Economics and Policy of Animal Genetic Resources Conservation and Sustainable Use

Adam G. Drucker
Senior (Ecological) Economist
Bioversity International, Rome
a.drucker@cgiar.org

Improving lives through biodiversity research

I. Economic Perspectives of AnGR Erosion

Illustration source: CIP- UPWARDS, 2003

Environmental destruction as seen by economists:

The conversion process

- Replacement of the existing slate of natural habitats and resources with a selection from a small range of specialised productions systems that provide more direct benefits to humans.

Swanson, 1997

Total Economic Value (TEV) =

$$DUV + IUV + OV + BV + XV$$

| Direct Use Value | Indirect Use Value | Option Value | Bequest Value | Existence Value |

Use Values

Non-Use Values

- **These components are also the reasons why we want to conserve**

- **Note also that many of the components provide a mixture of private and public goods**

Improving lives through biodiversity research

Importance of Development of Methods and Decision-Support Tools

- Key constraint to implementing conservation strategies is existence of pervasive externalities such that value of ABD is often not fully accounted for by individuals and society.

- Agricultural biodiversity needs to be properly valued

- Mechanisms needed to permit the "capture" of those values

- Requires development of appropriate economic methods, decision-support tools and policy intervention strategies.

Improving lives through biodiversity research

Method and Tool Development (Status)

- Significant development of methods over last 10-20 years for PGR and AnGR
  - e.g. see Drucker and Smale, 2005 for state of the art review covering over 170 publications plus associated 2008 updated database.

    (link on Bioversity International and IFPRI websites)

- A wide range of decision-support tools and analytical approaches successfully tested
  - Across different crop species/varieties and livestock breeds
  - Across different production systems and locations
  - In situ and ex situ.

Improving lives through biodiversity research

A Diversity of Methods and Tools

- econometric methods;
- optimization models (including Weitzman);
- Monte Carlo simulations;
- search theoretic frameworks;
- contingent valuation and choice experiments;
- experimental games
- production loss, opportunity cost, least-cost and safe minimum standards methods;
- economic surplus methods;
- cross-sectional farm and household methods;
- farm simulation and breeding programme evaluation;
- use of genetic production functions

Improving lives through biodiversity research

Policy Relevance – Types of questions such research can be expected to answer

- Which breeds should be conservation **priorities** (given that we cannot save everything)?

- How important are particular breeds to **livelihoods** and how can such values be harnessed to support poverty alleviation efforts?

- **Which traits and functions** (both marketed and non-marketed) are the most important and degree they can be traded off against each other?

- What are the **costs of AnGR conservation** programmes and how can we minimise these? What are the related benefits?

Improving lives through biodiversity research

CBD COP 8 Decision VIII/25

Encourages

- promotion of a common understanding of valuation techniques (para. 7)
- development of innovative tools for assessment and valuation of biodiversity resources (para. 10c)

Bioversity's economics work seeks to:

Facilitate the conservation of agrobiodiversity, improved indigenous farmer livelihoods and policy through the development of innovative economic analytical methods and incentive mechanisms.

Improving lives through biodiversity research

II. AnGR Conservation and Use in a Changing World
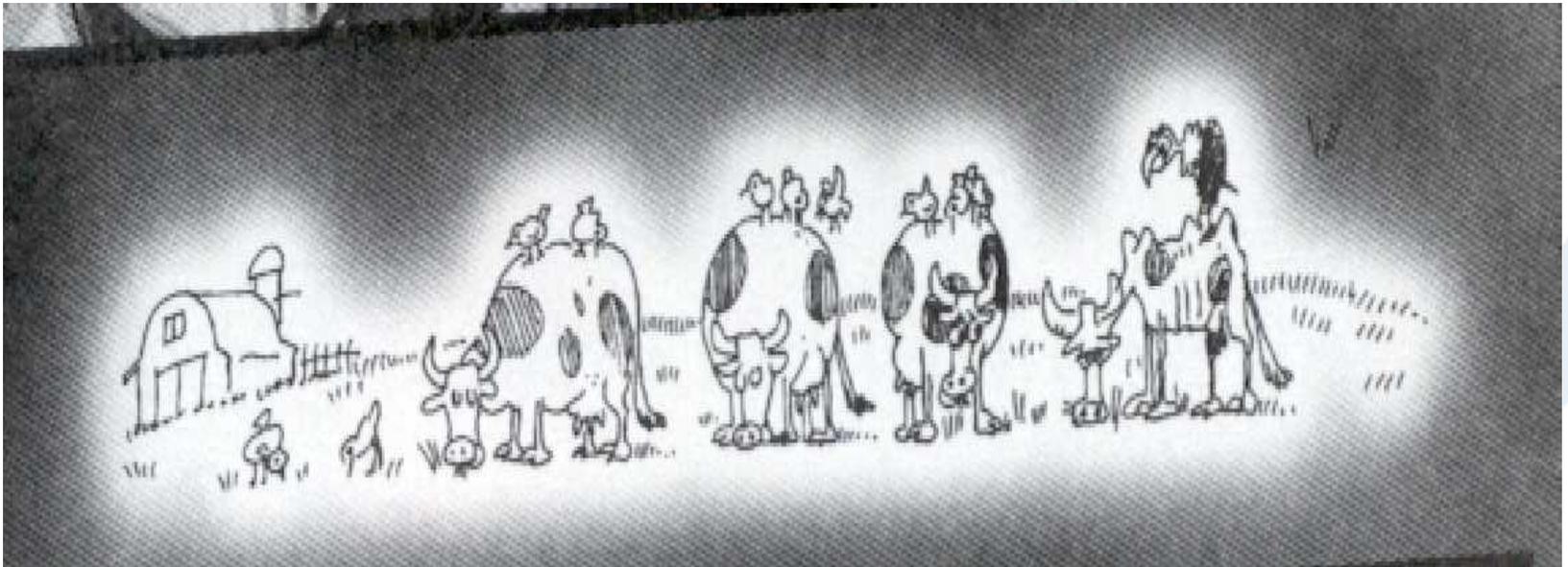
Sources of dynamic change

- ## Climate change
  - 1.4°- 5.8°C increase in annual global mean surface temperature compared to 1990.
  - Extreme weather and climatic events.
  - Climate changes in 22nd century could exceed those over last 1 million years.

- ## Human population growth
  - 9 billion by 2050

- ## Continuation of urbanisation trends
  - From 49.2% in 2005 to 60.8% in 2030

- ## Increasing affluence in the South as a result of development
  - world per capita GDP of US$10,000 - US$83,000 by 2100

- ## "Livestock Revolution"
  - 2x increase inb diary and meat consumption 1990-2020

- ## Globalisation (i.e. global integration of food and agricultural markets)

- ## Biotechnology development

Fuente: Hiemstra et al., 2006

Improving lives through biodiversity research

Why Worry about Climate Change and AnGR Loss?

- **Climate change can be expected to affect livestock productivity:**
  - <u>directly</u> by influencing the balance between heat dissipation and heat production, and
  - <u>indirectly</u> through its effect on the availability of feed and fodder.

- **Main livestock-relevant environmental impacts of climate change are:**
  - changes in fodder and water availability
  - land degradation
  - changes in disease challenge
  - speed of climate change relative to livestock and forage evolutionary adaptation
  - large-scale movement of livestock breeds may become increasingly necessary
    - Consequently, country interdependence on animal genetic resources may be expected to increase even further.

Source: Hiemstra et al., 2006; Drucker et al. 2009

Improving lives through biodiversity research

Current international interdependency (I)

Global Direction and Volume of flows of livestock germplasm in past 150 years

- North to North
    - very large, rapid expansion of intensive systems
- North to South
    - very large but sometimes (not always) detrimental
- South to South
    - (very?) large
- South to North
- limited and benefits small?

Source: Hiemstra et al., 2006

Current international interdependency (II) – West Asia North Africa Example

- The Fertile Crescent (West Asia) is one of the main centres of domestication for sheep and goats.

- Sheep breeds with fat tails dominate the region (53 out of 71 breeds), especially in West Asia, as this adaptation allows them to cope with fluctuation in feed availability.

- Ten sheep breeds are shared by at least two countries.
  - Awassi is the most important breed in Mediterranean West Asia and is shared by Turkey, Syria, Lebanon, Jordan and Iraq (Galal et al., 2008).
  - Fat-tailed Barberine sheep in North Africa are shared by Tunisia, Libya and Algeria.

- Awassi are in high demand in countries with similar climatic conditions, with the Gulf countries generating demand for imports. Australia and countries in the Horn of Africa have already acquired Awassi populations and use them for straight and crossbreeding programs (Hassen et al., 2002; Kingwell et al., 1995).

- Shami (Damascus) goat has is indigenous to Syria, but now reared in Syria, Jordan, Cyprus and Egypt (Iñiguez, 2005a). The breed is also in demand for crossbreeding programs in North Africa (e.g. Libya), as well as India.

Improving lives through biodiversity research

Current international interdependency (III): Forages

- Although only about 60 species are widely used as fodder, these have been moved around the globe.

- Most livestock systems depend on fodder species originating elsewhere.

- Sub-Saharan Africa is the centre of genetic diversity of tropical grasses with over 90% of the major cultivated forage grasses indigenous to the rangelands of sub-Saharan Africa (Boonman, 1993).
  - These grasses widely used to improve the extensive cattle lands in Latin America. By 1996, over 40 million ha were sown to *Brachiaria* in Brazil (Miles *et al.*, 1996).
  - Ruzi grass (*Brachiaria ruziensis)* introduced to Thailand and in increasing demand (Phaikaew *et al.*, 1993). *Cenchrus ciliaris* is now grown in 31 countries (Cox et al., 1988), with 4 million ha planted in the USA, over 6 million ha in Mexico, and 7.5 million ha in Australia (Humphreys, 1967).
  - Other African grasses including *Panicum maximum*, *Chloris gayana* and *Pennisetum purpureum* are now widely distributed and cultivated on a smaller scale throughout the tropics in smallholder systems.

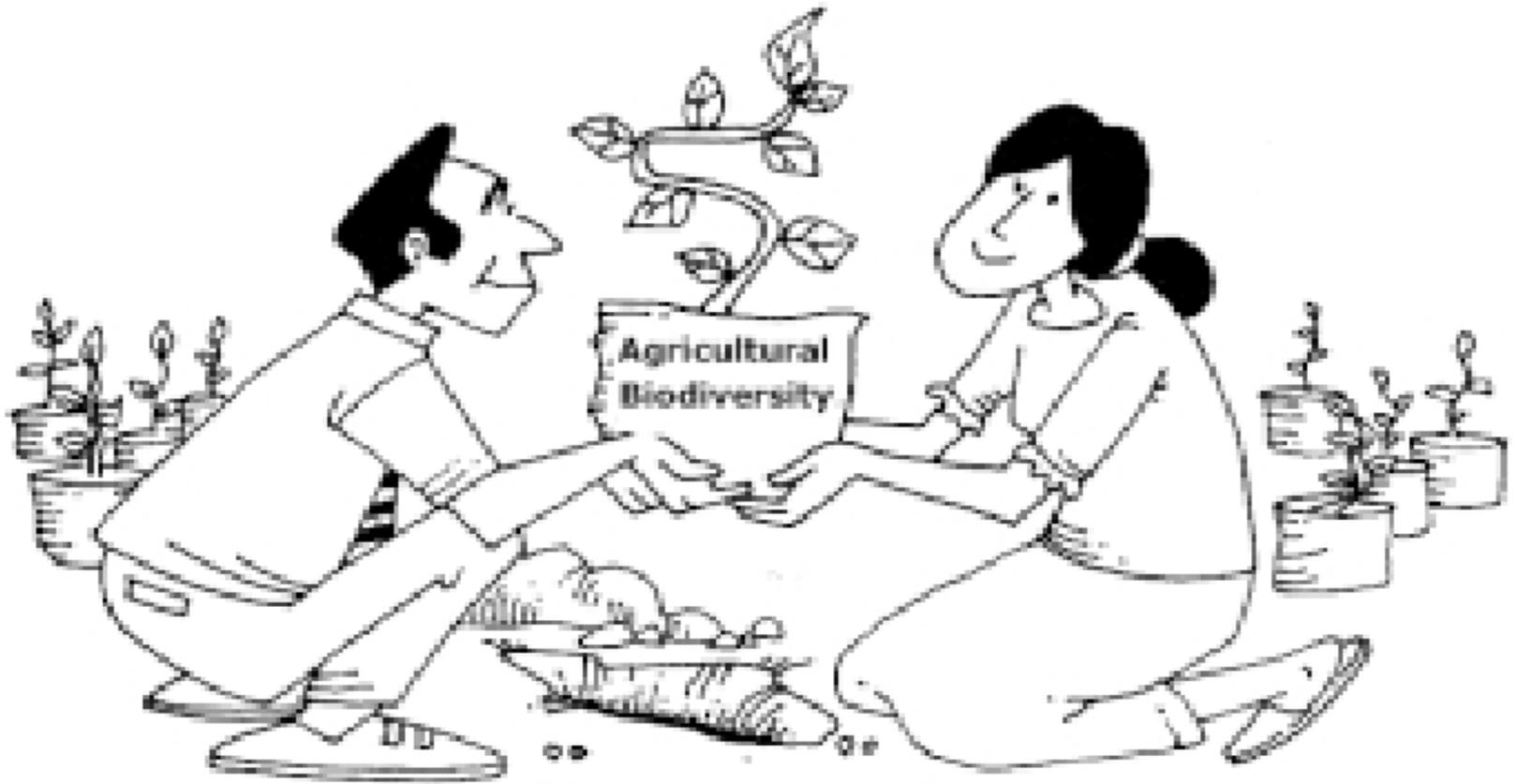*Improving lives through biodiversity research*

AnGR scenarios

Scenarios related to globalization and regionalization; biotechnology development; climate change and environmental degradation; and diseases and disasters. Consultative process involving >200 people from >40 countries (Hiemstra et al., 2006):

- Portfolio of breeds needed/demanded by society will change as a result of increased demand and the environmental impacts of climate change (**Scenario 1 – "livestock portfolio change"**)

- Livestock gene pool will be smaller than it is today because the process of globalisation tends to lead to the use of a limited number of "improved" breeds. The speed of climate change which is expected to outpace evolutionary adaptations will also contribute to the reduction in the genepool (**Scenario 2 – "gene pool reduction"**).

Potential Impacts and Implications

- **Scenario potential impacts suggest:**
  - Large-scale movement of livestock breeds in search of more appropriate climatic zones may become increasingly necessary, thereby increasing country interdependence.
  - Increased demand for the remaining breeds
  - Demand for both productive and adaptive traits could increase
  - Livestock trade becomes more important and biotechnology developments increase the returns to both public and private sector AnGR research.
  - Reduced gene pool and biotechnology developments makes remaining germplasm more valuable
    - much of which may in the future be increasingly accessible from ex situ and in situ conservation programmes.

- **Potential Implications include:**
  - Increasing concerns regarding the CBD-recognised sovereign control of national AnGR.
  - Such concerns may threaten international flows of livestock germplasm and access to AnGR, in a context where such flows and access issues have become more important.
  - Increased livestock germplasm flows within and between countries will create new opportunities for crossbreeding and introduction of exotics.
  - Need to ensure that any such flows are beneficial and do not threaten remaining livestock diversity.

Improving lives through biodiversity research

III. Policy Options for a Changing World

Illustration source: CIP- UPWARDS, 2003

Some Potential Policy Options

A range of policy instruments could be applied to address some of these issues. These include (Hiemstra et al. (2006):

1. **Developing procedures for access and benefit sharing**

2. **Regulation of export and import of AnGR**

3. **Support for both conservation (in vivo and in vitro) and improvement of indigenous AnGR**.

4. **Precautionary cryoconservation**

5. **Special provisions for indigenous AnGR in animal disease control acts**

6. Improved understanding of the **economics of genetic resource conservation** and sustainable use

7. **Development of decision-support tools** that allow conservation priorities to be set – we cannot save everything, so what is it that we should conserve?

Improving lives through biodiversity research

1a. Developing Procedures for ABS: Loss Sharing Anyone?

The case of the PSS gene

- World's most valuable livestock gene so far
- Test used in global pig populations to remove undesirable mutation
- Total income to Innovations Foundation approx $5m
- Net profit after deducting research cost approx $0
- Global additional cost of research greater than $2m
- No commercial interest

- Source: J. Gibson, pers com. 2001

Improving lives through biodiversity research

1b. Developing Procedures for ABS

Benefits − what are they and how can they be shared?

- Non-monetary (as well as monetary)
  - Information
  - Technology transfer, hardware, software and know-how
  - Training
  - Joint research and collaboration
  - Institutional capacity building
  - Local income generation and employment
  - Benefits in-kind

Improving lives through biodiversity research

1c. Developing Procedures for ABS

- Current AnGR research already involves considerable non-monetary benefit sharing

- Need to protect/enhance existing forms of benefit sharing
    - If access to AnGR for development research becomes more difficult, the very limited amount of work currently being done may cease altogether
    - Research organisations must be perceived as adding value in order to ensure continued supply of germplasm
    - Do alternatives to publically funded research efforts exist?

- Improvement of public and community use of biodiversity, including existing BS at local level

- Prior Informed Consent (PIC) and standardised Material Transfer Agreements (MTAs)

Source: Hiemstra et al., 2006; Drucker and Gibson, 2001.

improving lives through biodiversity research

1d. Developing Procedures for ABS: Property Rights Assignment I

- Assignments that affect the relationship between livestock-keeper communities, livestock breeders and biotechnology R&D must be considered carefully (efficiency and equity implications)

Source: Drucker and Gibson, 2001

Improving lives through biodiversity research

Bioversity
International

```
┌─────────────────────────────────────────────────┐
│          Nature (land use decision)              │
│                                                   │
│  consisting of:                                   │
│  • Lands and diversity of genetic resources       │
│  • Natural selection and evolutionary product     │
└─────────────────────────────────────────────────┘
```

Selected traits   Open access

```
┌─────────────────────────────────────────────────┐
│                "Traditional Farmer"               │
│                                                   │
│  consisting of:                                   │
│  • Observation                                    │
│  • Discriminatory selection and use               │
└─────────────────────────────────────────────────┘
```

Landraces   Farmers' Rights

```
┌─────────────────────────────────────────────────┐
│                  "Plant Breeder"                  │
│                                                   │
│  consisting of:                                   │
│  • Scientists                                     │
│  • Tools and technology                           │
│  • Existng varieties                              │
└─────────────────────────────────────────────────┘
```

New plant   Plant breeders
variety   rights

```
┌─────────────────────────────────────────────────┐
│                    Consumer                       │
└─────────────────────────────────────────────────┘
```

Improving lives through biodiversity research

Figure 1: Vertical industry for plant breeding
Source: Swanson and Goschl (2000)

1e. Developing Procedures for ABS: Property Rights Assignment II

- Assignment at retail end of plant breeding industry resulted in:
  - Increased number of R&D programmes;
  - Increased total number of plant breeders
  - Increased aggregate amount of R&D expenditure
  - Increased private R&D
  - **No** increase in essential input activities for maintaining a flow of genetic resources into the future (e.g. habitat and biodiversity conservation).

Source: Drucker and Gibson, 2001

Improving lives through biodiversity research

1f. Developing Procedures for ABS: Lessons from the ITPGR Process I

- Over a decade of negotiation and difficult to agree on a common approach

- Will achieving such an agreement be any easier for AnGR?

- Are there alternative legal and regulatory frameworks that would be more appropriate for AnGR and easier to establish?

- Who will benefit from the establishment of legal and regulatory frameworks?

- Will such a framework promote greater net benefits than a "free" market in movement and exploitation of livestock germplasm?

Improving lives through biodiversity research

Source: Drucker and Gibson, 2001

1g. Developing Procedures for ABS: Lessons from the ITPGR Process II

- PGR from developing countries were (and are) being enhanced in developed countries and then sold back to the developing world at substantial profit. Contrast to AnGR case:

  - With improving technologies, is this scenario likely to repeat itself for AnGR?

  - Will the economics of AnGR always remain substantially different from that of PGR?

  - Given the current geneflows (not well understood), what are the incentives for developing countries to involve themselves in the development of an international legal and regulatory framework?

  - Are there also important national regulatory issues to be addressed as well?

Source: Hiemstra et al., 2006; Drucker and Gibson, 2001

Improving lives through biodiversity research

2. Regulation of export and import of AnGR

- Including protocols for the guidance of donors and NGOs importing exotic breeds, involving *inter alia*:
  1. the use of "**genetic impact assessments**" (GIA), prior to importation, and subsequent implementation of mitigation mechanisms where appropriate.
  2. use of standardised **production environment descriptors** – PEDS - (FAO/WAAP, 2008) to facilitate comparisons and evaluation of breed performance, obtain data proxies for adaptedness, inform interventions related to AnGR management, and help delineate recommendation domains for such interventions;
  3. establishment of national **Biosafety Acts** within which the introduction of genetically modified AnGR could be regulated. Such GMOs may become increasingly common as biotechnology develops and climate change motivates new breeding efforts;

Source: Hiemstra et al., 2006; Drucker et al., 2008.

Improving lives through biodiversity research

3. Support for Conservation (in vivo and in vitro) and Improvement

Agricultural subsidies in the OECD = $260 billion p.a.

– Some support (<1%??) would help provide a level playing field with other breeds

– Of increasing importance given the need to both
  - slow the rate of AnGR loss from a shrinking gene pool
  - to facilitate conservation through sustainable use via access to well-characterised genetic materials.

- Source: Hiemstra et al., 2006; Drucker et al., 2008.

Improving lives through biodiversity research

4. Precautionary cryoconservation

- Loss of animals through droughts, floods and/or disease epidemics related to climate change may increase (Hoffman et al. 2008).

- Localized breeds are at risk of being lost in localized disasters. **Precautionary cryoconservation** of genetic material or other measures may be required.

- Source: Drucker et al., 2008.

Improving lives through biodiversity research

5. Provision for AnGR in animal disease control acts

- Climate change will increase the disease challenge and may result in wider-scale mass culling of animals (e.g., the UK response to the 2001 foot and mouth disease outbreak), potentially resulting in AnGR loss.

- Source: Hiemstra et al., 2006; Drucker et al., 2008.

Improving lives through biodiversity research

6 & 7. Economics and Decision-support Tools

• Which breeds should be conservation **priorities** (given that we cannot save everything)?

• How important are particular breeds to **livelihoods** and how can such values be harnessed to support poverty alleviation efforts?

• **Which traits and functions** (both marketed and non-marketed) are the most important and degree they can be traded off against each other?

• What are the **costs of AnGR conservation** programmes and how can we minimise these? What are the related benefits?

Payment for Environmental Services

PES principle defined as:

1. a **voluntary** transaction where

2. a **well-defined** environmental service or a land-use likely to secure that service

3. is being "bought" by a (min. one) environmental service **buyer**

4. from a (min. one) environmental service **provider**

5. if and only if the environmental service provider continuously secures environmental service provision (**conditionality**).

- *Four areas of <u>application</u>:* carbon, watershed, biodiversity and landscape beauty protection

Payment for Agrobiodiversity Conservation Services (PACS) to create incentives for conservation of agrobiodiversity and improve livelihoods.

• Assess impact of PACS schemes on institutions of collective action

• Consider when "payments" might be more cost-effective than market/value chain development for achieving conservation goals.

• Can PACS be used as an early warning system, including in the context of climate change?

Improving lives through biodiversity research

PACS Implementation Steps

- Define the conservation strategy (*what do we want to conserve?*)

- Define the conservation goal (how – at what level – do we want to conserve it?)

- Assist individual farmers or communities to develop a conservation service offer

- Assess farmer Willingness to Accept (WTA) rewards to undertake conservation

- Identify how rewards can be financed by the project (i.e. sources of rewards/funding)

Improving lives through biodiversity research

Identifying breed conservation priorities: "Weitzman" decision-support tool

- Analytical tool for cost-effective allocation of a given budget among a set of breeds/varieties such that the diversity conserved is maximized.

- Integrates genetic distance, extinction probability and economic (conservation cost, livelihoods contribution) data.

- Where sufficiently specified framework can be used for rational decision-making on national, regional or global scales.

- African Zebu cattle example identifies priorities of 3-9 out of 23 Zebu breeds. These are not necessarily the most endangered ones.
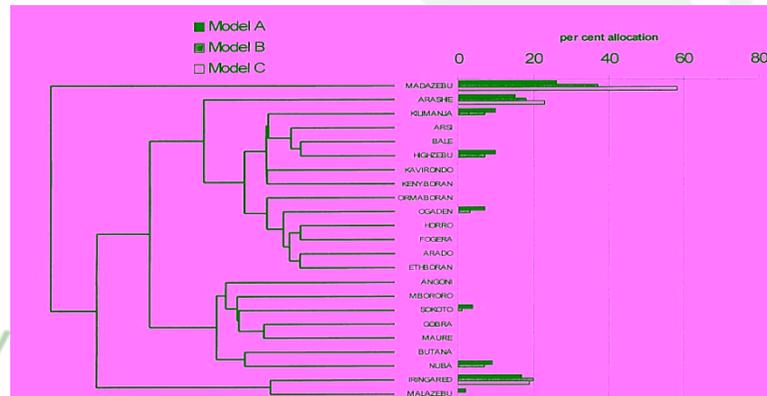
Source: Simianer et al. (2003)

Fig. 2. Maximum likelihood tree from the application of the Weitzman (1992) algorithm and optimum allocation of resources resulting from the three models considered.

AnGR Risk Status Indicator

FAO (1999) has established a classification system to report on the status of livestock breeds.

- Seven categories are used:
  - extinct, critical, endangered, critical-maintained, endangered-maintained, not at risk, & unknown.
    - A breed is "not at risk" if "the total number of breeding females and males are greater than 1,000 and 20, respectively;
    - or if the population size approaches 1,000 and the percentage of females being bred pure is close to 100% and the overall population size is increasing"

Simianer et al. (2003) and Reist-Marti et al. (2003) while giving greatest weight to population size and trends, also consider:
  - geographical distribution;
  - evidence of indiscriminate crossing;
  - the presence of a breeding infrastructure, breeder's organisation or conservation scheme;
  - socio-cultural importance;
  - the existence of especially important traits;
  - the reliability of the information available; and
  - the political situation in the country where the breed is located.

Improving lives through biodiversity research

How much to conserve?:
Safe Minimum Standard (SMS)

- **Expansion without Extinction.** Creating markets for a safe minimum level of environmental (agrobiodiversity) service provision through PACS

- Adapts SMS approach from wildlife applications to livestock breeds, using FAO "not at risk" criteria (1,000 breeding females, 20 males, stable trend)

- Conservation costs in EU, Italy and Mexico determined for variety of species/breeds based on opportunity cost differential plus administration.

- Results: Costs of SMS small (<1%) compared to existing subsidies and benefit-cost ratio (>2.9).
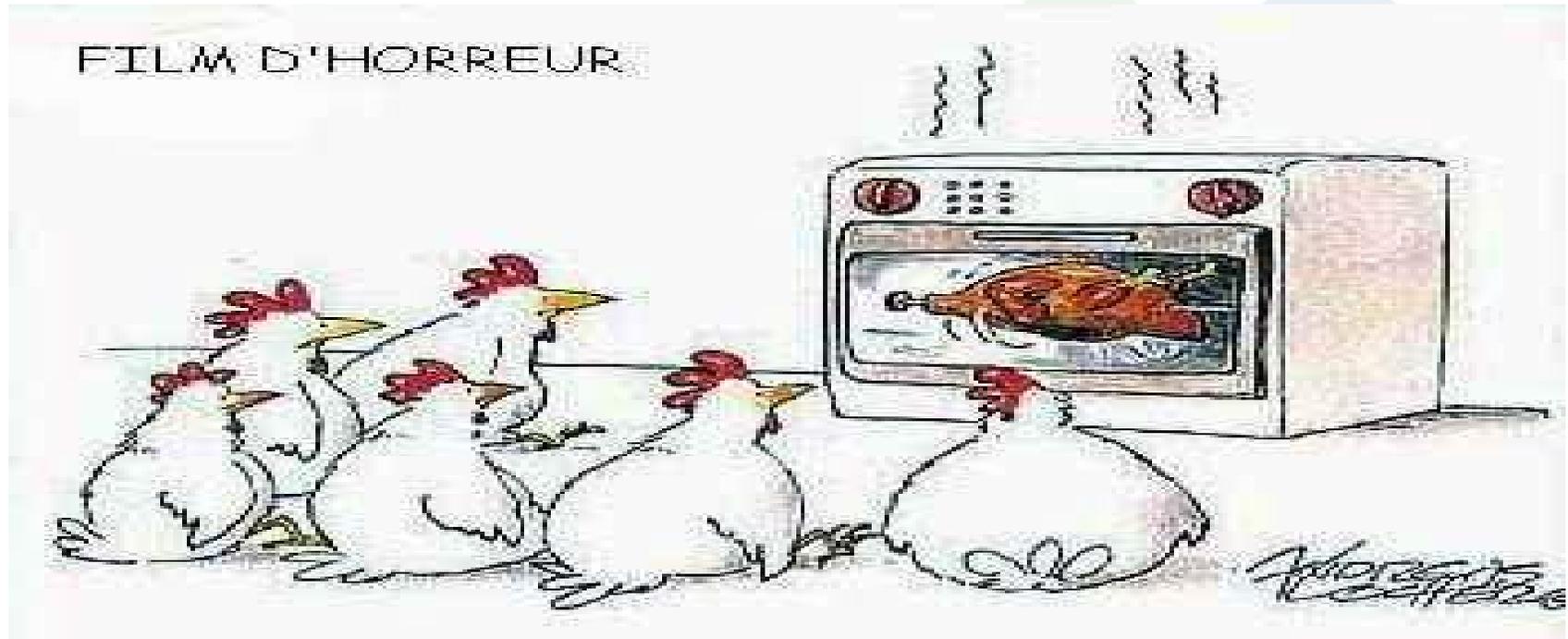
Source: Drucker, 2006)

Improving lives through biod

IV. **Concluding Remarks**

Illustration source: CIP- UPWARDS, 2003

Concluding Remarks I

- Economics has contributed relatively little to debate about value of genetic resources & diversity.

- Relatively limited uptake of associated tools & methods

FILM D'HORREUR

The Challenges Ahead (Economics)

- **Raise awareness** among national policy-makers regarding existence of and benefits of (e.g. in terms of improved cost-effectiveness) using such tools

- Improve national genetic resource economics **analytical capabilities**

- **Generate input data** required (availability/"get-ability")

- Apply in circumstances where tools/methods may be expected to have a significant **impact** on actual conservation and livelihood outcomes.

- Collaborate closely with communities and policy makers required in order to facilitate **uptake** ("ownership")

Improving lives through biodiversity research

Concluding Remarks II

- For informed decision-making regarding regulatory options, more debate and information needs to be acquired
  - e.g. relatively little baseline quantitative data on AnGR exchange is available.
  - National level policy factors/distortions and improved understanding
    - Macroeconomic (e.g. exchange and interest rates)
    - Regulatory and pricing (e.g. taxation, price controls, market and trade regulations)
    - Investment policy (e.g. infrastructure development)
    - Institutional policy (e.g. property rights)

- *Areas requiring further research include:*
  - Importance of continued access and trade in livestock germplasm
  - Nature and importance of existing benefits and how best to protect/enhance them
  - Potential impact of property rights assignments in terms of efficiency, equity and GR conservation *per se*
  - Consideration of alternative regulatory frameworks and policy options