Reaching food and nutrition security: The untapped potential of agricultural biodiversity

Emile Frison, Director General, Bioversity International

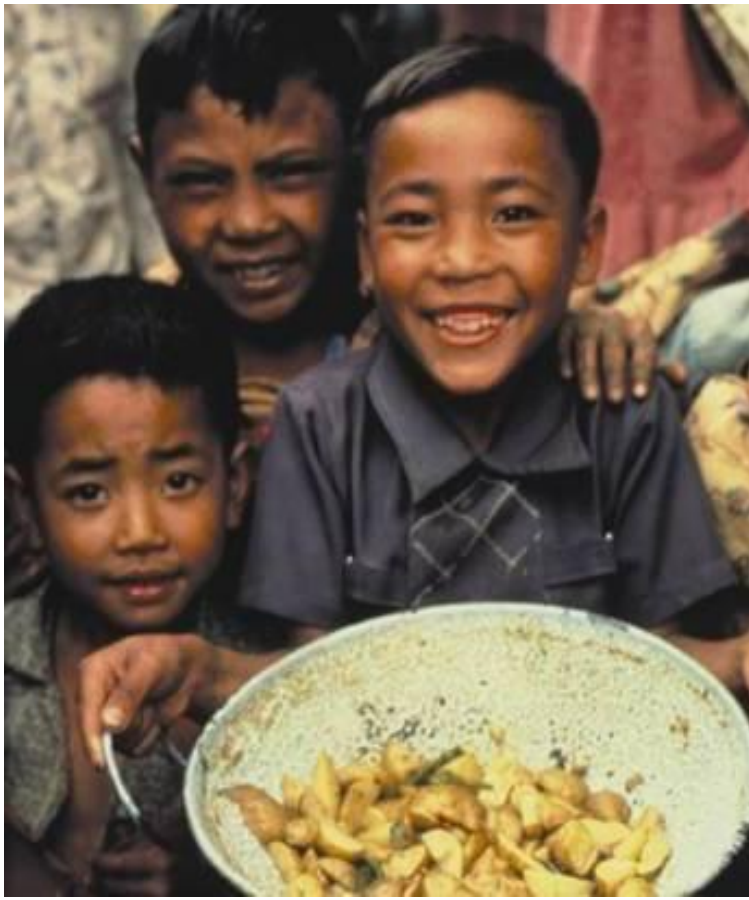
CGIAR Fund Office Seminar, 26 March 2013

The challenges we face

Feeding a growing population

By 2050...
World population will grow
to 9.2 billion = **growth of 37%**

Food production must increase
by more than 70% ...
and be sustainable



Triple burden of malnutrition

- **Hunger or Undernutrition** : Almost 1 billion people suffer from hunger and 3.5 million young children die of undernutrition every year.
- **Hidden hunger**: Young children and women are among those most at risk of developing micronutrient deficiencies.
- **Overnutrition and obesity**: More than 1.2 billion people are overweight globally. This number is rising quickly and dramatically everywhere.
- Increasingly in low income countries, under- and overnutrition exist side-by-side along with micronutrient deficiencies (the triple burden).

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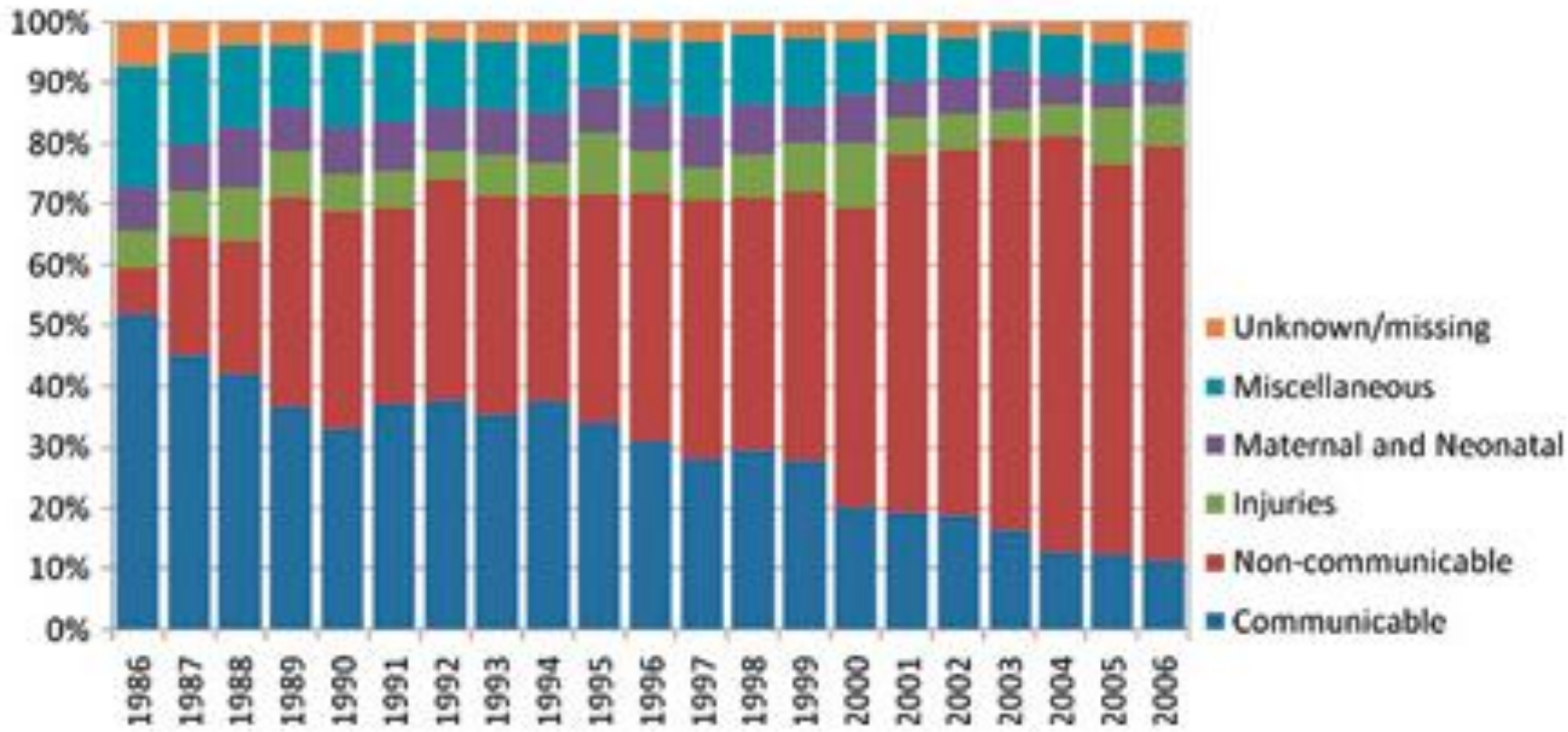
Increasing contribution of NCDs to cause of death

Rural Bangladesh (Matlab area, 1986–2006)

(Type 2 diabetes, cardiovascular diseases, some cancers, obesity)



Source: http://www.globalhealthaction.net/index.php/gha/article/view/19/2301

Climate change

Temperatures rise up to 2.5 degrees C

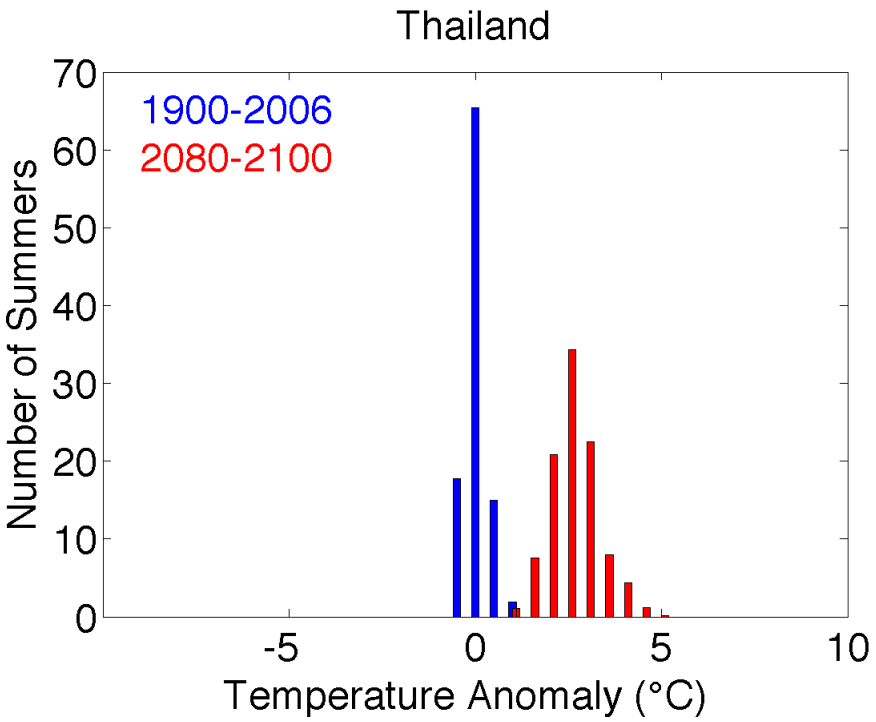
Changes in growing conditions

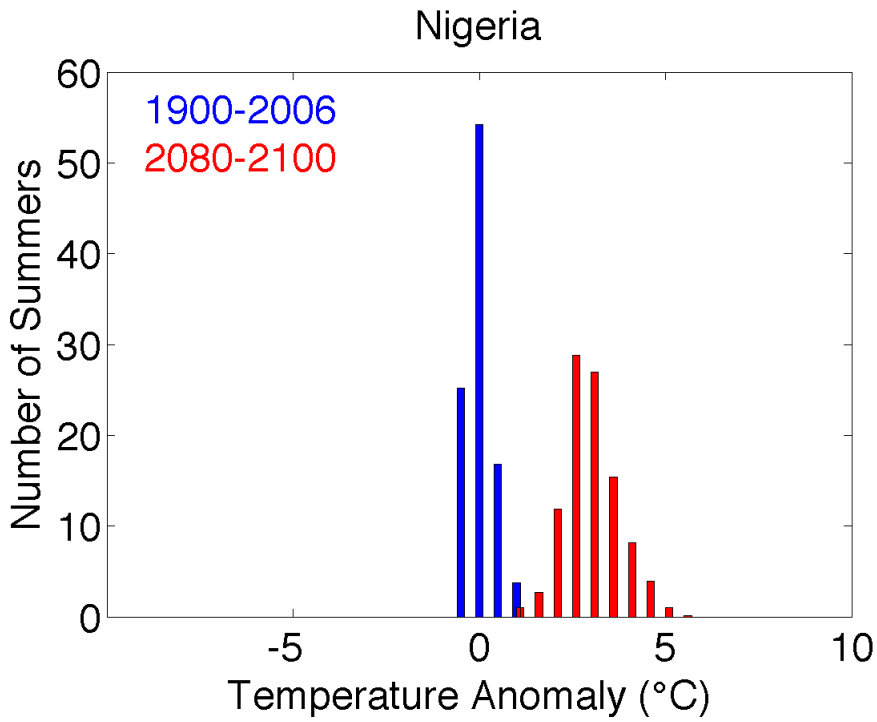
New pests and diseases

Water scarcity and desertification

Entirely new climates?

- Global warming creates new climates
- Coolest summers in 2090 will be warmer than the hottest summer now.

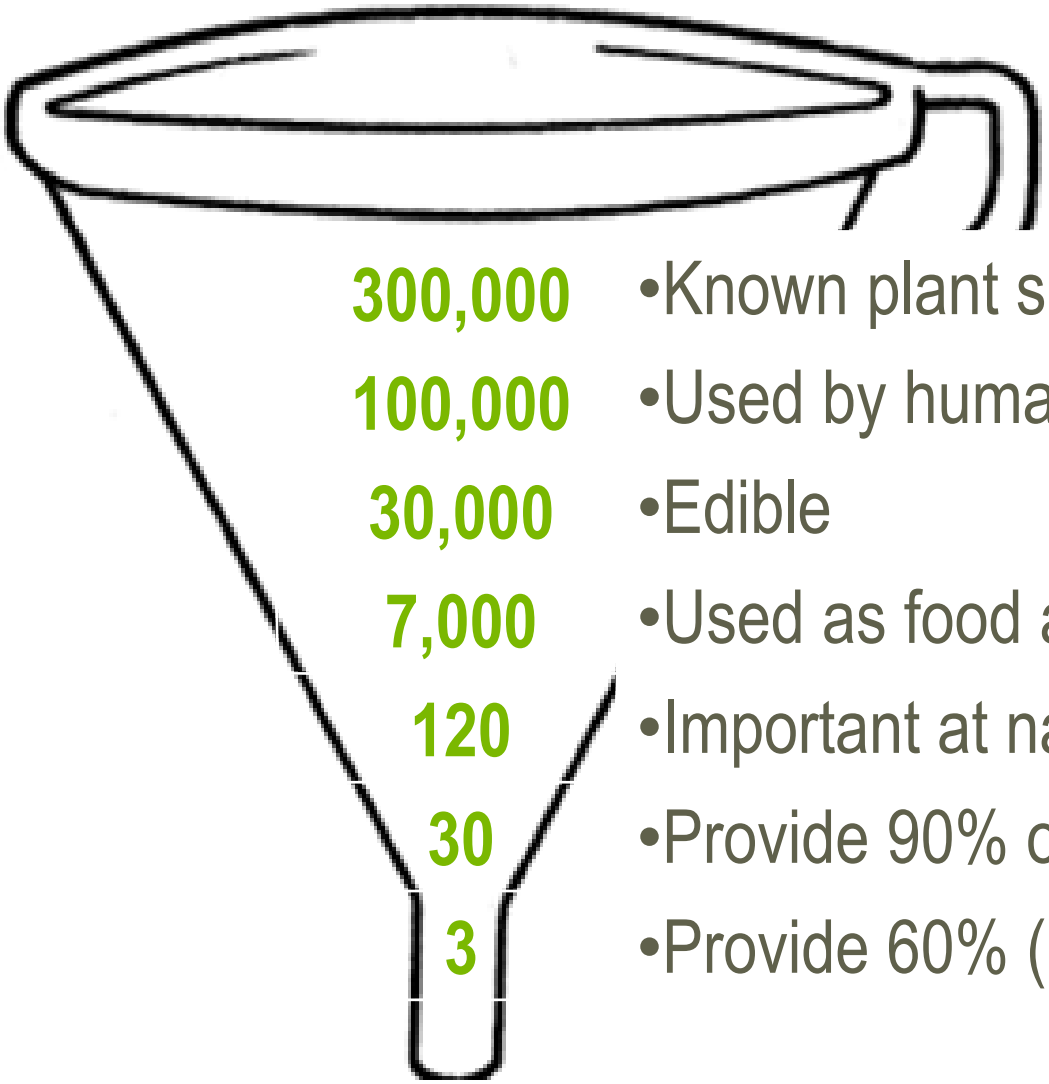




Climate change: more extreme events

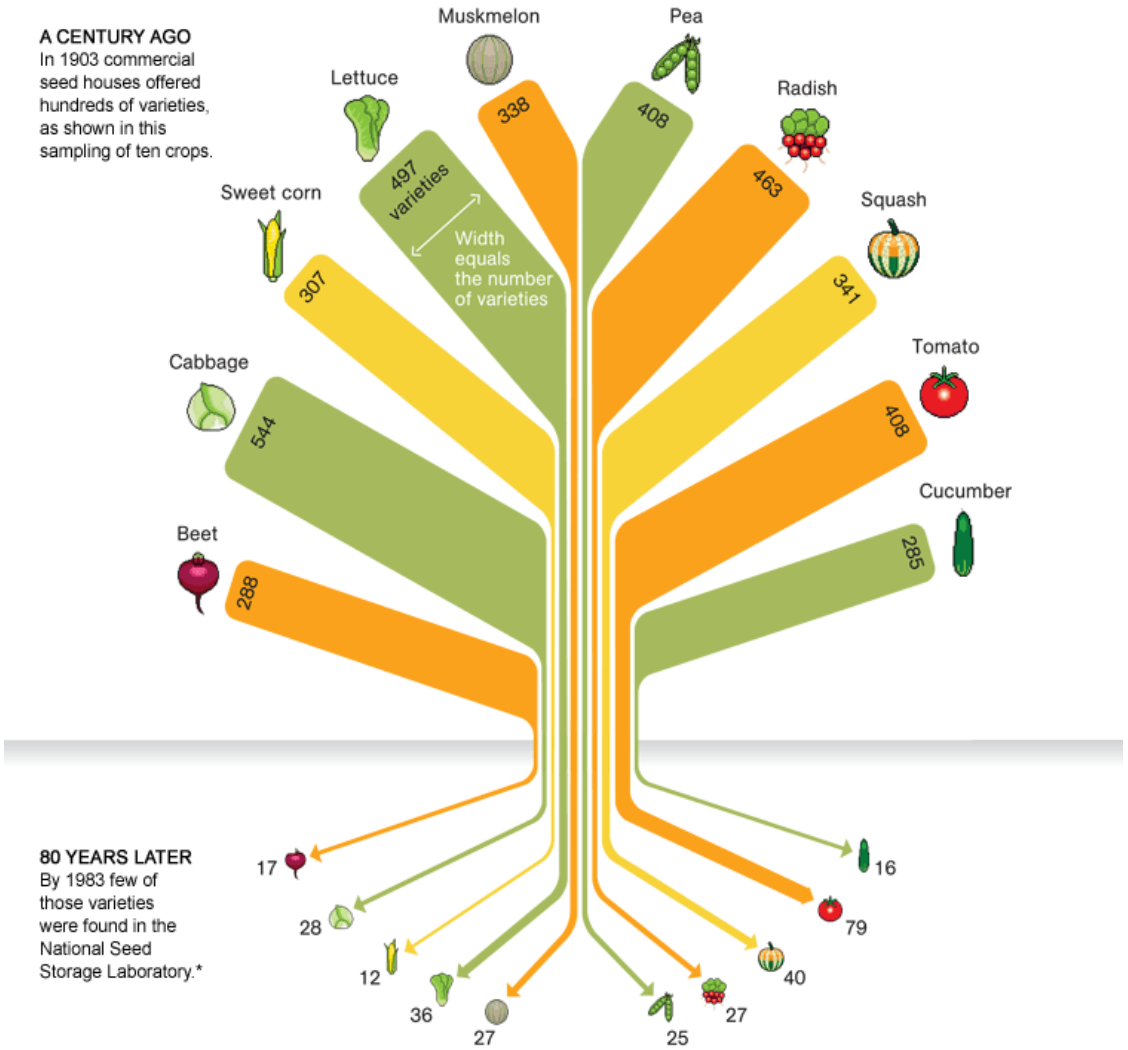
Less predictable seasons, greater risks…

Increasing reliance on few plants



300,000	•Known plant species
100,000	•Used by humankind
30,000	•Edible
7,000	•Used as food at local level
120	•Important at national scale
30	•Provide 90% of plant calories
3	•Provide 60% (rice, wheat, maize)

Loss of agricultural biodiversity



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How can agriculture meet these challenges?

We need to adapt...

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

If we want to focus on the needs of the poor and hungry

→ we need a different paradigm

Better use of agricultural and forest biodiversity and agro-ecological intensification

In order to simultaneously:

- Improve smallholder livelihoods
- Enable resilient ecosystem services
- Provide better nutrition and health
- Create system sustainability.

Better use also requires conservation

- To complement *ex situ* conservation with on-farm conservation of crop landraces important for smallholders and *in situ* conservation of crop wild relatives and forest tree biodiversity.

- To develop a global framework for availability:
  - Information
  - Supportive policies

Agricultural biodiversity for improved livelihoods

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Creating more opportunities for Neglected and Underutilized Species (NUS)

Dried vegetables and fruits

Pressure-popping

Noodles made from sorghum and millets

Shaded coffee intercropped with bananas for greater productivity in Latin America

- In Colombia, >80% of plantains produced in mixed systems with coffee, cocoa, cassava or fruit trees and contribute 10% to 20% to income.
  (Espinal 2005; Castellon 2010, Rajala 2010, Martinez 2011)
- In East Africa, mixed systems are less common, but economic benefits as compared to monocrop are significant.
  (van Asten et al., 2011)

Tropical fruit tree diversity: multiple strategies to ensure benefits to smallholder farming communities

- Piloting good practices that reduce risk and increase productivity
- Identify and improve access of best trees and information
- Increase the demand for the material marketing information, diverse products and value addition
- Ensure rights and provide recognition to custodian farmers and their networks
- Consolidate roles of smallholders farmers as conserver, innovator and promoter on community based approaches (CBM; PPB, CSB, FFS etc.)

Creating more opportunities for Neglected and Underutilized Species (NUS)

New uses for traditional crops: Enset

Traditional use is limited. But through innovation, new value added, new use and market for NUS created.

Growing Enset for animal feeding (*Ensete* sp)

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Agricultural and forest biodiversity for agro-system stability, resilience and ecosystem services

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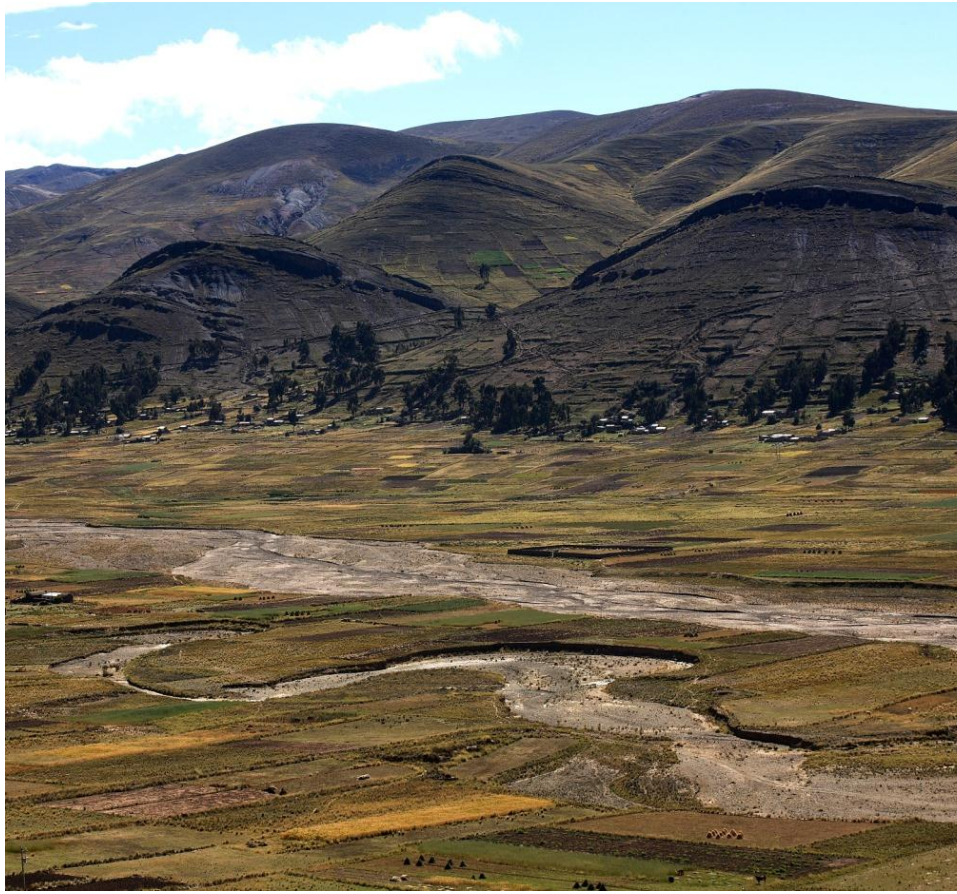
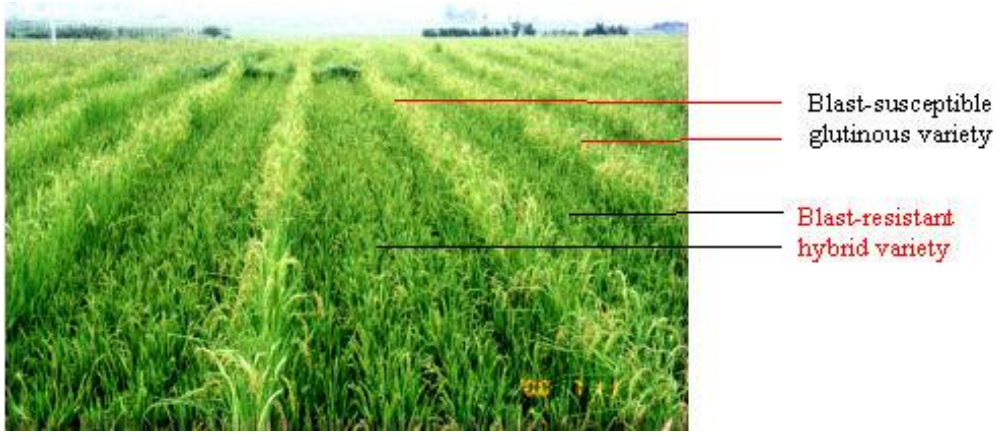
Agricultural and forest biodiversity for ecosystem services: improving ecosystem function

- Nutrient cycling and soil fertility
- Pollination
- Water management
- Erosion control
- Pest and disease regulation
- CO_2 sequestration and climate regulation



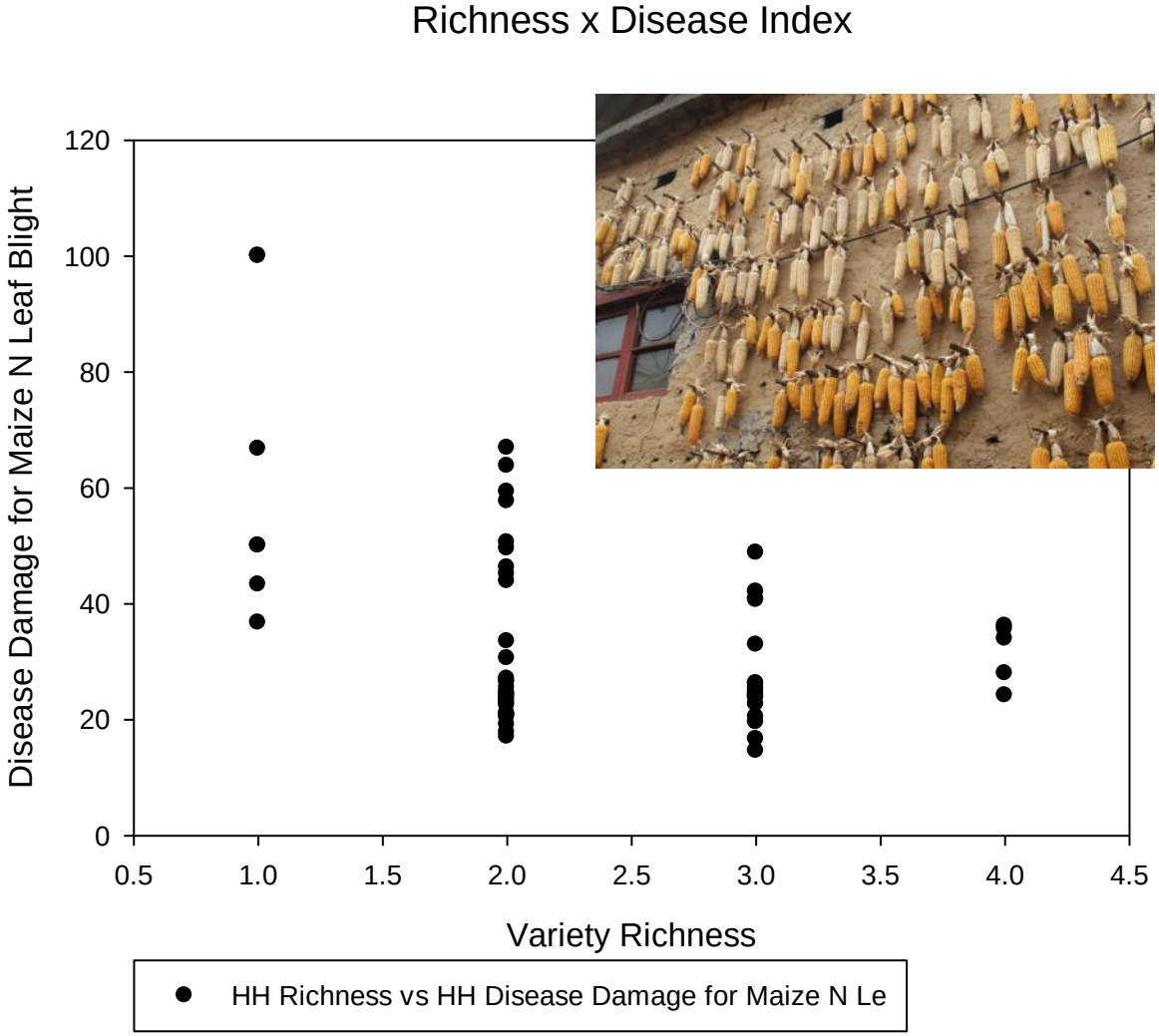
Disease management through diversification: cultivar mixture against rice blast in China

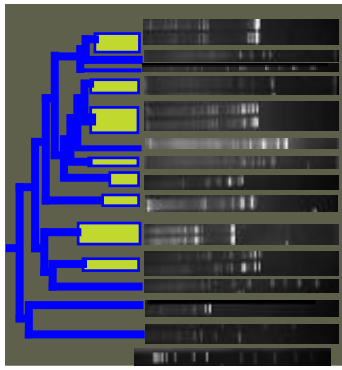
- Row interplanting of susceptible glutinous rice together with resistant hybrid rice



- Re-introduction of traditional glutinous rice varieties (formerly replaced by blast-resistant rice hybrids)
- Lesser use of fungicides, reduced production cost; higher profit, yield increase of glutinous rice.
- Farmer's adoption of the practice:
  1997: 15ha → 2002: 260,000ha → Continued expansion

Diversity and field resistance:
Higher varietal richness less variance and damage





Peng et al., 2010,
unpublished data

Farmers' management of genetic diversity

Prevents dilution of the stress resistance characteristics of local varieties

Participatory plant breeding to improve disease resistance in the local cold tolerant rice and barley landraces *in situ* in high mountain agricultural sites in Nepal

Sthapit, Jarvis, Skinner, Murray, 2012

UNEP GEF

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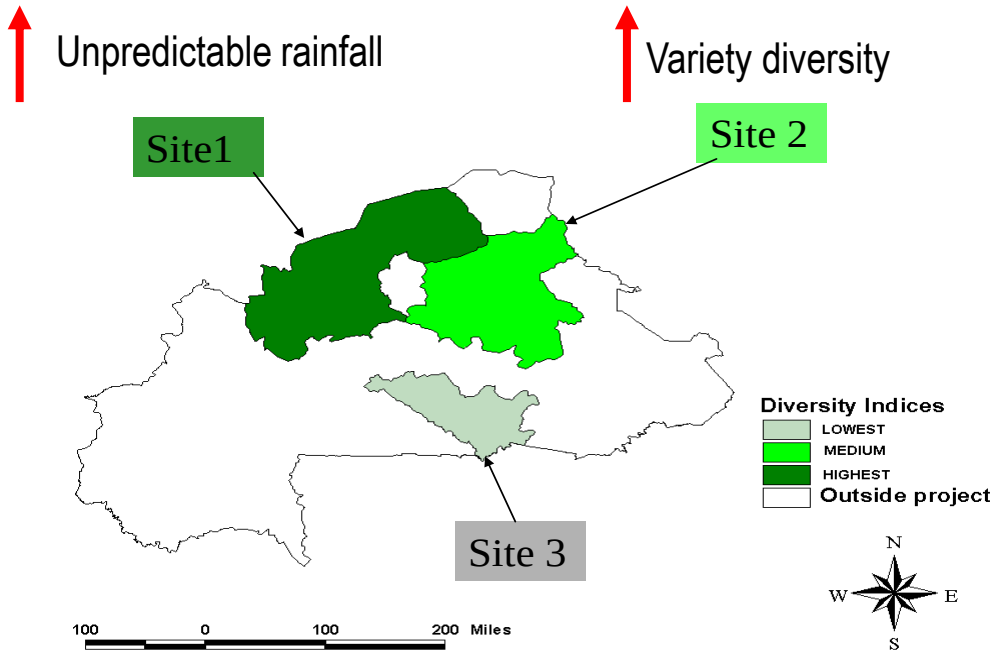
Participatory plant improvement with poor farmers in Nepal: use of pro-poor traits

- Breeding goal set by farmers:
  - Improve taste of *Mansara* landrace rice and productivity
  - Retain its traits for specific adaptation to marginal conditions (poor soils)

- Continue to select and maintain seed of segregating lines under target niches until preferred traits are fixed-address G x E interaction

Minimizing risk for unpredictable environmental conditions in Burkina Faso



4-5 traditional sorghum varieties per farm (1.2 ha) and 23 per community with any two plants drawn at random within a farm differed in 69% (within a community 91%)

(Sawadogo et al., 2005 and 2006)

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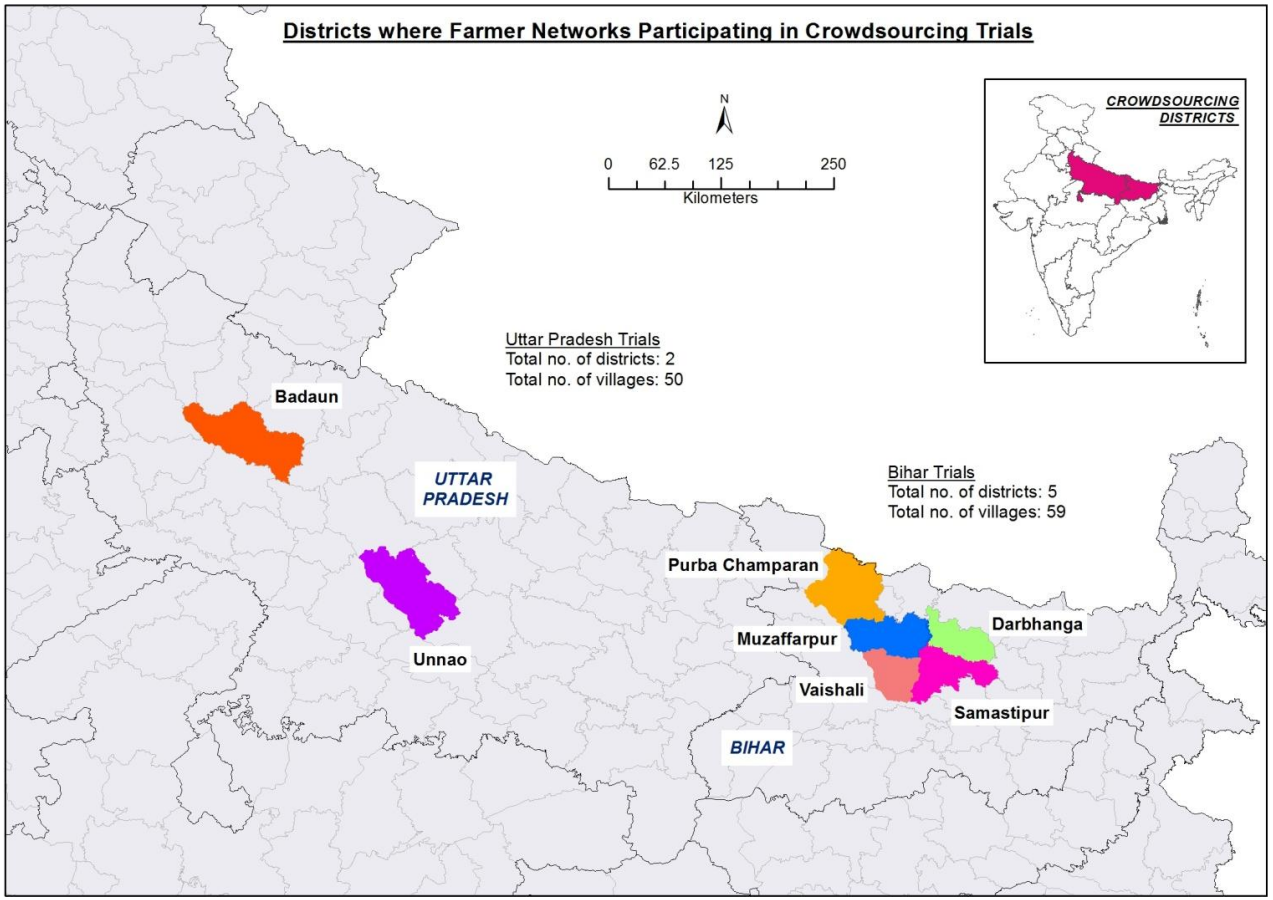
Broadening the genetic base of crop cultivation and empowering farmers for climate change adaptation through crowdsourcing



Citizen science approach scales out participatory crop research.

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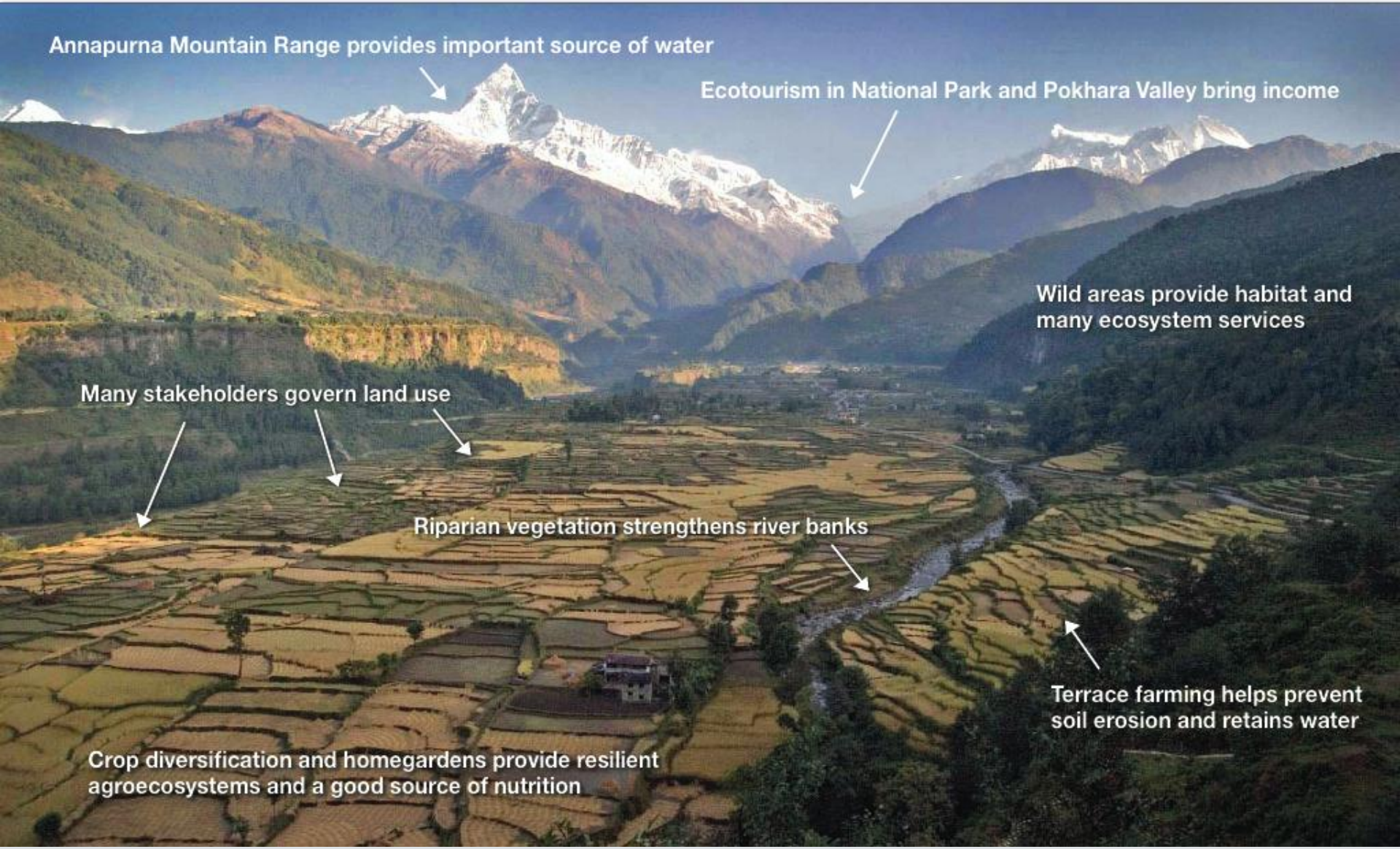
Systematic review of integrated landscapes in Asia



Agricultural and forest biodiversity, dietary diversity, sustainable diets and human nutrition

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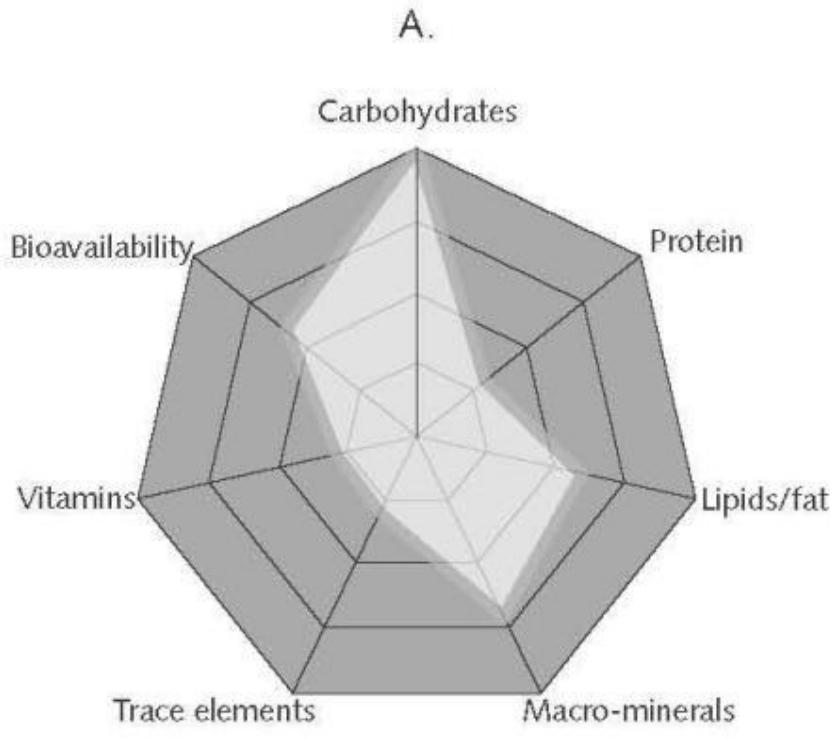
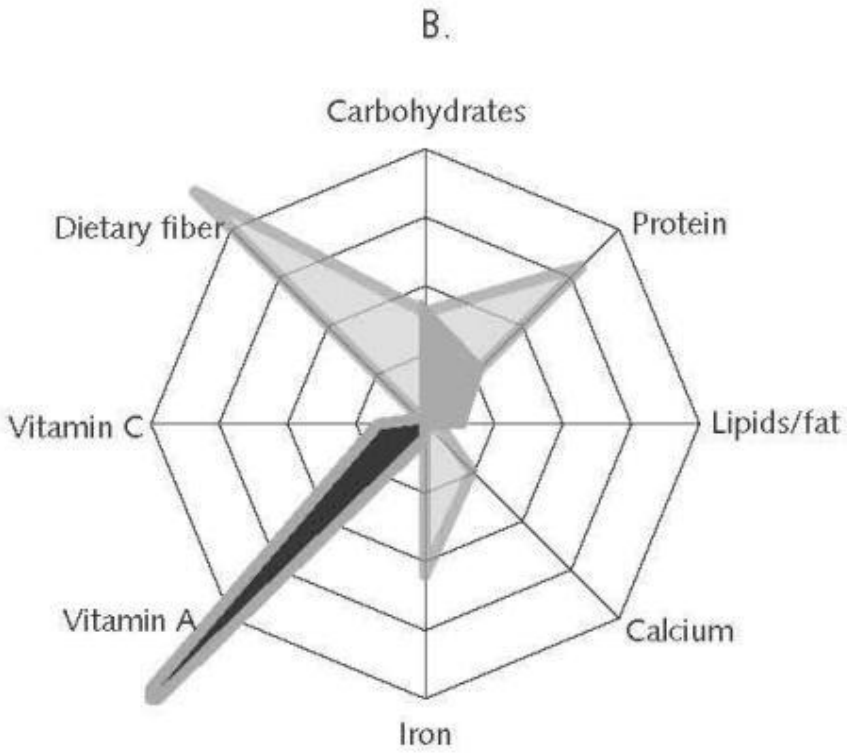
Nutrient diversity requirements



A. Ideal diet: dark gray; lack of protein and micronutrients: light gray.



B. Nutrient composition of 3 food crops shown as % of daily requirement: Corn: dark gray; Black beans: light gray; Pumpkin: black line.

(DeClerck et al., 2011)

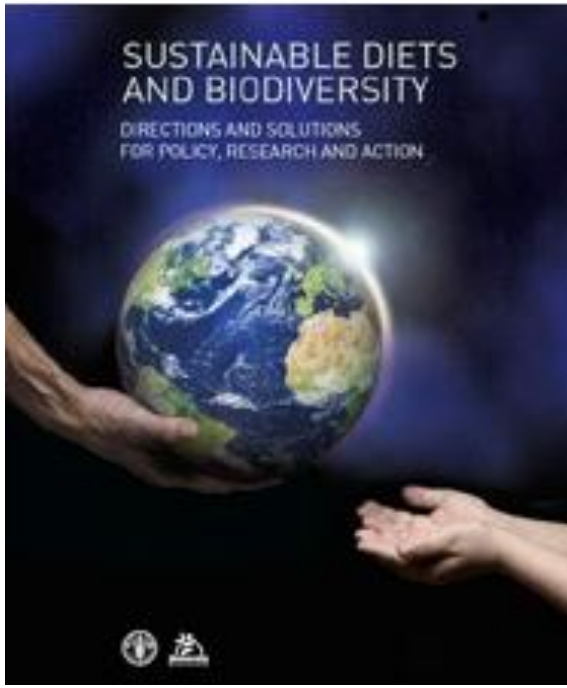
The nutrition transition

Simplifiction of diets:

- Increased fats, sugars and processed/refined foods
- Energy rich but nutrient poor

What is a Sustainable Diet?

Sustainable diets are those diets with **low environmental impacts** which contribute to **food and nutrition security** and to **healthy life** for present and future generations.



They are:

- protective and respective of biodiversity and ecosystems
- culturally acceptable
- accessible
- economically fair and affordable
- nutritionally adequate, safe and healthy

…while optimizing natural and human resources.

Agricultural biodiversity for nutrition

Promoting the use of agricultural biodiversity to provide affordable, nutritionally-rich food sources which contribute to dietary diversity and improved nutrition and health.

What has been tried in agriculture to improve nutrition?

- Fortification of commodities
- Biofortification of staple products
- Home gardening of fruits and vegetables
- Animal programmes to increase animal source proteins

Agricultural biodiversity (traditional foods, varieties…) is under-researched

Traditional African leafy vegetables (ALV) in Kenya

- Local ALV - nutritious, affordable, adapted to local growing conditions and cultural traditions.
- Identifying key issues hindering cultivation, conservation and marketing of traditional ALV in Nairobi peri-urban areas.

IMPACT

Of those growing ALVs, half of them (52%) participated in marketing.

Two-thirds of households increased their incomes, while half had increased their consumption.

(Gotor and Irungu, 2010)

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Minor millets in India

- High in iron and calcium
- High tolerance to drought → more productive than other grains.
- Worked with 200 farming families to increase production and marketing of three minor millets.
- By training the women in quality standardization, packaging and production, new millet based recipes developed into popular snack foods, which led to increased sales of millet-based products and malt in urban markets.

IMPACT

Monitored farmers increased yields by 70%.

Processing the millet into malt added value, and increased income, with some women tripling their profits by selling only the malt.

(Yenagi et al., 2010)

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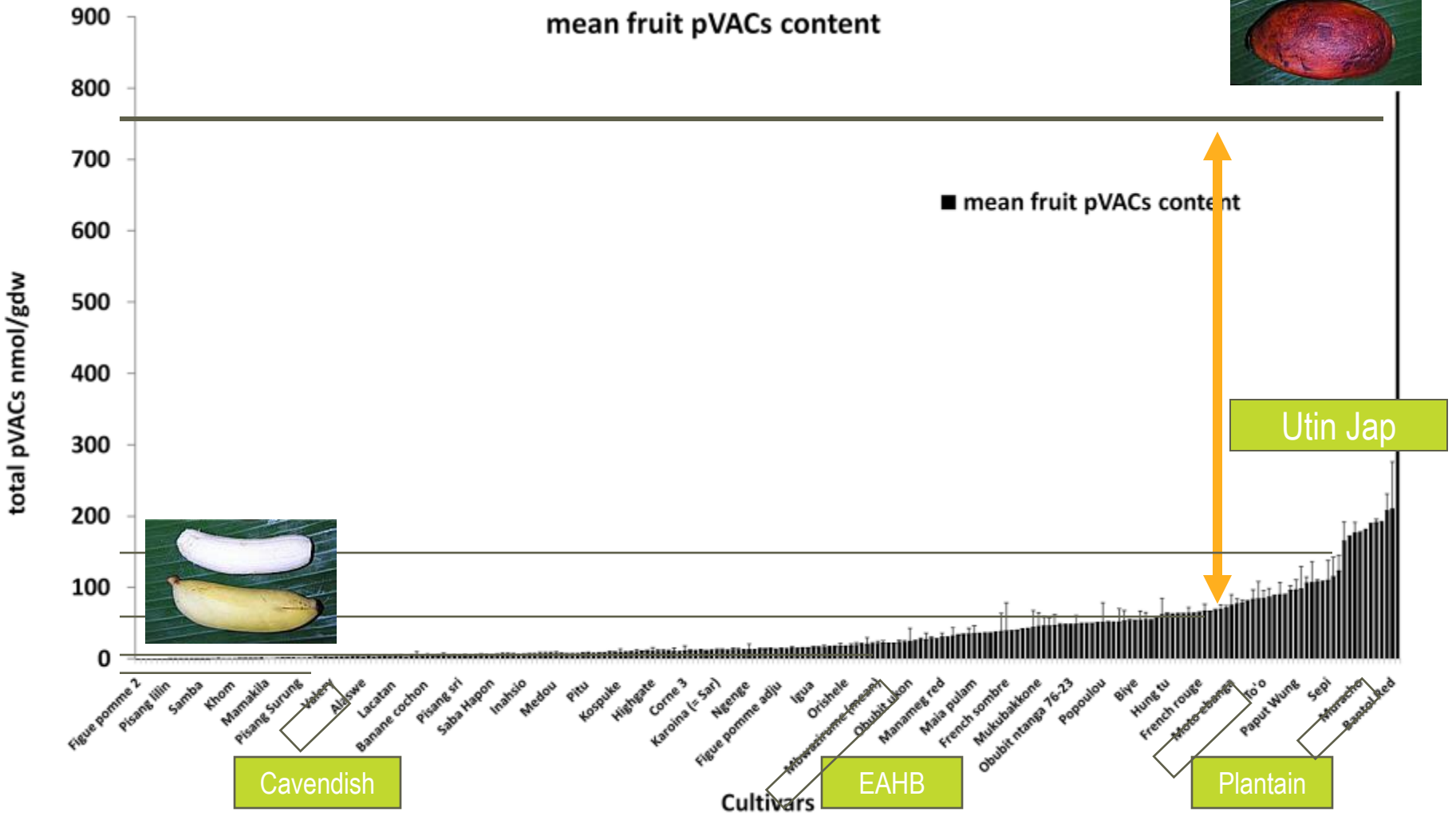
Exploiting existing diversity



Source: Davey et al., 2009

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Value chains and institutional innovations supporting use of agricultural and forest biodiversity

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Multiple values of agricultural and forest biodiversity

Total Economic Value of agricultural biodiversity = DUV + IUV + OV + BV + XV

DUV	IUV	OV	BV	XV
Direct Use Values	**Indirect Use Values**	**Option Values**	**Bequest Values**	**Existence Values**
Food Animal feed Fibres Fuel Construction materials Traction and transport Source of income	Agroecosystem resilience; Symbiotic/synergistc effects Maintenance of geneflow, evolutionary processes, indigenous knowledge and culture, soil and water quality, pollinators	(for an uncertain future)	Satisfaction arising from passing specific genetic resources/ diversity on to future generations	Satisfaction arising from knowing that a specific genetic resource / diversity exists
Private Goods	**Public Goods**			

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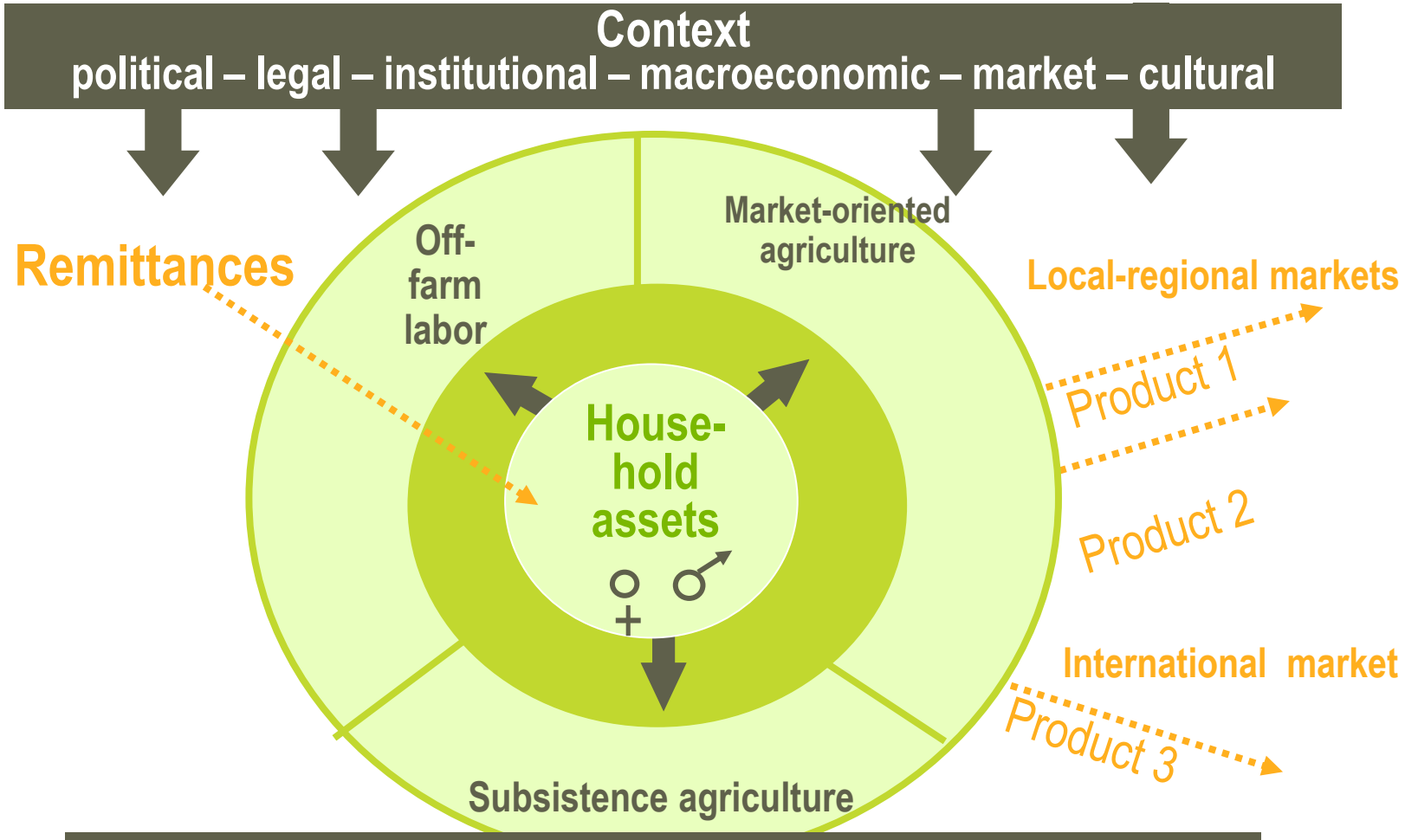
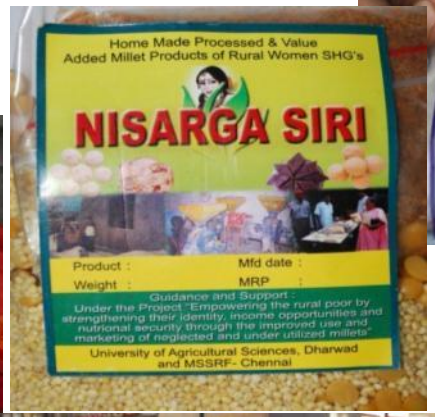
Multi-chain approach to value chain and livelihood development



Enhancing private values for the poor through innovations across the value chain

Elimination of drudgery makes millets viable options and more attractive food for households.



Develop new dishes and identify most suitable diversity.

(Padulosi et al., 2009)

Integrating across livelihoods, nutrition and sustainability

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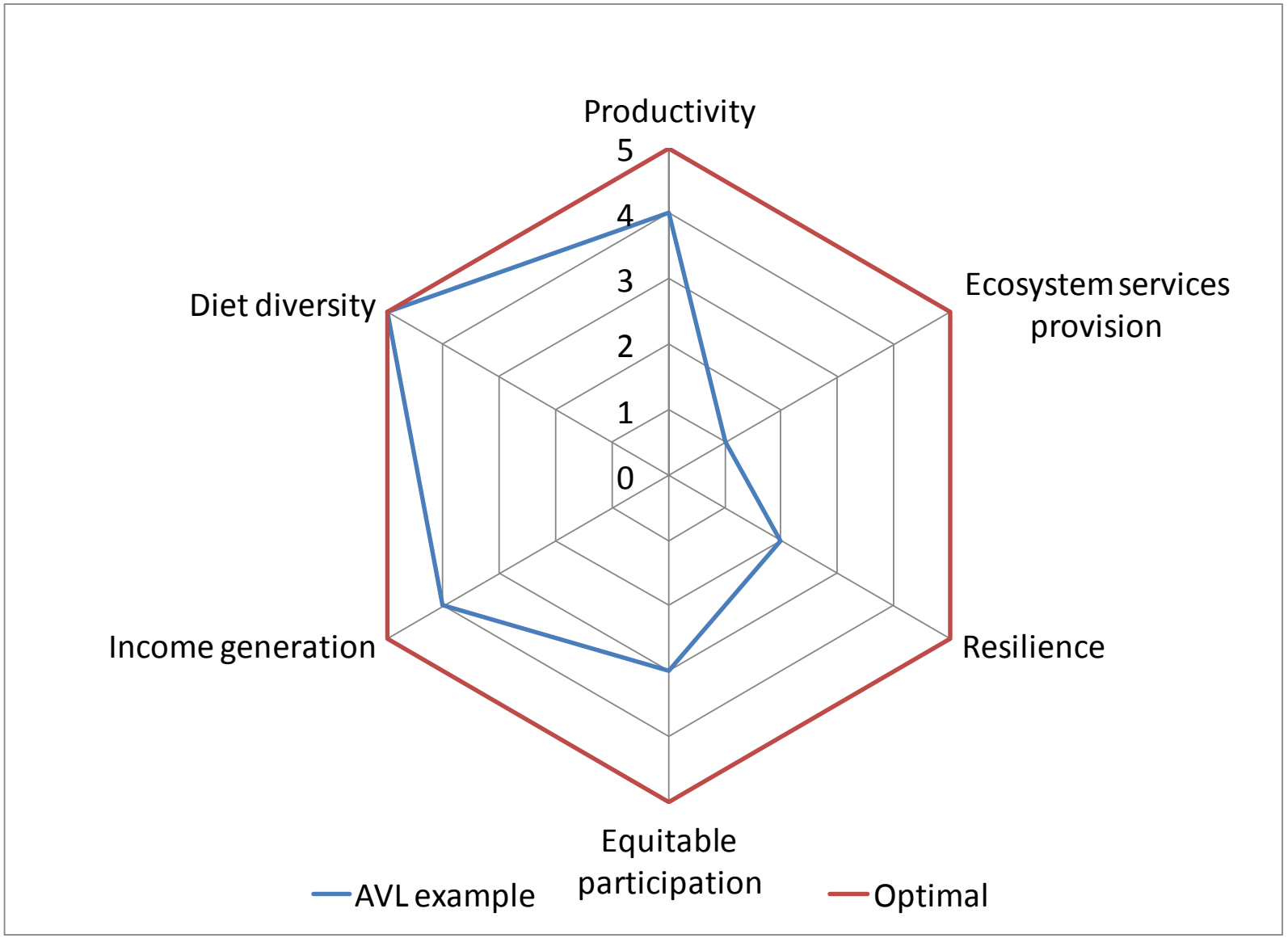
Integrating across outcomes



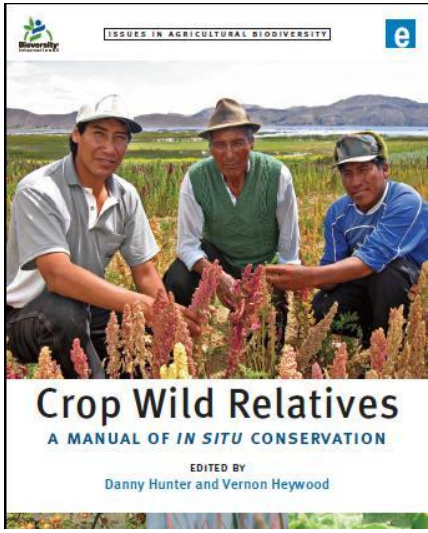
Conservation and availability of agricultural and forest biodiversity

In situ conservation, on farms and in the wild, of agricultural and forest biodiversity:

ensures the continued evolution and adaptation to changing conditions

In situ conservation of crop wild relatives through enhanced information management and field application

- Capacity building and conservation actions
- Public awareness
- National Information Systems
- International Information System
- Manual of *In Situ* Conservation



Five megabiodiversity country partners: Armenia, Bolivia, Madagascar, Sri Lanka and Uzbekistan

Wild relatives of 35 priority crops

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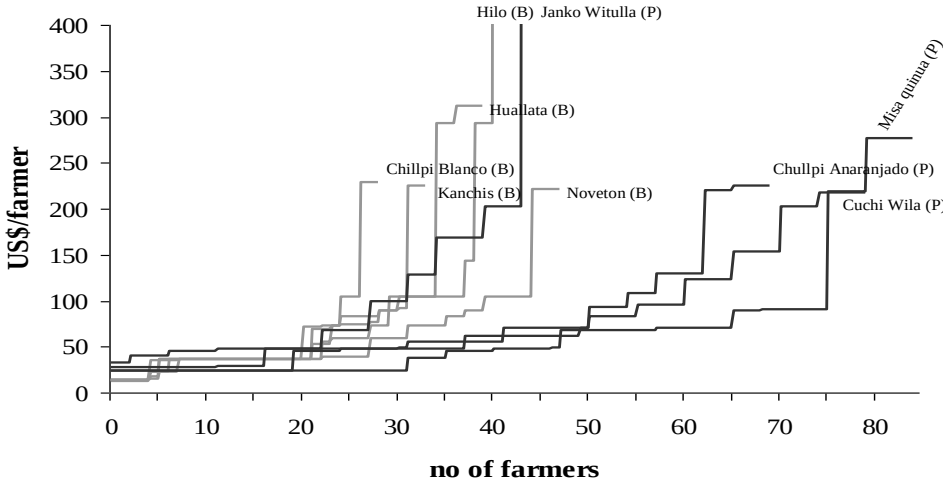
Enhancing capture of public value for the poor through PACS

- Targeting areas of high agricultural biodiversity and high poverty to maximize impact
- Establishing of monitoring systems, baselines, conservation goals

- Identifying least-cost providers for max impact of limited conservation budgets
- Identifying combinations of market, public, private sources for sustainable financing.



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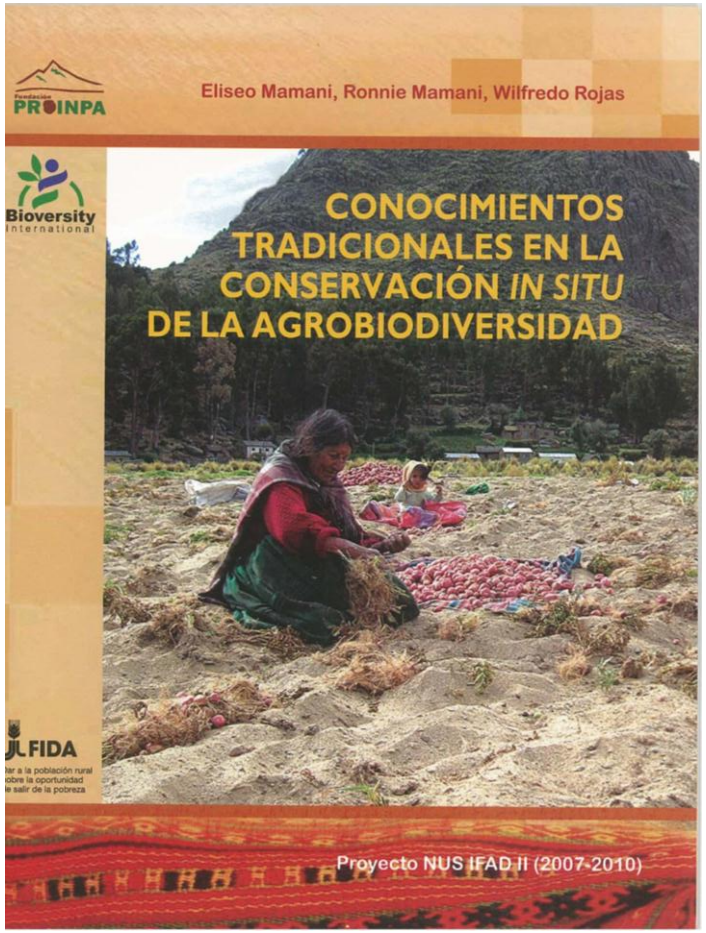
Agricultural biodiversity fairs and use of Andean crops: promotion, documentation, exchange

- Promoting sharing of diversity and knowledge
- Recognition to custodian farmers
- Visibility, documentation, monitoring, networking.

Increased conservation of target crops and associated indigenous knowledge

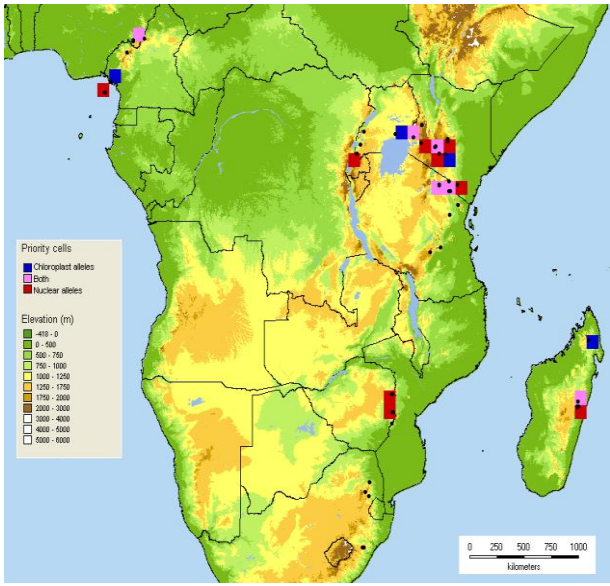


- Output: Documentation of traditional crops and associated IK, their agromorphological traits (focus in Coromata Media and Santiago de Okola, Bolivia).

- Outcome: Contribution to the valorization and use enhancement of target crops and reintroduction of lost diversity in its original area.

Conservation of *Prunus africana*, threatened by harvest of medicinal bark

- Analysis of patterns of variation in genotype and chemotype
- Phylogeographic study
- Development of conservation and management guidelines
- Mapping of priority conservation zones based on diversity from chloroplast and nuclear DNA analysis



Priority zones *for in situ* conservation of genetic diversity of *Prunus africana*

Collaboration with Austrian University and member countries of the Subsaharan Network on Forest Genetic Resources (SAFORGEN)

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Networking, information exchange and research on tools to control illegal logging

- 50% of timber exports from the Amazon, Central Africa, South-East Asia are illegal & threaten tree resources
- Regulatory controls in importing countries
- EUROPE: FLEGT Action Plan; Public Procurement Policies, Timber Regulation
- USA - Lacey Act
- Many protected timbers can be mistaken for legally harvested tree species because of similar wood anatomy

GTTN
GLOBAL TIMBER TRACKING NETWORK

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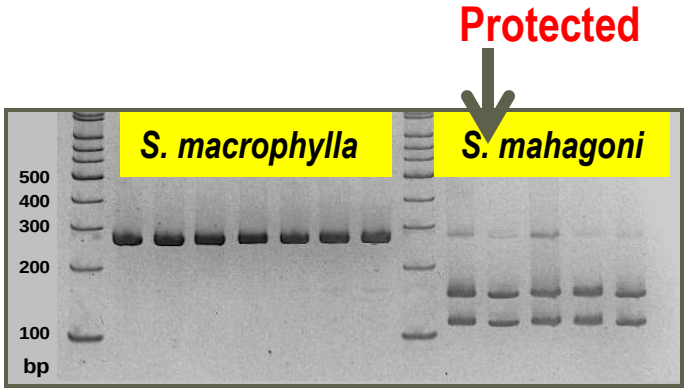
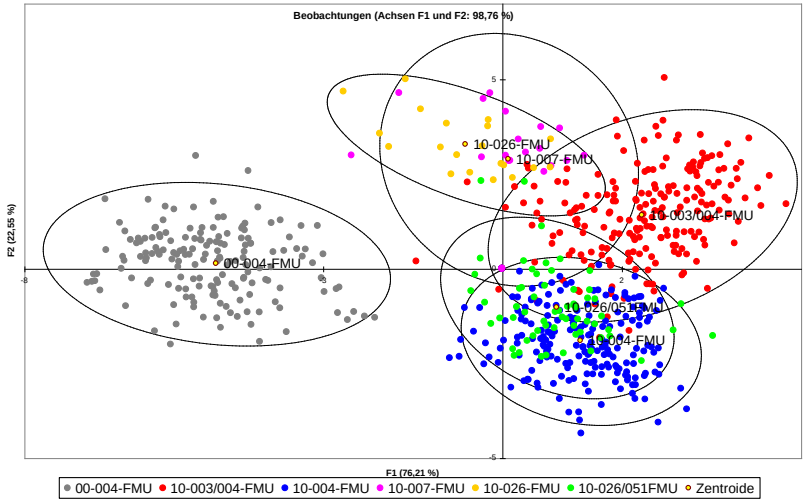
Networking, information exchange and research on tools to control illegal logging

DNA, an integrated “barcode” for species, is not susceptible to manipulation



Stable isotopes can differentiate between locations of origin



Iroko and Sapelli from concessions in Cameron (DA Rotating: D, ^{18}O, ^{13}C, ^{15}N, ^{34}S)

GTTN
Global Timber Tracking Network

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Improving the availability of plant genetic resources

- Information: need to know what is where
- A supportive policy environment

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Global Web Portal(s) for Agrobiodiversity
ex situ PGR and *in situ*/on farm ABD

Related Germplasm Platforms

Geographical Atlases of PGR Accessions

GBIF Internet Publishing Toolkit (IPT)

Related ABD Monitoring & Use

- FAO, ITPGRFA PID/SMTA, WIPO systems
- GBIF, GeoBON, Conservation Int'l
- Breeding & Agroecological information
- Other Global ABD monitoring systems

PGR/ABD Registries

- ✓ National (NBPGR, GRIN, etc.)
- ✓ Regional Networks (e.g. EURISCO)
- ✓ Crop-Specific (e.g. MGIS, IRIS, etc.)

Mobile Phone Data Collection

GBIF IPT

in situ/on farm Agrobiodiversity Data

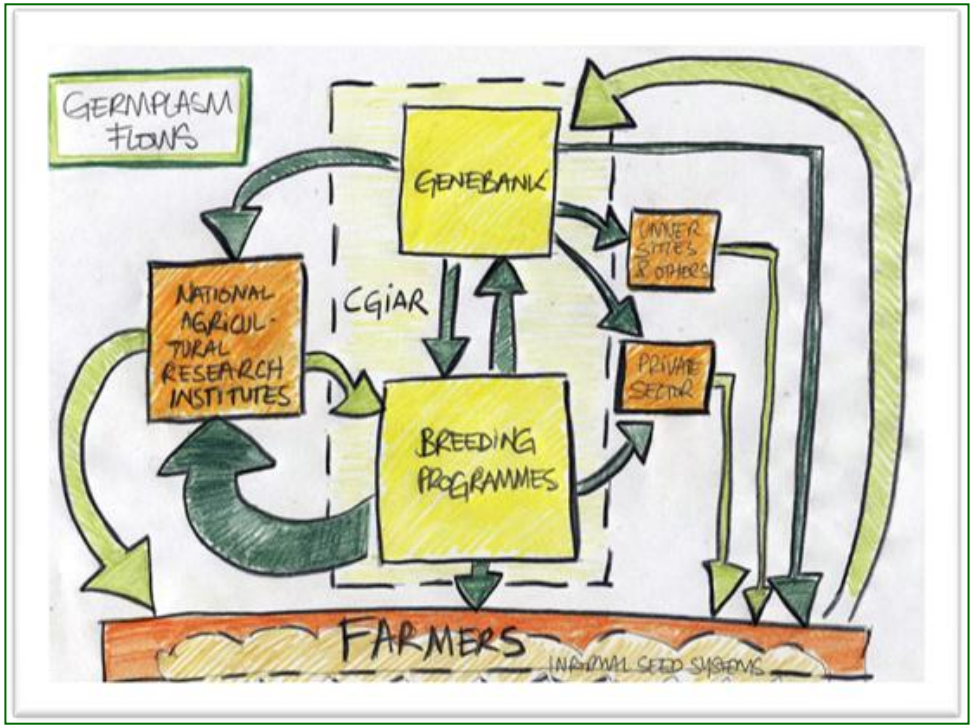
PGR Data Standards

- ✓ Global data identifiers
- ✓ Descriptors
- ✓ Crop Ontology
- ✓ Web service formats

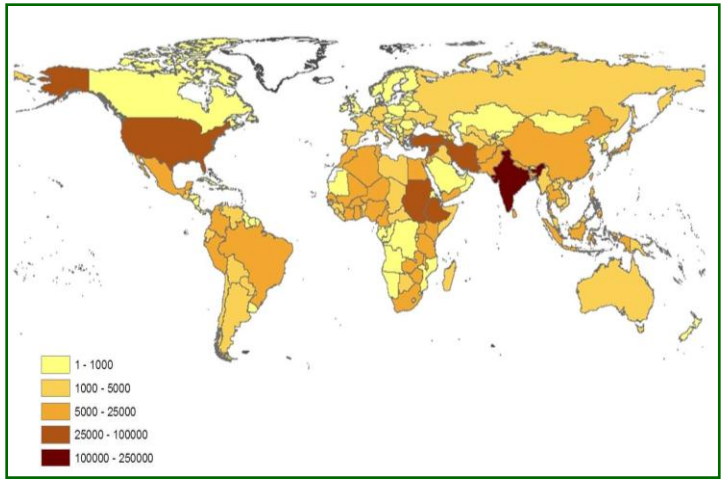
ex situ PGR Genebank MIS

- GRIN-Global
- Other Genebank MIS: e.g. SDIS

Impact of policies on different actors' ability to use germplasm



- Demonstrating of countries' interdependence on crop diversity.
- Understanding processes through which genetic resources are exchanged between different actors



- Proposing policy recommendations for facilitated exchange of genetic resources

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Science for a food secure future