Plant of the Day

Oryza sativa (rice)

- Domesticated 10,000 years ago in China.
- Two different subspecies, *japonica* and *indica*.
- Currently thought that *japonica* was domesticated first and then crossed into local varieties to create domestic *indica.*
- Over 40,000 different varieties of rice and 127,000 accessions in gene banks.

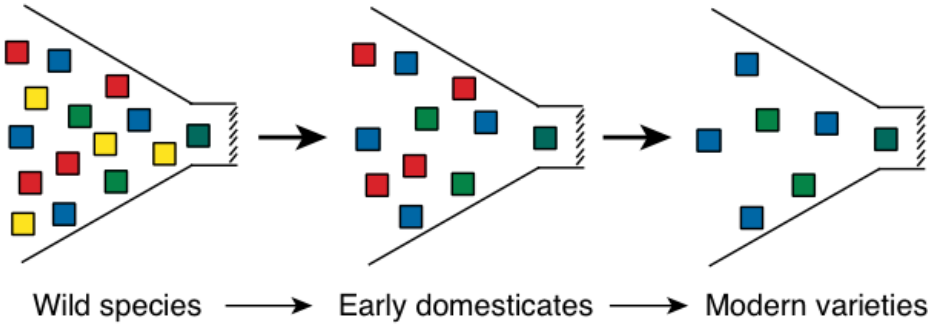

Crop diversity

Big Questions

- Why is crop diversity/agrobiodiversity important?
- What changes have occurred/are predicted to occur in global crop diversity?
- What are the major threats to crop diversity?
- What solutions do we have to these threats?

Crop diversity

- Most crop species have lower genetic diversity than their wild progenitors due to the ‘domestication bottleneck’



- However, crop species commonly harbor many distinct varieties and landraces that arose as a result of artificial, diversifying selection.

Crop diversity

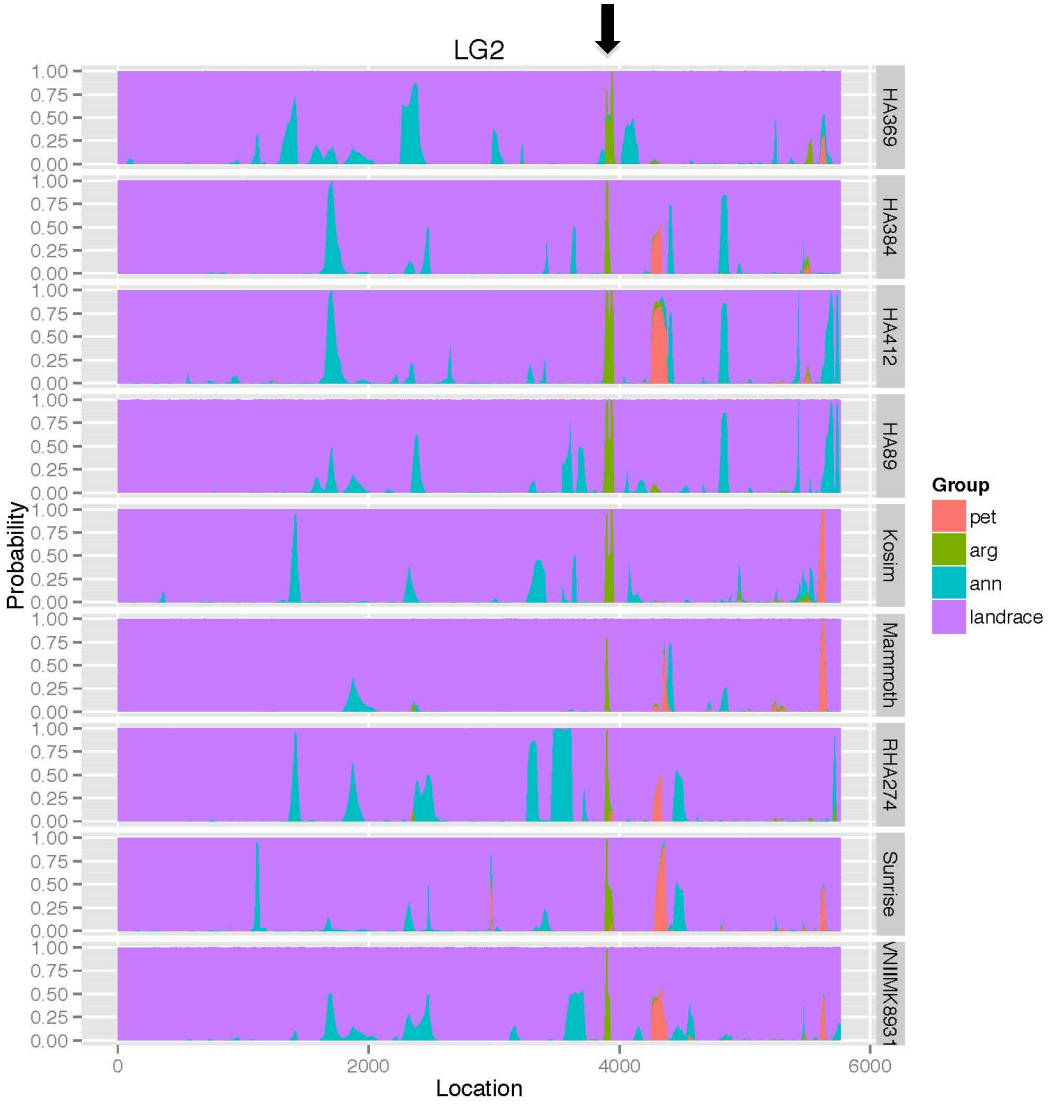
- e.g. potatoes (*Solanum tuberosum*)

Major uses of crop diversity

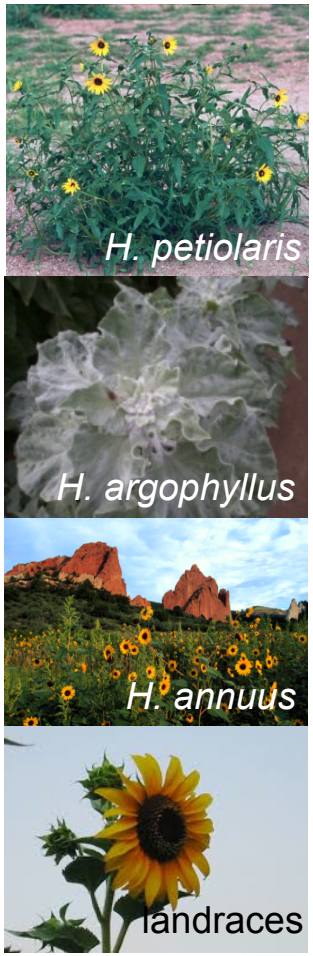
- Interspecific diversity (crop wild relatives) as well as intra-specific diversity are an important source for new alleles (such as disease resistance) in crop improvement efforts.

From last week:
Where does the cultivated gene pool come from?

Sclerotinia resistance locus



Wild Introgressions



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- Interspecific diversity (crop wild relatives) as well as intra-specific diversity are an important source for new alleles (such as disease resistance) in crop improvement efforts.
- Different landraces and varieties are often well adapted to their local/regional agro-ecological niche and are unique in many phenotypic traits, such as stress response/resistance.

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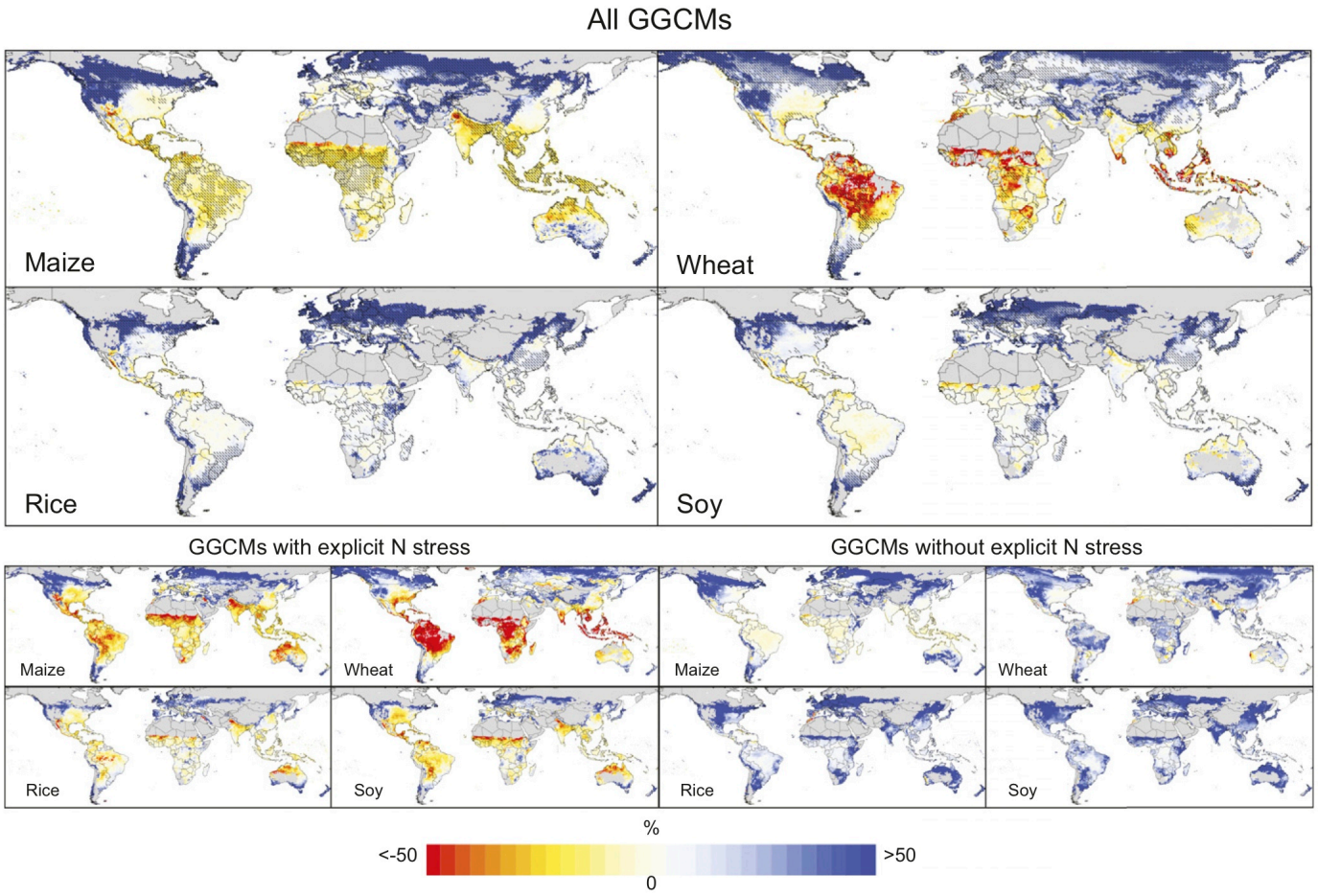
- Agro-biodiversity is thought to have the potential to play a major role in climate-change adaptations of agro-ecosystems


Newsweek

Peruvian Farmers Adapt to Global Warming

By Newsweek Staff | 3/13/10 at 7:43 PM

Global gridded crop models predict large reductions in yields of major crops
(especially under nitrogen stress)



Rozenweig *et al.* 2014

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- Agro-biodiversity is thought to have the potential to play a major role in climate-change adaptations of agro-ecosystems
- Indigenous people who cultivate much of the world's traditional crop diversity have often unique knowledge about uses of such diversity unknown to western society

Major uses of crop diversity

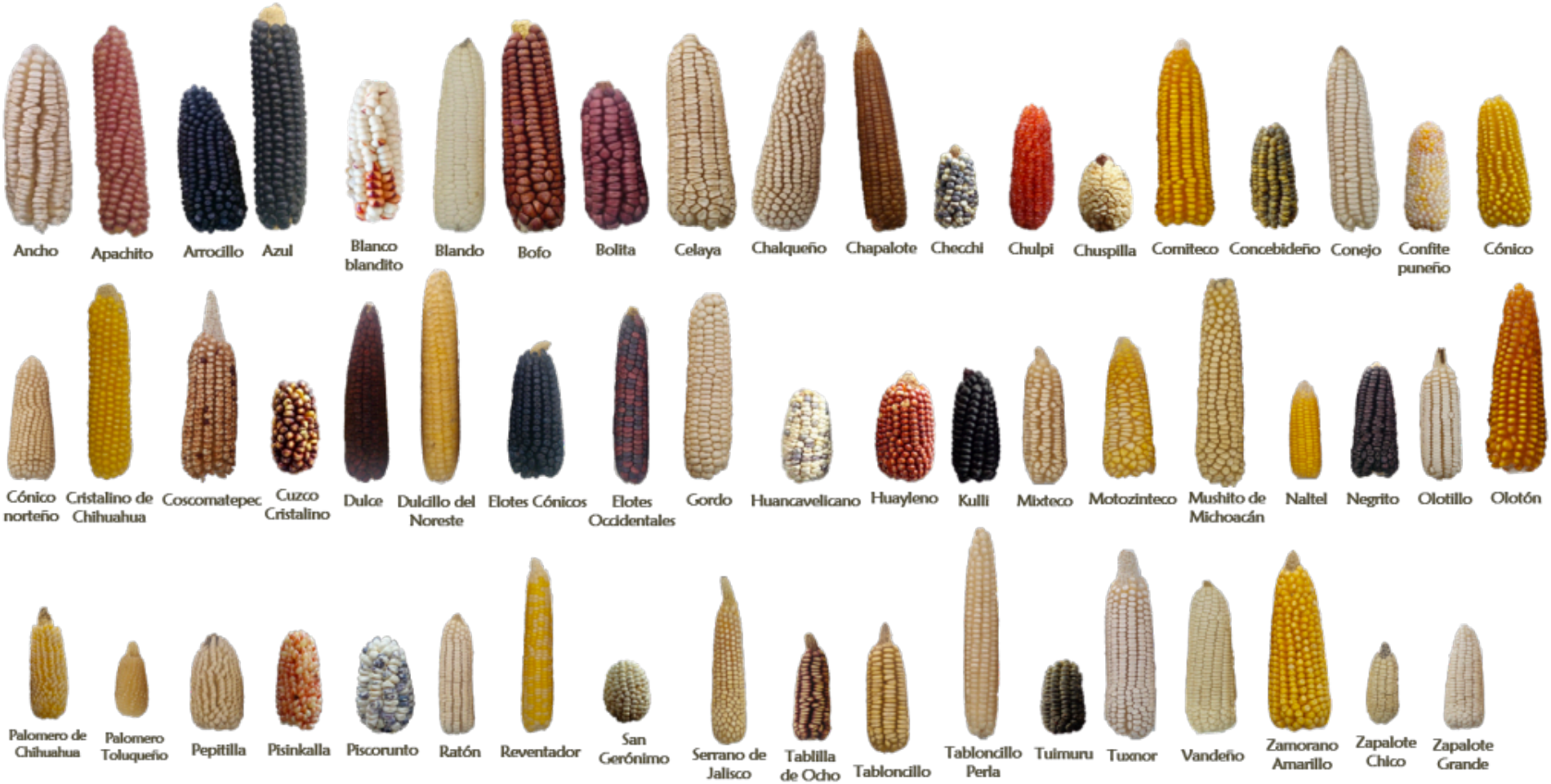
Chuño, a variety of “freeze-dried” potato that can be stored long term

Wild relatives of millet in Uganda (Global Crop Diversity Trust)

P. unisetum

With the heavily cultivated ecosystems, local elders helped in tracing the remnants of the species

Major uses of crop diversity



Mexican maize

Major uses of crop diversity

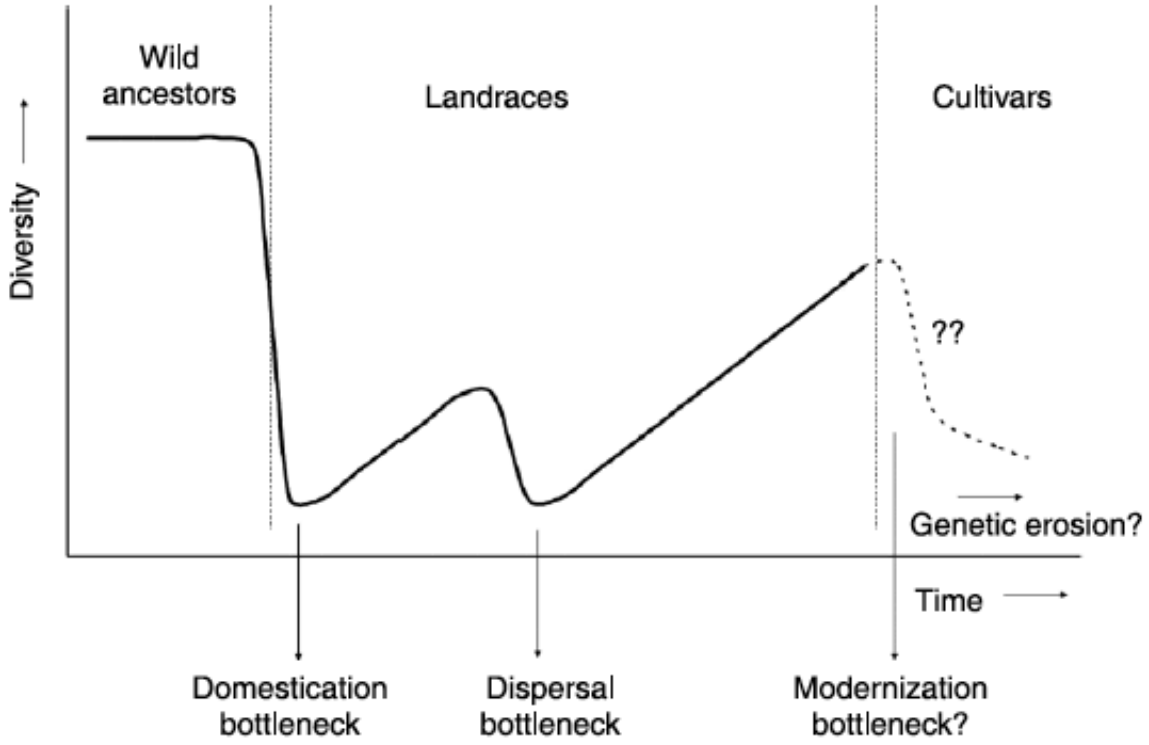
Although we emphasize the benefits of using diversity in crop breeding, it's not always used.

THINK – PAIR - SHARE

What are some reasons why crop wild relatives aren't used?
Is it better to use wild relatives or other cultivars?

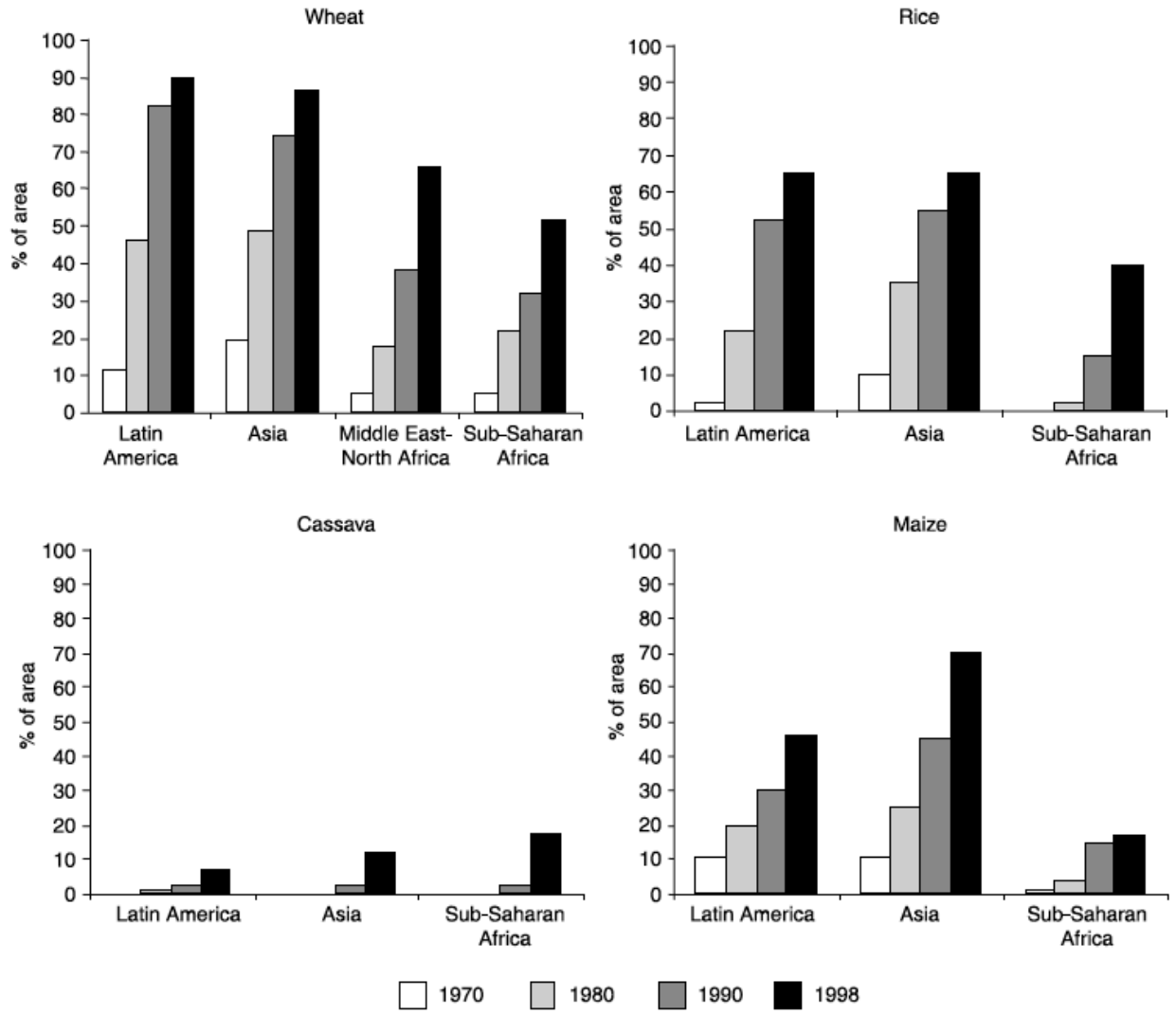
Major threats to crop diversity

- Agricultural intensification and crop monocultures can lead to genetic erosion (loss of genetic diversity) in crops



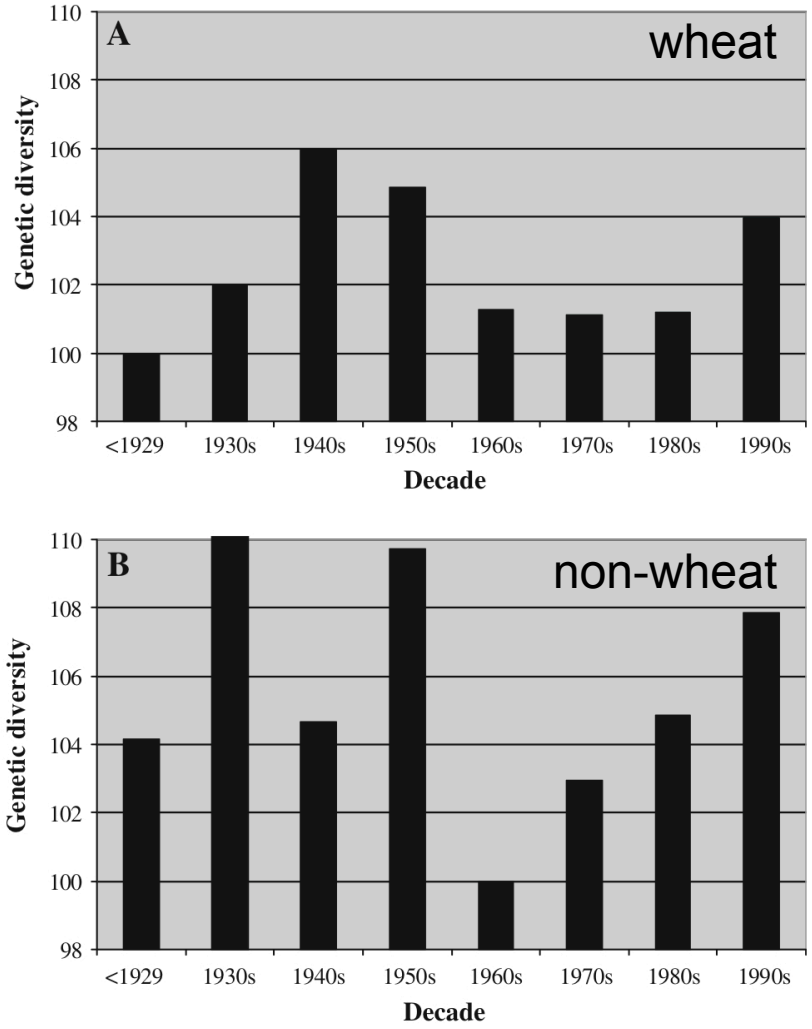
Van der Wouw *et al.* 2009

Uptake of modern varieties



Van der Wouw *et al.* 2009

However, the evidence for a modernization bottleneck is equivocal



From a meta-analysis of 24 wheat and 20 non-wheat studies of crop genetic diversity through time.

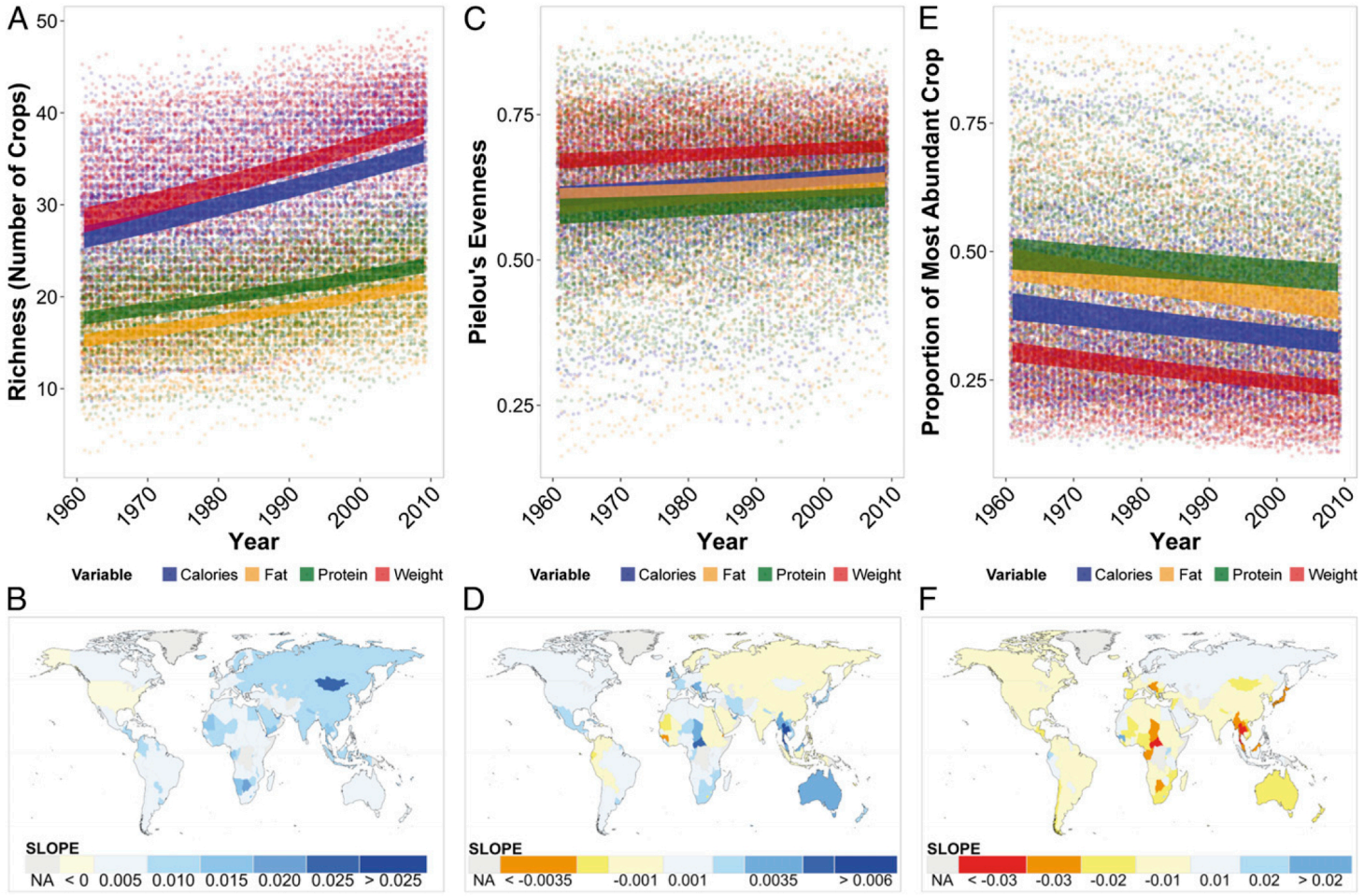
Van der Wouw *et al.* 2010

Major threats to crop diversity

- Agricultural intensification and crop monocultures can lead to genetic erosion (loss of genetic diversity) in crops
- Crop replacement as dictated by the global marketplace or as development strategy can lead to the loss of entire crop species



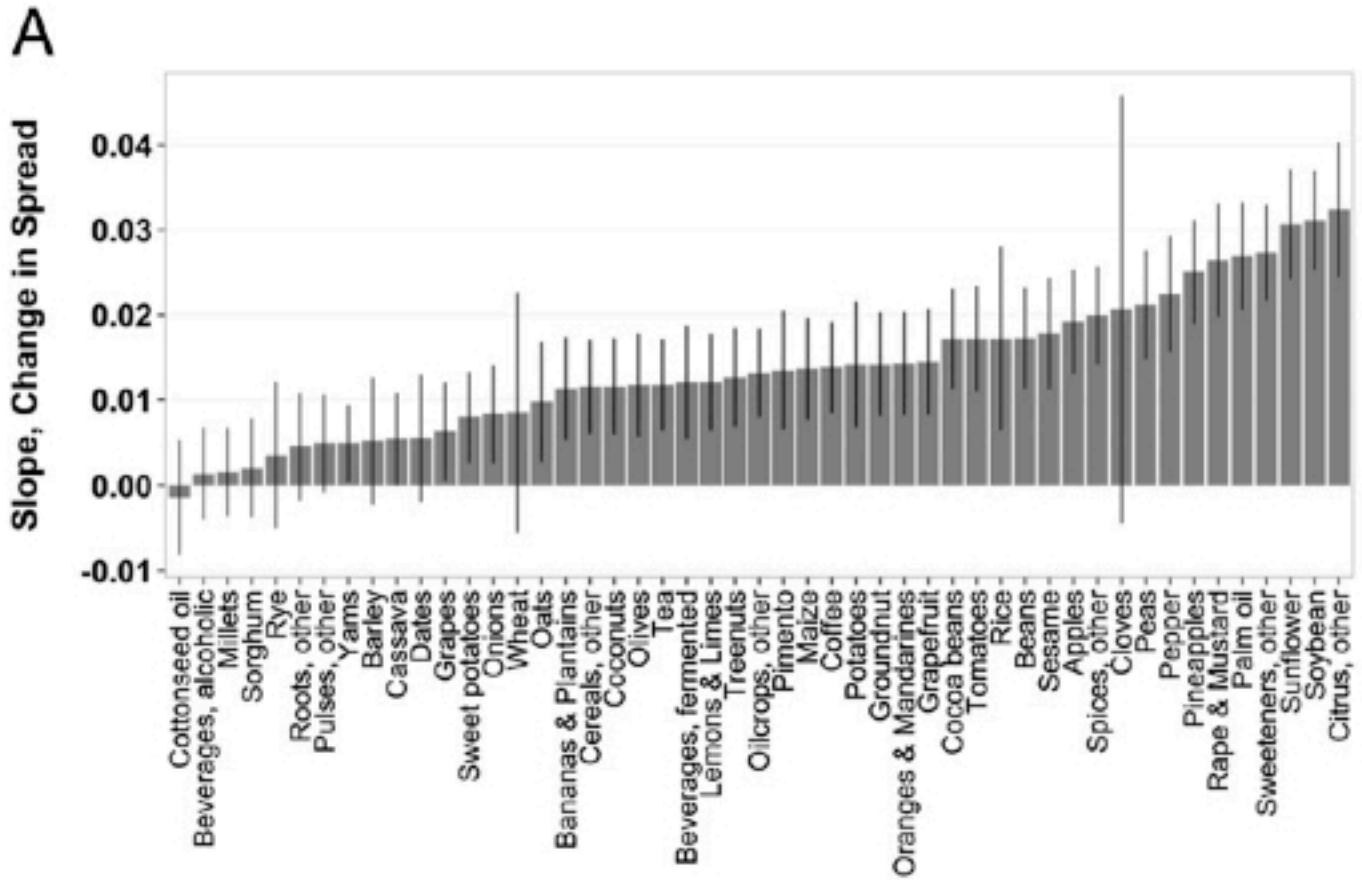

Changes in crop commodities worldwide



National food supplies contain more crop species (A & B), slightly increased evenness of crop contribution to calories (C & D), and reduced dominance by a single crop (E & F) over the last 50 years

Khoury *et al.* 2014

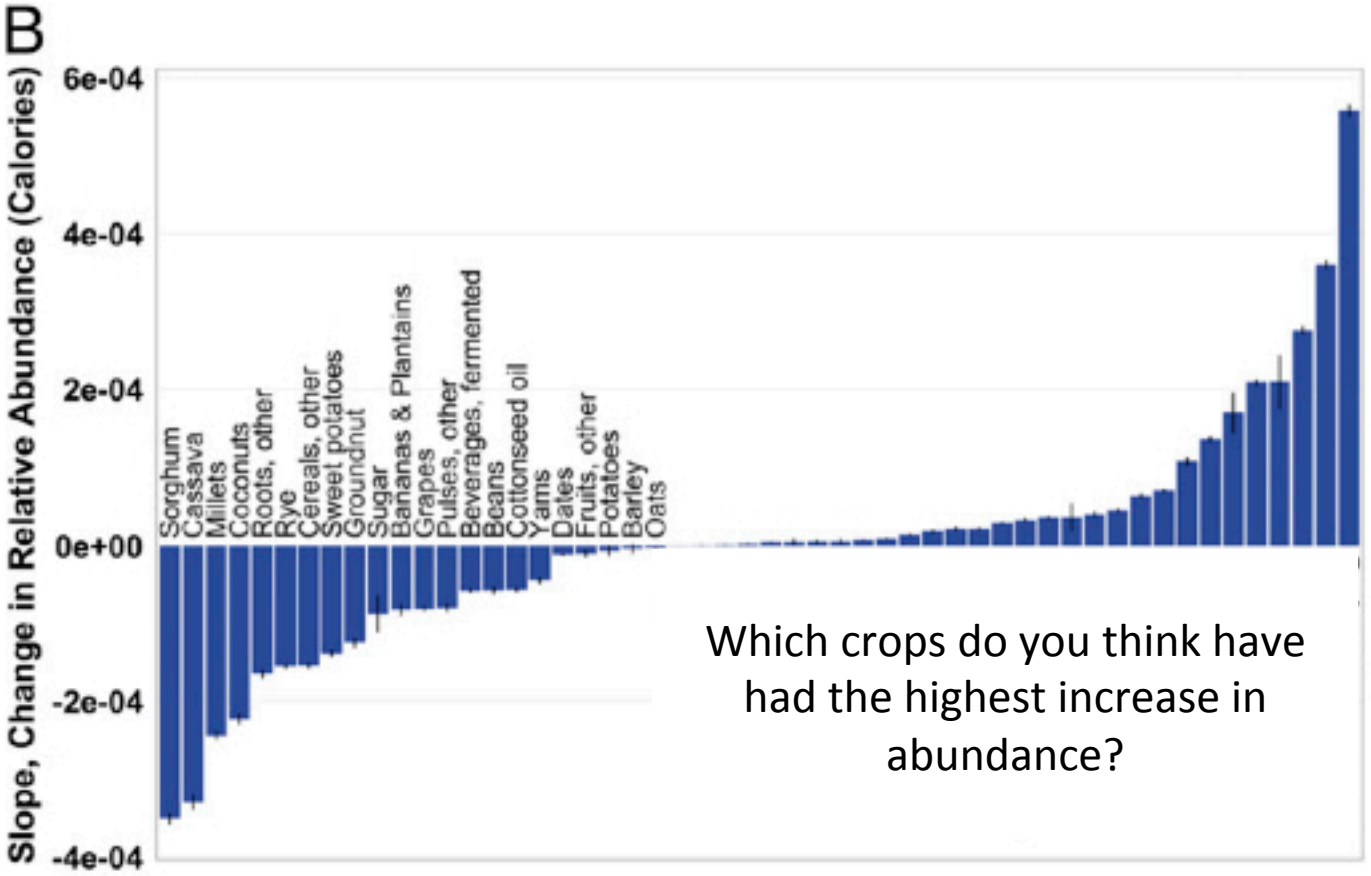
Change in crop geographic spread in national diets, 1961–2009



All crops (except cottonseed oil) are contributing to food supply in an increasing number of countries

Khoury *et al.* 2014

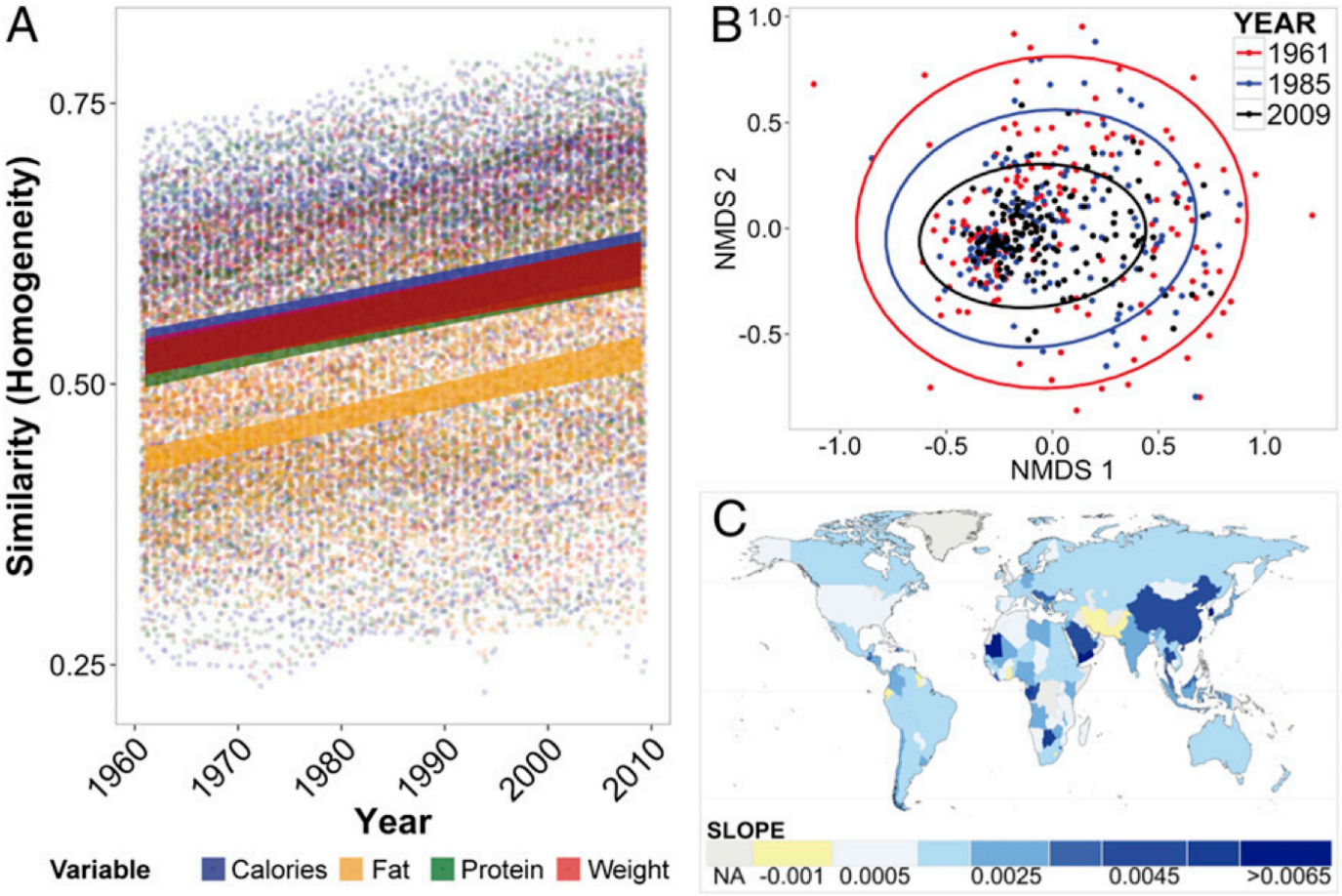
Change in crop abundance (calories) in national diets, 1961–2009



The degree of increase in spread (see previous slide) predicts the abundance of crop species in national food supplies.

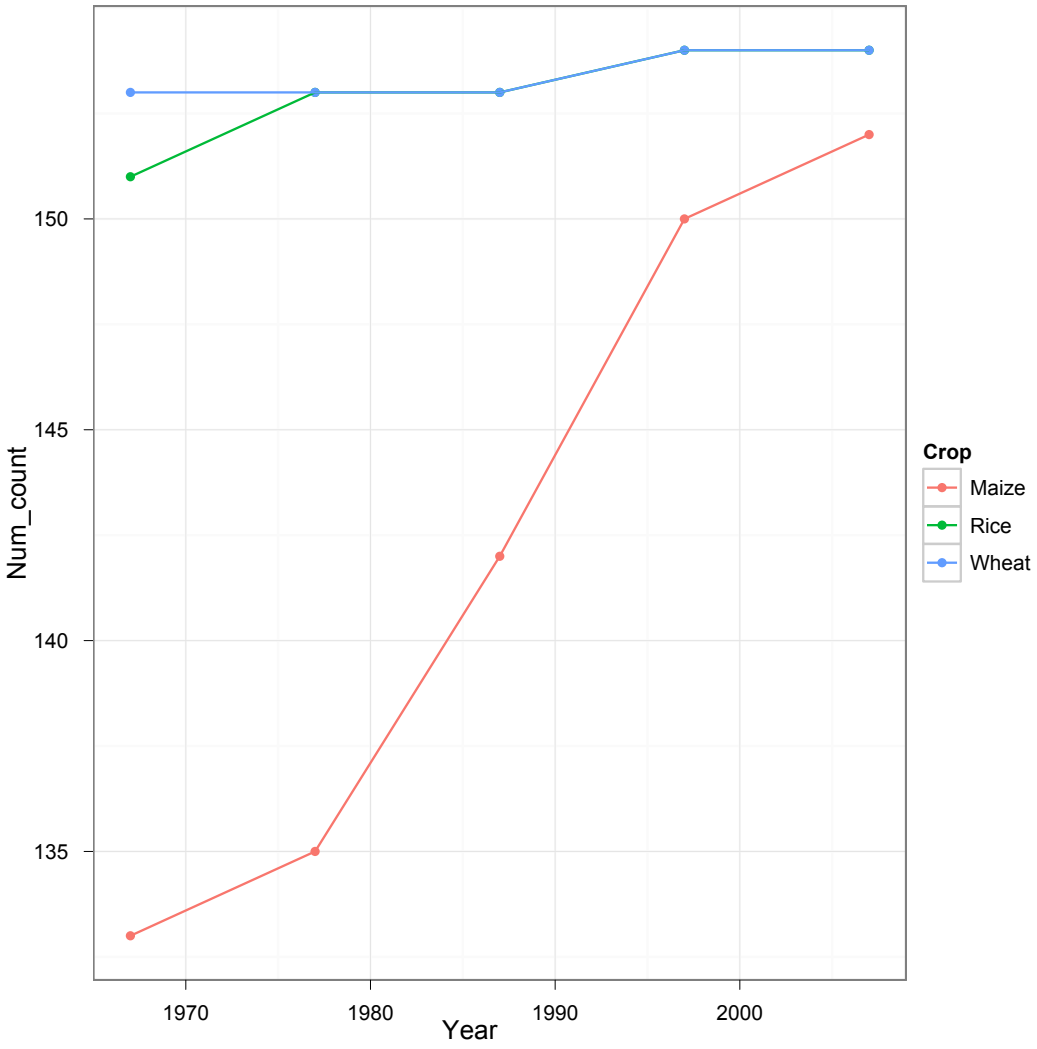
Khoury *et al.* 2014

Increase in homogeneity among national diets (crop contribution to calories), 1961–2009



Khoury *et al*. 2014

Change in number of countries in which maize, rice and wheat are being eaten



Khoury *et al.* unpublished

Neglected and Underutilized Species

What are neglected and underutilized species?

• At present, only 150 plant species are used and commercialised on a significant global scale

• Over 50% of the world's requirement for protein and calories are met by only three: rice, wheat and maize.

• There are an estimated 7,000 species that play a crucial role in poor people's livelihood strategies and may have a significant potential for commercialisation.

• Alongside their commercial potential, many of the underutilised plant species also provide important environmental services, as they are adapted to marginal soil and climate conditions.

Underutilized Species have the potential to contribute to livelihood improvement by:

- increasing incomes
- ensuring food security
- improving nutrition
- enhancing biodiversity
- tolerating stress conditions
- occupying important ecological niches
- production with low external inputs
- stabilizing ecosystems
- creating new markets

Conserving Crop Genetic Diversity

in – situ* conservation** ***vs. ***ex – situ* conservation**

Global *ex situ* conservation

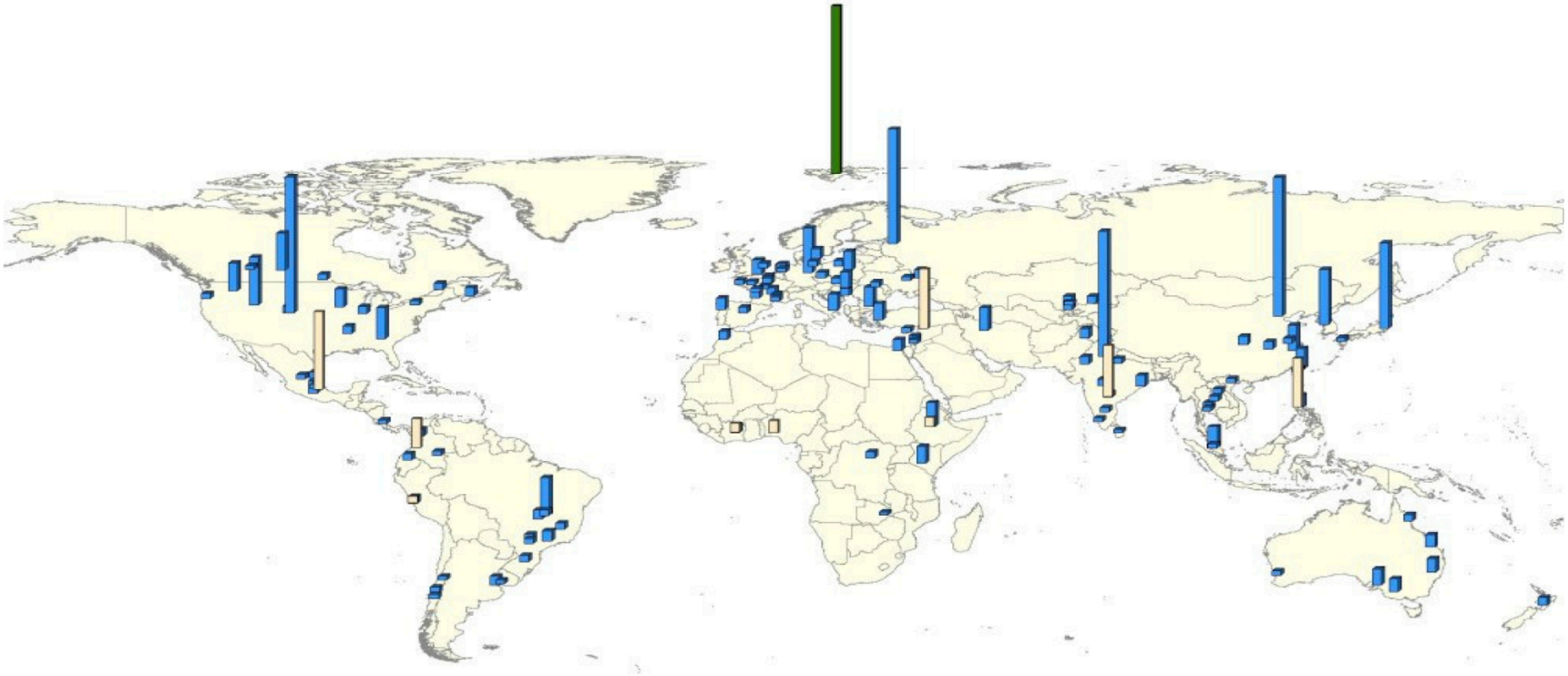


Fig. 1. Geographic distribution of genebanks with holdings of >10,000 accessions (*Source:* FAO, 2010)

From Dulloo *et al*. 2010

An example of *ex situ* conservation
The 'Doomsday' vault

Video of the vault: https://www.youtube.com/watch?v=QHw4AxJX5Wo

Unanswered Questions

- Will global diets continue to homogenize?
  - In highly developed countries, a diverse diet is often a signal of wealth.
- Will our efforts to save genetic diversity of crops and wild relatives be enough?
  - To increase yield
  - To adapt to changing climates
- What will be (or will there be) the next revolution in crop breeding?