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BioVisionAlexandria 2010

New Life Sciences: *Future Prospects*

A Celebration of the Life of Norman Borlaug

April 14, 2010

Co-organized with the Norman Borlaug Institute for Crop Improvement

chair: Prof. Malcolm Elliott

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em. Prof. Dr. Klaus Ammann, University of Berne, Switzerland

Biodiversity and Biotechnology: Against Myths and for the Good News as an Hommage to Norman Borlaug

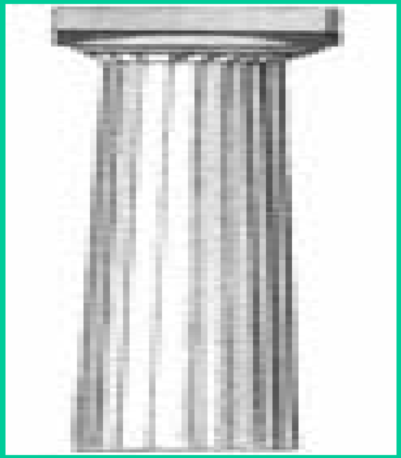
- **Myths about transgenesis and monocultures**
- **Agricultural eco-systems are very dynamic**
- **Myths about centers of (crop)-biodiversity**
- **Main topic of the lecture: Biotechnology contributes to biodiversity**

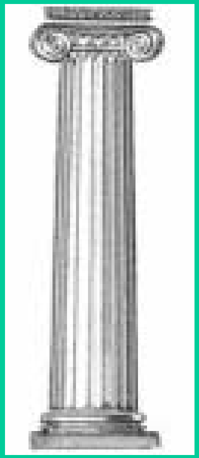
Last words from Norman Borlaug

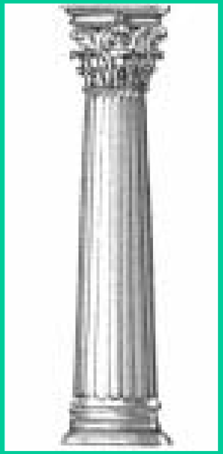
before we can build
a sustainable world,
we must

1. redefine sustainability
   and
2. free agriculture
   from ideology and myth

Sustainable World







Agriculture

Foster renewable natural resources, knowledge based agriculture: Organic Precision Biotech Ag, Balance local production with global trade

Socio-Economics

Equity: reconcile traditional knowledge with science, foster biomimetics, reduce agricultural subsidies, global dialogue including new creative capitalism

Technologies

Innovation supported by artificial intelligence, influence evolution, new technologies to process and use of housing, food, energy

What is needed is a serious reevaluation of the existing regulatory framework in the light of accumulated evidence and experience.
An authoritative assessment of existing data on GM crop safety is timely and should encompass protein safety, gene stability, acute toxicity, composition, nutritional value, allergenicity, gene flow, and effects on nontarget organisms.

Fedoroff, N.V., Battisti, D.S., Beachy, R.N., Cooper, P.J.M., Fischhoff, D.A., Hodges, C.N., Knauf, V.C., Lobell, D., Mazur, B.J., Molden, D., Reynolds, M.P., Ronald, P.C., Rosegrant, M.W., Sanchez, P.A., Vonshak, A., & Zhu, J.-K.
Radically Rethinking Agriculture for the 21st Century. Science, 327, 5967, pp 833-834
Podcast http://www.sciencemag.org/cgi/content/full/sci;327/5967/833/DC1 AND
http://www.botanischergarten.ch/Regulation/Fedorof-Radically-Rethinking-2010.pdf

Molecular processes
in Genetic Engineering
and Natural Mutation:

there is no difference

Werner Arber, Nobel Laureate 1978:

Interestingly, naturally occurring molecular evolution, i.e. the spontaneous generation of genetic variants has been seen to follow exactly the same three strategies as those used in genetic engineering14. These three strategies are:

(a) small local changes in the nucleotide sequences,
(b) internal reshuffling of genomic DNA segments, and
(c) acquisition of usually rather small segments of DNA
from another type of organism by horizontal gene transfer.

Arber, W. (2002)
Roots, strategies and prospects of functional genomics. Current Science, 83, 7, pp 826-828
http://www.botanischergarten.ch/Mutations/Arber-Comparison-2002.pdf

Arber, W. (2002)
Roots, strategies and prospects of functional genomics. Current Science, 83, 7, pp 826-828
http://www.botanischergarten.ch/Mutations/Arber-Comparison-2002.pdf

However, there is a principal difference between the procedures of genetic engineering and those serving in nature for biological evolution. While the genetic engineer pre-reflects his alteration and verifies its results, nature places its genetic variations more randomly and largely independent of an identified goal.
And after ca. 10 years of safety assessment transgenic crops are distributed to the millions in a short time.

Arber, W. (2002)
Roots, strategies and prospects of functional genomics. Current Science, 83, 7, pp 826-828
http://www.botanischergarten.ch/Mutations/Arber-Comparison-2002.pdf

Arber, W. (2002)
Roots, strategies and prospects of functional genomics. Current Science, 83, 7, pp 826-828
http://www.botanischergarten.ch/Mutations/Arber-Comparison-2002.pdf

Erroneous genomic concepts of organic farming

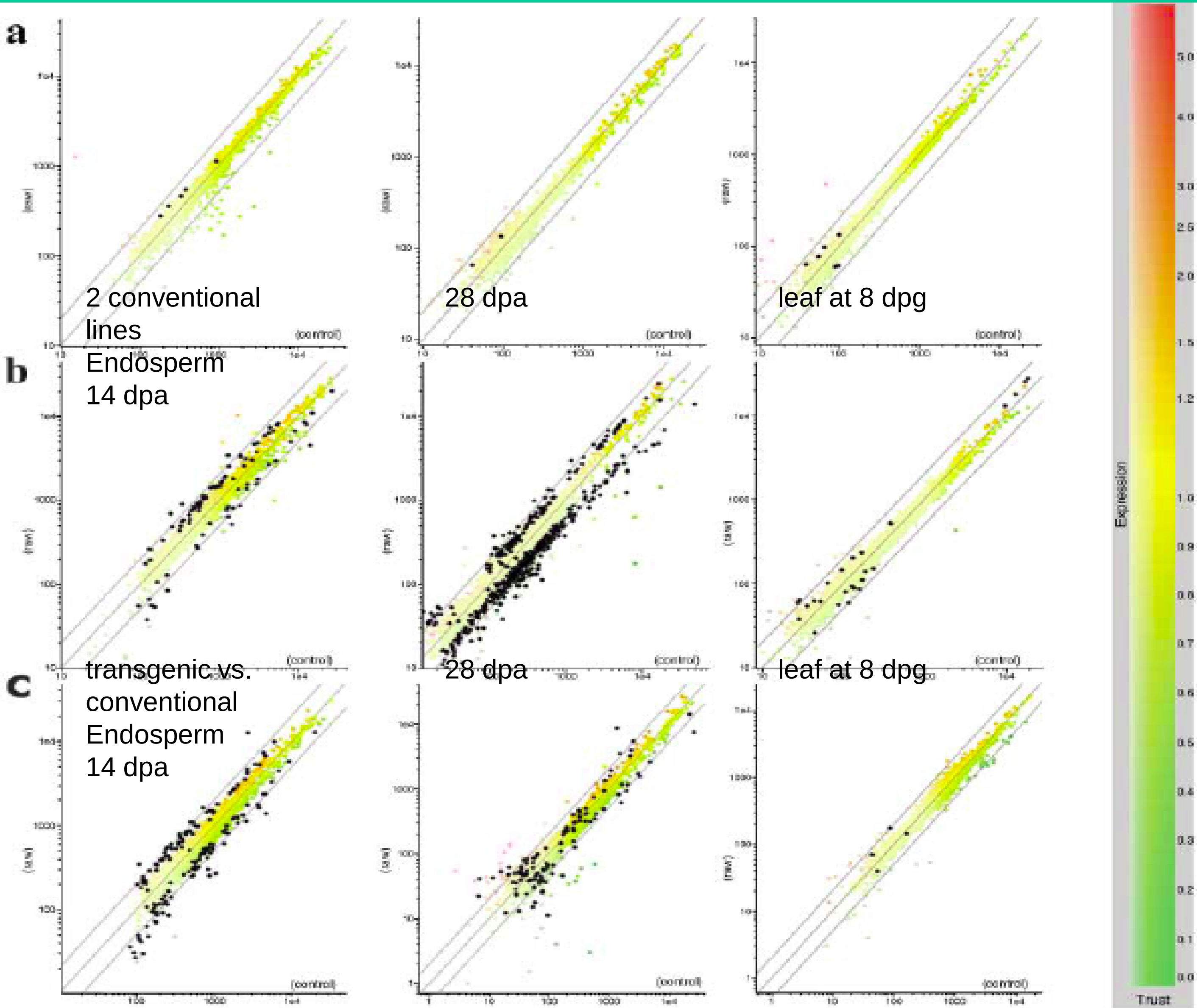
Concepts of Intrinsic Value and Integrity of Plants in Organic Plant Breeding and Propagation

E. T. Lammerts van Bueren,* P. C. Struik, M. Tiemens-Hulscher, and E. Jacobsen

van Bueren, E.T.L., Struik, P.C., Tiemens-Hulscher, M., & Jacobsen, E. (2003)
Concepts of intrinsic value and integrity of plants in organic plant breeding and propagation.
Crop Science, 43, 6, pp 1922-1929
http://www.botanischergarten.ch/Organic/van-Bueren-Organicbreeding.pdf

The natural approach taken by organic agriculture obviates the use of synthetic agrochemicals and emphasizes farming in accordance with agroecological principles. Also implicit in this approach is an appreciation for the *integrity* of living farm organisms, with the integrity being evaluated from a biocentric perspective. The ethical value assigned to integrity of organisms has challenged us to develop criteria for evaluating both integrity and breeding techniques. For cultivated plants, integrity refers to their inherent nature, their wholeness, completeness, species-specific characteristics, and their being in balance with their (organically farmed) environment. We evaluate integrity using criteria derived from four different perspectives: integrity of life, plant-specific integrity, genotypic integrity, and phenotypic integrity.

Transgenic crops show less genomic disturbance than conventional traits



Baudo, M.M., Lyons, R., Powers, S., Pastori, G.M., Edwards, K.J., Holdsworth, M.J., & Shewry, P.R. (2006)
Transgenesis Has Less Impact on the Transcriptome of Wheat Grain Than Conventional Breeding.
Plant Biotechnology Journal, 4, 4, pp 369-380
http://www.botanischergarten.ch/Organic/Baudo-Impact-2006.pdf

Shewry, P.R. & Jones, H.D. (2005)
Transgenic Wheat: Where Do We Stand after the First 12 Years? Annals of Applied Biology, 147, 1, pp 1-14
http://www.botanischergarten.ch/Organic/Shewry-Performance-2006.pdf

Baudo: comparison in genomic disturbance: GM crops are less disturbed (black dots) than classic bree

Radiation Mutation Breeding for all Durum Wheat, also the Raw Material of Pasta

Gamma Field for radiation breeding

100m radius

89 TBq Co-60 source at the center Shielding dike 8m high

Institute of Radiation Breeding
Ibaraki-ken, JAPAN
http://www.irb.affrc.go.jp/

Better spaghettis, whisky

1800 new plants

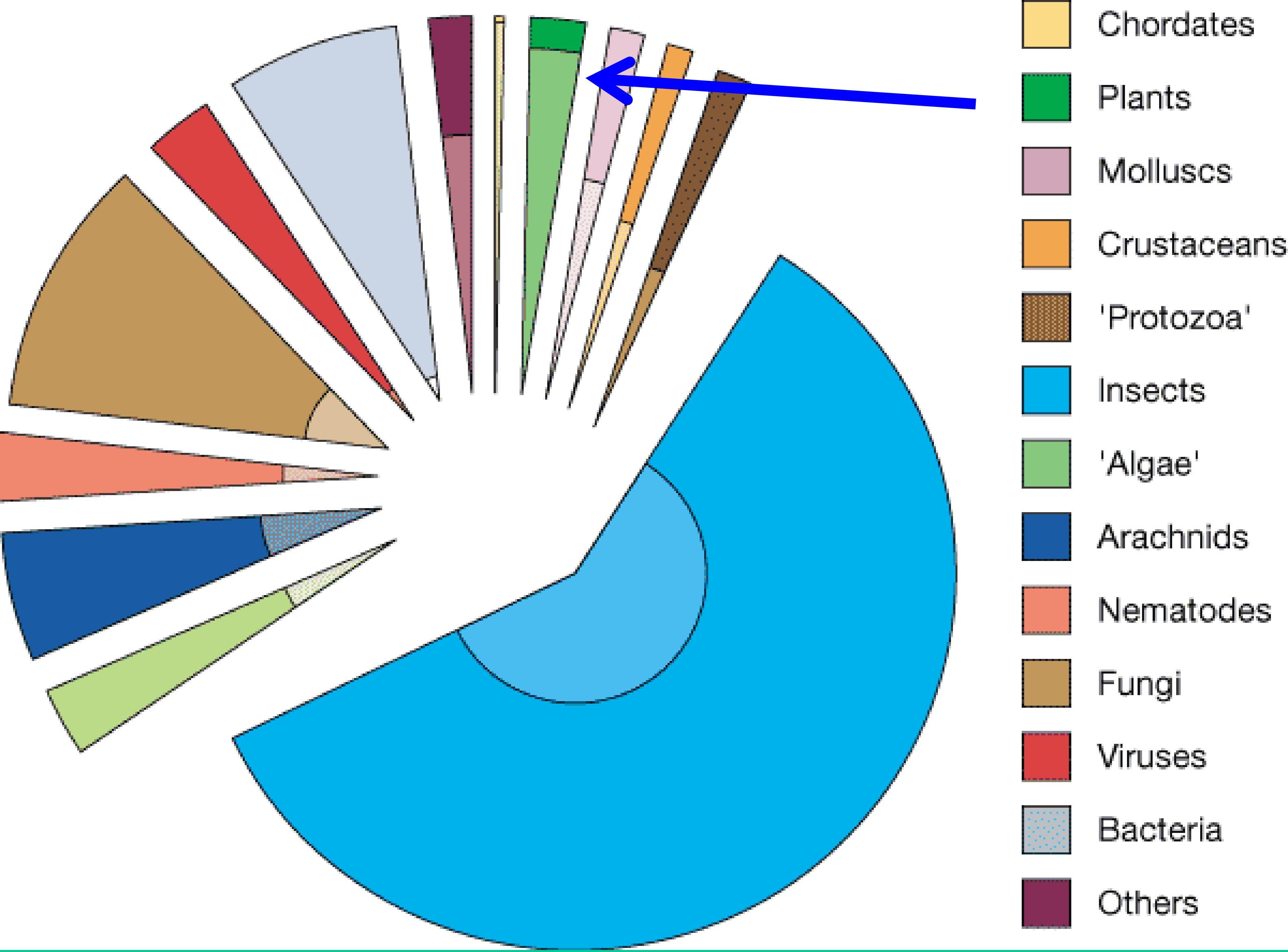
Scott Pollock

Real Frankenfood

Worldwide:

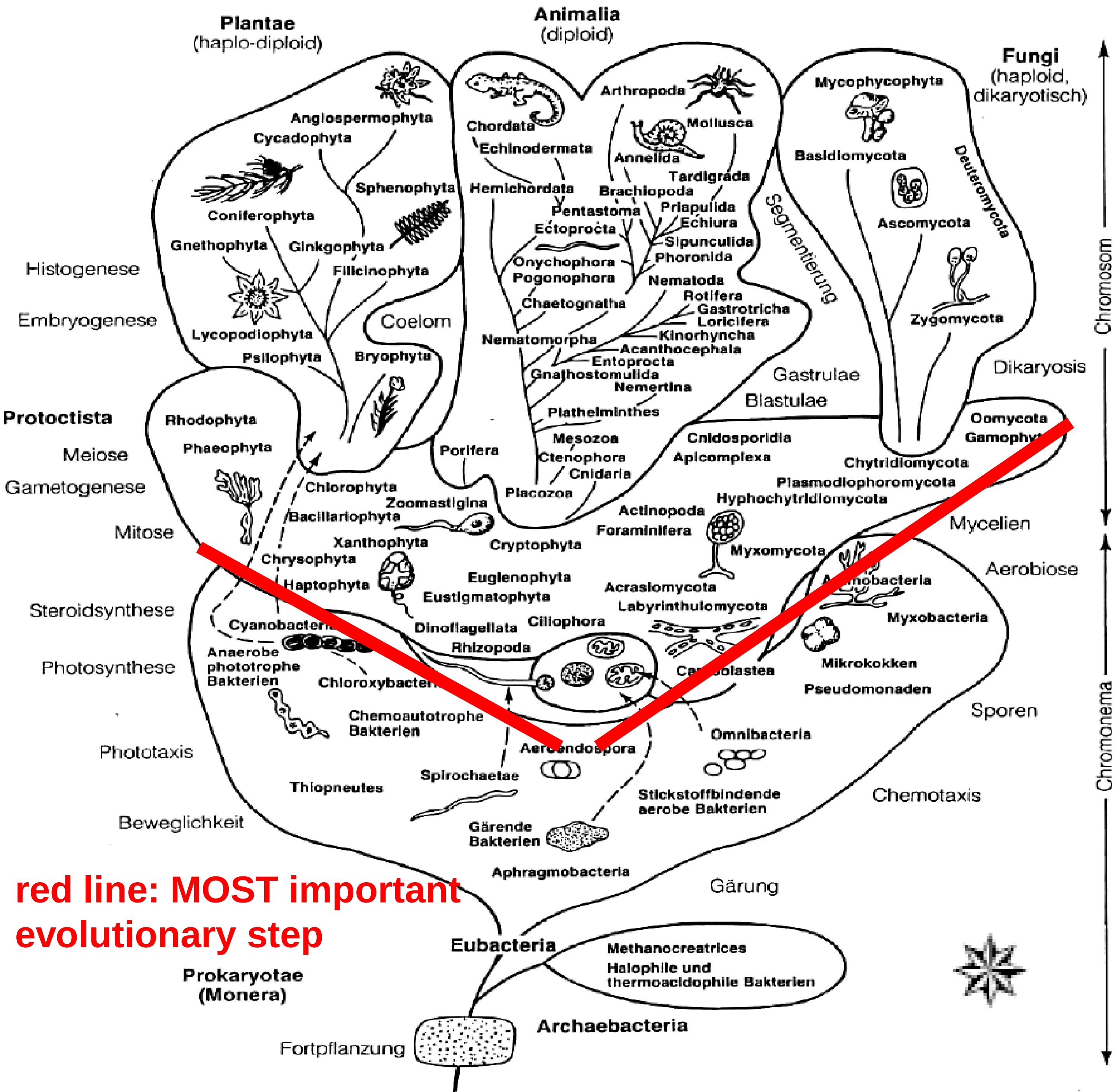
all pasta is made from
radiation mutated
durum wheat
Triticum durum

1.3. Distribution of species



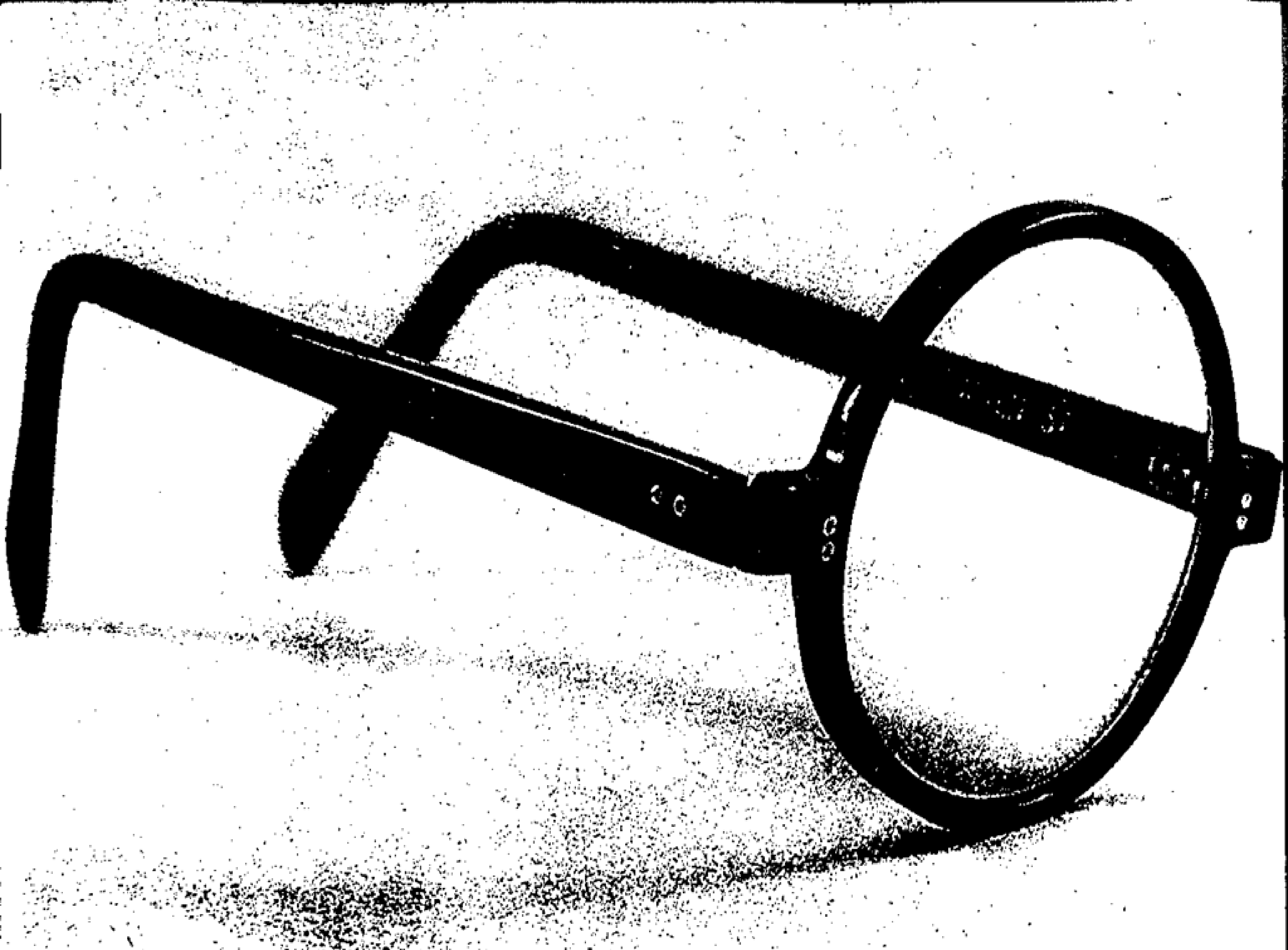
Nature Insight Biodiversity: Species richness in major groups of organisms
Purvis, A. & Hector, A. (2000)
Getting the measure of biodiversity. Nature, 405, 6783, pp 212-219
http://www.botanischergarten.ch/biodiversity/Purvis-Nature-Biodiv-Measure-2000.pdf

Evolution in perspective of the cell



Margulis, L. (1992) BIODIVERSITY - MOLECULAR BIOLOGICAL DOMAINS, SYMBIOSIS AND KINGDOM ORIGINS.

Biosystems, 27, 1, pp 39-51



Monocle: onesided views should not be accepted

Natures Crop Fields

cereals often grow in monodominant populations

barley, rice, wheat, sorghum were choosen by first farmers for their simple natural models

Wood, D. & Lenne, J. (2001)
Nature's fields: a neglected model for increasing food production. Outlook on Agriculture, 30, 3, pp 161-170
http://www.botanischergarten.ch/Organic/Wood-Natures-Fields-2001.pdf

Nature's fields: a neglected model for increasing food production

D. Wood and J. Lenné

D. Wood is based in ICRISAT in Andhra Pradesh, India. J. Lenné is Deputy Director General — Research, ICRISAT, Patancheru 502 324, Andhra Pradesh, India. E-mail: j.lenne@cgiar.org.

Dr D. Wood is an independent consultant specializing in genetic resource policy and ecological approaches to agriculture. He was formerly botanist at the East Africa Herbarium, Nairobi; lecturer in ecology in the University of the West Indies, Trinidad; Director of the Royal Society Research Station, Aldabra Atoll; plant explorer in Ethiopia and Yemen; and Head of the Genetic Resource Unit in CIAT, Colombia. Dr J. Lenné is the Deputy Director General — Research, International Crops Research Institute for the Semi-Arid Tropics and Visiting Professor of Agrobiodiversity at the University of Greenwich. She was formerly Programme Leader — Strategy for DFID Crop Protection Programme; Director, Crop Protection Division, ICRISAT, India; and Principal Plant Pathologist, CIAT, Colombia. Both authors have recently edited a book on Agrobiodiversity for CAB International.

Natural ecosystems can offer attractive models for sustainable crop production, but hitherto only relatively complex vegetation has been considered. This review focuses on simple vegetation with a single dominant species. There are many reports of wild relatives of rice, sorghum and wheat in simple, extensive, often annual and apparently stable natural stands. These 'wild fields' could provide appropriate models for the ecologically sound management of cereal fields. The authors suggest that early farmers had a working knowledge of the ecology of wild cereal vegetation: this was important during cereal domestication and subsequently in crop management. There is a need for field research on monodominant wild cereal vegetation to confirm the value of simple natural models and to provide an ecological pedigree for the sustainable management of fields for food production.

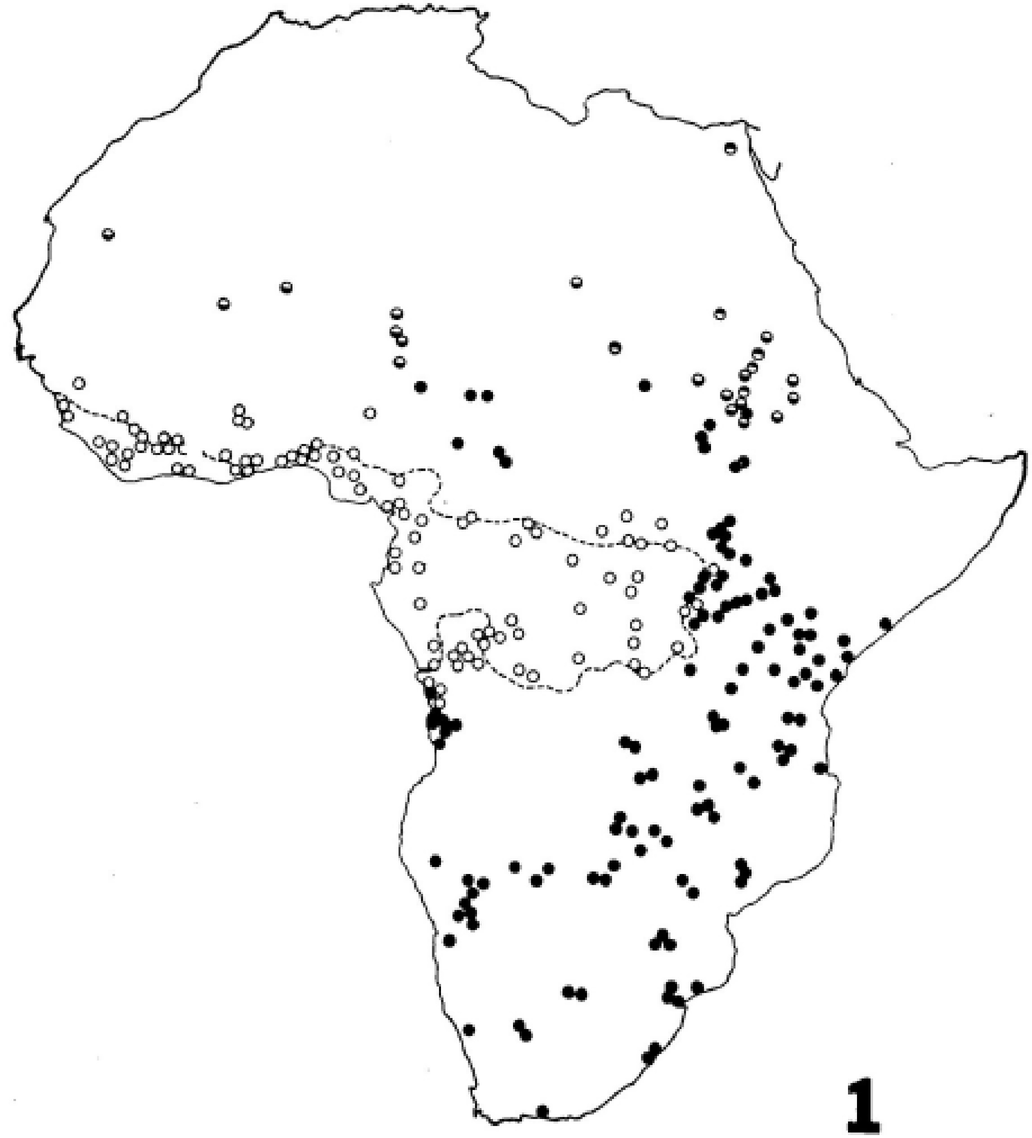


Fig. 1. Distribution of the wild varieties of *Sorghum bicolor*: var. *aethiopicum* ◐ ; var. *arundinaceum* ○ ; var. *verticilliflorum* ● ; var. *virgatum* ◑ . Each dot represents a collection.

Fig. 72 Distribution of the wild varieties of *Sorghum bicolor*, original caption from (De Wet et al., 1970) caption see above. See the full list of the taxa in the previous figure. The wild varieties in this map comprise *Sorghum* race *aethiopicum*, *arundinaceum*, *verticilliflorum* and *virgatum*.

Sorghum verticilliflorum in Western Africa:

Extensive areas with monospecies fields of wild sorghum

De Wet, J.M.J., Harlan, J.R., & Price, E.G. (1970)
Origin of Variability in Spontanea Complex of Sorghum Bicolor. American Journal of Botany, 57, 6, pp 704-&
http://www.botanischergarten.ch/Africa-Harvest-Sorghum-Lit-1/DeWet-bicolor-variability-1970.pdf

The concequences: we should forget about the sterile ideological warfare on organic farming versus high tech farming. Lets integrate those two agricultural strategies for the benefit of all farmers

Ammann, K. (2008)
Feature: Integrated farming: Why organic farmers should use transgenic crops. New Biotechnology, 25, 2, pp 101 - 107
http://www.botanischergarten.ch/NewBiotech/Ammann-Integrated-Farming-Organic-2008.publ.pdf

Ammann, K. (2009)
Feature: Why farming with high tech methods should integrate elements of organic agriculture. New Biotechnology, 25, 6, pp 378-388
http://www.botanischergarten.ch/Organic/Ammann-High-Tech-and-Organic-2009.pdf

deRenobales-Scheifler, M. (2009)
More sustainable food: Genetically modified seeds in organic farming Junta General del Principado de Asturias Sociedad Internacional de Bioética (SIBI), Gijon, Basque, Spain, pp 119
http://www.sibi.org/ingles/jgp/p2009.htm English, AND http://www.sibi.org/jgp/p2009.htm Spanish AND http://www.botanischergarten.ch/Organic/DeRenobales-Scheifler-GM-Seeds-Organic-2009.pdf AND http://www.araba.ehu.es/p208-content/eu/contenidos/noticia/20100211_mertxe_renobales/eu_np/20100211_mertxe_renobales.html

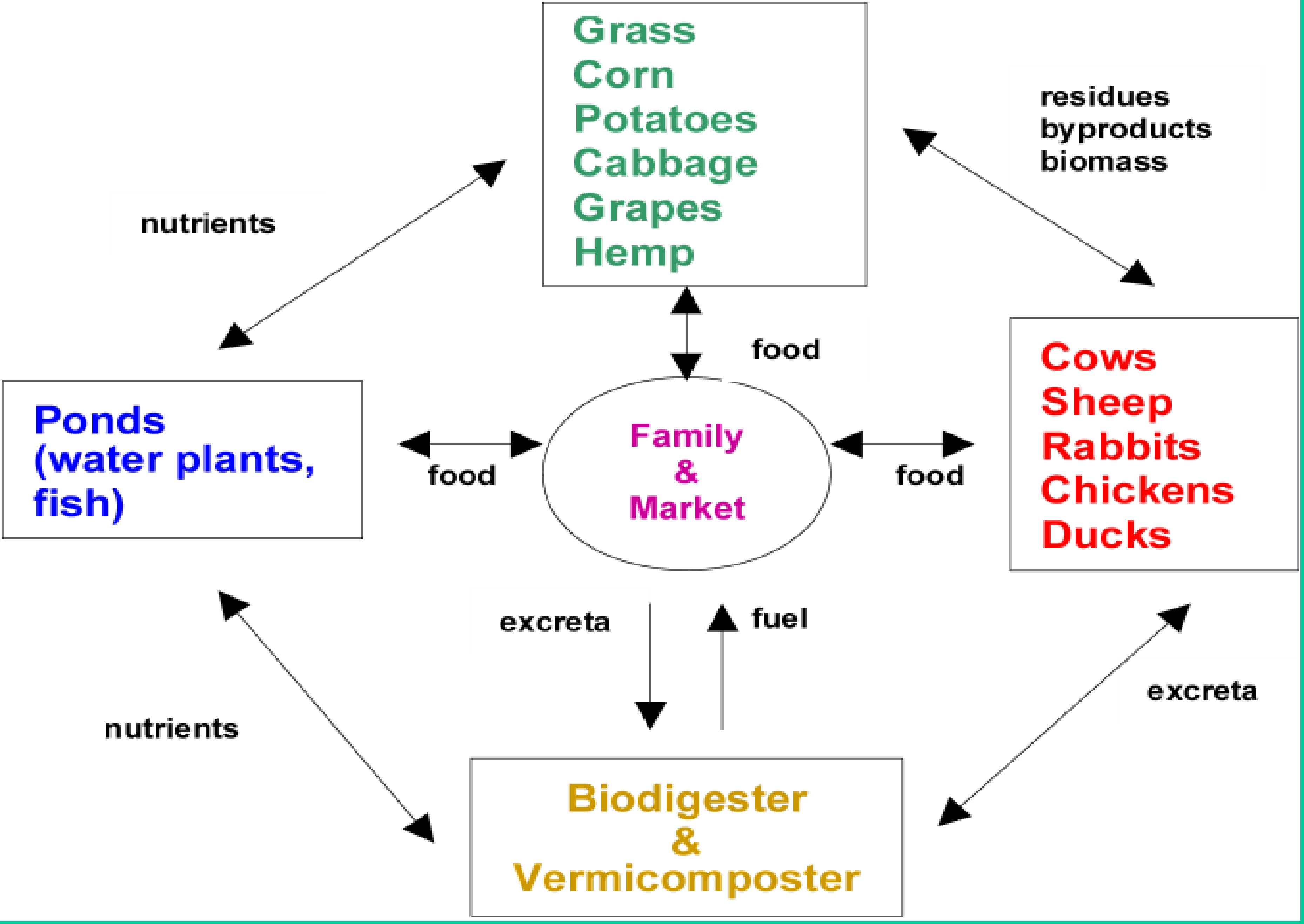
Ammann, K. (2008)
Feature: Integrated farming: Why organic farmers should use transgenic crops. New Biotechnology, 25, 2, pp 101 - 107
http://www.botanischergarten.ch/NewBiotech/Ammann-Integrated-Farming-Organic-2008.publ.pdf

Ammann, K. (2009)
Feature: Why farming with high tech methods should integrate elements of organic agriculture. New Biotechnology, 25, 6, pp 378-388
http://www.botanischergarten.ch/Organic/Ammann-High-Tech-and-Organic-2009.pdf

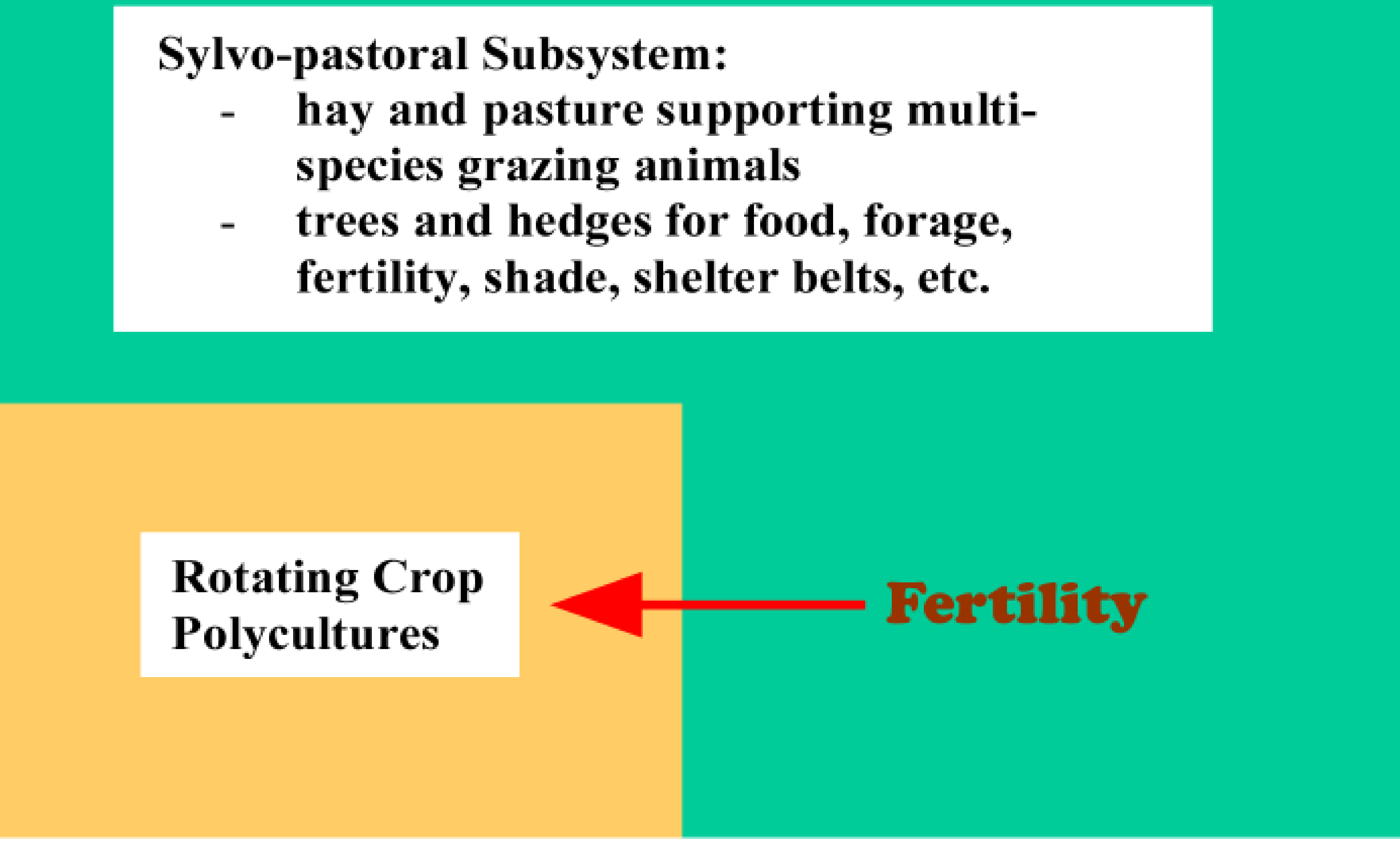
Bauer de Jonghe in Holland, produziert Gemüse im Bio-Standard ohne Pestizide
Foto Claus Lange, Text Michael Miersch Weltwoche 06 2003

Old Order Amish Farmer in Lancaster, Penssylvania

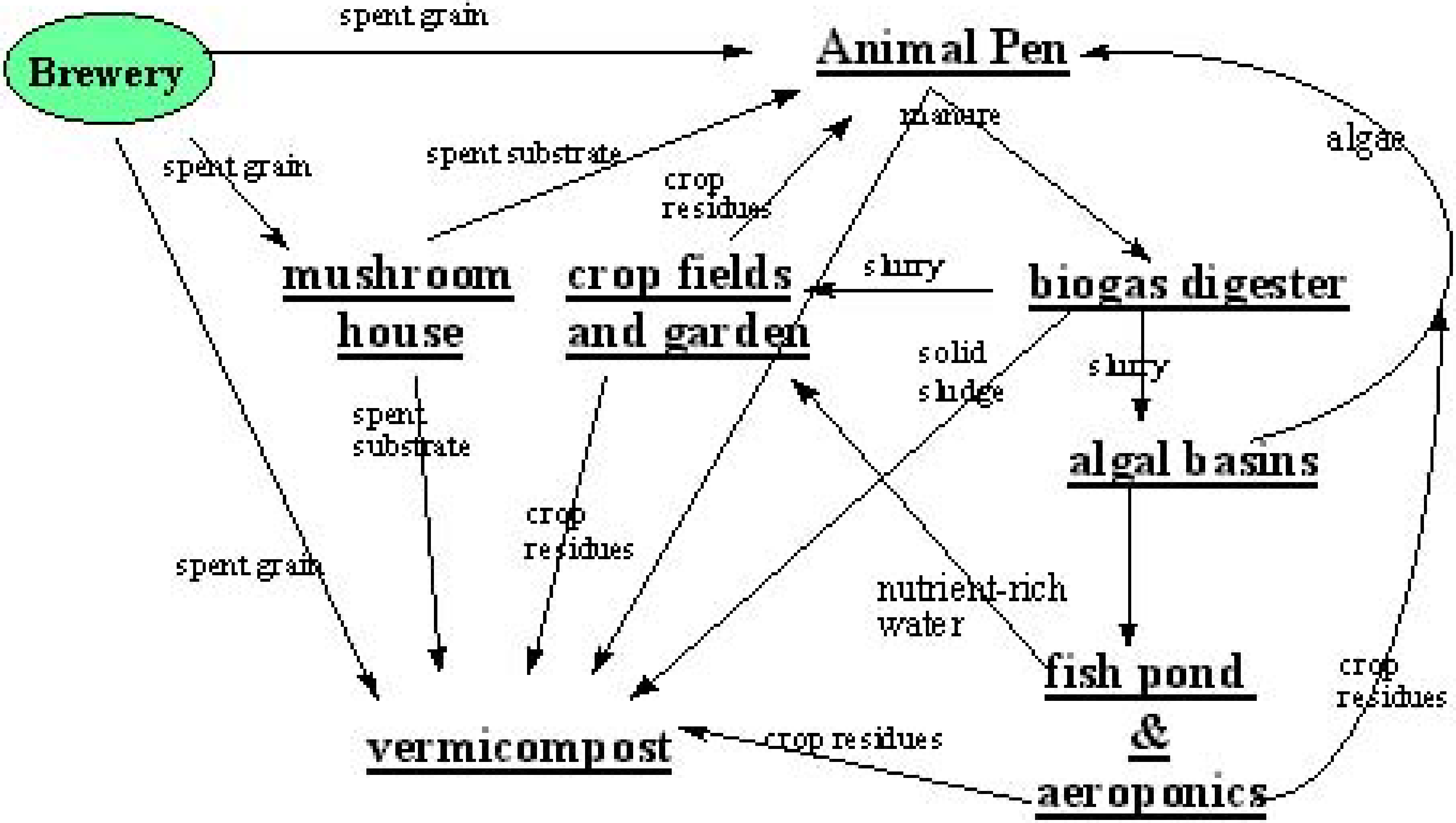
Agricultural eco-systems are very dynamic, contrary to natural ecosystems, evolving on a slower pace



tclocal.org/2009/09/visioning_county_food_2.html



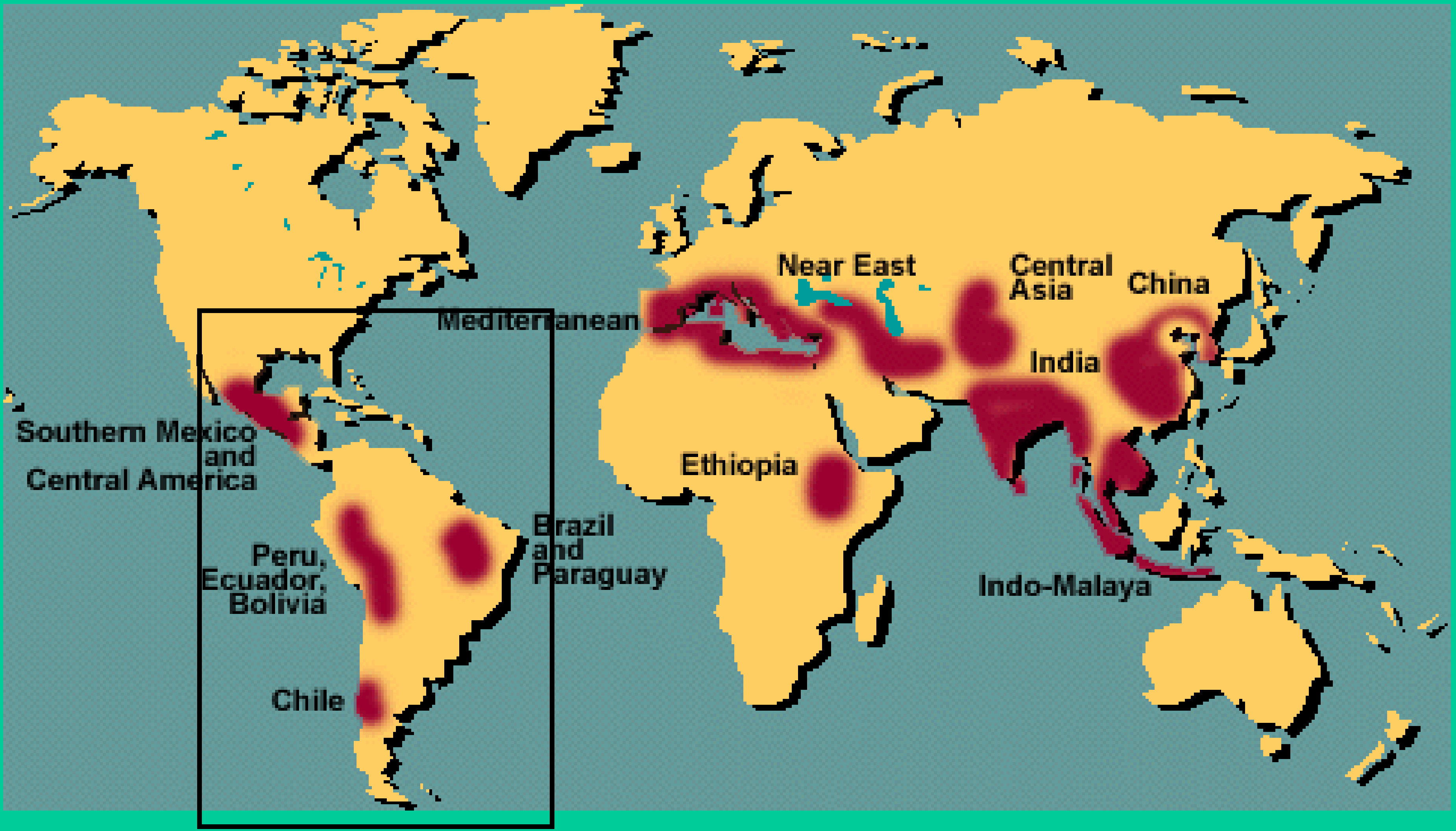
tclocal.org/2009/09/visioning_county_food_2.html



tclocal.org/2009/09/visioning_county_food_2.html

Myths about centers of (crop)-biodiversity 1

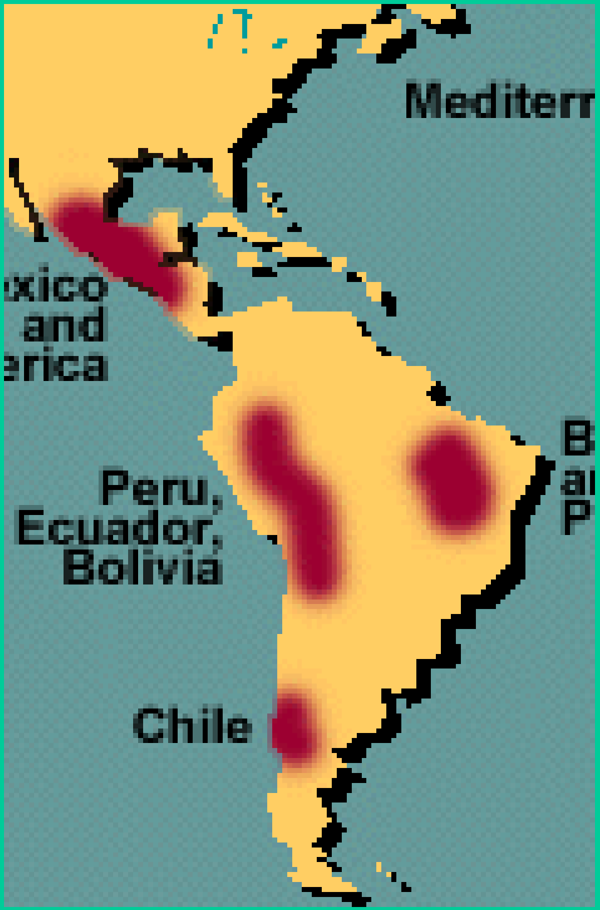
Centers of origin not more susceptible to invasive disturbance



Vavilov Centers of Crop Diversity

14. Vavilov, N.I. 1949. *Chronica Botanica: An International Collection of Studies in the Method and History of Biology and Agriculture*. Vol. 13. Waltham, MA

Vavilovs Cente



Vavilov
Crop Centers

Greenpeace report
Crop Centers

World Conservation Monitoring Center
Biodiversity Centers

No clear definition of crop biodiversity centers

Plant species richness, still a matter of debate

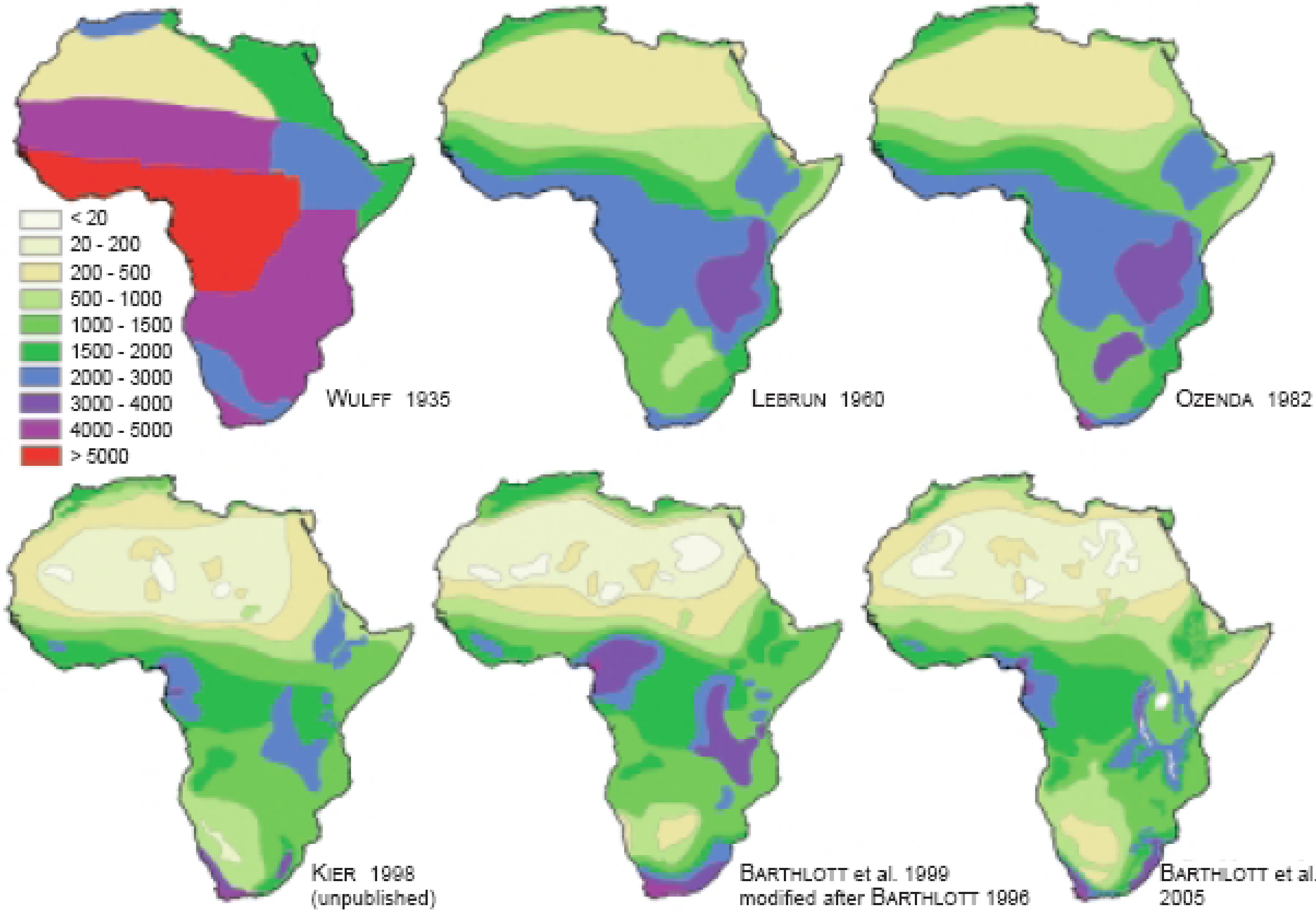
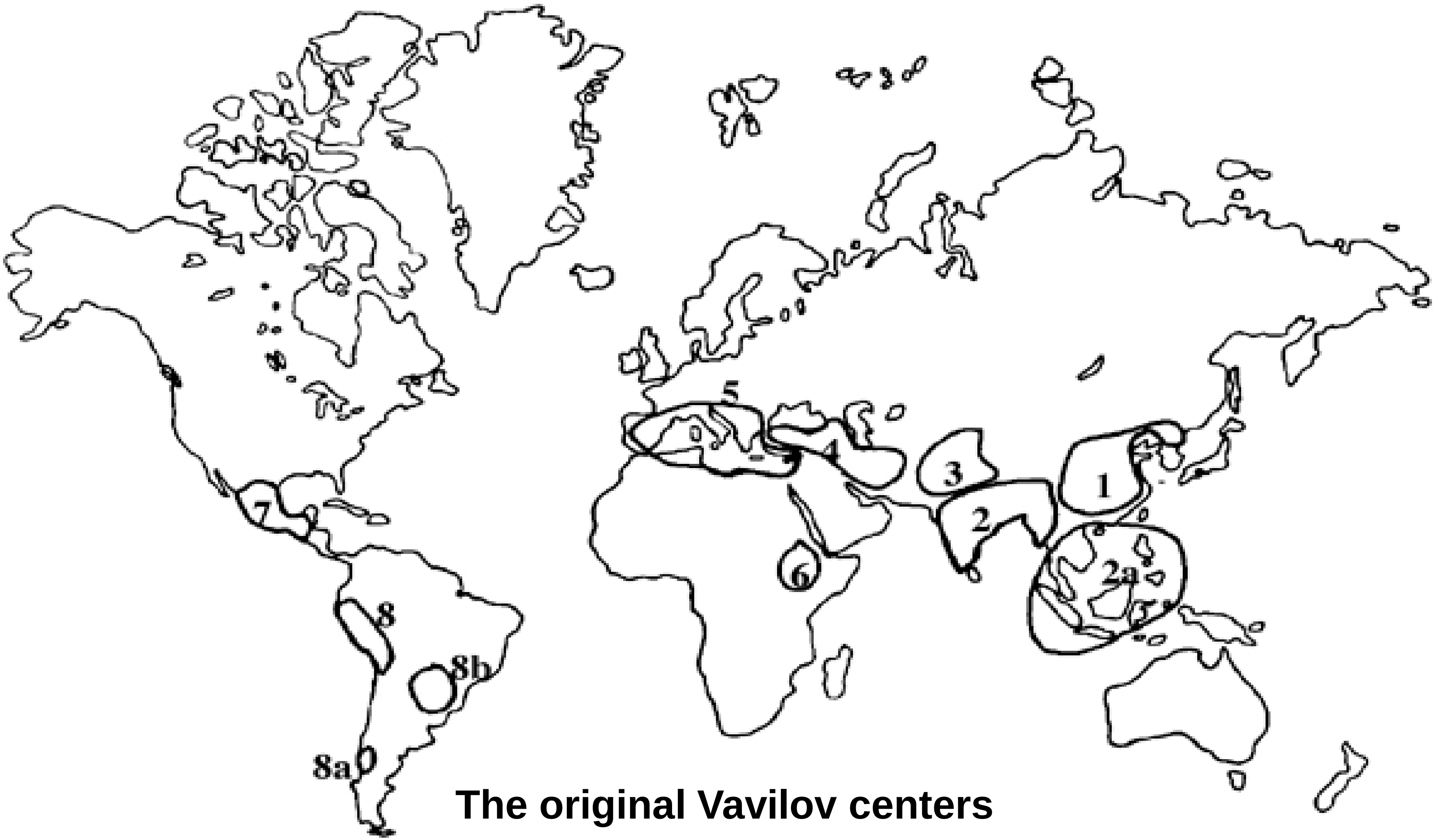


Fig. 1: Historical evolution of maps displaying plant species richness patterns in Africa. Apart from the map of WULFF (1935), which indicates the total species richness of the displayed areas, the maps show species richness per standard area of 10,000 km². All maps are inventory-based and to a varying degree rely on expert-opinion. The same legend of ten classes as displayed was applied to all maps

Barthlott, W., Hostert, A., Kier, G., Koper, W., Kreft, H., Mutke, J., Rafiqpoor, M.D., & Sommer, J.H. (2007) Geographic patterns of vascular plant diversity at continental to global scales. Erdkunde, 61, 4, pp 305-315 http://www.botanischergarten.ch/Biodiv-Systematik/Barthlott-Geographic-Patterns-2007.pdf AND http://www.nees.uni-bonn.de/biomaps/biota.html



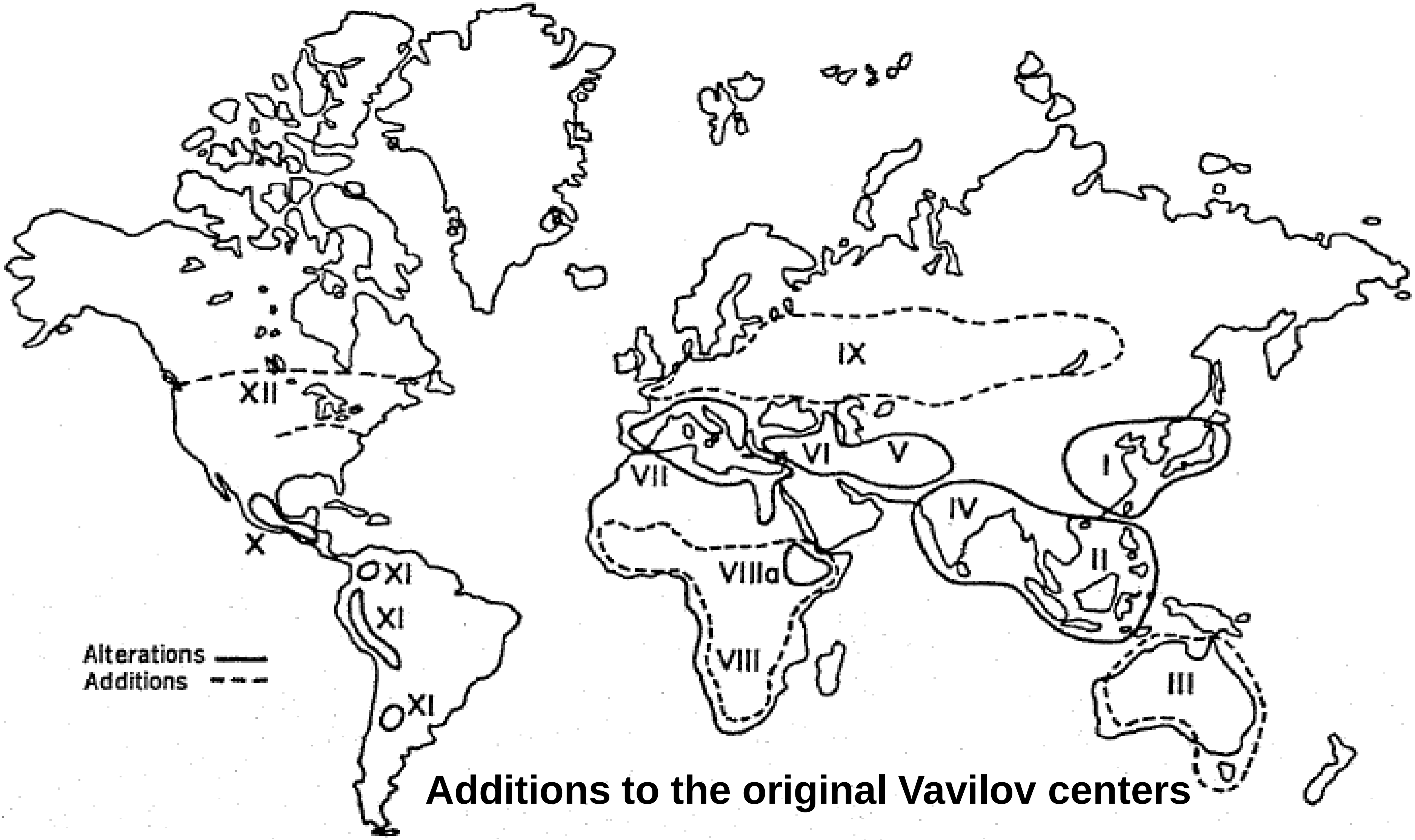
The original Vavilov centers

The original eight centers of crop diversity according to Vavilov, N.I.

http://www.plantsciences.ucdavis.edu/gepts/PB143/lec02/pb143l02.htm

Hawkes, J.G. (1990)
VAVILOV,N.I. - THE MAN AND HIS WORK. Biological Journal of the Linnean Society, 39, 1, pp 3-6
http://www.botanischergarten.ch/Genomics/Hawkes-Vavilov-Man-Work-1990.pdf

Zentren wichtiger Kulturpflanzen weltw



Additions to the original Vavilov centers

P.M. Zhukovsky's alterations (solid lines) and additions (broken lines) to Vavilovs original concept of crop diversity, from Zeven, A. C. and P. M. Zhukovsky (1975).
Dictionary of cultivated plants and their centres of diversity. Wageningen, Pudoc.
http://www.plantsciences.ucdavis.edu/gepts/pb143/lec10/pb143l10.htm

Given a particular location that is susceptible to recurrent exotic invasion, native species richness can contribute to invasion resistance by means of neighborhood interactions and should be maintained or restored.

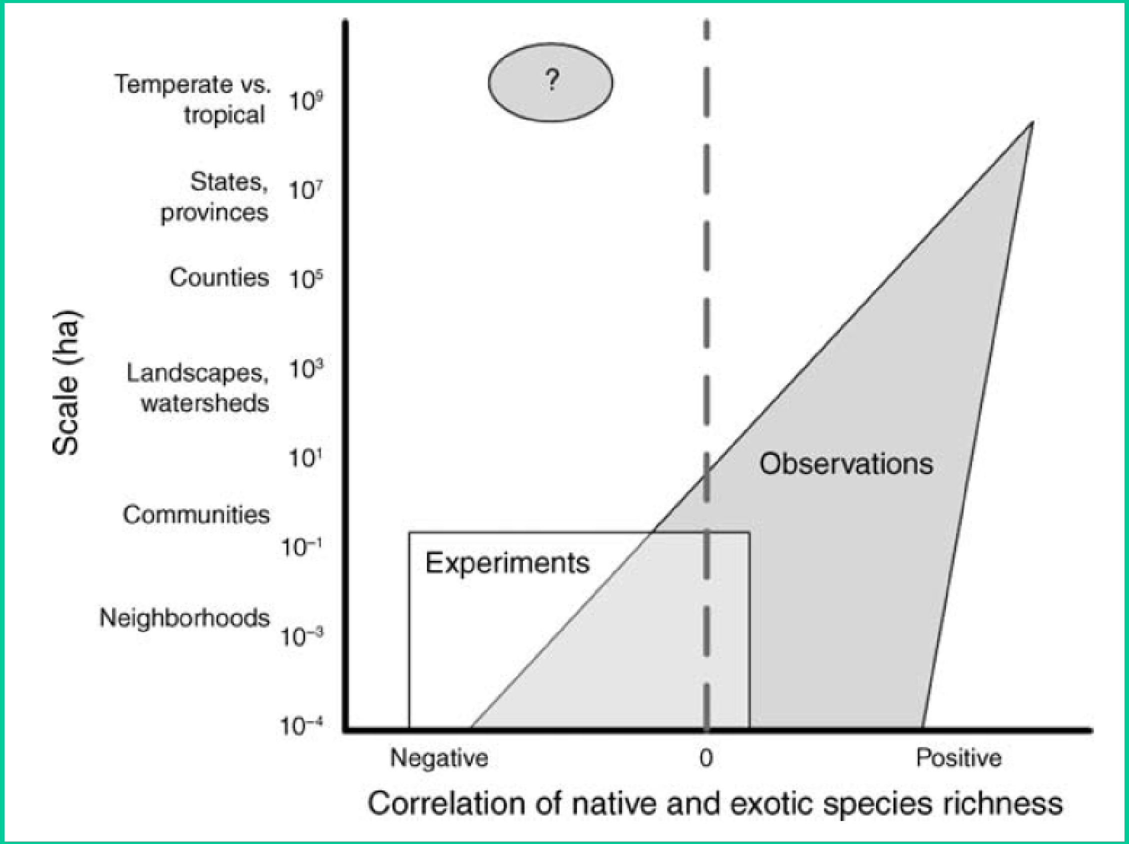


FIG. 1. Conceptualized diagram of the invasion paradox. Fine-grained studies, many of which are experimental, often suggest negative correlations between native and exotic species richness but are highly variable. Nearly all broader-grain observational studies indicate positive native–exotic richness correlations. Likely exceptions are comparisons between temperate and tropical biomes, **where preliminary data suggest that biodiversity hotspots have very few exotic species.**

Fridley, J.D., Stachowicz, J.J., Naeem, S., Sax, D.F., Seabloom, E.W., Smith, M.D., Stohlgren, T.J., Tilman, D., & Von Holle, B. (2007)
The invasion paradox: Reconciling pattern and process in species invasions. Ecology, 88, 1, pp 3-17
http://www.botanischergarten.ch/Invasive/Fridley-Invasion-Paradox-2007.pdf

Myths about centers of (crop)-biodiversity 2

example of center of origin for sorghum in Africa, traditional and novel views

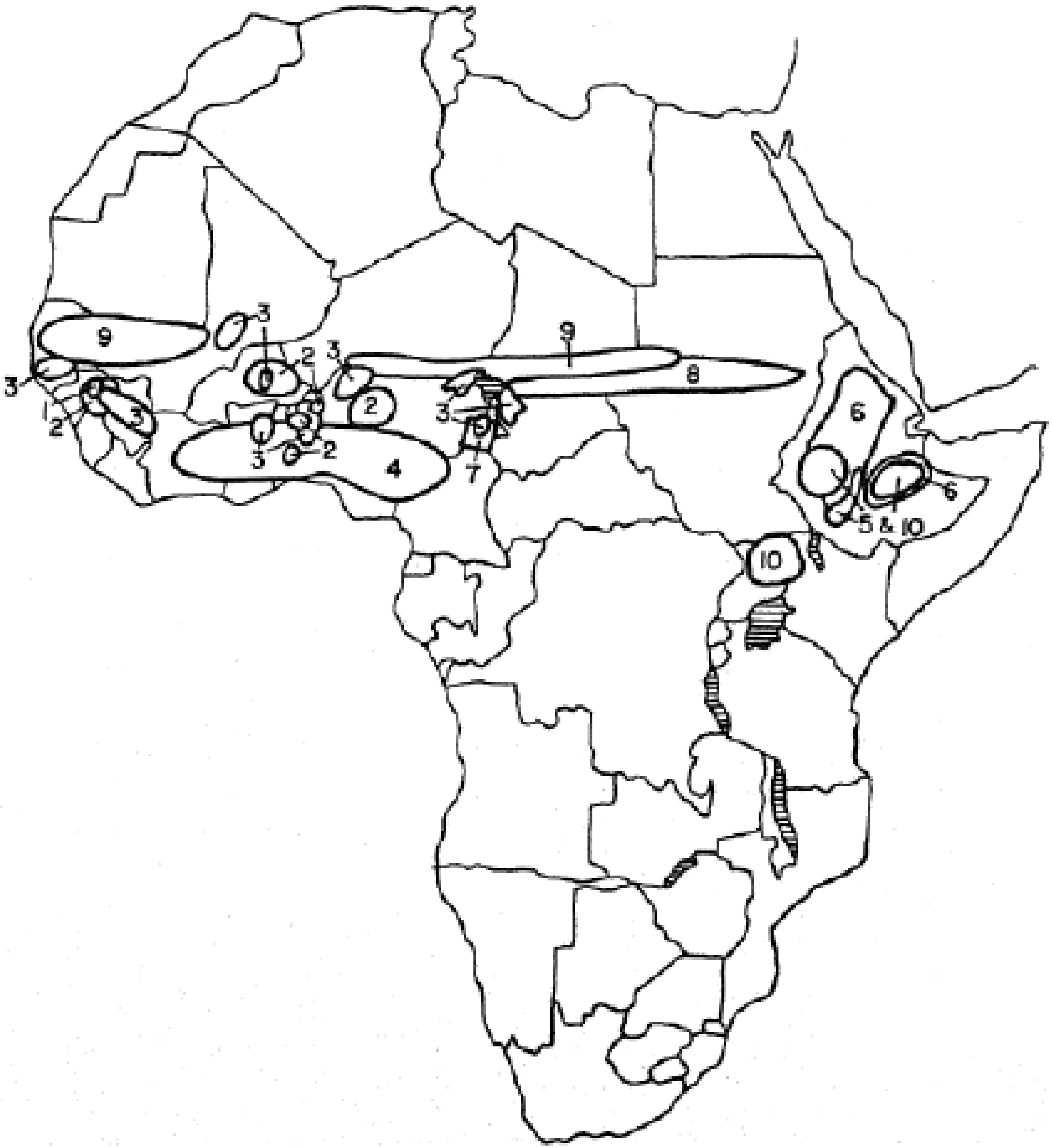
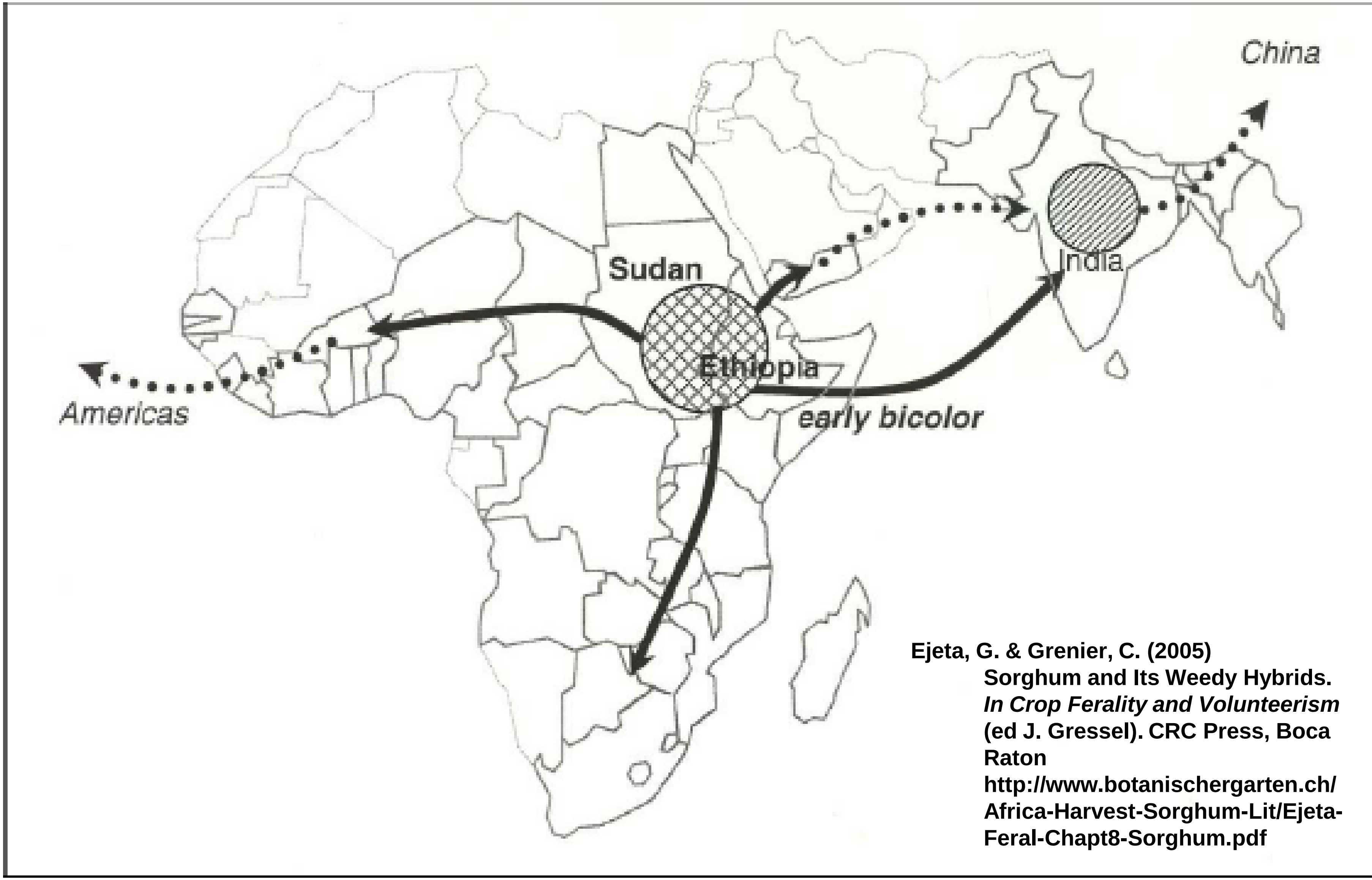


Fig. 81 Probable areas of domestication of selected African crops: 1, Brachiaria deflexa; 2, Digitaria exilis and Digitaria iburua; 3, Oryza glaberrima; 4, Dioscorea rotundata; 5, Musa ensete and Guizotia abyssinica; 6, Eragrostis tef; Voandzeia and Kerstingiella; 8, *S. bicolor; 9, Pennisetum americanum; 10, Eleusine coracana, from (Harlan, 1971)*

From Ammann, K., Sorghum Biology draft

A more differenciated picture with African crops



Ejeta, G. & Grenier, C. (2005)
Sorghum and Its Weedy Hybrids.
In Crop Ferality and Volunteerism
(ed J. Gressel). CRC Press, Boca
Raton
http://www.botanischergarten.ch/
Africa-Harvest-Sorghum-Lit/Ejeta-
Feral-Chapt8-Sorghum.pdf

Fig. 13 Pattern of Domestication and Spread of the Genus *Sorghum*. From (Ejeta & Grenier, 2005)
see chapter on Centers of Origin of the Genus *Sorghum* for more comments.

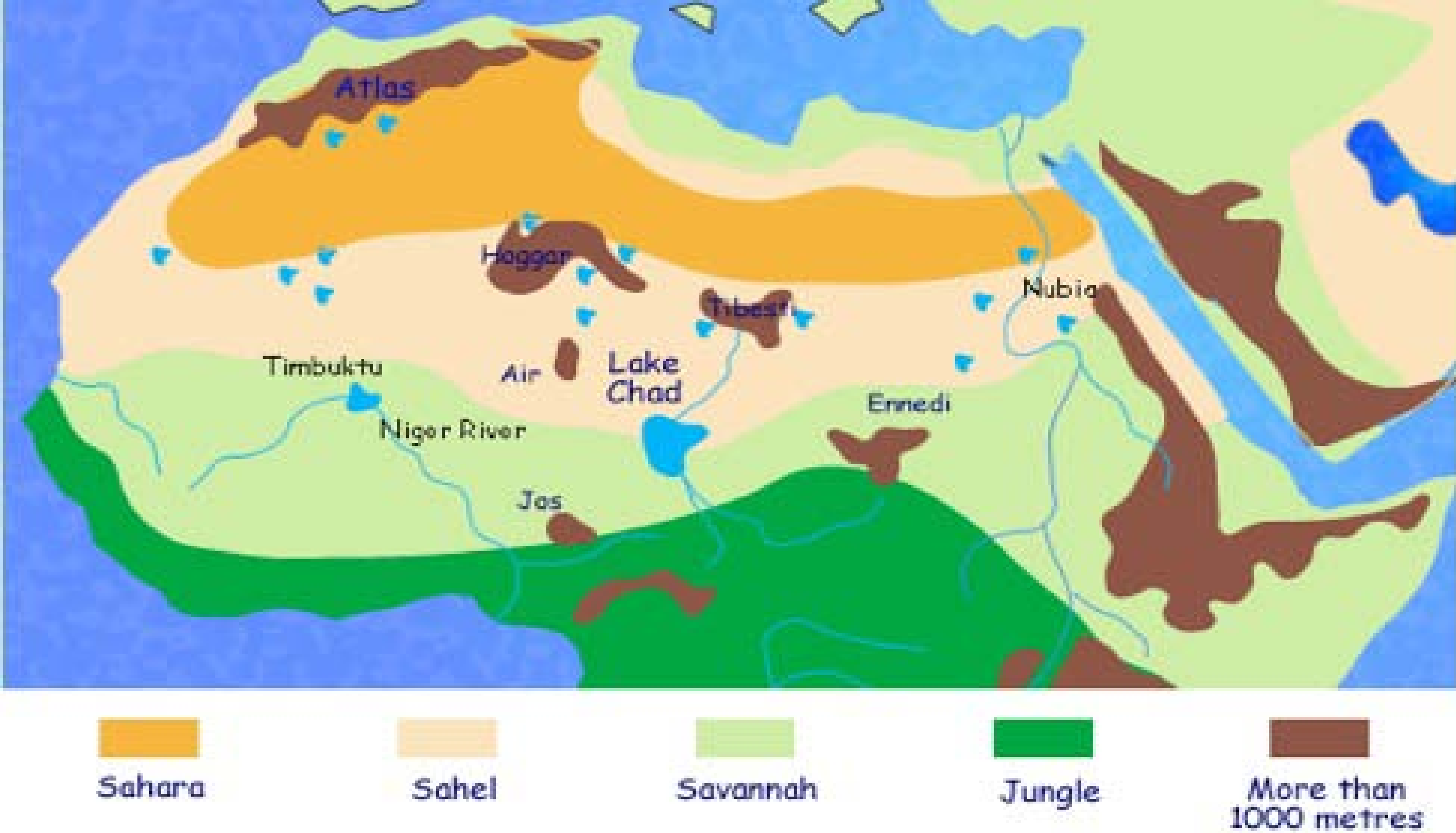
A Green Sahara

Between 5,000 and 10,000 years ago, parts of the now-dry Sahara were swampy wetlands.

The site of the remains -- the Gobero Preserve in Niger in the southern Sahara -- once stood along a lake shore.

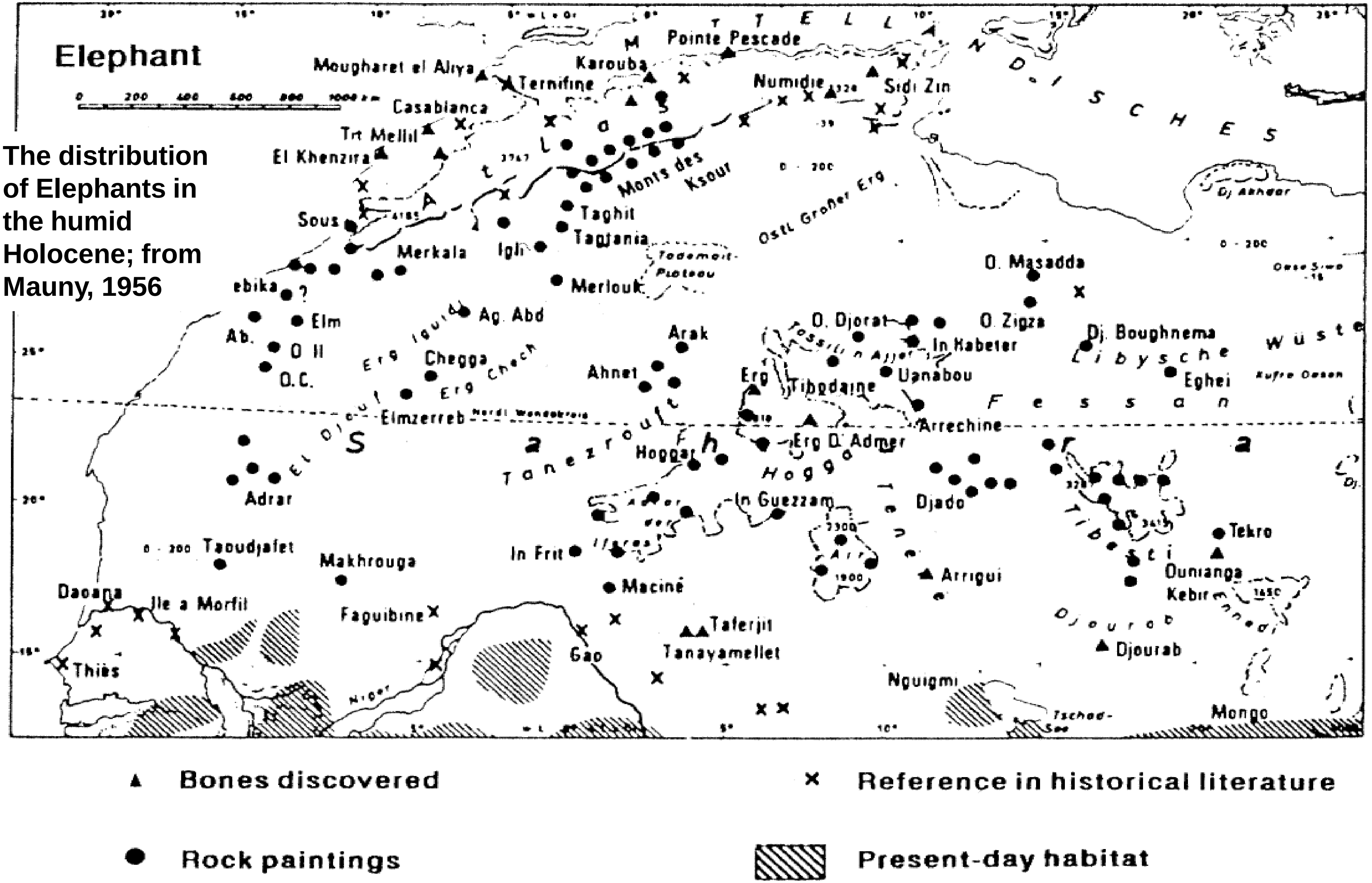
Along with human remains, the researchers found skeletons of fish, crocodiles and other animals. Photo Credit: National Geographic Society

www.pbs.org/.../index.html?page=2



The Sahara and the neighbouring Sahel were not the sandy lands that we know today, but rather areas that experienced prolonged periods of humidity and contained numerous lakes and swamps that have since dried up. Archaeological findings indicate that fauna typical of the savannah once grazed in what are today super-arid, dune-covered regions.

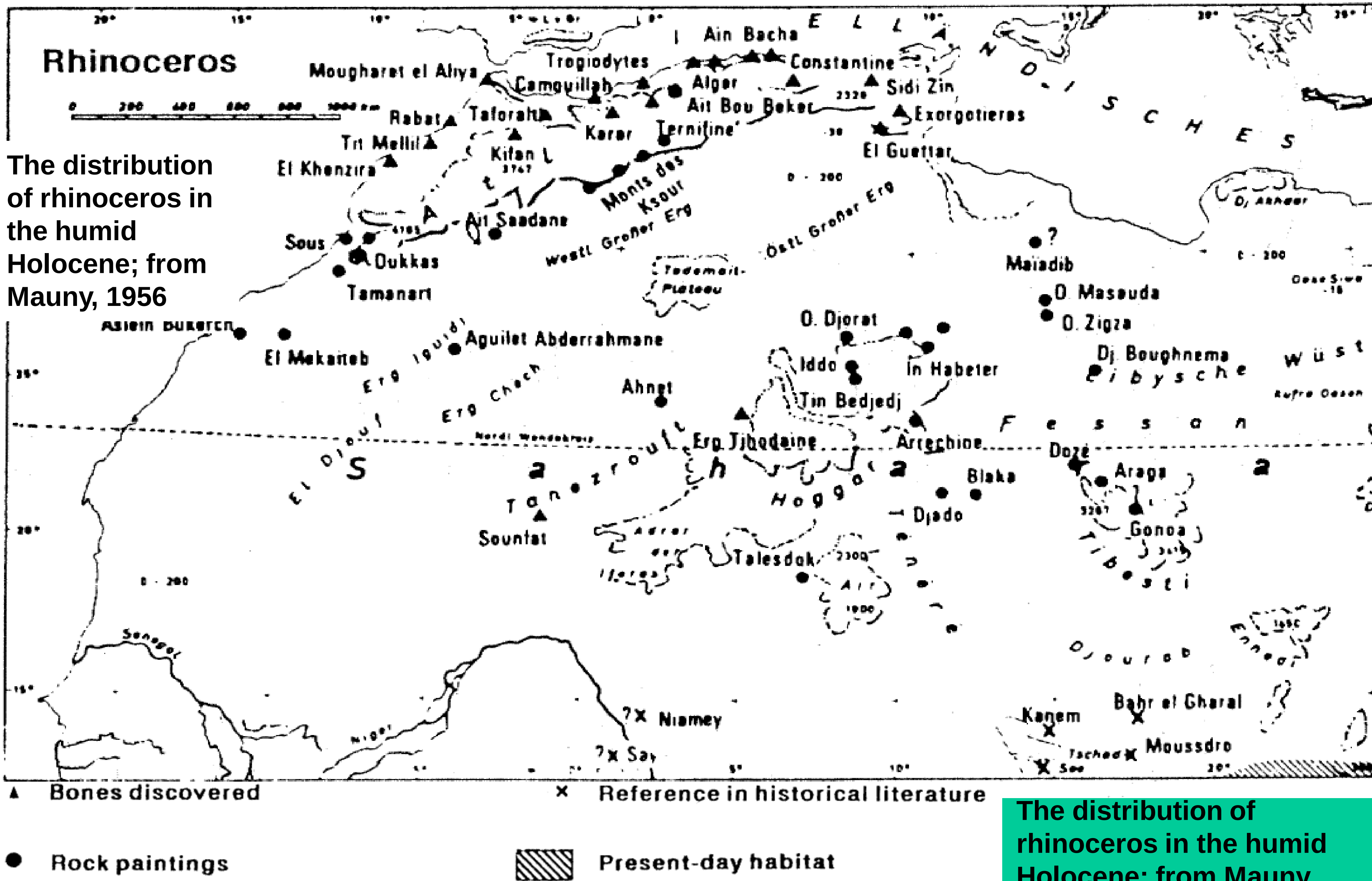
web.me.com/.../A_wetter_Africa.html



The distribution of Elephants in the humid Holocene; from Mauny, 1956

Messerli, B. & Winiger, M. (1992)
CLIMATE, ENVIRONMENTAL-CHANGE, AND RESOURCES OF THE AFRICAN MOUNTAINS FROM THE MEDITERRANEAN TO THE EQUATOR. Mountain Research and Development, 12, 4, pp 315-336
http://www.botanischergarten.ch/Africa-Harvest-Sorghum-Lit-1/Messerli-Environmental-Change-1992.pdf

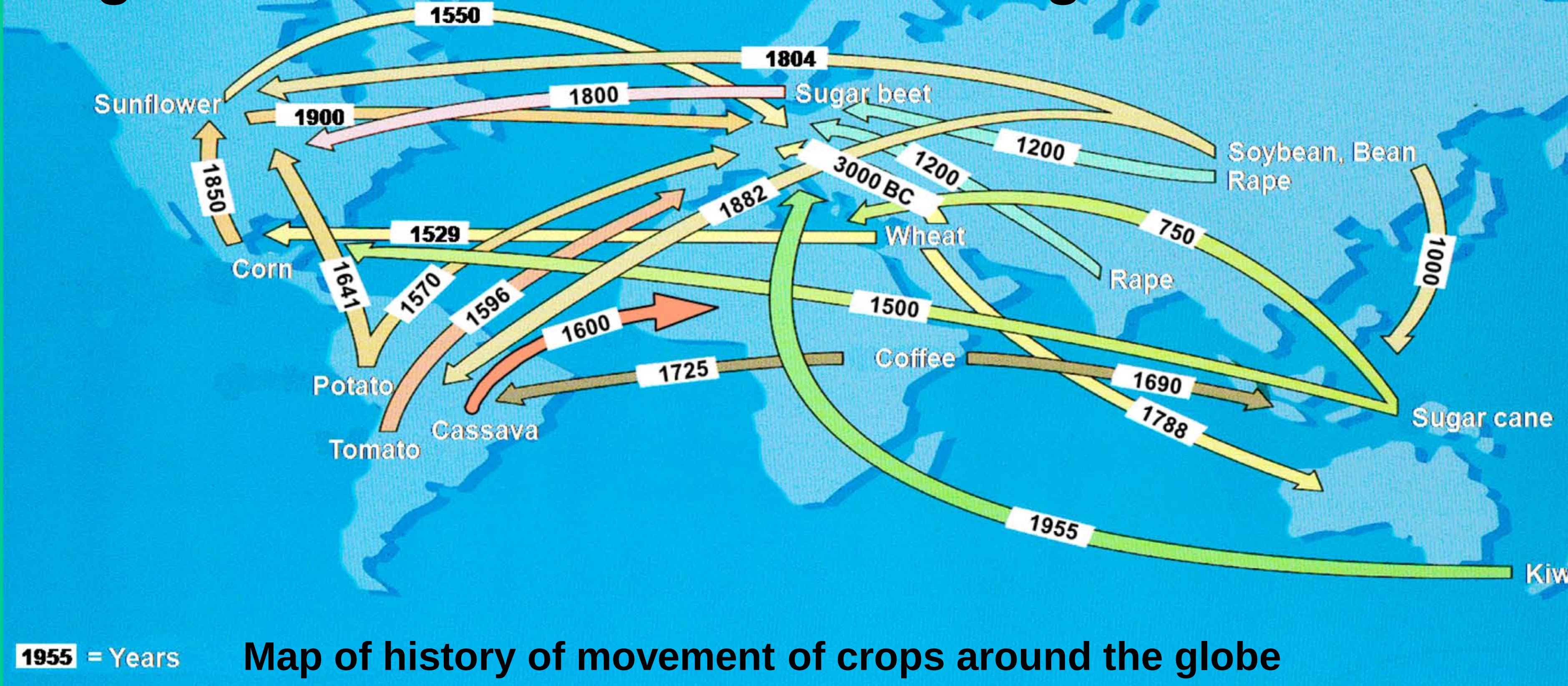
The distribution of rhinoceros in the humid Holocene; from Mauny, 1956



The distribution of rhinoceros in the humid Holocene; from Mauny, 1956

Messerli, B. & Winiger, M. (1992)
CLIMATE, ENVIRONMENTAL-CHANGE, AND RESOURCES OF THE AFRICAN MOUNTAINS FROM THE MEDITERRANEAN TO THE EQUATOR. Mountain Research and Development, 12, 4, pp 315-336
http://www.botanischergarten.ch/Africa-Harvest-Sorghum-Lit-1/Messerli-Environmental-Change-1992.pdf

For the major crops, there is no indigenous original center of landraces existing



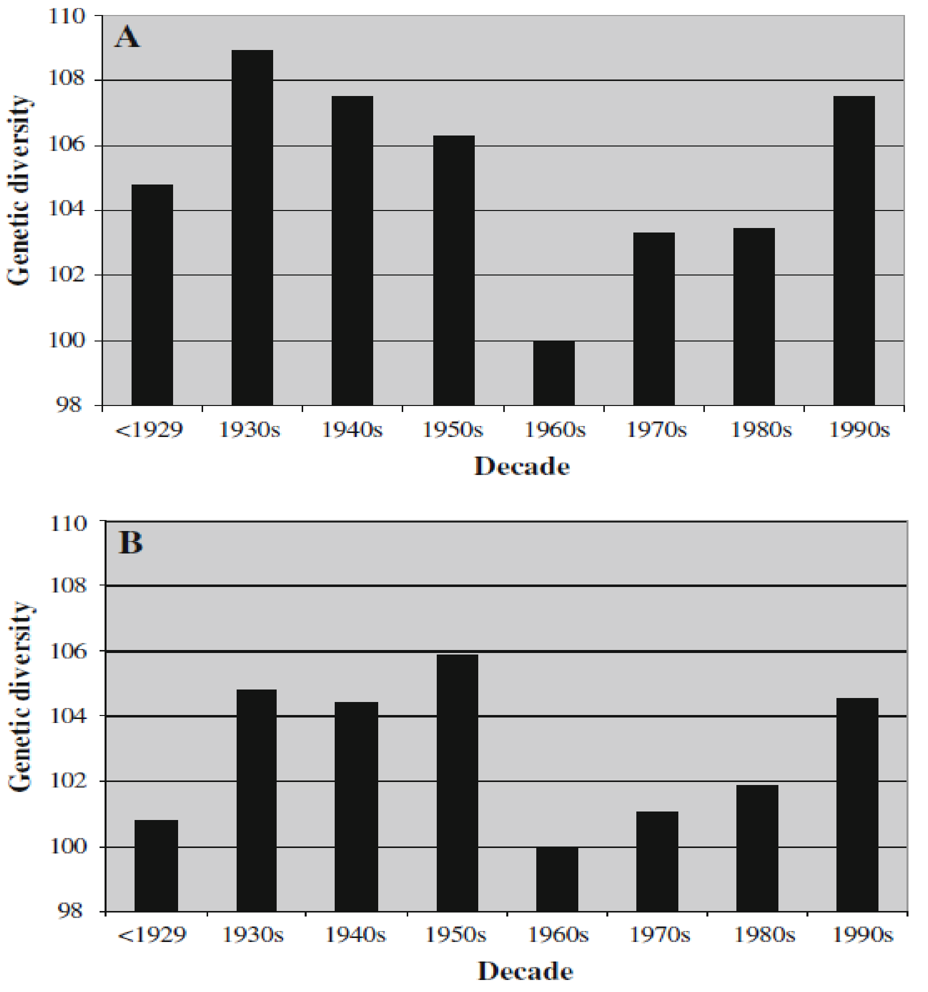
Map of history of movement of crops around the globe

Dubock, A.C. (2009)
Crop conundrum. Nutrition Reviews, 67, 1, pp 17-20
<Go to ISI>://WOS:000261881200002 AND
http://www.botanischergarten.ch/Golden-Rice/Dubock-Crop-Conundrum-2009.pdf

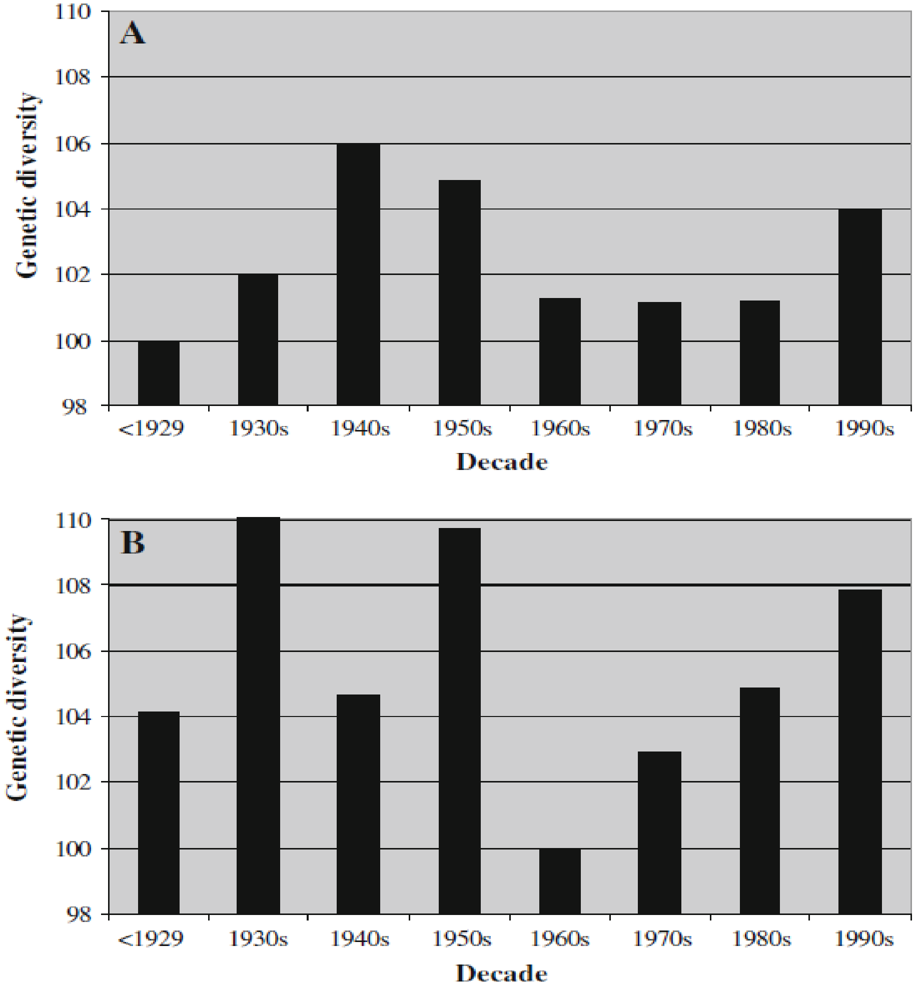
Main topic of the lecture:

Biotechnology contributes to biodiversity

After the 1960s and 1970s breeders have been able to again increase the diversity in released varieties



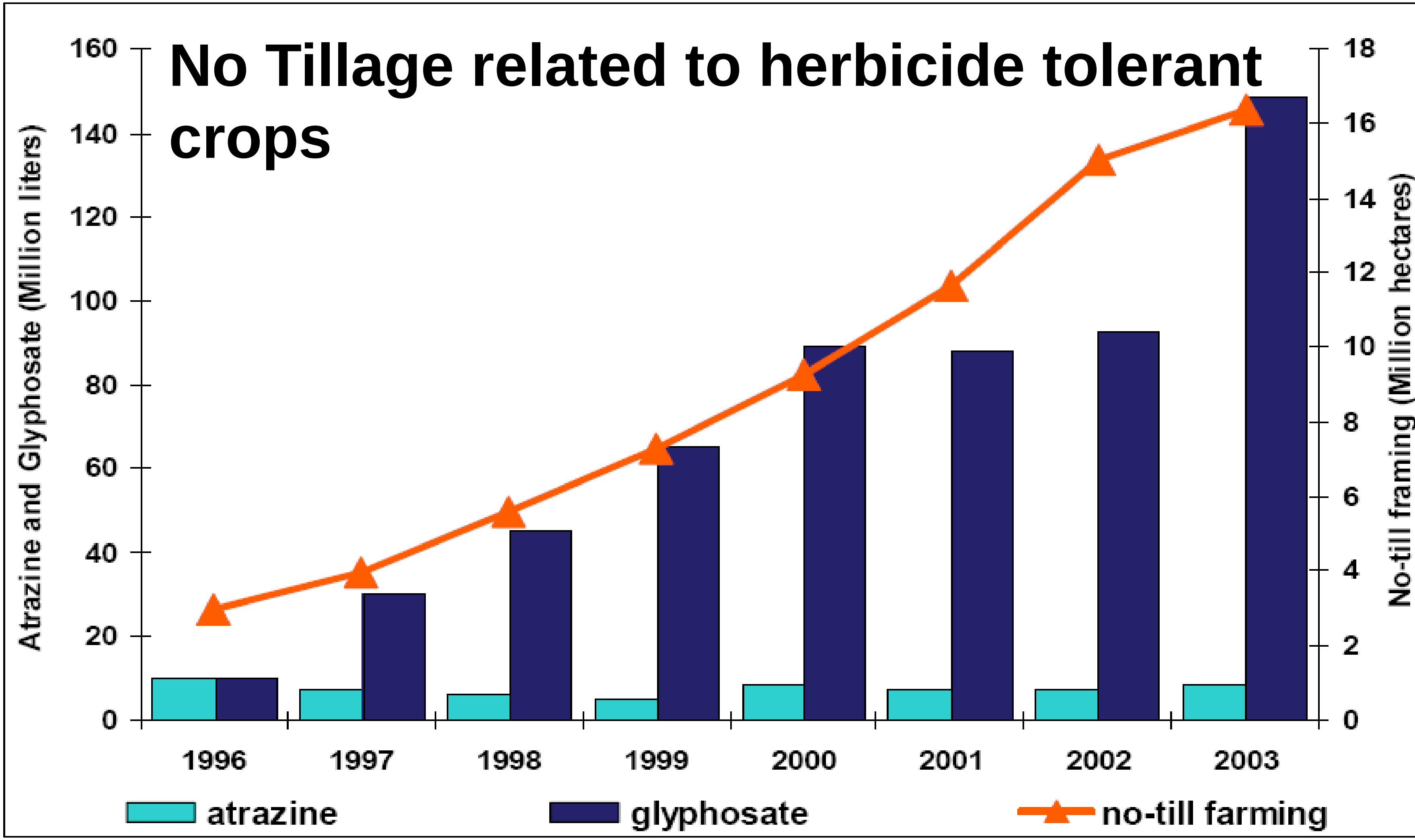
Crop genetic diversity in the twentieth century based on an unweighted (a) and a weighted (b) meta analysis of 44 publications. The diversity in the decade with the lowest diversity was set to 100



Wheat genetic diversity (a) and crop genetic diversity (excluding wheat) (b) in the twentieth century based on a weighted meta analysis of 20 publications. The diversity in the decade with the lowest diversity was set to 100

van de Wouw, M., van Hintum, T., Kik, C., van Treuren, R., & Visser, B. (2010)
Genetic diversity trends in twentieth century crop cultivars: a meta analysis. TAG Theoretical and Applied Genetics, 120, 6, pp 1241-1252
http://www.botanischergarten.ch/Africa-Harvest-Sorghum-Lit-1/van-de-Wouw-Genetic-Diversity-Trends-2010.pdf

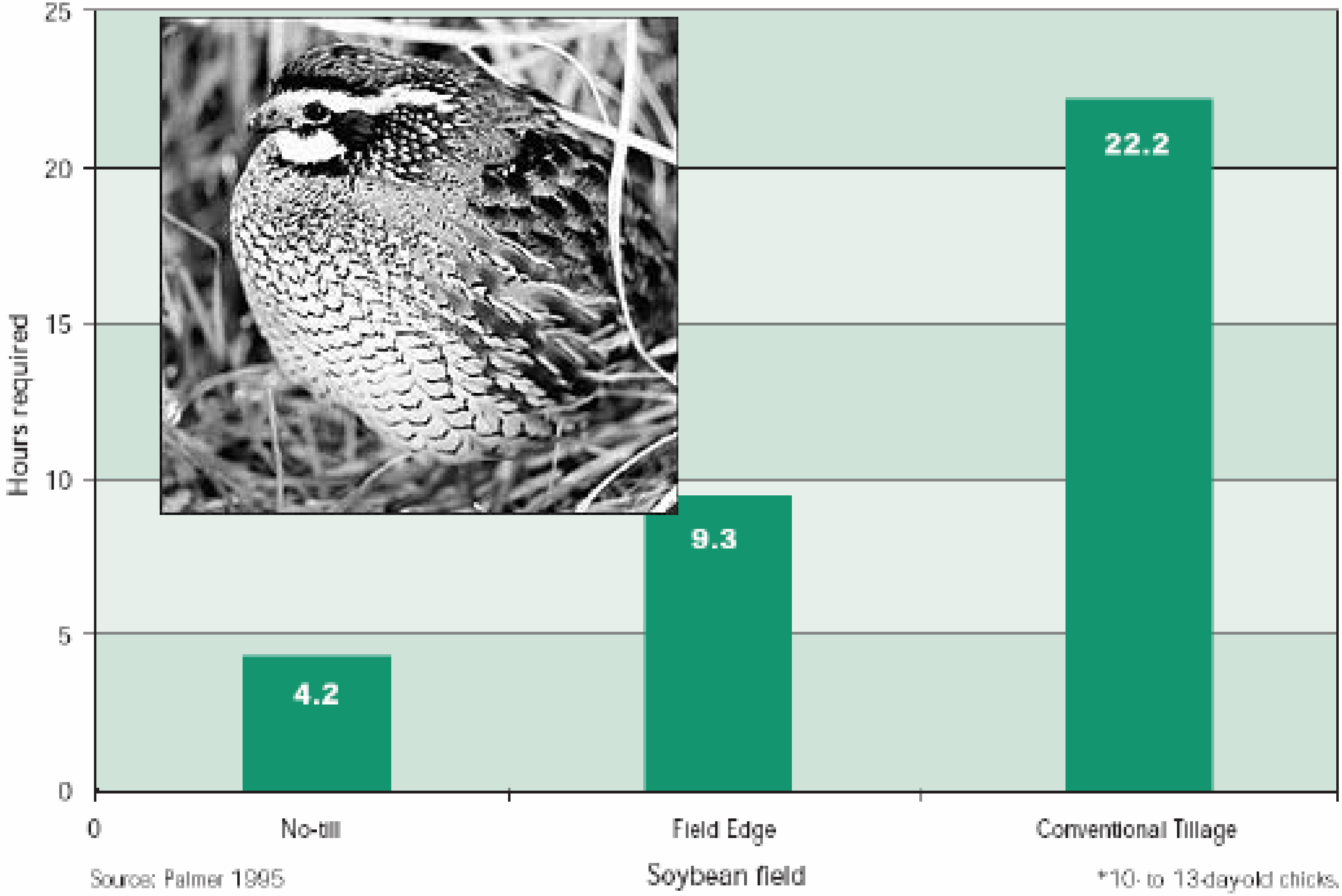
Figure 3.5: Evolution of the area planted with no-till farming and type of herbicide used



Sources: AAPRESID and CASAFE

Trigo, E. J. and E. J. Cap (2007).
Ten Years of Genetically Modified Crops in Argentine Agriculture, Argentine Council for Information and Development of Biotechnology – ArgenBio.: pp 52. http://www.botanischergarten.ch/HerbizideTol/Trigo-10years-Argentina-2006.pdf

Evolution of the area planted with no-till farming and type of herbicide used: Tri



Ecological benefits of No-Tillage with herbicide tolerant crops

Figure 12: Time needed for Bobwhite Quail Chicks to Satisfy Daily Inect Requirements

Fawcett, R. & Towery, D. (2002), Electronic Source: Conservation tillage and plant biotechnology: How new technologies can improve the environment by reducing the need to plow., published by: Purdue University, accessed: 2003 www.ctic.purdue.edu/CTIC/CTIC.html or http://www.botanischergarten.ch/HerbizideTol/Fawcett-BiotechPaper.pdf

Time neede for Bobwhite Quali Chicks to satisfy daily insect requirements: Clear ecological benefit of no tillag

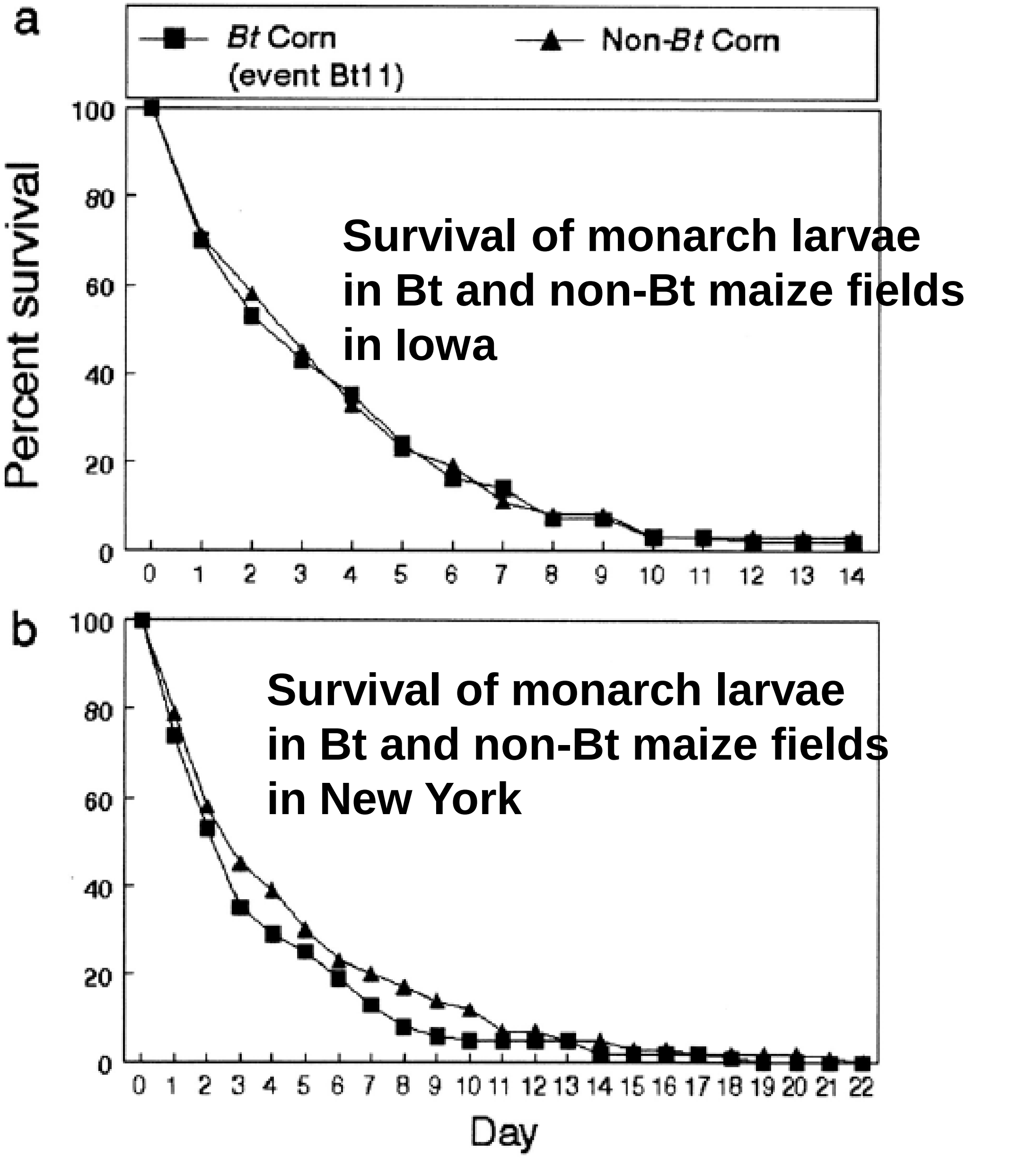
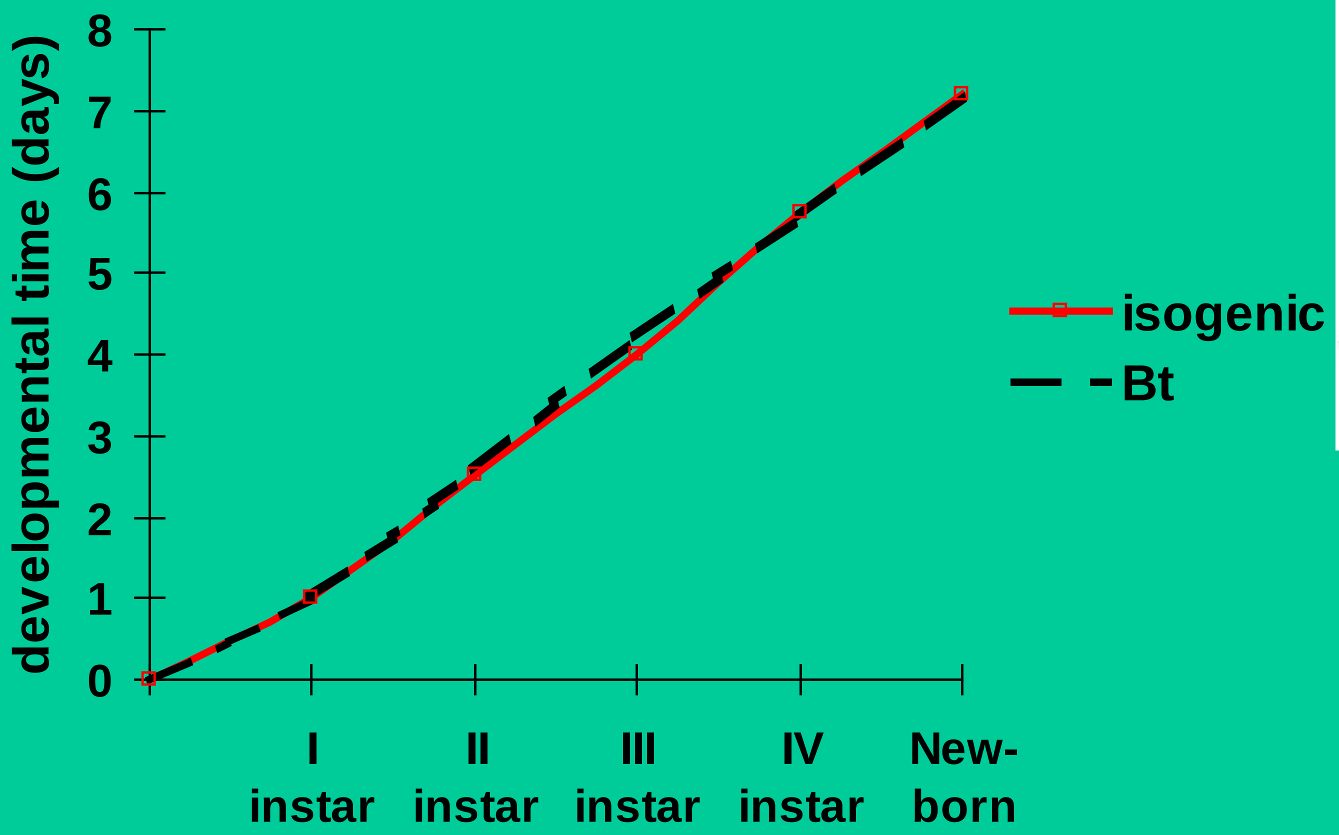


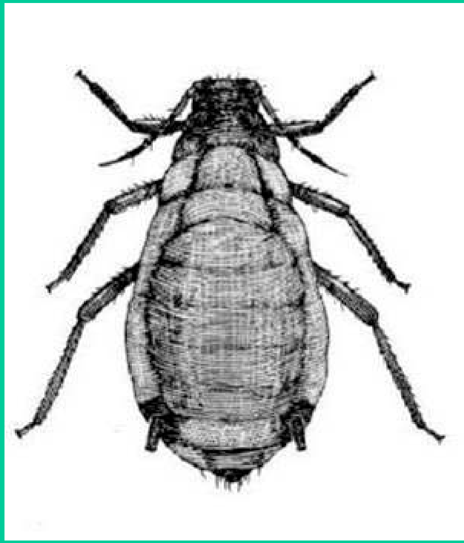
Figure 26: Survival curves for monarch larvae placed in and near *Bt* and non-*Bt* corn fields. (*a*) Iowa. (*b*) New York. The survival curves of larvae pooled over the three Bt corn sites were not significantly different from those in non-Bt (Fig. 13a). In New York, trends in survivorship were also statistically the same for cohorts of larvae feeding for 22 days on milkweeds in Bt and non-Bt fields (Fig. 13b). (Stanley-Horn et al., 2001)

Sears, M.K., Hellmich, R.L., Stanley-Horn, D.E., Oberhauser, K.S., Pleasants, J.M., Mattila, H.R., Siegfried, B.D., & Dively, G.P. (2001)
Impact of Bt corn pollen on monarch butterfly populations: A risk assessment. Proceedings of the National Academy of Sciences of the United States of America, 98, 21, pp 11937-11942
http://www.botanischergarten.ch/Bt/Searsreport-prelim-2000.pdf

Stanley-Horn, D.E., Dively, G.P., Hellmich, R.L., Mattila, H.R., Sears, M.K., Rose, R., Jesse, L.C.H., Losey, J.E., Obrycki, J.J., & Lewis, L. (2001)
Assessing the impact of Cry1Ab-expressing corn pollen on monarch butterfly larvae in field studies. Proceedings of the National Academy of Sciences of the United States of America, 98, 21, pp 11931-11936
http://www.pnas.org/cgi/content/full/98/21/11931

Averages of two years (1997-1998) of development times (days) of a specific stage for *Rhopalosiphum padi* feeding on transgenic and isogenic corn leaves





Rhopalosiphum padi

Lozzia, G., Furlanis, C., Manachini, B., & Rigamonti, I. (1999)
Effects of Bt Corn on Rhodopalosiphum Padi (Rhynchota Aphidiae) and on Its Predator Chrysoperla Carnea Stephen (Neuroptera Chrysopidae). Boll. Zool. Agr. Bachic. Ser. II, 30, 2, pp 153-164
http://www.botanischergarten.ch/Bt/Lozzia-Effects-Bt-1998.pdf

Lozzia, G.C. (1999)
Biodiversity and Structure of Ground Beetle Assemblages (Coleopterae, Carabidae) in Bt Corn and Its Effects on Non Target Insects. Boll. Zool. Agr. Bachic. Ser. II, 31, pp 37-58
http://www.botanischergarten.ch/Bt/Lozzia-Biodiversity-1999.pdf

Early, but largely ignored research: Averages of two years (1997-1998) of development times (days) of a specific stage for *Rhopalosiphum padi* feeding on transgenic and isogenic corn leav

No statistically significant differences between treatmemts and control for Spiders

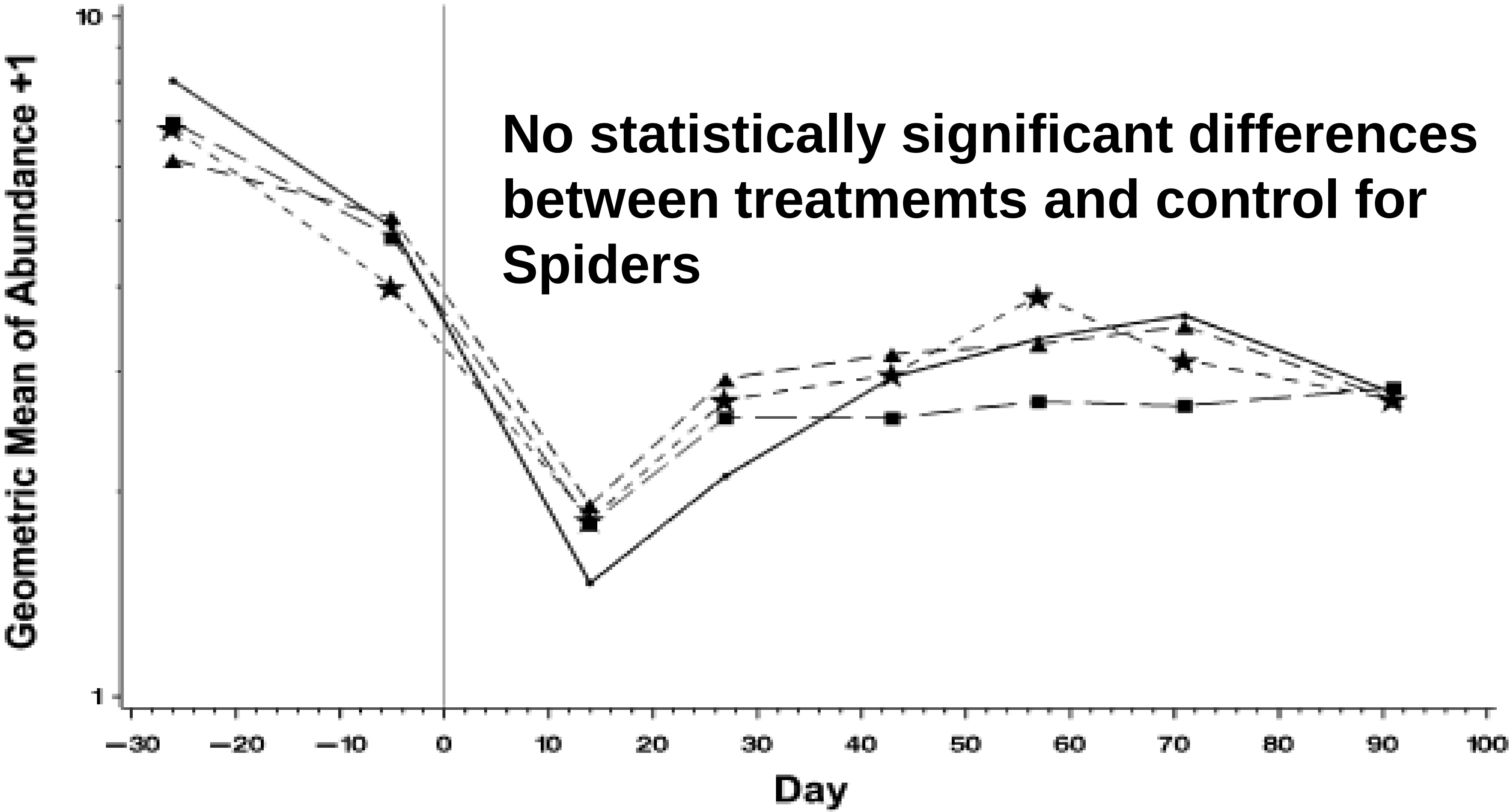


FIGURE 6. Population density of *Alopecosa* sp. (Araneae: Lycosidae). Plotted are the geometric means of abundance +1 per trap against time: (●) untransformed corn (control); (★) Bt-corn; (▲) untransformed corn treated with Delfin; (■) untransformed corn treated with Karate Xpress; Day 0, spray day. No statistically significant differences between treatments and the control were observed (Tukey test, $P = 0.05$).

Candolfi, M.P., Brown, K., Grimm, C., Reber, B., & Schmidli, H. (2004)
A faunistic approach to assess potential side-effects of genetically modified Bt-corn on non-target arthropods under field conditions. Biocontrol Science and Technology, 14, 2, pp 129-170
http://www.botanischergarten.ch/Bt/Candolfi-Biocontrol-2004.pdf

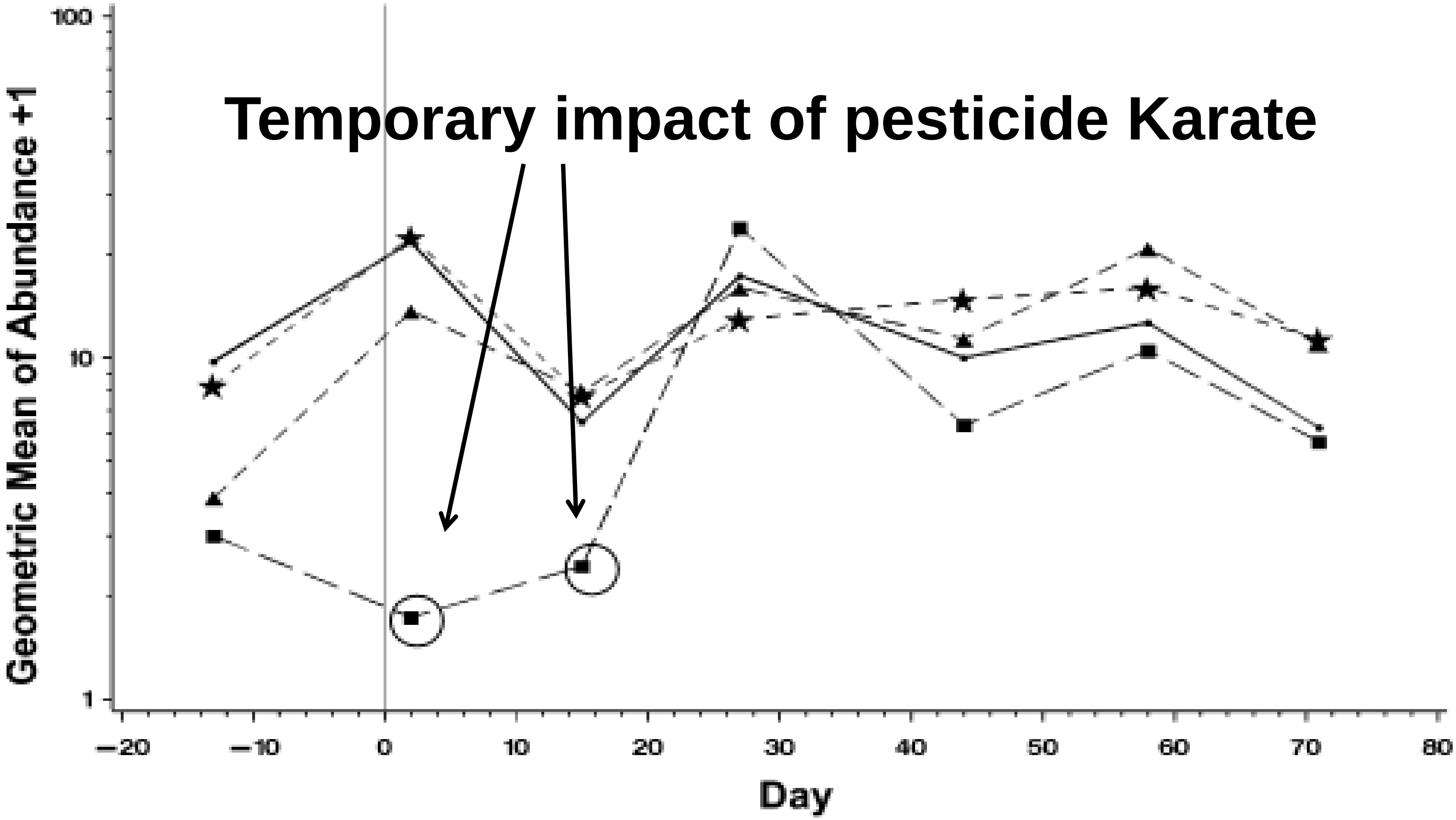


FIGURE 9. Population density of *Orius* sp. (Heteroptera: Anthocoridae). Plotted are the geometric means of abundance +1 per trap against time: (●) untransformed corn (control); (★) Bt-corn; (▲) untransformed corn treated with Delfin; (■) untransformed corn treated with Karate Xpress; Day 0, spray day. Statistically significant treatment effects when compared to control are circled (Tukey test, $P \leq 0.05$).

Candolfi, M.P., Brown, K., Grimm, C., Reber, B., & Schmidli, H. (2004)
A faunistic approach to assess potential side-effects of genetically modified Bt-corn on non-target arthropods under field conditions. Biocontrol Science and Technology, 14, 2, pp 129-170
http://www.botanischergarten.ch/Bt/Candolfi-Biocontrol-2004.pdf

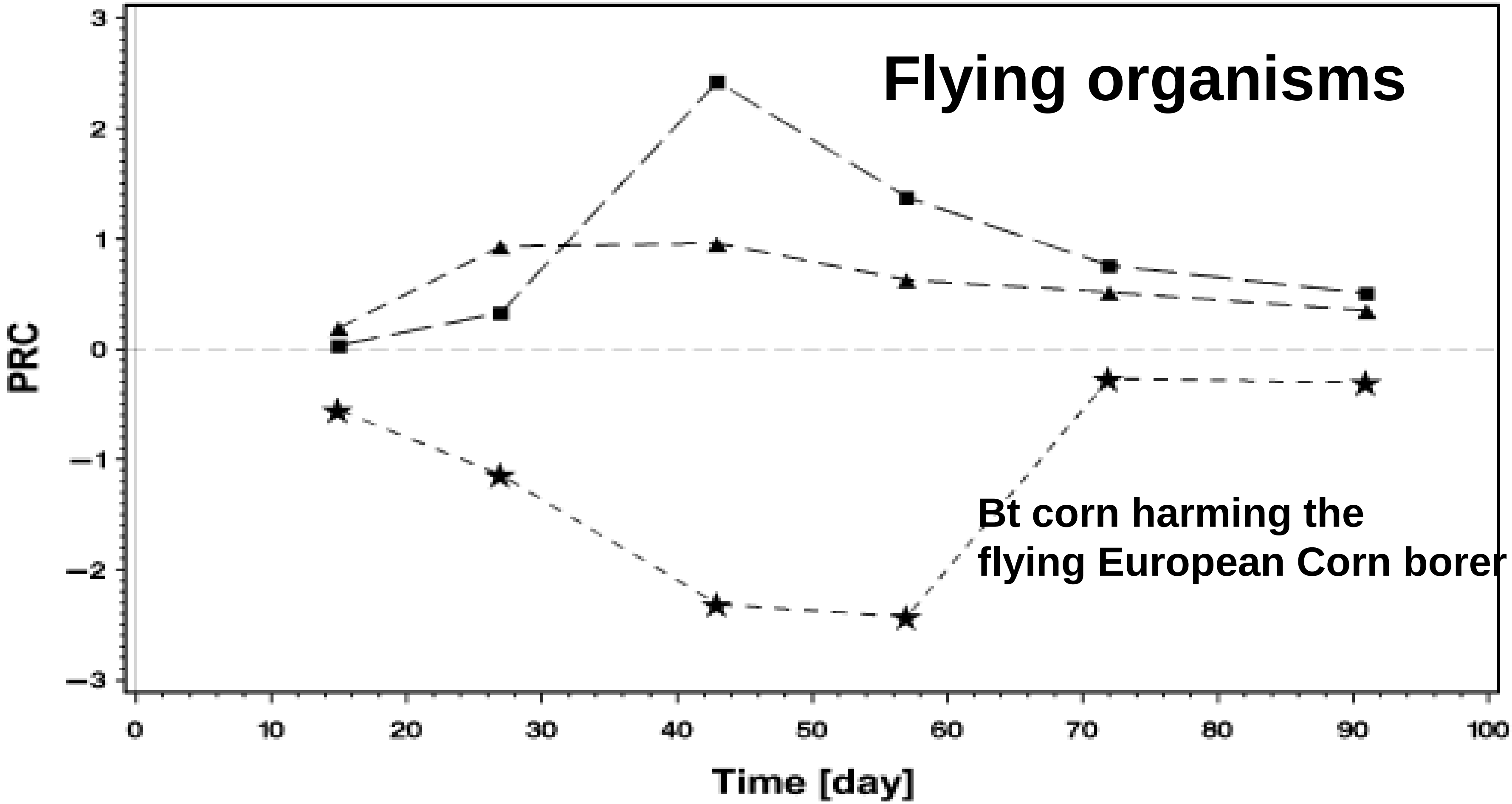


FIGURE 13. Principal response curve analysis for flying organisms: zero line of the *y*-axis, untransformed corn (control); (★) Bt-corn; (▲) untransformed corn treated with Delfin; (■) untransformed corn treated with Karate Xpress; Day 0, spray day. No statistically significant (Crossvalidation/ Jacknife) treatment effects were observed.

Candolfi, M.P., Brown, K., Grimm, C., Reber, B., & Schmidli, H. (2004)
A faunistic approach to assess potential side-effects of genetically modified Bt-corn on non-target arthropods under field conditions. Biocontrol Science and Technology, 14, 2, pp 129-170
http://www.botanischergarten.ch/Bt/Candolfi-Biocontrol-2004.pdf

COMPREHENSIVE META STUDY SHOWS:
Insecticde effects were much larger than those of Bt crops

OPEN ACCESS Freely available online

PLoS one

Bt Crop Effects on Functional Guilds of Non-Target Arthropods: A Meta-Analysis

L. LaReesa Wolfenbarger[1], Steven E. Naranjo[2]*, Jonathan G. Lundgren[3], Royce J. Bitzer[4], Lidia S. Watrud[5]

1 Department of Biology, University of Nebraska at Omaha, Omaha, Nebraska, United States of America, **2** USDA-ARS Arid Land Agricultural Research Center, Maricopa, Arizona, United States of America, **3** USDA-ARS North Central Agricultural Research Laboratory, Brookings, South Dakota, United States of America, **4** Department of Entomology, Iowa State University, Iowa, United States of America, **5** U.S. Environmental Protection Agency, National Health and Environmental Effects Research Laboratory, Western Ecology Division, Corvallis, Oregon, United States of America

Predator-nontarget herbivore relationships. We examined community level responses using predator/prey ratios to provide an alternate measure of impact on pest management services. To estimate predator to prey ratios, we identified studies in our database in which both predator and herbivore functional groups were measured. We then summed the mean abundance of predators ($Mean_{Predator}$) and herbivores ($Mean_{Herbivore}$) for each relevant study and used these measures to estimate the quotient of predators over herbivores (prey). The variance of this quotient is given as

$$\frac{Mean_{Predator}}{Mean_{Herbivore}} * \sqrt[2]{\frac{Var_{Herbivores}}{Mean^2_{Herbivores}} + \frac{Var_{Predators}}{Mean^2_{Predators}}}$$

where $Var_{Herbivore}$ and $Var_{Predator}$ are the sum of variances of individual herbivores or predators in a given study. We assumed that the covariance between predators and herbivores was zero, and thus this variance estimate is conservative. Species of

Wolfenbarger, L.L., Naranjo, S.E., Lundgren, J.G., Bitzer, R.J., & Watrud, L.S. (2008)
Bt Crop Effects on Functional Guilds of Non-Target Arthropods: A Meta-Analysis. PLoS ONE, 3, 5, pp e2118
http://dx.doi.org/10.1371%2Fjournal.pone.0002118 AND
http://www.botanischergarten.ch/Bt/LaReesa-Bt-crop-Meta-Analysis-2008.pdf

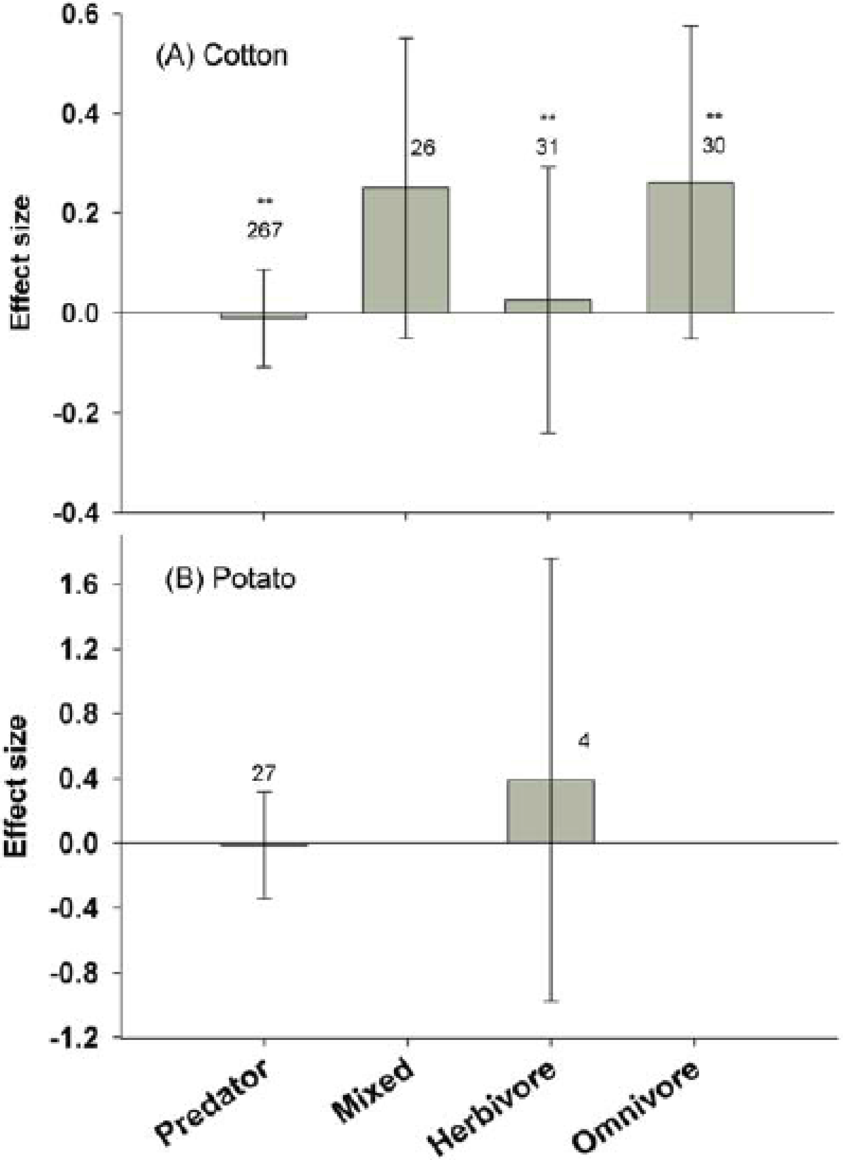


Figure 5. Effect of insecticide-treated Bt crops vs. insecticide-treated non-Bt control field on non-target functional guilds. Bars denote the 95% confidence intervals, asterisks denote significant heterogeneity in the observed effect sizes among the studies (* <0.05, ** <0.01, *** <0.001), and Arabic numbers indicate the number of observations included for each functional group.
doi:10.1371/journal.pone.0002118.g005

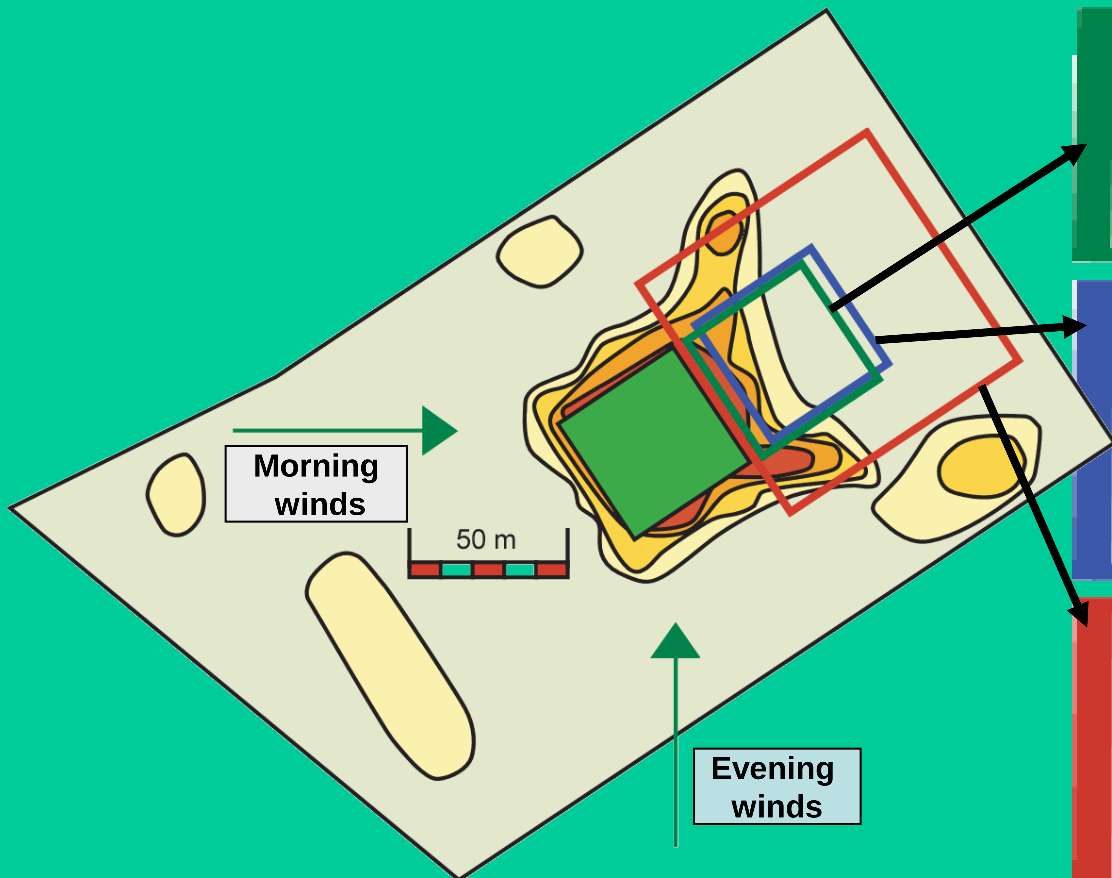
Conclusions/Significance: Overall, we find no uniform effects of Bt cotton, maize and potato on the functional guilds of non-target arthropods. Use of and type of insecticides influenced the magnitude and direction of effects; insecticde effects were much larger than those of Bt crops.

These meta-analyses underscore the importance of using controls not only to isolate the effects of a Bt crop per se but also to reflect the replacement of existing agricultural practices. Results will provide researchers with information to design more robust experiments and will inform the decisions of diverse stakeholders regarding the safety of transgenic insecticidal crops.

Wolfenbarger, L.L., Naranjo, S.E., Lundgren, J.G., Bitzer, R.J., & Watrud, L.S. (2008)
Bt Crop Effects on Functional Guilds of Non-Target Arthropods: A Meta-Analysis. PLoS ONE, 3, 5, pp e2118
http://dx.doi.org/10.1371%2Fjournal.pone.0002118 AND
http://www.botanischergarten.ch/Bt/LaReesa-Bt-crop-Meta-Analysis-2008.pdf

Co-existence in Spain 2003

results depend on field size but coexistence is managable



0.25 ha: no safety distance
1, 77 % GM intermixed
Labeling required

0.25 ha: 6m safety distance
0.77 % GM intermixed
Labelling not required

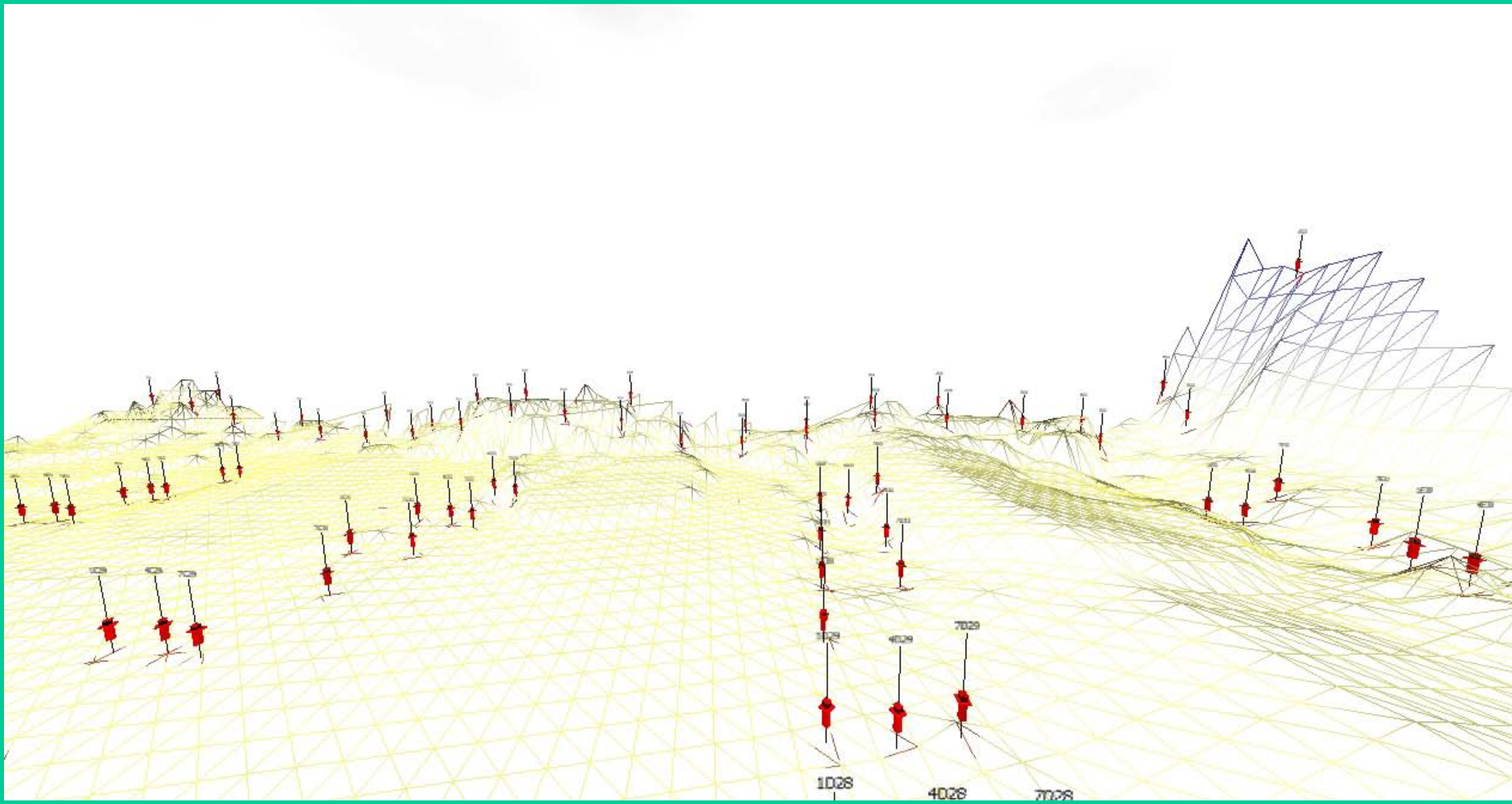
1 ha: no safety distance
0.83 % GM intermixed
Labelling not required

© ABIC2004 / Eric Mele, IRTA

Brookes, G. & Barfood, P. (2004).
Co-existence of GM and non GM crops: case study of maize grown in Spain, PG Economics Ltd, pp 13 Dorchester, UK1.
http://www.botanischergarten.ch/Coexistence/Brookes-Coexistence-Casestudy-Spain.01.pdf

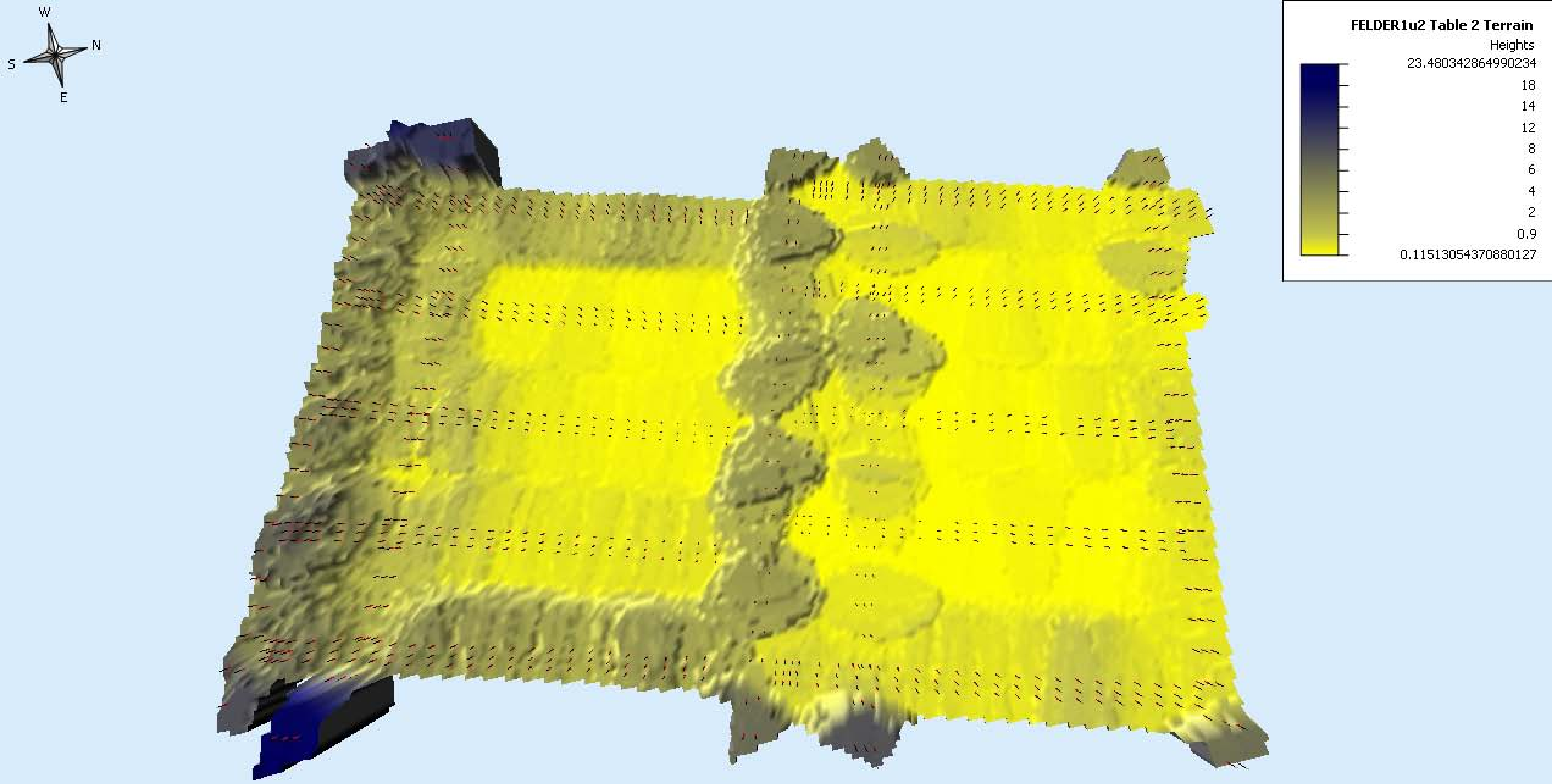
0.25 ha: no safety distance, 1.77% GM, labeling required intermixed

Maize Field Trial on Gene Flow: GIS supported results show: 10-20m safety distances are enough



Maize field I, individual sampling plants

Ammann, K., Kovacovsky, K., & Bratschi, D. (2009)
Maize Geneflow - GPS-Mapping and 3-dimensional Landscape Modeling, final report WP2 SIGMEA project, Wider Fields University of Bern Participation pp 25 (Manuscript)
http://www.botanischergarten.ch/SIGMEA/SIGMEA-Bern-Final-Report-20090831.pdf



Outcrossing of blue kernel maize surrounding yellow kernel maize, Slightly different growing conditions due to sowing machine turning Change in flowering synchronization: higher outcrossing, SIGMEA

Ammann, K., Kovacovsky, K., & Bratschi, D. (2009)
Maize Geneflow - GPS-Mapping and 3-dimensional Landscape Modeling, final report WP2 SIGMEA project, Wider Fields University of Bern Participation pp 25 (Manuscript)
http://www.botanischergarten.ch/SIGMEA/SIGMEA-Bern-Final-Report-20090831.pdf

Maize Field I and II from gene flow experiment in Switzerland: spots caused through sowing machine turned around, caused change in flowering synchroni-zation: higher outcrossing, but all results well within the legal threshold of the E

European Safety Attitude: let not the Europeans decide about Biosafety in Africa, **do your own safety assessment**

European safety attitude: a problem for many countries in the developing wo

ASK FORCE: blog debates biosafety

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December 01, 2007, 10:24:19 PM

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Author | Topic: Are Bt toxins killing aquatic insects? (Read 580 times)

PRRI Secretariat
Guest

Are Bt toxins killing aquatic insects?
« **on:** October 26, 2007, 10:12:40 AM »

Quote

Topic:
In an article of PNAS (Proceedings of the National Academy of Sciences, USA) it is reported that aquatic organisms are potentially harmed by residues and toxins of Bt maize.

Source:
Toxins in Transgenic Crop Byproducts May Affect Headwater Stream Ecosystems. Proceedings of the National Academy of Sciences %R 10.1073/pnas.0707177104
By Rosi-Marshall, E.J., Tank, J.L., Royer, T.V., Whiles, M.R., Evans-White, M., Chambers, C., Griffiths, N.A., Pokelsek, J., & Stephen, M.L. (2007)
Online publication: http://www.pnas.org/cgi/reprint/0707177104v2

The abstract:

http://pubresreg.org/index.php?option=com_content&task=blogcategory&id=70&Itemid=71

危机 = 危 + 机

Risk = Hazard / Opportuniy

Widespread definition, but onetrack-minded

Risk = Hazard x Likelyhood

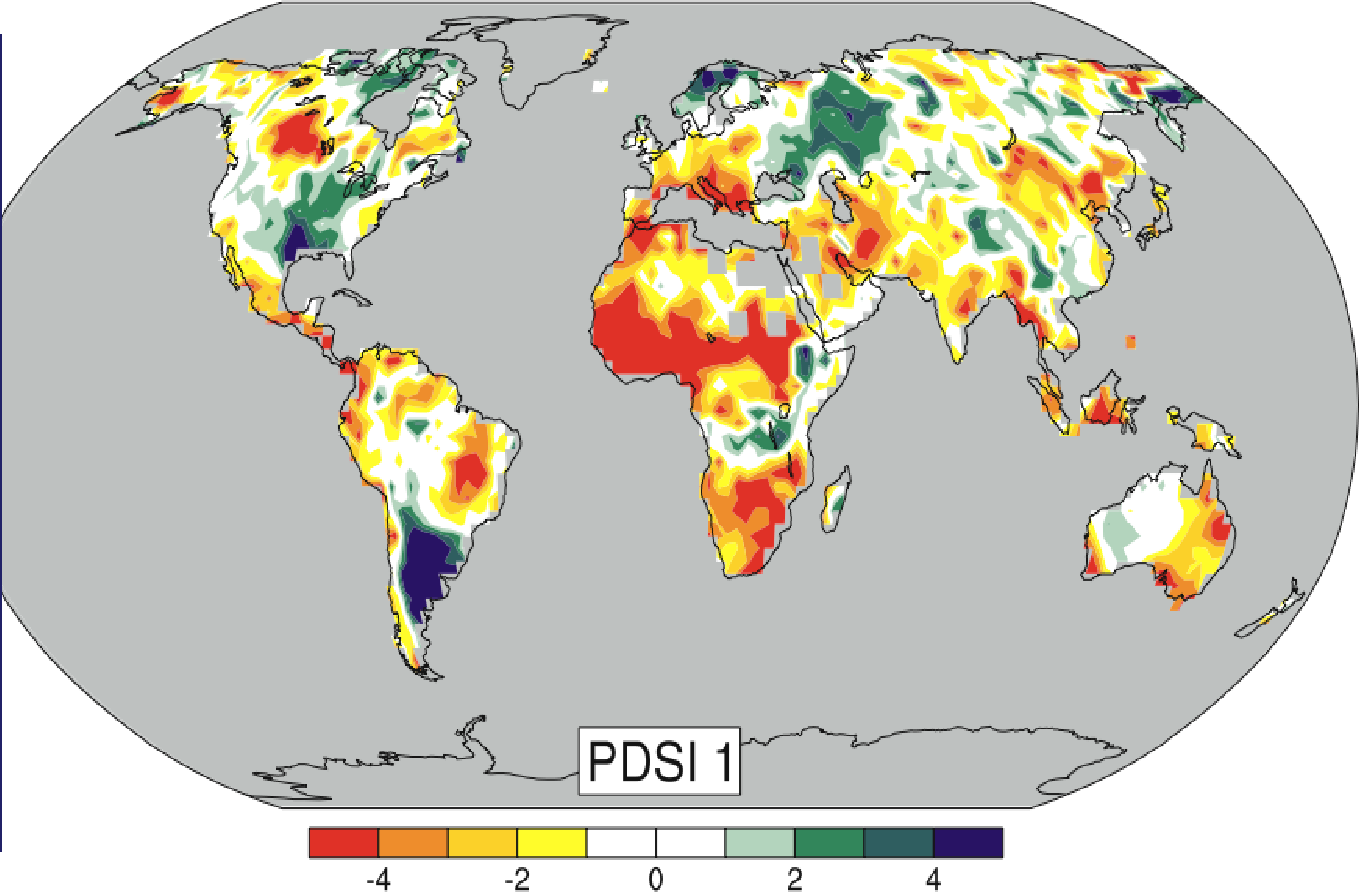
Or worse: Risk = Social bla bla x media frenzy

Ammann, K. (2004)
The Role of Science in the Application of the Precautionary Approach,. *In Molecular Farming, Plant-made Pharmaceuticals and Technical Proteins* (eds R. Fischer & S. Schillberg), Vol. 1, pp. 291-302. Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim, http://www.botanischergarten.ch/Precautionary/Ammann-Precautionary-Approach1.pdf

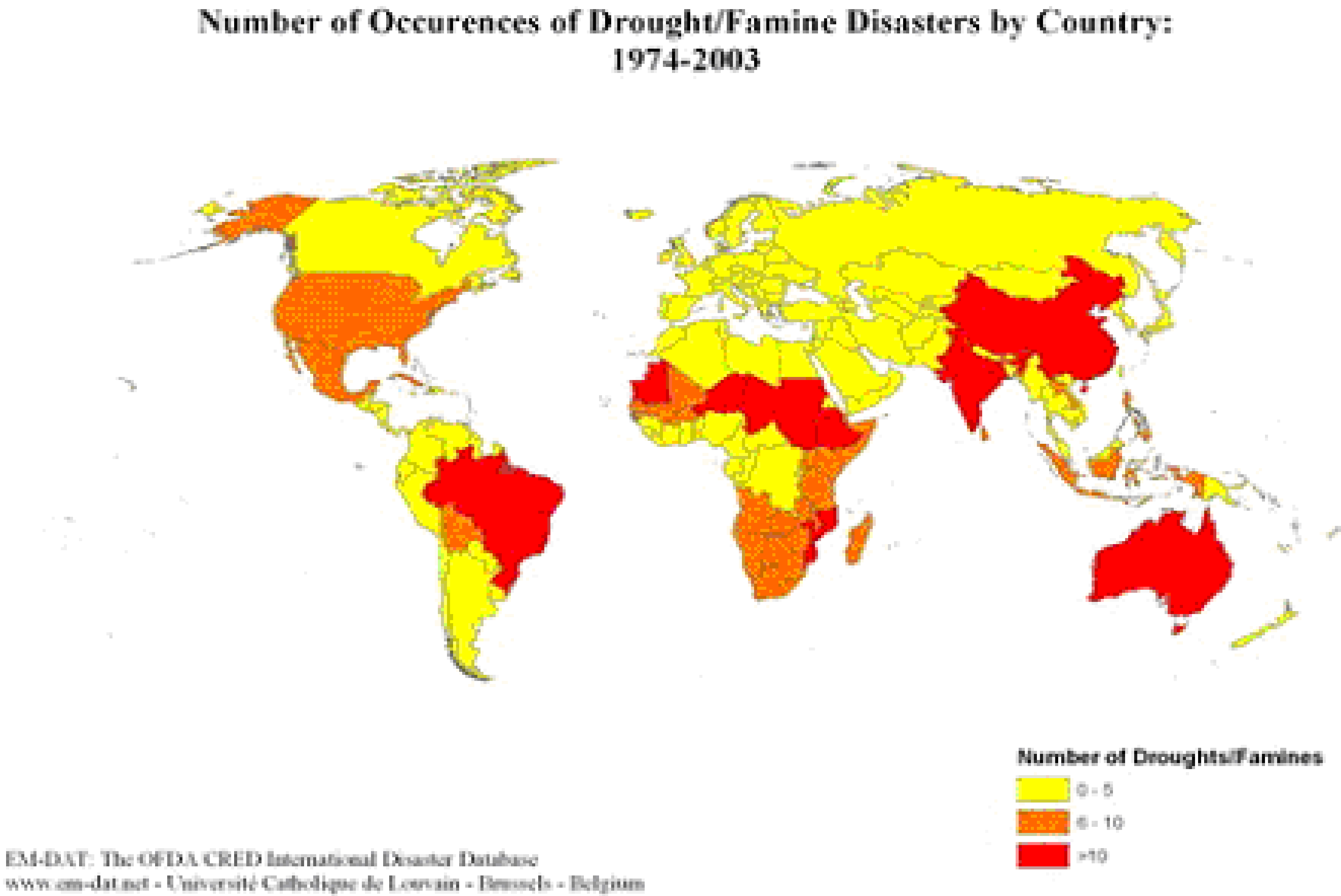
Chinese risk definiti

opportunities

idn.ceos.org/climdiag/Metadata.do?Portal=clim...

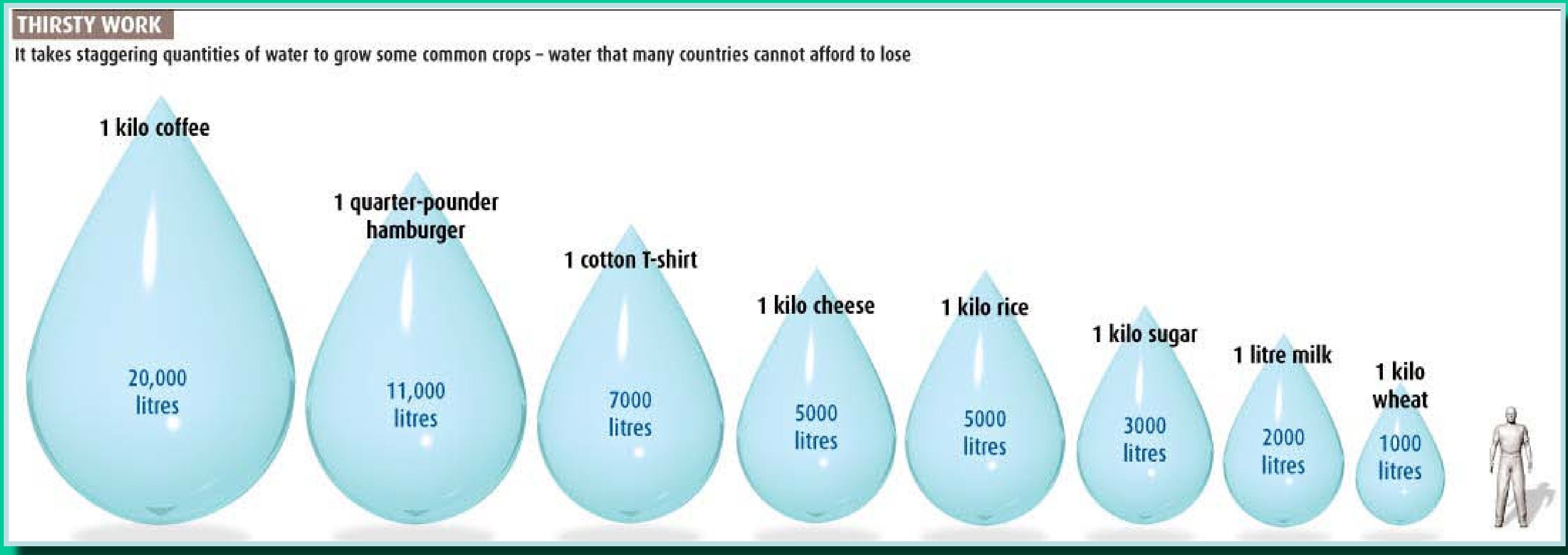


Palmer drought severity index



www.odec.ca/projects/2005/pete5o0/public_html/Pages/Background.html

- **Embedded water** or **hidden water**
- Water used in the production of a good or service In the context of trade



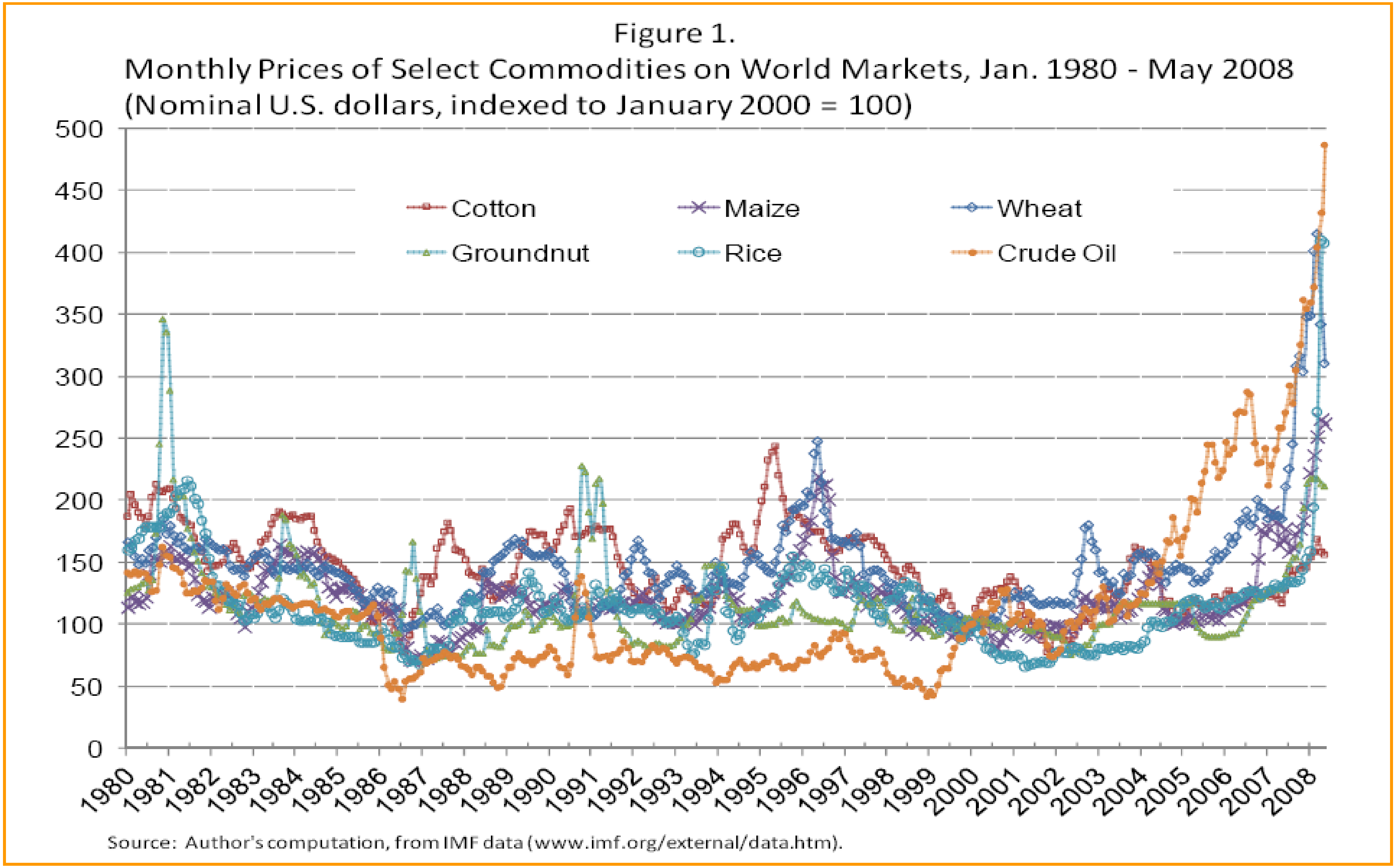
http://technology.newscientist.com/

Relevant examples of genes conferring drought resistance

Table 2
Relevant examples of genes conferring drought tolerance

Genes	Function	Mechanism of action	References
DREBs/CBFs; *ABF3*	Stress induced transcription factors	Enhanced expression of downstream stress related genes confers drought/cold/salt tolerance. Constitutively overexpression can lead to stunting growth	Oh et al. (2005), Ito et al. (2006)
SNAC1	Stress induced transcription factor	*SNAC1* expression reduces water loss increasing stomatal sensitivity to ABA	Hu et al. (2006)
OsCDPK7	Stress induced Ca-dependent protein kinase	Enhanced expression of stress responsive genes	Saijo et al. (2000)
Farnesyl-transferase (*ERA1*)	Negative-regulator of ABA sensing	Down-regulation of farnesyltransferase enhances the plant's response to ABA and drought tolerance reducing stomatal conductance	Wang et al. (2005)
Mn-SOD	Mn-superoxide dismutase	Overexpression improves stress tolerance also in field conditions	McKersie et al. (1996)
AVP1	Vacuolar H^+-pyrophosphatase	Overexpression facilitate auxin fluxes leading to increased root growth	Gaxiola et al. (2001), Park et al. (2005)
HVA1; *OsLEA3*	Stress induced LEA proteins	Over-accumulation of LEA increases drought tolerance also in field conditions	Bahieldin et al. (2005), Xiao et al. (2007)
ERECTA	A putative leucine-rich repeat receptor-like kinase is a major contributor to a locus for Δ on *Arabidopsis* chromosome 2	*ERECTA* acts as a regulator of transpiration efficiency with effects on stomatal density, epidermal cell expansion, mesophyll cell proliferation and cell–cell contact	Masle et al. (2005)
otsA and otsB	*Escherichia coli* trehalose biosynthetic genes	Increased trehalose accumulation correlates with higher soluble carbohydrate levels, elevated photosynthetic capacity and increased tolerance to photo-oxidative damage	Garg et al. (2002)
P5CS	δ-Pyrroline-5-carboxylate synthetase	Enhanced accumulation of proline leads to increased osmotolerance	Kavi Kishor et al. (1995), Zhu et al. (1998)
mtlD	Mannitol-1-phosphate dehydrogenase	Mannitol accumulation leads to increased osmotolerance	Abebe et al. (2003)
GF14λ	14-3-3 protein	Lines overexpressing *GF14λ* have a "stay green" phenotype, improved water stress tolerance and higher photosynthetic rates under water deficit conditions	Yan et al. (2004)
NADP-Me	NADP-malic enzyme	The overexpression decreased stomatal conductance and improves WUE	Laporte et al. (2002)

Cattivelli, L., Rizza, F., Badeck, F.W., Mazzucotelli, E., Mastrangelo, A.M., Francia, E., Mare, C., Tondelli, A., & Stanca, A.M. (2008) Drought tolerance improvement in crop plants: An integrated view from breeding to genomics. Field Crops Research, 105, pp 1-14 http://www.botanischergarten.ch/DroughtResistance/Cattivelli-Drought-Tolerance-2008.pdf



Masters, W.A. (2008)

Beyond the Food Crisis, Aid and Innovation in Africa. ATDF Journal, 5, 1/2, pp 3-15

http://www.botanischergarten.ch/Developing/ATDF-Journal-5-1-2-2008.pdf

Potential crop for dry regions for biofuel production

- India's Planning Commission estimates 1,300 liters of oil per hectare from oilseeds
- Skeptical experts suggest half this value (Fairless, 2007)

Biodiesel crop species	Oil (L/ha)
Oil palm	2,400
Jatropha	*1,300*
Rapeseed (canola)	1,100
Sunflower	690
Soybean	400

Data: United Nations Development Program/World Bank

Project Prof. Margit Laimer, BOKU, Vienna, Austria

Yield potentials

Laminaria hyperborea

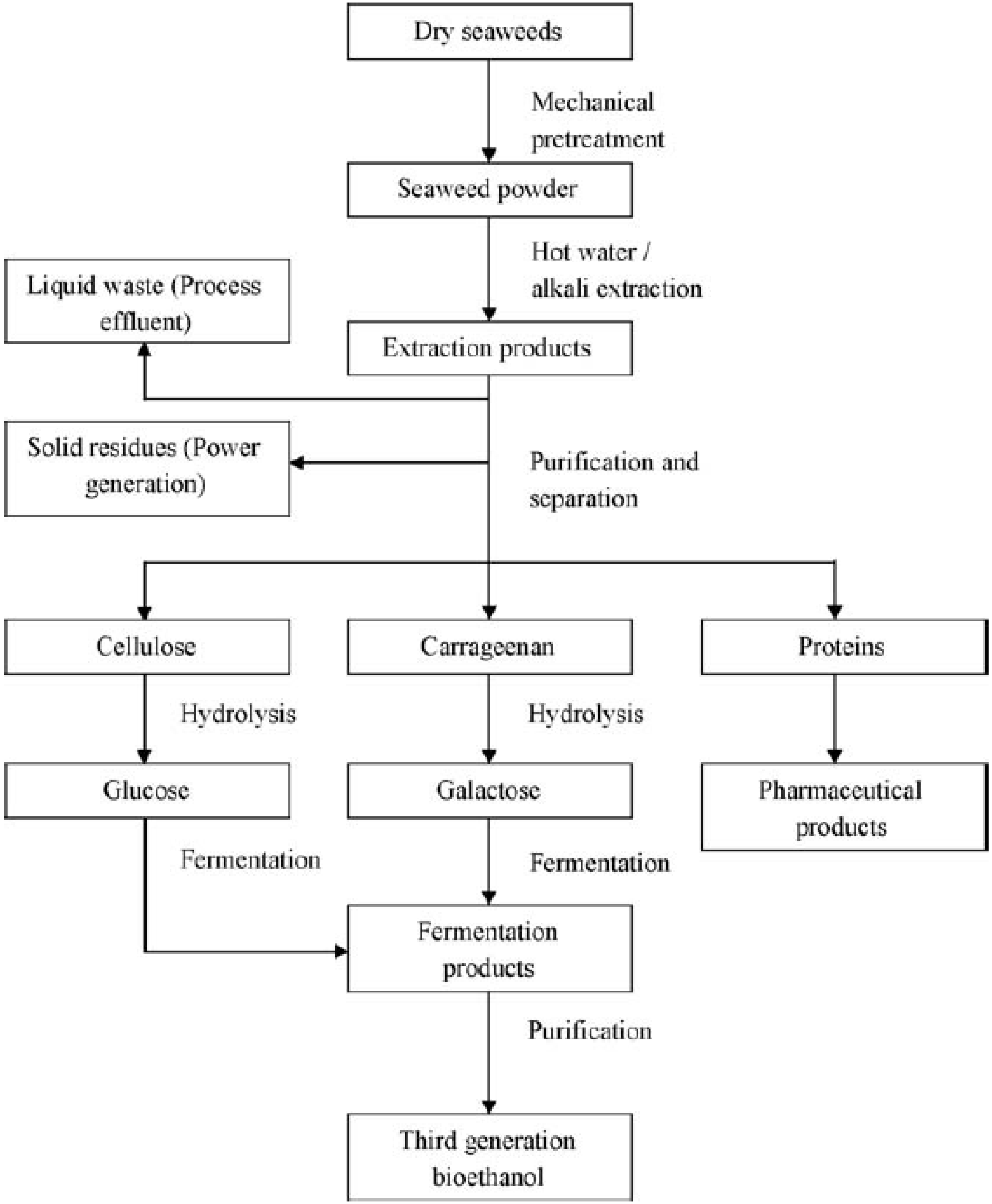
1000 fields
3km long
0.6km broad

harvested
every third year

replaces the
production of
Saudi Arabia
in crude oil

figures from a
prelimininary
project of the
Delft University
of Technology
and Shell

Laminaria and Alaria as suitable macroalgae



Block flow diagram of conversion of seaweeds into TGB using algal biorefineries concept.

Conversion of seaweeds into TGB using algal biorefineries concept. Algal biorefineries concept is a green and zero pollution idea. Incorporating ecotourism with seaweed cultivation and refining would be a wise idea as it complies with the principle of sustainable development. It is also an alternate livelihood option for the coastal economy. Cameron Highland located at Peninsular Malaysia would be a good ecotourism example to follow.

Goh, C.S. & Lee, K.T. (2010) A visionary and conceptual macroalgae-based third-generation bioethanol (TGB) biorefinery in Sabah, Malaysia as an underlay for renewable and sustainable development. Renewable & Sustainable Energy Reviews, 14, 2, pp 842-848 http://www.botanischergarten.ch/Biofuel/Goh-Visionary-Conceptual-Macroalgae-Bioethanol--2010.pdf

PERSPECTIVE

Radically Rethinking Agriculture for the 21st Century

N. V. Fedoroff,[1*] D. S. Battisti,[2] R. N. Beachy,[3] P. J. M. Cooper,[4] D. A. Fischhoff,[5] C. N. Hodges,[6] V. C. Knauf,[7] D. Lobell,[8] B. J. Mazur,[9] D. Molden,[10] M. P. Reynolds,[11] P. C. Ronald,[12] M. W. Rosegrant,[13] P. A. Sanchez,[14] A. Vonshak,[15] J.-K. Zhu[16]

Population growth, arable land and fresh water limits, and climate change have profound implications for the ability of agriculture to meet this century's demands for food, feed, fiber, and fuel while reducing the environmental impact of their production. Success depends on the acceptance and use of contemporary molecular techniques, as well as the increasing development of farming systems that use saline water and integrate nutrient flows.

Fedoroff, N.V., Battisti, D.S., Beachy, R.N., Cooper, P.J.M., Fischhoff, D.A., Hodges, C.N., Knauf, V.C., Lobell, D., Mazur, B.J., Molden, D., Reynolds, M.P., Ronald, P.C., Rosegrant, M.W., Sanchez, P.A., Vonshak, A., & Zhu, J.-K. Radically Rethinking Agriculture for the 21st Century. Science, 327, 5967, pp 833-834

http://www.sciencemag.org/cgi/content/abstract/327/5967/833 AND Podcast http://www.sciencemag.org/cgi/content/full/sci;327/5967/833/DC1 AND http://www.botanischergarten.ch/Regulation/Fedorof-Radically-Rethinking-2010.pdf

Fig. 1. Saline farming. Upper and lower right, brackish-water agriculture and tomato farming, Negev desert, Israel; center, saline farming of the halophyte salicornia, Eritrea.

Saline Farming

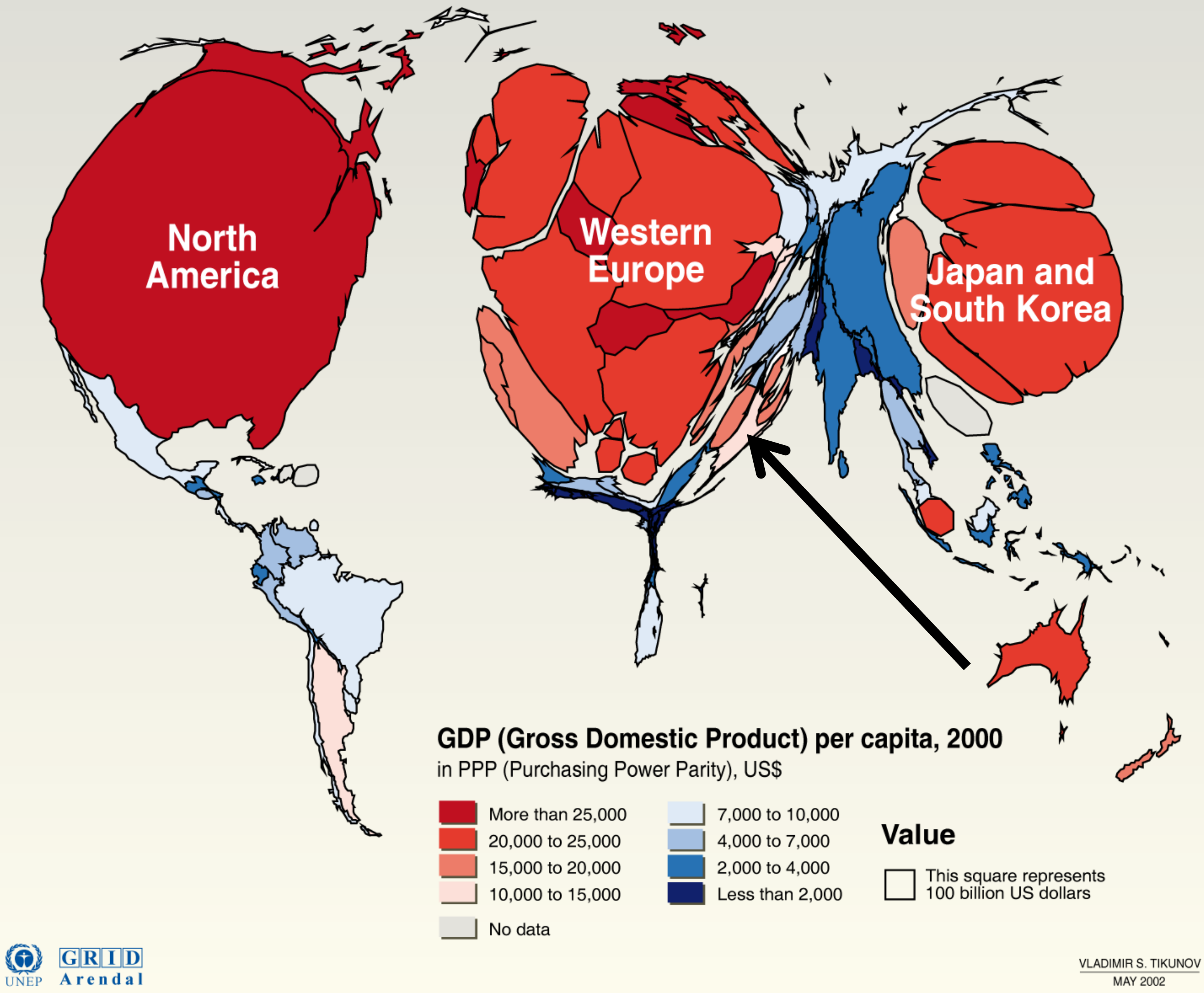
Fedoroff, N.V., Battisti, D.S., Beachy, R.N., Cooper, P.J.M., Fischhoff, D.A., Hodges, C.N., Knauf, V.C., Lobell, D., Mazur, B.J., Molden, D., Reynolds, M.P., Ronald, P.C., Rosegrant, M.W., Sanchez, P.A., Vonshak, A., & Zhu, J.-K. Radically Rethinking Agriculture for the 21st Century. Science, 327, 5967, pp 833-834
Podcast
http://www.sciencemag.org/cgi/content/full/sci;327/5967/833/DC1 AND
http://www.botanischergarten.ch/Regulation/Fedorof-Radically-Rethinking-2010.pdf

Salicornia

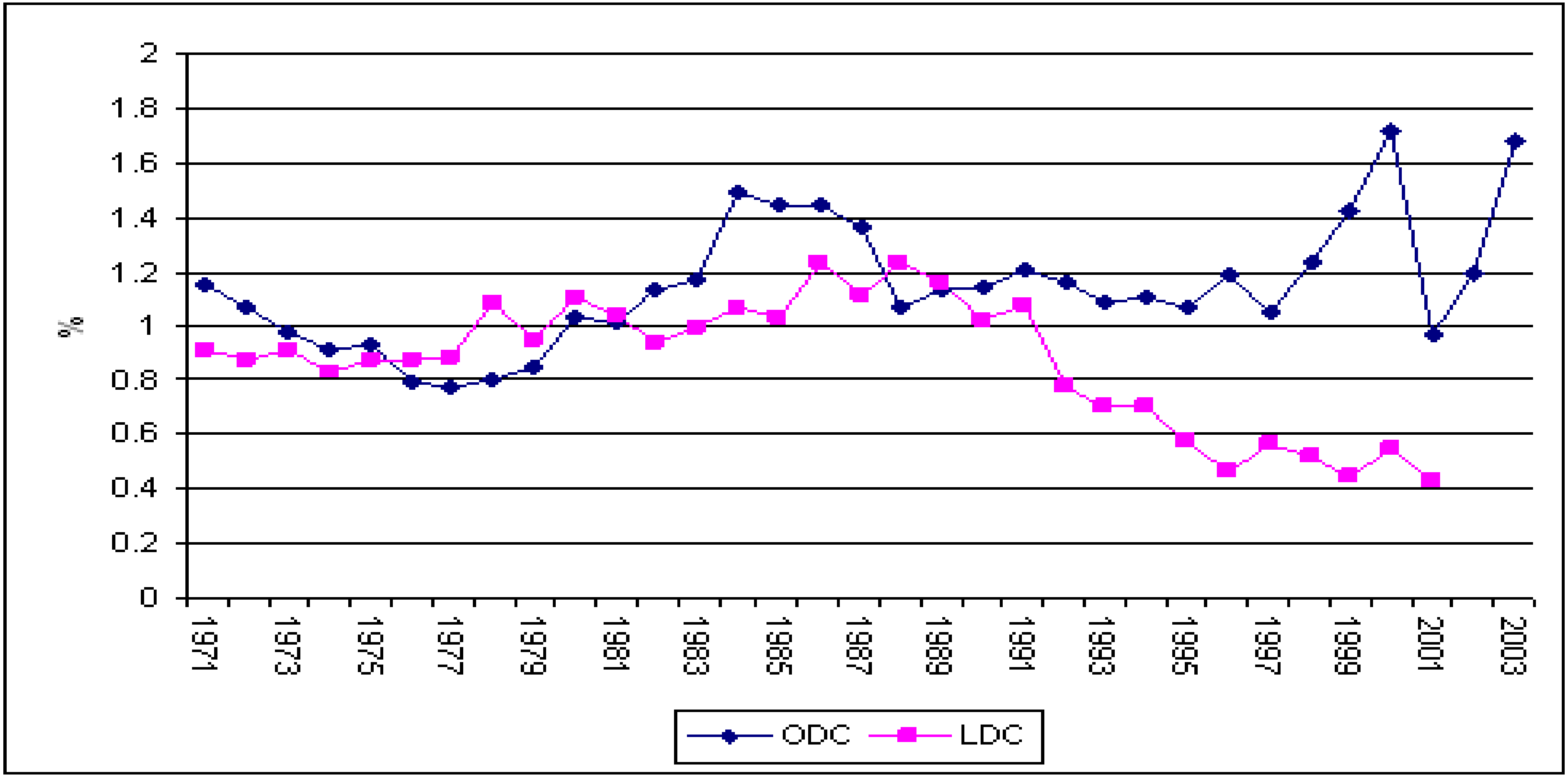
with great potential in coastal situations of desert countries like the Gulf States and Israel

several annual and perennial species and other gen**era**

AN ALTERNATIVE VIEW OF THE WORLD



Agricultural research intensity in the Least Developed Countries (LDCs) and other developing countries (ODC), 1971-2003
Investment in agricultural research as % of agricultural output



Bell, M. (2007)
The Least Developed Countries, UNCTAD Report 2007, UNCTAD pp 134 Background Paper No. 10 (Report)
http://www.unctad.org/sections/ldc_dir/docs/ldcr2007_Bell_en.pdf

INTERNATIONAL FOOD
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REPORT

THE WORLD FOOD SITUATION

New Driving Forces and Required Actions

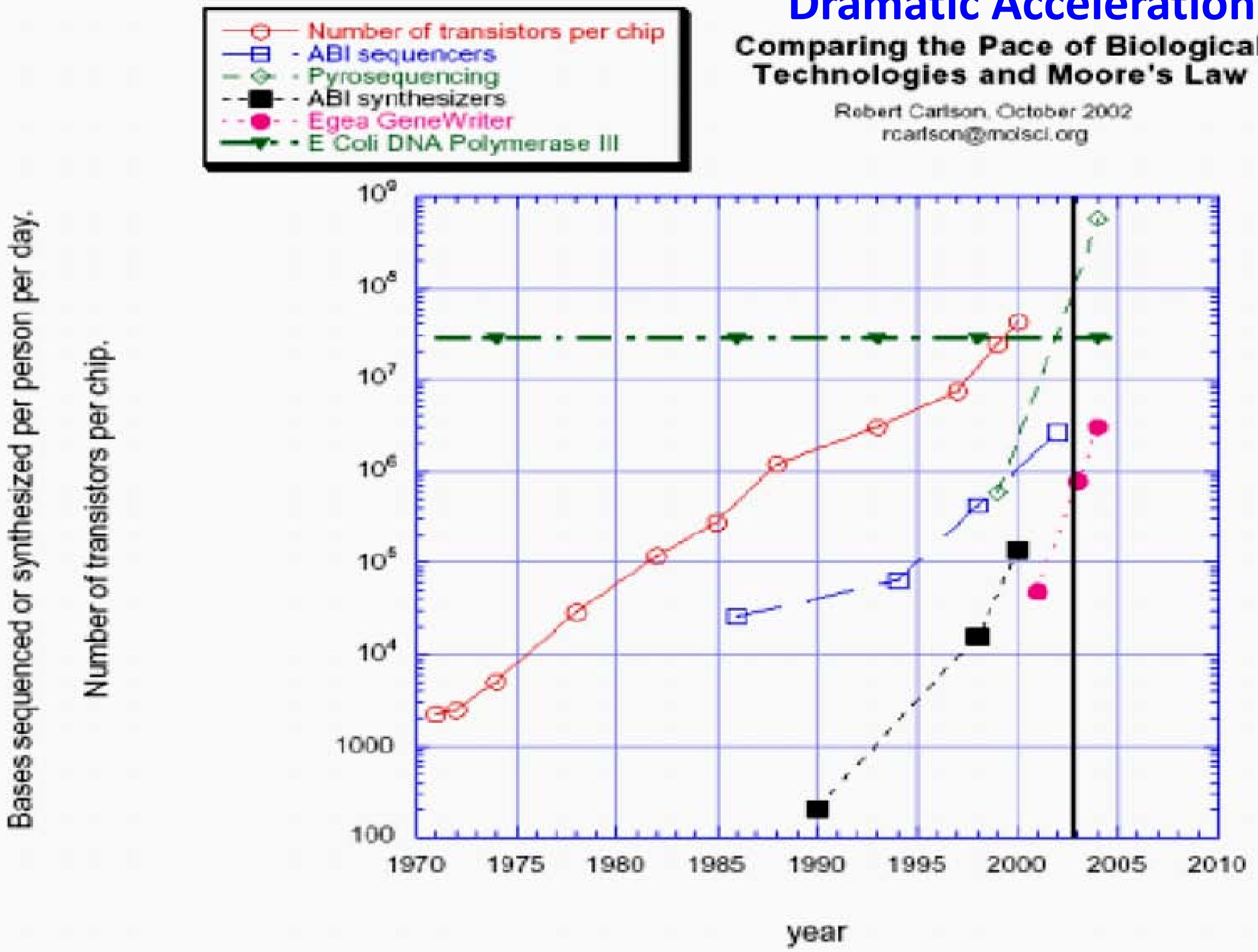
Joachim von Braun

The world food situation is currently being rapidly redefined by new driving forces. Income growth, climate change, high energy prices, globalization, and urbanization are transforming food consumption, production, and markets. The influence of the private sector in the world food system, especially the leverage of food retailers, is also rapidly increasing. Changes in food availability, rising commodity prices, and new producer-consumer linkages have crucial implications for the livelihoods of poor and food-insecure people. Analyzing and interpreting recent trends and emerging challenges in the world food situation is essential in order to provide policymakers with the necessary information to mobilize adequate responses at the local, national, regional, and international levels. It is also critical for helping to appropriately adjust research agendas in agriculture, nutrition, and health. Not surprisingly, renewed global attention is being given to the role of agriculture and food in development policy, as can be seen from the World Bank's World Development Report, accelerated public action in African agriculture under the New Partnership for Africa's Development (NEPAD), and the Asian Development Bank's recent initiatives for more investment in agriculture, to name just a few examples.

Von Braun Joachim (2007)
The World Food Situation, New Driving Forces and Required Actions IFPRI, International Food Policy Research Institute, Washington DC., IS: ISBN 10-digit: 0-89629-530-3, ISBN 13-digit: 978-0-89629-530-8, pp 27
http://www.ifpri.org/publication/world-food-situation-2

Prometheus Unbound: Revolutionary Advances in Biological Technologies

Dramatic Acceleration in Analysis



Carlson, R. (2003)
The Pace and Proliferation of Biological Technologies. Biosecurity and Bioterrorism: Biodefense Strategy, Practice, and Science, 1, 3, pp 203-214
http://www.botanischergarten.ch/Genomics/Carlson-Pace-Proliferation-2003.pdf

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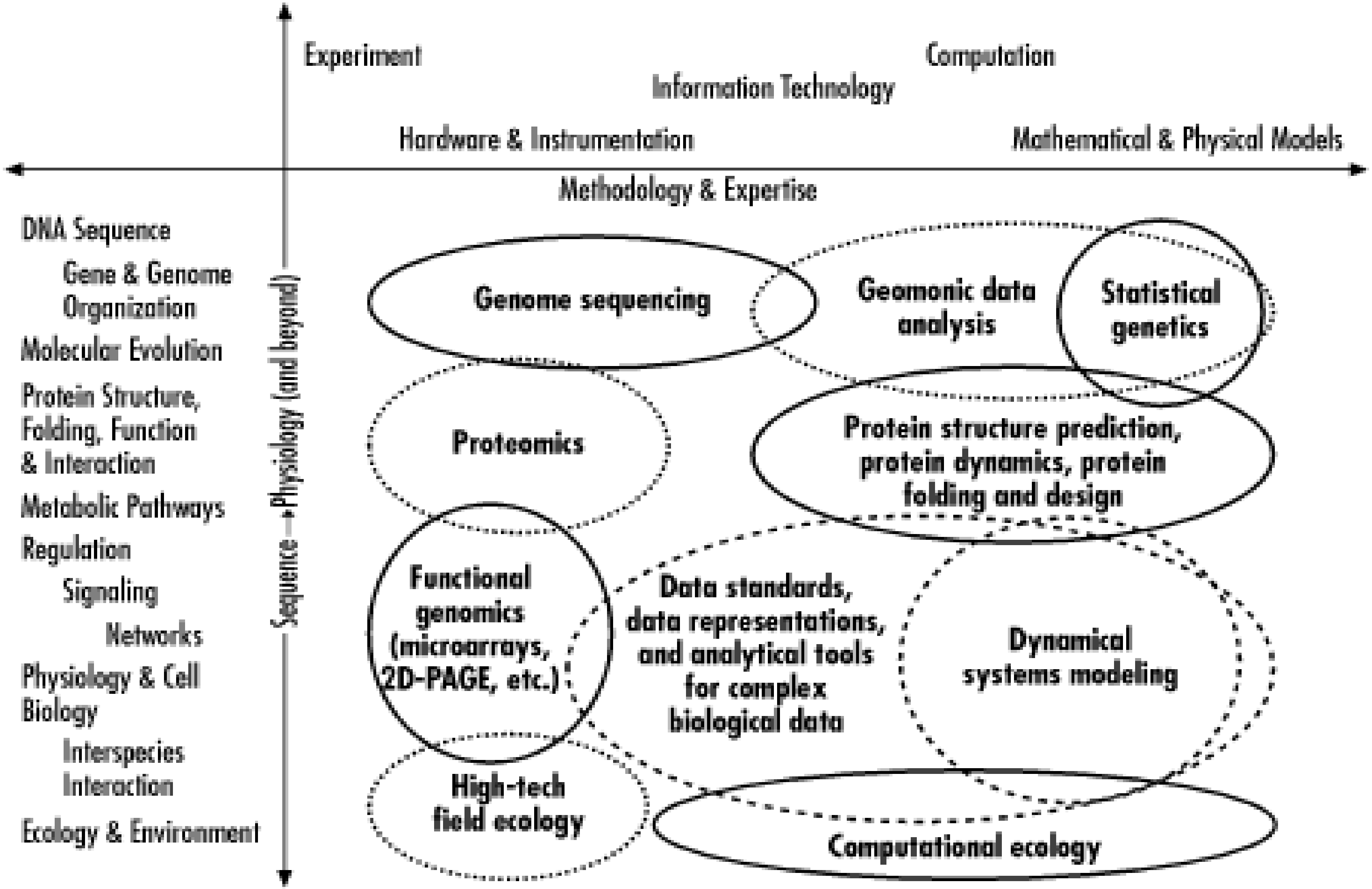
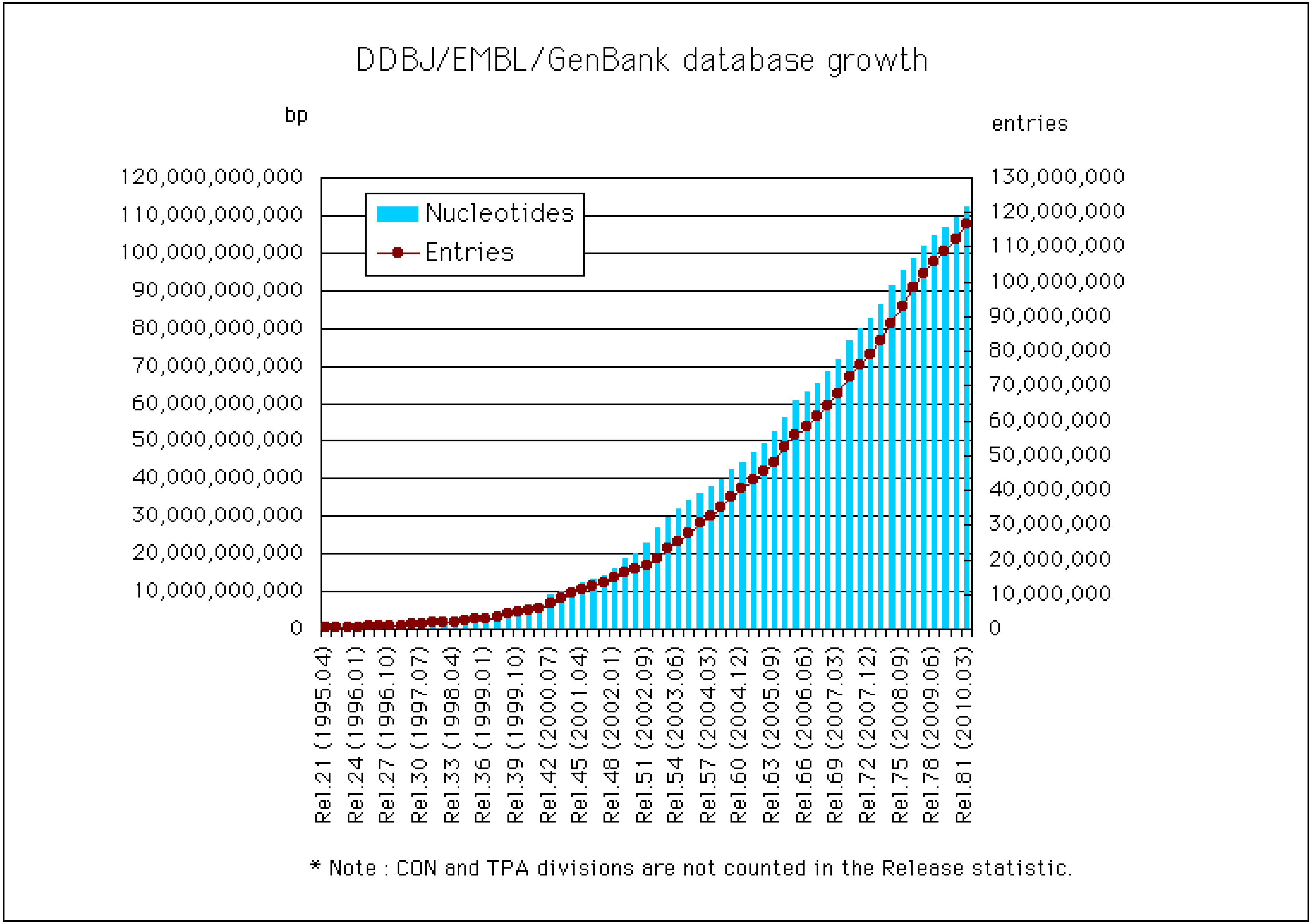


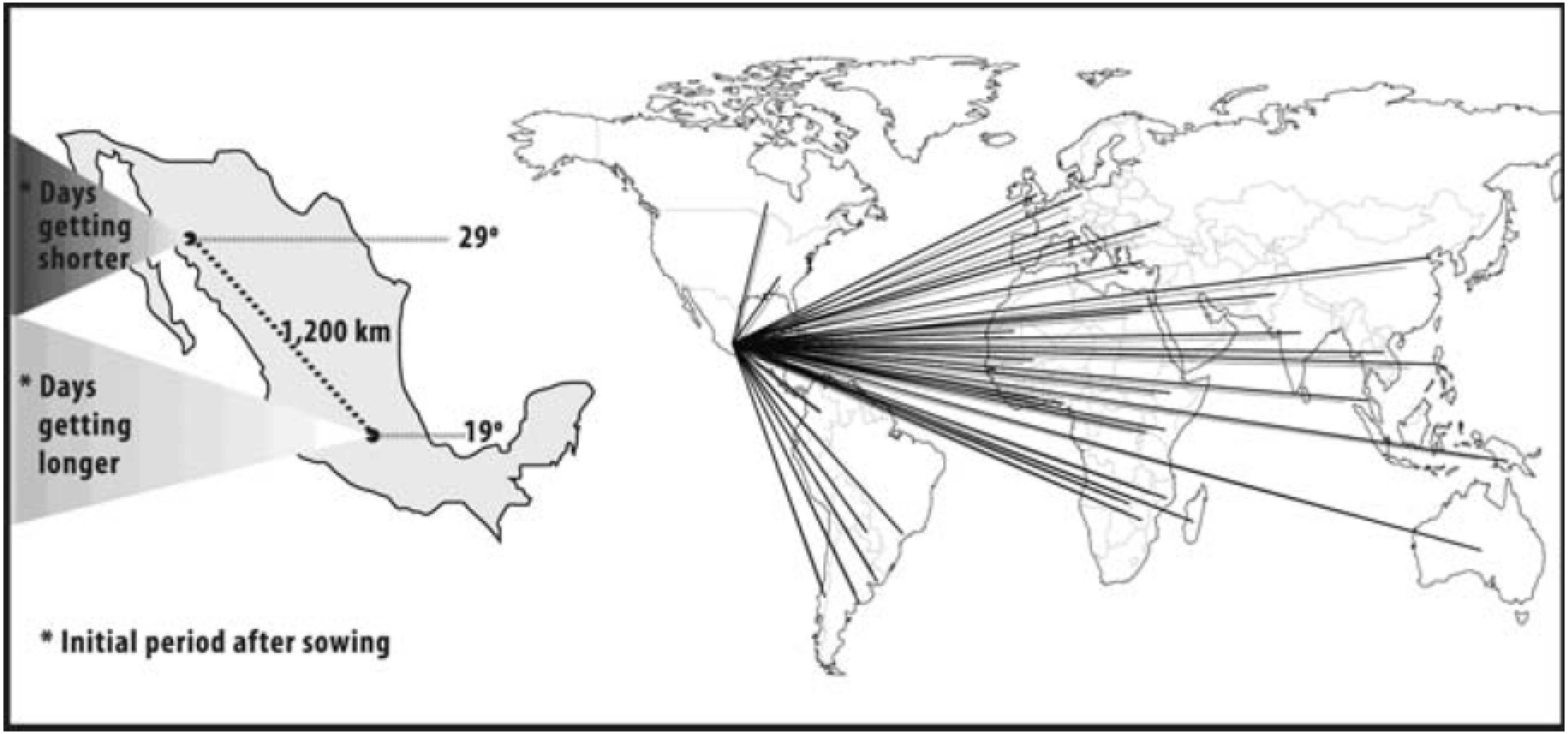
Gibas, C. & Jambeck, P. (2001)
Developing Bioinformatics Computer Skills *In Developing Bioinformatics Conputer Skills, an Introduction to Software Tools for Biological Applications*, pp. 446. O-Reilly http://oreilly.com/news/bioinformatics_0401.html AND http://oreilly.com/news/bioint_0501.html



http://www.ddbj.nig.ac.jp/images/breakdown_stats/DBGrowth-e.gif

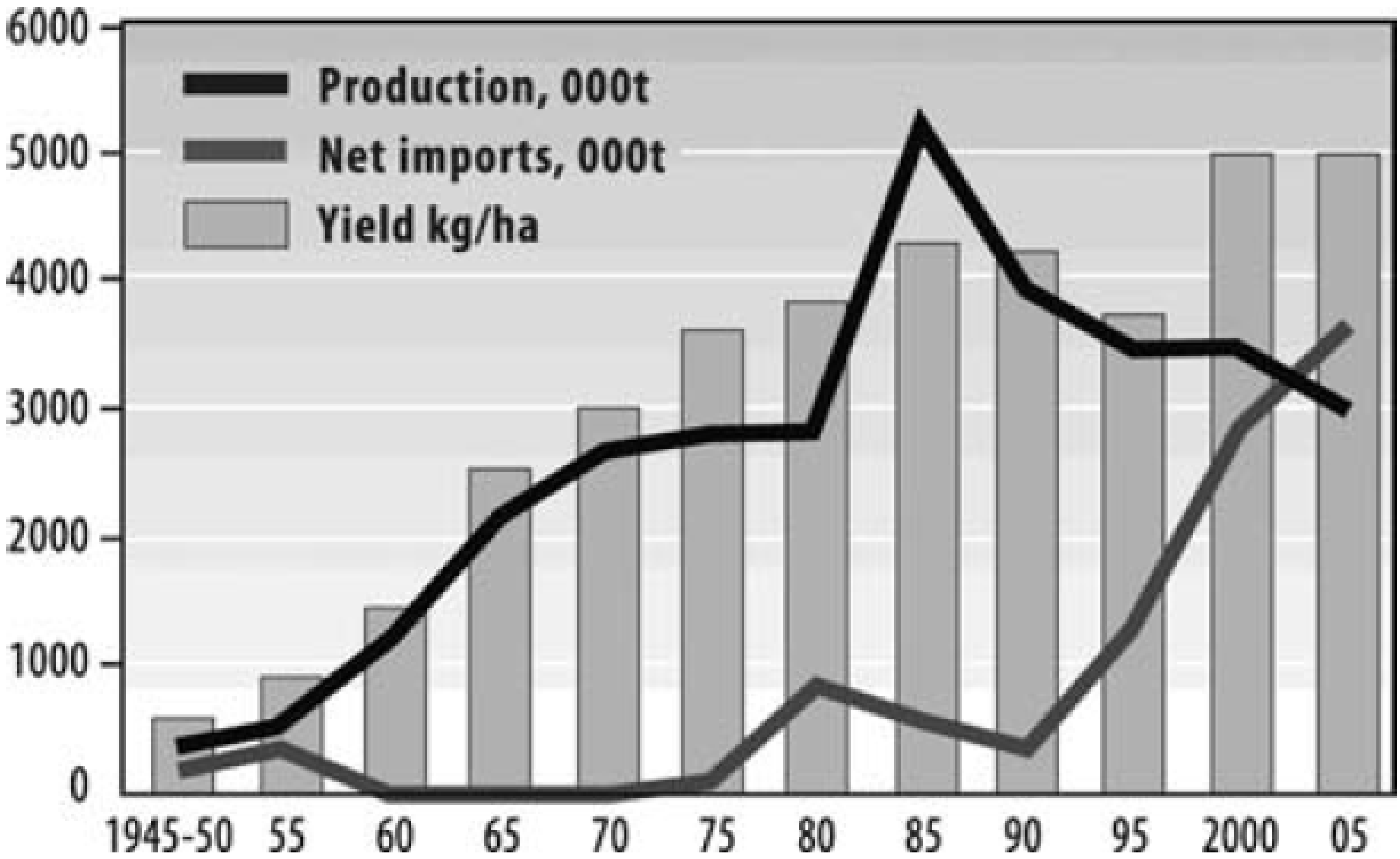
outside London airport mid August 2007: Their slogan: "We are armed ... only with peer reviewed science". www.flickr.com/photos/naturewise/1174298274/

Hommage to Norman Borlaug 2010



Shuttle breeding and multi-location international testing produced the broadly adapted Mexican wheat that triggered the green revolution

Borlaug, N.E. (2007)
Sixty-two years of fighting hunger: personal recollections. Euphytica, 157, 3, pp 287-297
http://www.botanischergarten.ch/Developing/Borlaug-Sixtytwo-Years-2007.pdf



Wheat production, yields and net imports in Mexico

Borlaug, N.E. (2007)
Sixty-two years of fighting hunger: personal recollections. Euphytica, 157, 3, pp 287-297
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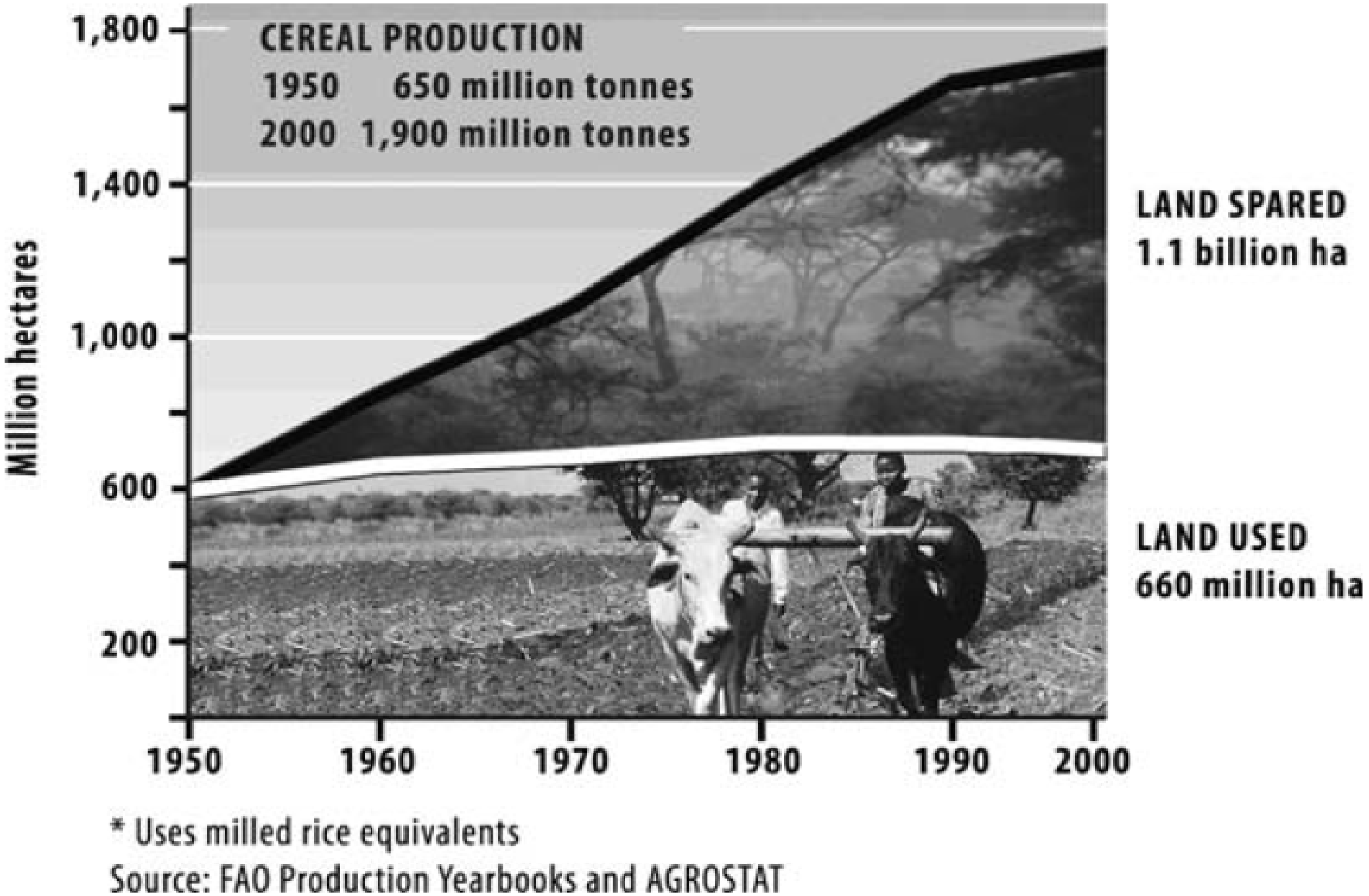

World cereal* production areas saved through improved technology, 1950–2000

Borlaug, N.E. (2007)
Sixty-two years of fighting hunger: personal recollections. Euphytica, 157, 3, pp 287-297
http://www.botanischergarten.ch/Developing/Borlaug-Sixtytwo-Years-2007.pdf

Norman Borlaug 2000

Extreme environmental elitists seem to be doing everything they can to derail scientific progress.

Small, well-financed, vociferous, and antiscience groups are threatening the development and application of new technology, whether it is developed from biotechnology or more conventional methods of agricultural science.

Borlaug, N.E. (2000)
Ending world hunger. The promise of biotechnology and the threat of antiscience zealotry. Plant Physiology, 124, 2, pp 487-490
http://www.botanischergarten.ch/Developing/Borlaug-Antiscience-2000.pdf

Norman Borlaug 2007

Those of us on the food front still have a big job ahead of us.

So let's get on with the job. Most of those who are in attendance today will face the challenge of producing the science and technology to increase world cereal production by at least 50% over the next two decades, and to do so in environmentally more sustainable ways. There is no room for complacency.

Borlaug, N.E. (2007)
Sixty-two years of fighting hunger: personal recollections. Euphytica, 157, 3, pp 287-297
http://www.botanischergarten.ch/Developing/Borlaug-Sixtytwo-Years-2007.pdf