Plant B+B online café,
May 20, 2021

Socio-economics of GM biofortification

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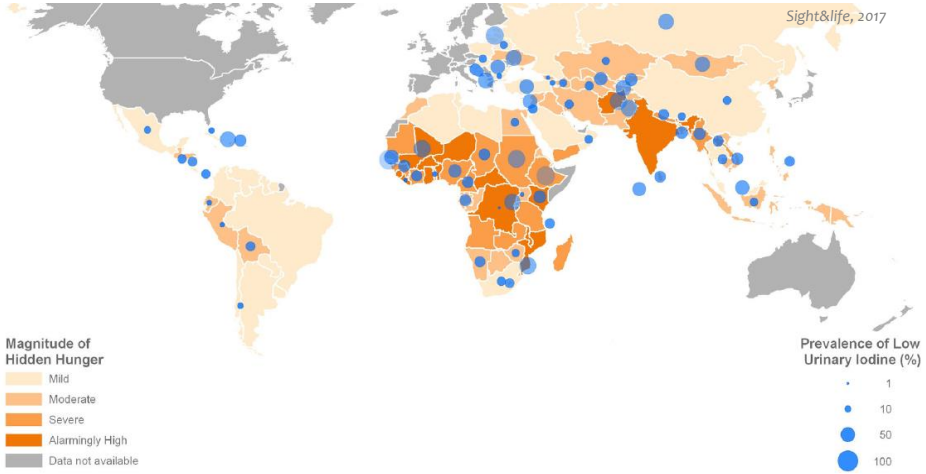
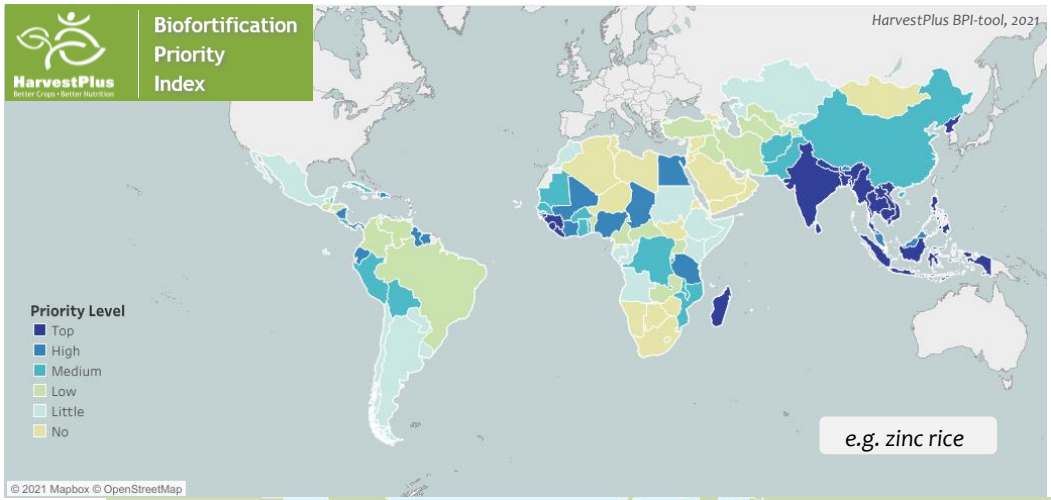
Crop improvement

	CONVENTIONAL	GENETIC ENGINEERING
AGRONOMIC traits ⇒ Productivity ⇒ Producer	**Green Revolution (60's)** Crossing high-yielding crops, fertilizers, …	**Gene Revolution (90's)** 1st generation Pest resistant, insecticide tolerant, drought resistant, …
QUALITY traits ⇒ Health ⇒ Consumer	**Biofortification (00's)**	**GM biofortification (??)** 2nd generation

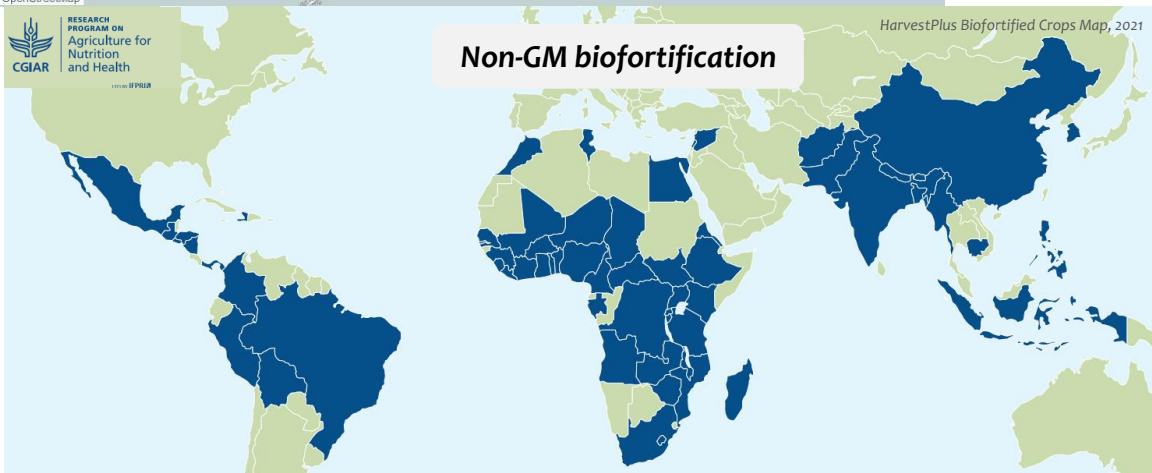
* From needs



* To priorities

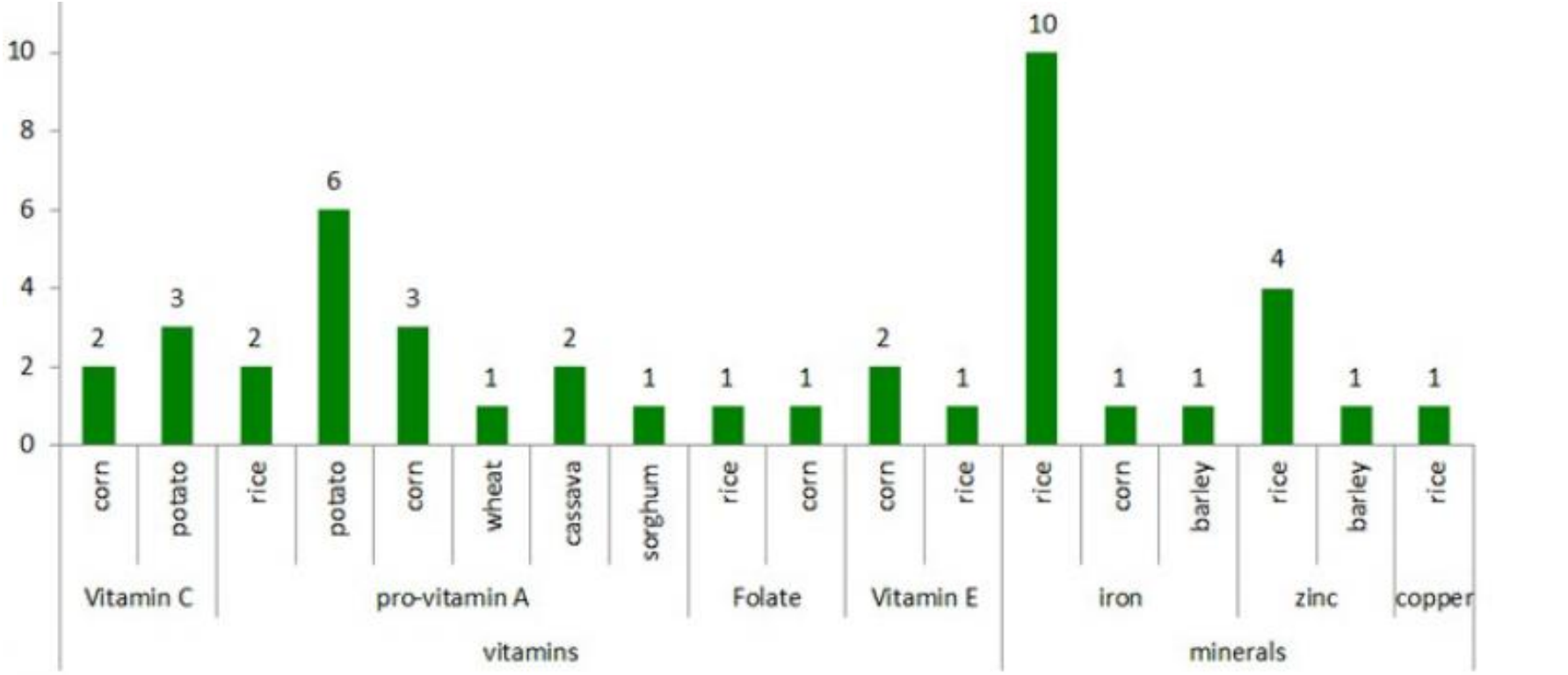


* To actions



GM biofortification

* Various promising efforts … **But not (yet) commercialized**



(De Steur, Blancquaert et al 2015)

Successful GM biofortification reports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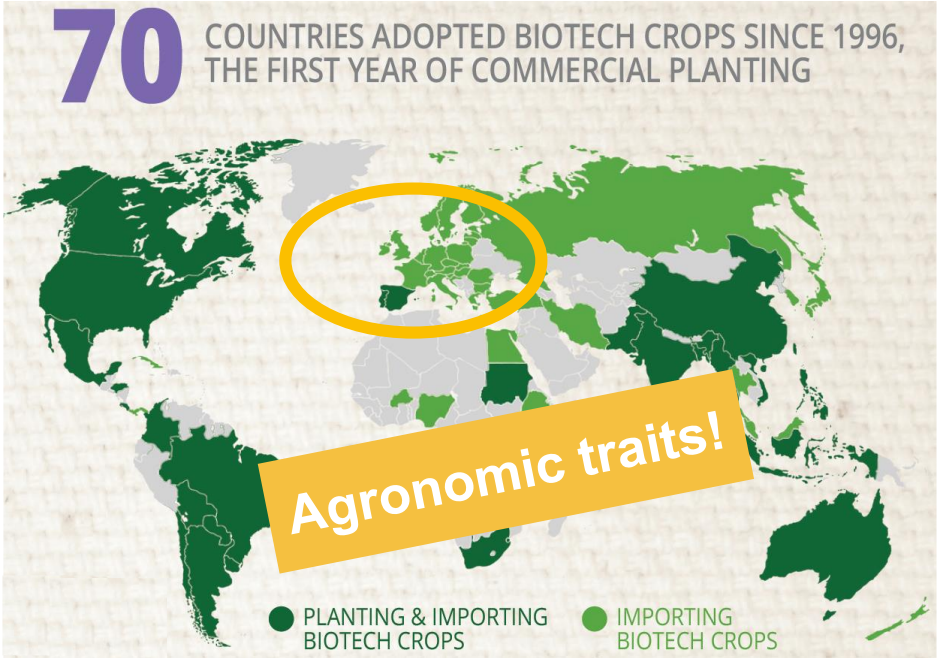
Philippines approves Golden Rice for direct use as food and feed, or for processing
PLANT SCIENCE
After 20 years, Golden Rice nears approval
Bangladesh may become the first country to adopt transgenic rice enriched in vitamin A
By Erik Stokstad
Soon. That has long been scientists' answer when asked about the approval of Golden Rice, a genetically modified (GM) crop that could help prevent
Over the past 2 years, regulators in the United States, Canada, New Zealand, and Australia approved Golden Rice for consumption. There are no plans to grow the crop in these countries, but approval will prevent problems if Golden Rice somehow accidentally turns up in food supplies
certification agency within the Ministry of Agriculture, which requires field trials in multiple places to test for seed quality. If all goes smoothly, farmers might have Golden Rice seed to plant by 2021.
How popular it will be is uncertain. Farmers in Bangladesh quickly adopted
TIME
THIS RICE COULD SAVE A MILLION KIDS A YEAR
but protesters believe such genetically modified foods are bad for us and our planet. Here's why.
Swiss Professor Ingo Potrykus with his beta-carotene-enriched rice

GMOs

* Political approval



ISAAA 2018

* Public approval

Eurobarometer

Eurobarometer 2010

% respondents who agree or totally agree that GM food should be encouraged

	1996	1999	2002	2005	2010
United Kingdom	52	37	46	35	44
Ireland	57	45	57	43	37
Portugal	**63**	**47**	**56**	**56**	**37**
Spain	**66**	**58**	**61**	**53**	**35**
Denmark	33	33	35	31	32
Netherlands	59	53	52	27	30
Finland	65	57	56	38	30
Belgium	57	40	39	28	28
Sweden	35	33	41	24	28
Italy	51	42	35	42	24
Austria	*22*	*26*	*33*	*24*	*23*
Germany	*47*	*42*	*40*	*22*	*22*
Luxembourg	*44*	*29*	*26*	*16*	*19*
France	*43*	*28*	*28*	*23*	*16*
Greece	*49*	*21*	*26*	*14*	*10*

Eurobarometer

Eurobarometer 2019

Concern 2010	Concern 2019	
GM ingredients in food/drinks	GM ingredients in food/drinks	Genome editing
66%	27%	4%
4th of 17 topics	8th of 15 topics	15th of 15 topics

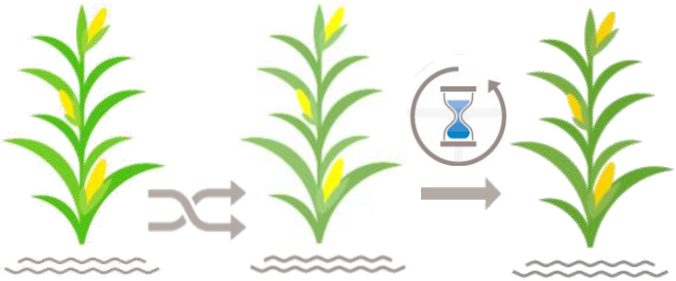
Meta-analysis

(1673 survey questions, 214 studies)

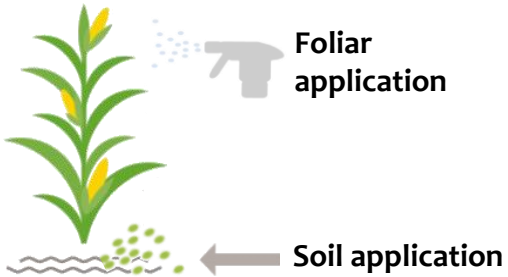
Although there is general consensus about the negative public climate towards GMOs in the EU, **evidence demonstrates that the European consumer is not as reluctant** towards the use of biotechnology in food as previously thought (Hess et al., 2013)

Micronutrient strategies

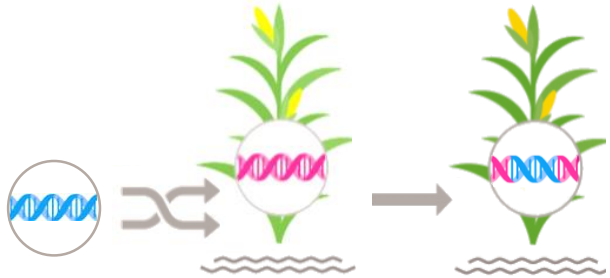
Conventional breeding



Agronomic approaches



GM technology



fortification

supplementation

micronutrient interventions

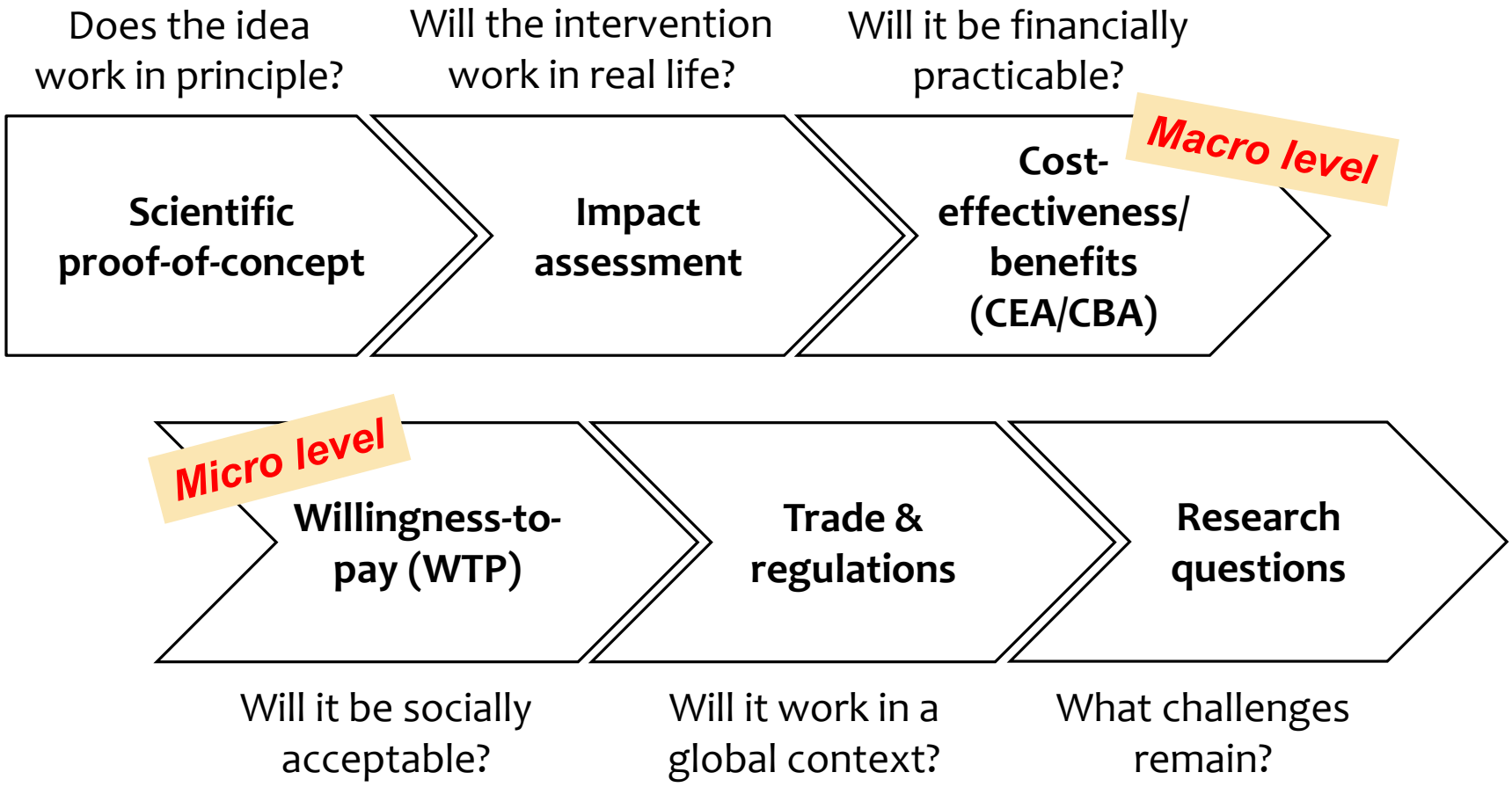
biofortification

diversification

controversial GM technology *versus* consumer benefits

Ex-ante market potential of GM biofortified crops

Socio-economics of GM biofortified foods



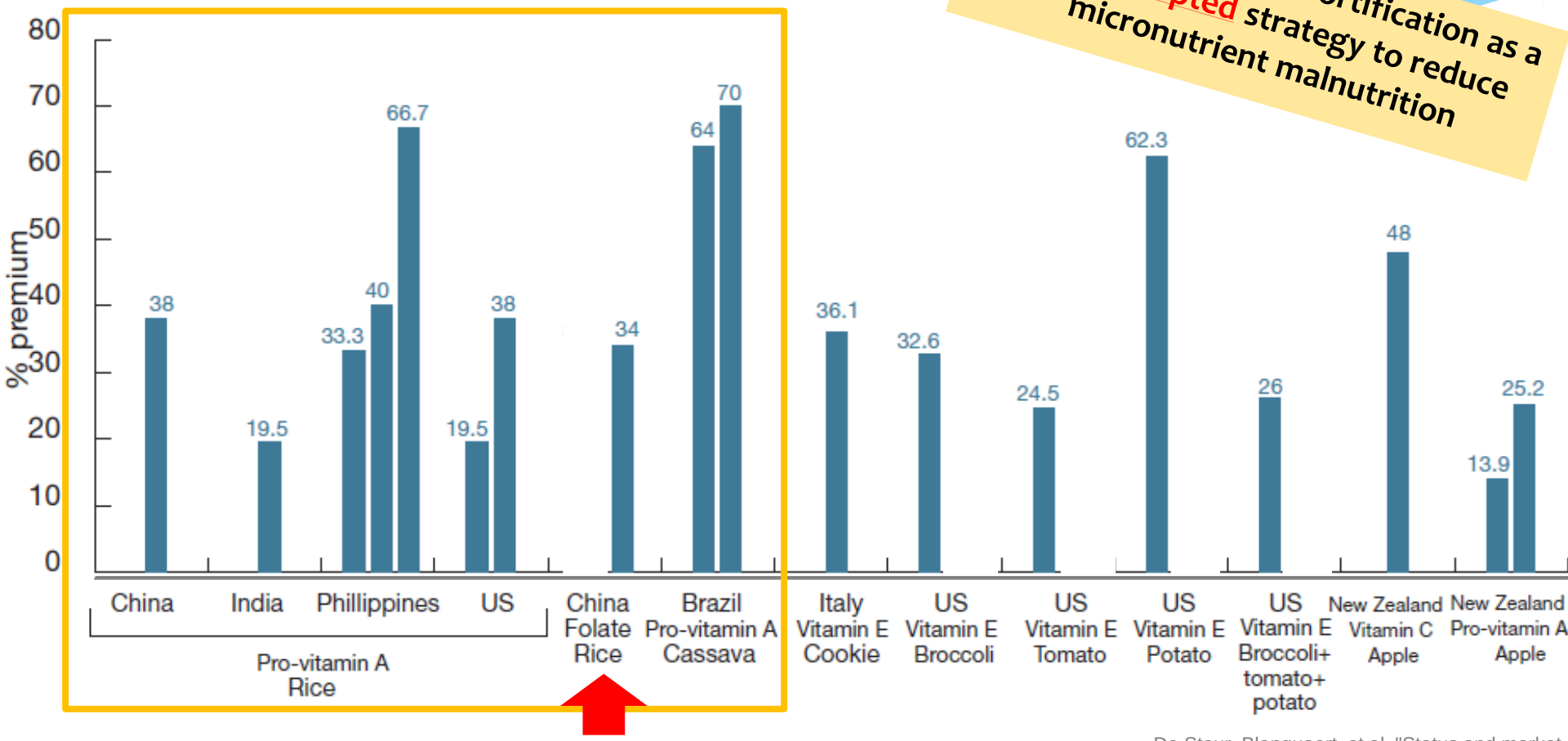
De Steur, H., Demont, M., Gellynck, X. & Stein, A. 2017. "The social and economic impact of biofortification through genetic modification." *Current Opinion in Biotechnology*, 44:161–168.

SOCIO-ECONOMIC EVIDENCE (micro-level)

WTP for GM biofortified foods

- Mean premium (%)

Support for GM biofortification as a well-accepted strategy to reduce micronutrient malnutrition

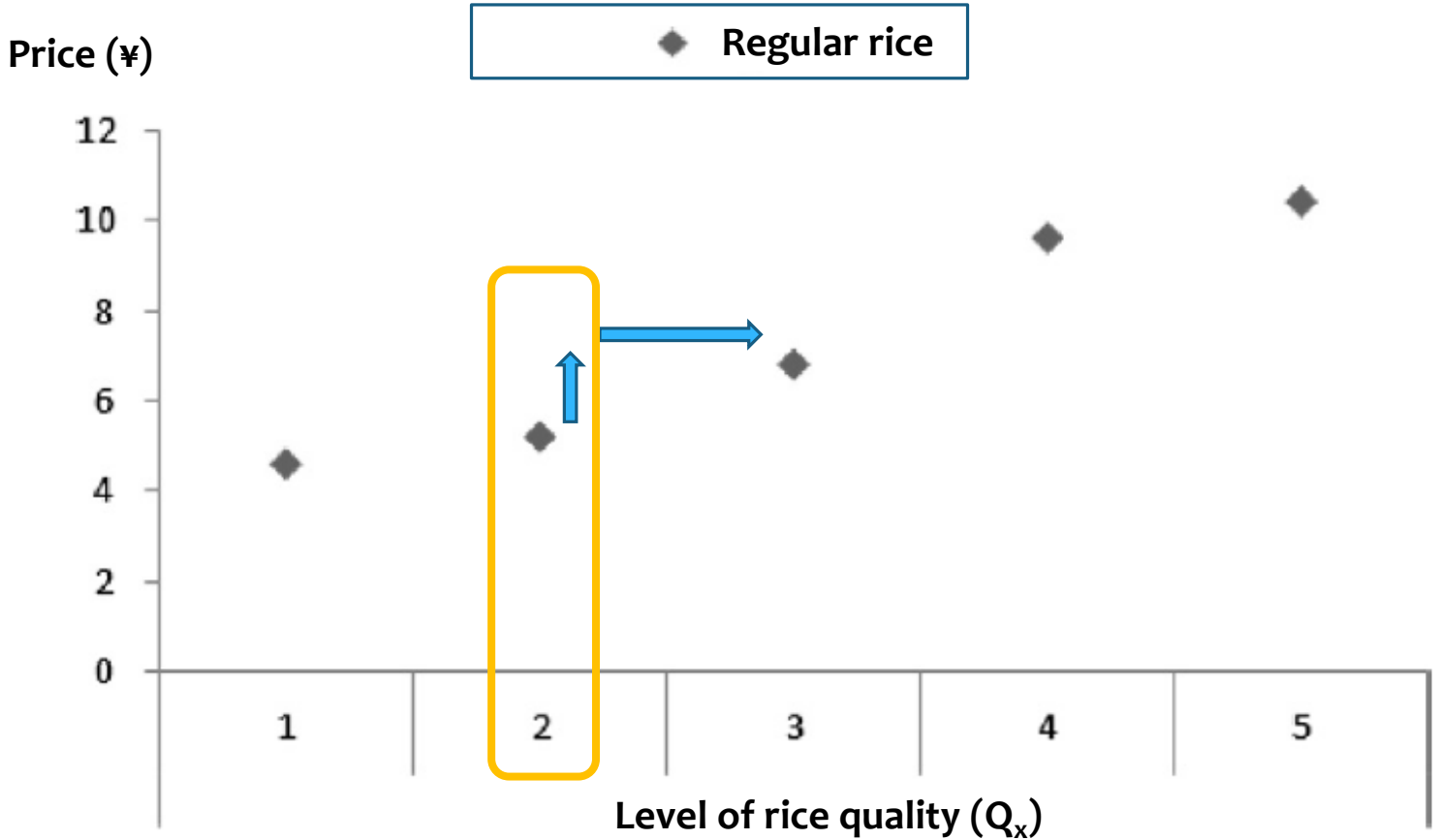


De Steur, Blanquaert, et al. "Status and market potential of transgenic biofortified crops." *Nat. Biotech* 33.1 (2015): 25-29.

⇒ **Conventional ≈ GM biofortification >>> 1st generation GM food**

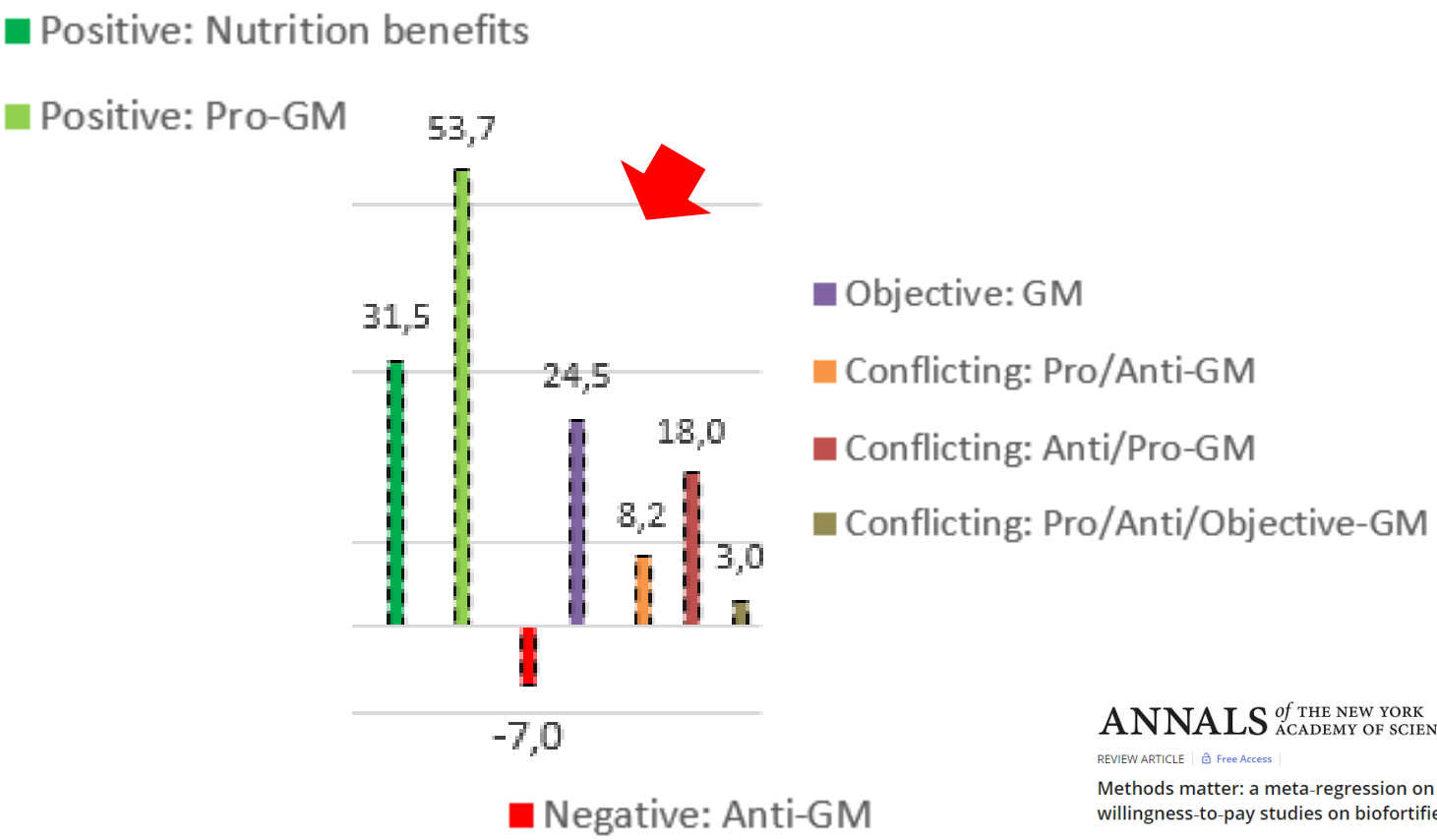
WTP for Folate Biofortified Rice (FBR)

* Experimental auctions on rice (Q2)
* Women of cba, Shanxi, China
* Premium for 1 kg FBR (Q2) = **33,7%**



Willingness-to-pay for GM biofortified foods
The role of information

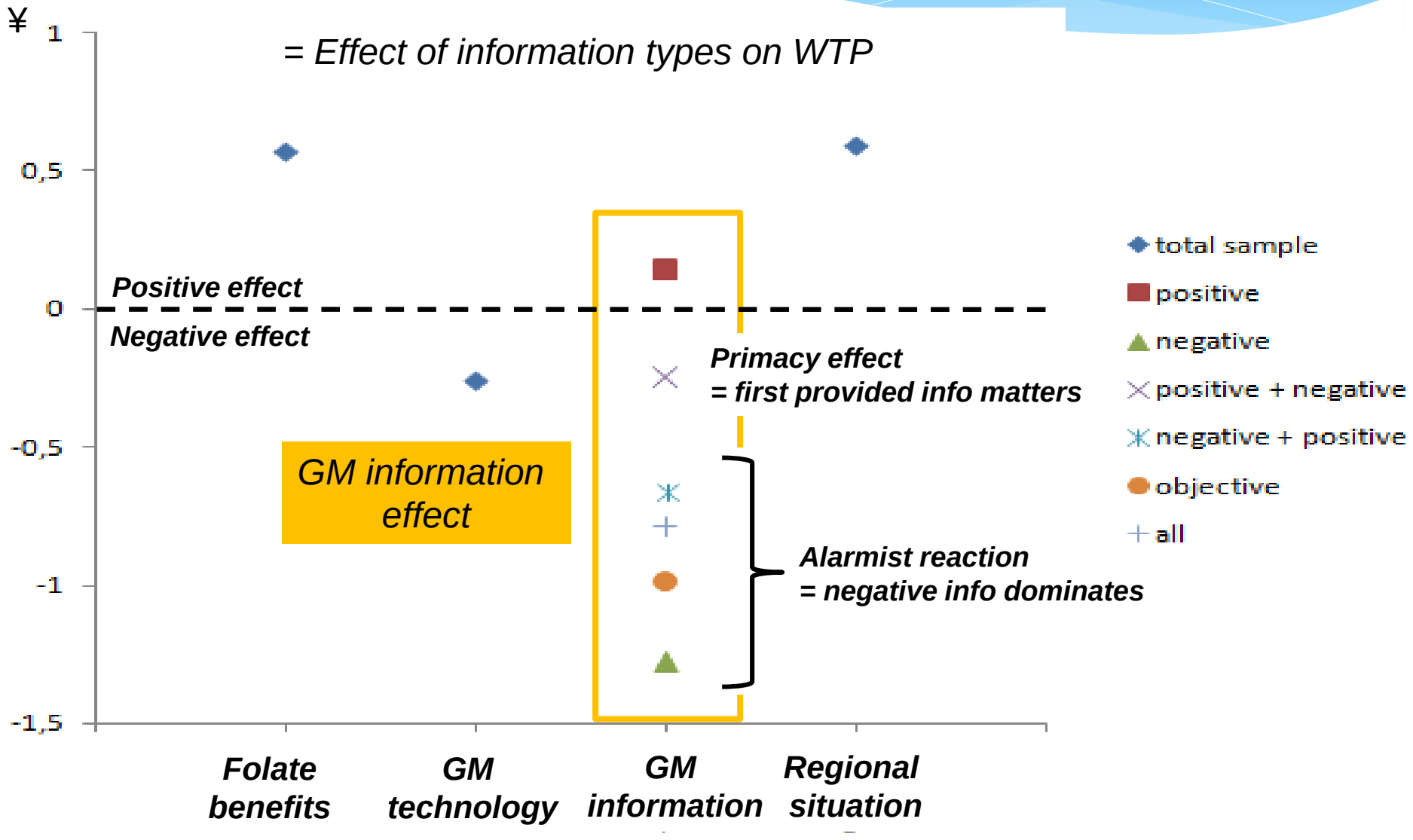
Information effects in WTP studies (n = 3955)



ANNALS of THE NEW YORK ACADEMY OF SCIENCES
REVIEW ARTICLE | Free Access
Methods matter: a meta-regression on the determinants of willingness-to-pay studies on biofortified foods
Hans De Steur, Joshua Wesana, Dieter Blancquaert, Dominique Van Der Straeten, Xavier Gellynck

© Hans.DeSteur@UGent.be

WTP for Folate Biofortified Rice (FBR) in China



GM (bioforitified) foods

The role of information

Controversial Seralini GMO–rats paper to be retracted

with 189 comments

A heavily criticized study of the effects of genetically modified maize and the Roundup herbicide on rats is being retracted — one way or another.

The paper — by Gilles Seralini and colleagues — was published in *Food and Chemical Toxicology* last year. There have been calls for retraction since then, along with other criticism and a lengthy exchange of letters in the journal. Meanwhile, the paper has been cited 28 times, according to Thomson Scientific's Web of Knowledge, and the French National Assembly (their lower house of Parliament) held a long hearing on the paper last year, with Seralini and other scientists testifying.

Seralini Paper Influences Kenya Ban of GMO Imports

Bags containing 'MON 810', a variety of genetically modified maize (corn) developed

Kenya's government has banned genetically modified (GM) organisms from entering the country, a move that reports say could result in a big negative impact on the country's plans for biotechnology research and development. According to journalist Linda Nordling, writing at SciDev, this move won't prove beneficial for Kenya, in part because of the way

The driving force behind the Kenyan government's decision to bypass its own biotech watchdog and ban GM imports out of hand? The Seralini et al. GM rat study, possibly

NATURE | NEWS

China sacks officials over Golden Rice controversy

Chinese families did not give consent for children to consume genetically modifed rice in the part US-funded study.

Jane Qiu

10 December 2012

Rights & Permissions

China has sacked three officials for breaching Chinese laws and ethical regulations during a trial in which children were fed genetically modified rice.

The trial's legitimacy was questioned in August by the environmental group Greenpeace. A three-month investigation, led by the Chinese

SOCIO-ECONOMIC EVIDENCE (macro-level)

Cost-effectiveness/-benefits of GM biofortified foods

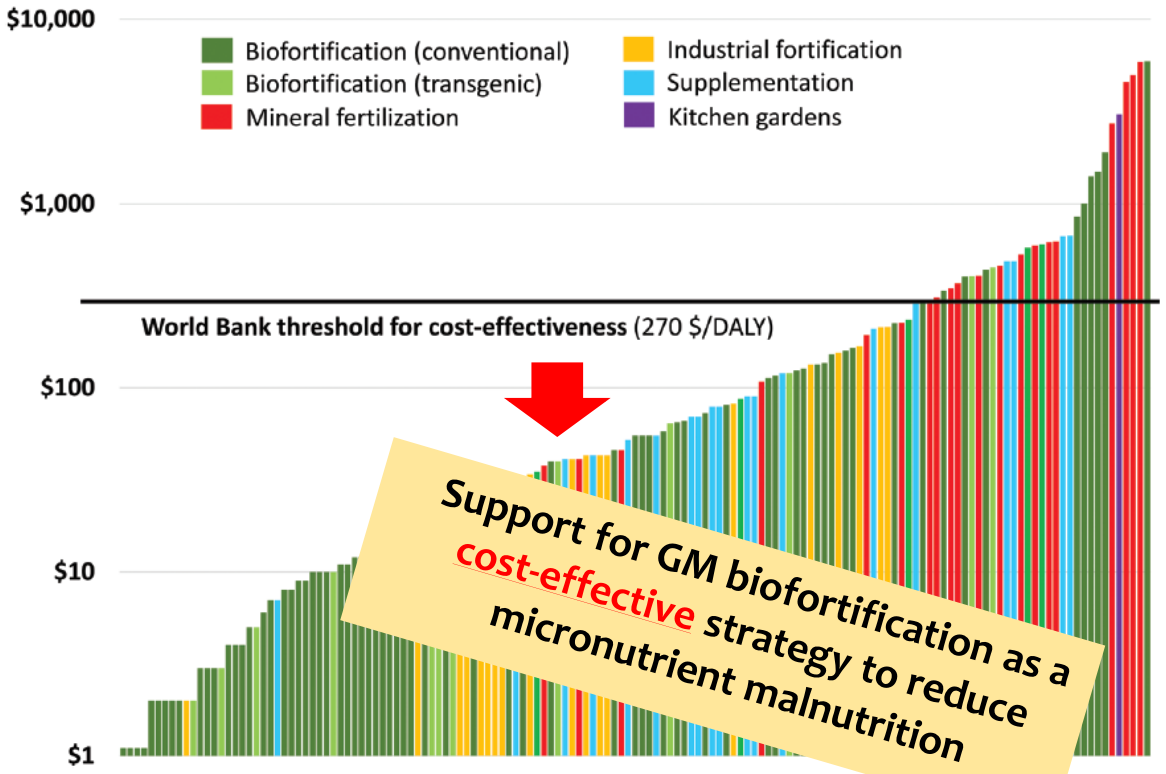


Figure 1. Cost-Effectiveness of Different Micronutrient Interventions. Authors' own presentation based on a large number of original cost-effectiveness studies identified through a systematic literature review. Each column represents one cost-effectiveness estimate expressed in terms of the cost in US$ per disability-adjusted life year (DALY) saved (log scale).

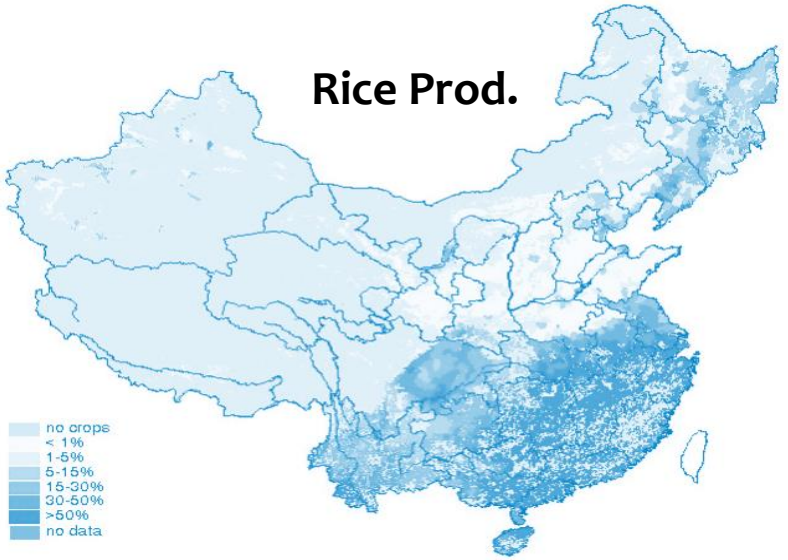
Source: Bouis et al, CAST #69 issue paper, 2020

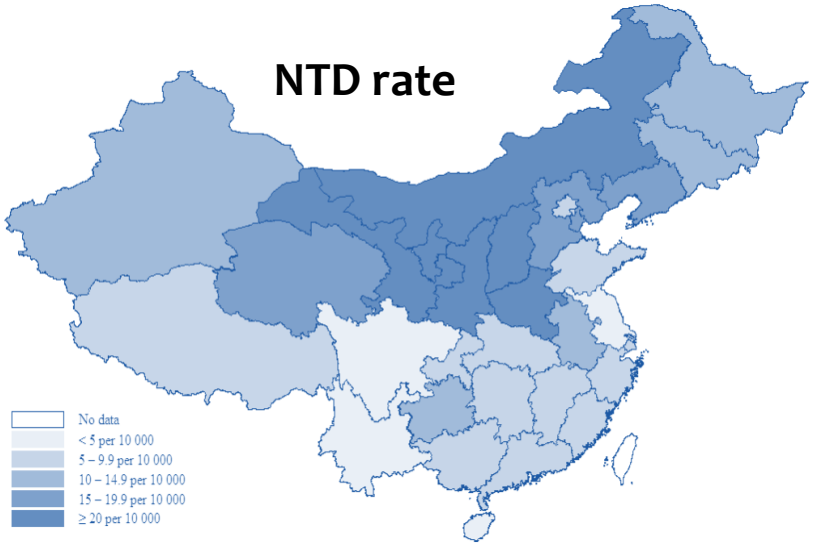
GM biofortified crops:

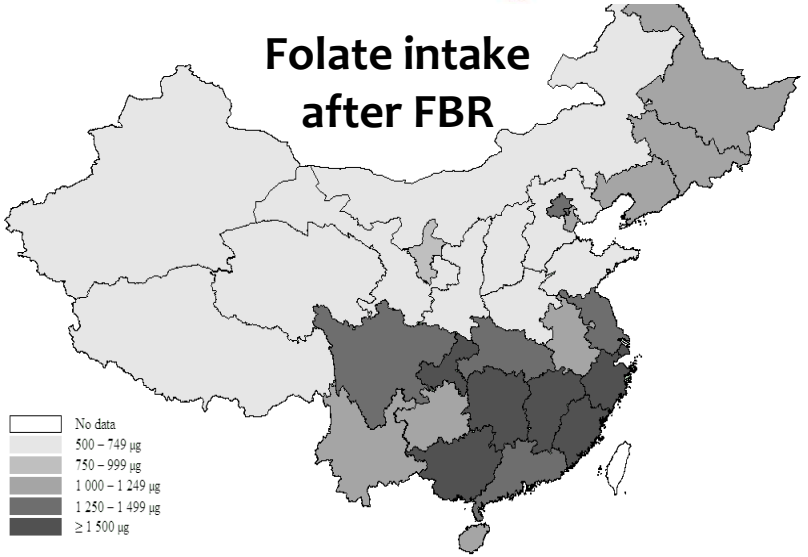
* **Annual burden ↓ :**
  * 12.5 % (low) – 51.4 % (high)
* **CEA:**
  * $ 7.9 – $ 27.8 to save DALY

De Steur, H., et al (2016)

Folate biofortified rice (FBR) in China







Multi-biofortified rice in China

From single ….

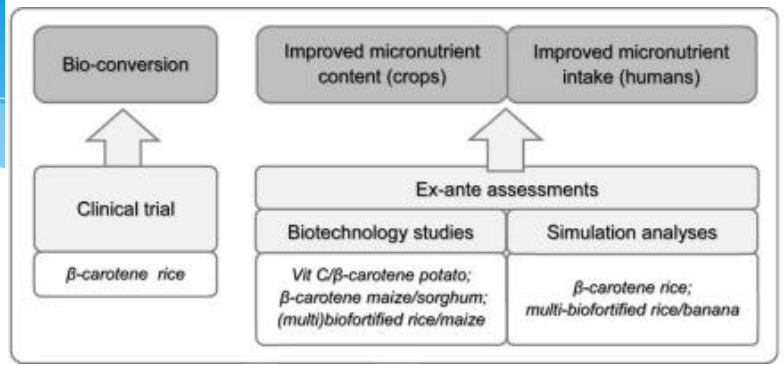
…. to multi-biofortification

Cost-effectiveness of biofortified rice in China

	Cost-effectiveness *(US$ per DALY saved)*	
	Pessimistic scenario	Optimistic scenario
Single biofortification		
Folate	64.2	21.4
Vitamin A	18.1	5.0
Zinc	4.8	1.2
Iron	3.8	0.8
Multi-biofortification	**9.6**	**2.3**

Below WB 'Cost-effectiveness' threshold

Conclusions



"GM biofortified crops: potential effects on targeting the micronutrient intake gap in human populations." *COBT* 44: 181-188.

Does the idea work in principle?

Will the intervention work in real life?

Will it be financially practicable?

Scientific proof-of-concept ✓

Nutrition impacts ✓

...

...

Will it be socially acceptable?

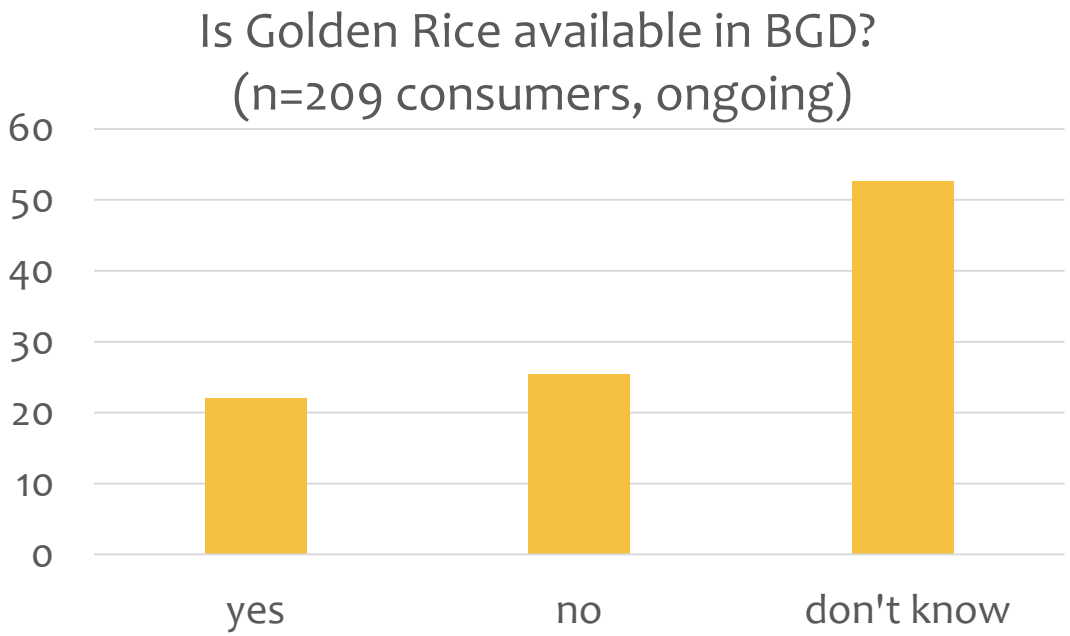
Will it work in a global context?

What challenges remain?

De Steur, H., Demont, M., Gellynck, X. & Stein, A. 2017. "The social and economic impact of biofortification through genetic modification." *Current Opinion in Biotechnology*, 44:161–168.

Conclusions

* Success of GM biofortification crucially hinges on building demand, informing consumers and governing value chains
* Complex issues require a multitude of actions



THANK YOU
FOR YOUR ATTENTION !

* **Current Opinion on Biotechnology, Vol 44, Special issue Plant Biotechnology:**

Biofortification of crops: *Achievements, future challenges, socio-economic, health and ethical aspects*

* **Part I**: Thiamin, Iron, Iodine, B6, Ascorbate, Provitamin A, Vitamin E, Folate, Utilization/storage
* **Part II:** Ethics, Socio-economics & Micronutrient impacts

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