Human activity and global impact: will/should genetically modified crops help ensure survival?

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EXIST
Exeter Initiative for Science and Technology

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MY OWN BACKGROUND

- Many years of research on plant genes, gene expression and DNA replication
- Several key papers on mechanisms of plant GM (*e.g.* in *Nucleic Acids Res* & *Cell Mol Biol*)
- GM techniques used in research
- Several 'new' plant gene sequences entered into public data bases
- Frequent 'commentator' on GM and related issues

A PERFECT STORM

- We need to feed ***more people*, using *less land*, *less water*, *less fertiliser* and *fewer* (or fewer applications of) *agri-chemicals.***

From *A Perfect Storm* Sir John Beddington, 2009

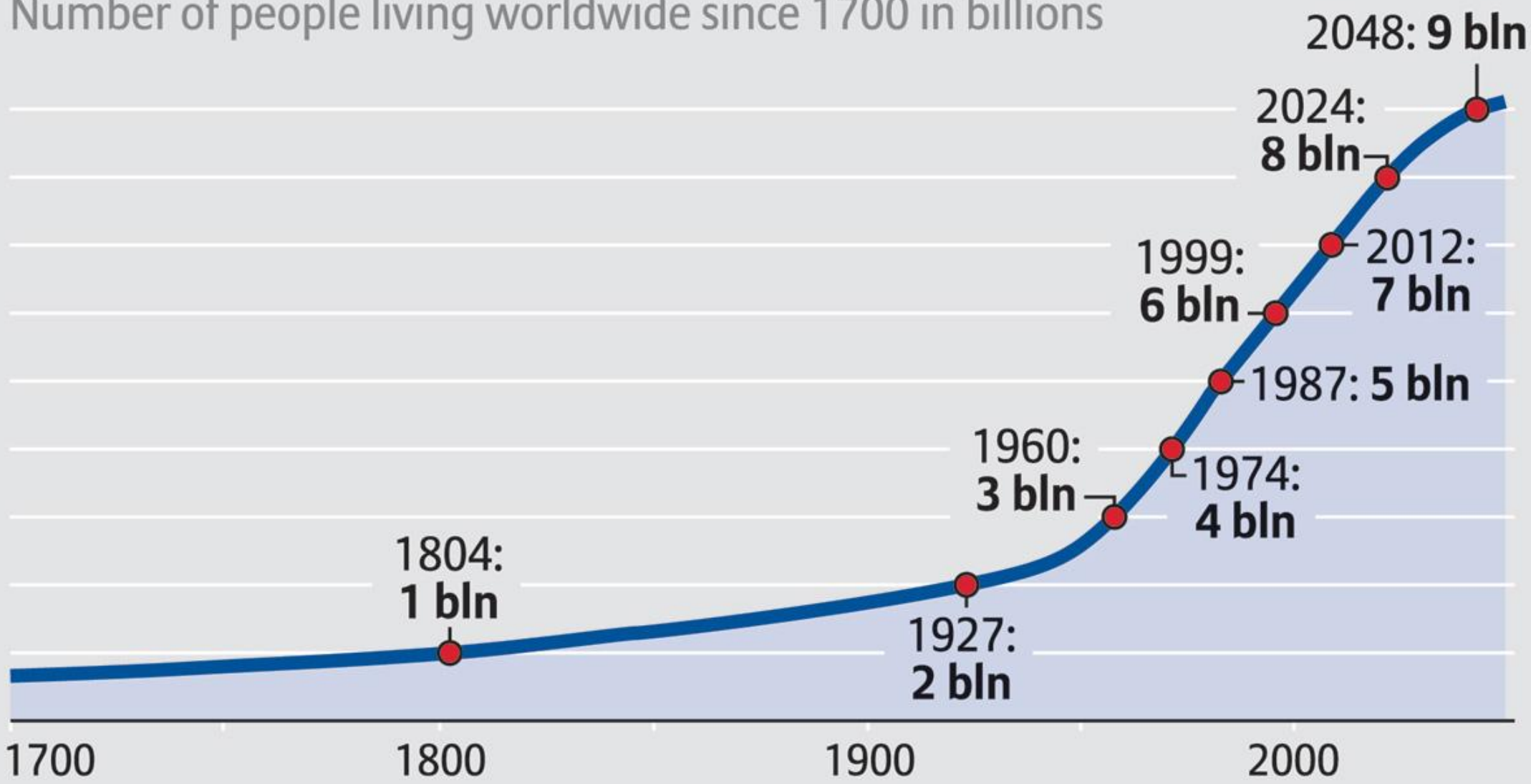
POPULATION

- Ca 7,200,000,000 at 10.50am (BST) 20/08/2014
- 7,000,000,000 (‘7 billion’) mark was passed in late 2011/early 2012 (depending on source of data)
- Population growth slowing but population of 9 billion predicted by 2050

POPULATION OF THE EARTH

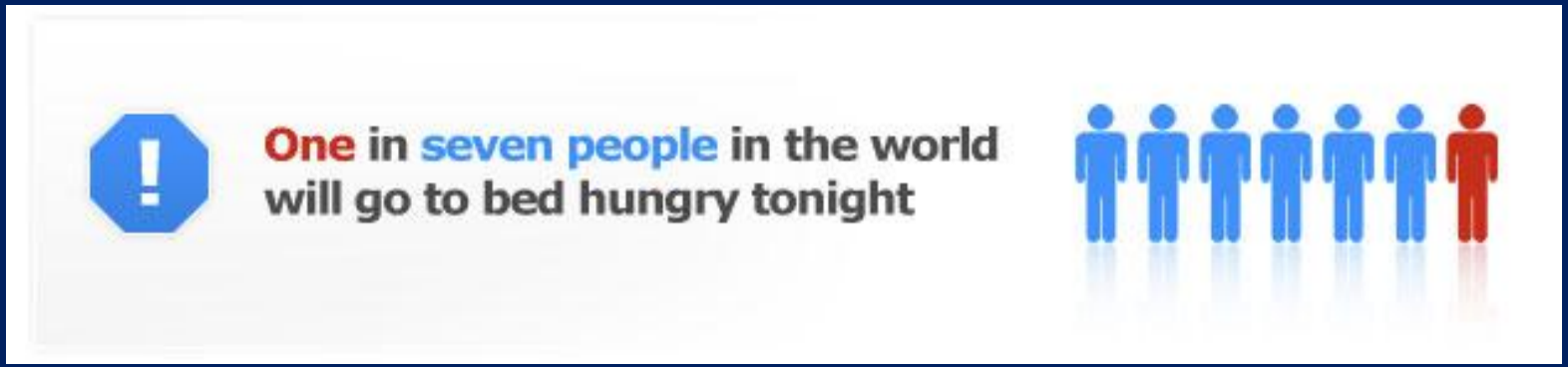
Allianz

Number of people living worldwide since 1700 in billions



Source: United Nations World Population Prospects, Deutsche Stiftung Weltbevölkerung

For further information please visit: www.knowledge.allianz.com



Asia and sub-Saharan Africa make up nearly 75% of the total

But there are 18 million in developed,industrialised countries

Ray DK, Mueller ND, West PC, Foley JA (2013)
Yield Trends Are Insufficient to Double Global Crop Production by 2050.
PLoS ONE 8(6): e66428.
doi:10.1371/journal.pone.0066428

WATER

- 69% of available fresh water is used in agriculture
- 1 in 10 do not have access to safe drinking water
- In in 3 do have access to adequate sanitation

CLIMATE

- **Now thought impossible to keep average temperature increase below 2°C**
- **Plant responses to increased CO_2 and increased temperature have been difficult to predict**
- **Need to prepare for more extremes, including more frequent droughts**

AND TO MAKE MATTERS WORSE

- There are social, economic and political factors which include
- Diet – especially consumption of large quantities of meat
- Social inequality
- Corruption
- War


Picture by Nick Smirnoff

FACED WITH ALL THIS …

- Plant breeders need every possible weapon in their armoury
- ‘Conventional’ breeding
- Mutagenesis
- Genetic modification

- In order to
- Increase nutritional quality of crops
- Make crops more resistant to pests and diseases
- Increase crop robustness in the face of environmental stresses

SOME BRIEF THOUGHTS ON GM

- **Plant GM warmly welcomed by nearly all the plant science community in 1983**
- **No *a priori* reason why it should be dangerous – and it isn't!**
- **First commercial growth of GM plants in 1996.**
- **Now grown in 28 countries; land area devoted to crops bred by GM methods is 170 million hectares**
  - **Several different crops, incl soybean, cotton, maize, oli-seed rape**
- **Not one instance of any harm suffered by any consumer of GM crops/crop products**
- **But have been opposed every step of the way**
  - **Golden Rice is a clear example of this**

Gates Foundation: photosynthesis improvement in rice ('one-cell C4')

Recent Developments

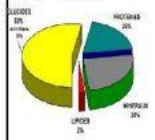
Salt-tolerant pasta wheat bred in Australia – conventional breeding but could have been done more easily by GM

Trait introgressed from wild einkorn wheat but the gene itself has been identified

Drought-tolerant soybeans bred by GM techniques in Argentina, using a gene from sunflower

‘Moderately’ drought-tolerant maize licensed for commercialisation in USA

GUIDE D'UTILISATION DES ALGUES EN CUISINE

ALGUES	Laitue de mer	Dulse	Porphyre - Nori -	Wakamé	Kombu Royal	Spaghettis de mer
Nom latin	*Ulva sp.*	*Palmaria palmata*	*Porphyra sp.*	*Undaria pinnatifida*	*Saccharina latissima*	*Himantalia elongata*
Saveur	**Fraîche**, **corsée** et rappelle le goût de l'**oseille**.	**Douce** et **iodée**. Saveurs de **crustacés**.	**Thé** fumé, **champignon** séché, **huître**	Mélange **discret** de saveurs marines. Goût d'**huître**.	**Sucrée** et **iodée**.	**Iodée.**
Texture	Souple.	Croquante au sortir de la mer, et fondante après une rapide cuisson.	Souple et fine. (Epaisse d'une seule couche de cellule)	Lame souple et stipe (nervure centrale) rigide.	Charnue et croquante. Tendre sur les extrémités.	Tendre
bord bord						
Utilisations	Crue et émincée elle accompagnera les **salades** et les **crudités**. Hachée elle agrémentera les **sauces**, les **potages** ou les **vinaigrettes**. S'utilise aussi comme **papillote**.	Se consomme crue avec les **crudités** et les **salades**. Agrémente les **sauces**, les **potages** et les **vinaigrettes**. Agrémente une tourte aux fruits de mer.	Se met en caviar sur une **pomme de terre** au four. Accompagne délicieusement les **omelettes**, les **béchamels** et les **sauces**.	Renforce les saveurs d'un **potage** avec onctuosité. S'emploie également dans les **tourtes** et les **salades**.	Cette **papillote royale** permet de réaliser tout type d'aumonières. S'emploie pour la **cuisson des légumineuses**...	Accompagne les **légumes**, les **poissons**, les **tourtes**...
Particularités 	Riche en minéraux : calcium (20% de l'AQR*), fer (10%), magnésium (100%). vitamines A et C.	Riche en Protéines et en minéraux : magnésium (10%), phosphore, iode (100%) et fer. Bien équilibrée en vitamines A, B, C.	Qualité de protéines voisine de celles de l'oeuf. Très intéressante pour le phosphore, , la provitamine A (30%), le fer et la vit. B12 (100%).	Très intéressante pour le calcium et les vitamines du groupe B, dont la vitamine B12. Bonne teneur en vitamine C, en sodium en fer et en potassium.	Très riche en minéraux : calcium, potassium et sodium. C'est l'algue la plus riche en iode.	Riche en minéraux et en vitamines, particulièrement pour la vitamine C.

* : A.Q.R. Apport Quotidien Recommandé **(%)** pour 5 g d'algues déshydratée ou 20 g d'algues fraîches.

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Thinking outside the box

Can algae 'save the planet'?

Climate change genomics

SO … WILL GM CROPS 'HELP TO ENSURE OUR SURVIVAL'?

- **GM crops are not are panacea for all problems in agriculture and crop science – far from it**
- **GM techniques are part of an array of techniques available to the plant breeder**
- **And it's a tough call**

  Ray DK, Mueller ND, West PC, Foley JA (2013) Yield Trends Are Insufficient to Double Global Crop Production by 2050. *PLoS ONE* 8(6): e66428. doi:10.1371/journal.pone.0066428

- **In addition to plant breeding we need more efficient crop husbandry and effective land use**
- **Not forgetting non-science, non-agriculture issues**

SO … WILL GM CROPS ‘HELP TO ENSURE OUR SURVIVAL’?

- It’s your call!