egenis

Identifying Best Practice for Productive Partnerships

Apomixis Consortium

Characterization of the
Functional Components required for Apomixis in Maize

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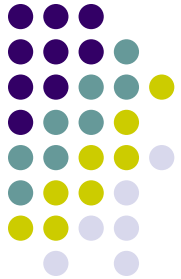
E·S·R·C ECONOMIC & SOCIAL RESEARCH COUNCIL

UNIVERSITY OF EXETER

ESRC genomics network

Overview of Presentation



I. Context for the Consortium: the Apomixis research field

II. The Consortium: History, Organizational Mechanisms, and Goals

III. Discussion: Dynamics of Core Processes

IV. Analysis: Benefits and Value

I. The Significance of Apomixis?

1) What is Apomixis? 'Apomixis' is **asexual reproduction** through seeds found in many 'wild' plant species e.g. dandelion, grasses

- ➢ It is uncommon among crop plants (except tropical forages, *Citrus* etc)
- ● Apomicts produce seed which contains a copy of the maternal genome
- ➢ Researchers aim to harness this ability ('cloning'?) for agriculture

2) Why? 'Apomixis Technology' would theoretically enable breeders to **fix hybrid vigor & stablisise hybrid genomes**

- ➢ This may benefit seed companies (e.g. reduced costs, diversify resources); and commercial and resource-poor farmers (e.g. recycle hybrid seed, fix cultivars for niche microclimates and specific uses)

3) What is the Timeline? Variable, contingent on scientific viewpoint and sustained investment ('frontier research')

- ➢ In late 1990s, optimistic short-term goal of fully apomictic crop was predicated on dominance of interspecific hybridisation programmes
- ➢ Currently viewed as mid-to-long term goal, predicated on molecular bio, with gradual emergence of technological capability within 20 years

I. The Apomixis Research Field …

1) The Apomixis research field is fragmented

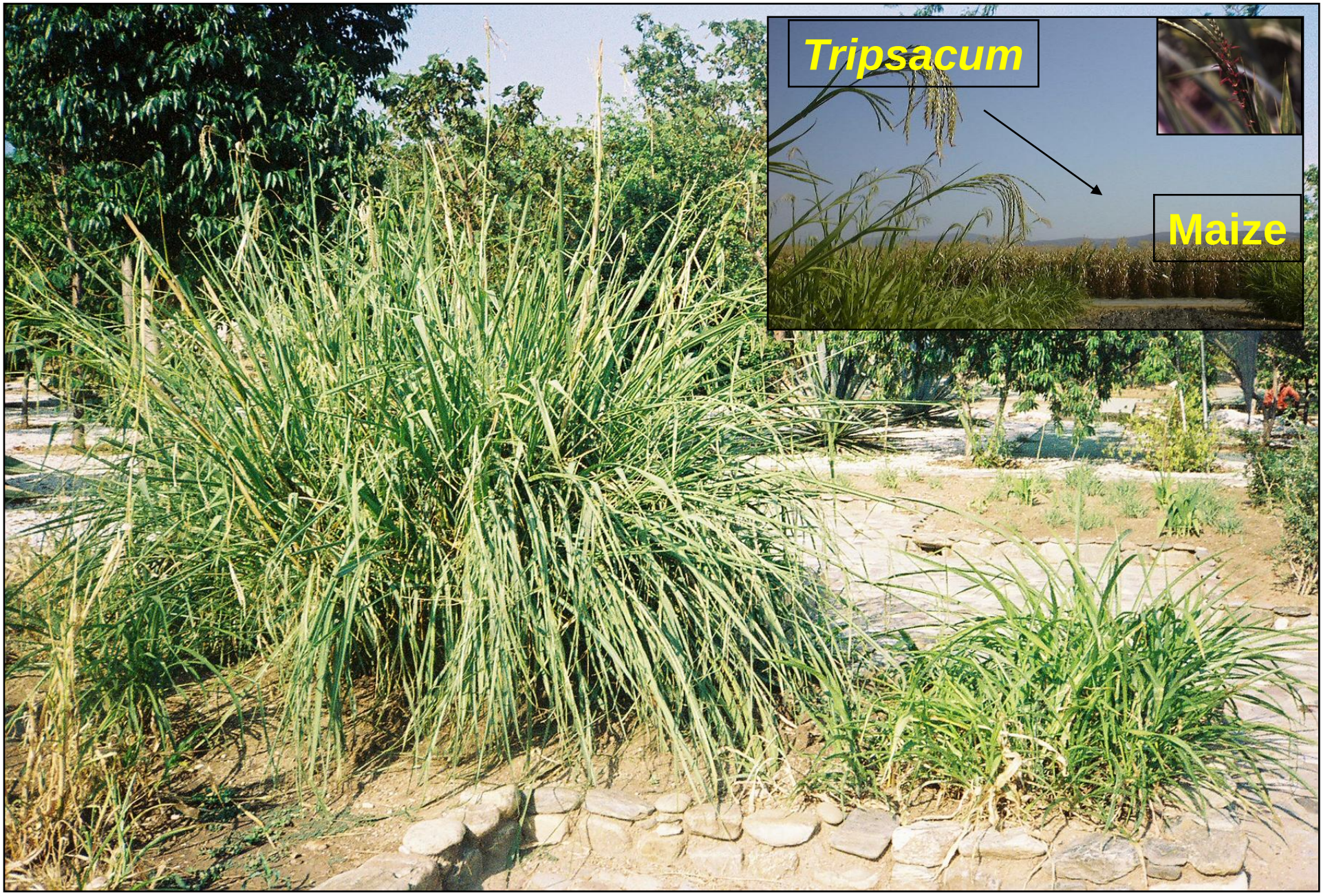
- A loosely integrated, surprisingly 'small' network (c.100 researchers)
- With a range of foci and model systems
- With different approaches to **technology devt**., i.e. molecular biology in various forms, but increasingly few integrating plant breeding

2) Research has a diverse funding base

- Research is funded by the public sector, private sector, & **PPP**s

3) The 'Molecular Turn'

- The major transformation that has occurred over the last 10 years is the 'molecular turn'
- i.e. the emergence of a molecular biology hegemony (shift from breeding to lab), with implications for technology models, stakeholders & end users
- Coinciding with private sector investment (late 1990s), related debates concerning IPR and apomixis e.g. Bellagio Declaration on necessity of enabling access to technology by resource-poor
- The historical context for the emergence and management of this PPP …


Tripsacum
Maize

The Apomixis Consortium (2009)

IRD
Institut de recherche pour le développement

CIMMYT MR

Limagrain
de la terre à la vie

ANU
THE AUSTRALIAN NATIONAL UNIVERSITY

(post-2004)

syngenta

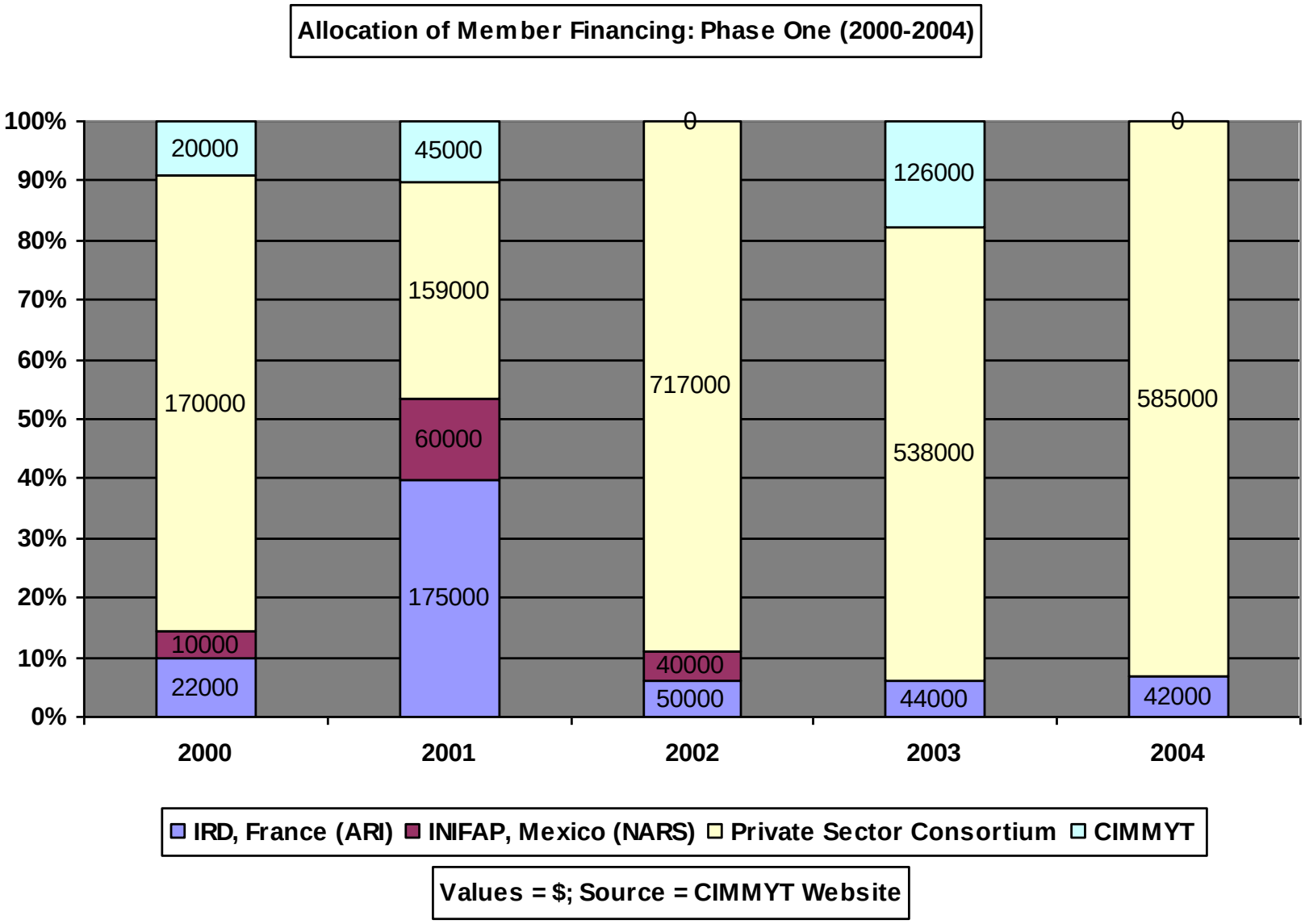
II. Apomixis Consortium: Co-Innovation

1) What is the contributory structure of the Consortium?
- Decided on an annual basis, linked to 4-year agreement and plan?

2) Who provides what: Private Sector
- Cash support is provided by the Private Sector companies
- Each company contributes technologies & services (e.g. genetic materials for maize transformation, databases, further details undisclosed)

3) Who provides what: Public Sector
- IRD (and ANU post-2004) contribute by allocating two research scientist positions apiece to the project
- CIMMYT has previously contributed research scientist position (in Mexico then ANU), support staff and costs for in-kind activities in Mexico
- Its in-kind contribution was phased out in 2008 due to strategic re-emphasis of unrestricted funds; and related discrepancy between CIMMYT's focus on applied plant breeding and crop improvement, and PPP's strategic research agenda
- CIMMYT was committed to returning to in-kind contribution should research refocus on pre-breeding but as this is unlikely in phase 3, has withdrawn

4) Analysis: Contributions based on a 'co-innovation' structure


Allocation of Member Financing: Phase One (2000-2004)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
20000
170000
10000
22000
45000
159000
60000
175000
0
717000
40000
50000
126000
538000
44000
0
585000
42000
2000
2001
2002
2003
2004
IRD, France (ARI)
INIFAP, Mexico (NARS)
Private Sector Consortium
CIMMYT
Values = $; Source = CIMMYT Website

II. Apomixis Consortium: Management

1) What is the management structure of the Consortium?

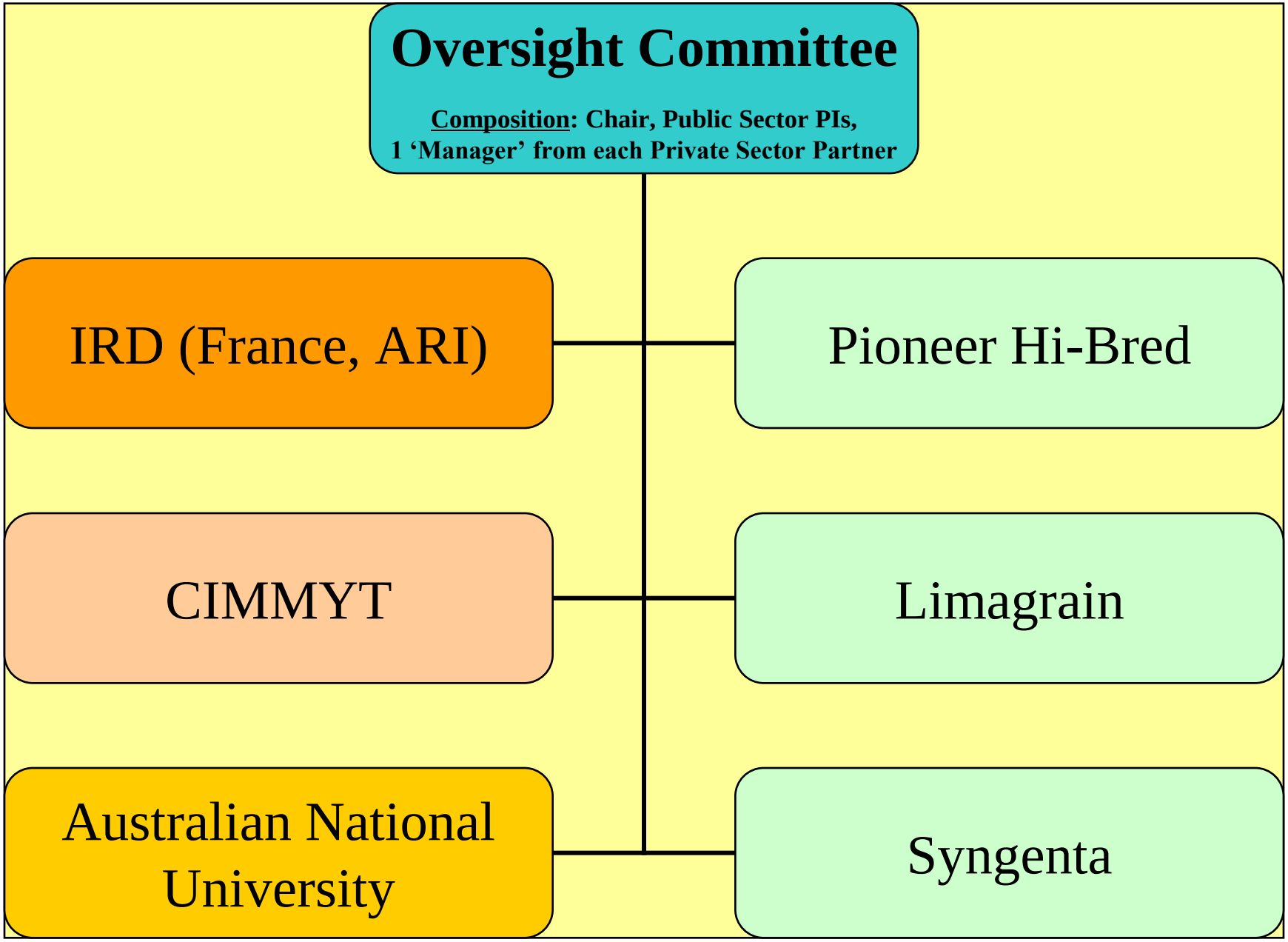
- Project activities are managed by an “Oversight Committee”
- This includes all PIs from the each of the public institutions
- And one manager (scientist?) from each of the private sector partners

2) How does this work in practice?

- Each member is responsible for day-to-day coordination of their portion of the agreed activities that are conducted at their facilities
- Work-plans are collectively reviewed, revised and approved on a semi-annual basis
- Based on collective assessment of outputs from previous six months

3) Analysis: Effectiveness also related to authority of members within their institutions and the support of institutions for members; i.e. is Private Sector policy of placing scientists in managerial positions matched by Public Sector

- OC and its temporal structure is key to management of dynamic, emergent co-innovation process informed by frontier research


Oversight Committee
Composition: Chair, Public Sector PIs,
1 'Manager' from each Private Sector Partner
IRD (France, ARI)
CIMMYT
Australian National University
Pioneer Hi-Bred
Limagrain
Syngenta

II. Apomixis Consortium: IPR

1) How has IPR been managed? In original agreement, a two-tier licence
   - Premise for CIMMYT's entry, as CIMMYT Apomixis Project was focused on the resource-poor ('Equity in Access to Hybrid Vigor for Resource-Poor'), and scientists were signatories to Bellagio Declaration
   - Farmers earning under $5,000 p.a. would receive Apomixis Technology free, which was feasible given the goal was 'natural' apomictic maize

2) Subsequent developments? All partners have contributed significant amounts of in-house legal time to IP management issues
   - Under current agreement, market segmentation model is maintained
   - Private Sect has non-exclusive licence to deploy outputs in target markets
   - CIMMYT & IRD deliver to resource-poor farmers based on means test

3) Analysis: Stakeholders present for all potential end-users (importance of CIMMYT membership), but dependent on type of technology produced
   - & are there consequences for freedom-to-operate if product integrates previously patented technology? (wider implications for co-innovation)

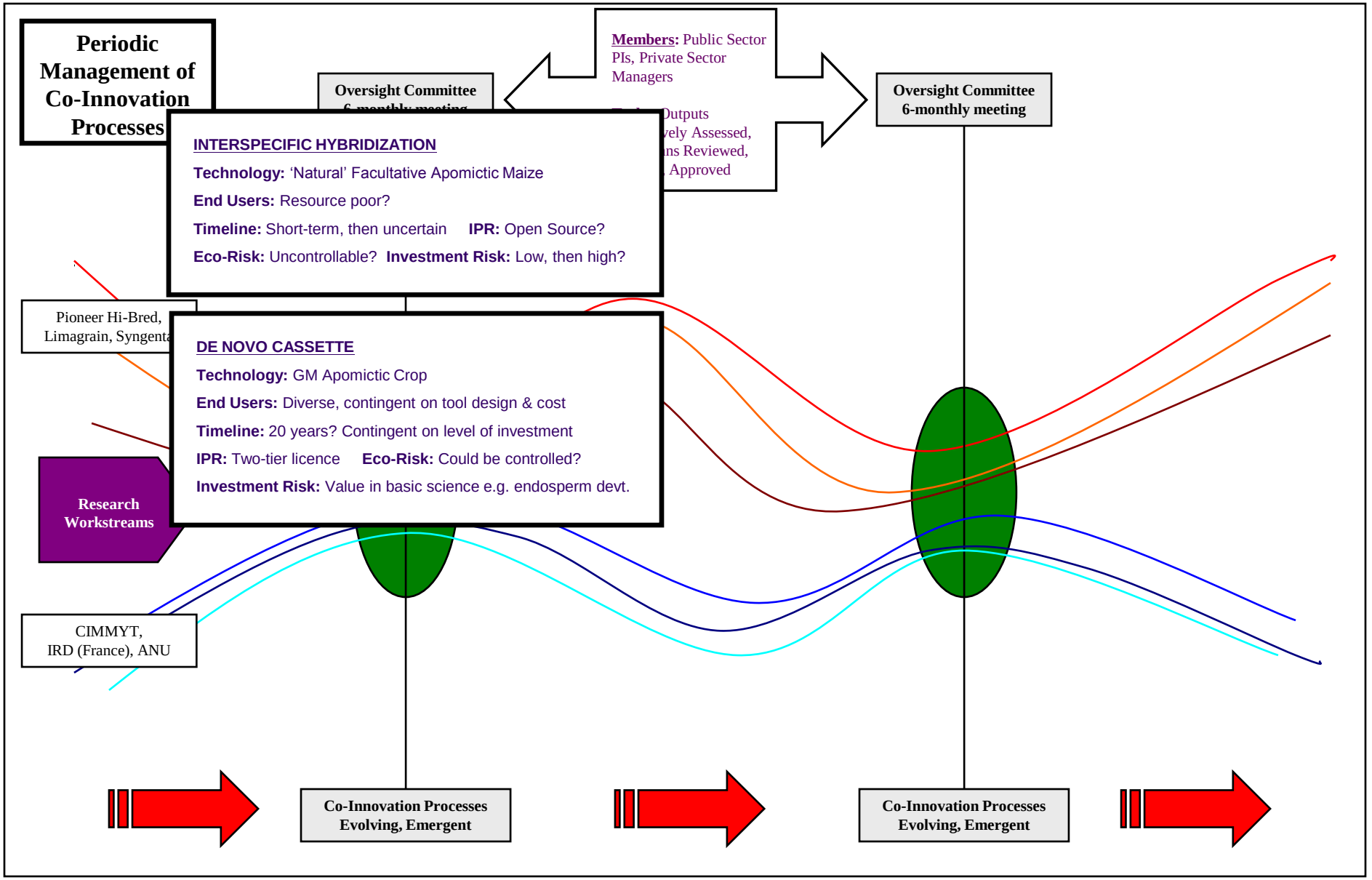
III. Discussion: Dynamics of Core Processes

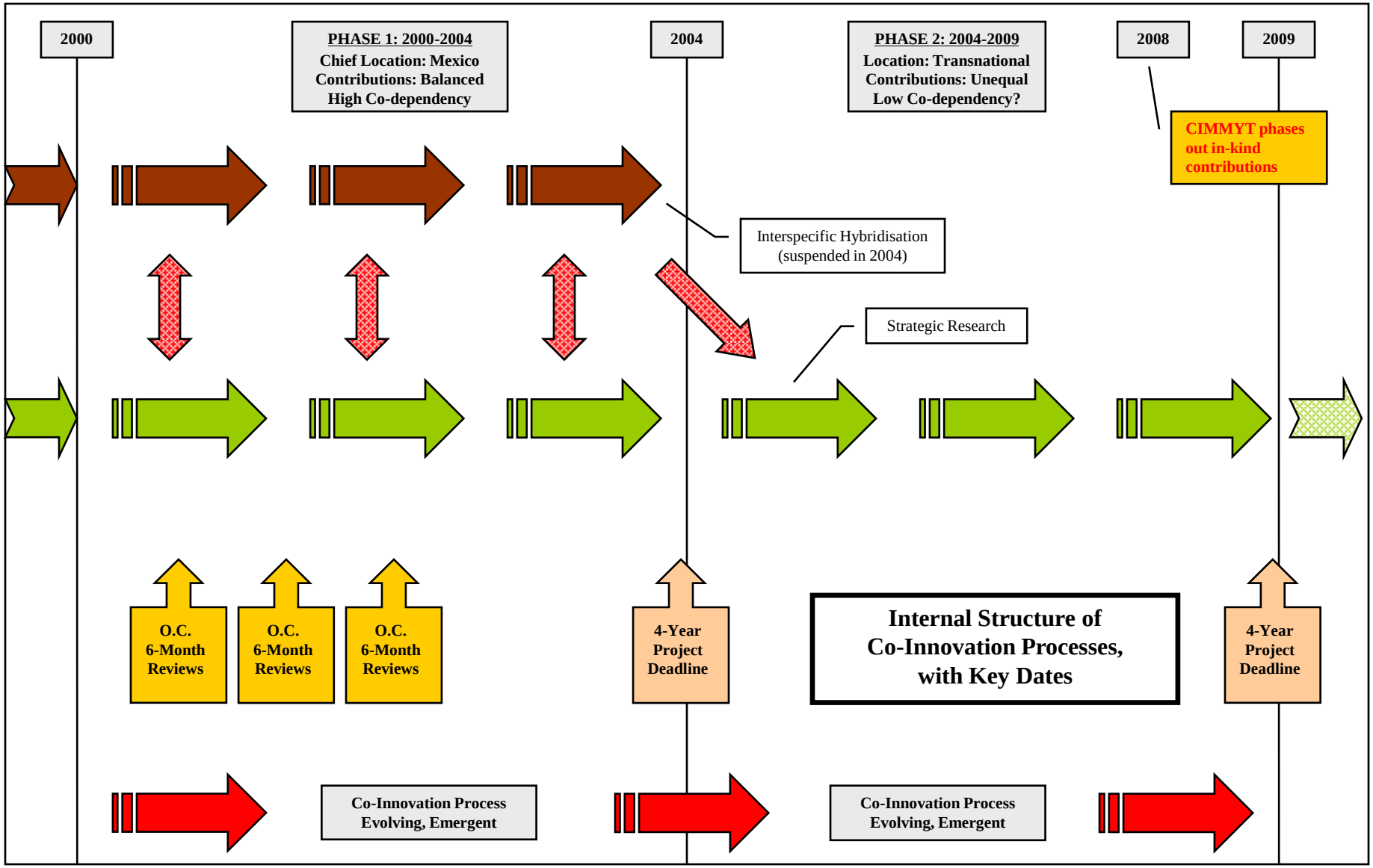
Key Factors:

- Co-Innovation: The Apomixis Consortium is a PPP founded on 'Co-Innovation', where each partner actively participates in the process of planning, executing, and reviewing research
  - And each partner contributes skills and resources that enable that process

2) 'Frontier Research': The dynamics of co-innovation are structured by the focus of the PPP on 'frontier' research
   - i.e. joint research with uncertain but very beneficial outcomes – potentially a distinct trajectory from co-innovation but practically integrated
- What degree of uncertainty? Russian plant breeders and scientists first grasped the potential of apomixis for agriculture in the 1930s
  - No significant progress until 1980s; still real uncertainty about when and how an apomictic technology can be delivered; but total confidence in its potential value

3) Dynamics: The interaction of managerial, organizational, contributory, and IPR structures pivots around interaction between the co-innovation / frontier research paradigms … (See figures on following slides)


Periodic Management of Co-Innovation Processes
Oversight Committee
Members: Public Sector PIs, Private Sector Managers
Outputs
vely Assessed,
ns Reviewed,
Approved
Oversight Committee 6-monthly meeting
INTERSPECIFIC HYBRIDIZATION
Technology: 'Natural' Facultative Apomictic Maize
End Users: Resource poor?
Timeline: Short-term, then uncertain IPR: Open Source?
Eco-Risk: Uncontrollable? Investment Risk: Low, then high?
Pioneer Hi-Bred, Limagrain, Syngenta
DE NOVO CASSETTE
Technology: GM Apomictic Crop
End Users: Diverse, contingent on tool design & cost
Timeline: 20 years? Contingent on level of investment
IPR: Two-tier licence Eco-Risk: Could be controlled?
Investment Risk: Value in basic science e.g. endosperm devt.
Research Workstreams
CIMMYT, IRD (France), ANU
Co-Innovation Processes Evolving, Emergent
Co-Innovation Processes Evolving, Emergent


2000
PHASE 1: 2000-2004
Chief Location: Mexico
Contributions: Balanced
High Co-dependency
2004
PHASE 2: 2004-2009
Location: Transnational
Contributions: Unequal
Low Co-dependency?
2008
2009
CIMMYT phases out in-kind contributions
Interspecific Hybridisation (suspended in 2004)
Strategic Research
O.C. 6-Month Reviews
O.C. 6-Month Reviews
O.C. 6-Month Reviews
4-Year Project Deadline
Internal Structure of Co-Innovation Processes, with Key Dates
4-Year Project Deadline
Co-Innovation Process Evolving, Emergent
Co-Innovation Process Evolving, Emergent

IV. Analysis: Benefits & Value

1) Dynamic temporal structure enables on-going review and management of evolving and emergent research trajectories

2) Co-innovation enables pooling of resources from leading stakeholders in different fields, and development and maintenance of rich project heritage

3) In frontier research, PPP enables partners to work together in 'pre-competitive' mode, reducing individual exposure to risk
   - With provision for 'competitive' mode when breakthroughs occur through IPR etc

4) Strategic research reduces exposure via progress on valued topics e.g. endosperm devt. – and contributions to the public good via research publications

4) Social Value: Diverse stakeholders cater for range of potential end-users

5) Apomixis technology might develop piecemeal: is PPP well-positioned?
   - Different components of apomixis might gradually be incorporated into pre-breeding and product output (view of leading experts in field)
   - In this regard, strategic research workstream is of future value

   - Conclusion: Structure of co-innovation model for frontier research is robust?

IV. Analysis: Is the Model Robust?

1) Policy consensus: effective PPPs are central to future advances in agricultural biotechnology

- Richards (2004) & others qualify this statement, acknowledging centrality of PPP model, while claiming 'agro-technological monocultures' can sometimes restrict innovation; impede democratic impact of new biotech
- Advocating attention to possibilities for diversification and competition between different approaches, both research paradigms and research infrastructures

2) How does this play out for Apomixis research?

- 'Molecular Turn' created a lab-based monoculture?
- But … are technological 'heterocultures' needed to realise an 'Apomixis Technology'? Some scientists believe that *de novo* model will not deliver
- & agro-technological diversification (inc. introgression) is the way forward

3) The Consortium: Key Shifts

- Heteroculture of field & lab research became a monoculture of lab research …
- Strategic research is now focused on GM solution? What form might technology take for resource-poor?
- **Scientific challenges of frontier research and strategic research decisions have weakened co-dependency in PPP … CIMMYT withdraws**

IV. Analysis: the Wider View?

1) Heterocultures, or Monocultures?

- In Apomixis PPPs / frontier research, there is a strong case for sustaining research flexibility to enable exploration and anticipate the emergent and unknown … this may be manifested as a transient ‘monoculture’?
- But recognition of the value of a research ‘heteroculture’ for sustaining a partnership with a capacity to deliver for diverse end-users is also of significance

2) Need for Sustained Long-term Investment

- Sustained, intensified long-term investment needed to enable innovation in Apomixis / frontier research
- This will build capacity, increase the scope of the research field
- But conflicts with short-term funding agendas …