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

- Ecosystem property (e.g. production)
- Time

- Perturbation
- Resistance
- Resilience
- Stability
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\textsuperscript{nd} year
- No difference in quality
Woldeamlak et al.: Hanfetz

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

<table>
<thead>
<tr>
<th>Crop</th>
<th>Yield (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barley</td>
<td>1511</td>
</tr>
<tr>
<td>Wheat</td>
<td>1283</td>
</tr>
<tr>
<td>Hanfetz</td>
<td>1744</td>
</tr>
</tbody>
</table>

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

– CO2 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

<table>
<thead>
<tr>
<th>Per 100 gm</th>
<th>Amaranth (leaf)</th>
<th>Cleome</th>
<th>Nightshade</th>
<th>Cabbage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron mg</td>
<td>8.9</td>
<td>6.0</td>
<td>1.0</td>
<td>0.7</td>
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<tr>
<td>Calcium mg</td>
<td>410</td>
<td>288</td>
<td>442</td>
<td>47</td>
</tr>
<tr>
<td>ß carotene</td>
<td>5716</td>
<td>10452</td>
<td>3660</td>
<td>100</td>
</tr>
</tbody>
</table>
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