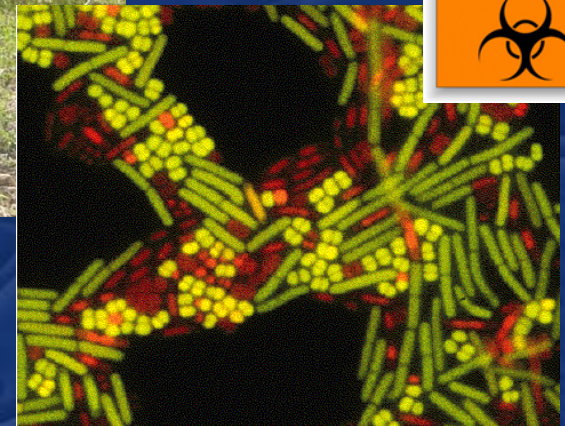
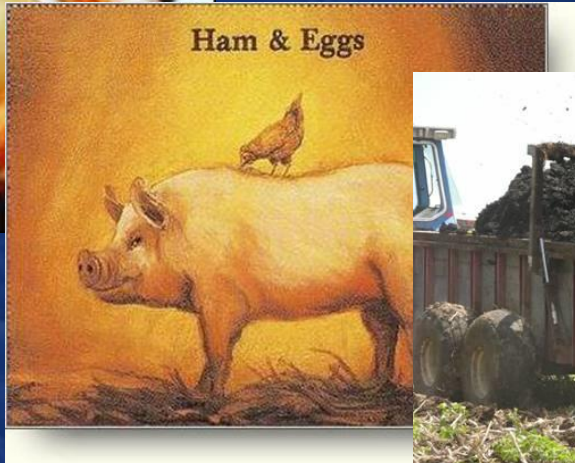


# Antibiotic resistance in soils and crop production systems



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# Antibiotic resistance in nature

- Antibiotic resistant bacteria are ubiquitous in soil, in water, in polar wildlife, in remote people
- Ancient- Genes in DNA from permafrost dated to 30,000 years ago, deep caves that have been sheltered from any contact with the earth's surface.
- Genes found in the natural 'metagenome' therefore represent a reservoir of antibiotic resistance.



**Fecal material is enriched  
for Antibiotic resistant bacteria.  
Soils fertilized with these  
materials become enriched  
with Antibiotic resistance genes.**

## **Diverse and abundant antibiotic resistance genes in Chinese swine farms**

Yong-Guan Zhu<sup>a,b,1,2</sup>, Timothy A. Johnson<sup>c,d,1</sup>, Jian-Qiang Su<sup>a</sup>, Min Qiao<sup>b</sup>, Guang-Xia Guo<sup>b</sup>, Robert D. Stedtfield<sup>c,e</sup>,  
Syed A. Hashsham<sup>c,e</sup>, and James M. Tiedje<sup>c,d,2</sup>

PNAS | February 26, 2013 | vol. 110 | no. 9 | 3435–3440

Applied and Environmental  
Microbiology

**Impact of Manure Fertilization on the  
Abundance of Antibiotic-Resistant Bacteria  
and Frequency of Detection of Antibiotic  
Resistance Genes in Soil and on  
Vegetables at Harvest**

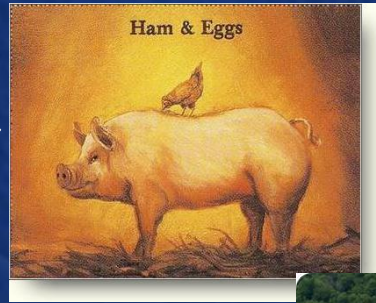
Romain Marti, Andrew Scott, Yuan-Ching Tien, Roger  
Murray, Lyne Sabourin, Yun Zhang and Edward Topp  
*Appl. Environ. Microbiol.* 2013, 79(18):5701. DOI:  
10.1128/AEM.01682-13.  
Published Ahead of Print 12 July 2013.



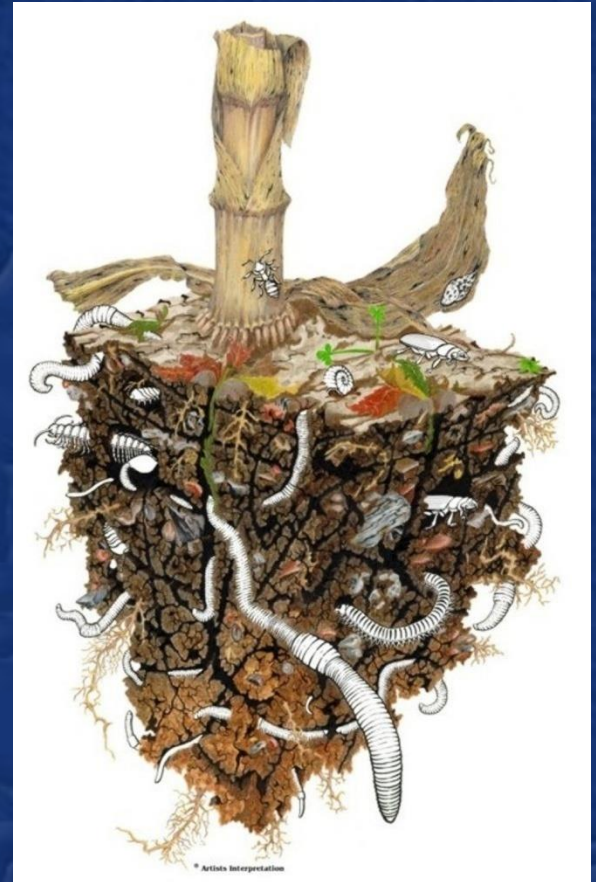
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# Bugs and Drugs



# Potential concerns



AI → B → CO<sub>2</sub>

Persistence

A diagram showing a flow from AI to B to CO<sub>2</sub>. Below this, the word 'Persistence' is written. Underneath are two circular icons: a green one with a smile and a red one with a frown. A curved blue arrow points from the green smiley face to the red frowny face.



# How is CARB/NAP addressing these concerns?

- **4.1 Conduct research to enhance understanding of environmental factors that facilitate the development of antibiotic-resistance and the spread of resistance genes that are common to animals and humans.**



# Key knowledge gaps

- Impacts of ‘fecal fertilizers’ and irrigation with reclaimed water on potentiation of AMR in soil?
- Transmission of AMR from amended soil to crops to humans or animals?
- Consequences of exposure to soil and manure/biosolids/wastewater-borne AMR for human health? Relative to other sources of AMR exposure?
- Interpreting the significance of these phenomena within a policy-relevant risk assessment framework.



Thank you

