

# Agricultural biodiversity for sustainable livelihoods



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# Bioversity International



Alliance of CGIAR  
Centres

“Improving lives  
through biodiversity  
research”

# How we work

No laboratories or field sites

Research with partners  
(NARIs, NGOs, IGOs, Universities, local communities and others)

Also a catalyst,  
coordinator, facilitator,  
consensus broker,  
think tank

Interact with networks





# Where we work

A staff of over 350 operating from 18 locations around the world



## Diversity for Well-Being

- Focus on people
- Agricultural biodiversity:
  - Conservation and use
  - Sustainability, resilience, nutrition
- Commodity based production systems (banana, coconut, cacao)
- Policy and public awareness

# The challenges we face

**Increasing number of hungry and poor**  
**Threats of climate change**  
**Malnutrition**



# A growing world

By 2050...

World population grows to  
9.2 billion = growth of 37%

Increased consumption of  
animal proteins →  
increased demand on feed





# Warming up: climate change

Temperatures rise up to 2.5 C

Changes in growing  
conditions

New pests and diseases

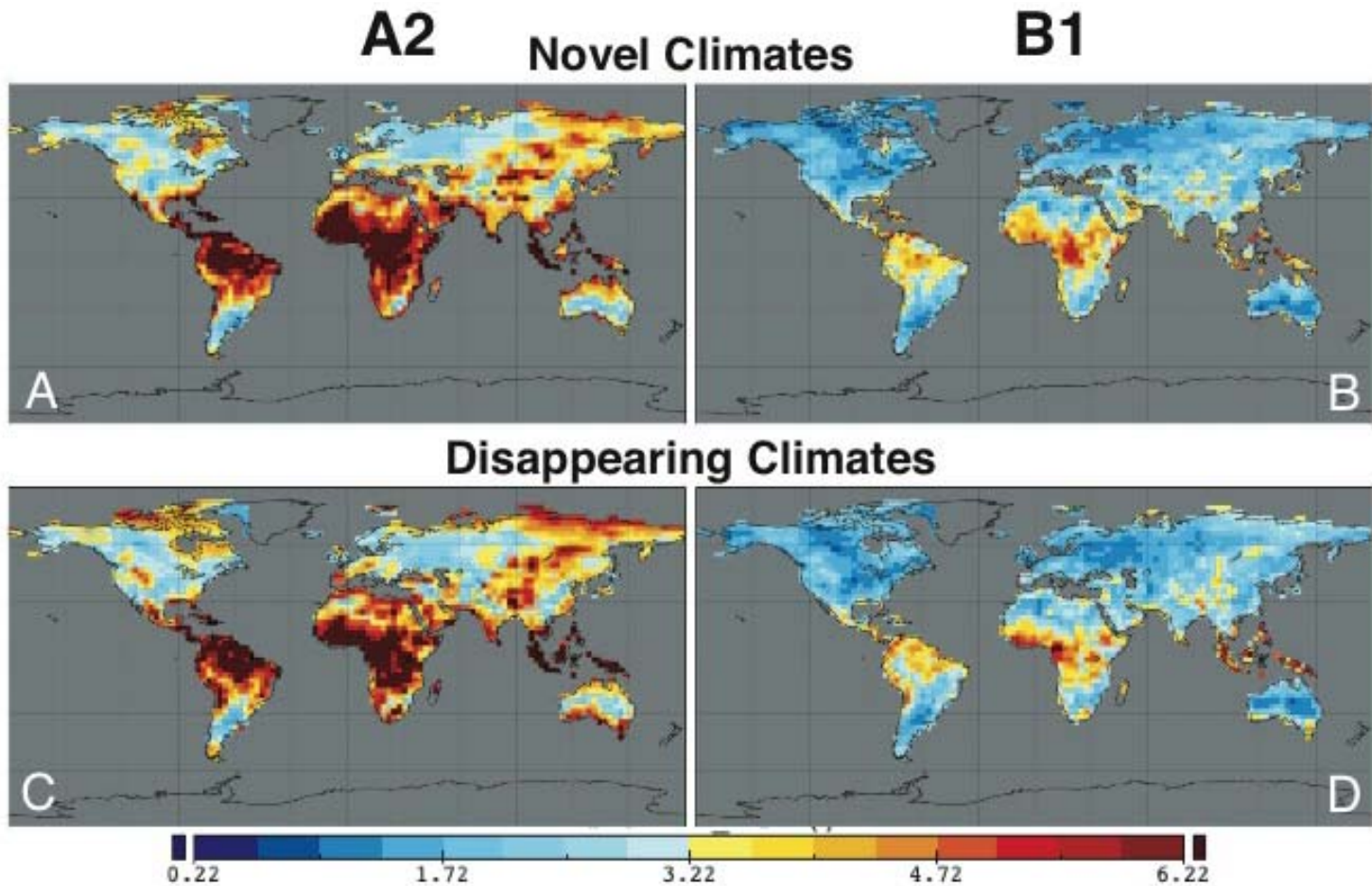
Water scarcity and  
desertification

Greater weather fluctuations





# Entirely new climates: where?

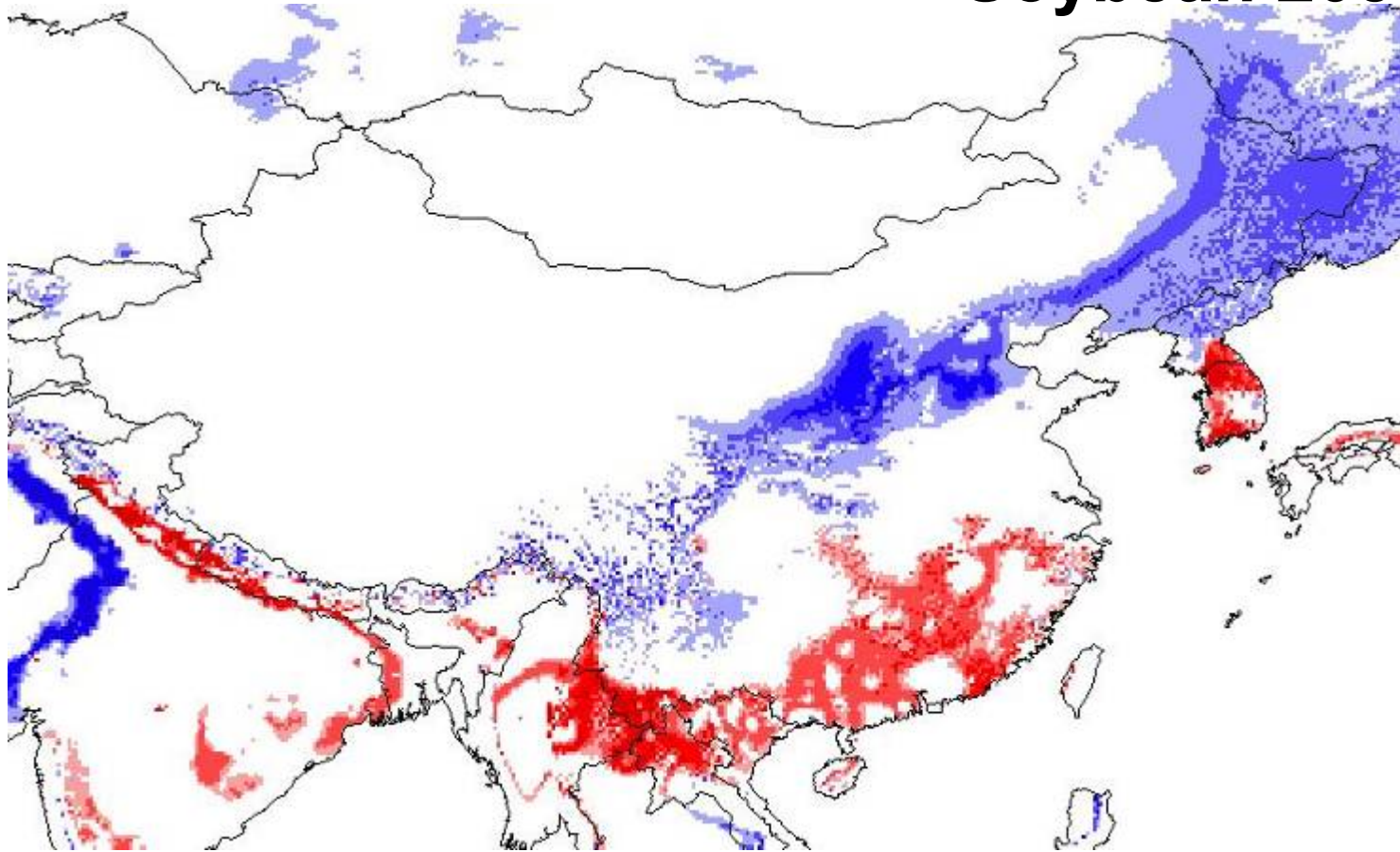


**Hot colours, high risk of climate change**

# Changing conditions



Soybean 2055

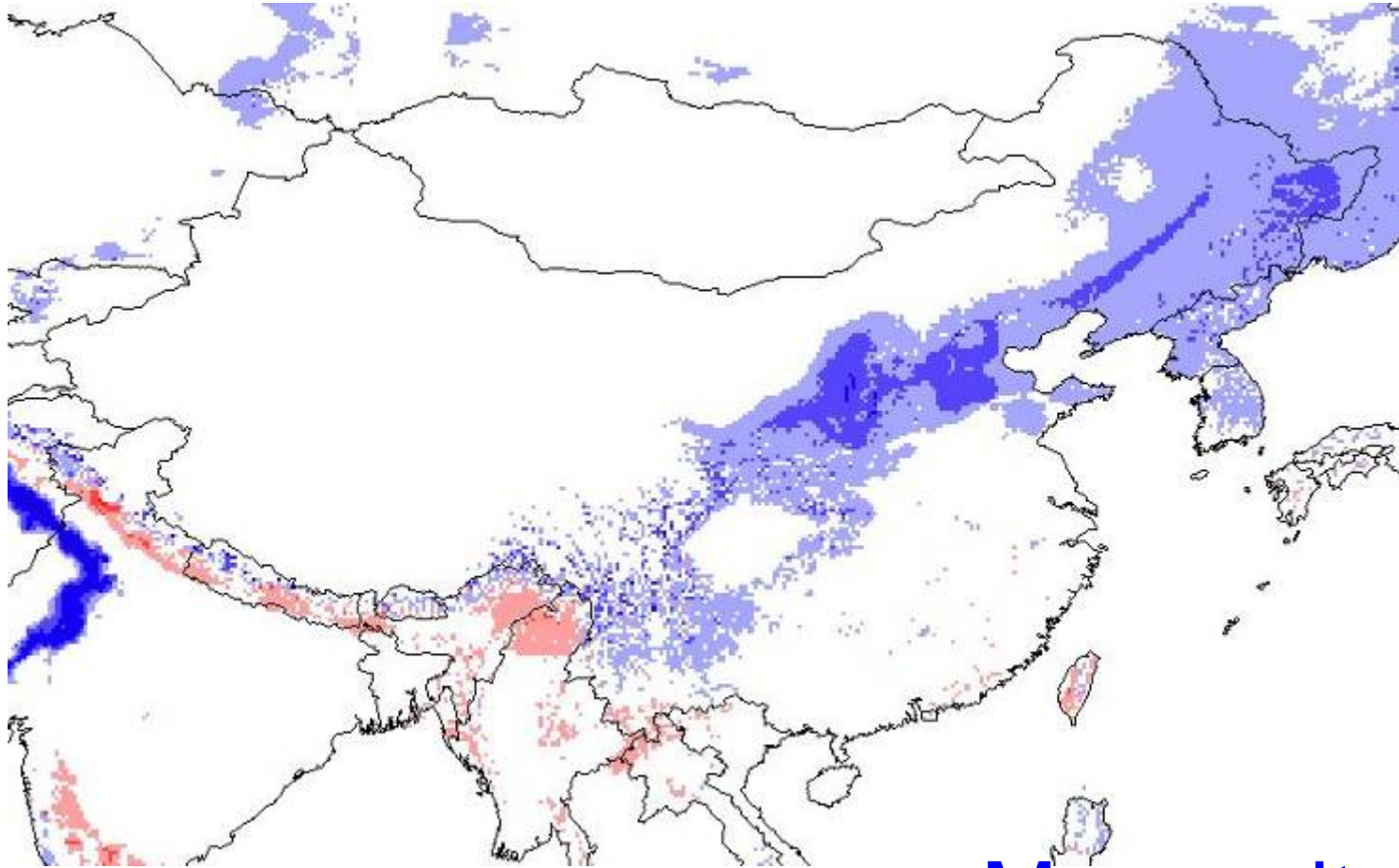


Less suitable

More suitable

# Changing conditions (2)

**Peanut 2055**



**Less suitable**

**More suitable**



# How will agriculture cope?

We need to adapt...

Agricultural systems that produce more under harsher conditions while protecting the environment



# Agricultural Biodiversity



## Three levels of Diversity

- Ecosystems
- Species
- Genetic

# Agricultural Biodiversity



- Two broad categories
- Managed
  - Unmanaged



# Benefits of Agricultural Biodiversity

- Conventional view
  - Source of traits for crop and livestock improvement
- Unconventional, but gaining ground
  - As a source of resilience and stability
  - As a source of increased incomes, improved livelihoods and better nutrition (and health)

# Genetic diversity

- Foundation of all improvements
- Generations of farmers
- Source for breeders too

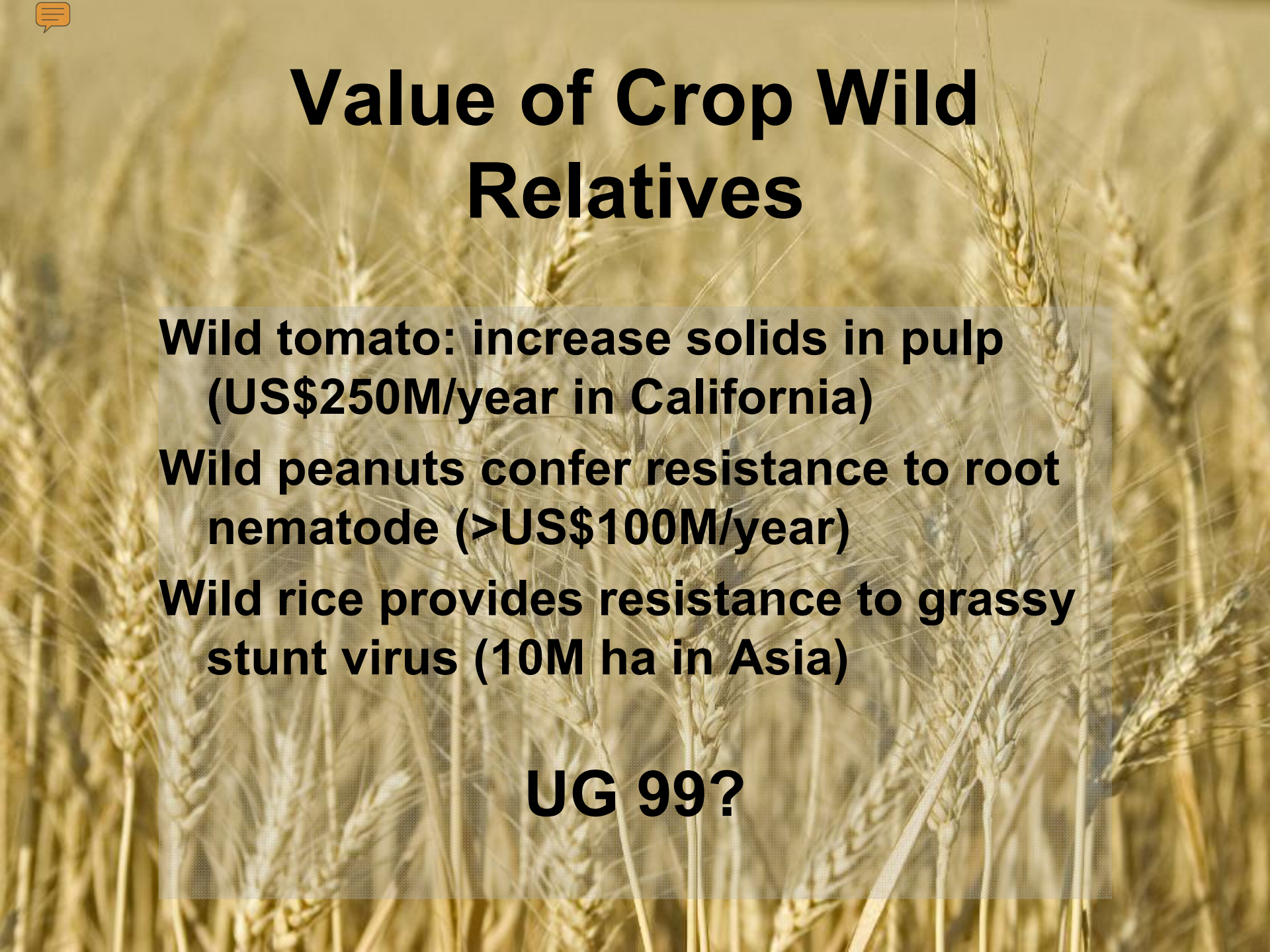


# Managing pests and diseases

- One third of global harvest lost to pests and diseases
- Soybean Rust US\$ 2 billion projected losses in US
- Black sigatoka US\$ 350 million over 8 years
- UG 99 more than US\$ 1 billion projected in losses







# Value of Crop Wild Relatives

**Wild tomato: increase solids in pulp  
(US\$250M/year in California)**

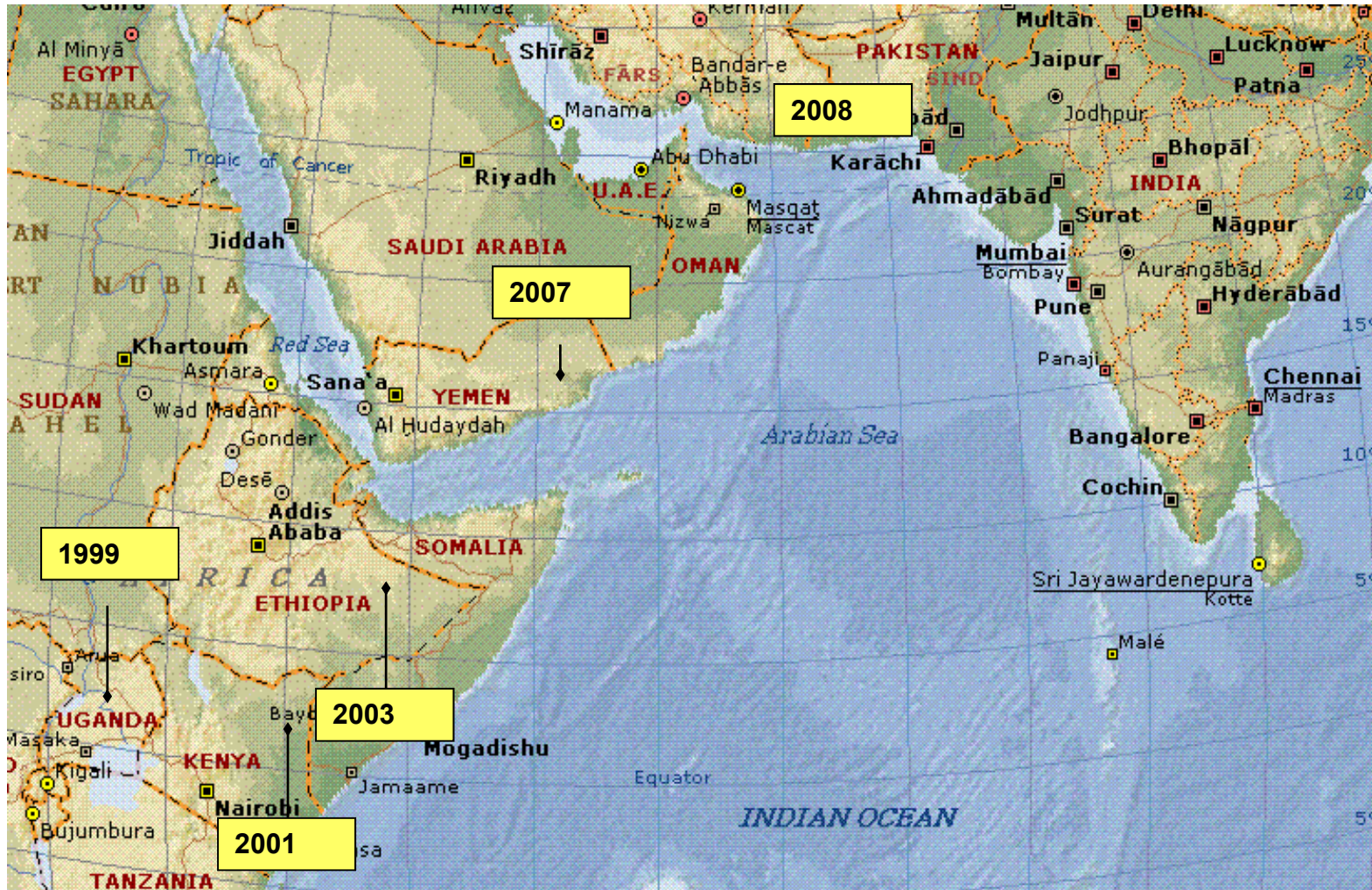
**Wild peanuts confer resistance to root  
nematode (>US\$100M/year)**

**Wild rice provides resistance to grassy  
stunt virus (10M ha in Asia)**

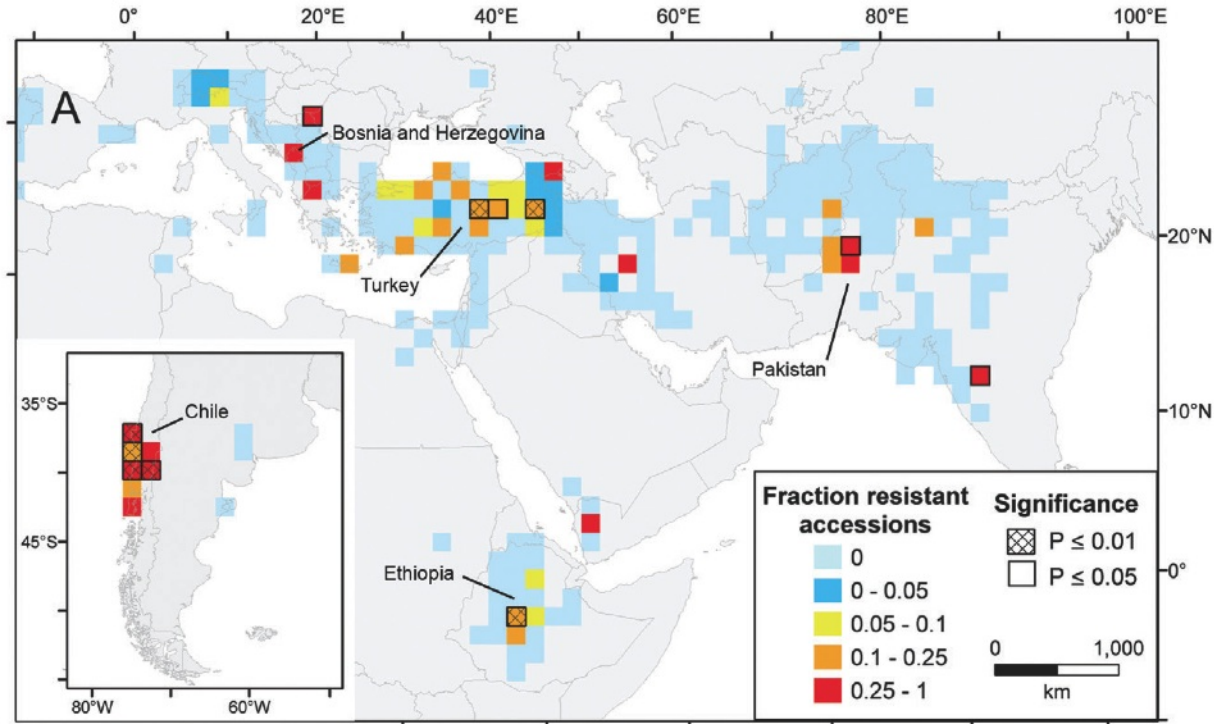
**UG 99?**



# Sustainable use and genetic vulnerability – Ug99



# Search for resistance



- Screened 5700 common wheat and 2719 durum wheat landraces (old data)
- Mapped resistance geographically
- Looked for excess presence of resistant accessions



# Biodiversity delivers

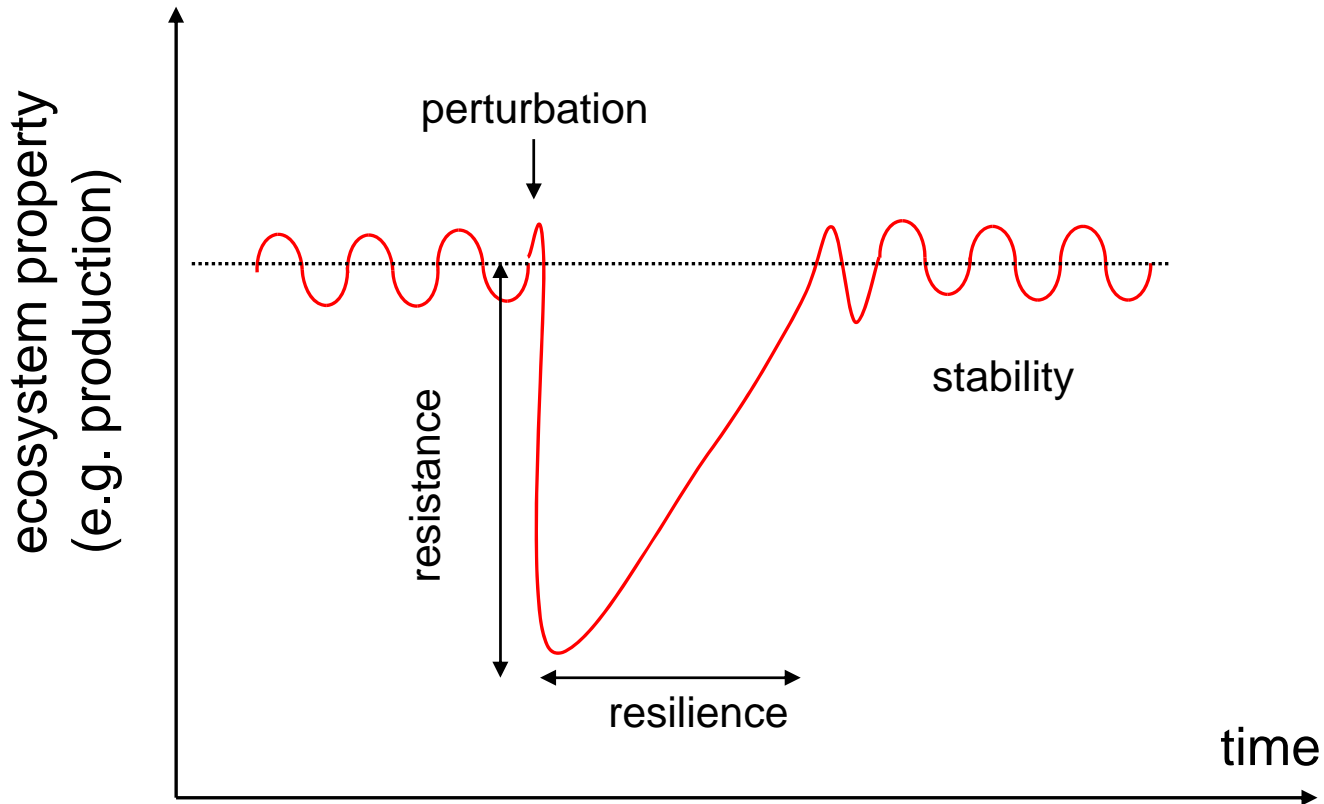


## Diversity for ...

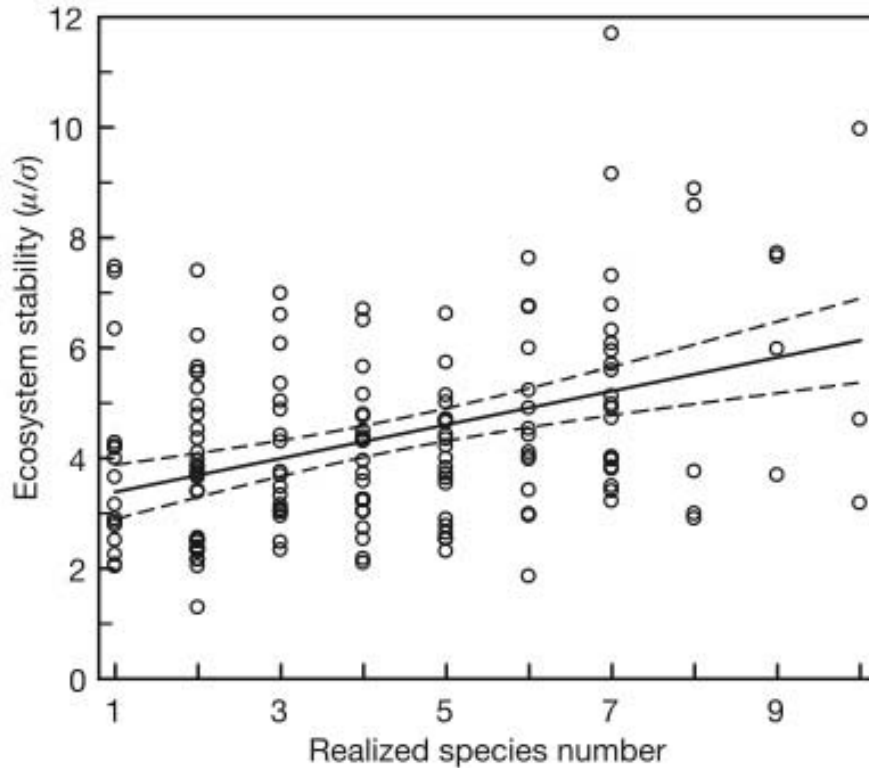
- Resistance to disturbances, pests and diseases
- Stable and productive harvests
- Environmental services

**Intensification without simplification**

# Diversity and production



# Diversity and stability



**Long-term plots**

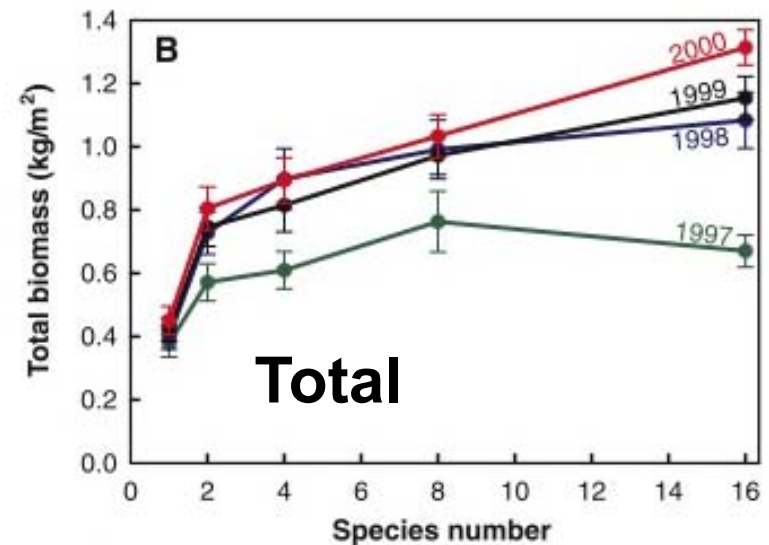
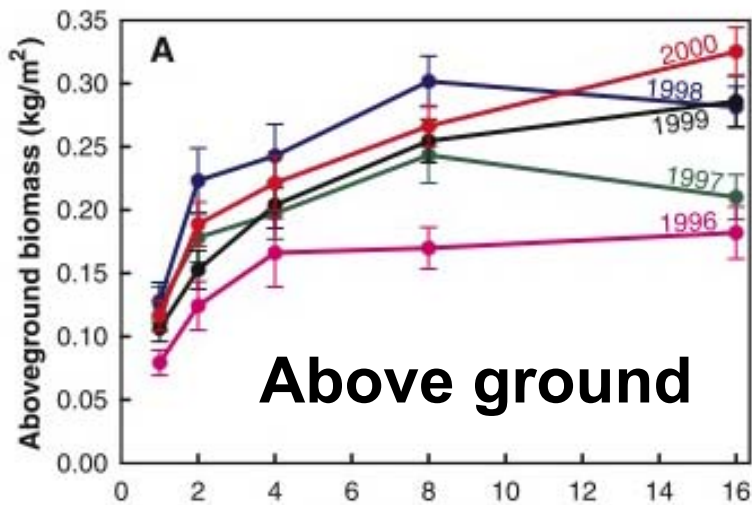
**University of  
Minnesota**

Tilman *et al.* (2006)





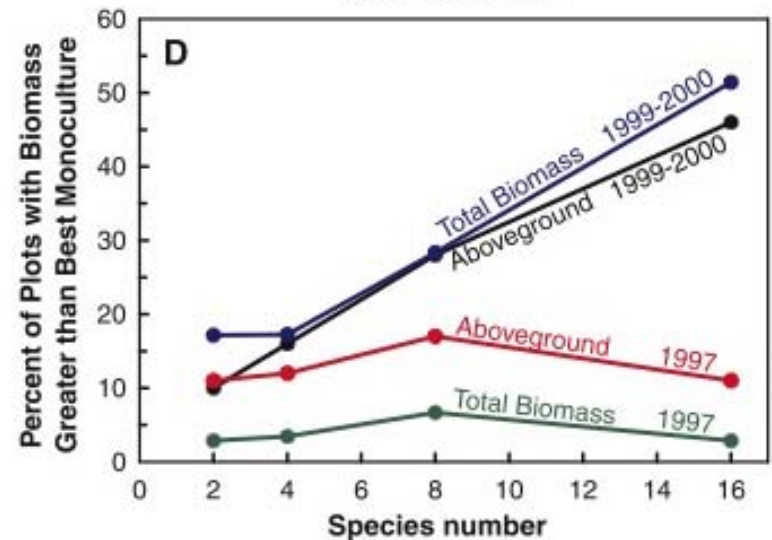
# Diversity and Production



**Better than the best  
monoculture**

**16 species = 2.7 x  
monoculture**

Tilman *et al.* (2001)



# Bullock *et al* : Hay

- Convert arable fields to hay meadows
- Two seed mixtures
  - Rich (25-41 species)
  - Poor (6-17 species)
- Species rich yields 60% higher from 2<sup>nd</sup> year
- No difference in quality



# Woldeamlak *et al* : Hanfetz

- Hanfetz in Eritrea:  
(67% barley 33% wheat)

Barley            1511 kg/ha

Wheat            1283

Hanfetz           1744

Also more stable year on year





# Zhu *et al* : Rice blast

- Susceptible varieties in rows mixed with resistant varieties
  - 89% greater yield
  - 94% less severe disease
- Resurrecting traditional varieties
- Extended to species diversity



# Wolfe *et al* : Barley mildew



## East Germany

- Severity of mildew declined from 50% to 10%
- Yields maintained
- Post unification mixtures down, fungicides up

# Diversity for managing pests and diseases

- UNEP-GEF Managing pests and diseases
  - Diversity to improve resistance and resilience
  - Maize, faba bean, rice, common bean, barley, cassava and banana
  - Begins with understanding farmer knowledge (participatory diagnostic tools)



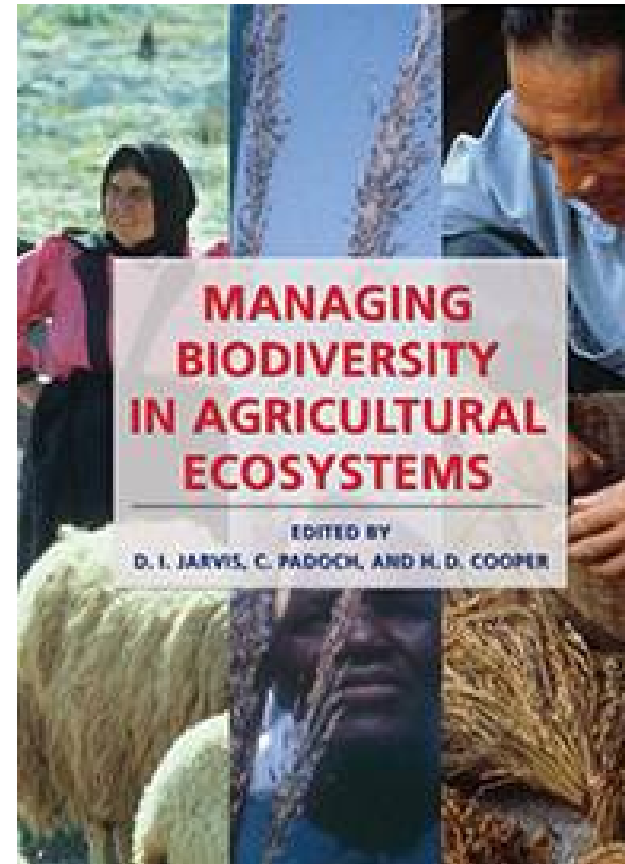


# Diversity for ecosystem services

## Agricultural biodiversity for ecosystem services

- CO<sub>2</sub> sequestration and climate regulation
- Nutrient cycling and soil fertility
- Pollination
- Water management
- Erosion control
- Pest and disease regulation

## Improved ecosystem function



# Valuing ecosystem services

- What is the value of these services?
- Difficult to measure in market terms (private/public good)
- Supporting and regulating services not valued: lack of policy  
→ need tools

# Biggest benefit: better nutrition

- Hidden hunger: missing micronutrients
  - At least 2 million worldwide
  - Mostly women and children
- Double burden: diseases of “affluence”
  - Type 2 diabetes, obesity, heart disease, cancers





# Child deaths per year



- Out of 3.5M child death per year, 63% or 2.2M are caused by underweight births and inter-uterine growth restrictions
- These are strongly correlated to poor maternal nutrition



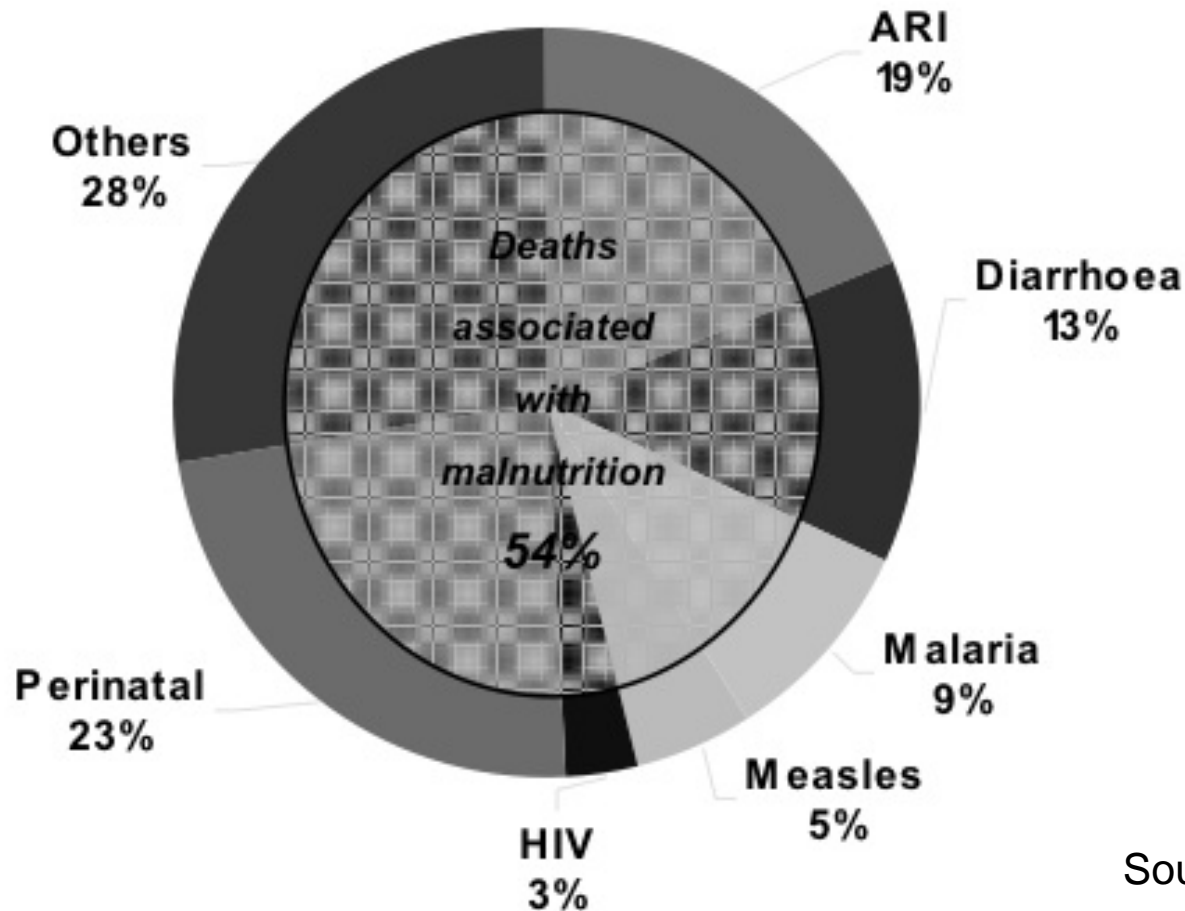
# Long-term impact of mother and child nutrition



- In first two years,  
irreversible
  - Worse health
  - Lower educational achievement
- Next generation
  - Underweight birth, even if nutrition is improved after 2



# Deaths associated with malnutrition



Source: WHO





# Dietary Simplification (1)



- Cheapest food is energy rich but nutrient poor
- Energy from fats and oils in Senegal
  - 1963: 8%
  - 1998: 20%



# Dietary Simplification (2)

- Reduced access to traditional and indigenous foods
  - Rural pressures
  - “Backward”



# Benefits of diverse diets

## First world evidence

- USA
  - decreased risk of mortality
- Italy
  - decline in gastric cancer rate
- Sweden
  - a healthy diet increases longevity
- Sweden
  - decreased risk of colorectal cancer





# Developing countries: only a few studies

- Kenya
  - Dietary diversity strongly and consistently correlated with anthropometric status
- Mali
  - Food Variety (no. of food items) and Dietary Diversity (no. of food groups) correlated with nutritional adequacy



# Diversity of Diet

- Diverse diet protects
- Indigenous/traditional species/varieties offer nutritional advantages



Promote local  
agricultural biodiversity  
for improved diets and  
health

→ Also more sustainable



# Focus on neglected species

- Wide range of species, not all cultivated
- Indigenous, locally adapted, environmentally friendly, nutritious
- Perceived as backward
- Abandoned by scientists and ignored by policy makers
- Bioversity has slowly promoted and expanded to build a global project





# African leafy vegetables

Per 100 gm	Amaranth (leaf)	Cleome	Nightshade	Cabbage
Iron mg	8.9	6.0	1.0	0.7
Calcium mg	410	288	442	47
$\beta$ carotene $\mu$ g	5716	10452	3660	100



# Kenya

- Traditional leafy vegetables
- Partnered with Family Concern (NGO) and Uchumi Supermarkets
- Seed supply and agronomy
- Training for cleaner, high-quality produce
- Leaflets to educate shoppers
- Sales increase 1100% in two years



# Reinvigorating culture

- Old people know the value of these crops
- Specific varieties for specific maladies
  - Red rice for pregnancy and anaemia
  - Rich sorghum for lactating mothers...
- Information as important as availability
  - Recipe leaflets, cooking classes, promotion





# Other examples

India: small millets



Bolivia: Andean grains



# Impact on Nutrition and Health



- Need to build strong scientific evidence base at a sufficient scale to convince the major development actors



# Conclusion

**Agricultural biodiversity meets short term needs for the long term:**

- Sustainable, resilient production systems
- More food, better nutrition, more income
- Environmental protection and sustainability

**→ Agrobiodiversity: an essential tool for meeting tomorrow's challenges**





Thank you