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USDA Agricultural Outlook Forum 2007



AGRICULTURAL BIODIVERSITY AS AN INSURANCE POLICY

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Professor, University of California, Davis

Presented: Friday, March 2, 2007

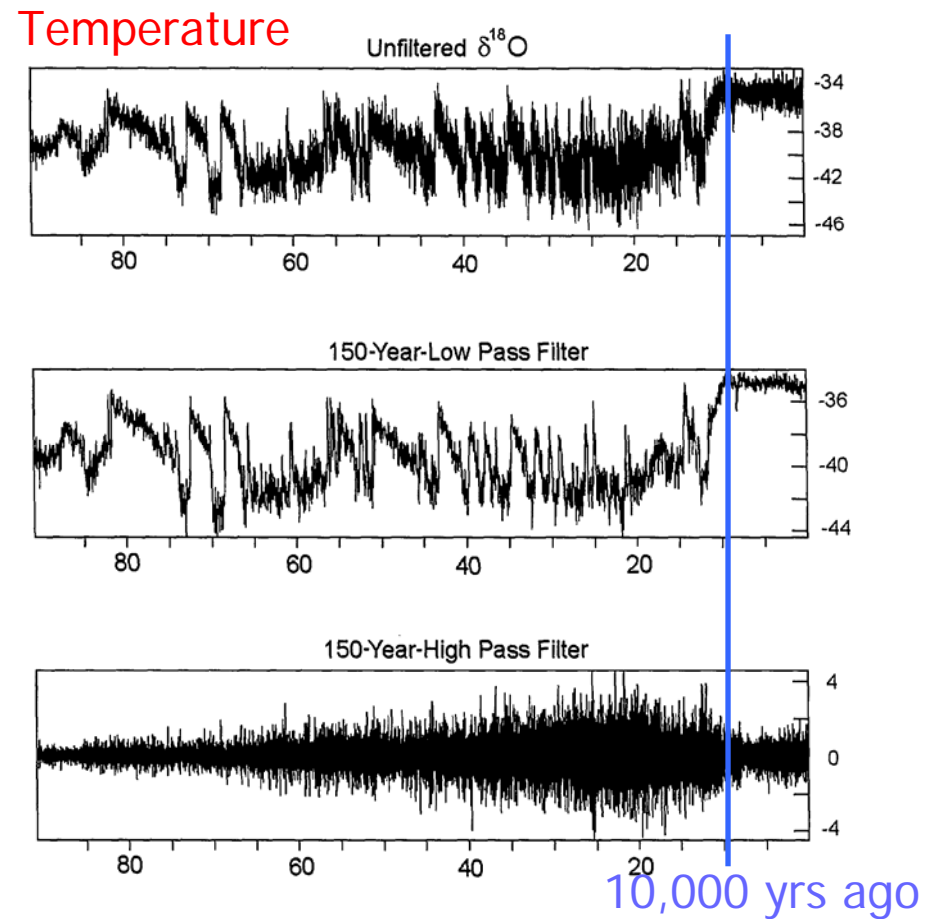
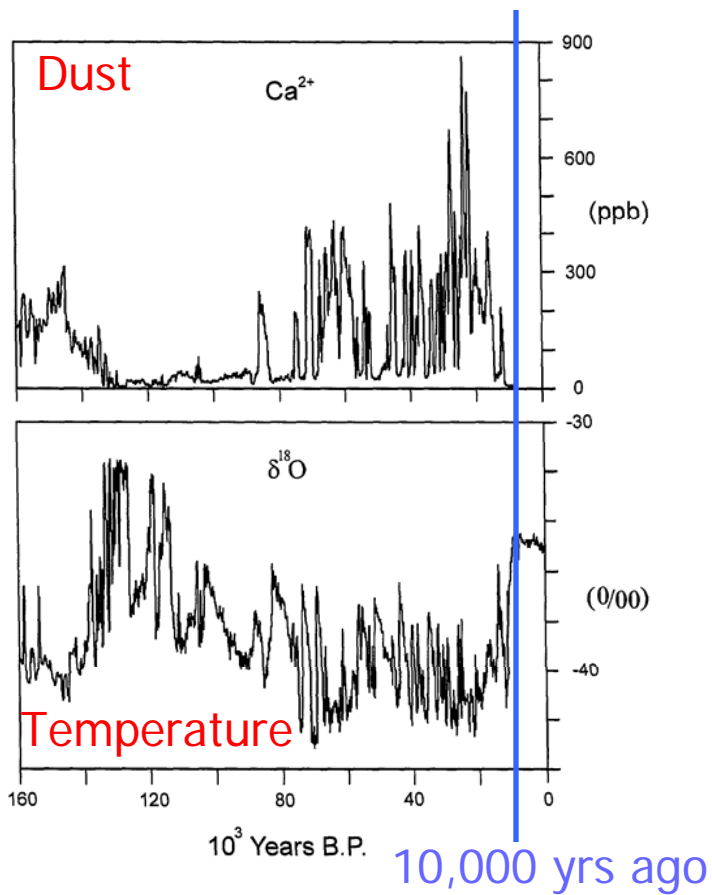
[Thank you]

- USDA: Office of the Chief Economist
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[Outline

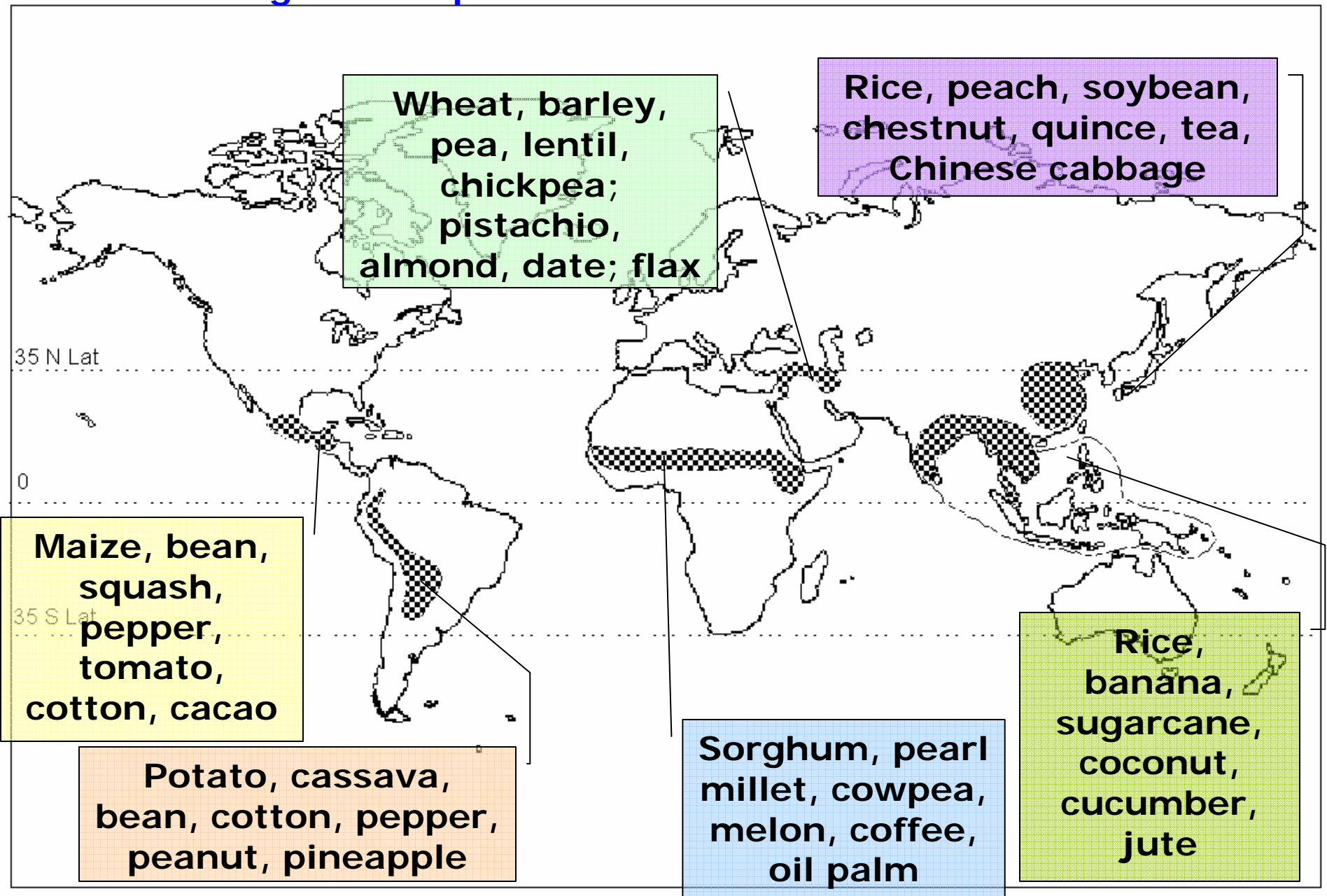
- The value of biodiversity
 - Analogies
 - Evolutionary and historic approaches
- Agricultural biodiversity:
 - Identification
 - Documentation and evaluations
 - Maintenance
- Utilization of agricultural biodiversity
 - Exchange
 - Introduction into elite genetic backgrounds
- Summary

Major global climate change 10,000 yrs ago



Richerson et al. 2001

Centers of Origin of Crop Plants



Plant or Animal

**Morphology
Behavior
Genetics
Physiology
Evolution**

**Domestication
& Evolution under
Cultivation**

Humans

**Cultural development:
knowledge of plants, animals
technology
Population growth
Economic opportunities/constraints**

Environment

**Climate change
Contrast between dry and
humid season
Contrast between wild and
domesticated env.
Diversity of niches**



[20th century: De-diversification]

- Pioneers in the genetic resources movement:
 - Erna Bennett, Otto Frankel, Jack Hawkes, Jack Harlan
- 1970: Southern Corn Leaf Blight
- Johannesburg Summit 2002 on Sustainable Development
 - Five priority areas:
 - Water, energy, health, [agriculture](#), and [biodiversity](#)



[Harlan & Martini (1936)]

- “... the world’s priceless reservoir of germplasm. Unfortunately, from the breeder’s standpoint, it is now being imperiled ... When new barleys replace those grown by farmers of Ethiopia or Tibet, the world will have lost something irreplaceable. When that day comes our collections, constituting as they do but a small fraction of the world’s barleys will assume an importance now hard to visualize.”

[Root causes for de-diversification?]

- Unparalleled population growth
 - Demographic transition in the developing world
- Globalization of communications, travel, and trade
 - Correlation between biodiversity and cultural diversity (e.g., Sutherland 2003)

Threats to genetic resources

- Habitat destruction
- Replacement of landraces by improved cultivars
- Increasingly narrow cultivar gene pool

Genetic Erosion

Habitat destruction



Tarija, Bolivia



Oaxaca, Mexico



Huigra, Ecuador



Padilla, Bolivia

Example of the Cerrado Region of Brazil



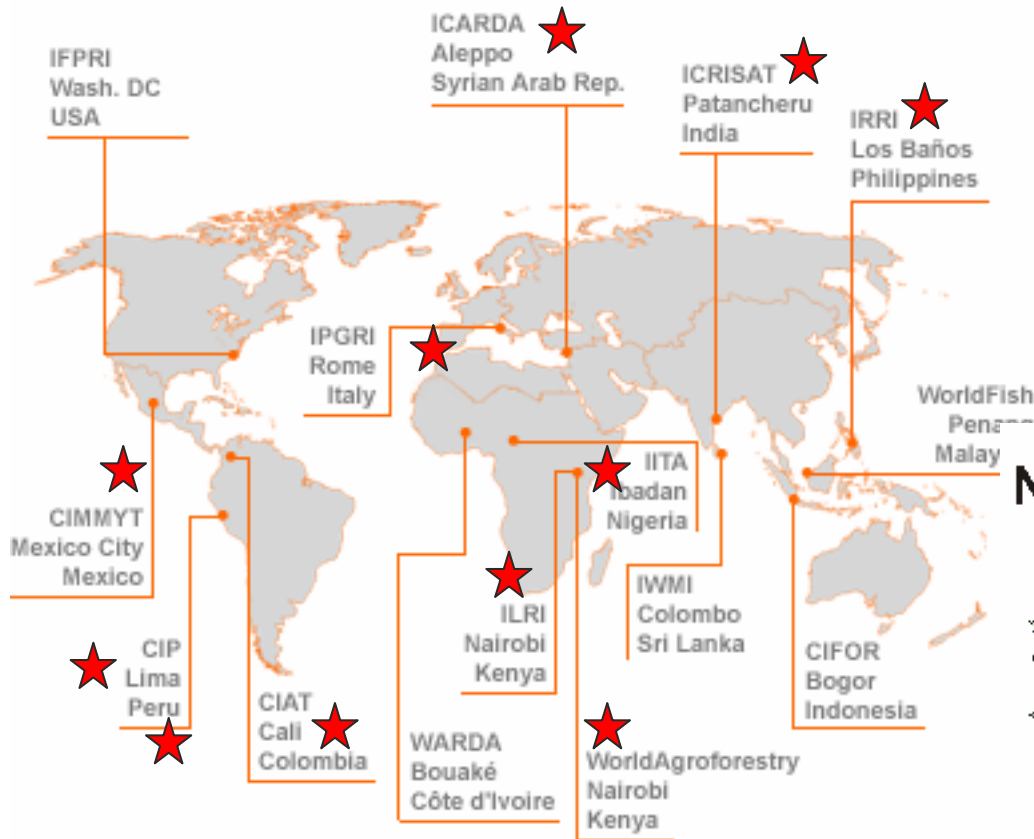
- Biodiversity hotspot: ~ 10000 species
- High level of endemism: 45%
- Center of origin of *Manihot* spp.: cassava
- Only 21% of Cerrado is intact

- Agricultural frontier of Brazil
- In 2000: 35% of crop production
- 58% of soybean production
- 40 million head of cattle

[Agricultural Biodiversity]

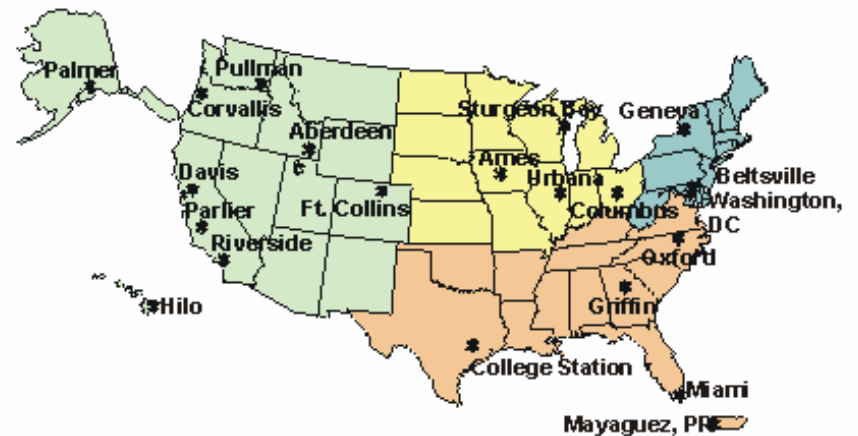
- Identification, documentation and evaluation, and maintenance

Gene Banks: *Ex situ* conservation



- CGIAR system
- USDA-NPGS
- Other national or international banks

National Germplasm Repositories



Broadening the Germplasm Conservation Movement



SEED SAVERS EXCHANGE
founded 1975

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DEPARTMENTS

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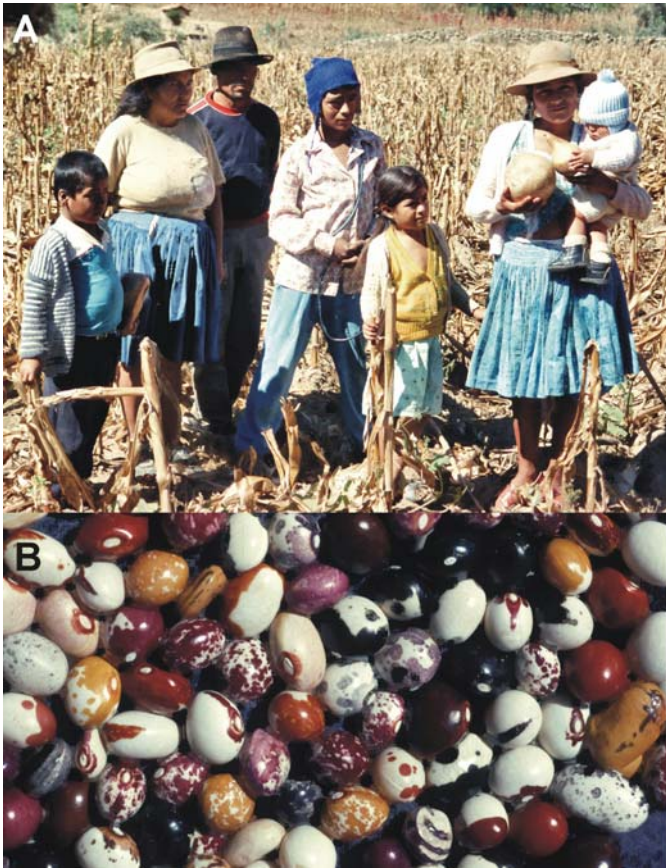


<http://www.slowfood.com/>



<http://www.nativeseeds.org/>

In situ conservation



- Farmer role in conservation?
Examples
 - Cassava: Pujol & McKey 2005
 - Common bean: Zizumbo-Villareal et al. 2005
 - Peppers: Hernandez-Verdugo et al. 2001

- Who represents farmers?
- How to reward them for conservation work?
- Different reward system?

[Farmer's seed banks]



Cost of maintaining genetic diversity

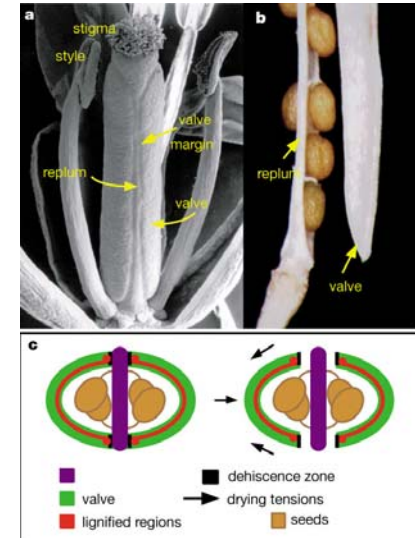
- Keystone Dialogue (1991), US National Research Council (1993), FAO (1997):
 - \$ 250 – \$ 300 million/year
- Koo et al. 2003: CGIAR system: 11 gene banks
 - Storage costs/accession/yr: \$ 1.50 most crops; \$ 2.16 maize; \$ 11.98 cassava *in vitro*
 - Endowment of \$ 149 million with a 4% return: revenue stream of \$ 5.7 million
- Global Diversity Trust Fund:
 - \$ 260 million endowment for a \$ 12 million revenue stream

[Agricultural Biodiversity]

- Exchange and Utilization

Increasing Role of Genomics

- Examples: Domestication genes
 - Major genes:
 - *tb1*: maize branching
 - *Shp1*, *Shp2*: seed dispersal
 - QTLs:
 - Fruit weight in tomato
 - Heading date in rice
- Genome scanning:
 - Differentiation or reduction in genetic diversity
 - Yamasaki et al. 2005 → hypothetical domestication genes
- Marker-assisted selection
 - Accelerate transfer:
 - Miklas et al. 2006



[Intellectual Property Rights]

- Major change in attitude towards genetic resources:
 - Before 1980: common heritage of humanity
 - 1980: U.S. Supreme Court decision: living organisms also patentable subject matter
 - After 1980: further decisions clarifying that crop cultivars can be patented (utility patent, in addition to pre-existing plant patents)

International Treaties

- Convention on Biological Diversity (1993)
 - Sovereignty of states; Access and benefit sharing
 - Primarily bilateral
- World Trade Organization
 - Trade-related Intellectual Property (TRIPs)
- Union pour la Protection des Obtentions Végétales (UPOV)
 - Plant Variety Protection (PVP)
- International Treaty on Plant Genetic Resources for Food and Agriculture (2004)
 - Multilateral agreement for exchange of germplasm of most crops
 - Pay into international fund (Global Crop Diversity Trust)
 - Exceptions: soybean, peanut, tomato, cacao, coffee, grape, rubber, oil palm

[IPR consequences?]

- From tragedy of the commons to the thicket of the anti-commons or hyperownership
- Mutually reinforcing system of IPRs – International Treaties – Biotechnology
- Questions:
 - Is this system going to promote biodiversity conservation?
 - How will germplasm exchange be affected?
 - Will genetic diversity of elite crop germplasm be affected?
 - How to recognize farmer's contributions and traditional knowledge?

Azufrado Pimono 78

Azufrado Peruano 87

Enola (ATCC)

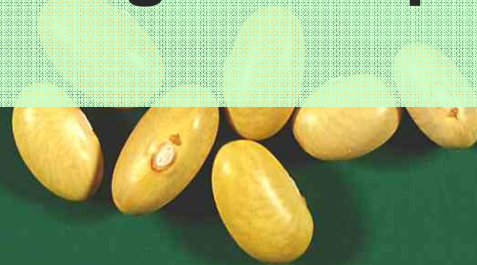


❖ **Not the only example of patented foreign germplasm**

➤ **Popping beans, neem, maca, ayahuasca, basmati rice, etc.**

❖ **Discussion points:**

- **Should biodiversity *per se* be subjected to IPR?**
- **What IPR regime? Exemptions?**
- **How is this IPR regime implemented?**



[Conclusions ...]

- Agriculture has resulted from major climate change 10,000 years ago. How will agriculture weather the current climate change episode?
- Biodiversity may be part of the answer because it provides the raw material for breeding
- Increase the efficiency of conservation, exchange, and utilization