How Much Did You Pay for Your Food Today?

Peggy G. Lemaux
University of California, Berkeley
http:/ucbiotech.org
http://pmb.berkeley.edu/~lemauxlab

CHINA
$155.06

CANADA
$345

Each amount is the total for food for a family of 4 for a week.

INDIA
$39.27

MEXICO
$189.09

GERMANY
$500.07
HIGHEST

CHAD
$1.23
LOWEST

Where Does California Rank?

Which means $5.68/day/ person

USA (California)
$159.18

So, what if I told you, I would give you $30 for food for today, would you take it?

But, wait, actually it has to pay for a month of food

And everything else you need to live – shelter, transportation, clothing!!

A student from Sacramento State took me up on the challenge – What happened?

I actually made the $30 last for 3 weeks! I originally weighed 187.6 lbs; I currently weigh 173. I spent the money on bread, peanut butter, jelly and honey…bread to meet the carbs requirement and peanut butter and jelly to meet the protein, fiber, sodium and sugar requirements.

Ricky Lazaro Jr.

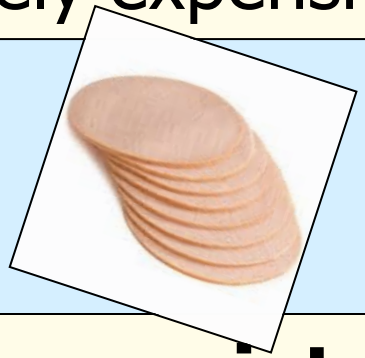


Ricky paid attention to what foods he bought – to get a good variety to meet his dietary needs.

What about a 2012 PHS116 student?

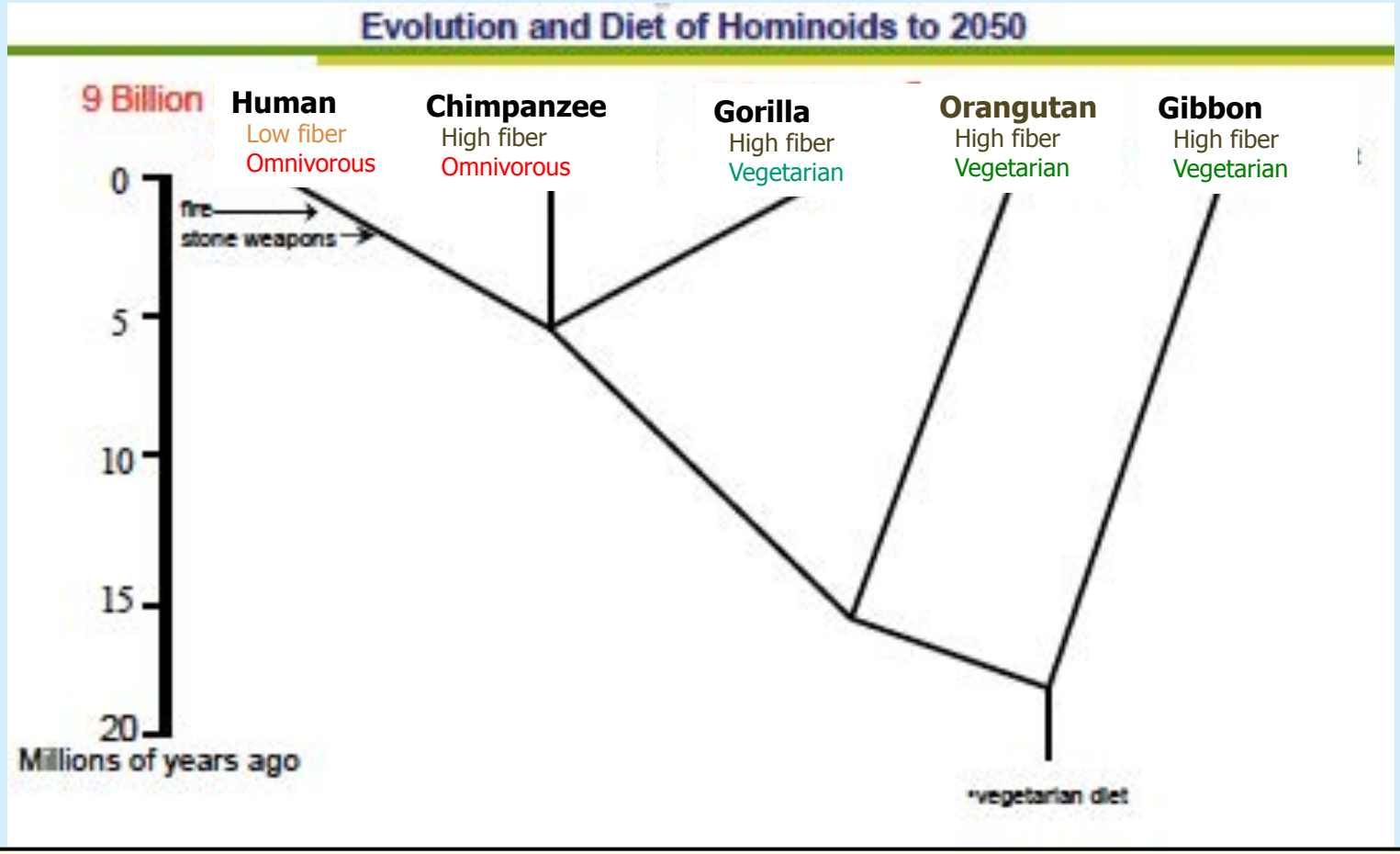
Student's response to the challenge

I lasted 22 days, eating only Texas Toast and bologna…The bread and meat were high calorie, low cost. I did not get vegetables or fruits because they are comparatively expensive.



Did this person make appropriate dietary choices based on his body's health needs?

Do Americans in general make appropriate choices? Let's take a look at the history of food consumption…



Human diets changed over millions of years from high-fiber vegetarian diets for primates to low-fiber omnivorous diets for humans

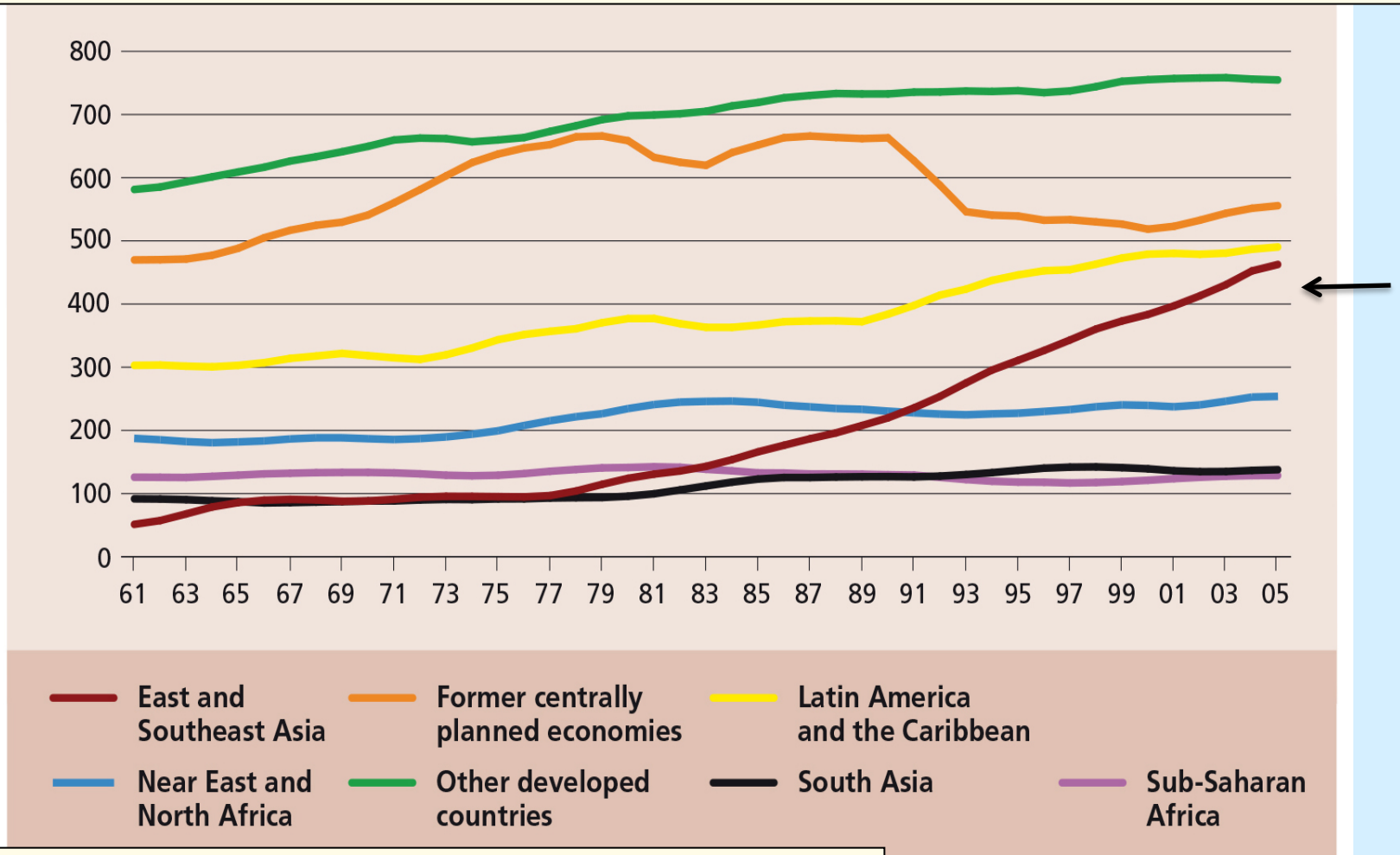
What impact does this have on human health and the environment?

Human Health Effects: There Are Lipid-lowering Benefits from Consuming a High-Fiber Diet of Fruits and Vegetables

	Cholesterol-lowering (Reduced total, saturated fat, cholesterol)	High-Fiber Starch-Based Neolithic	High-Fiber Vegetable-Based Simian
Vegetable Protein (g/d)	28	64	93
Total Dietary Fiber (g/d)	26	46	143
Phytosterols (g/d) (Reduce cholesterol levels)	0.3	0.5	1.0
Nuts (almonds & hazelnuts) (g/d)	0	0	70

There are positive health effects from high-fiber, vegetarian diets that lower serum lipid levels

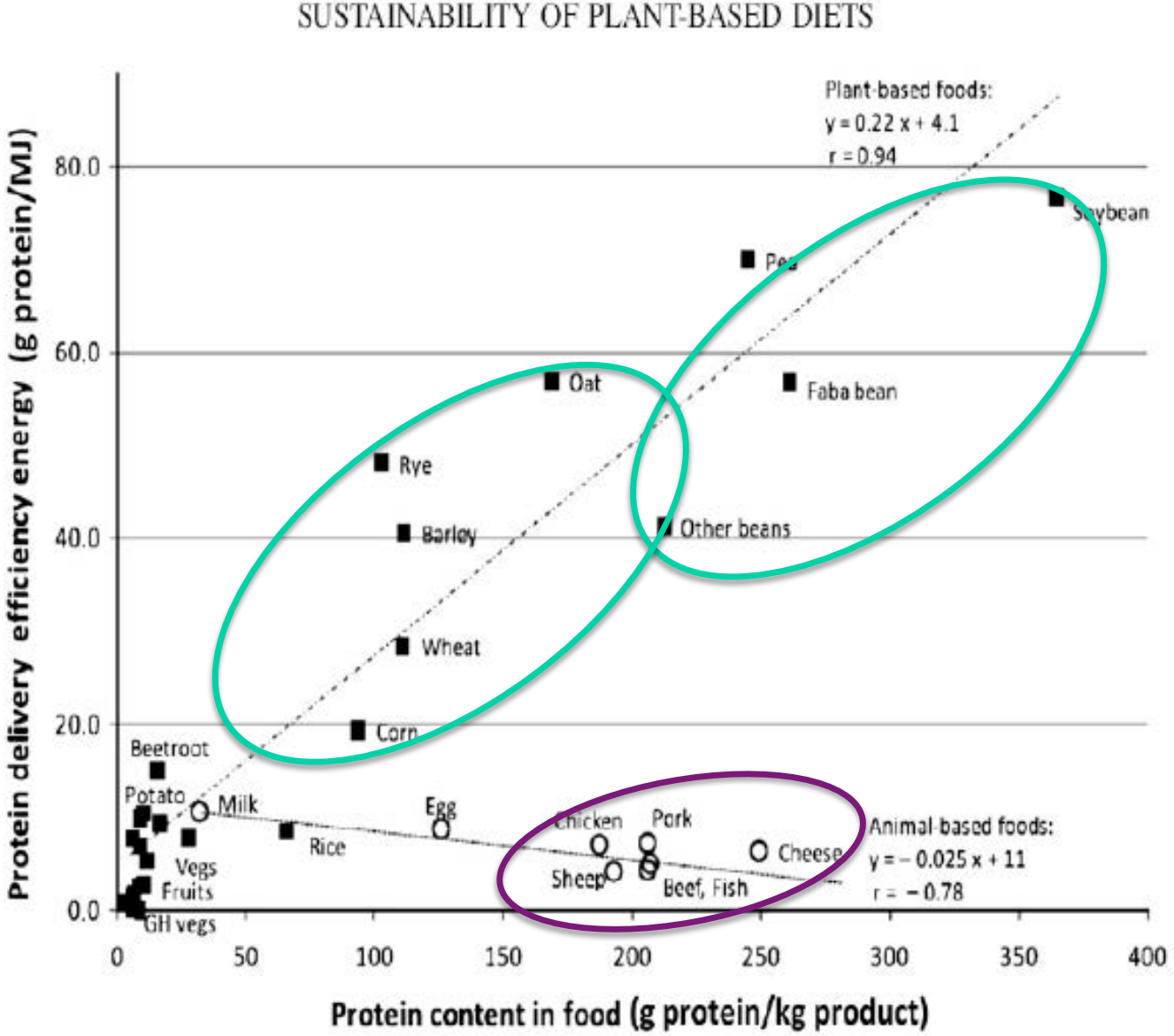
Environmental impacts:
Switching from high-fiber, vegetarian diet causes massive increases in meat consumption –especially developing countries



ding butter). *Source:* FAO, 2009b.

Consumption of Energy via Meat Per Capita, Is Rising Rapidly in S.E. Asia

od The state of food and agriculture 2009: Livestock in e, 2009. ISBN 978-92-5-106215-9. http://www.fao.org/docrep/012/i0680e/i0680e00.htm



Why is switching to a meat-based diet an environmental issue?
Protein delivery efficiency (energy in vs. energy out) is <u>very different</u> between plant-based foods and meat

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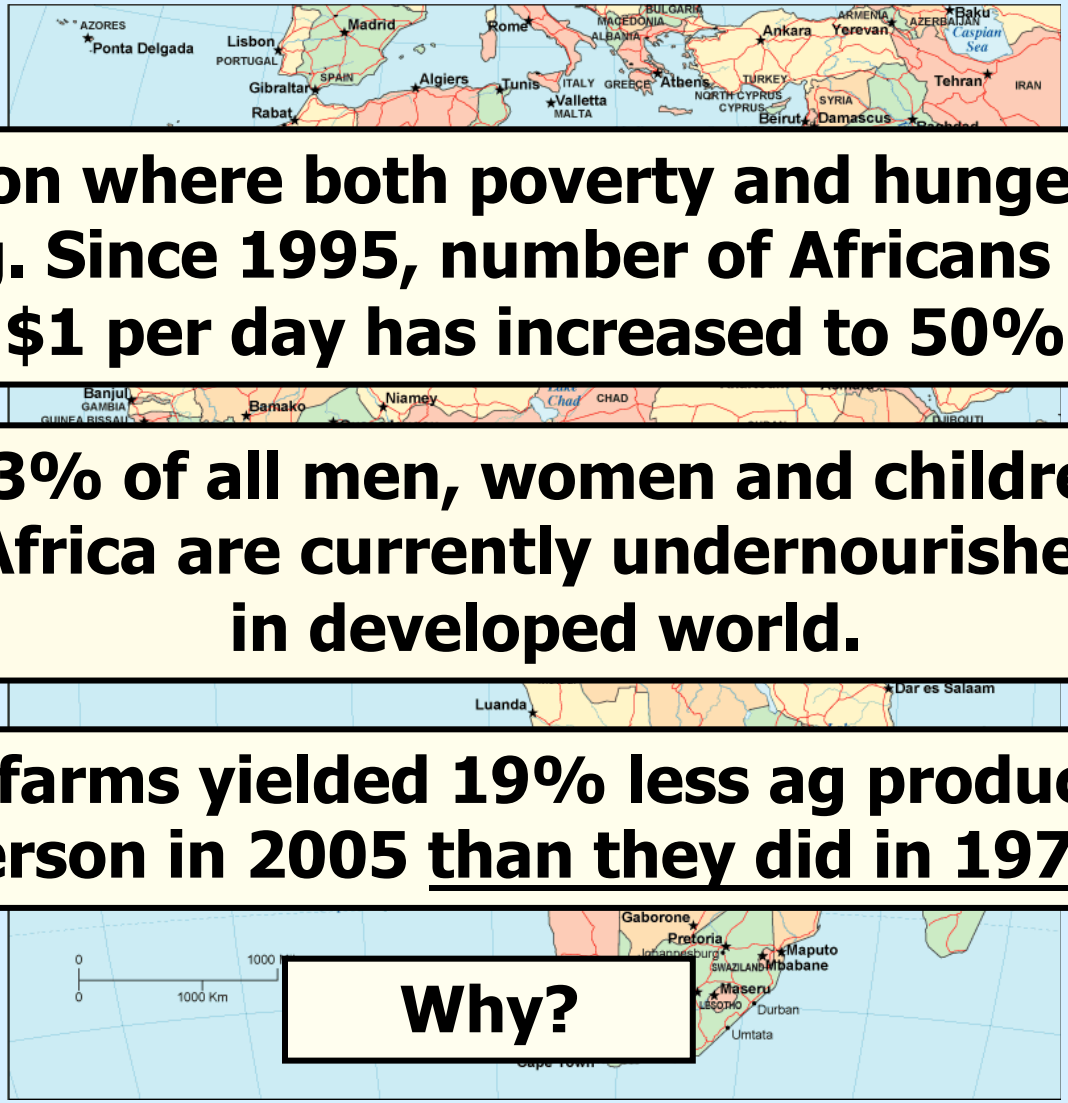
So…

Failure to direct human food consumption toward plant-based foods could have major human health and environmental consequences.

Conclusion: Plants ARE IMPORTANT!!

Have you ever thought how lucky you are to have the variety, quality and quantity of fresh fruits and vegetables to eat?

But, the situation with food availability in less developed countries, like Africa, requires a different perspective. Why?



Only region where both poverty and hunger continue increasing. Since 1995, number of Africans living on < $1 per day has increased to 50%.

Nearly 33% of all men, women and children in sub-Saharan Africa are currently undernourished vs. 17% in developed world.

African farms yielded 19% less ag production per person in 2005 than they did in 1970!!

Why?

From "Starved for Science: How Biotechnology Is Being Kept out of Africa" by R. Parlberg 2008

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Senegal

United States

Technologies used for agriculture in Africa and other developing countries are different from those in the developed world…

And crop yields vary dramatically from the developed world

CROP	YIELD (kilograms per hectare)			
	Kenya	Ethiopia	India	Developed World
Maize	1,640	2,006	1,907	8,340
Sorghum	1,230	1,455	797	3,910
Rice	3,930	1,872	3,284	6,810
Wheat	2,310	1,469	2,601	3.110
Chickpea	314	1,026	814	7,980

5X

3X

25X

WHY?

Many reasons…among them is lack of genetic improvement to give higher yields under their specific growing conditions.

In developed world how have we made genetic improvements to increase yields?

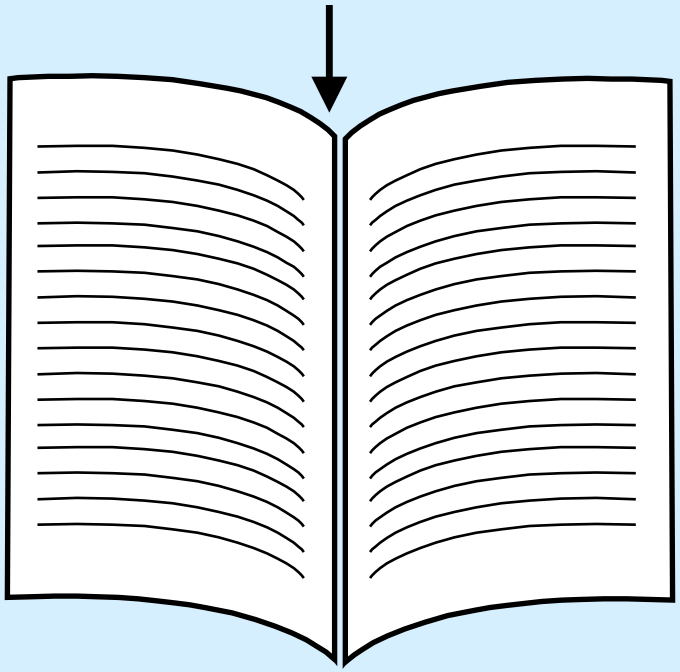
Triticum monococcum
Ancient variety

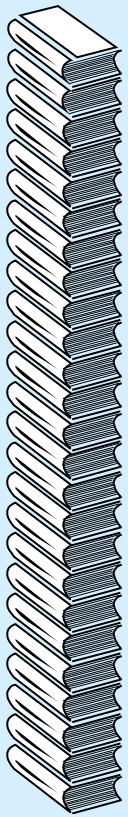
Triticum aestivum
Modern bread variety

Information in the wheat genome

Chemical units represented by alphabetic letters

...CTGACCTAATGCCGTA...



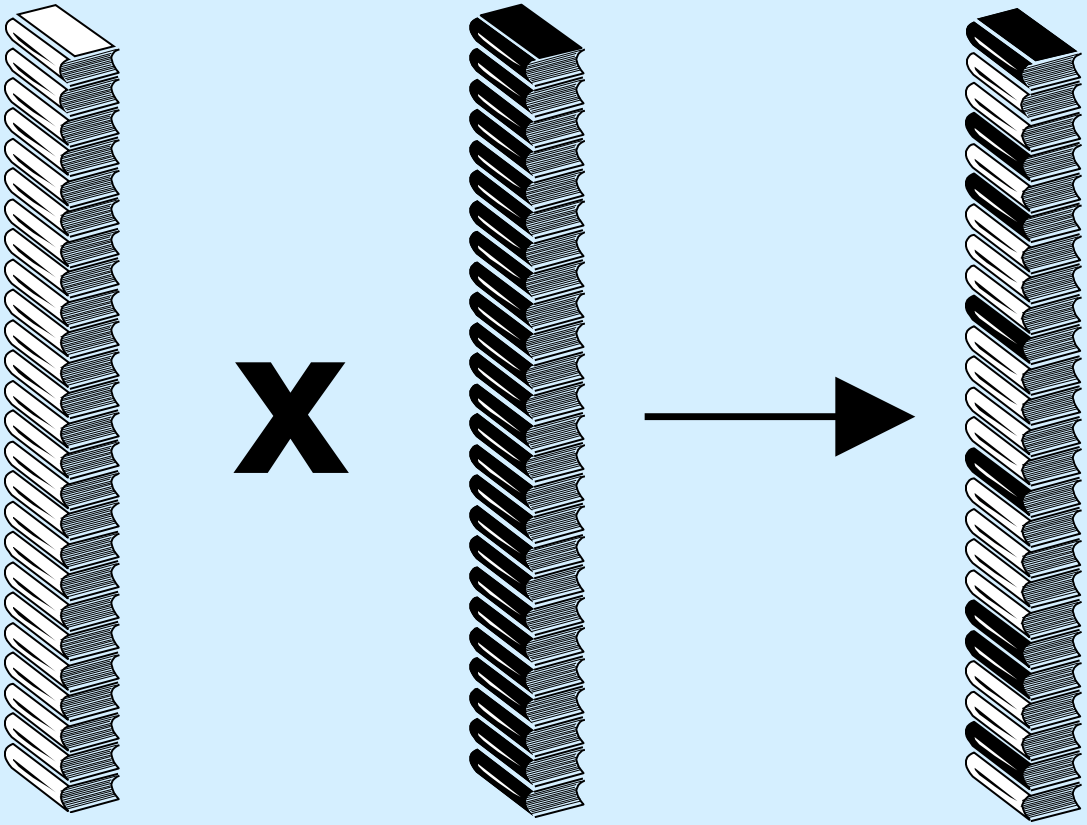


1700 books
1000 pages each

1700 books
(or 1.7 million pages)

Classical breeding

Two wheat varieties with some of the same and some different information in their books



Random retention of information: ~50% from each parent

1700 books (or 1.7 million pages)

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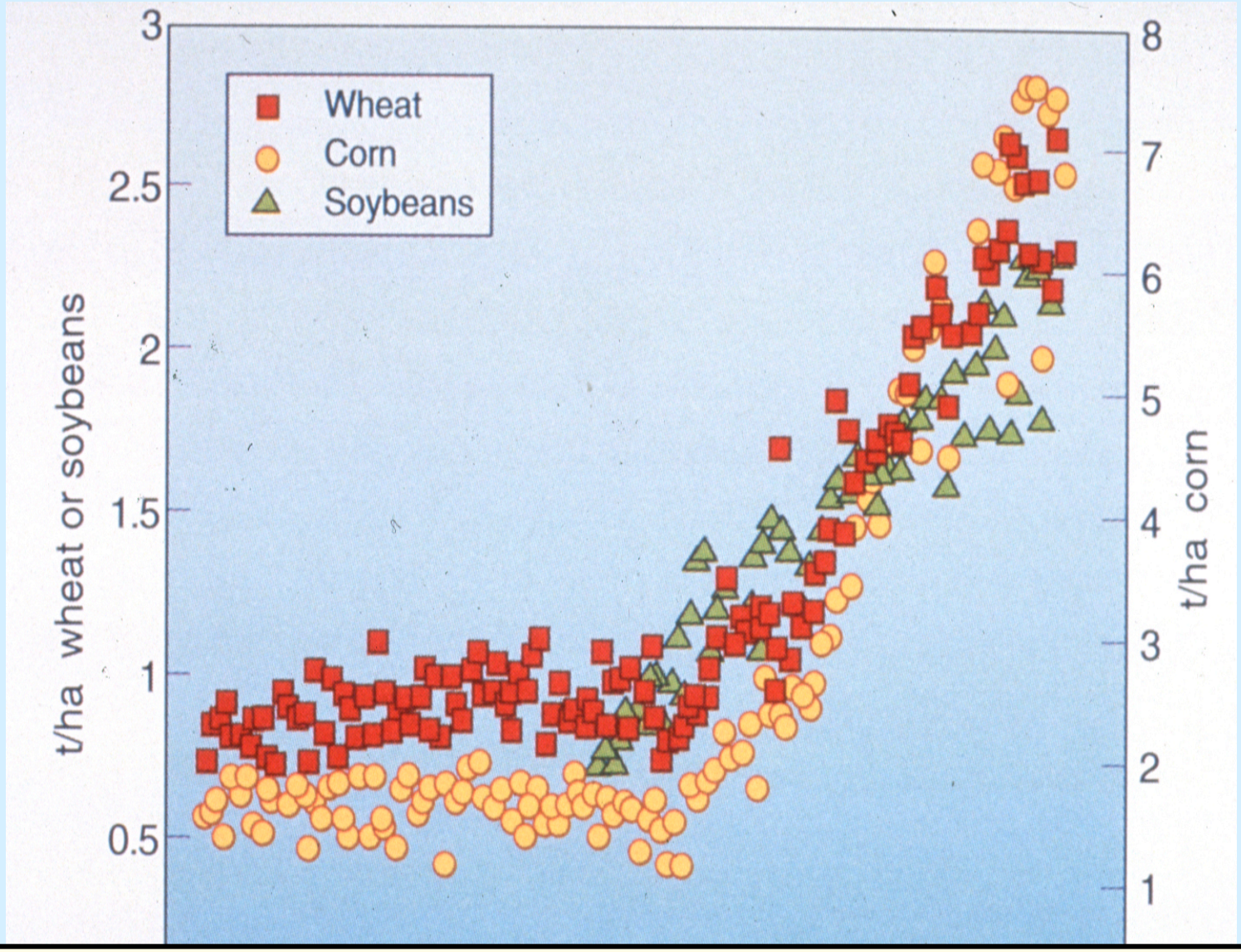

Since the 1930's classical breeding, inputs and farm mechanization led to dramatic yield improvements


But there are other ways to create new varieties through genetic modification
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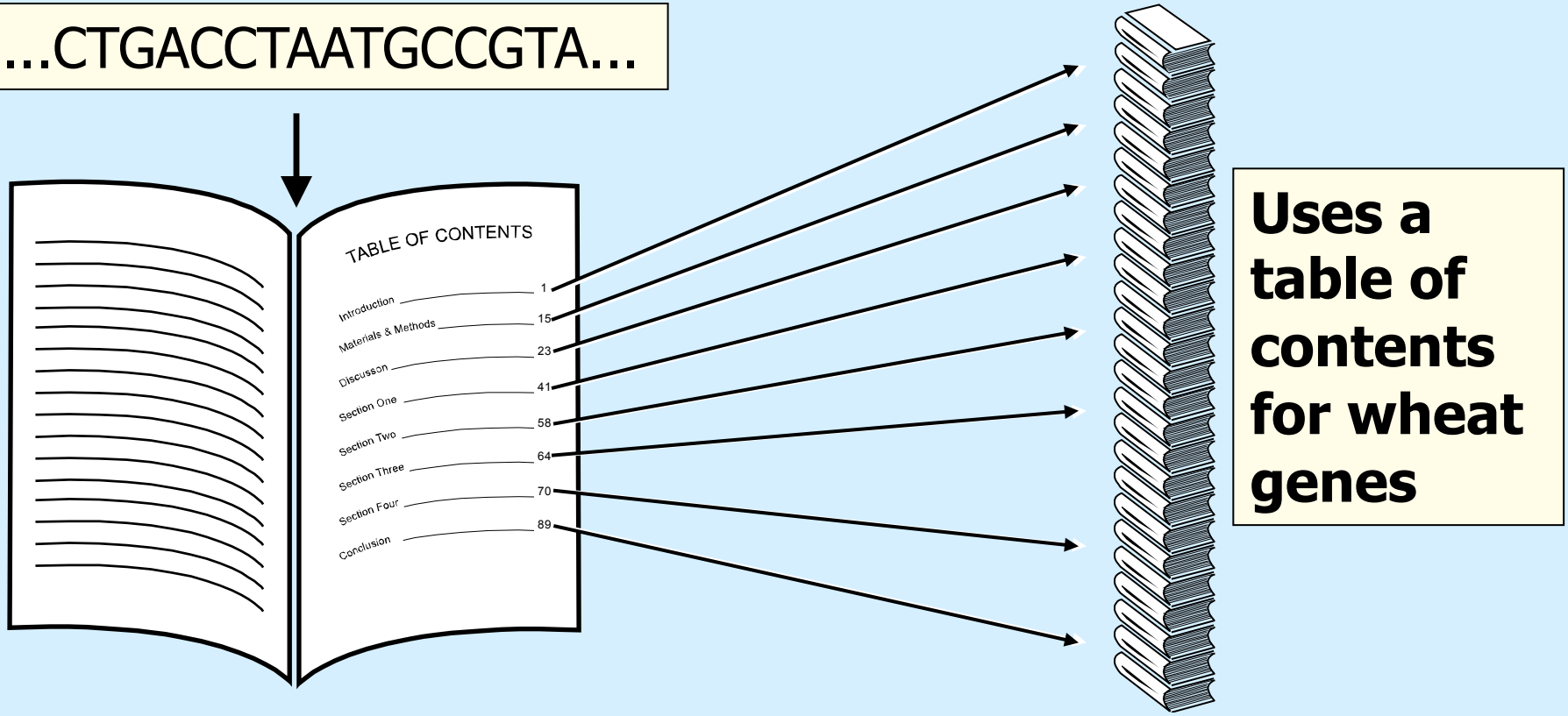
Marker-Assisted Breeding

...CTGACCTAATGCCGTA...



Uses a table of contents for wheat genes

Genomics

1700 books
(or 1.7 million pages)

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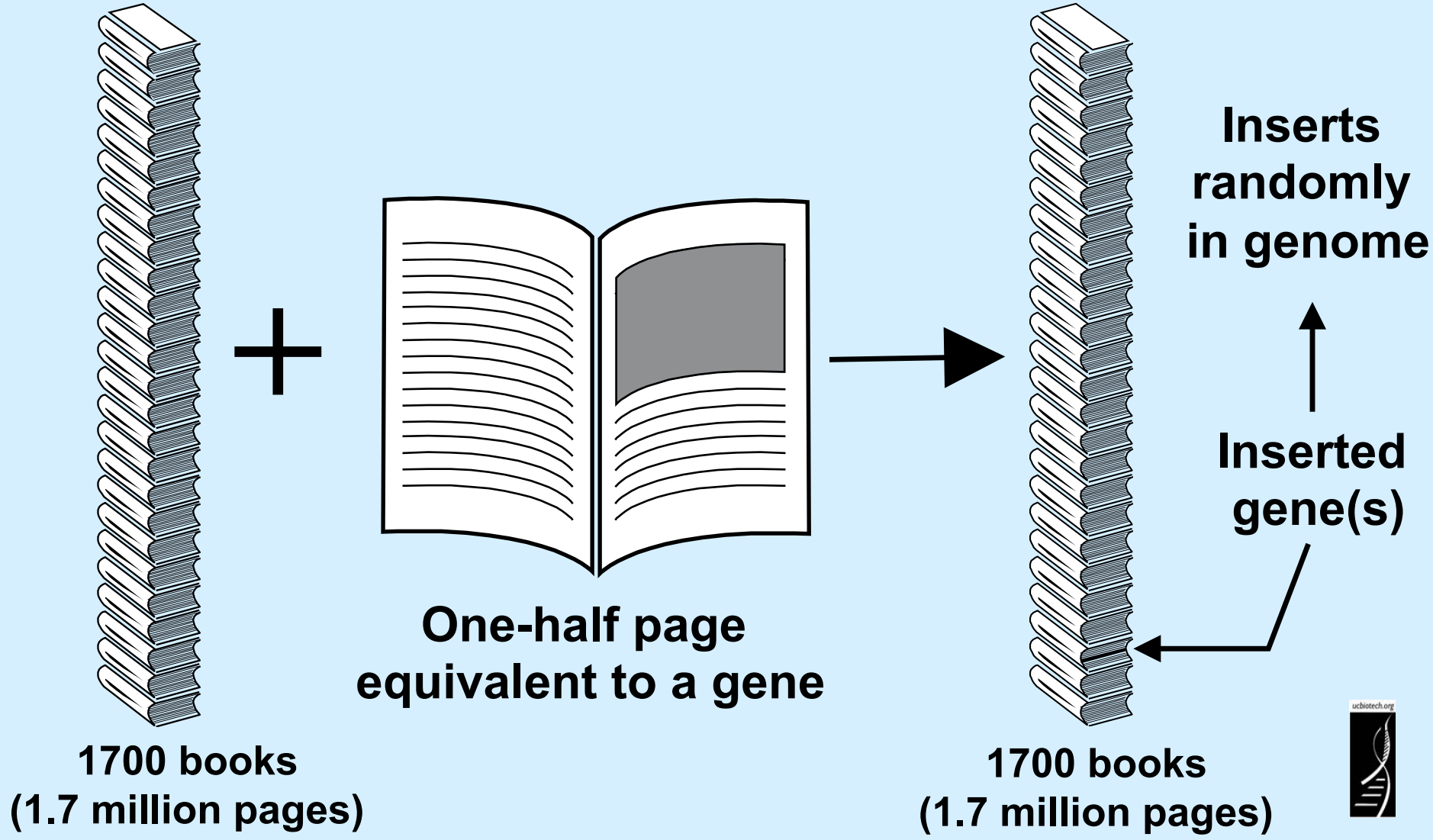
Marker-assisted breeding in rice to protect it against bacterial blight and blast disease

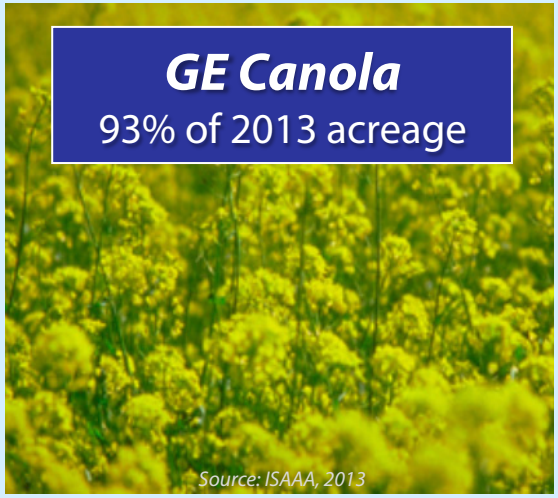
Limited to diversity in compatible relatives

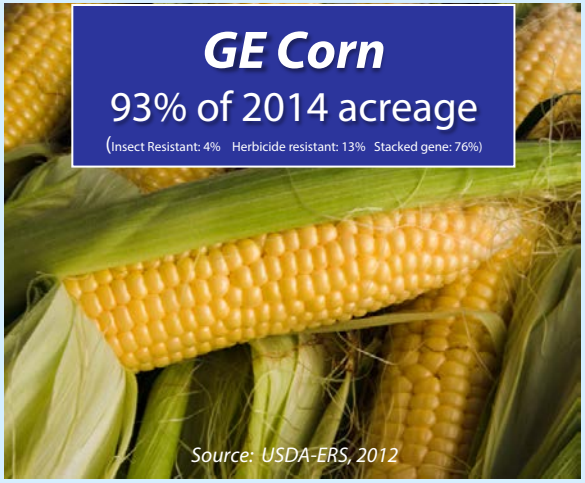
How can these limitations be overcome?

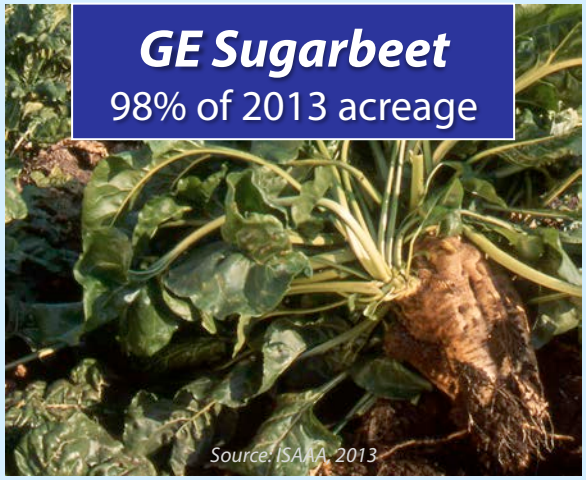
Biotechnology, Genetic Engineering or GM

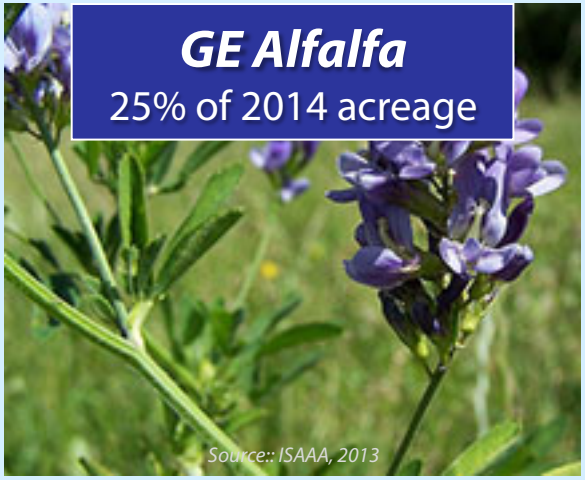


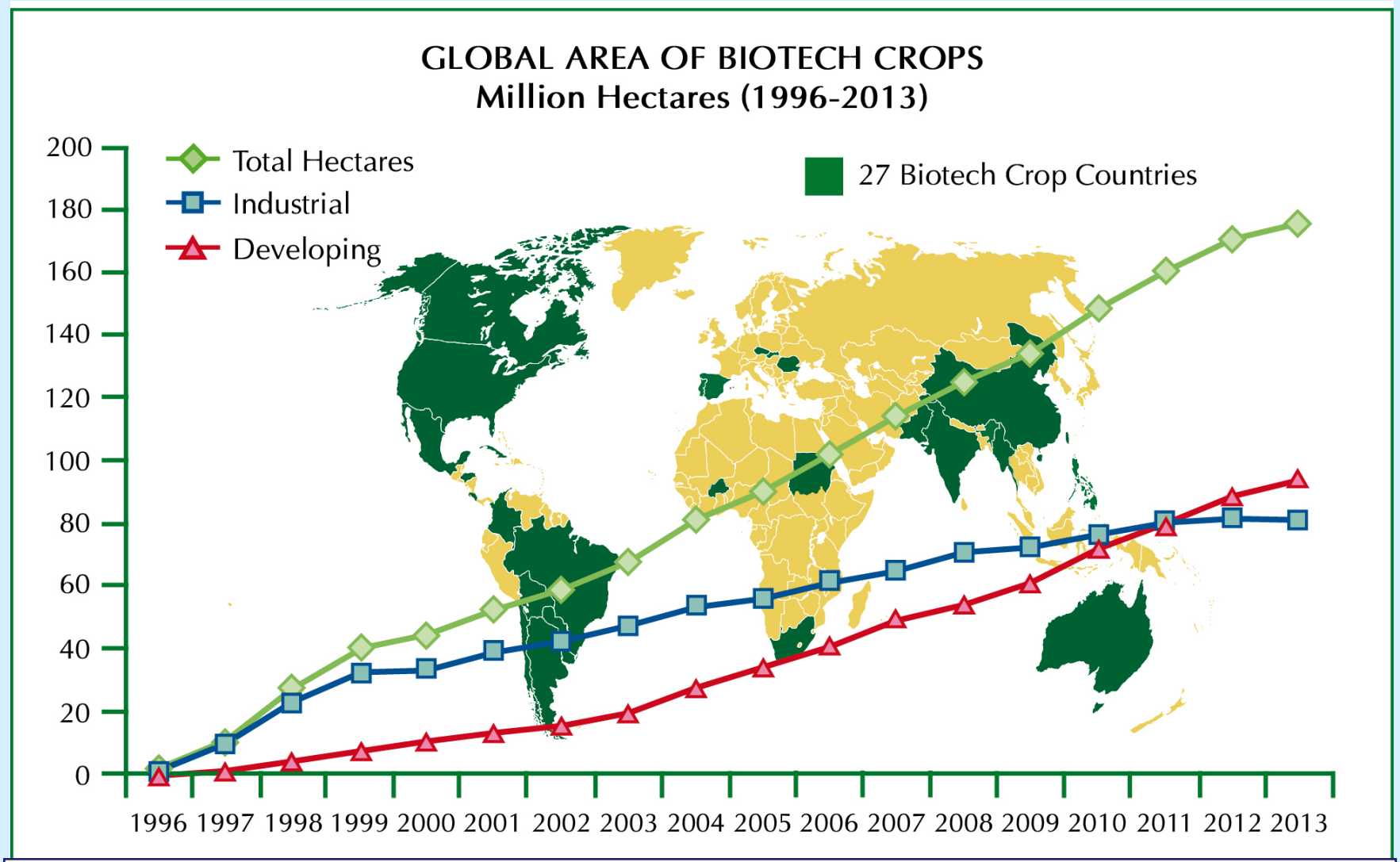
In the U.S. these are the commercial GE varieties in fields







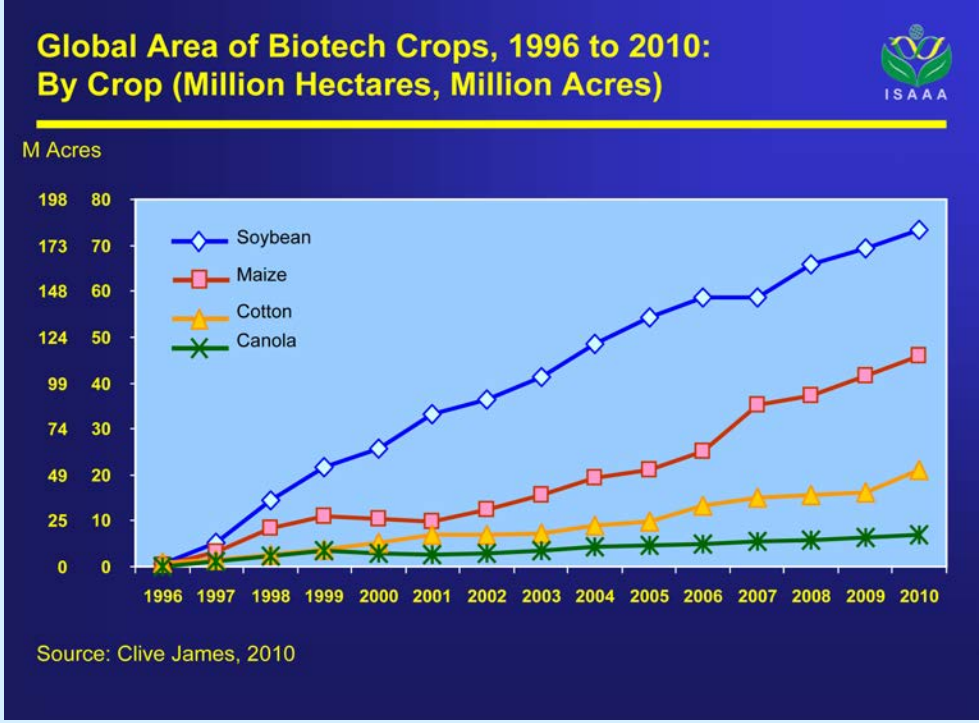


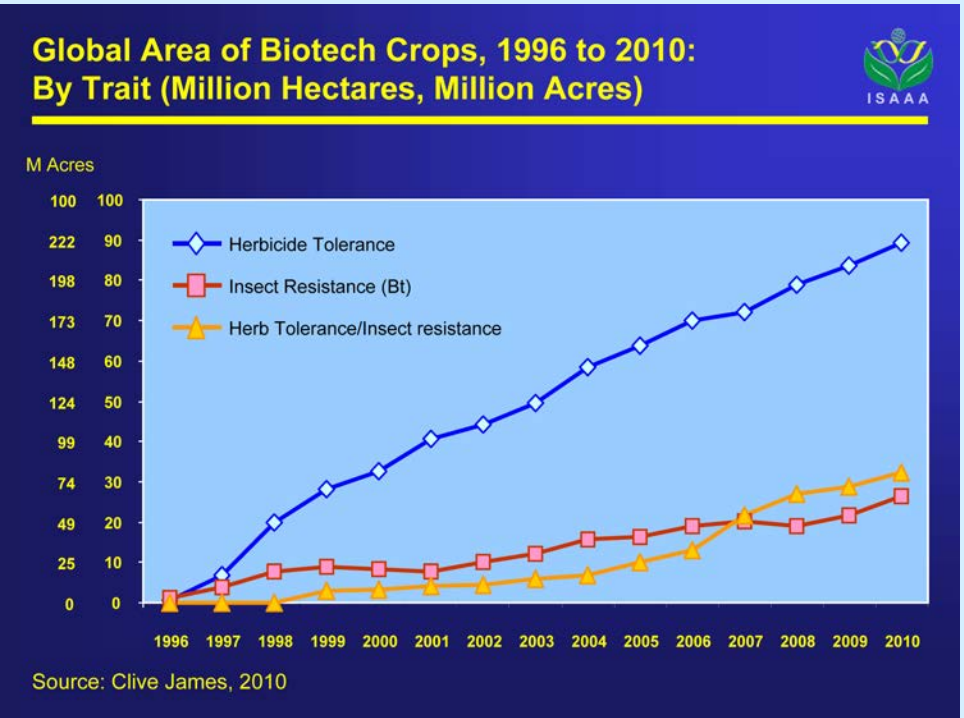


And these crops are also grown in many developing countries. 2013 figures indicate 15.4 million farmers in 27 countries planted 433M acres (>3X size of California) – over 90% were small acreage farmers

But only three countries in Africa are growing them at present – mostly insect-resistant maize

Advances for African farmers are only in limited crops – not necessarily those of most value to them and…





…the number of traits is also limited - herbicide and insect resistance.

Why?

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More of world's crops are genetically engineered

By Elizabeth Weise, USA TODAY

Lemaux says "Because of the expenses involved, creating engineered crops for developing countries requires humanitarian contributions by philanthropists, like the Gates and the Rockefeller Foundations, or perhaps by companies who see value in such endeavors."

And, although many academic scientists want to play a meaningful role, they have limited resources to do so.

SOURCE: "More of world's crops are genetically engineered", USA Today, February 23, 2011.
http://www.usatoday.com/tech/news/biotech/2011-02-22-biotech-crops_N.htm

So, could such groups use genetic engineering to modify crops to benefit developing countries?

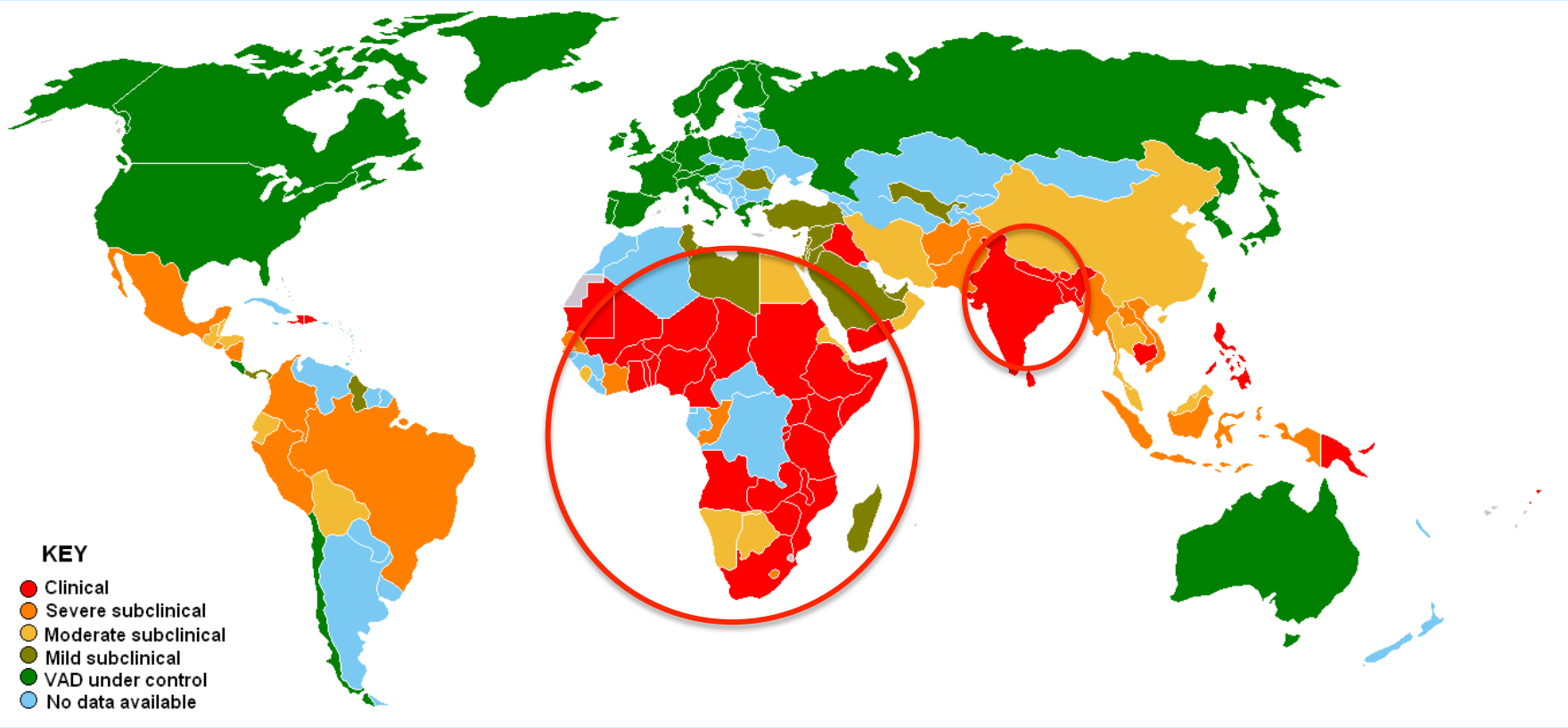
Two public sector stories focused on genetic engineering of crops for developing countries:

Golden Rice

Nutritionally Enhanced Banana

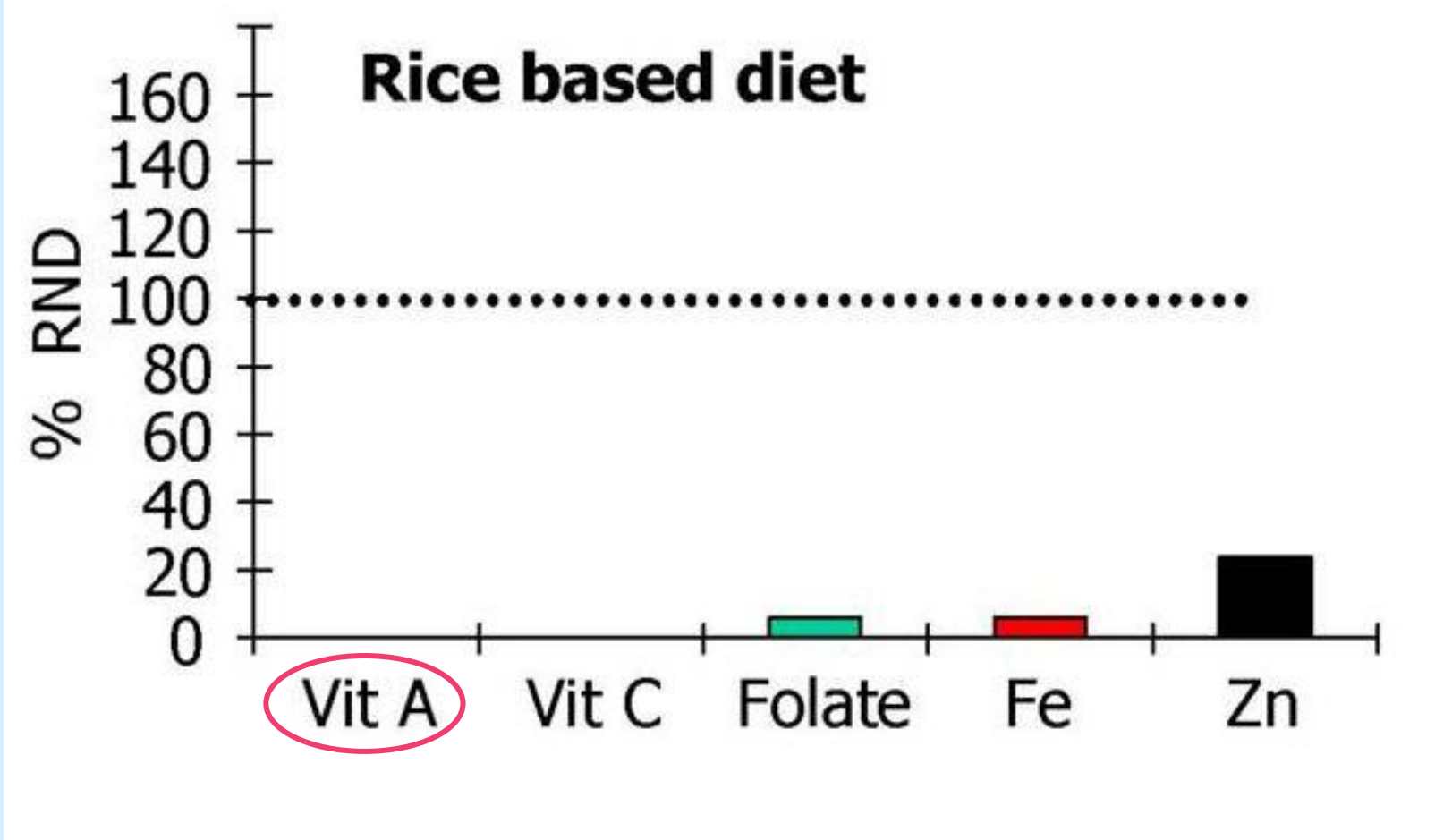
Development of Golden Rice

Vitamin A deficiency (VAD): as judged by severity of health impact



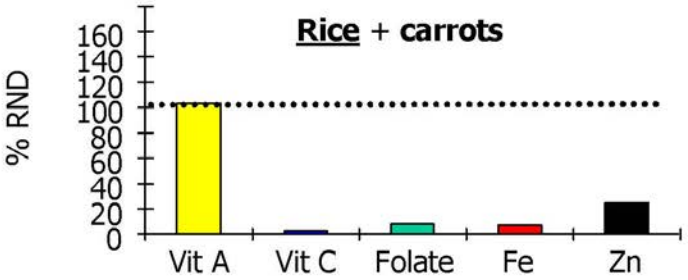
VAD causes mortality, blindness, night blindness, impaired immunity system, impaired brain development. Consuming too much can be toxic, causing birth defects.

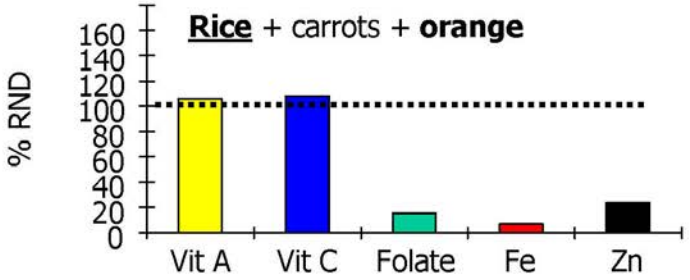
Rice is a predominant diet in many developing countries but it is a very poor source of vitamins and minerals.

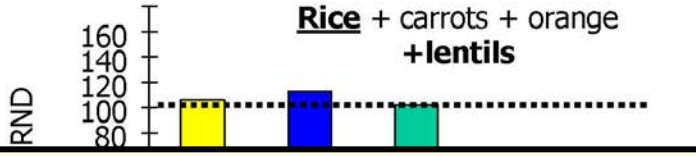


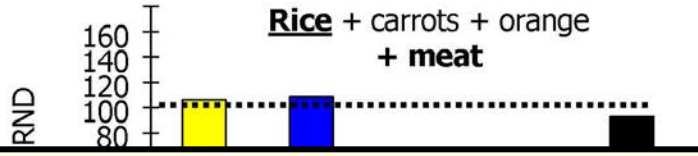
From: "Nutrition: A Cornerstone for Human Health and Productivity", Richard J. Deckelbaum. Seminar, Earth Institute of Columbia University, April 14, 2005

Modified from G. Barry, IRRI

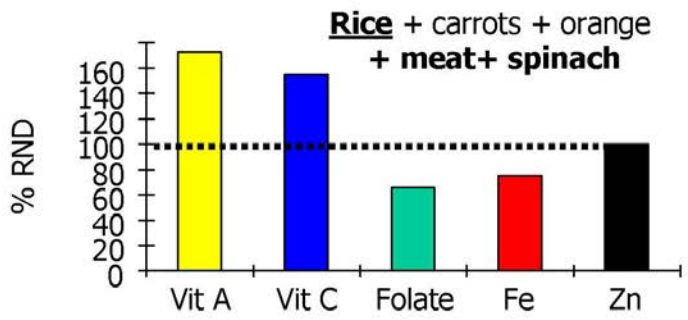


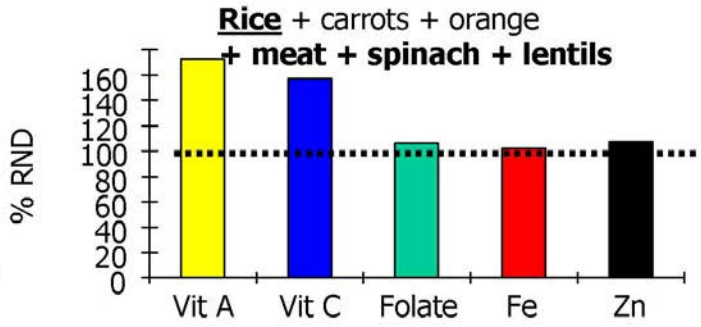






…but not everyone has that luxury!!





Rice diets can be supplemented with other fruits, vegetables and meat to acquire needed nutrients…

Modified from G. Barry, IRRI

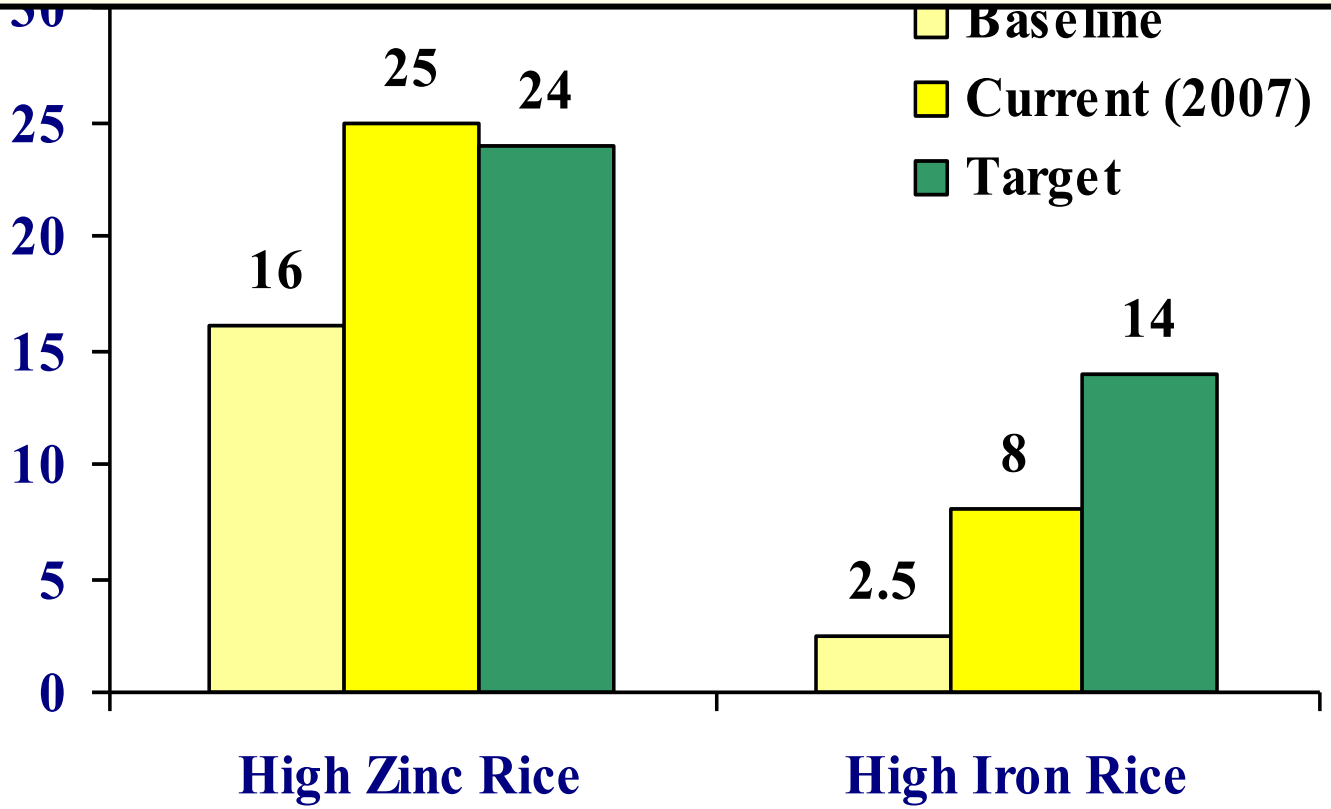
: "Nutrition: A Cornerstone for Human Health and Productivity", Richard J. Deckelbaum. Seminar at The Earth Institute of Columbia University, April 14, 2005

But, can we biofortify rice with vitamins and minerals?

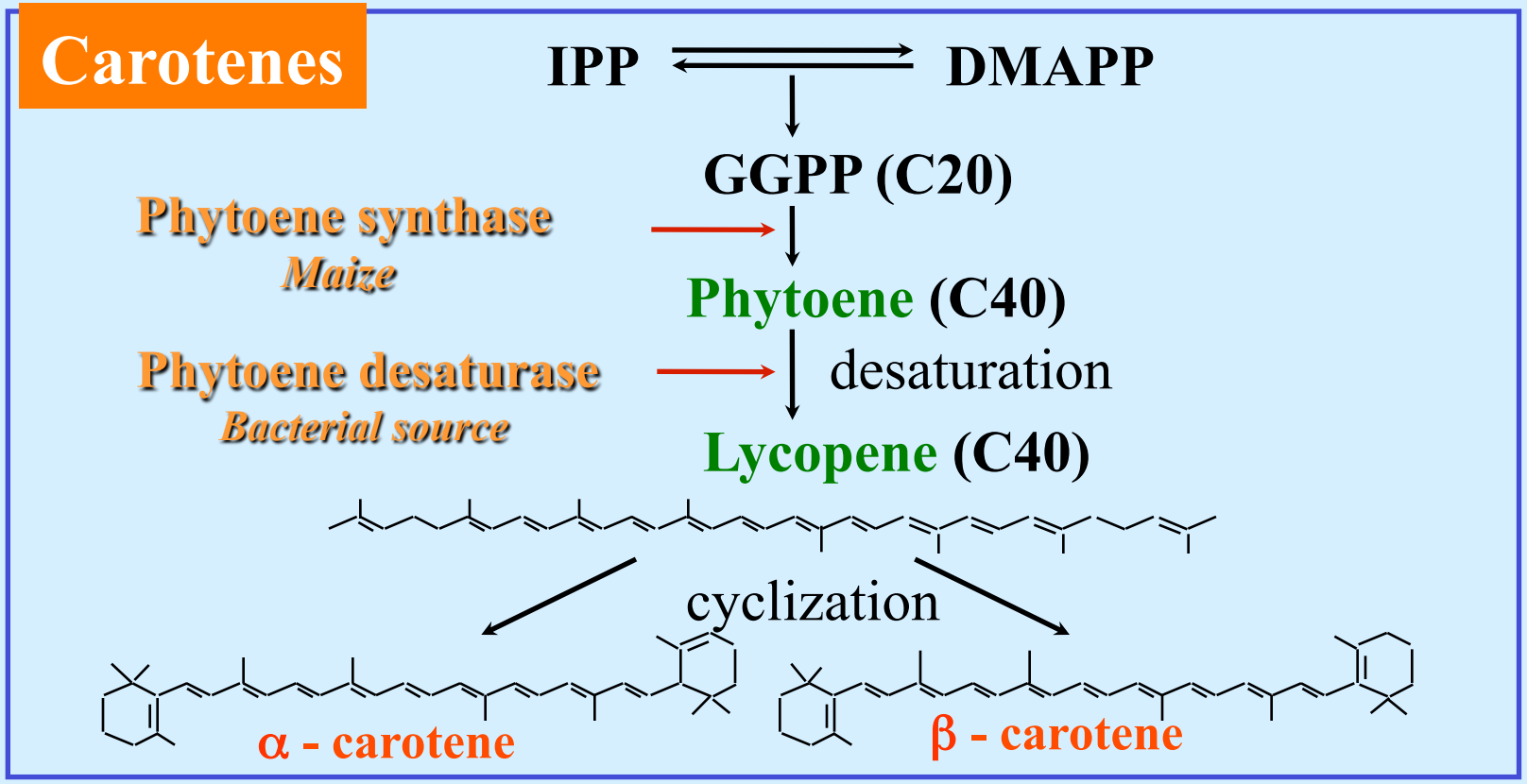
How?

Rice was created with increased iron and zinc by classical breeding with other rice varieties with these traits…

But increasing vitamin A is not possible since no compatible varieties exist with high vitamin A levels.



E. Boncodin, Fedl Budget Secy Manila Philippines



So, rice was engineered with genes from other crops and a bacterium to make provitamin A that is converted to vitamin A in the body

But could it help?

Normal portion of Golden Rice 2 provides half of a child's Vitamin A needs

NO MAGIC BULLET

NEW YORK TIMES

SUNDAY, AUBUST 25, 2013

NEWS ANALYSIS

Golden Rice: Lifesaver?

By AMY HARMON

Published: August 24, 2013 408 Comments

STEVE CARELL
TONI COLLETTE

ONE bright morning this month, 400 protesters smashed down the high fences surrounding a field in the Bicol region of the Philippines and uprooted the genetically modified rice plants growing inside.

Enlarge This Image

Joe Aznar for The New York Times

Genetically engineered Golden Rice grown in a facility in Los Baños, Laguna Province, in the Philippines.

Despite potential positive health effects, in 2013 activists destroyed a field trial of Golden Rice in the Philippines

Why? This is what they said: "GMOs, like Golden Rice, threaten continuation of life on our planet - far worse than nuclear war".

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Development of Nutritionally Enhanced Banana

Bananas are the world's most important fruit crop: the staple food of Uganda

- Key dietary component in nearly all countries in the wet tropics
- Source of fibre, shelter AND banana beer
- Major source of income as exports

But there are major micronutrient deficiencies in Uganda:

Vitamin A deficiency (VAD)

Iron deficiency anemia (IDA)

Enhancing vitamin A in banana using Golden Rice strategy

Control
1.25 ug/g dwt βCE

Exp1>APsy2a
9.96 ug/g dwt βCE

Ubi>APsy2a
16.10 ug/g dwt βCE

13-fold increase in Vit. A levels

Ugandan Banana Biofortification Field Trials

First field trial of **any** genetically engineeried crop in sub-Saharan Africa where they were <u>generated in an African laboratory</u>

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"There is a whole host of GM crops in development in Africa specifically designed to address needs of poor farmers and poor food consumers…like cassava, sorghum, **bananas**…And it's precisely these crops that are **stuck at the field trial stage**," Because governments are reluctant to approve GM crops due to **intense lobbying by opponents**.
http://www.chathamhouse.org/expert/comment/15204]

NO MAGIC BULLET

But could it help?

Take-Home Messages

- Today's diets differ markedly from diets of our primate ancestors
- Their high-fiber, vegetarian diets could play a positive role in human health today
- Shift to meat-based diets has negative impacts on the environment due to low energy efficiency conversions
- Food availability in developing countries has negative health impacts for those populations
- Improvements in food yields have lagged in Africa due to lack of genetic improvements from breeding and new genetic technologies
- Advances in nutritional improvement, like Golden Rice and Vitamin A-enriched banana, might provide advances in developing countries, if allowed to reach consumers

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SCIENCE-BASED INFORMATION & RESOURCES ON AGRICULTURAL BIOTECHNOLOGY

HOME | IN THE NEWS | BIOTECHNOLOGY INFORMATION | SCIENTIFIC DATABASE | RESOURCES | LINKS | GLOSSARY | CONTACTS

know GMOS

This website, developed for the University of California Division of Agricultural and Natural Resources Statewide Biotechnology Workgroup, provides educational resources focused broadly on issues related to agriculture, crops, animals, foods and the technologies used to improve them. Science-based information related to these issues is available, as well as educational tools and information, which can be used to promote informed participation in discussions about these topics.

DISPLAY CARDS NOW IN SPANISH!

We now have Spanish cards available to distribute with both educational displays. Click here for more details!

BIOTECHNOLOGY INFORMATION

ANNUAL REVIEWS

Review articles: Focused on food, environmental and socioeconomic issues of GE crops and foods.

RESOURCES FOR OUTREACH & EXTENSION, RESEARCHERS & TEACHERS

Slide Archive: Extensive collection of PP slides on agriculture & biotechnology.

Available on loan:

Educational displays: "Genetics and Foods" and Genetic Diversity and

Gene-IE Juice bar: interactive activity to isolate DNA from common fruits and vegetables.

Tic Tac Grow: Educational game to teach what foods come from what crops.

HELPFUL SITES

Seed Biotechnology Center Mobilizes research, education & outreach efforts in partnership with seed & biotechnology industries.

Program, UC Davis

Provides education on use of animal genomics & biotechnology in livestock production.

Want more information: See http://ucbiotech.org

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