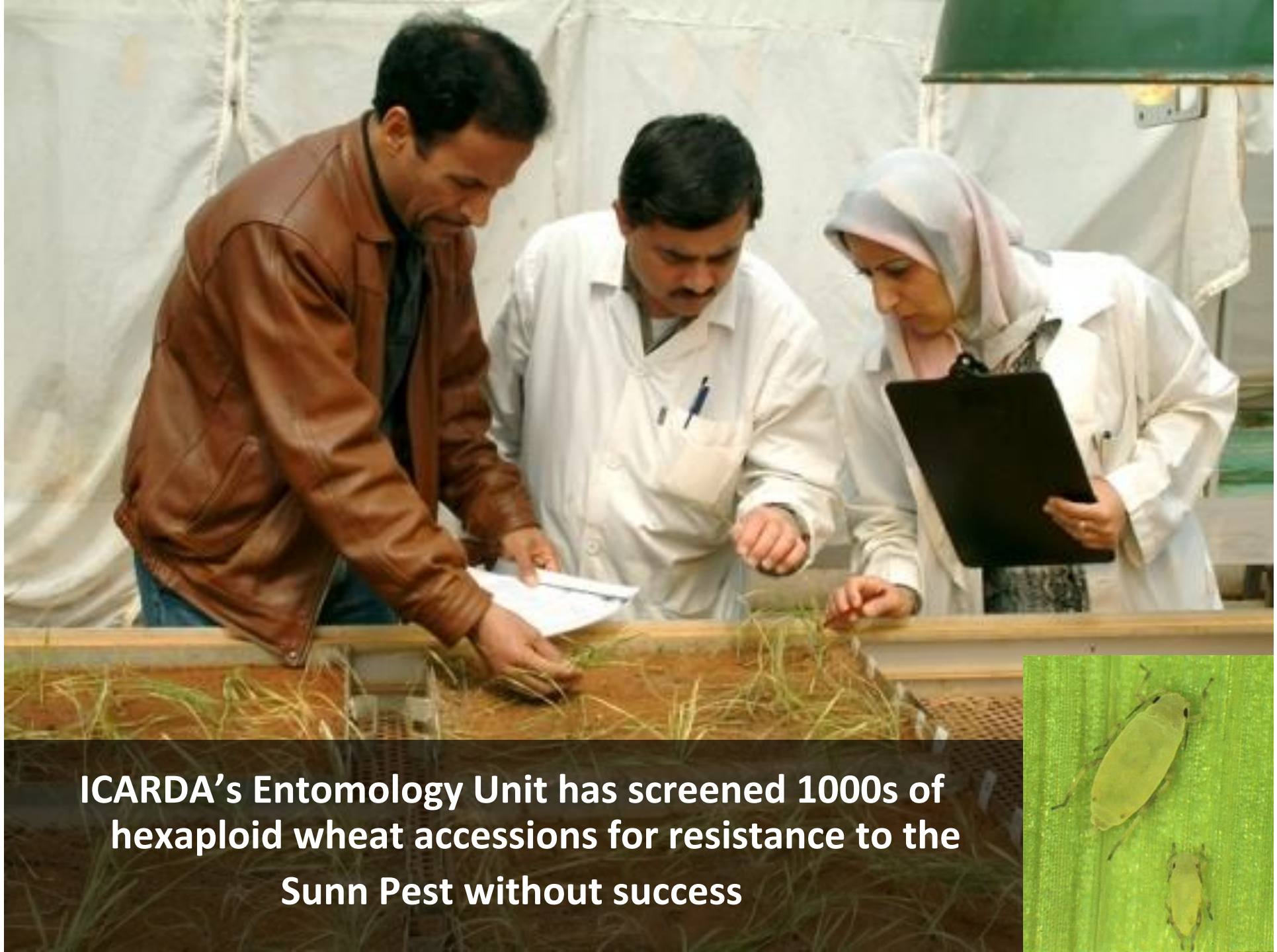
Data layers sieve accessions based on latitude & longitude

FIGS

Faster solutions for crops of tomorrow

Simple filtering method

FOCUSED IDENTIFICATION OF GERMPLASM STRATEGY



ICARDA's Entomology Unit has screened 1000s of hexaploid wheat accessions for resistance to the Sunn Pest without success

Sunn pest set selection

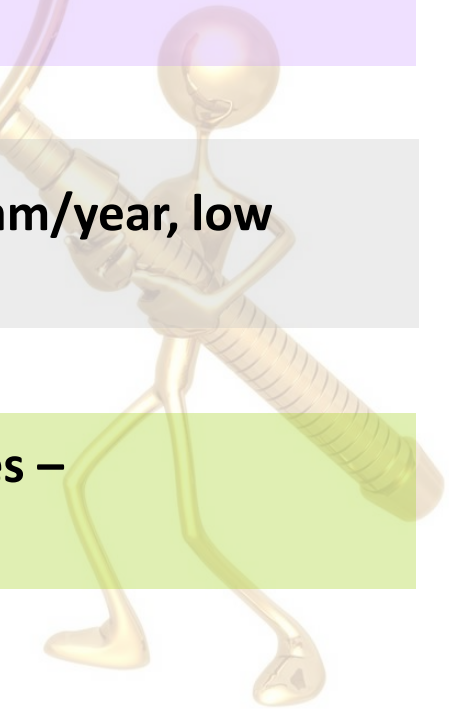
Starting with a set of over 16,000 accessions from VIR, ICARDA and AWCC

Selected material collected between 30-45 latitude, 35-80 longitude

Excluded CHN, PAK, IND as only recent reports of Sunn pest in these countries – retained 6,328 accessions

Excluded particularly dry environments - rainfall below 280mm/year, low Aridity Index

Excluded sites where the winters temps fall below -10 degrees – retained 534 accessions



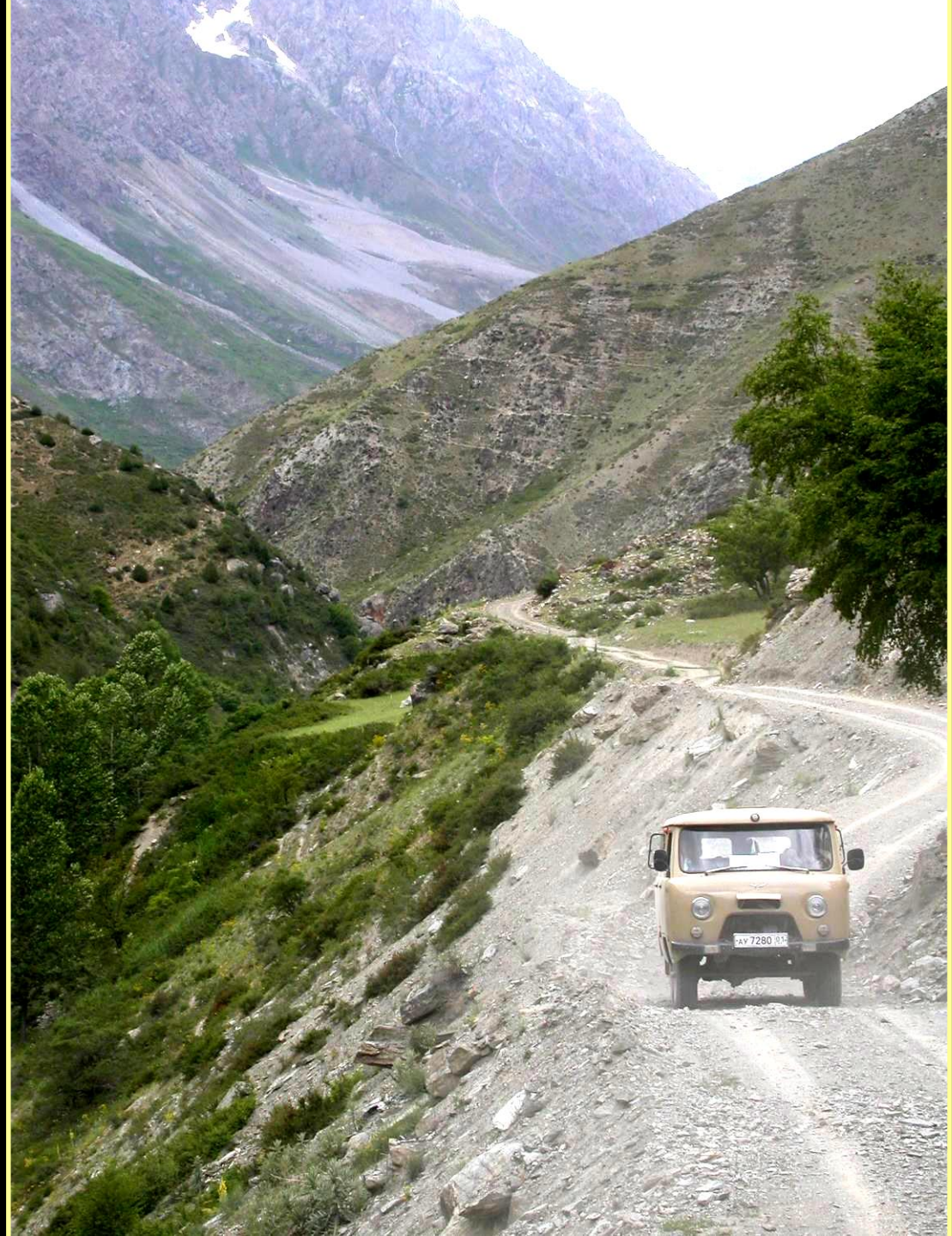
Sunn pest set selection

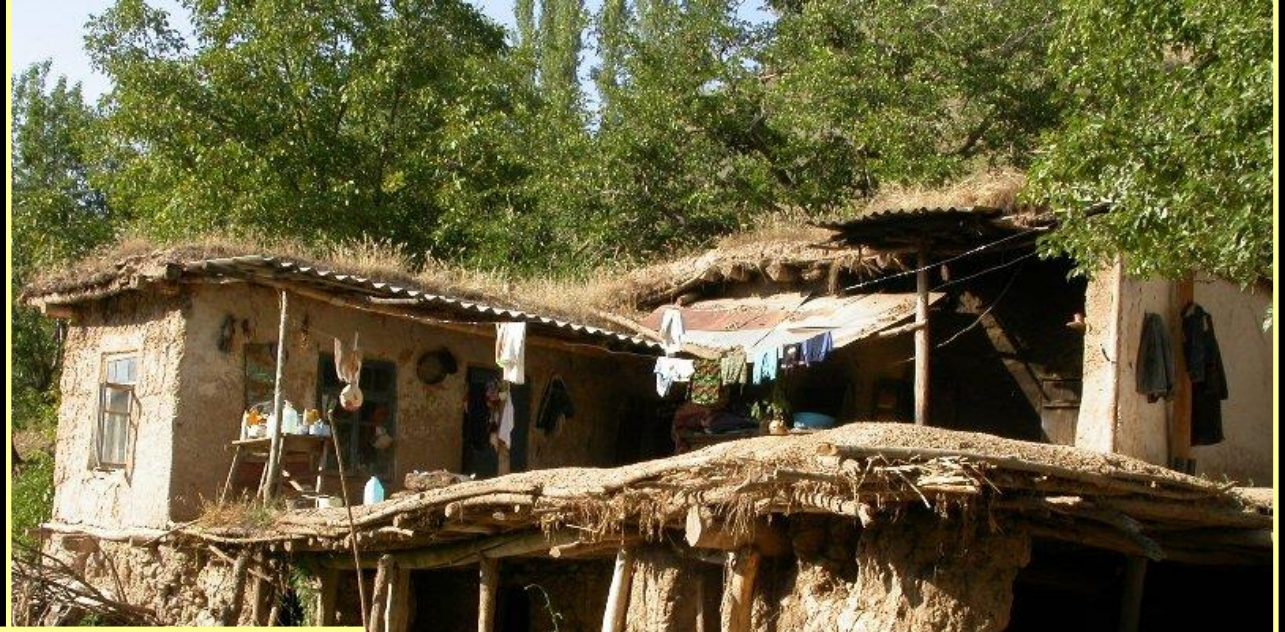
534 accessions screened at ICARDA

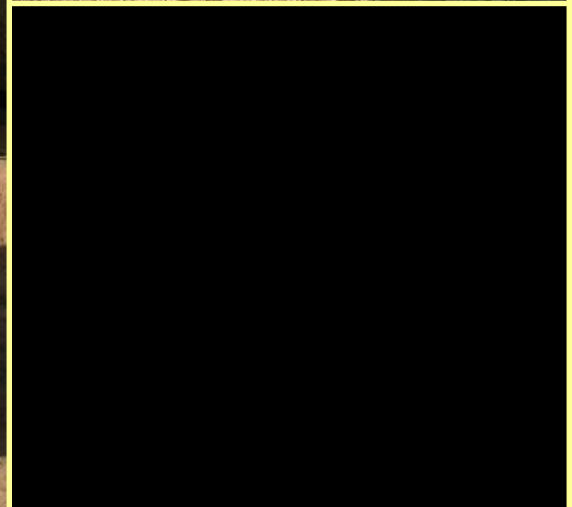
Verified
under controlled conditions

8 landrace accessions from Afghanistan and 2 from Tajikistan identified as resistant at juvenile stage

Now in ICARDA breeding program



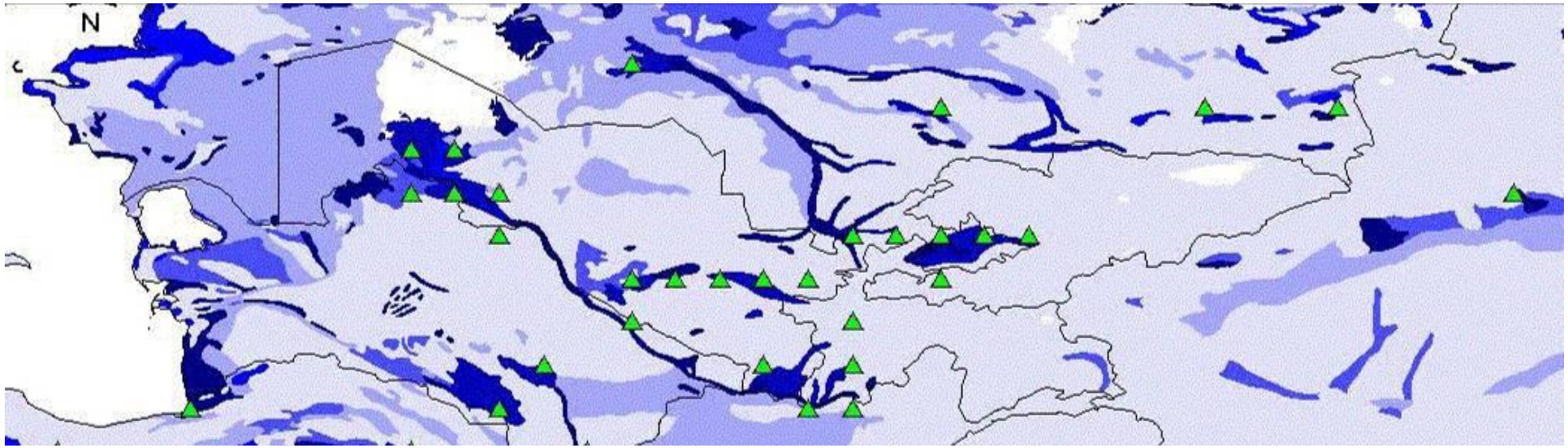




Screening for salinity tolerance in bread wheat landraces

VIR,ICARDA,AWCC collection

FIGS subset chosen by mapping collection sites over salinity probabilities



Bread wheat landrace collection sites

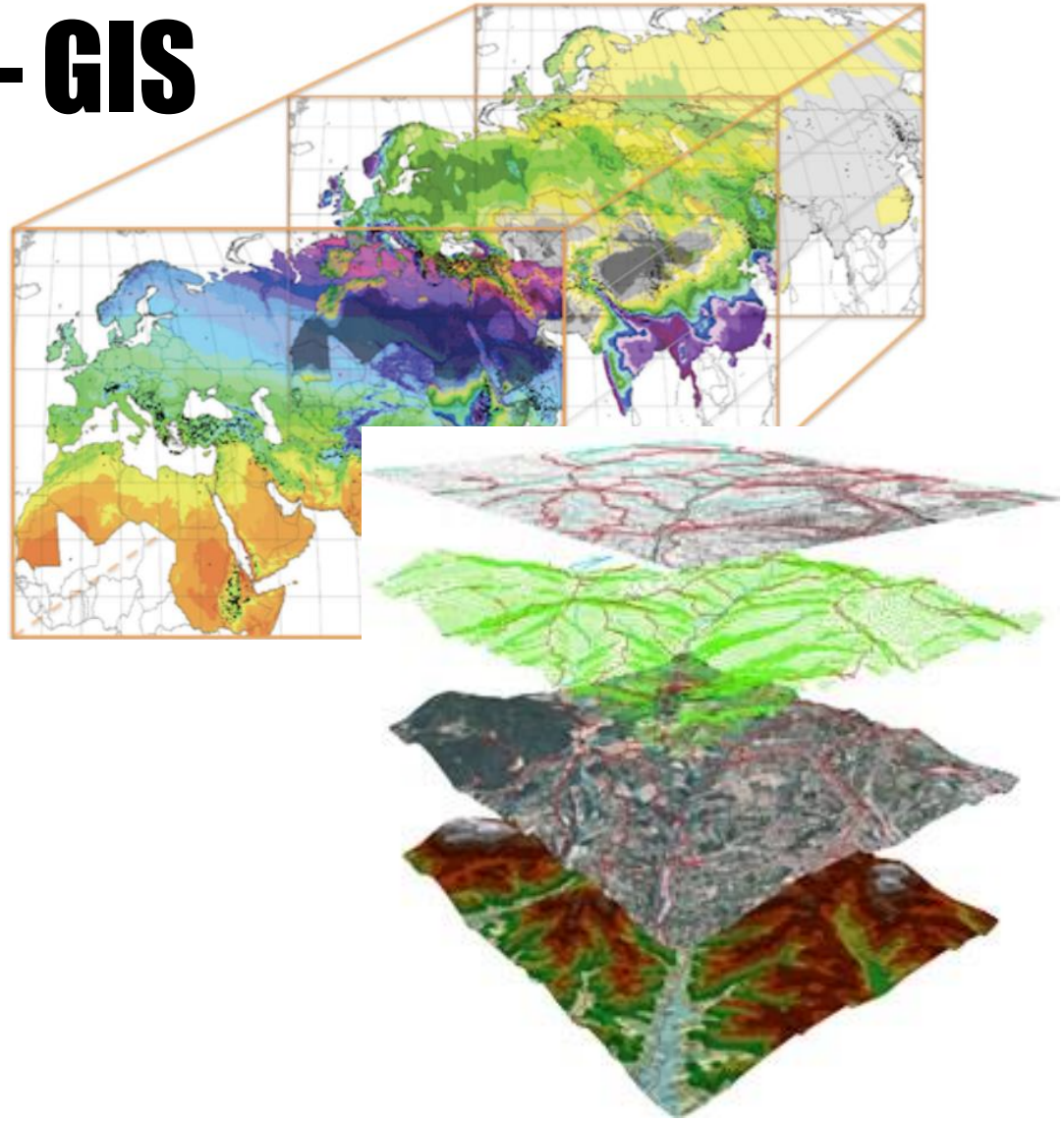
Faba bean

Wet set

Dry set

Long-term daily averages – GIS

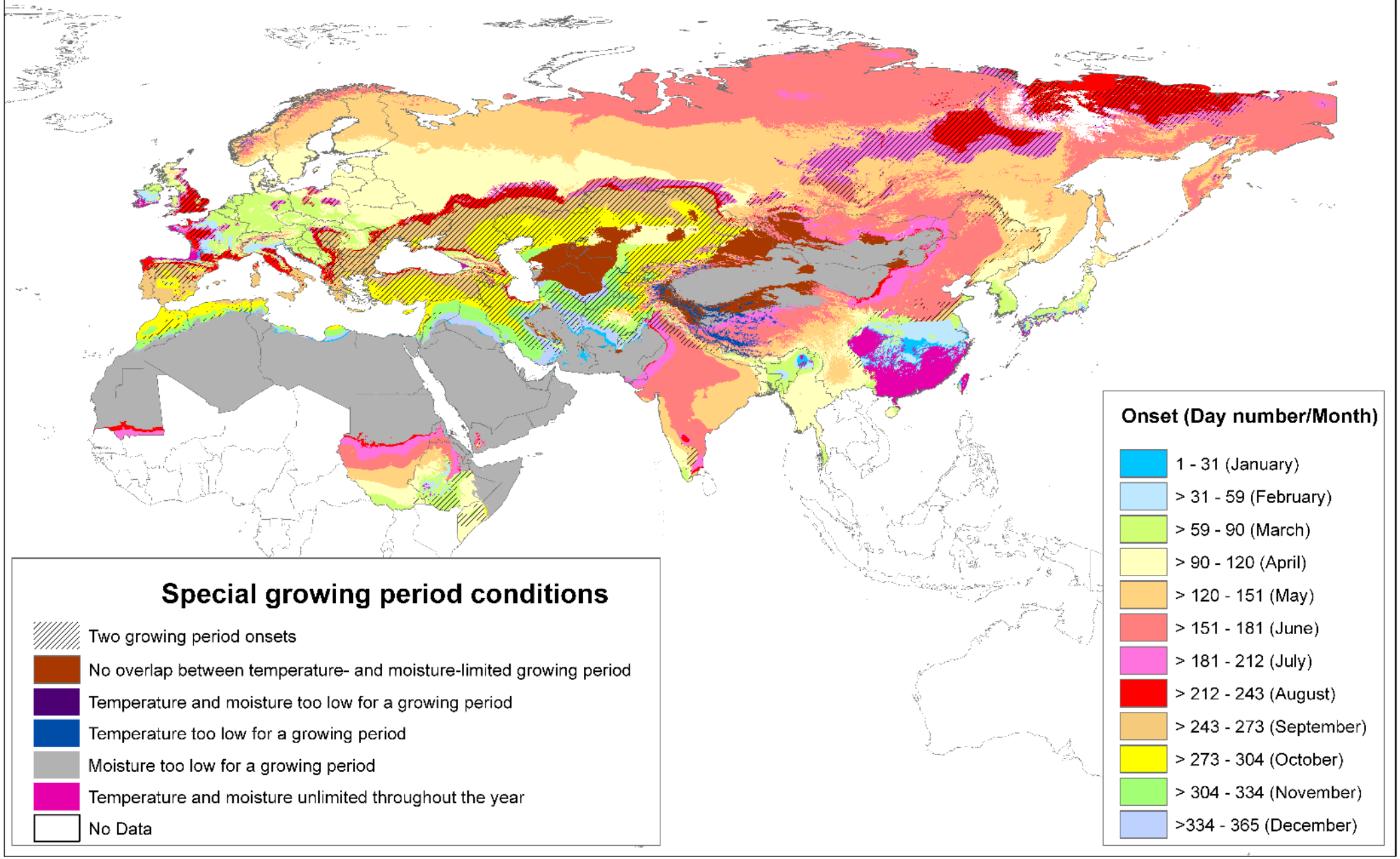
Temp at 2 meter
max temp at 2 meter
min temp at 2 meter
Precipitation
Absolute humidity
Relative humidity
Photosynthesis active radiation
Wind at east-west direction
Wind at north-south direction
Vapor pressure deficit



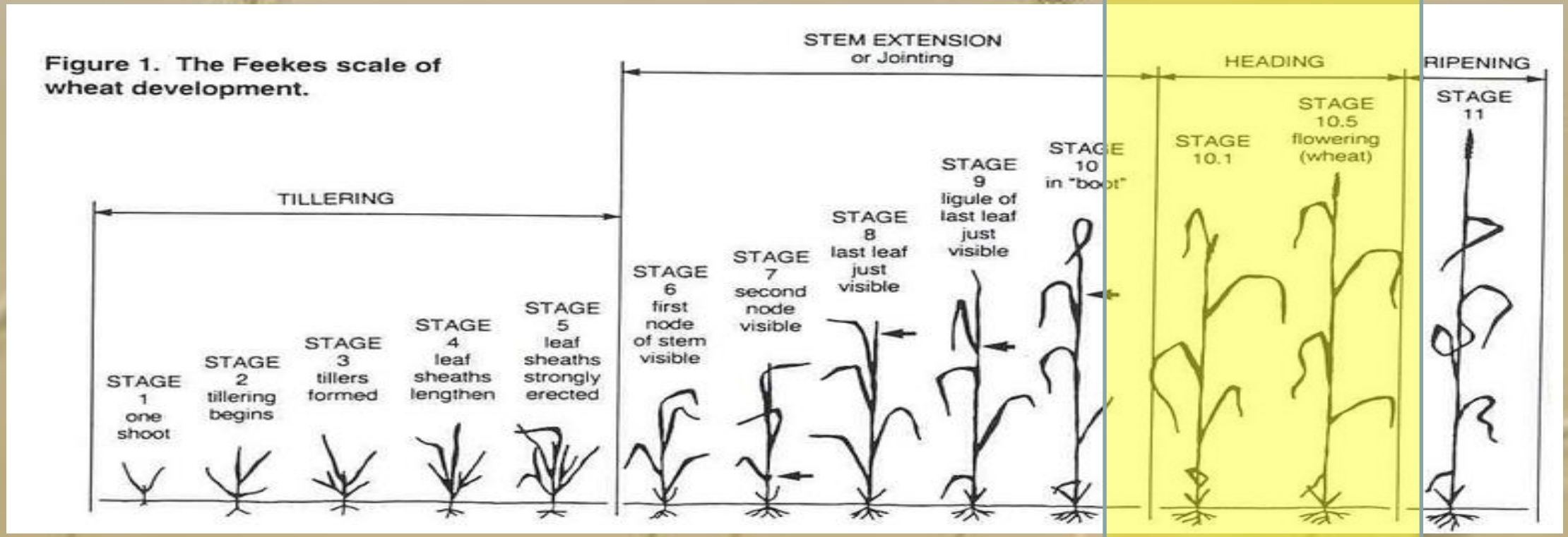
109,500 global surfaces generated

Over 200TB of data

Onset of the temperature & -moisture-limited growing period (1)



Applying FIGS within growing season



Target reproductive phase of crop development

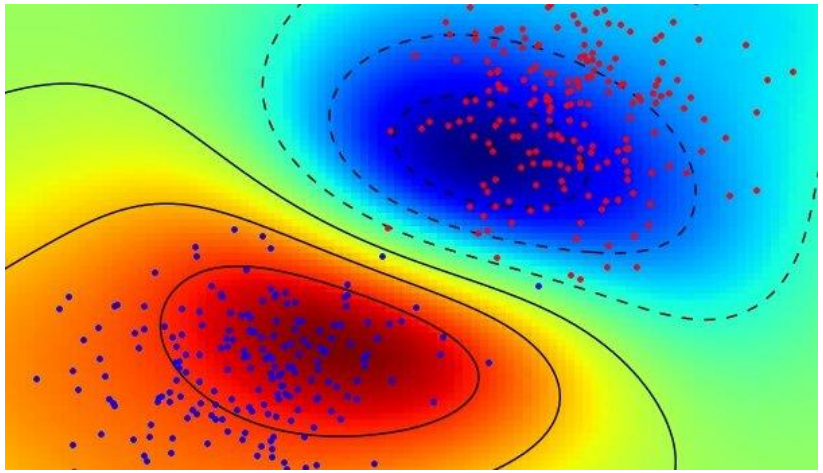
Russian wheat aphid
Pod borer
Powdery mildew – wheat and barley
Barley yellow dwarf virus
Spot blotch
Net blotch
Drought tolerance
Beet western yellows virus
Chickpea chlorotic stunt virus
Alfalfa mosaic virus
Been yellow mosaic virus



FIGS pathways

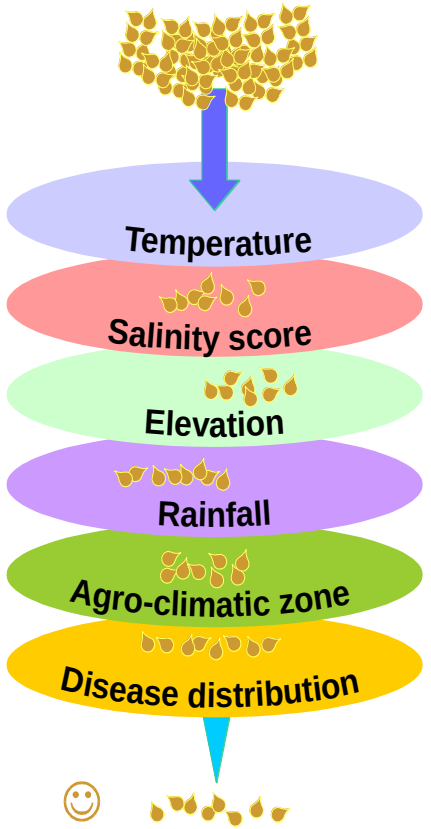
User defined trait

Classify collection sites



Statistical models

Filter collection sites



Data layers sieve accessions based on latitude & longitude

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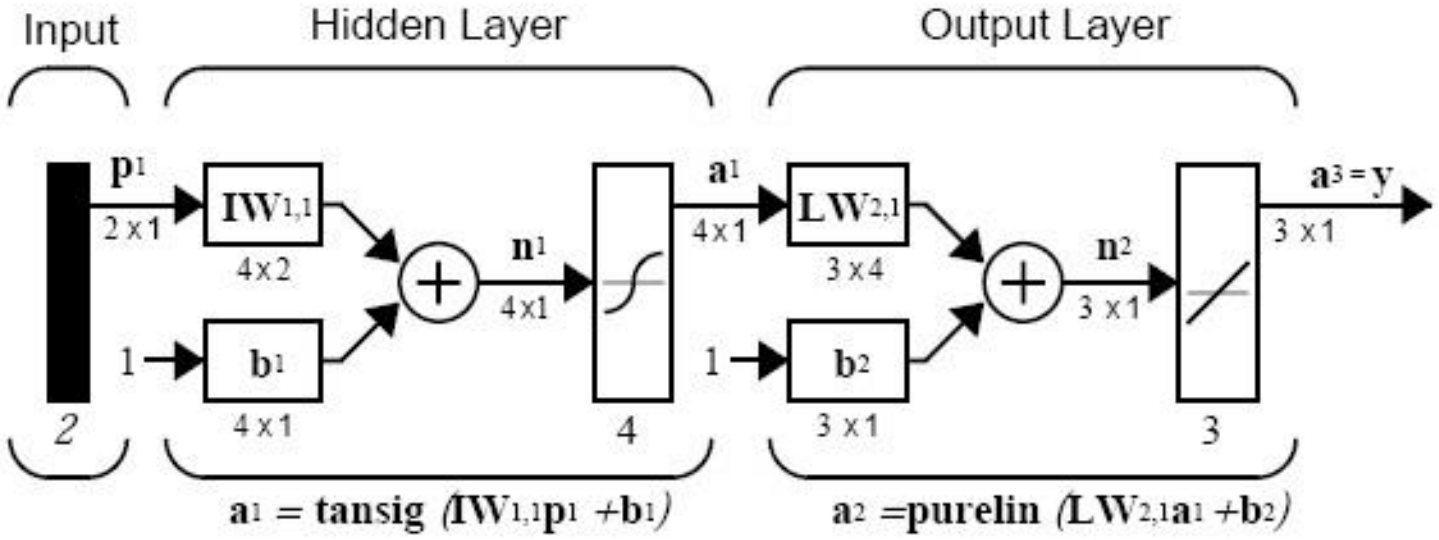
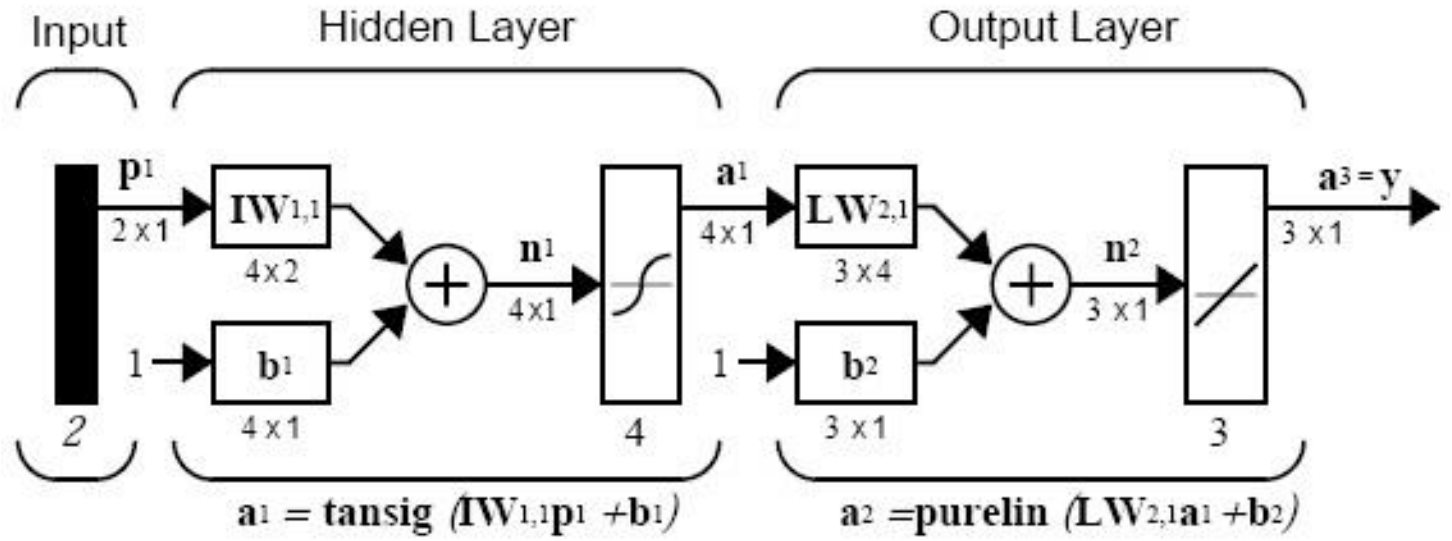
Multiple trait state data + Collection site daily data

Non-linear model



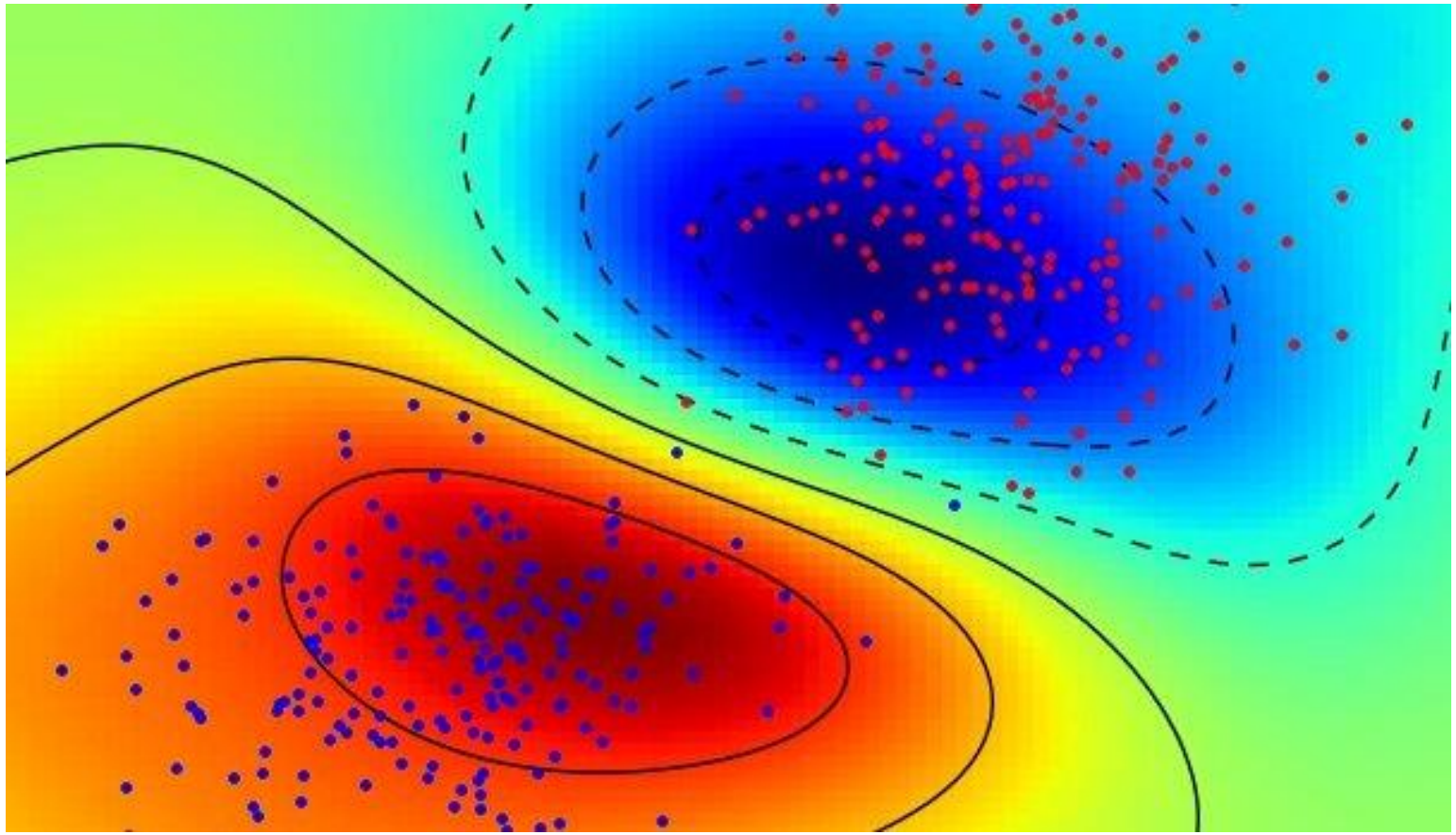
Support vector machine, Random forest, Neural networks

Model attempts to discriminate between trait states



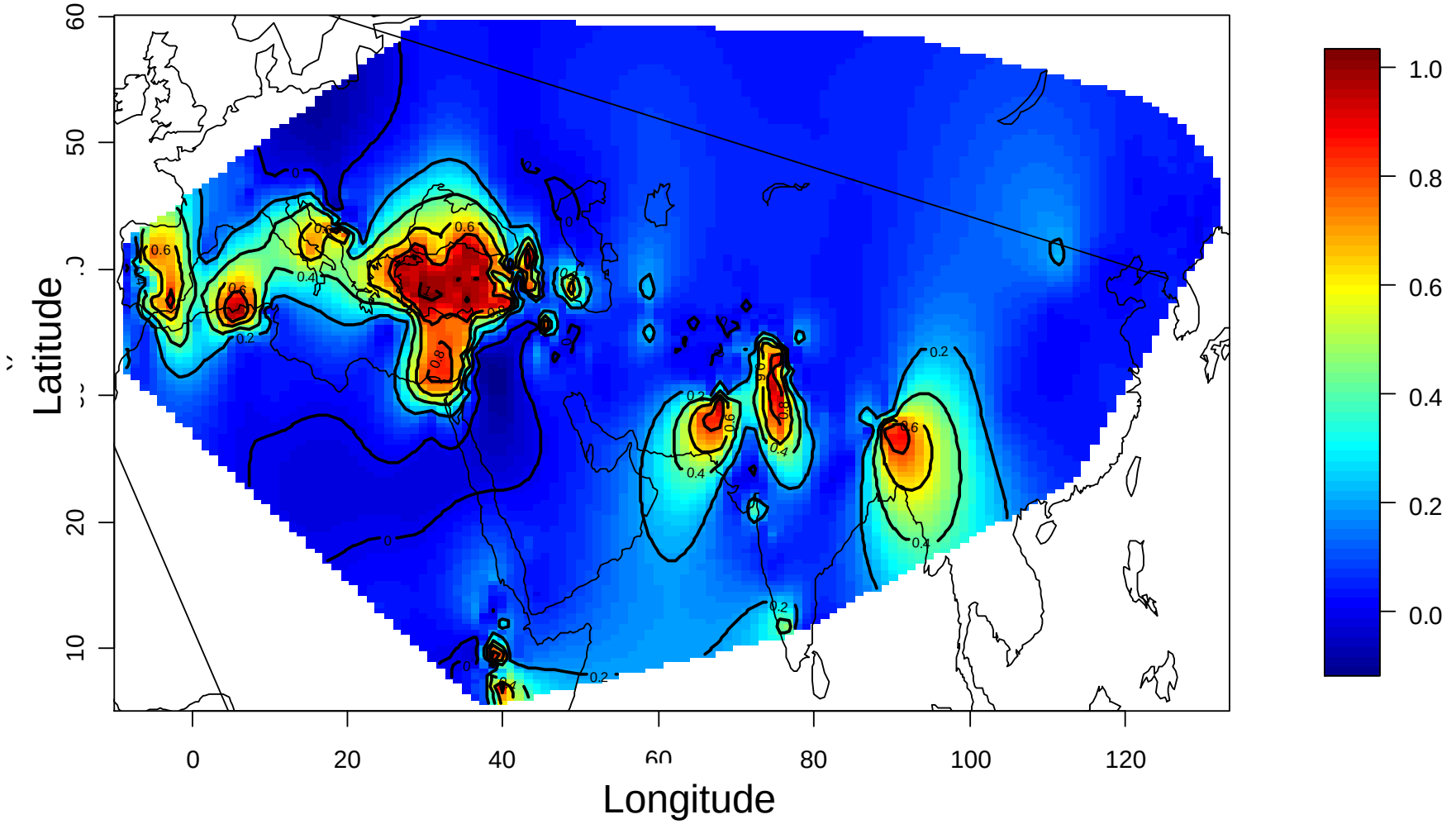
Model parameters iteratively refined

Trained model used to predictively classify sites



Predictive modelling

Areas where resistance is likely to occur (dark red)



Bari, A., A. Amri, K. Street, M. Mackay, E. De Pauw, R. Sanders, K. Nazari, B. Humeid, J. Konopka, and F. Alo. (in press) **Predicting resistance to stripe (yellow) rust** in plant genetic resources using Focused Identification of Germplasm Strategy (FIGS). Cambridge Journal of Agricultural Science, UK.

Hamid Khazaei, Kenneth Street, Abdallah Bari, Micheal Machay, F.L. Stoddard (in press). The FIGS (Focused Identification of Germplasm Strategy) approach identifies traits related to **drought adaptation** in Vicia faba genetic resources. PLOS ONE journal.

Bari, A., K. Street, M. Mackay, D.T.F. Endresen, E. De Pauw, and A. Amri (2012). Focused Identification of germplasm strategy (FIGS) detects **wheat stem rust resistance** linked to environmental variables. Genetic Resources and Crop Evolution 59:1465–1481

Endresen, D.T.F., K. Street, M. Mackay, A. Bari, E. De Pauw, K. Nazari, and A. Yahyaoui (2012).Sources of Resistance to **Stem Rust (Ug99)** in Bread Wheat and Durum Wheat Identified Using Focused Identification of Germplasm Strategy (FIGS). Crop Science [Online first].

Endresen, D.T.F., K. Street, M. Mackay, A. Bari and E. De Pauw (2011). Predictive association between **biotic stress traits** and ecogeographic data for wheat and barley landraces. Crop Science 51: 2036-2055. doi:

FIGS – where now?

- Incorporate molecular data
- More accurate season onsets
- Software application

Acknowledgments

ICARDA

GRDC
Grains Research & Development Corporation
Your GRDC working with you

ACIAR

Zakaria Kehel