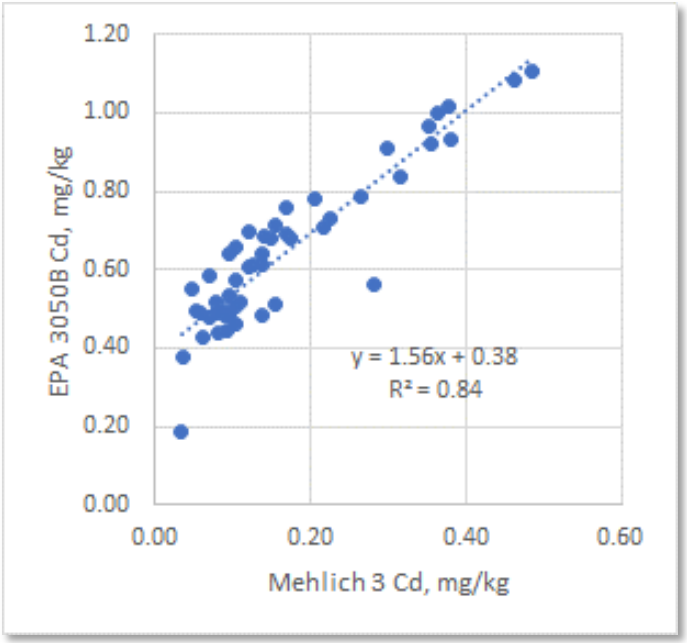
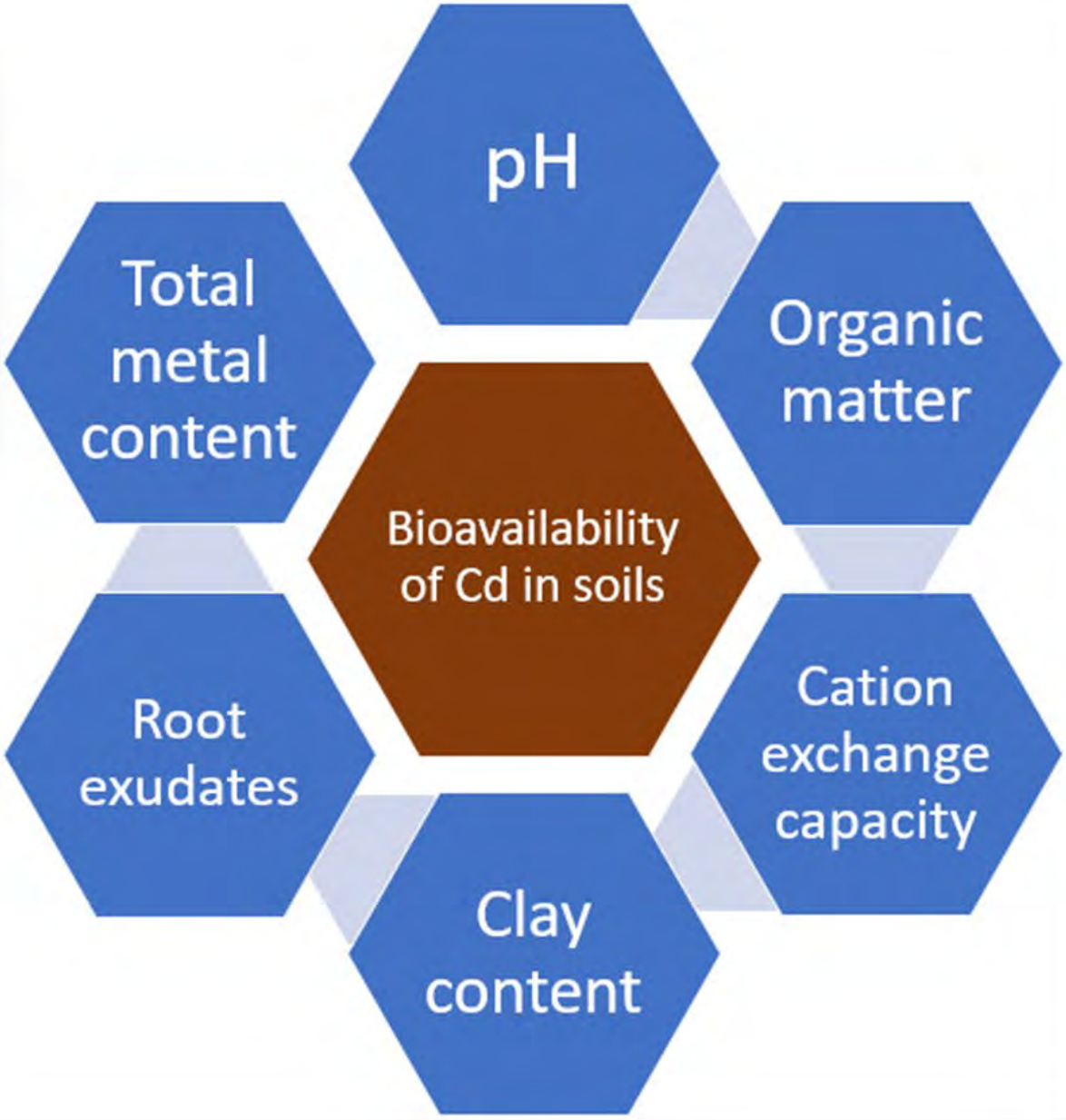
Opportunity is knocking and we must answer

A path for farming and food production in the shadow of "big problems"

Dr. Patrick Drohan, Ecosys. Sci. & Mgmt. Penn State

Session I: Soil analysis and nutrient management
Catchment Science, 2019
Nov. 5, 2019


1.20
1.00
0.80
0.60
0.40
0.20
0.00
EPA 3050B Cd, mg/kg
y = 1.56x + 0.38
R² = 0.84
0.00
0.20
0.40
0.60
Mehlich 3 Cd, mg/kg


pH
Total metal content
Organic matter
Bioavailability of Cd in soils
Root exudates
Cation exchange capacity
Clay content


40

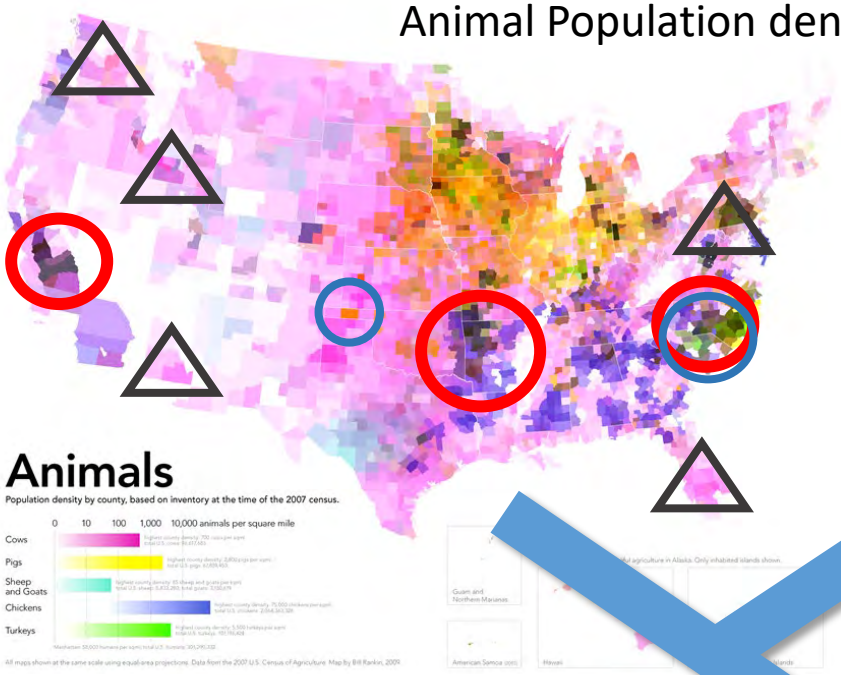

TaylorMade

YouTube screen grab shows former FARC senior commander Ivan Marquez, left, and fugitive rebel, Jesus Santrich, announcing the resumption of armed revolt in Colombia. Getty Images

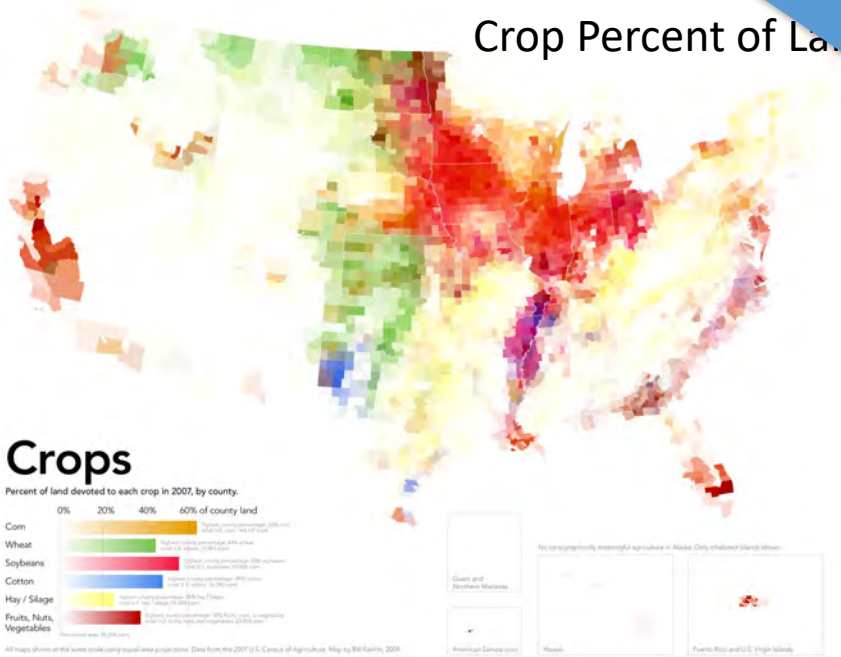

Beijing
HEBEI
1 h 35 min
8 h 24 min
735 km
SHANXI
Linfen
Google


对标一流学技术 提升技能促发展
尧都区农业中心
国家小麦产业技术体系黄淮冬麦区北片新品种试验
广适组：
冀麦659
中麦6079
临农11
济麦418
衡H1608
LH1703
鲁研454
衡H165171
TKM0311
鲁研733
鲁研951
TKM6007
LS4155
石15-6375
济麦22
节水组：
鲁研373
中麦6032
鲁研697
济麦0435
LH1706
鲁研1403
LS018R
LH16-4
LS3666
济麦44
济麦22
山西省农业科学院小麦研究所

Animal Population density



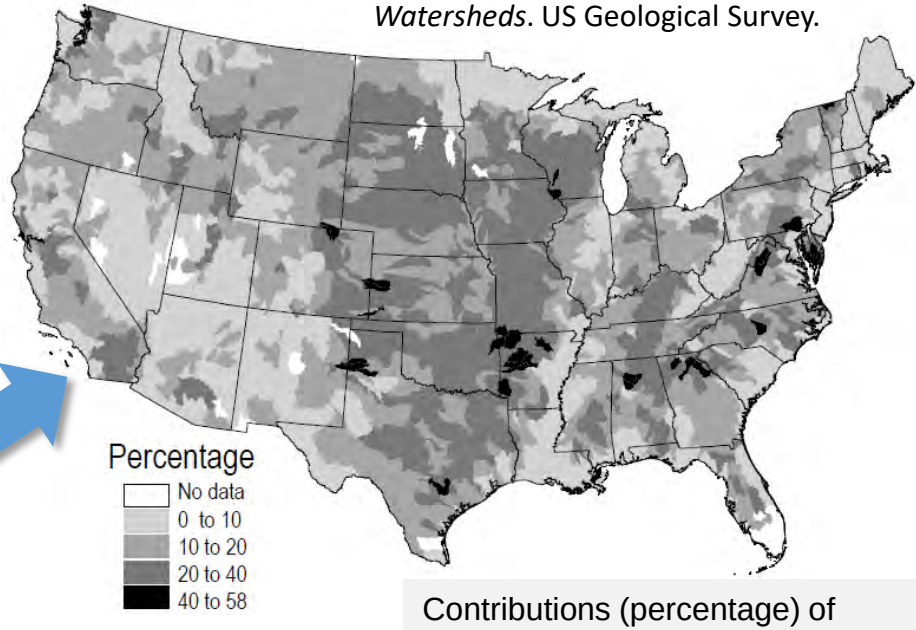
Crop Percent of La



https://worldmapper.org

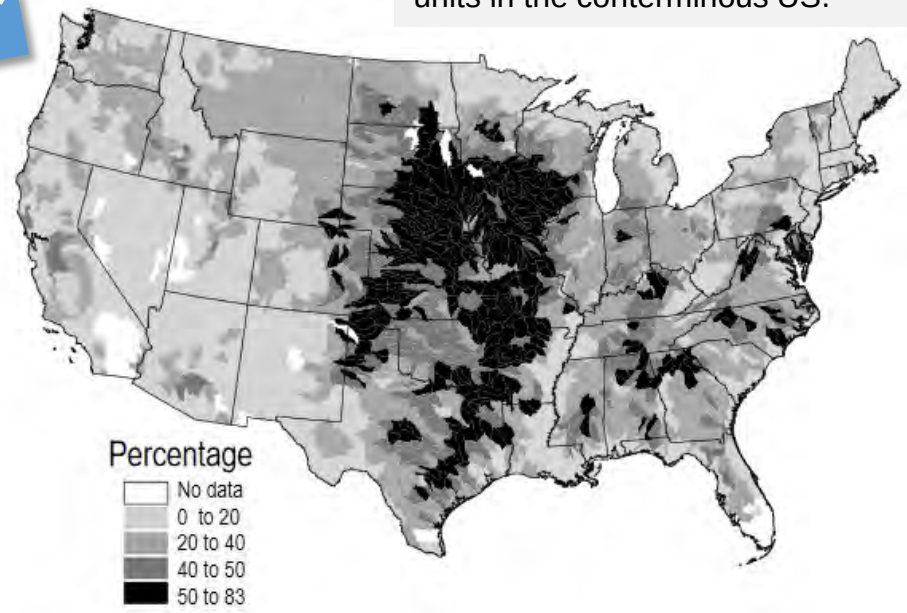
a Total Nitrogen

Smith, R.A. and Alexander, R.B., 2000. *Sources of Nutrients in the Nation's Watersheds*. US Geological Survey.



Contributions (percentage) of animal agriculture to nutrient export from hydrologic cataloging units in the conterminous US.

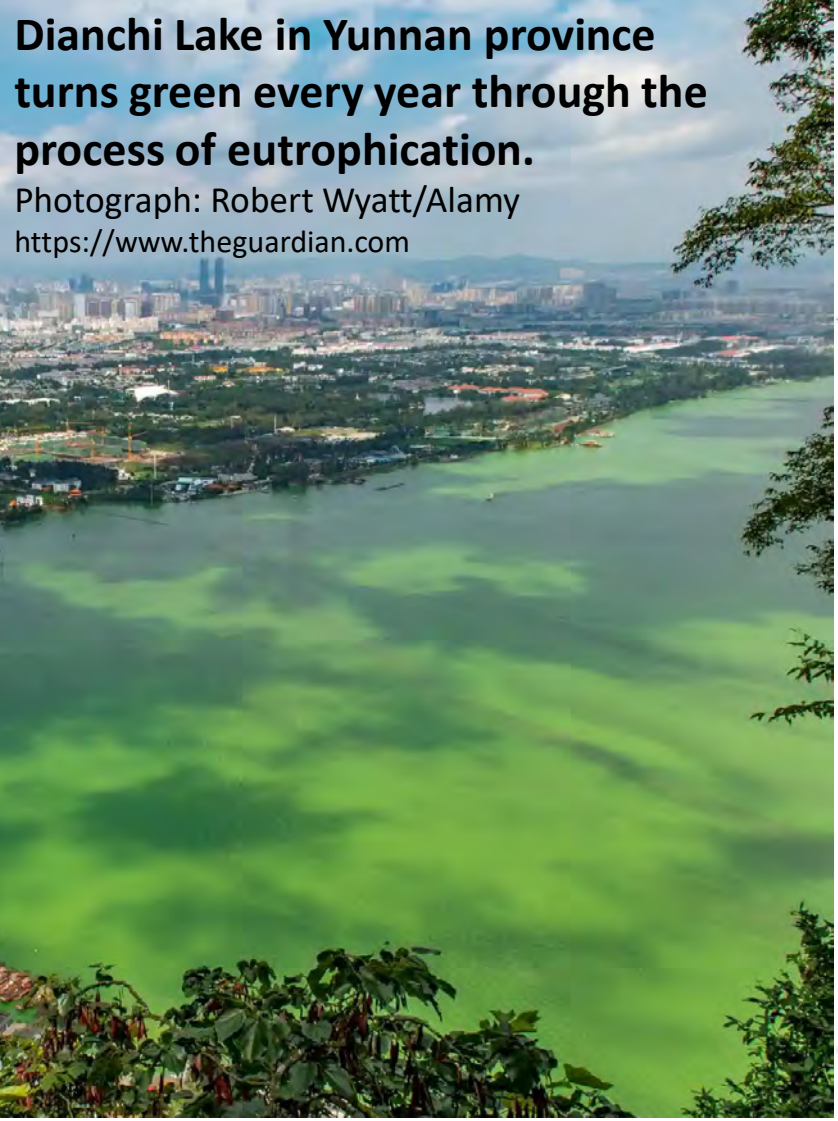
b Total Phosphorus

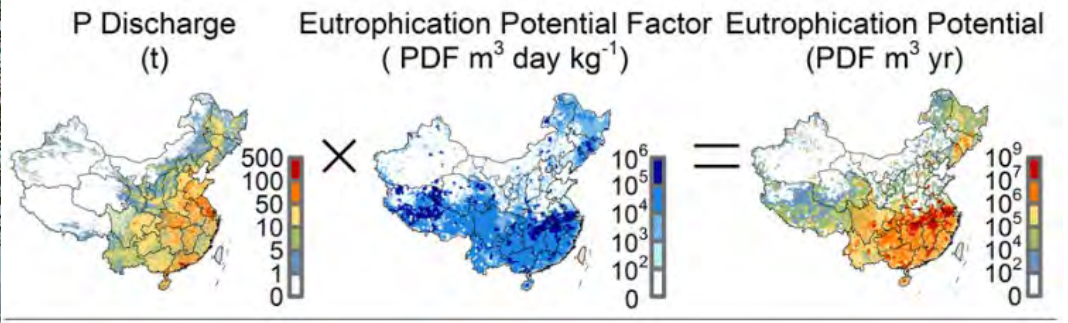


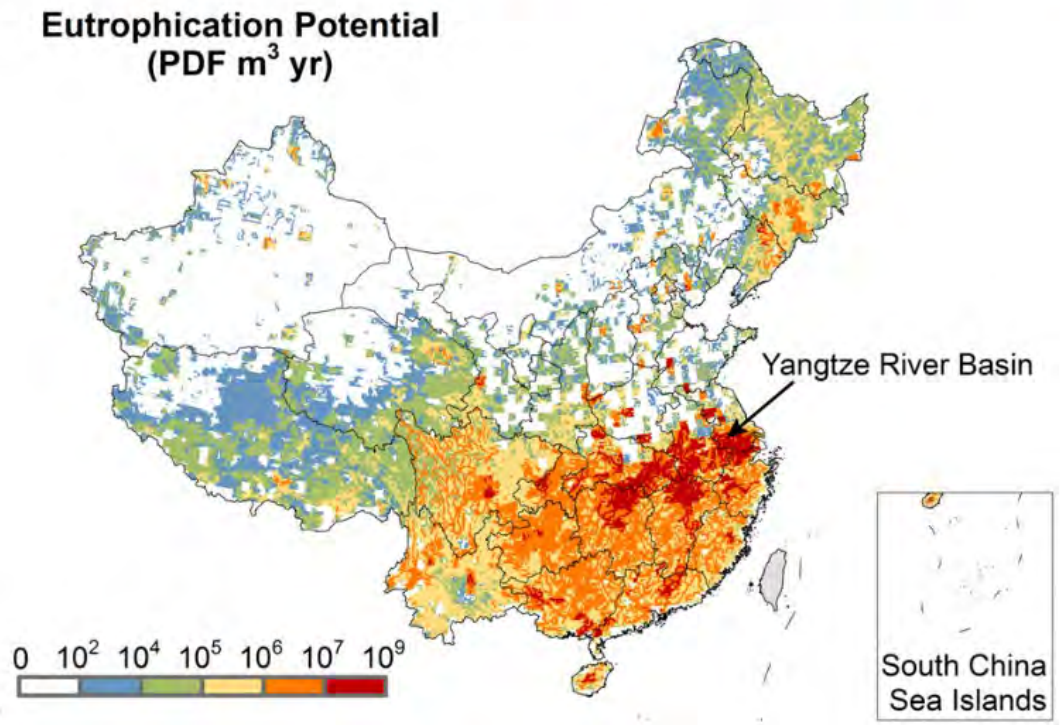
Dianchi Lake in Yunnan province turns green every year through the process of eutrophication.

Photograph: Robert Wyatt/Alamy

https://www.theguardian.com







PNAS

Intensification of phosphorus cycling in China since the 1600s

Xin Liu[a,1], Hu Sheng[a,1], Songyan Jiang[a], Zengwei Yuan[a,2], Chaosheng Zhang[b], and James J. Elser[c]

[a]State Key Laboratory of Pollution Control and Resource Reuse, School of the Environment, Nanjing University, Nanjing 210023, China; [b]GIS Centre, Ryan Institute and School of Geography and Archaeology, National University of Ireland, Galway H91 CF50, Ireland; and [c]School of Life Sciences, Arizona State University, Tempe, AZ 85287

Edited by Stephen R. Carpenter, University of Wisconsin, Madison, WI, and approved January 21, 2016 (received for review October 2, 2015)


Topsoil pile about 11 stories high

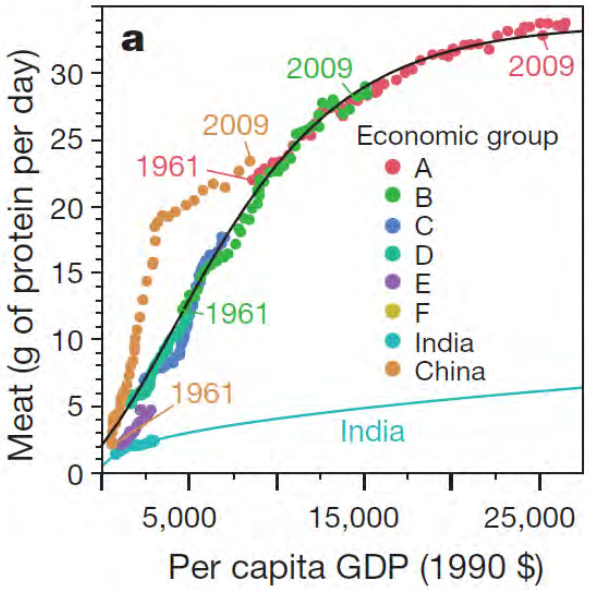


Fig. 2 from the paper

Nature
2014

ARTICLE

doi:10.1038/nature13959

Global diets link environmental sustainability and human health

David Tilman[1,2] & Michael Clark[1]

Tilman and Clark (2014)

Linfen City Supermarket

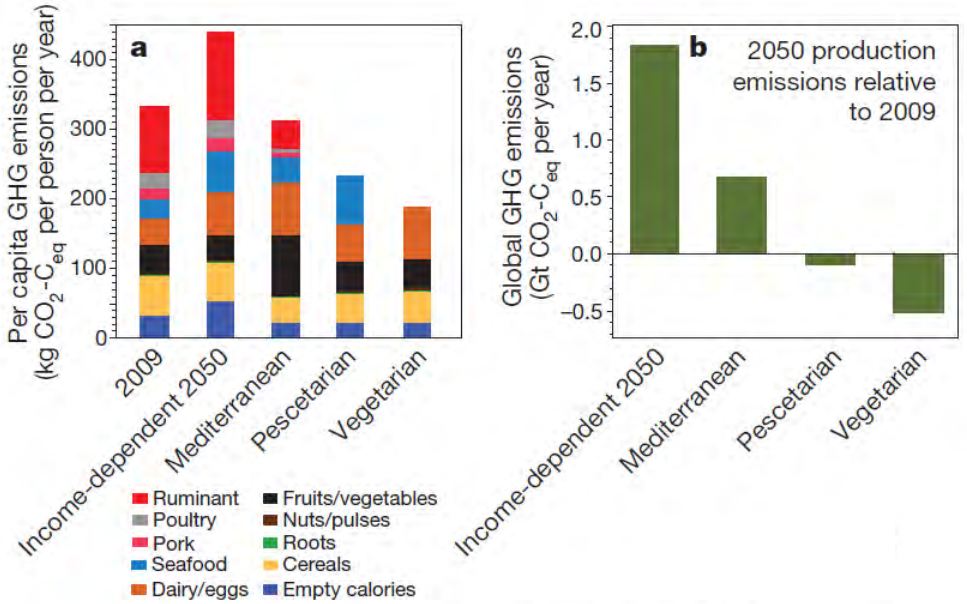


Figure 4 | Effect of diets on GHG emissions and cropland. **a**, Per capita food production GHG emissions for five diets (2009 global-average, 2050 global income-dependent, Mediterranean, pescetarian and vegetarian). **b**, **c**, Forecasted 2009 to 2050 changes (2009 value set to 0) in global food emissions (**b**), and cropland for each diet (Methods; alternative scenarios,

ARTICLE

Nature
2014

doi:10.1038/nature13959

Global diets link environmental sustainability and human health

David Tilman[1,2] & Michael Clark[1]

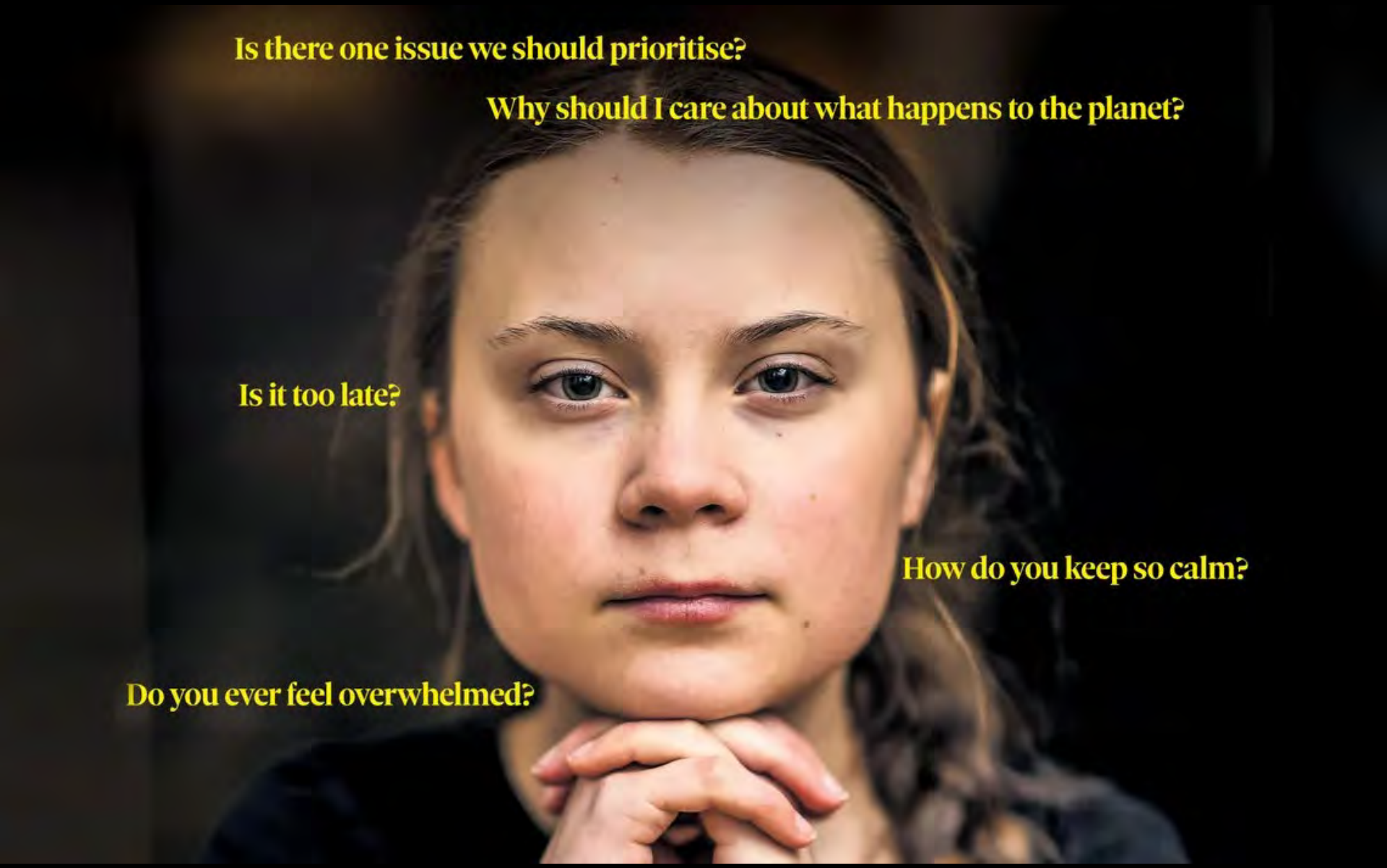
Tilman and Clark (2014)


芝麻街英语


Youssoufia
Skills
جنـــــاح أ
Bâtiment A
استقبال
Accueil
فضاء التوجيه
Espace Ecoute et Orientation
الأنشطة الثقافية و الترفيهية
Animation Culturelle
فضاء المهارات
Espace Soft Skills

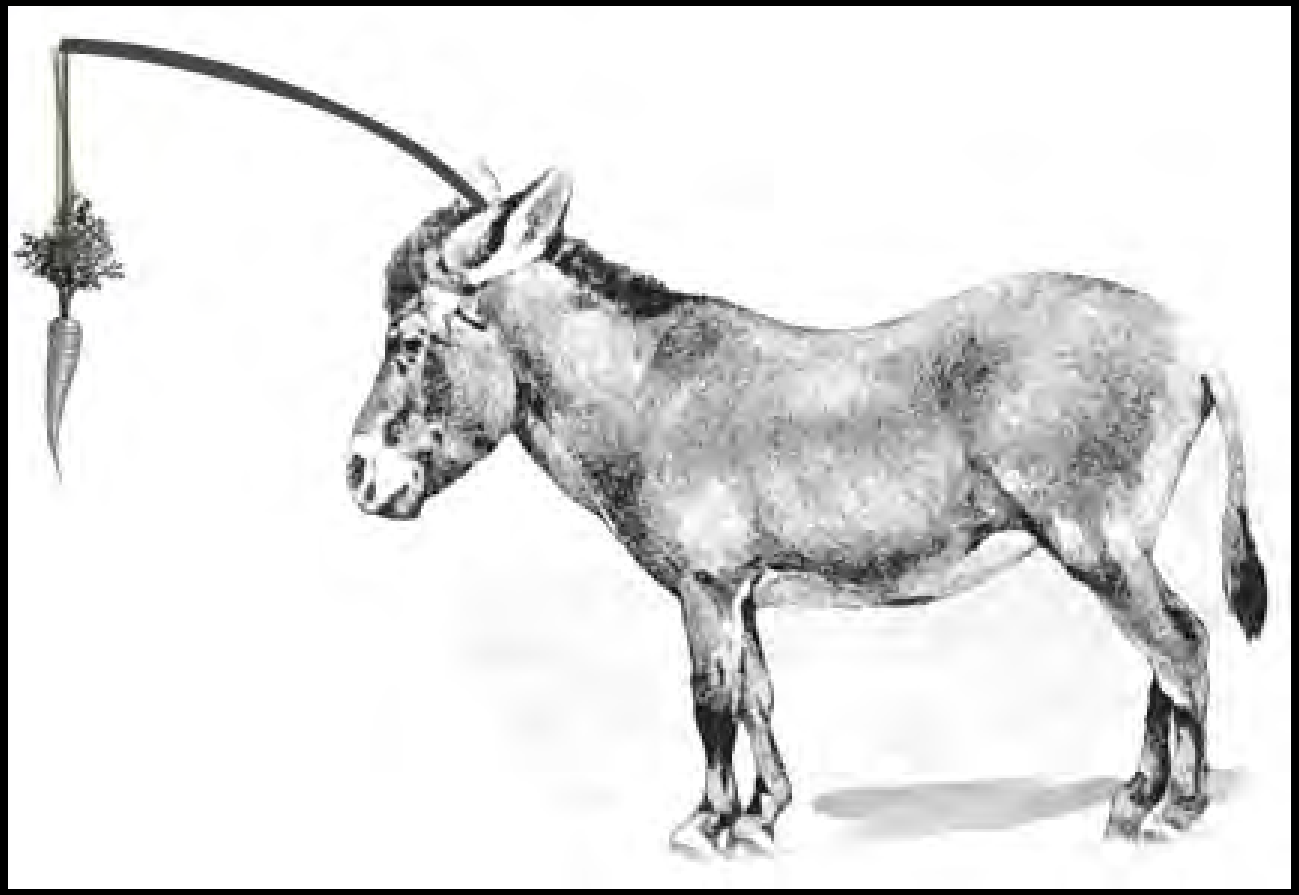
OCP


M. Guiltinan



‘Everyone is welcome. Everyone is needed’: Greta Thunberg photographed in her home city, Stockholm, March 2019. Photograph: Michael Campanella/The Guardian


Images



7 Ideas for Affecting Change

… and a “caution”

1. Climate Change Adaptation Now

ANALYSIS
https://doi.org/10.1038/s41893-018-0210-1

nature sustainability

Food production shocks across land and sea

Richard S. Cottrell[1,2*], Kirsty L. Nash[1,2], Benjamin S. Halpern[3,4,5], Tomas A. Remenyi[6], Stuart P. Corney[2], Aysha Fleming[1,7], Elizabeth A. Fulton[1,8], Sara Hornborg[1,2,8,9], Alexandra Johne[2], Reg A. Watson[1,2] and Julia L. Blanchard[1,2]

NATURE SUSTAINABILITY | VOL 2 | FEBRUARY 2019 | 130–137 | www.nature.com/natsustain

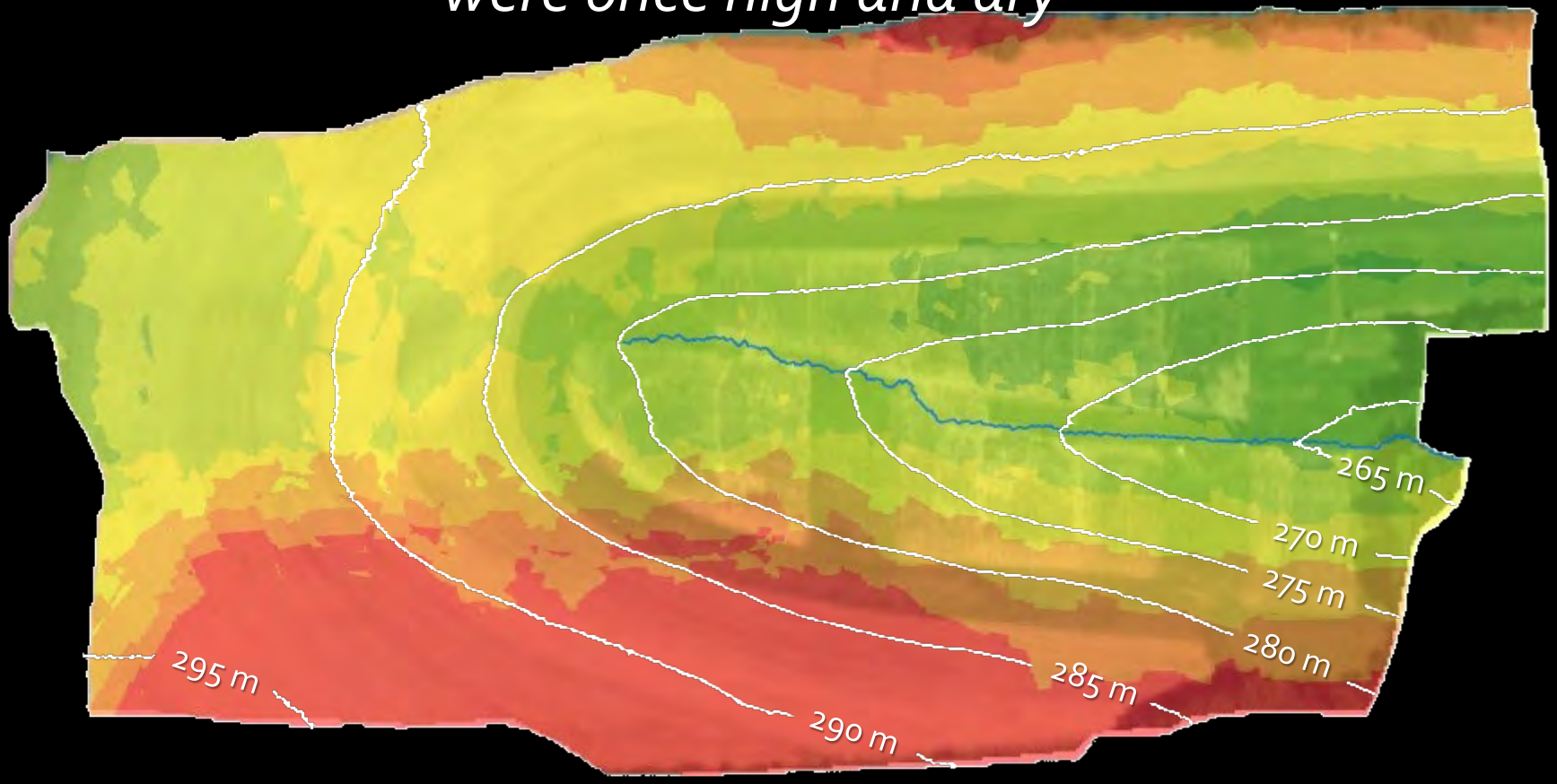
Sudden losses to food production (that is, shocks) and their consequences across land and sea pose cumulative threats to global sustainability.

Critically, shock frequency has increased through time on land and sea at a global scale.

Geopolitical and extreme-weather events were the main shock drivers identified, but with considerable differences across sectors.

2011 Tropical Storm Lee

Extreme events are activating legacy nutrient sources that were once high and dry

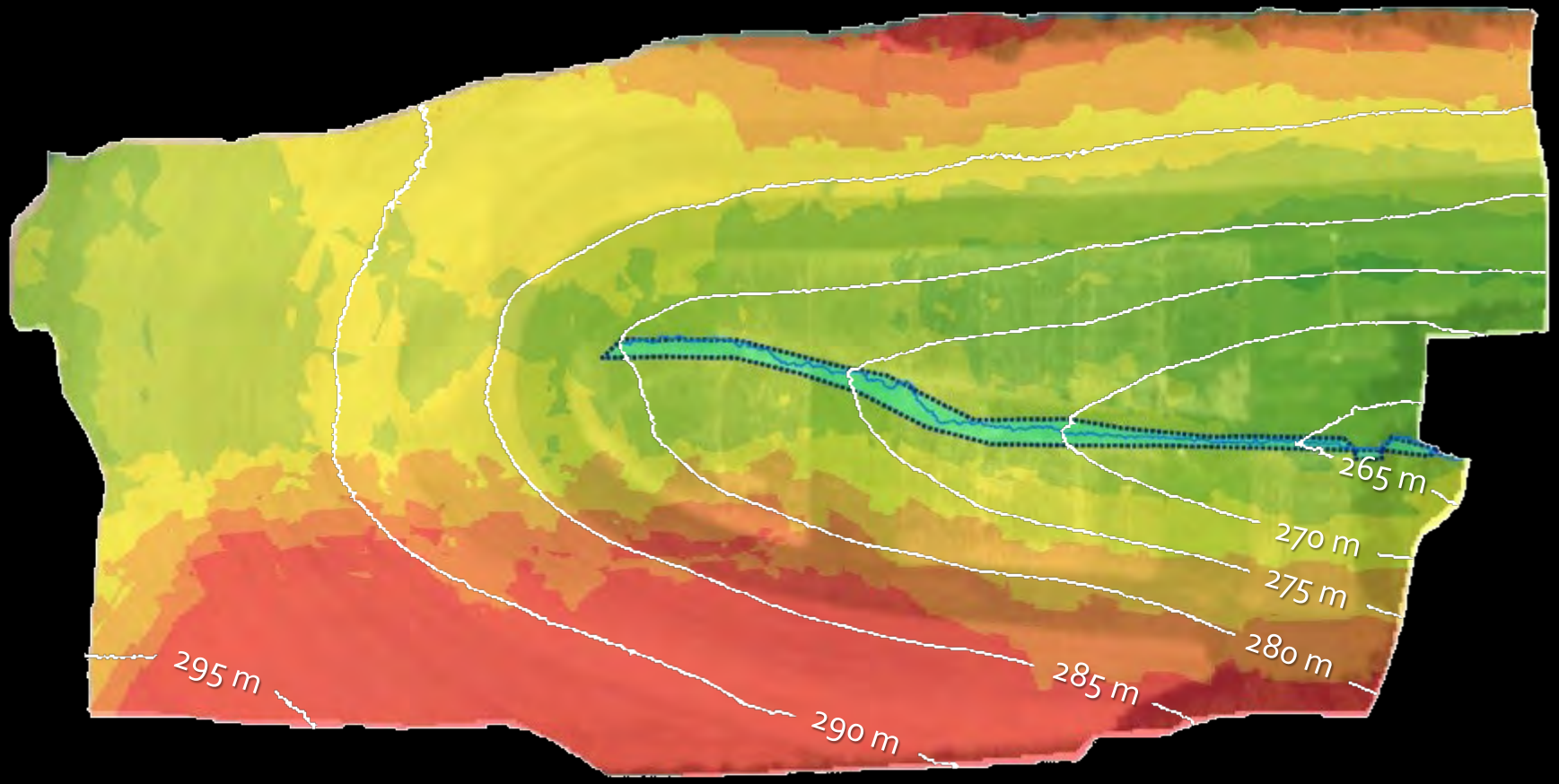


Mehlich-3 soil P (mg/kg)

150 200 250 300 350 400

Contributing area a small storm

only 0.4% of watershed was likely generating runoff and P loss

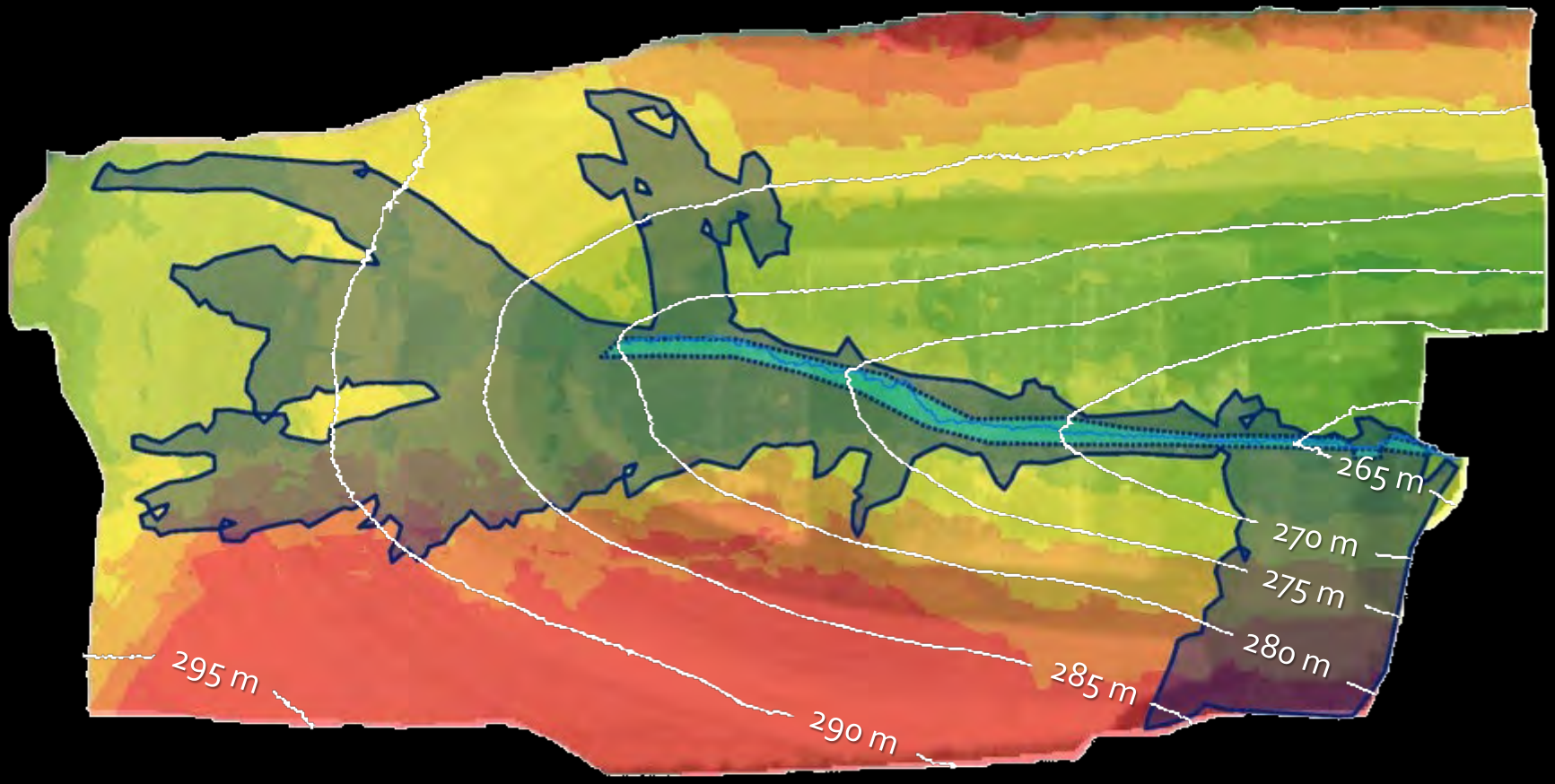


Mehlich-3 soil P (mg/kg)

150 200 250 300 350 400

The contributing area for Lee was larger

as much as 28% of the watershed generated runoff and P loss

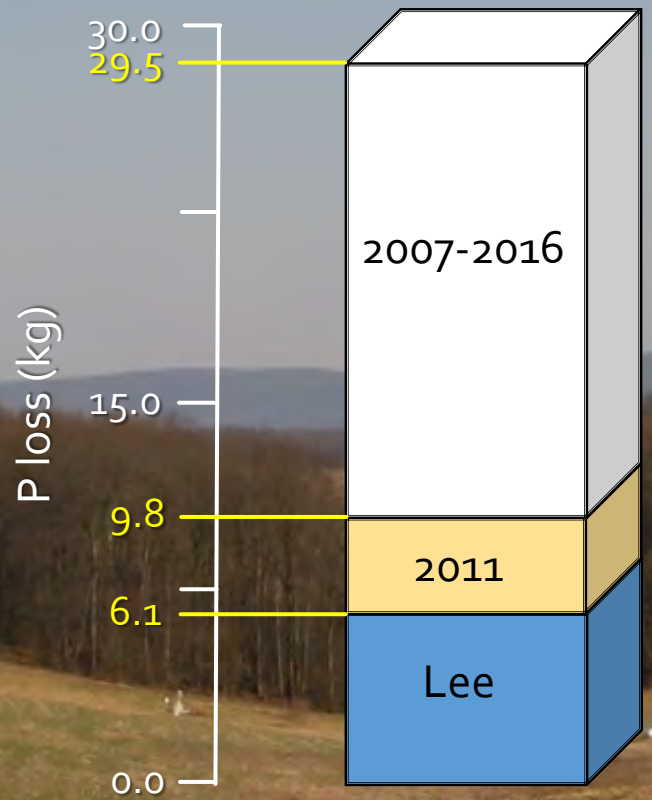


Mehlich-3 soil P (mg/kg)

150 200 250 300 350 400

P loss from Tropical Storm Lee was profound

Lee contributed significantly to 2011 and decadal P loss

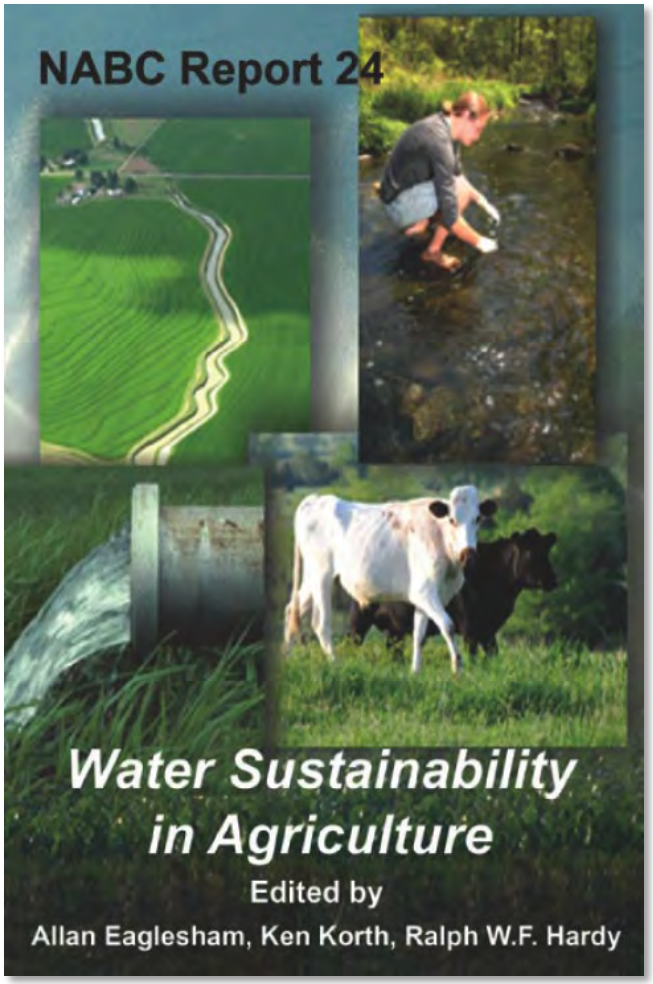


Tropical Storm Lee accounted for 21% of the P loss over the past decade.

Tropical Storm Lee accounted for 63% of the P loss in 2011.

ACTION ITEM: National and International Action Plans with Detailed Logistic Response

2. Now Reshape Agriculture



Who chooses what to grow?

"A nationwide systems analysis is needed across agriculture to assess where the most water-efficient crops are being grown in each region.

If that analysis concludes that certain crops are performing inefficiently, what infrastructure needs to be developed, and what social shifts need to occur for improvement?"

Entrepreneurial agriculture is not altruistic, is doing little to achieve sustainability, and will have a tough time adapting to climate change under the "invisible hand."

3. Functional Land Use Management can Guide Reshaping Agriculture

We expect our land (soil) to provide:

1. Primary Productivity
2. Water purification and regulation
3. Carbon Storage and Regulation
4. Provision of Habitat for Biodiversity
5. Cycling and provision of nutrients, especially nutrient renovation

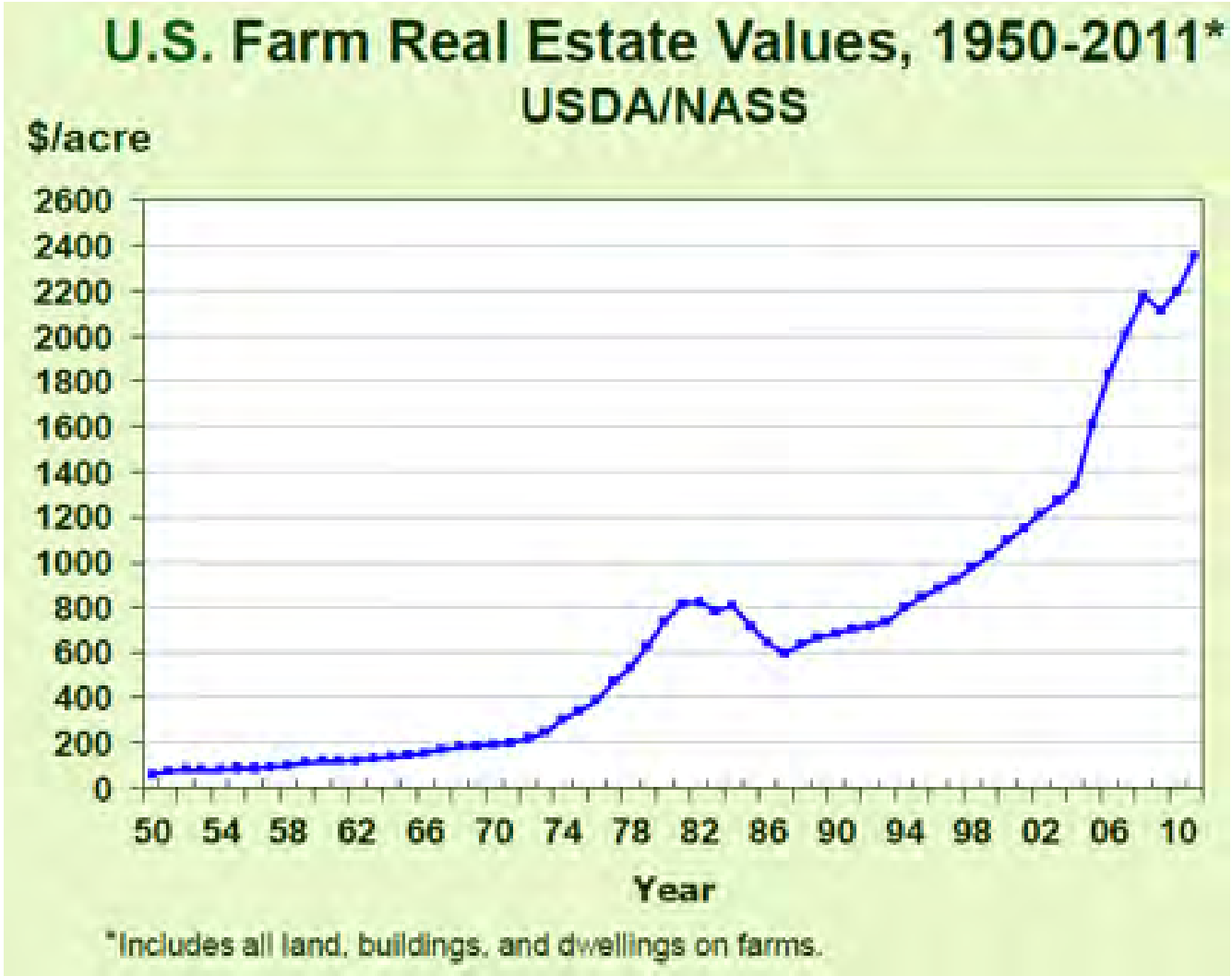
All soils can perform all five functions, but some soils are better at supplying selective functions.

Functional Land Management:
A framework for policy implementation
Meet demands by incentivizing land use and soil management practices that selectively augment specific soil functions, where required.

FIGURE 1 | Illustrative representation of the suite of five soil functions proposed by Schulte et al. (2014). The white box indicates primary production; blue, water purification and regulation; black, carbon storage and regulation; green, provision of a habitat for biodiversity; purple, cycling of nutrients.

Schulte, R. P., Creamer, R. E., Donnellan, T., Farrelly, N., Fealy, R., O'Donoghue, C., & O'hUallachain, D. (2014). Functional land management: A framework for managing soil-based ecosystem services for the sustainable intensification of agriculture. *Environmental Science & Policy*, *38*, 45-58.

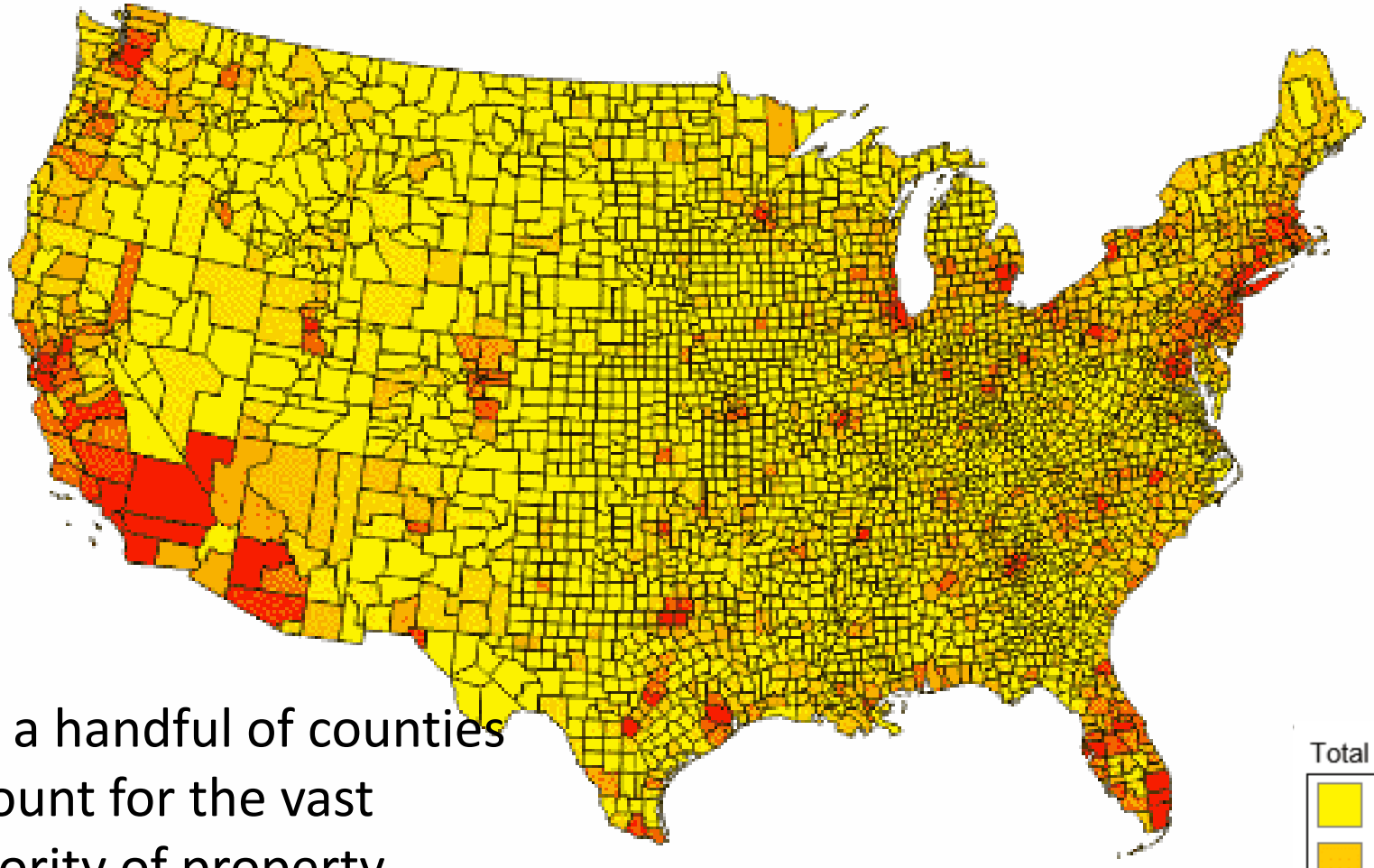
4. Land dispersal to improve mgmt.?



http://www.economist.com/blogs/freeexchange/2015/04/land-value-tax

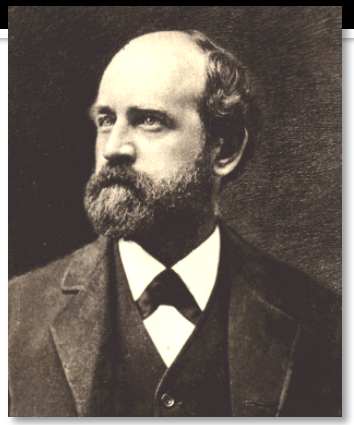
Property values between counties across the continental United States

(Max Galka/Metrocosm)

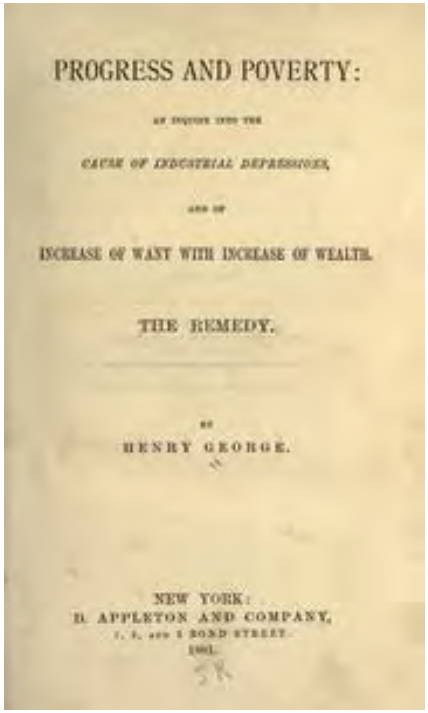


Just a handful of counties account for the vast majority of property values in the U.S.

Solution: Henry George Land Tax



- "Unequal distribution of wealth inevitably transforms popular government into despotism. This is not a thing of the far future. It has already begun in the United States, and is proceeding rapidly before our very eyes." – HG, 1880
- George suggested to tax the value of land - not the improvements
  - prevents high land rents, hoarding, etc.
  - distribute the proceeds to the poor, or use them for infrastructure and other public improvements.
  - breaks down inequalities in wealth


PROGRESS AND POVERTY:

AN INQUIRY INTO THE

CAUSE OF INDUSTRIAL DEPRESSIONS,

AND OF

INCREASE OF WANT WITH INCREASE OF WEALTH.

THE REMEDY.

BY

HENRY GEORGE.

NEW YORK:
D. APPLETON AND COMPANY,
1, 3, AND 5 BOND STREET.
1881.

5. Getting more people on the ground working with land owners

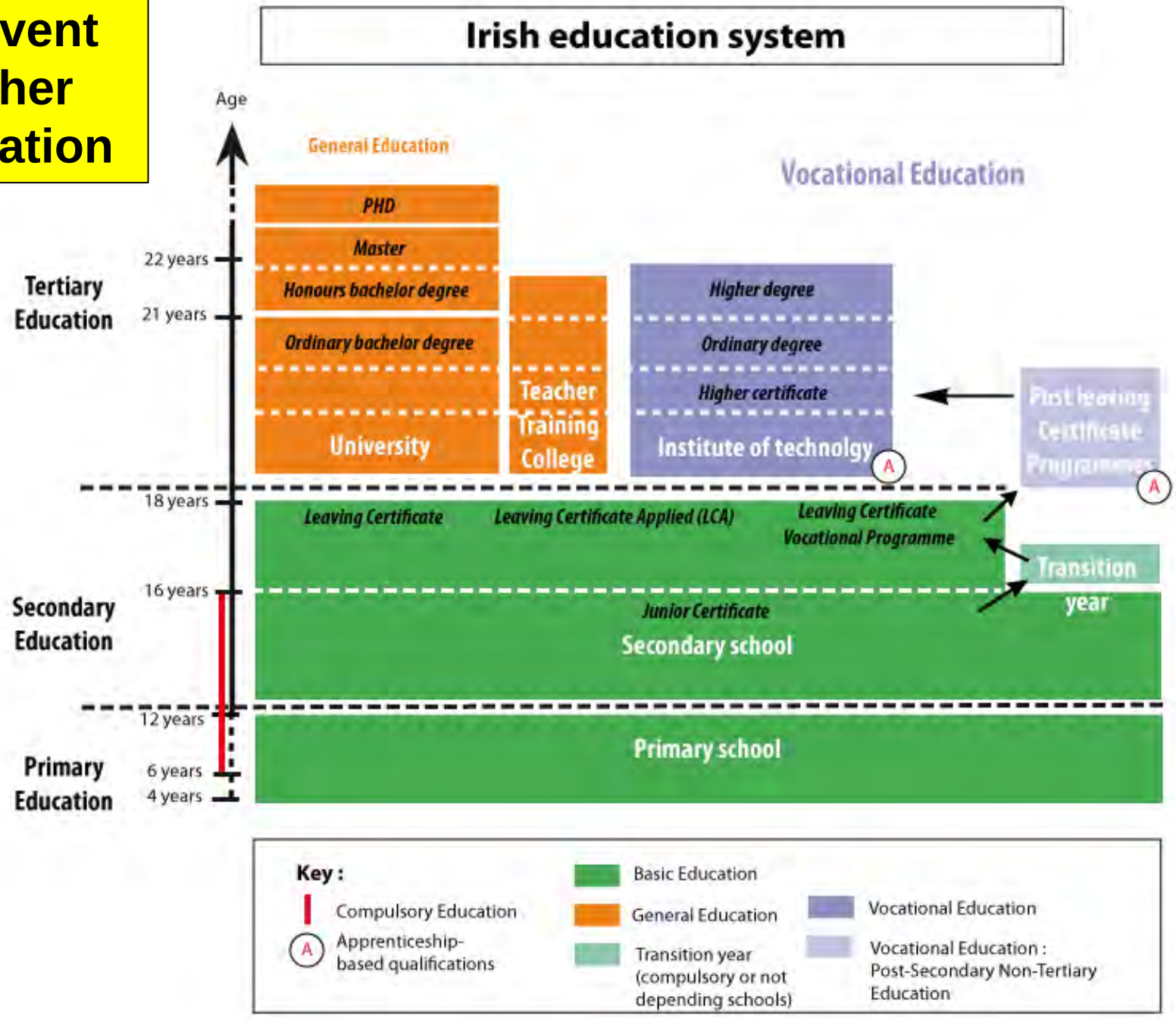
Profession	Proportion with a College Degree
Flight attendants	29.8%
Retail salespersons	24.5%
Customer service representatives	21.6%
Baggage porters and bellhops	17.4%
Secretaries (not legal/medical/executive)	16.6%
Hotel, motel, and resort desk clerks	16.1%
Telemarketers	15.8%
Taxi drivers and chauffeurs	15.2%
Manicurists and pedicurists	11.5%
Shampooers	11.5%
Locksmiths and safe repairers	10.2%
Telecomm. installers & repairers	13.1%

Is the 4 year college model right??

Can we achieve an educated, empathetic, creative, responsible society via other models?

https://www.collegedata.com/en/pay-your-way/college-sticker-shock/

Reinvent Higher Education



https://www.education.ie/en/the-education-system/

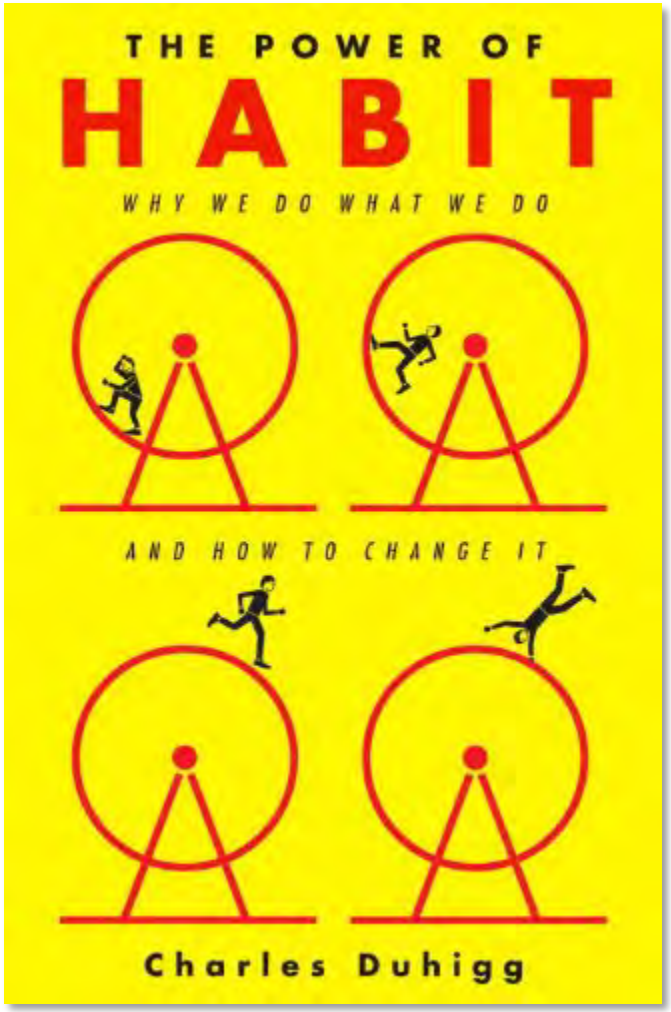
6. Land manager/farmer knowledge

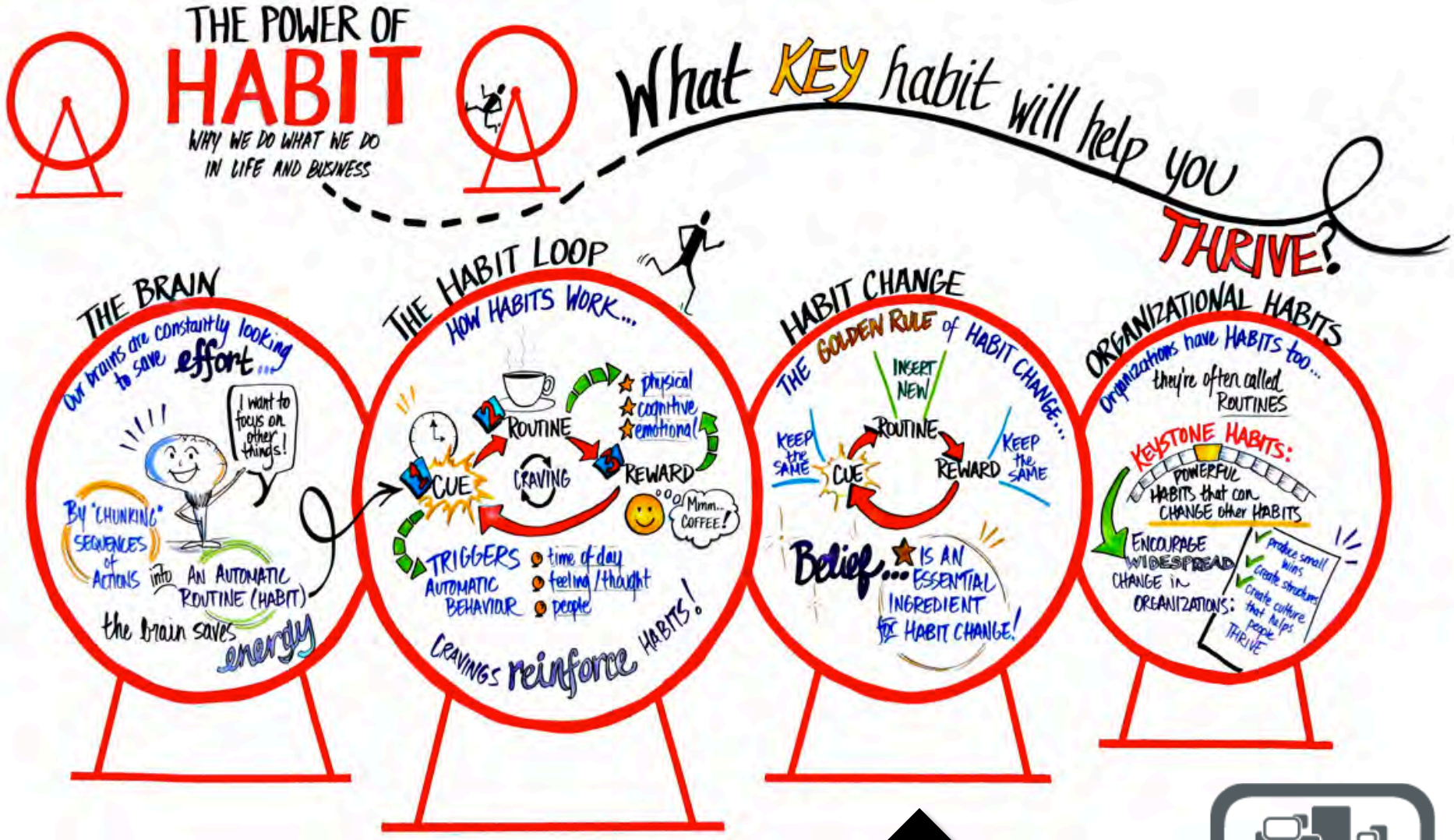
- Global 2 year colleges?
- Students earn certificates: 100 cr hours
  - Credit hours used to certify someone to manage land as a farmer, rancher, etc.
  - Credit hours meet basic requirements for entry level positions in federal gov't
  - Qualifies one for subsidies (e.g. GLAS payments in IRE)

That's downright Un-American!

7: Bigger Worldwide Education Effort

- **Goal:** Change Human Behavior and Perception of land/food/ecosystem.
  - SOIL HEALTH initiative???





New York Times business reporter Charles Duhigg, “The Power of Habit: Why We Do What We Do in Life and Business”

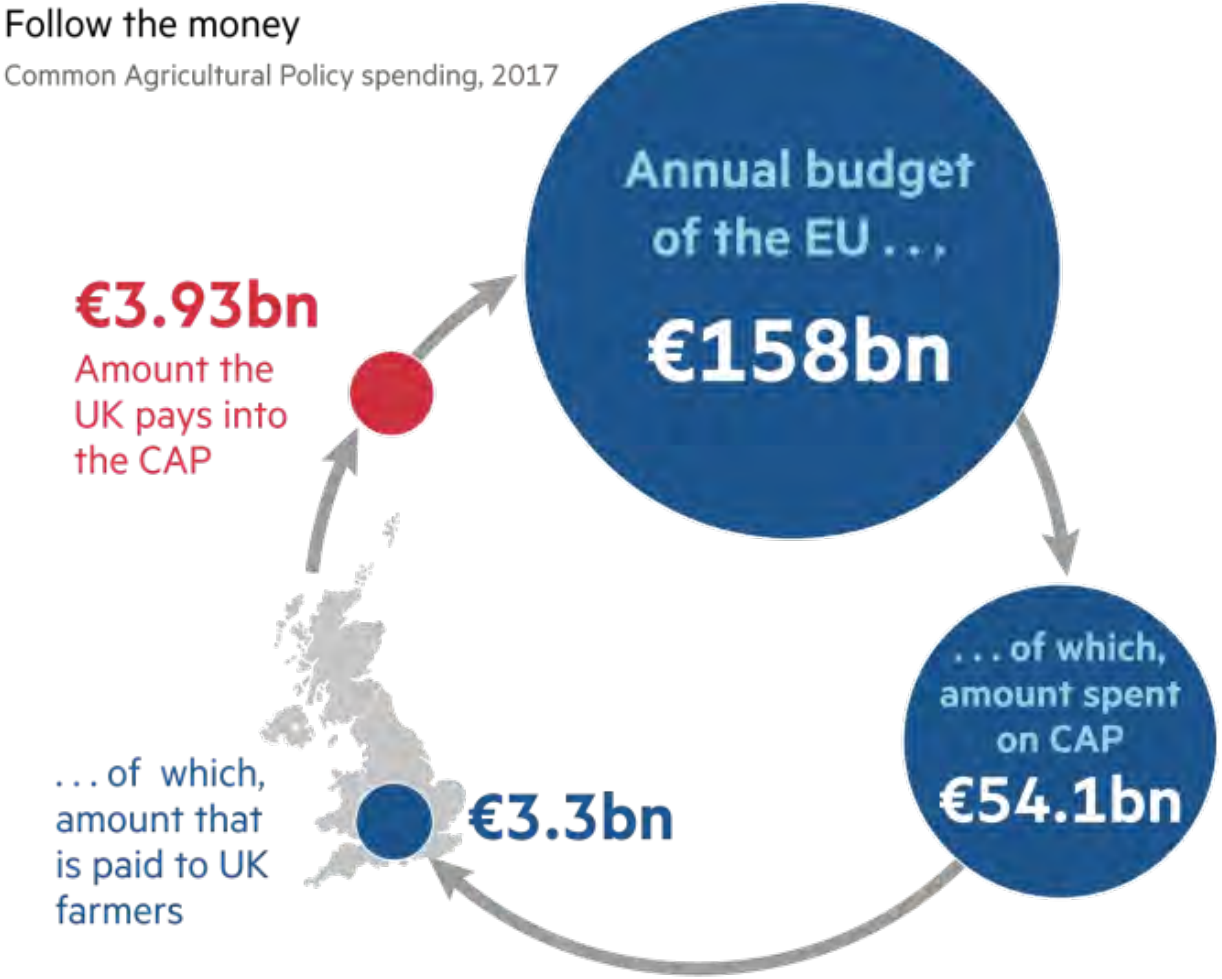
GET THE picture

Start with children….

8. EU CAP Model for Ag by Continent

Follow the money

Common Agricultural Policy spending, 2017



Sources: European Commission; HM Treasury; Defra

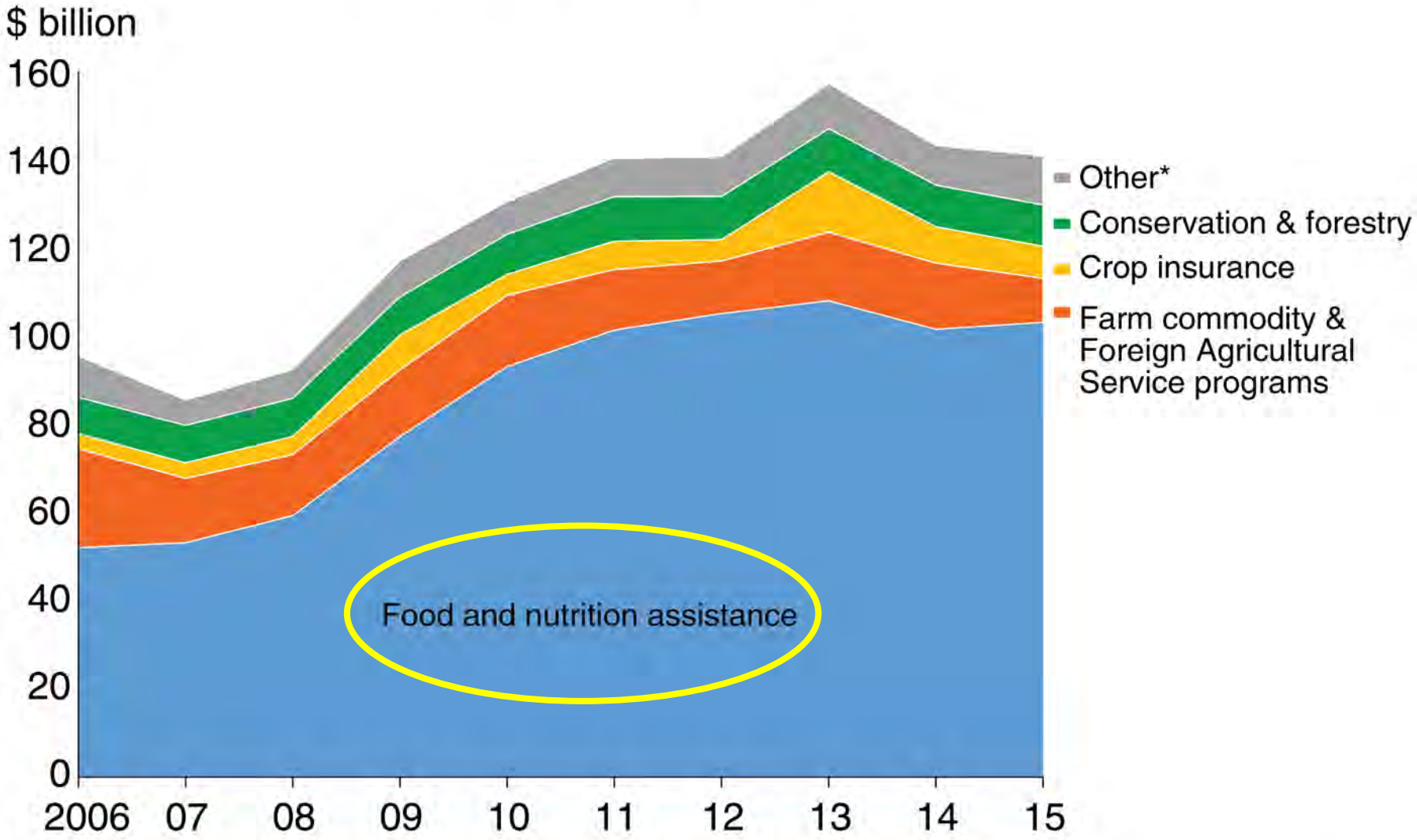
© FT

https://www.ft.com/content/9606face-8605-11e9-97ea-05ac2431f453

USA - EU Comparison

- EU Common Agricultural Policy (CAP) direct payments in 2017 provided:
  - UK with €3.0 billion,
  - RoI €1.2 billion,
  - Sweden €686 million, and
  - Finland €523 million
- In total, the European Union supported agriculture in 2016 with €38.5 billion in direct payments and €12.6 billion in rural development financial support.
- USA farmers in 2017 received total subsidies valued at €16.2 billion ($18.2 billion).
  - Pennsylvania in 2017 provided €88 million ($101 million) in farmer subsidies.

USDA budget outlays, fiscal years 2006-15



*Includes rural development, food safety, marketing and regulatory programs, research, and departmental activities. Note: Nominal dollars.

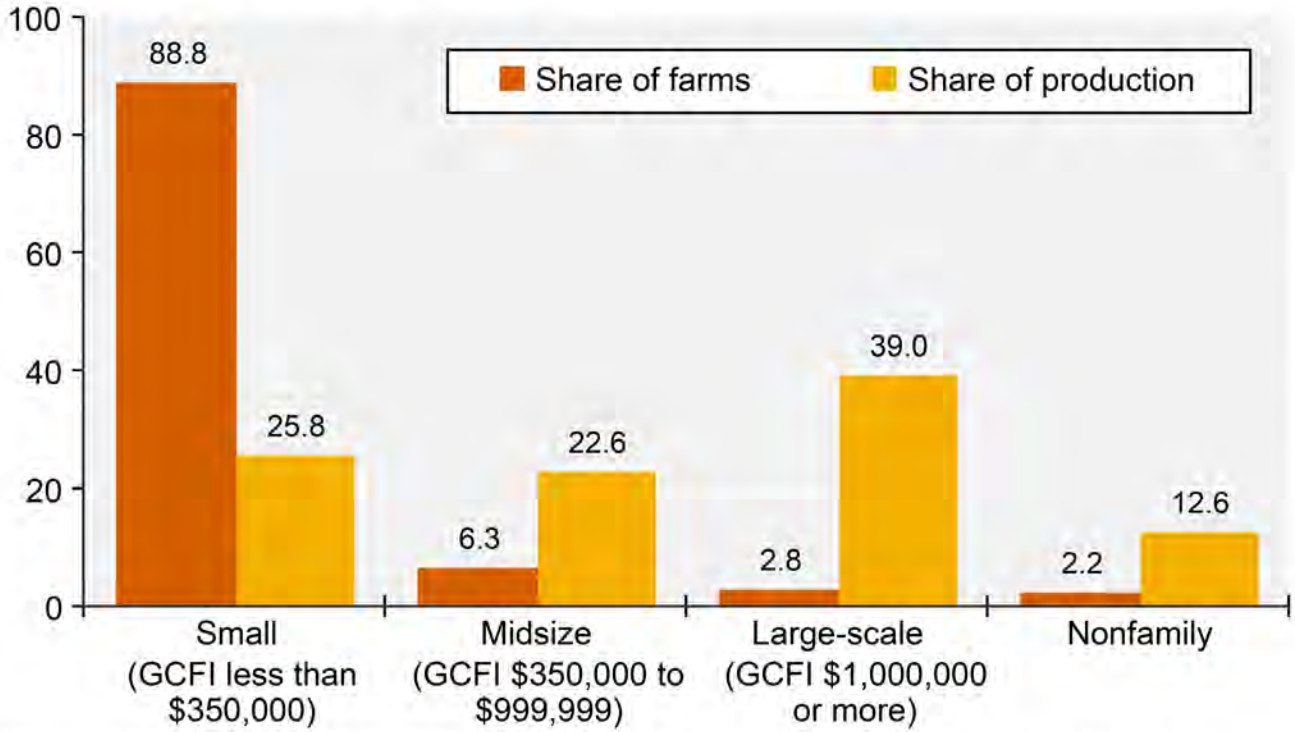
Source: USDA, Economic Research Service using data from FY2008-FY2016 USDA Budget Summary and Annual Performance Plan.

8. A Caution Flag

ERS
ECONOMIC RESEARCH SERVICE
United States Department of Agriculture

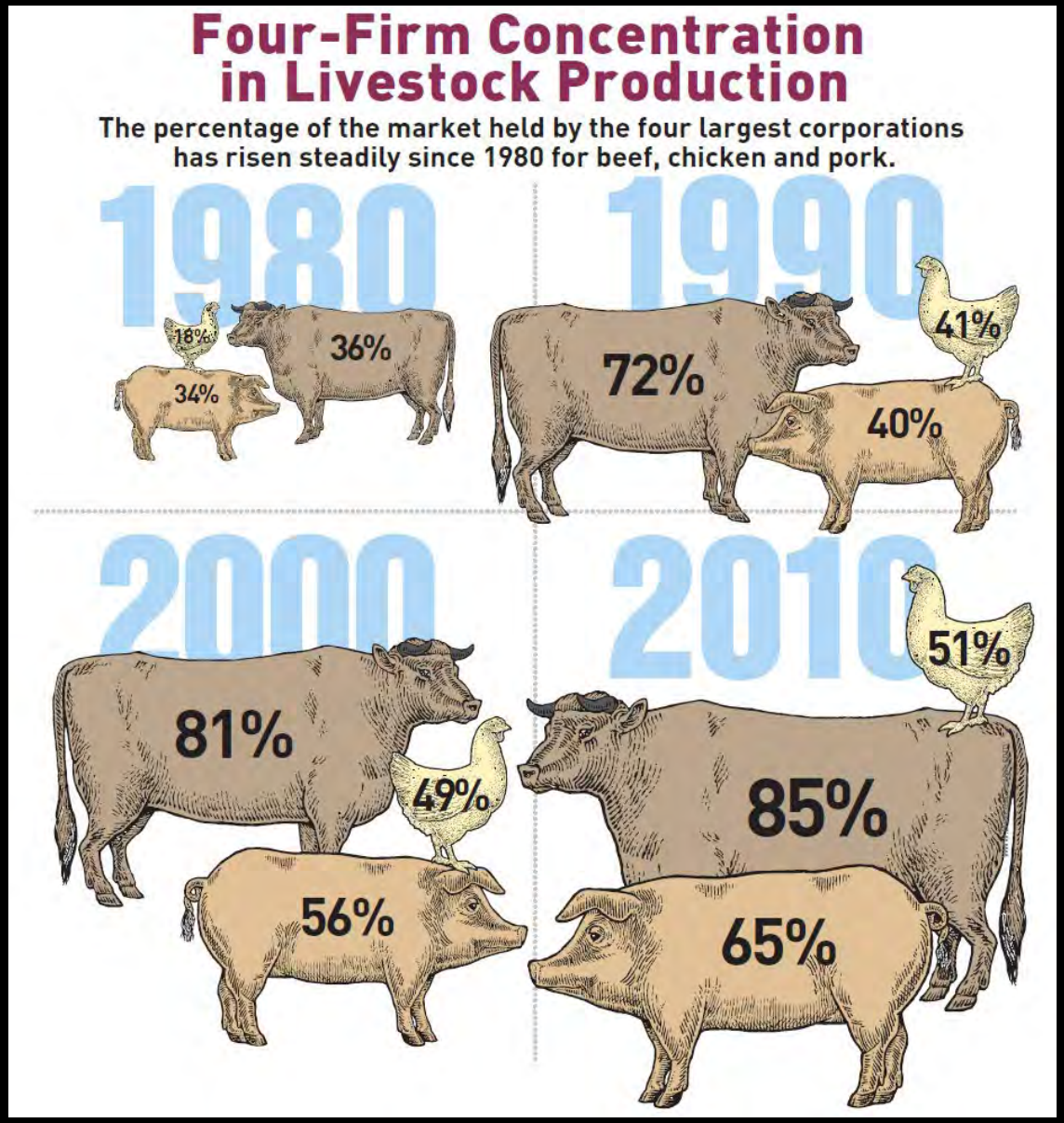
Farms and their value of production by ERS farm type, 2017

Percent of U.S. farms or production



Note: GCFI refers to annual gross cash farm income before expenses; ERS refers to Economic Research Service. Nonfamily farms are those where neither the principal operator, nor individuals related to the operator, own a majority of the farm business.
Source: USDA, Economic Research Service and National Agricultural Statistics Service, Agricultural Resource Management Survey. Data as of November 30, 2018.

Consolidation



Concentrated wealth in the agricultural sector

Percentage of sales earned by the 4 largest companies in their respective industries.

PEW

https://www.pewtrusts.org/en/research-and-analysis/fact-sheets/2012/07/18/how-corporate-control-squeezes-out-small-farms

Consolidation linked to International Trade

$$

Economies of Scale

Increasingly competitive international trade