ICT framework for global wheat rust surveillance and monitoring

Jens G. Hansen[1], Poul Lassen[1], Mogens Hovmøller[1] & David Hodson[2]

AARHUS UNIVERSITY

CIMMYT MR
International Maize and Wheat Improvement Center

IPM 2.0
Towards future-proof crop protection in Europe

EFPP

Outline

- What are the problems?
- Call for global action by Norman E. Borlaug
- Integrated Information Resources. ICT Framework for wheat rust data storage, data management and dissemination
- Major achievements and implications for Europe

What are the problems ?

The Economist

Log in | Register | Subscribe | Digital & mobile | Events | Topics A-Z | Newsletters | Jobs

Wednesday September 19th 2012 | Search

World politics | Business & finance | Ec

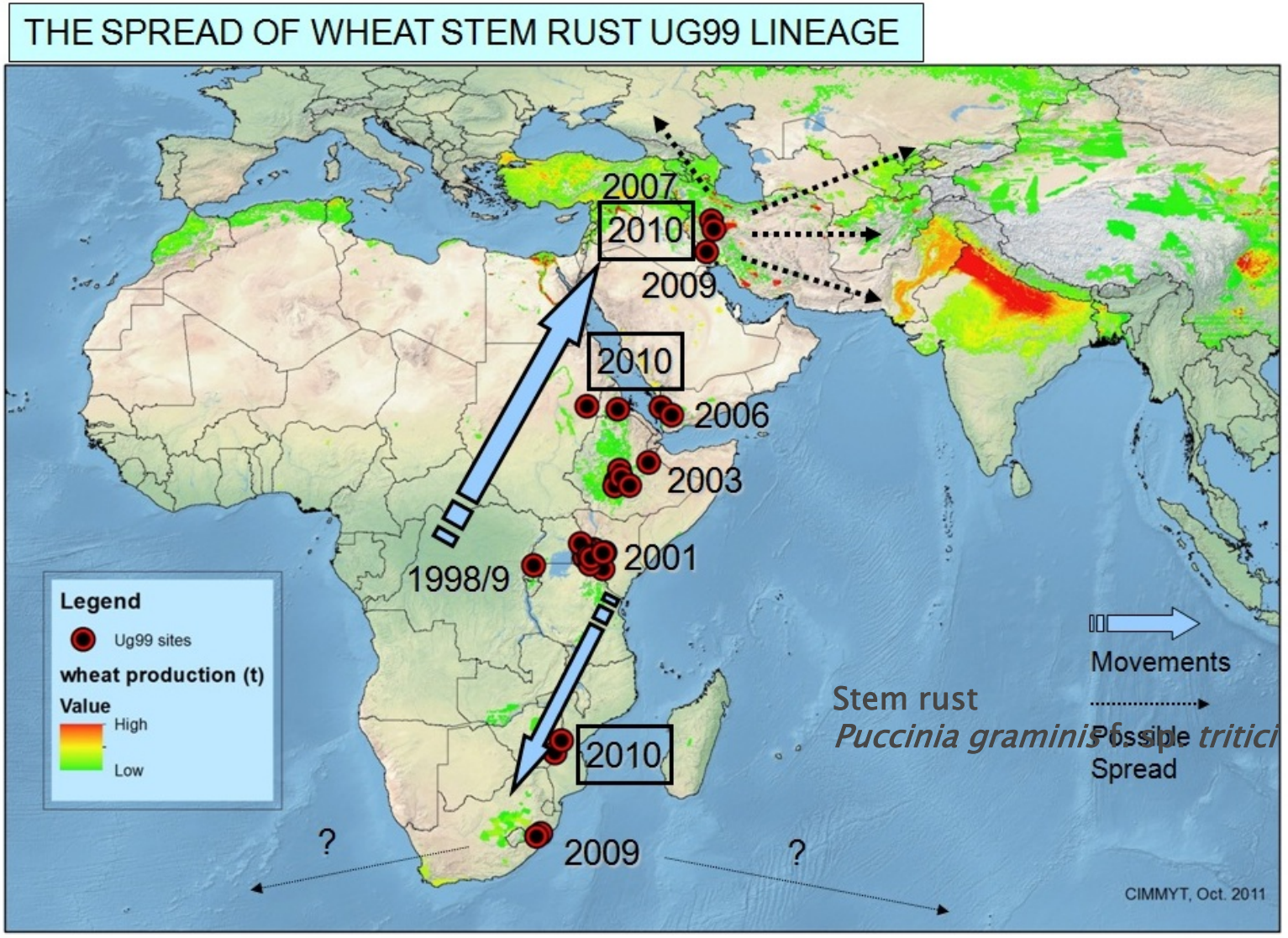
Wheat rust and world farming

Rust in the bread bas

A crop-killing fungus is spreading wheat-growing areas

Jul 1st 2010 | from the print edition

IT IS sometimes called the "polio of agr disease. Wheat rust is not just back af scary forms. In some ways it is worse t Nigeria. Wheat rust has spread silently camped at the gates of one of the wor announced the discovery of two new s producer yet infected.



What are the problems ?

EDITORIAL

Mogens Støvring Hovmøller and Annemarie Fejer Justesen are senior scientists and Stephanie Walter is a postdoctoral scientist in the Department of Integrated Pest Management, Aarhus University, Slagelse, Denmark. E-mail: mogens.hovmoller@agrsci.dk; stephanie.walter@agrsci.dk; annemariefejer.justesen@agrsci.dk

Escal

LAST MONTH,
Russia, at th
crop. This c
focused on t
epidemics th
must coordi
research, pla
In the 19
rust that thr
ative pathog
since the 19
ing most co
stem rust on
large-scale e
of yellow ru
threat to the

Stripe rust, Sweden, 2011

www.sciencemag.org S

Durable Rust Resistance in Wheat

CHRONICLEONLINE

Feb. 27, 2011

$40M grant to fight wheat pathogen that threatens global food security

By Linda McCandless

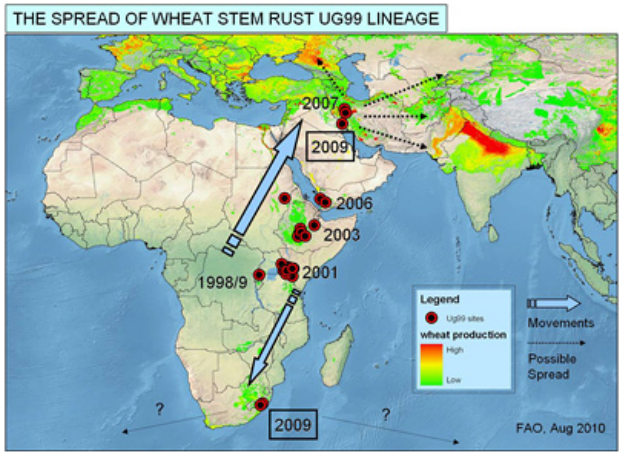
The United Kingdom's Department for International Development (DFID) and the Bill & Melinda Gates Foundation announced today that they will invest $40 million in a global project led by Cornell to combat deadly strains of Ug99, an evolving wheat pathogen that poses a dangerous threat to global food security, particularly in the poorest nations of the developing world.

The five-year grant to the Durable Rust Resistance in Wheat (DRRW) project at Cornell will support efforts to identify new stem rust-resistant genes in wheat, improve surveillance, and multiply and distribute rust-resistant wheat seed to farmers and their families.

"We cannot overstate the importance of this for addressing the causes of poverty, hunger and disease in the developing world," said Ronnie Coffman, Cornell professor of plant breeding and genetics and director of DRRW. "Against the backdrop of rising food prices, and wheat in particular, researchers worldwide will be able to play an increasingly vital role

Durable Rust Resistance in Wheat project

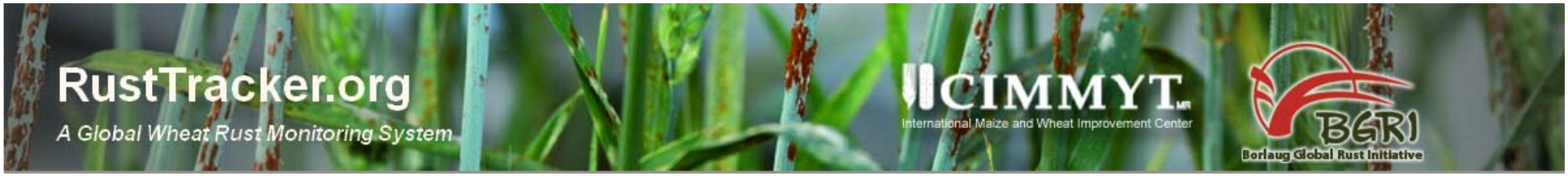
Cornell plant breeder Ronnie Coffman, right; Bedada Girma, left, of the Ethiopian Institute of Agricultural Research; and Eshetu Sisay, manager of the Gonde Seed Farm, look for signs of infection in fields of stem and yellow rust-resistant wheat in Ethiopia.



Click to enlarge

Durable Rust Resistance In Wheat
Led by Cornell University

$40.000.000
Phase II: 2011–2014



Cornell University

CHRONICLE ONLINE

Sept. 4, 2012

'Rust-Tracker' to monitor deadly wind-borne wheat fungus

Ronnie Coffman, right, with project collaborator Germa Bedada.

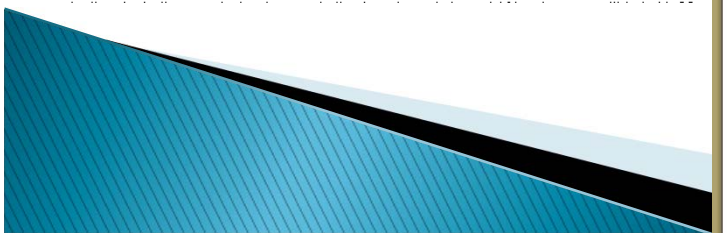
Top wheat experts reported a breakthrough in their ability to track strains of a deadly, rapidly mutating wheat pathogen called stem rust that threatens wheat fields from East Africa to South Asia.

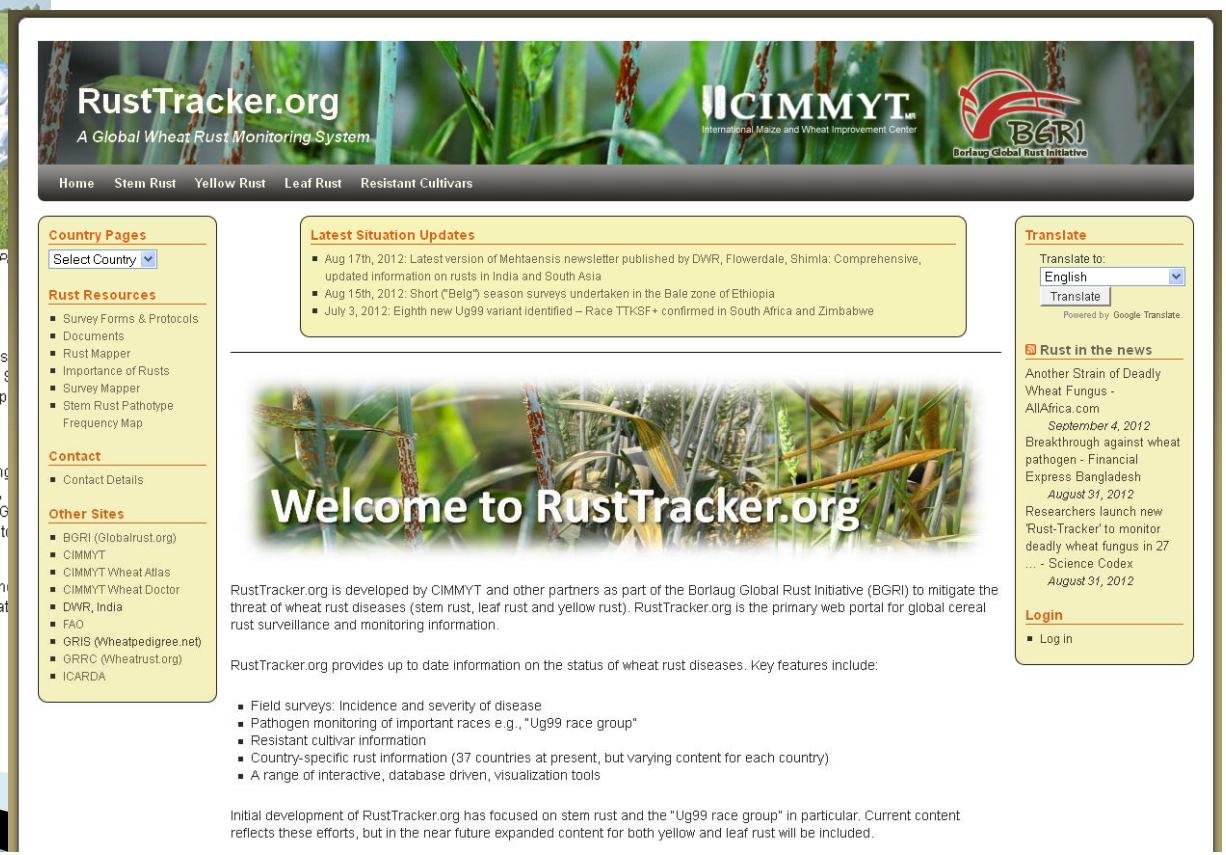
Using data submitted by farmers and scientists, creators of Rust-Tracker, a global cereal rust monitoring system, say they can monitor 42 million hectares of wheat in 27 developing countries in the path of a wind-borne disease so virulent it could quickly turn a healthy field of wheat into a black mass of twisted stems and dried-up grains.

At a symposium in Beijing organized by the Borlaug Global Rust Initiative (BGRI) Sept. 1-4, scientis reported significant progress developing and introducing 20 new varieties of rust-resistant wheat. S for the new varieties is being deployed in eight nations for farmers to plant to prevent massive crop But the experts warned that wheat fields in many countries remain largely unprotected from the dangerous pathogen.

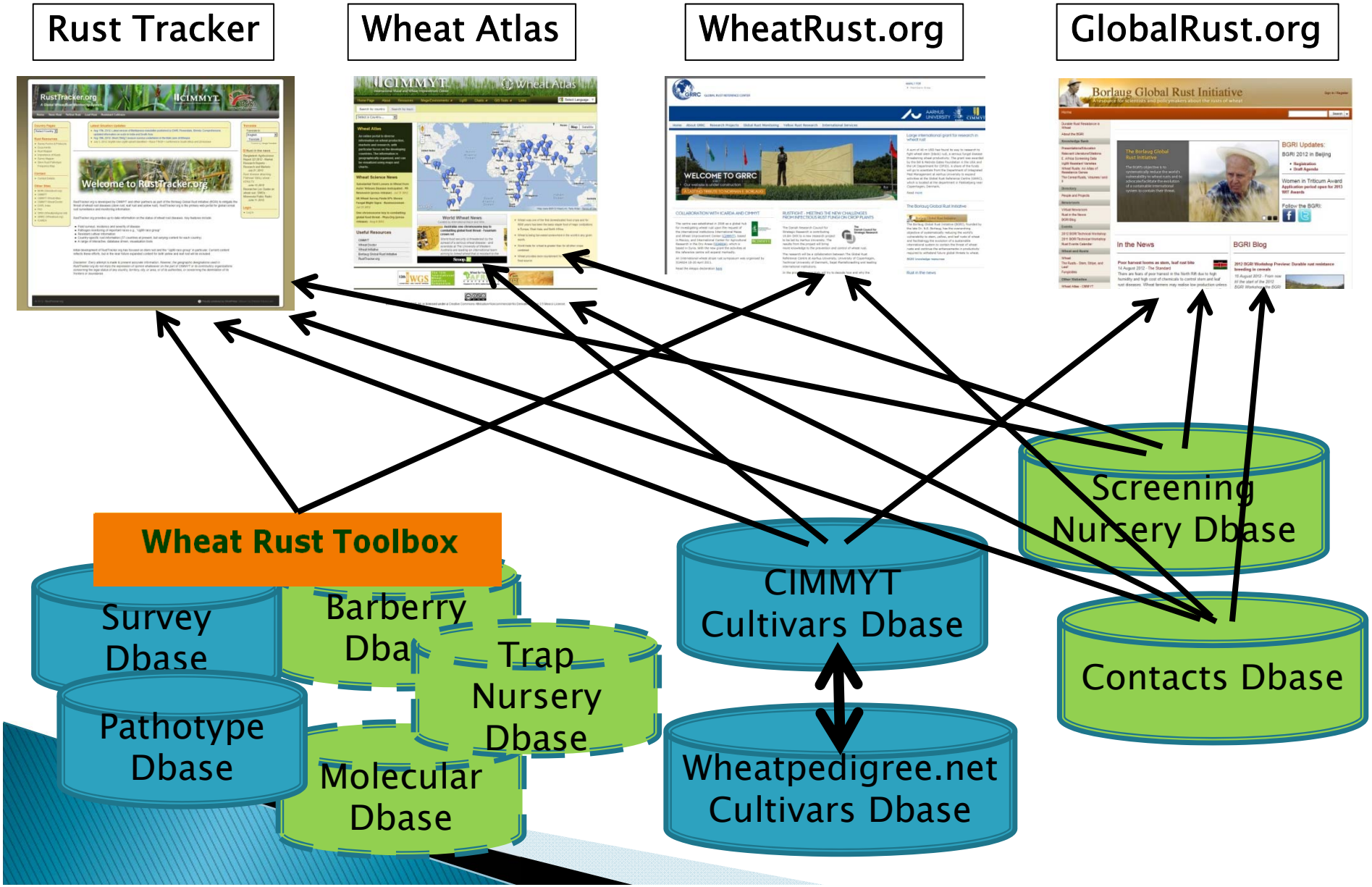
"The research being presented at this meeting takes us significantly closer to our goal of protecting global wheat crop from rust diseases," said Ronnie Coffman, Cornell professor of plant breeding, principal investigator, director of the Durable Rust Resistance in Wheat Project and vice chair of BG "But the vast wheat-growing region that stretches across North Africa and Central Asia all the way t gateway to China -- the world's largest wheat-growing nation -- is still vulnerable."

Studies presented in Beijing reported on progress with isolating genes that confer resistance to th Ug99 fungus in a wild relative of wheat from Israel and Lebanon. An estimated 85 percent of wheat





Integrated Information Resources



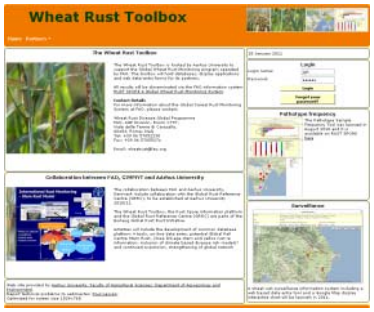
Wheat Rust Toolbox framework

EuroWheat

GRRC

RustTracker

Wheat rust toolbox



Models and applications layer [.NET]

XML, CSV

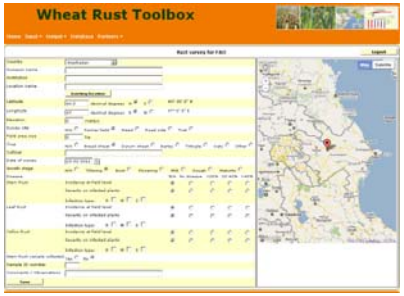
Exchange and integration with external platforms

SQL Databases: CropProblem etc.

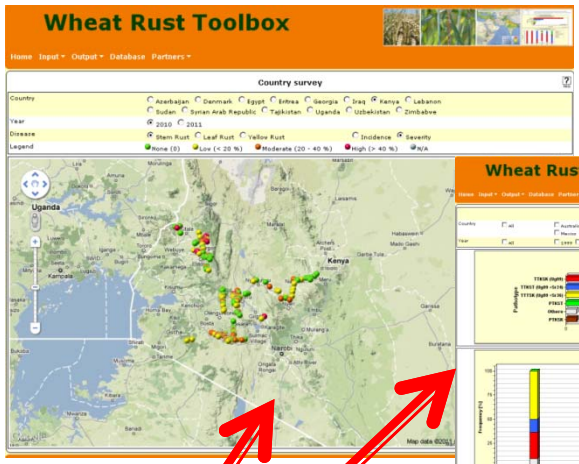
Wheat Rust Toolbox: Data management & web tools

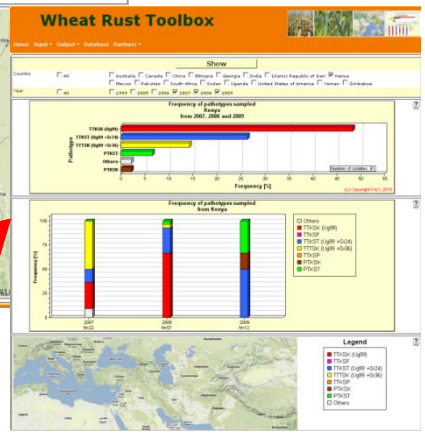
NB: Generic - Applicable to all rusts

On-line Data Entry



Smartphone survey tool





Outputs:
- Survey Mapping
- Pathotypes, +...

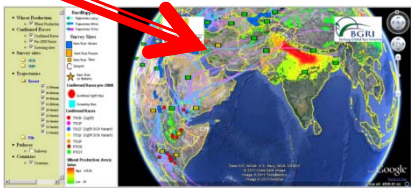
Quality control/publish

User Management

Data Export / Exchange

Wheat Rust Toolbox

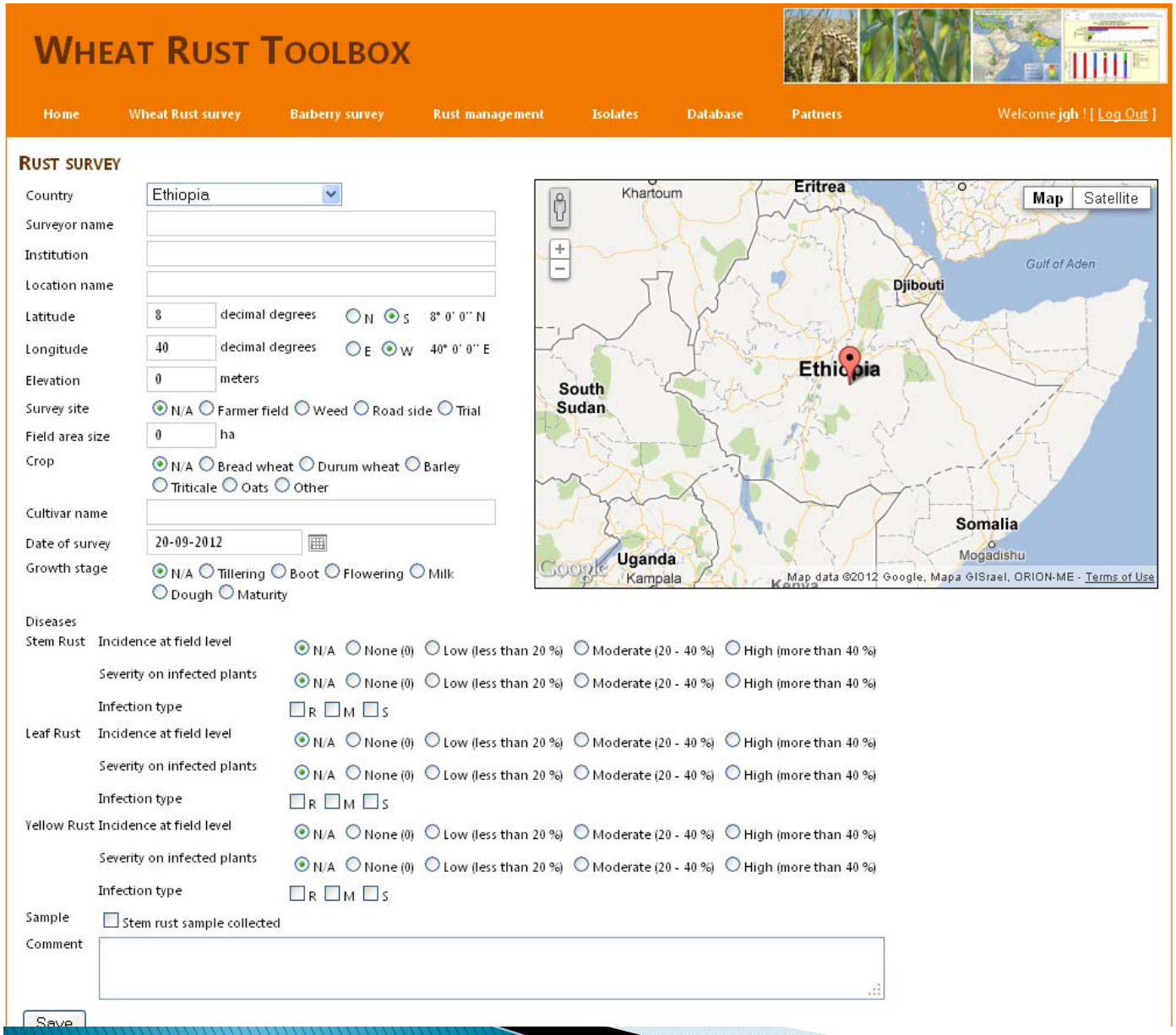
Crop Problem Dbase (survey, pathotypes, [*Trap nursery, Molecular*])



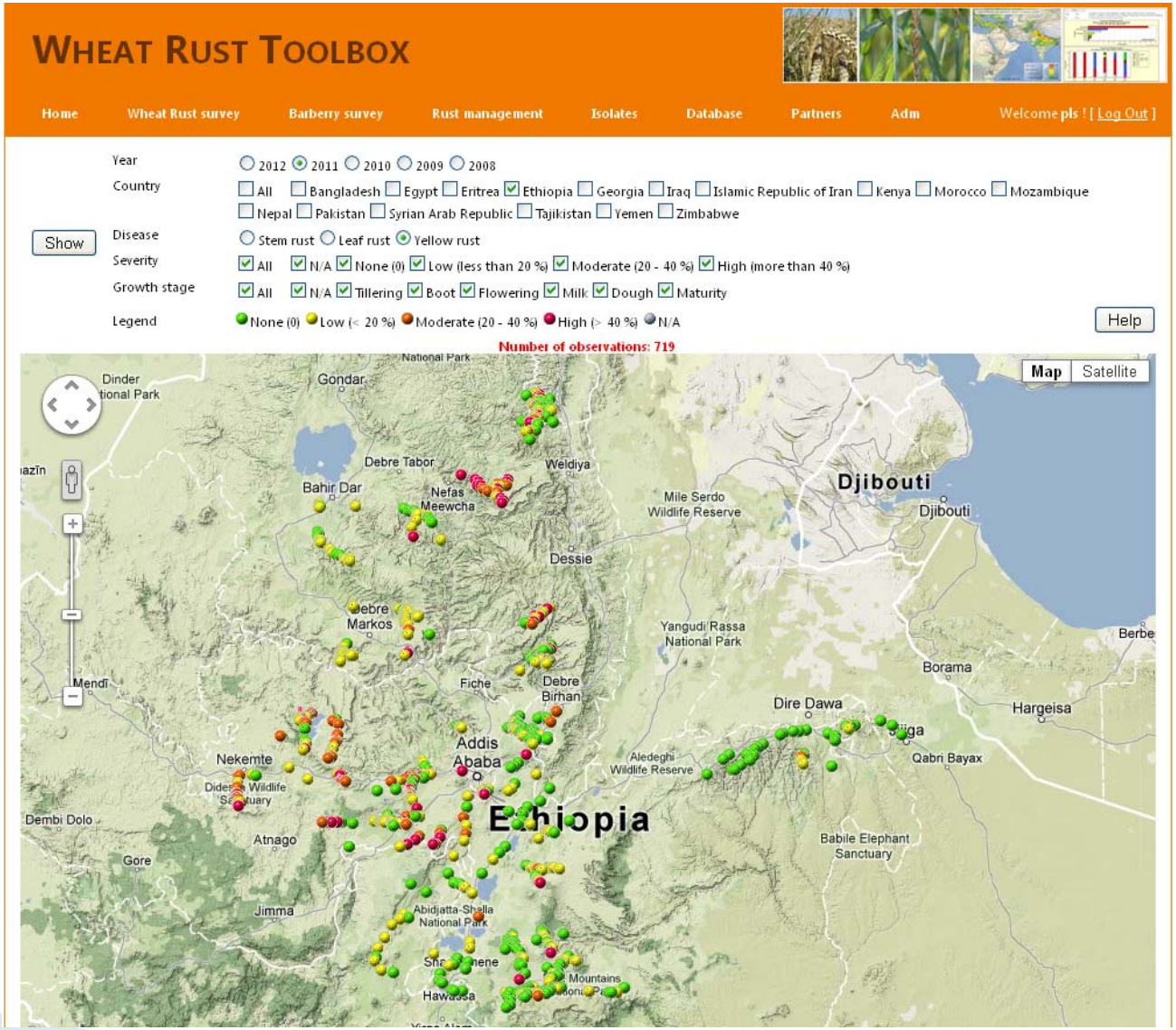
External Applications e.g., RustMapper

AARHUS UNIVERSITET

Data entry: Web page or Smart Phone



Survey mapper tool



“My Rust” – Analyse and download own data

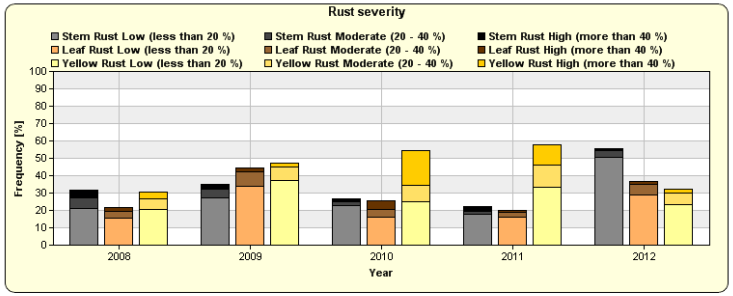
Home | Rust survey | Rust management | Input | Output | Database | Partners — Welcome jgh ! [Log Out]

COUNTRY Ethiopia

SUMMARY

	2008	2009	2010	2011	2012	Total
Number of observations	578	877	1084	719	162	3420
Number of observations with Stem Rust	184	309	292	158	90	1033
Number of observations with Leaf Rust	125	391	278	144	59	997
Number of observations with Yellow Rust	177	416	590	414	52	1649
Number of observations with no rust	1	0	221	207	30	459

RUST SEVERITY ○ Numbers ◉ Frequency



YEAR ◉ 2012 ○ 2011 ○ 2010 ○ 2009 ○ 2008

DISEASE ◉ Stem rust ○ Leaf rust ○ Yellow rust

LEGEND None (0) Low (< 20 %) Moderate (20 - 40 %) High (> 40 %)

Number of observations with location coordinates: 162

Web site provided by Aarhus University, Faculty of Science and Technology, Department of Agroecology.
Report technical problems to webmaster: Poul Lassen. Optimized for screen size 1024x768

WHEAT RUST TOOLBOX

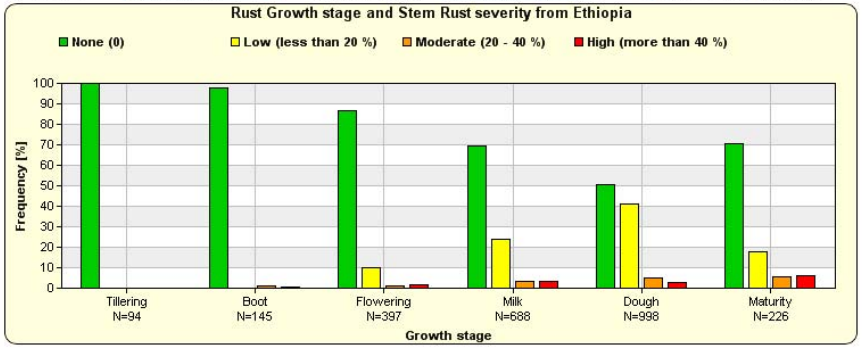
Home | Wheat Rust survey | Barberry survey | Rust management | Isolates | Database | Partners — Welcome jgh ! [Log Out]

RUST ANALYSING TOOL

Country: Ethiopia

Year: ☑ 2012 ☑ 2011 ☑ 2010 ☑ 2009 ☑ 2008

First selection: Growth stage — Second selection: Stem Rust severity — ○ Observations ◉ Frequency



Web site provided by Aarhus University, Faculty of Science and Technology, Department of Agroecology.
Report technical problems to webmaster: Poul Lassen. Optimized for screen size 1024x768

Hotspot analysis and risk mapping

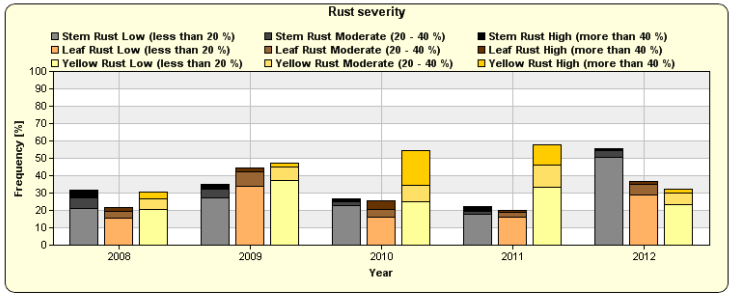
Home | Rust survey | Rust management | Input | Output | Database | Partners | Welcome jgh ! [Log Out]

COUNTRY Ethiopia

SUMMARY

	2008	2009	2010	2011	2012	Total
Number of observations	578	877	1084	719	162	3420
Number of observations with Stem Rust	184	309	292	158	90	1033
Number of observations with Leaf Rust	125	391	278	144	59	997
Number of observations with Yellow Rust	177	416	590	414	52	1649
Number of observations with no rust	1	0	221	207	30	459

RUST SEVERITY ○ Numbers ◉ Frequency



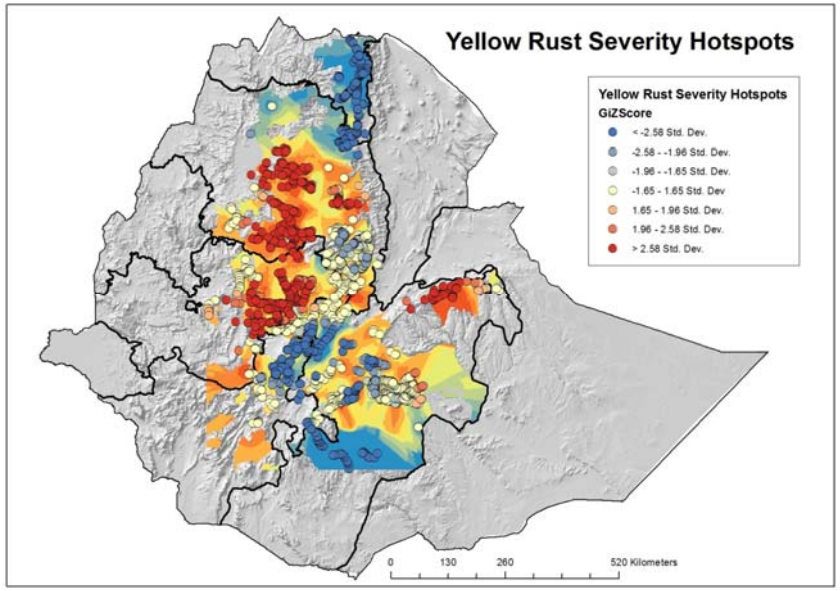
YEAR ◉ 2012 ○ 2011 ○ 2010 ○ 2009 ○ 2008

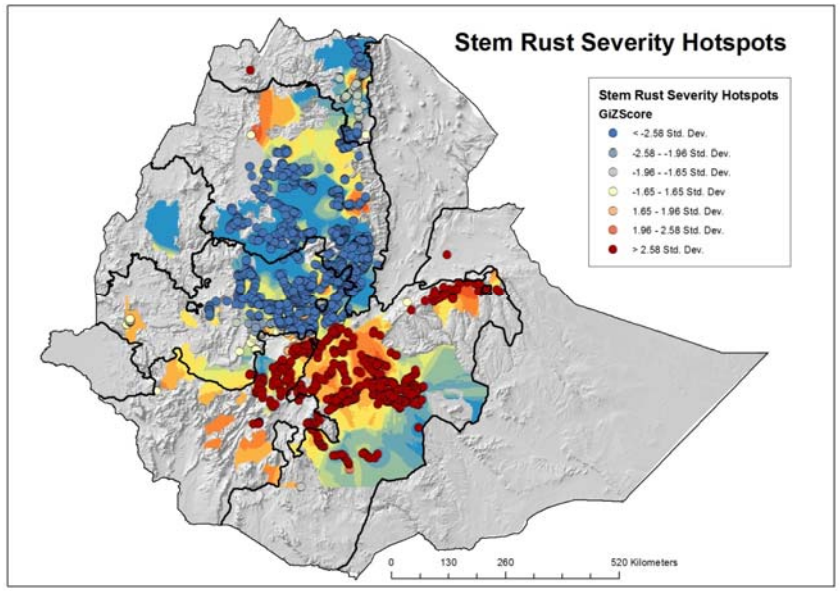
DISEASE ◉ Stem rust ○ Leaf rust ○ Yellow rust

LEGEND None (0) Low (< 20 %) Moderate (20 - 40 %) High (> 40 %)

Number of observations with location coordinates: 162

Web site provided by Aarhus University, Faculty of Science and Technology, Department of Agroecology.
Report technical problems to webmaster: Poul Lassen. Optimized for screen size 1024x768





GRRC

GLOBAL RUST REFERENCE CENTER

Headed by
Prof. Mogens S. Hovmøller

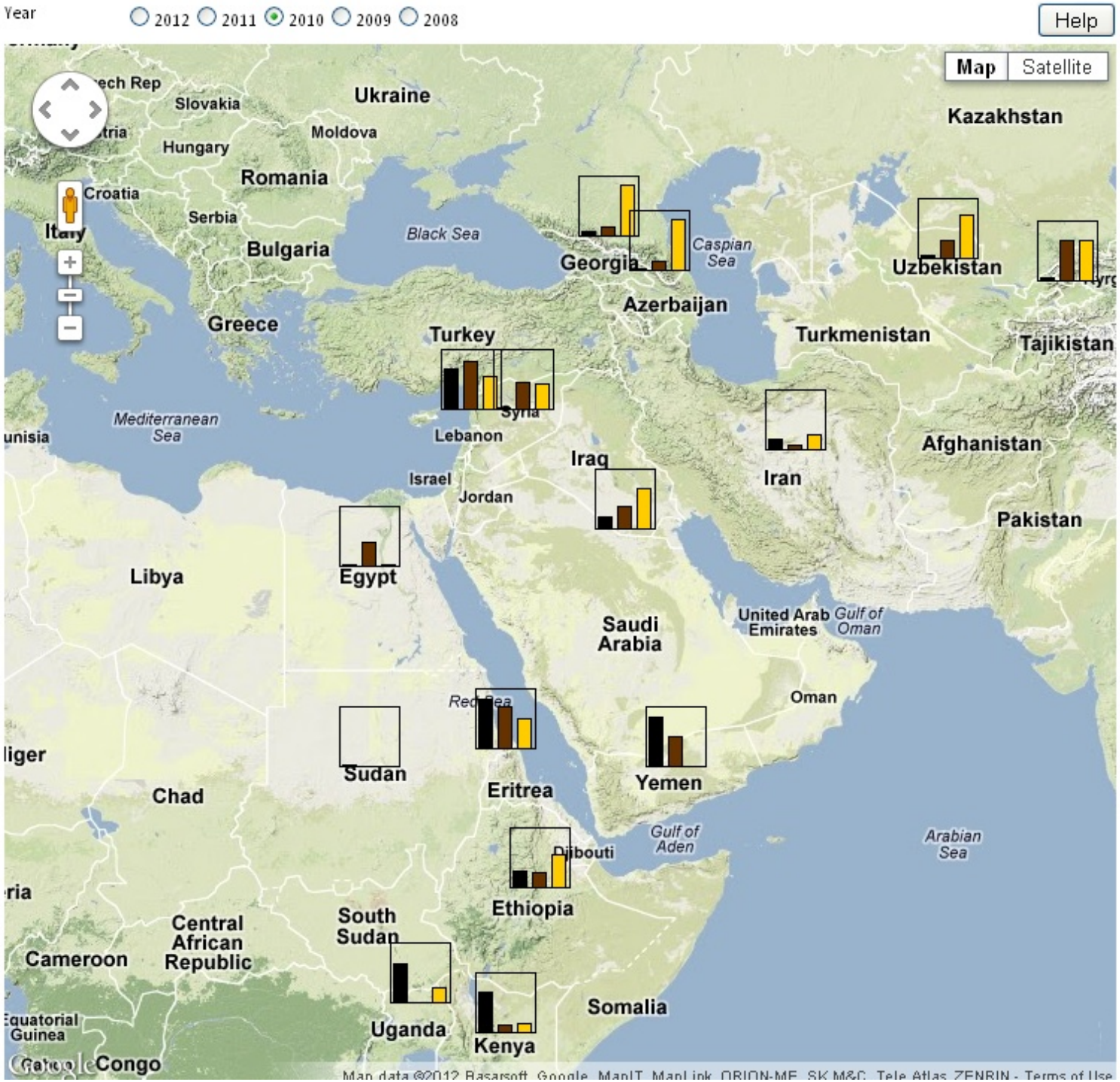
- Maintenance of global rust isolate collection
- Training & education of students, visitors and scientists
- Isolate characterization
  - Virulence phenotyping
  - Genotyping
  - Epidemic potential
- Rust tracking – early warning
- Development of the 'Wheat Rust Toolbox' & databases

Surveillance Summary:

Bars:

- Stem rust
- Leaf rust
- Stripe rust

Frequency of Fields attacked > 0 % severity



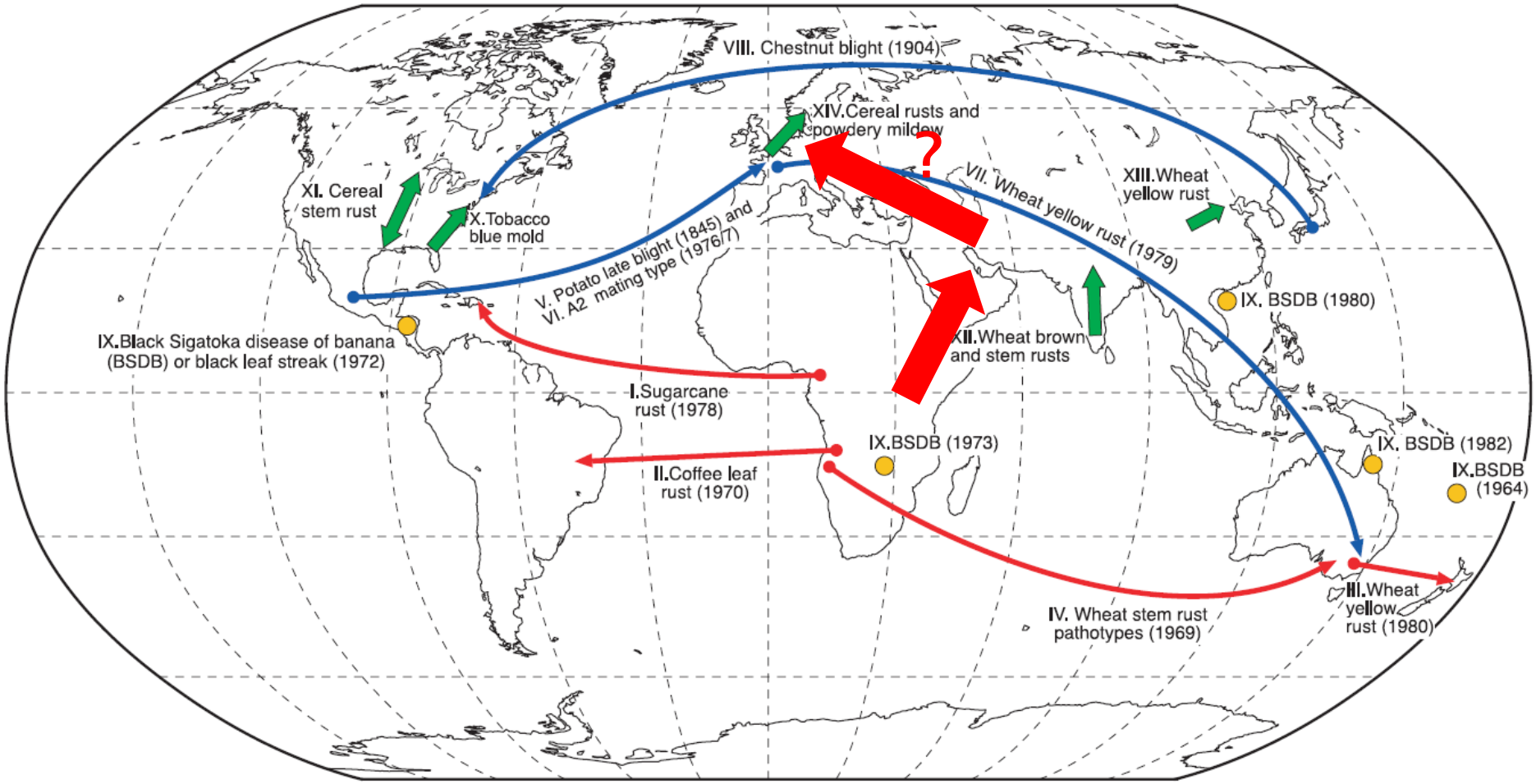


Fig. 1. Selected dispersal events of fungal pathogens. Red and blue arrows indicate invasions of new territories (first year recorded in brackets). Red arrows indicate dispersal that probably occurred by direct movement of airborne spores [I (*12*), II (*11*), III (*23*), and IV (*52*)]. Blue arrows indicate pathogens that were probably transported to the new territory in infected plant material or by people and spread thereafter as airborne spores [V (*9*), VI (*21*), VII (*22*), and VIII (*10*)]. Orange circles indicate the worldwide spread of black Sigatoka disease of banana; the first outbreak recorded on each continent is marked [IX (*19*)]. Green arrows indicate periodic migrations of airborne spores in extinction-recolonization cycles [X (*32*), XI (*33*), XII (*34*), XIII (*35–38*), and XIV (*41*)]. [Background world map © C. Lukinbeal, Southern Connecticut State University, New Haven, Connecticut]

REVIEW: EPIDEMIOLOGY

Aerial Dispersal of Pathogens on the Global and Continental Scales and Its Impact on Plant Disease

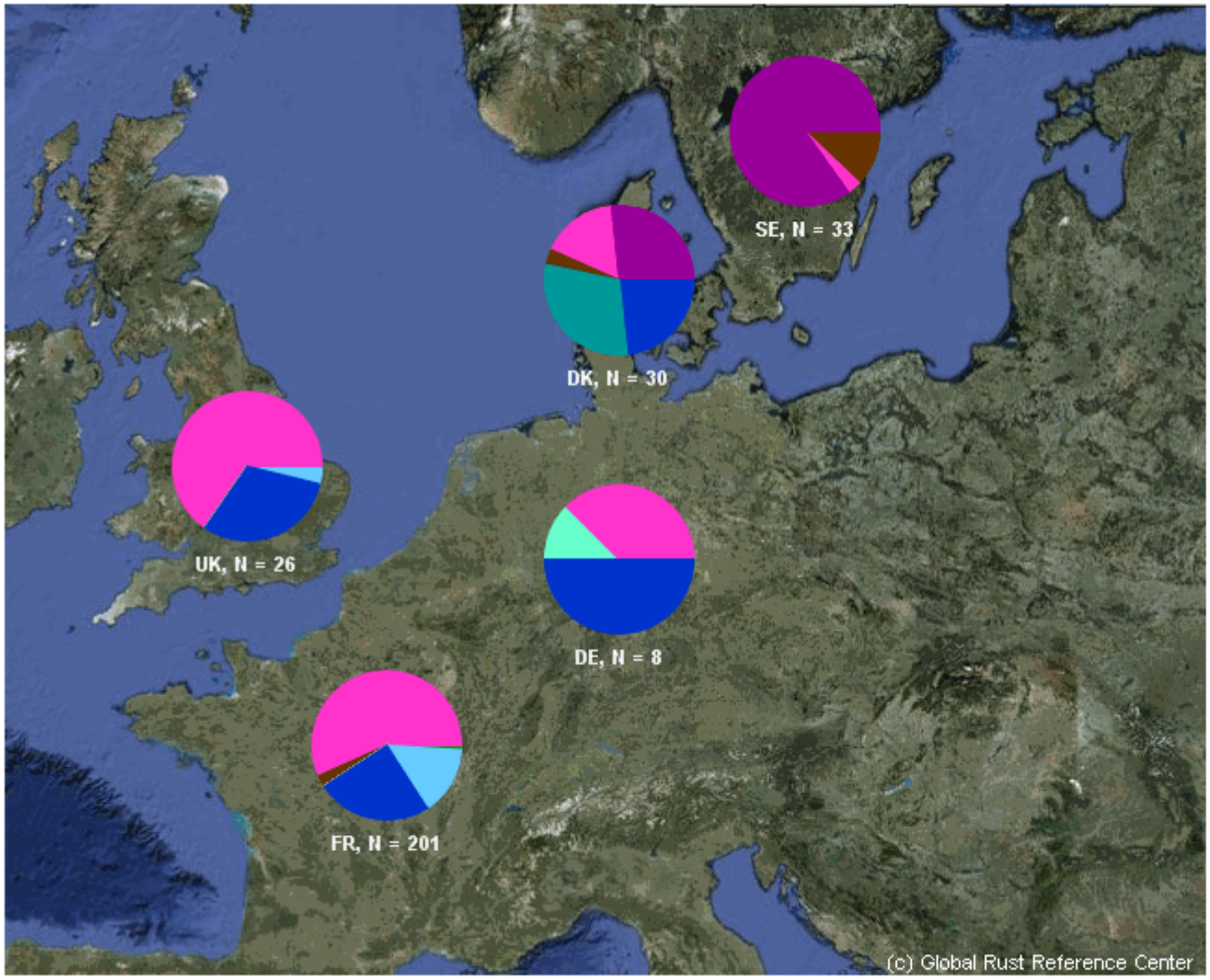
James K. M. Brown1* and Mogens S. Hovmøller2*

Pathotype by year, Europe map

Show

Year All 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011

Help



- [123----9-17-] (Brigadier I)
- [1234---9-17-] (Brigadier II)
- [123-6--9-17-] (Lynx I)
- [12346--9-17-] (Lynx II)
- [1234---9-17.32] (Robigus I)
- [123----9-17.32] (Robigus II)
- [12346--9-17.32] (Oakley)
- [-2--678----] (Mediterranean 6E16)
- [-2--6789---] (Wheat aggressive)
- [----678-10--] (Triticale aggressive I)
- [-2--678-10--] (Triticale aggressive II)
- [--346-----32] (Tulsa)
- [123467-9-17.32] (Warrior/Ambition)
- [123-6789-17.32] (Kranich)

Data provided by: Institut National de la Recherche Agronomique (France), Julius Kühn-Institut, Federal Research Centre for Cultivated Plants (Germany and Austria), National Institute of Agricultural Botany (United Kingdom) and Aarhus University (Denmark and Sweden)

What's new?

2009-2010

- New aggressive race threatening triticale production appeared in Scandinavia and Germany
- Losses of 50-100% were typical for organic growers in DK

What's new in Europe?

2009-2010

- New aggressive races is threatening triticale production appeared in Scandinavia and Germany
- Losses of 50-100% were typical for organic growers in DK

2011

- Two multi-virulent races showing massive telia-formation (greenhouse and field) appeared for the first time
- The 'Ambition/Warrior' race present in Spain, France, UK, Germany, Denmark and Sweden, - in high frequencies

What's new?

2009-2010

- New aggressive races is threatening triticale production appeared in Scandinavia and Germany
- Losses of 50-100% were typical for organic growers in DK

2011

- Two multi-virulent races with aboundant telia-formation (greenhouse and field) appeared for the first time
- The 'Ambition/Warrior' race present in Spain, France, UK, Germany, Denmark and Sweden

2012

- Unusual high number of varieties affected in field trials
- Widespread epidemics in Spain, France, UK, Denmark and Sweden – increasing demands for fungicide sprays

Outstanding questions/ Warrior/Ambition race

Geographical and evolutionary origin?

- Recombination involving *Pst* of NW-European origin?
- Mutation in a European strain
- Exotic incursion

Or Preliminary results (September 2012):

1.

2. →
- Isolates of Ambition/Warrior race had unique SSR fingerprint
- Ambiton/Warrior race had many characteristics in common with Pst populations in Asia

3. →
- Likely new exotic incursion into NW Europe

Summary

- Integrated Information Resources – and ICT framework established
- Data collected in dedicated structured databases, use of standard methods, network of expert labs, quality control, “on-the-fly” dissemination on several information platforms.
- More robust conclusions, stimulate data contribution and collaboration between partners and users
- 27 Countries participate in surveillance – 20% of global wheat area
- 8 members of the Ug99 race group – we know what they are, where they are and where they (most likely) are heading!
- Introduction of SR rust resistant cultivars in risk areas on the track
- New exotic stripe rust from Asia to Europe/Africa to USA, Asia and Australia. The Global Rust Reference Center and its network of partners is prepared to analyse it in a global context

Acknowledgments

- All contributing national partners
- PBI, University of Sydney
- ICARDA
- CIMMYT
- AAFC, Canada
- CDL, Minnesota, USA
- University of the Free State, South Africa
- GRRC, Aarhus University, Denmark
- BGRI / Cornell University

Donors:

- Bill & Melinda Gates Foundation
- DFID
- USAID
- IFAD