Rethinking Realizing Value from Genetic Resources

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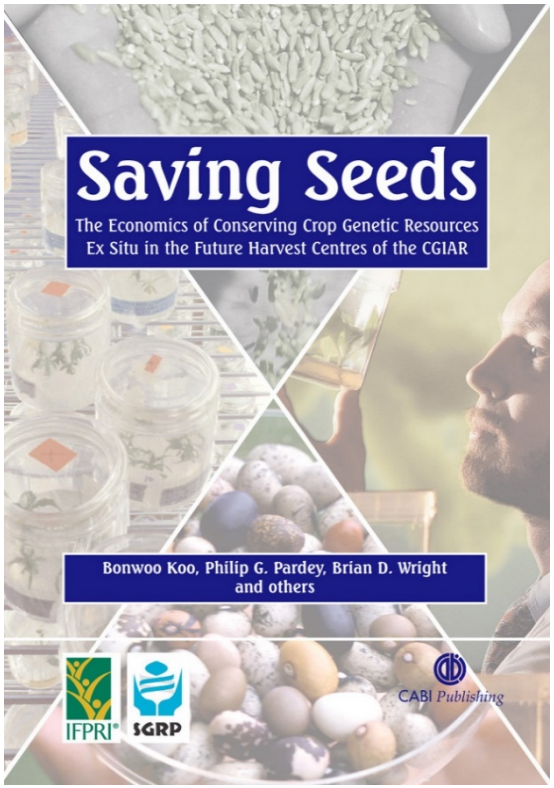
Funding the CGIAR Genebanks

Side Meeting to the CGIAR System Council Meeting, 9 May 2017

Royal Tropical Institute, Amsterdam

Genebank Benefits vs Costs



Estimating the marginal benefits of conserving each type of genebank accession is an important, but particularly difficult, task.

In part because attributing an appropriate part of the agronomic improvement in a plant to the use of conserved germplasm is a daunting, if not intractable, inferential challenge.

- Cost data are estimable, at least in in principle, from historical data relevant to existing genebank operations.
- If the total and marginal costs of the genebank operations are judged to be less than any reasonable lower-bound estimate of the corresponding benefits, then it may not be necessary to confront the challenge of precisely estimating the latter to establish the economic justification of the genebank operation.

The Value in Genes

Existence Value

- Benefits from knowing a particular environmental resource, endangered species, or seed variety **exist**

  Quantification: Willingness to pay

Use Value

- The economic (and other, often related, e.g. environmental or health) benefits from **using a variety/gene** (trait discovery, breeding, etc)

  Quantification: R&D evaluation evidence (with attribution issues)

Option Value

- The benefit derived from **using a variety/gene sometime in the future**

  Quantification: R&D evaluation evidence (with attribution issues)

Genetic Resources—Existence and Options Value

Time Inconsistencies

Conservation costs being borne now

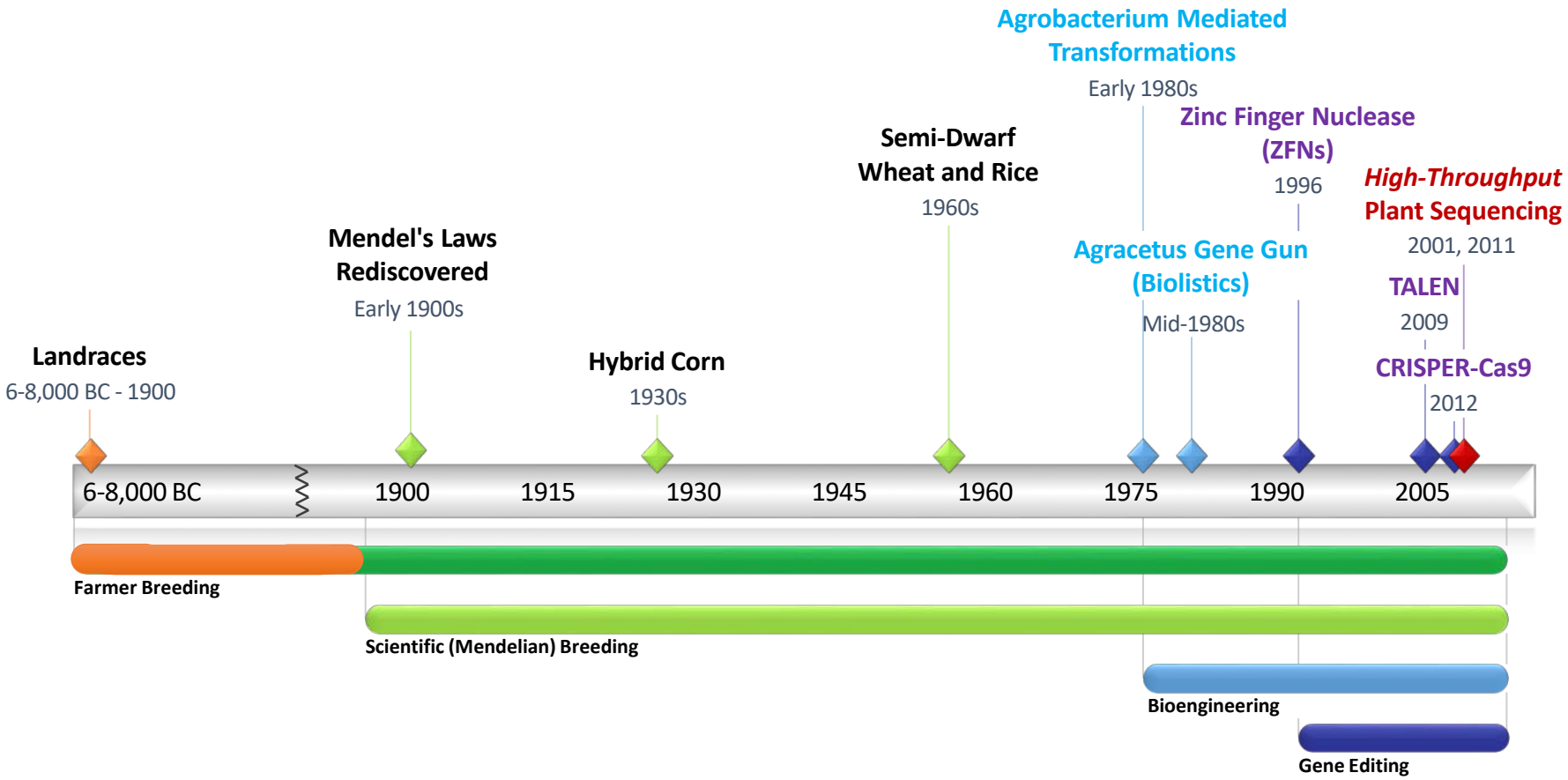
Option values being realized sometime in the future

CROP TRUST

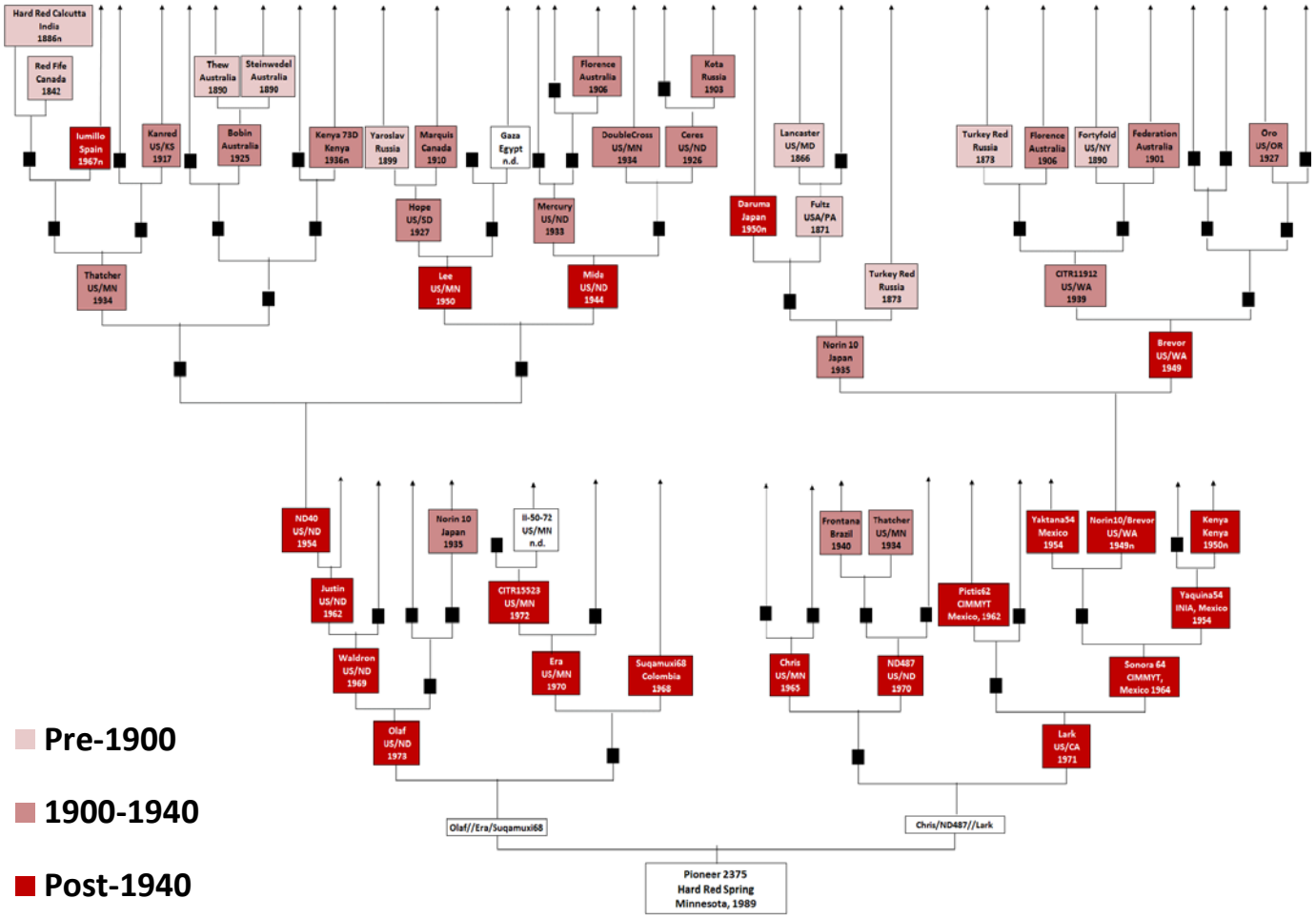
SECURING OUR FOOD FOREVER

USD 34 million a year to fund a global system for the conservation of crop diversity.

Timeline – Manipulation of Crop Genetics

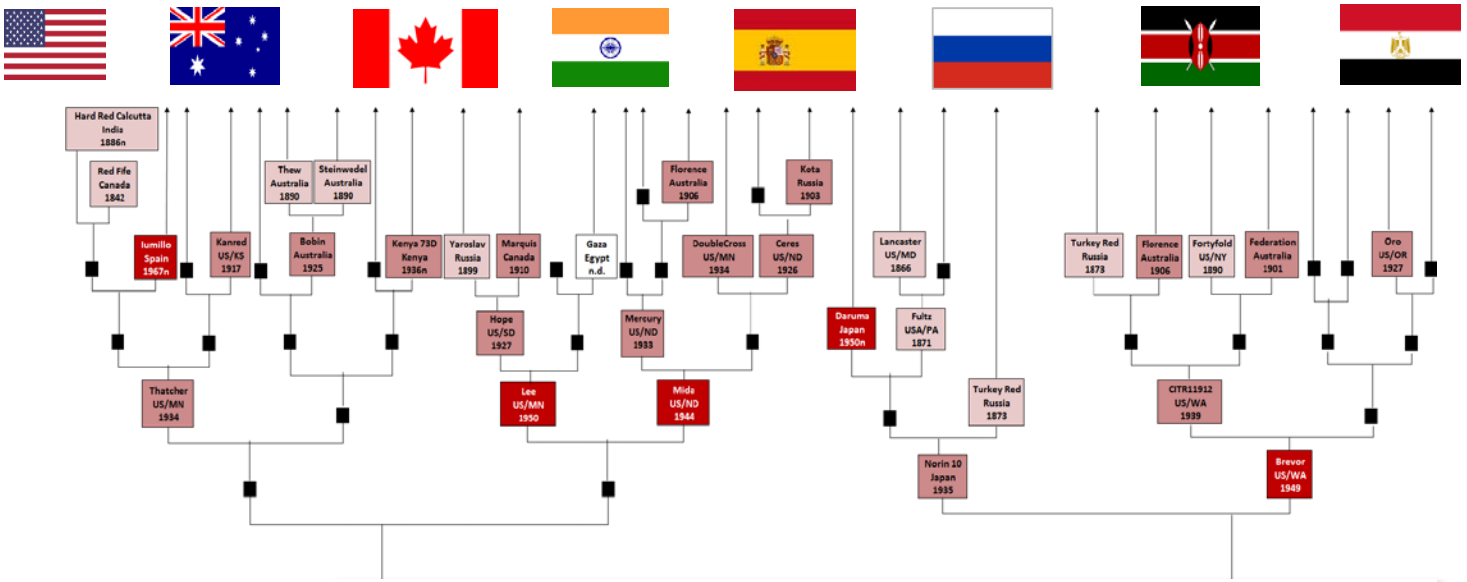


Attributing Value/Benefits (Benefit Sharing)



Pioneer 2375 (MN 1989, hard red spring wheat)

Attributing Value/Benefits (Benefit Sharing)



Wild Relatives

Farmer Bred (Landraces)

Scientifically (Mendelian) Bred

- Almost one-quarter of the 133 documented nodes in this pedigree developed or discovered prior to 1920 (60 years before release)
- Half the nodes predate 1960
- Agglomeration of material from distant nodes (5.3% from Minnesota)

Pre-1900

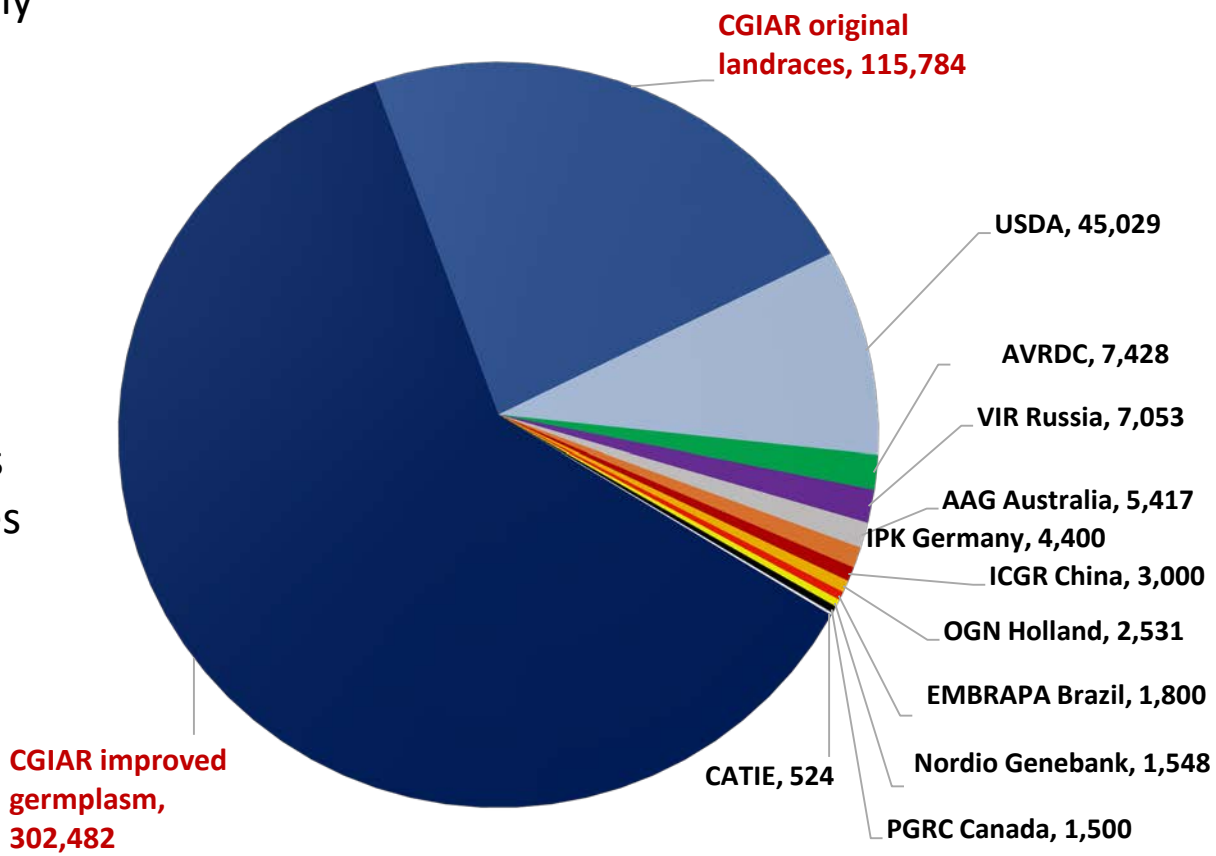
1900-1940

Post-1940

Pioneer 2375 (MN 1989, hard red spring wheat)

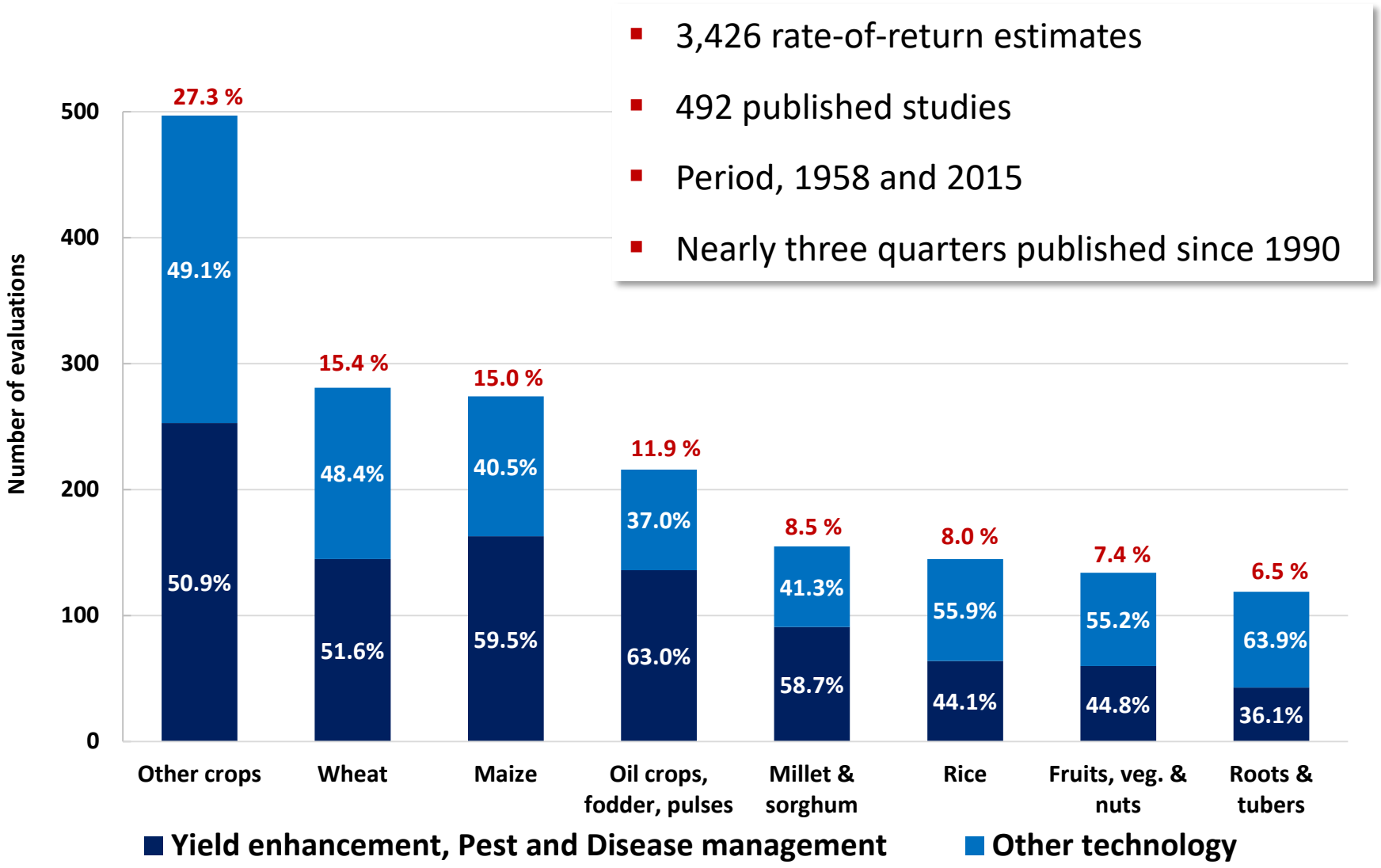
Sharing Seeds (annual average, 2008-2010)

- The CGIAR provides 80% of the germplasm exchanged globally by the public sector in the frame of the International Treaty on Plant Genetic Resources on Food and Agriculture.
- Over 80% of these samples went to developing countries and countries with economies in transition.



Prime facie evidence of use value, but…….

Genetic Resources—Use Value



Genetic Resources—Use Value

The returns on investment are large

- IRR (Internal rate of return) mean of 63.2 percent per year
- MIRR (Modified internal rate of return) mean of 14.3 percent per year
- BCR (Benefit cost ratio) mean of 27:1

Time structure of the returns to R&D

- The returns to contemporary R&D investments are as high as ever (no signs of a reduction in the returns to ag R&D over time)

Developed vs developing country returns

- Median reported IRR for developing countries (41.1%py) is greater than the median for developed countries (34.0%py).
- This difference must be taken with a grain of salt because of substantial developing- versus developed-country differences in the composition of the evaluation evidence such as who performed the evaluation, how it was performed and what was evaluated.

COMMENT

TECHNOLOGY The geeks and entrepreneurs of commercial space travel p.304 | ECOLOGY Trees, a lesson in standing tall by standing together p.306 | CHINA Sponge cities to retain run-off, control flooding, and reuse storm water p.307 | OBITUARY Seymour Papert, father of educational computing p.309

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A wheat test plot in Maryland.

Agricultural R&D is on the move

Big shifts in where research and development in food and agriculture is carried out will shape future g food production, write **Philip G. Pardey** and colle

The geographical distribution of food and agricultural research and development (AgR&D) is changing. Our analysis of more than 50 years of data indicates that the governments of middle-income nations are investing more than those of high-income ones for the first time in modern history. The numbers also suggest that, globally, private-sector spending on AgR&D is catching up with public-sector spending. Meanwhile, the gap between spending by high-income and low-income countries is widening.

Investments in R&D are inextricably intertwined with growth in agricultural productivity and food supplies[1]. But it takes decades[2], not months or years, for the consequences of these investments to be fully realized. Today's R&D investment decisions will cast shadows forward to 2050 and beyond, making the trends we report here especially significant for the future of food production.

DATA GATHERING

To track shifts in where AgR&D occurs worldwide, we revised and updated the various data series on spending maintained by the University of Minnesota's International Science and Technology Practice and Policy (InSTePP) Center in St Paul. Successive versions of these series have been developed over decades by collating and harmonizing data obtained from many government and international agencies, private firms and unpublished sources, and using statistical approaches developed to infer missing observations[3]. Our global update took 6 years, and involved direct input from more than 60 collaborators at national and international statistical and scientific agencies.

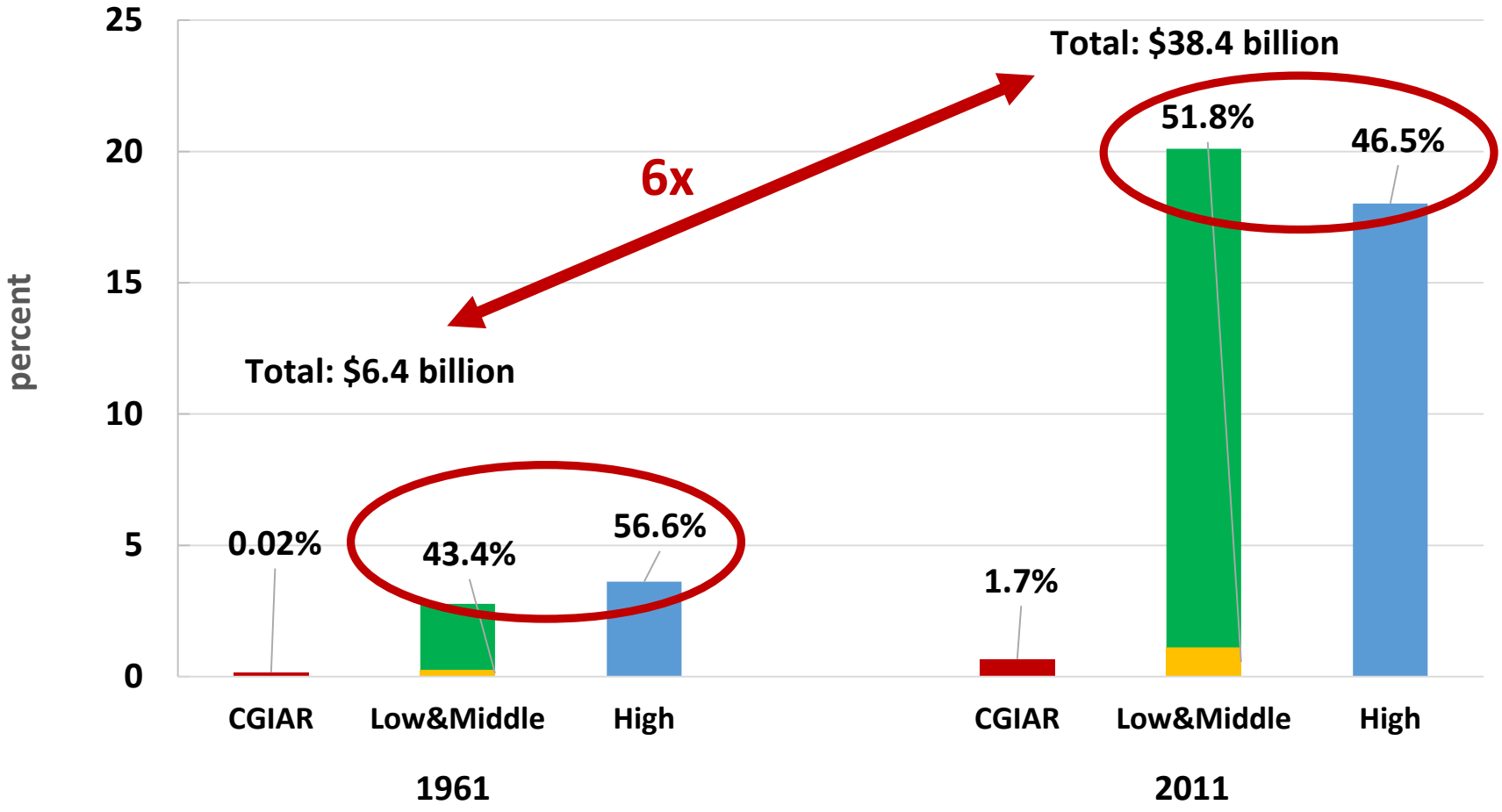
Extensive details on the construction of our data series are available online (see go.nature.com/2cc9t4b). In short, the data include new and revised estimates of the amount of AgR&D spending by universities and government agencies for 158 countries from 1960 to 2011. They also include new global estimates of the amount of such R&D spending by private firms for three decades, from 1980 to 2011. (All spending in local currency units was converted to

Nature

September 2016

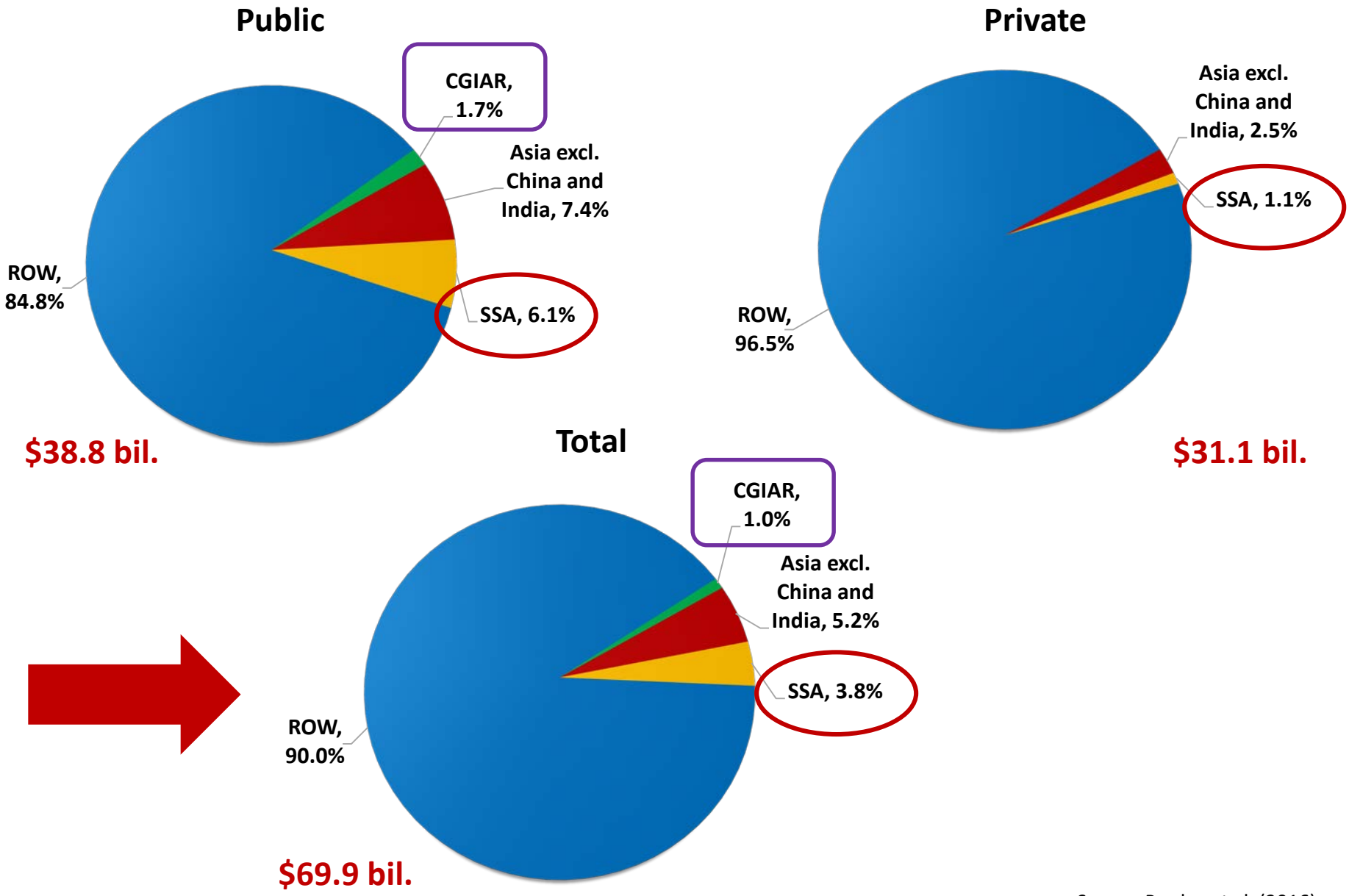
The Shifting (or Shifted!) Structure of Global Food & Agricultural R&D

Public Agricultural R&D Spending Worldwide, 1961 & 2011



Source: Pardey et al. (2016).

Spending Slices of the Global Ag & Food R&D Pie, 2011



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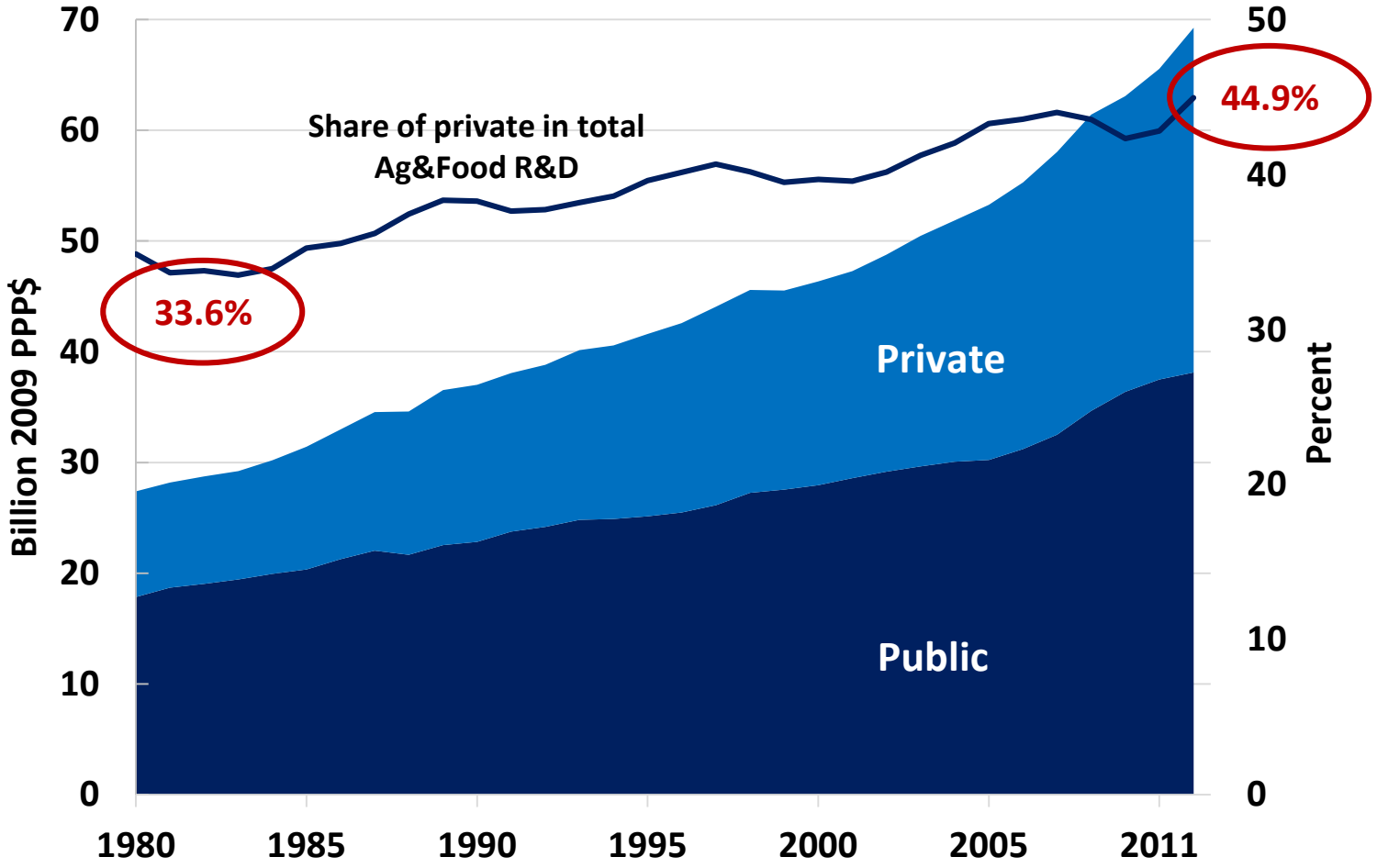
Rising Private Sector Participation



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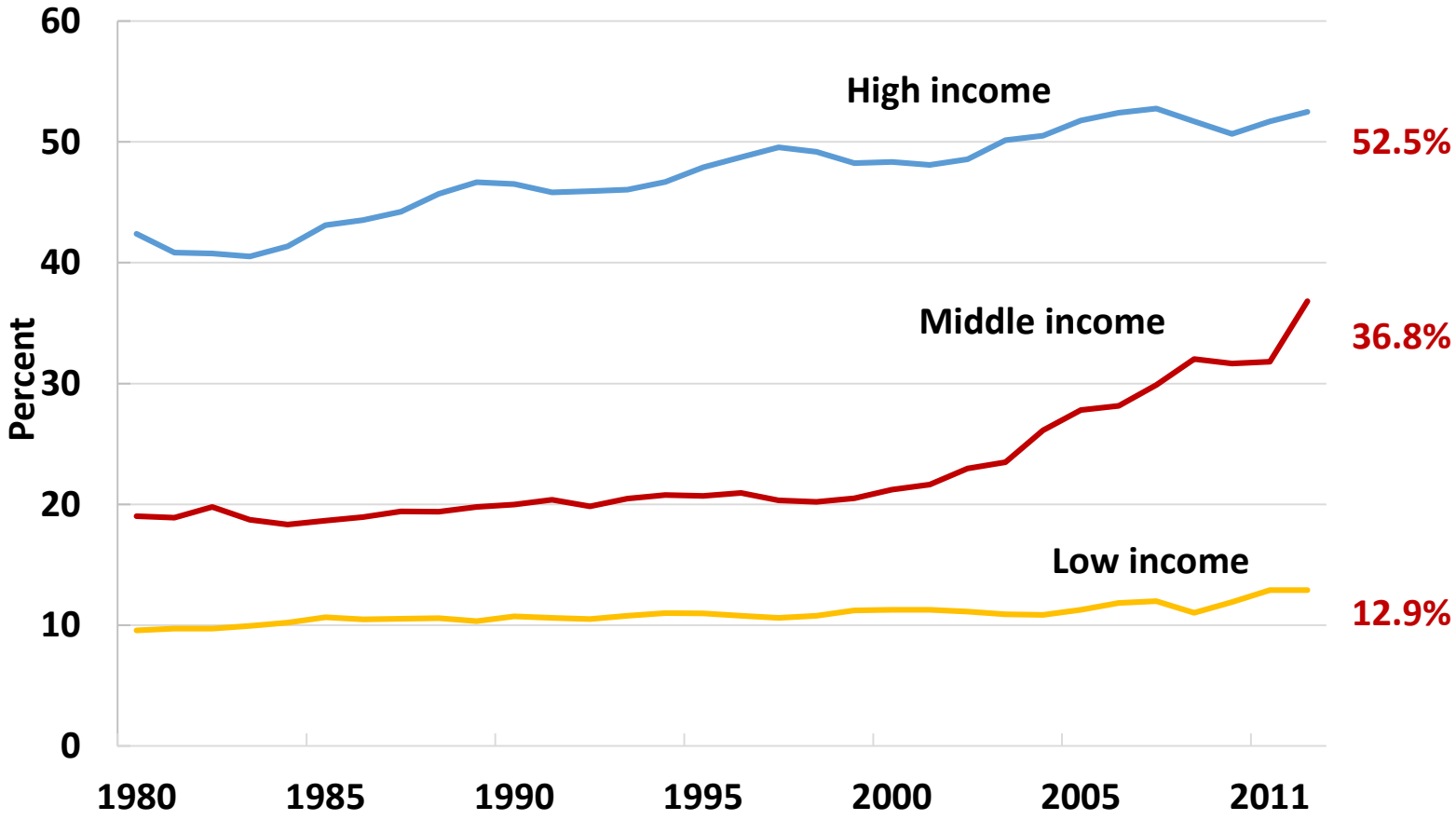
Private R&D to the (low-income country) Rescue?



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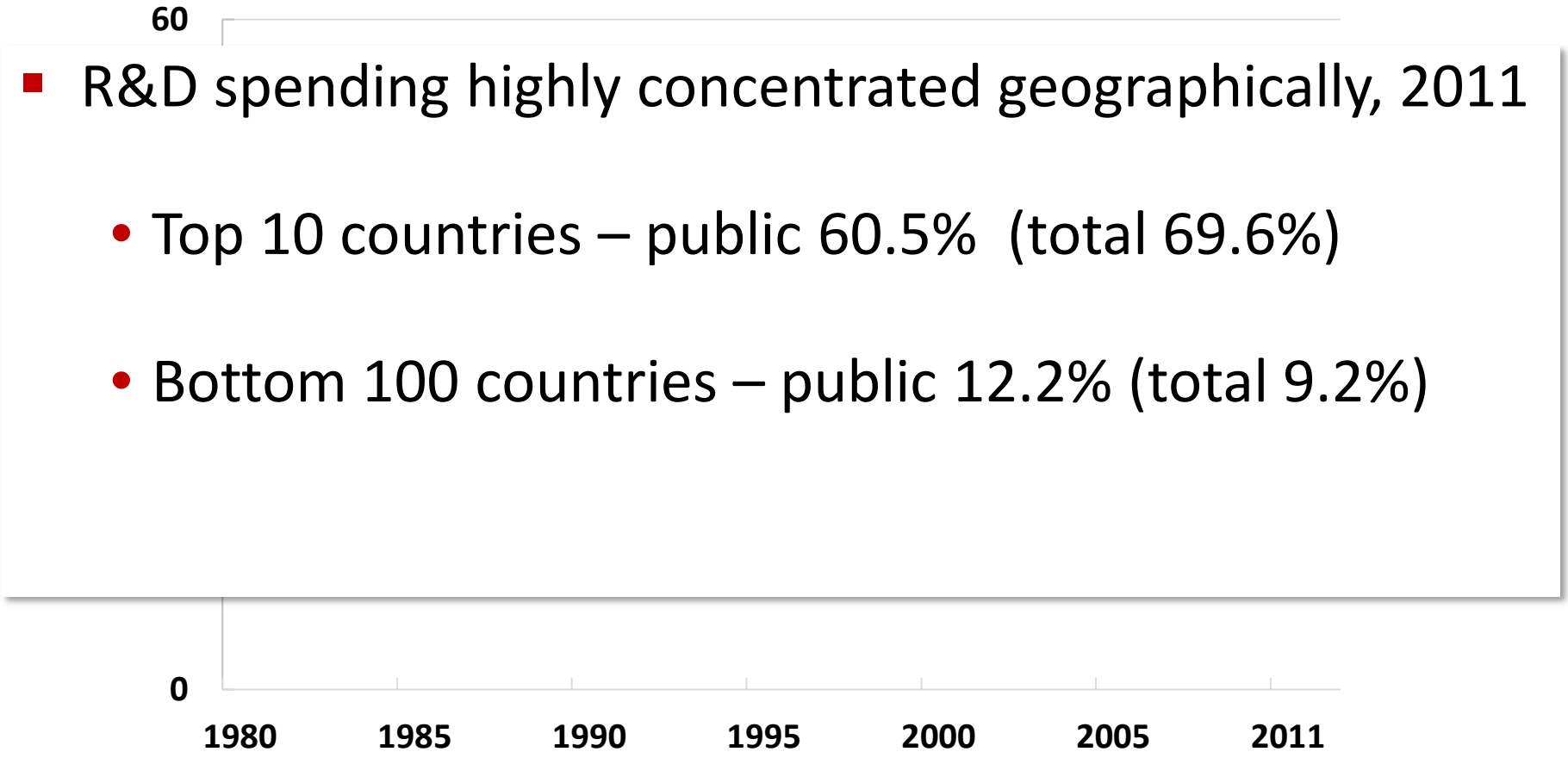
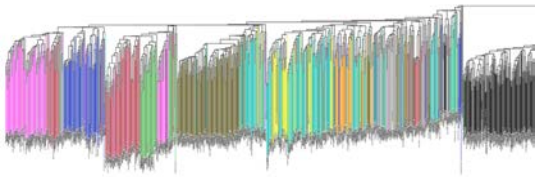


- R&D spending highly concentrated geographically, 2011
  - Top 10 countries – public 60.5% (total 69.6%)
  - Bottom 100 countries – public 12.2% (total 9.2%)

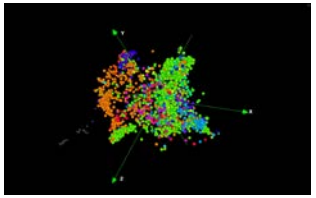
Rethinking the Value Proposition

From Genebank Accessions to Genes to Traits

DARTseq: A generic genotyping by sequencing platform routinely applied to hundreds of crops species as well as animals and microbes



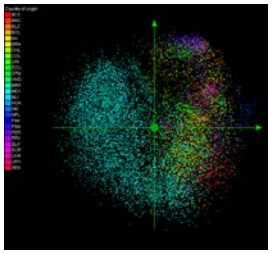
>5,000 sweet potato accessions (CIP)



>30,000 maize accessions (CIMMYT)

>60,000 maize accessions (CIMMYT)

Seeds of Discovery



>4,000 cassava accessions (CIAT)

Most of WorldFish's organisms

Rethinking the Value Proposition

Genetic Value Chains

- **Accelerate** gene/trait discovery
- **Expand the scope** of gene/trait discovery
  - Yield enhancing
  - Yield preserving (biotic and abiotic stresses)
  - Quality improving
- Better **targeting** of technology deployment

Rethinking the Value Proposition

Genetic Value Chains

- Requires an **INTEGRATED** and ***informatics-enabled*** approach to genetic curation, gene sequencing, gene discovery, and gene deployment

- **For the first time in history,** the technical capabilities are now available, but need to be deployed, along with
  - Institutional innovations
    - Genetic value chains
      - Breakdown the genebank-breeding divides
      - Leverage public-private opportunities
    - Geographical spillovers
  - Investment innovations—aligning incentives, benefits and costs
    - Programmatic approaches
    - Pre-commercial public-private R&D

Thanks

www.instepp.umn.edu