

Aerobic composting reduces antibiotic resistance genes in manure and the resistome dissemination in agricultural soils



UNIVERSITY OF BORÅS

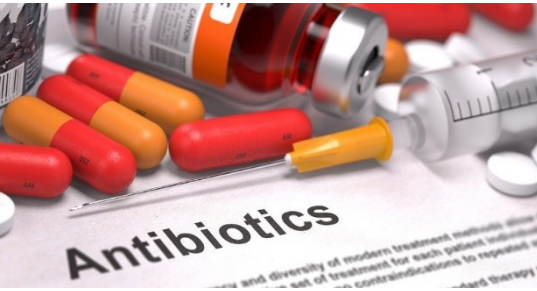
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University of Borås, Borås, Sweden**

ASSOCIATE PROFESSOR

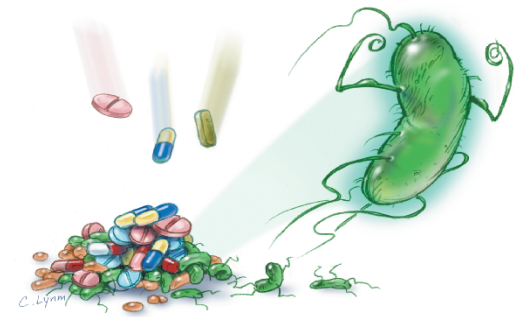
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Contents



- Livestock manure generation and antibiotic percentages
- Problems and ecofriendly management to reduce the antibiotic resistant genes
- How composting is better option to mitigate the antibiotic resistant genes.



Manure Generation

❖ In the last 5 year, the world population increased from 2.0 to 3.0 billion, but with the increasing demand for animal protein, pig production in China increased to about 0.58 billion in 2017 (Guo et al., 2018).

❖ The trend of increasing live stocks manure generation is higher in China compared to other Asian countries. Among the total waste generated from East Asia and Pacific region, up to 70 % waste is generated from China and India.

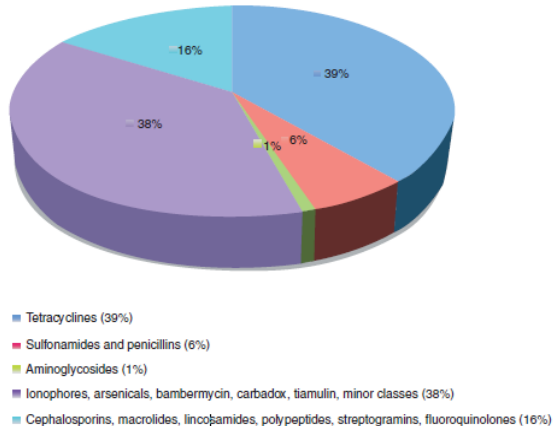


Fig 1. General distribution of antibacterial ingredients sold in 2012 by Animal Health Institute Members in the United States for veterinary use (Source: Animal Health Institute 2008).

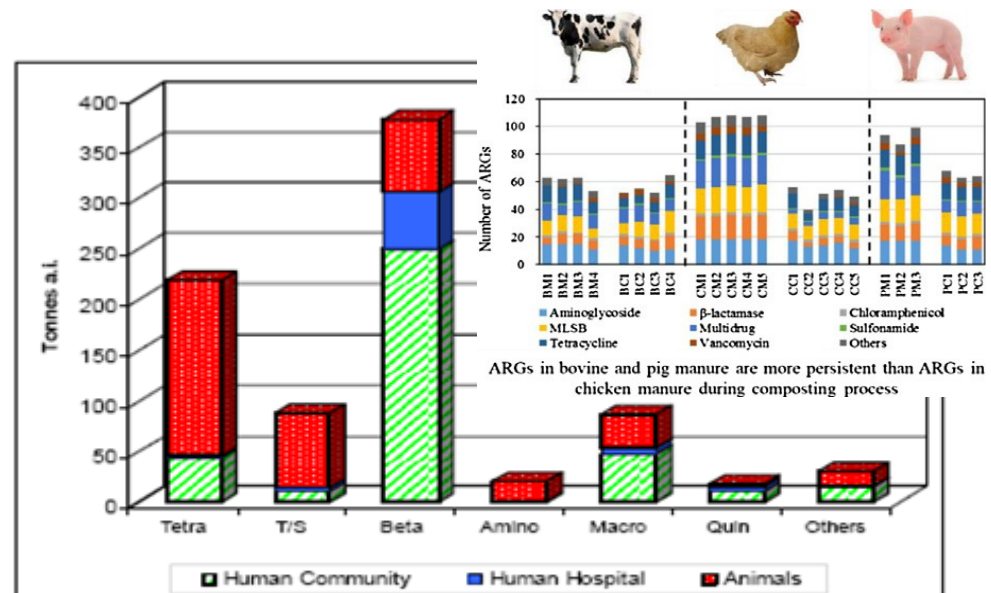
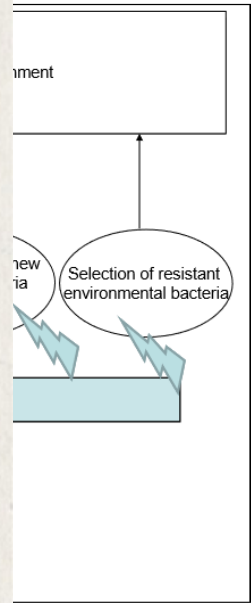
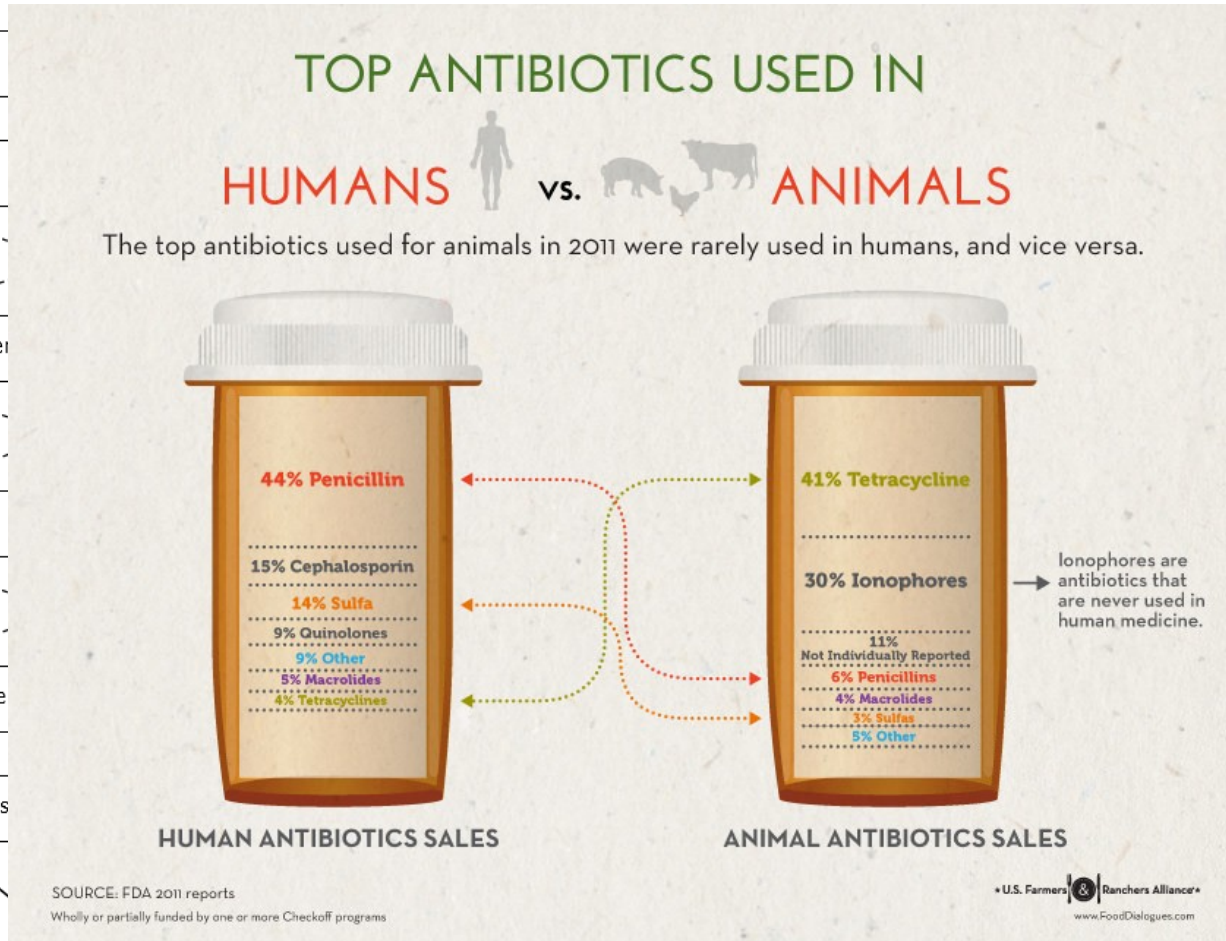
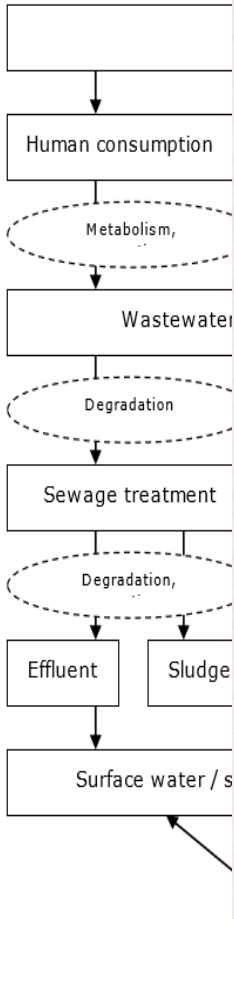
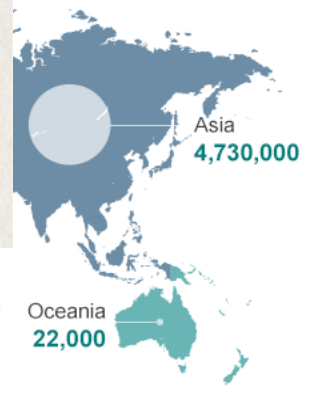


Fig 2. Tones of base active ingredient of each class of antimicrobials used in humans in the community in the UK and hospitals in England and Wales only and used in animals in the UK in 2012.

Fate of antibiotics in the environment



year by 2050



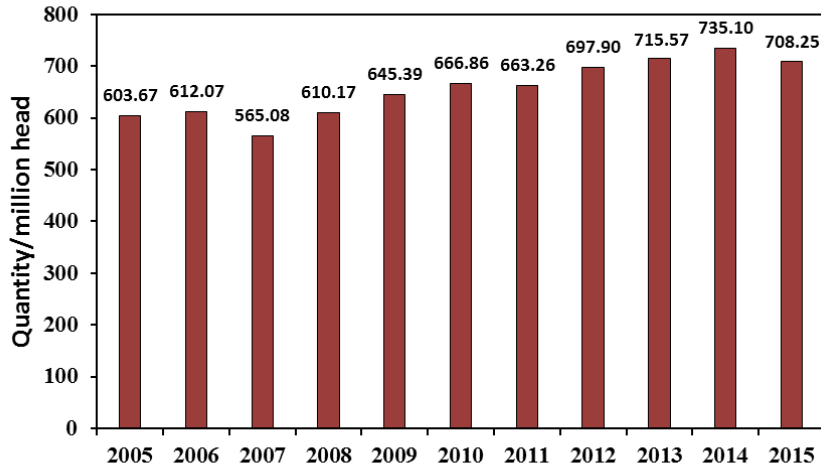
Livestock Farming Status in China



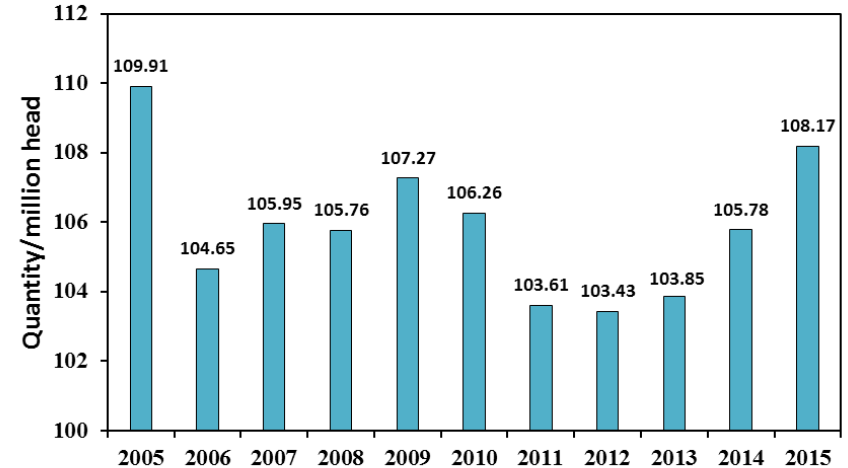
Livestock Farming Status in China



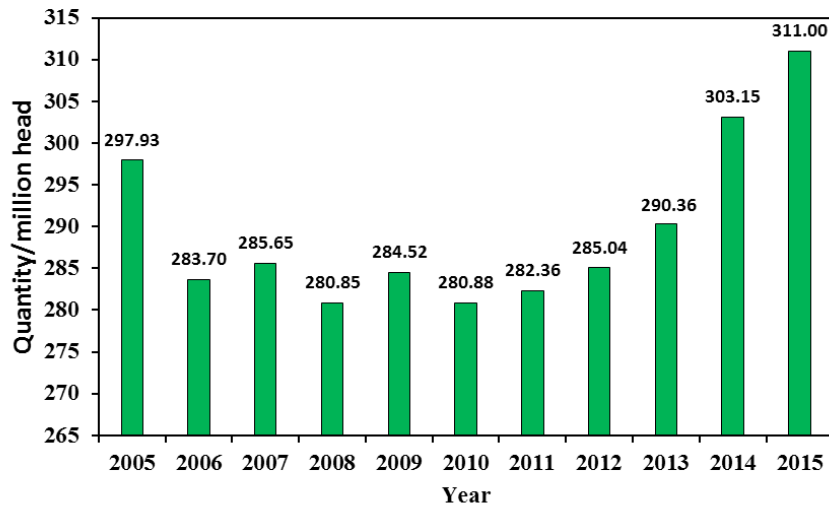
Pig



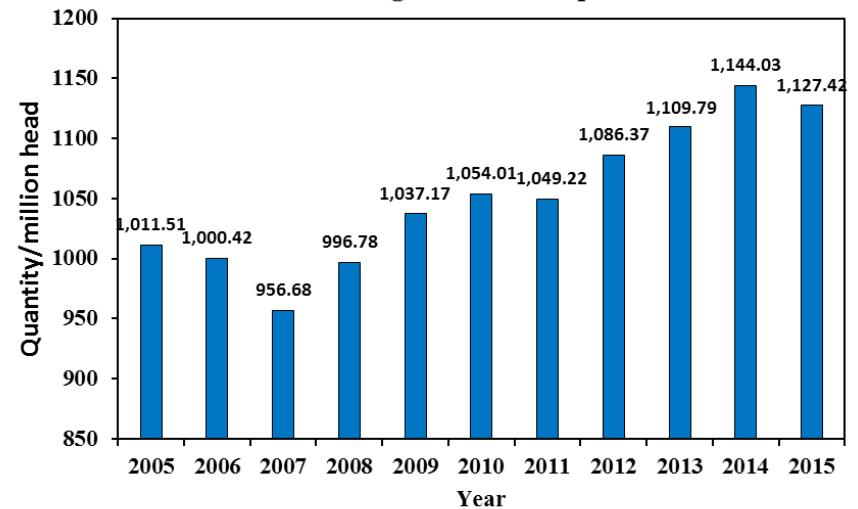
Cattle



Sheep



Pig+Cattle+Sheep



Source: China Statistical Yearbook (based on slaughter)

Livestock Farming Status in China

With rapid development of the livestock industry, the production of manure increased year by year.

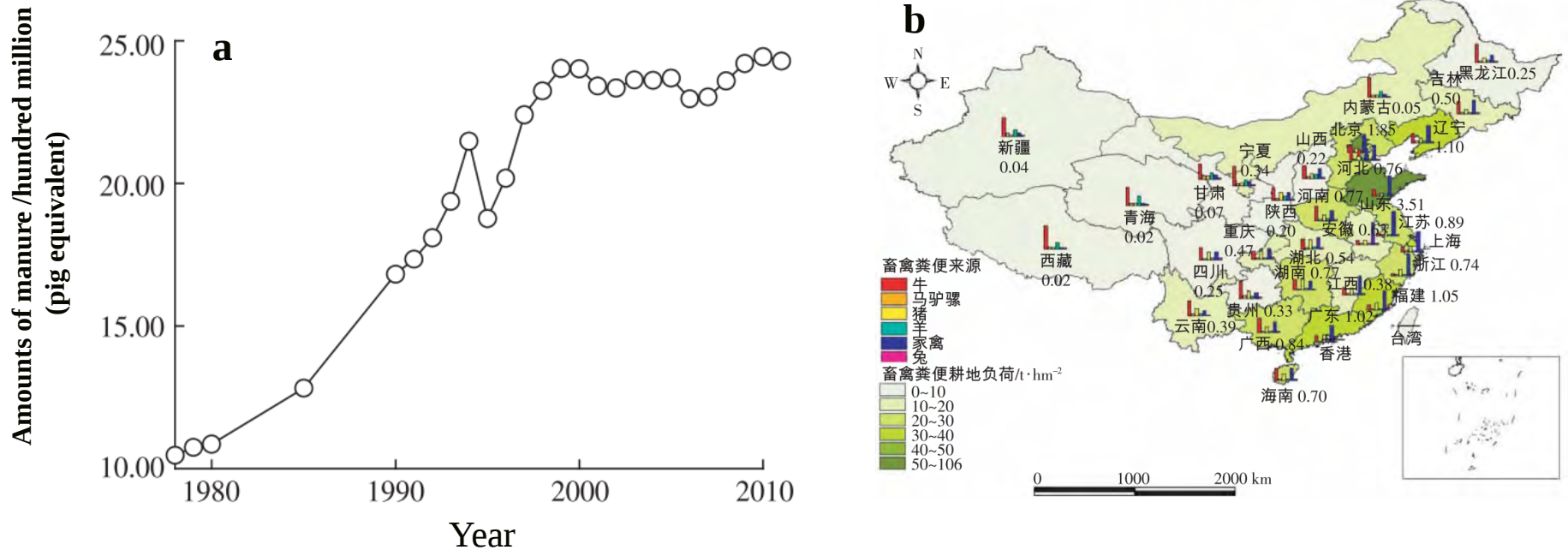
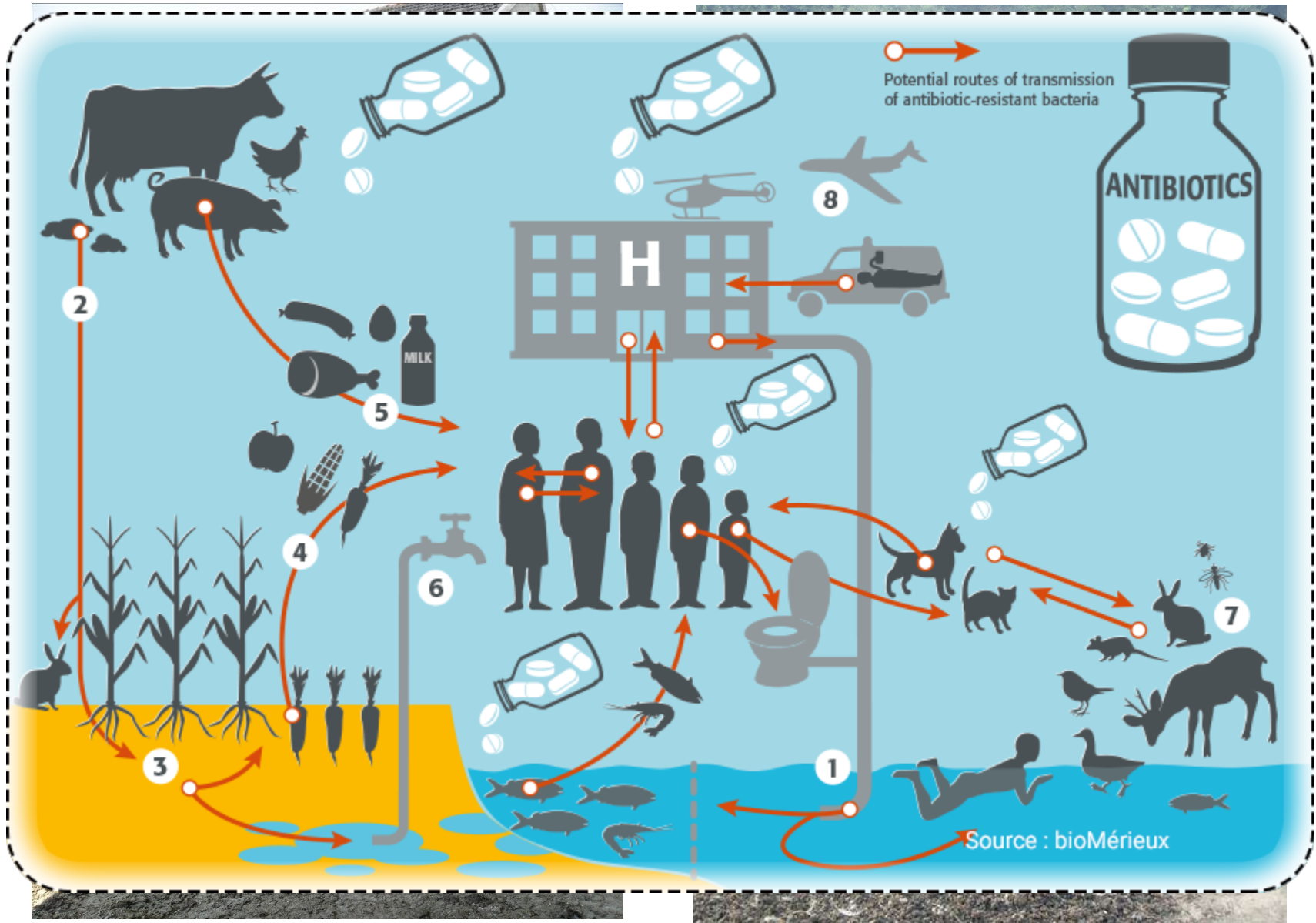


Fig. 3 Amounts (a) of livestock manure in China during 1978 to 2011, and cropland load of manures in 2011 (b)

Source: Zhu et al., 2014.



Nutrient And Pollutant Contents in Livestock Manure

A. The nutrient contents in livestock manure

Category	N(%)	P ₂ O ₅ (%)	K ₂ O(%)	Cu(mg/kg)	Zn(mg/kg)
Pig Manure	0.2~5.19	0.39~9.05	0.94~6.65	12.1~1742	40.5~2287
Cattle Manure	0.32~4.13	0.22~8.74	0.20~3.75	8.9~437.2	31.3~634.7
Chicken Manure	0.60~4.85	0.39~6.75	0.59~4.63	16.8~736.5	38.8~1017
Sheep Manure	0.25~3.08	0.35~2.72	0.89~3.00	13.1~47.9	30.2~161.1

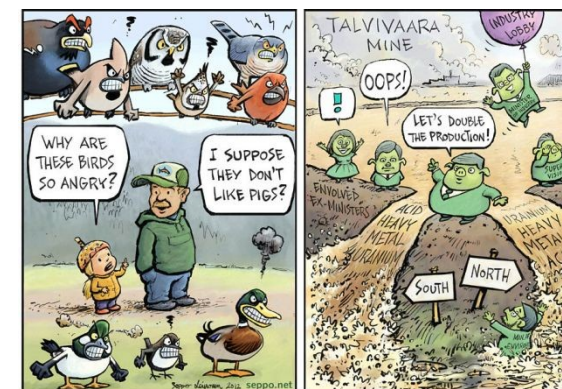
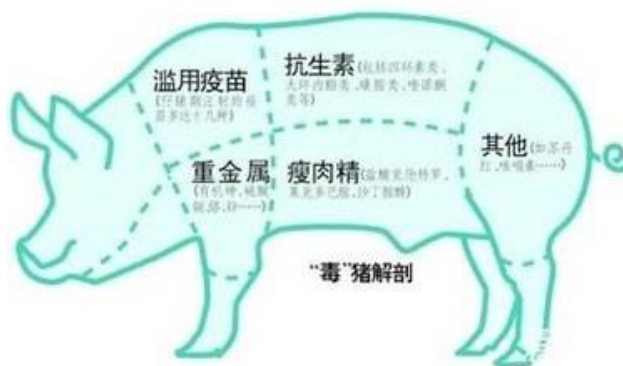
Source (Li et al., 2009)

B. Heavy metals contents in livestock manure

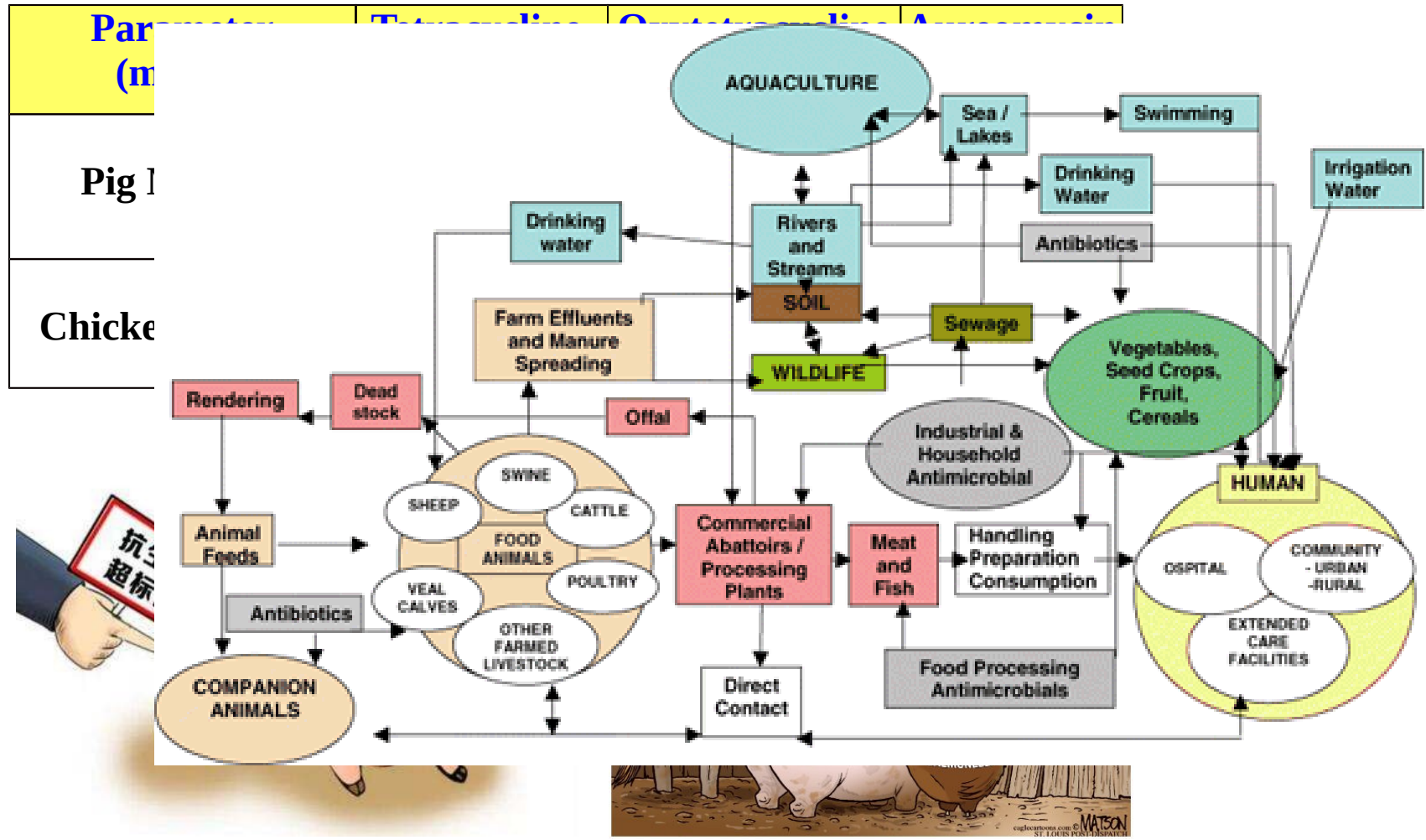
Unit: (mg/kg)

Category	Cd	Pb	Cr	As	Hg	Ni
Pig Manure	0.06~2.75	0.71~16.02	0.20~116.20	0.54~88.97	0~0.13	4.03~20.45
Chicken Manure	0.04~1.48	0.92~26.94	0.60~42.75	0.57~66.99	0~0.12	7.44~15.08
Cattle Manure	0.10~1.67	2.11~23.61	0.05~29.04	0.42~5.95	0~0.11	3.73~19.15

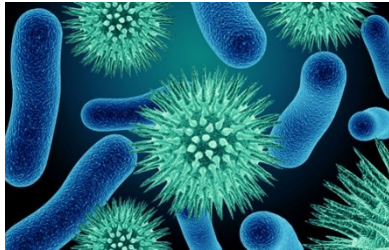
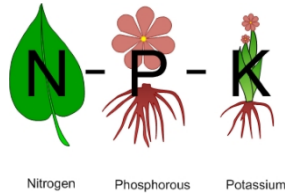
Source (Jia et al., 2016)



C. Antibiotic contents in pig and chicken manure



Environmental Pollutions of Livestock Manure/ Solid waste



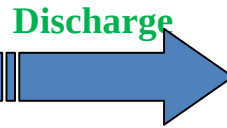
Pathogens



Heavy metals



Antibiotic and resistance gene



Air pollution
(Obnoxious gases)

Water contamination
(Eutrophication)

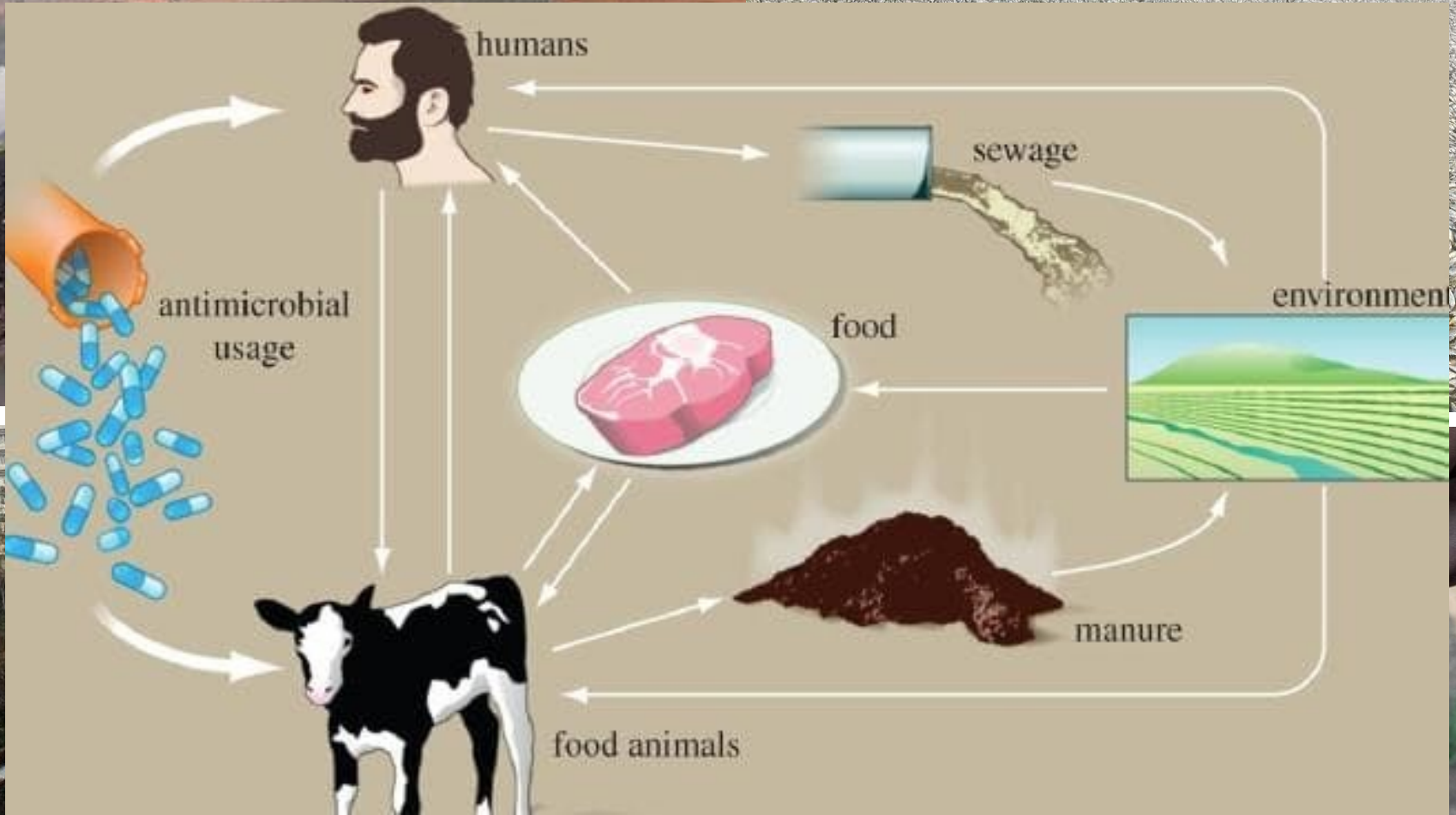
Soil pollution
(Heavy metals、 resistance genes)

Food safety

(Heavy metals)

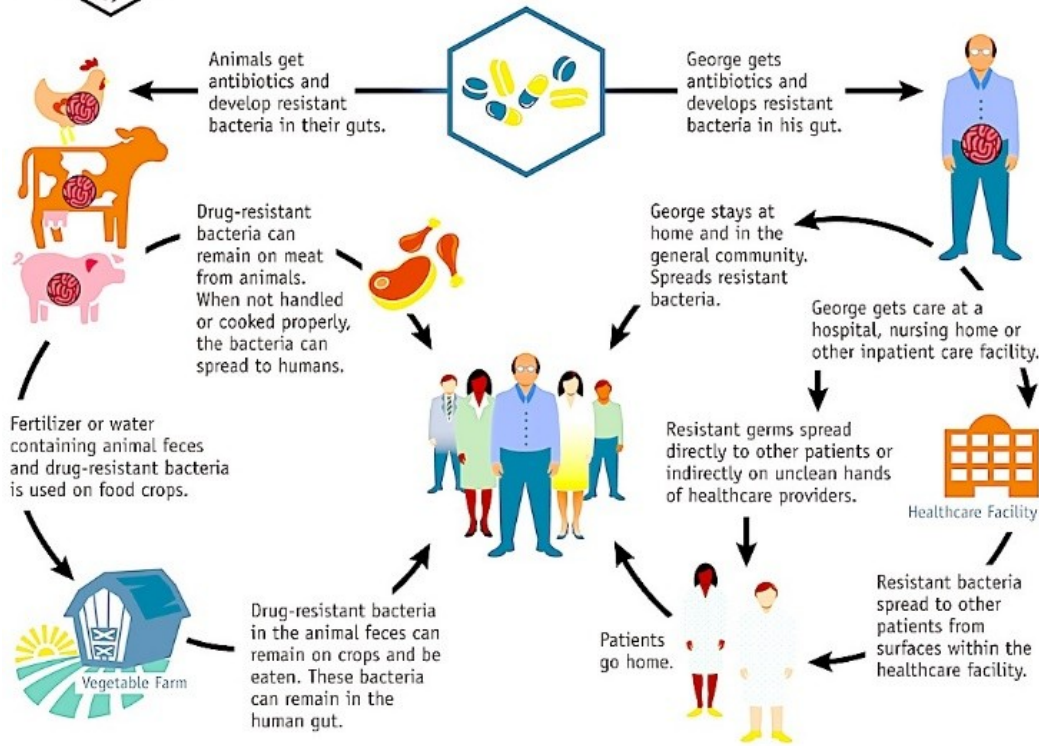
Causing bacterial disease





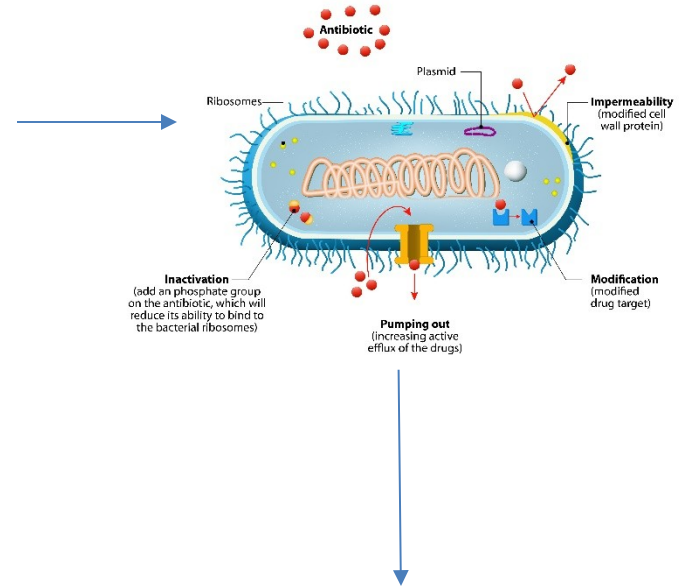


Examples of How Antibiotic Resistance Spreads

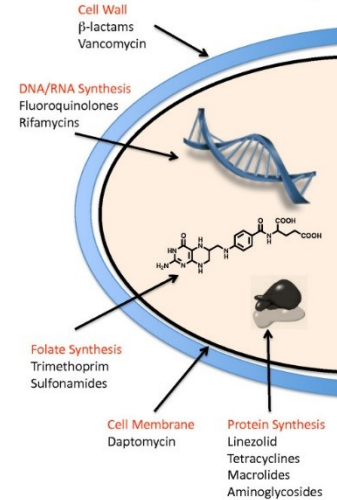


Simply using antibiotics creates resistance. These drugs should only be used to treat infections.

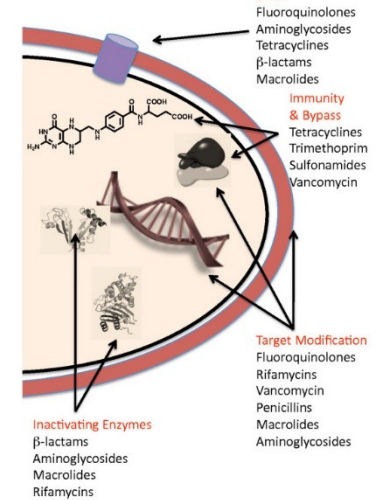
MECHANISMS OF ANTIMICROBIAL RESISTANCE



Antibiotic Targets



Antibiotic Resistance



Materials and Methods

Clay as additive
0%, 2%, 4%, 6%, 8% and 10%

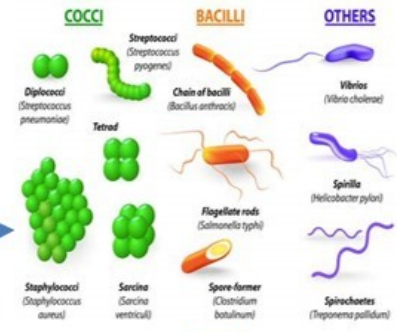
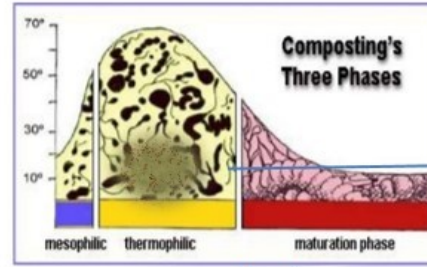
Chicken manure feed with
growth promoting substrate



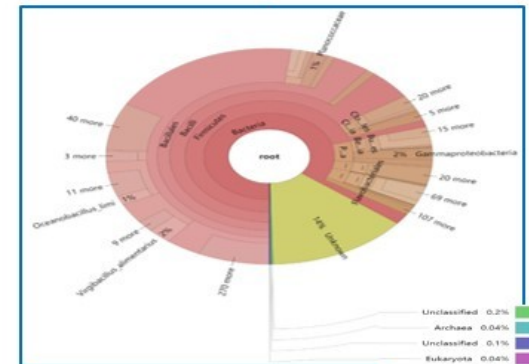
Chicken manure
+
Wheat Straw

Aerobic
composting

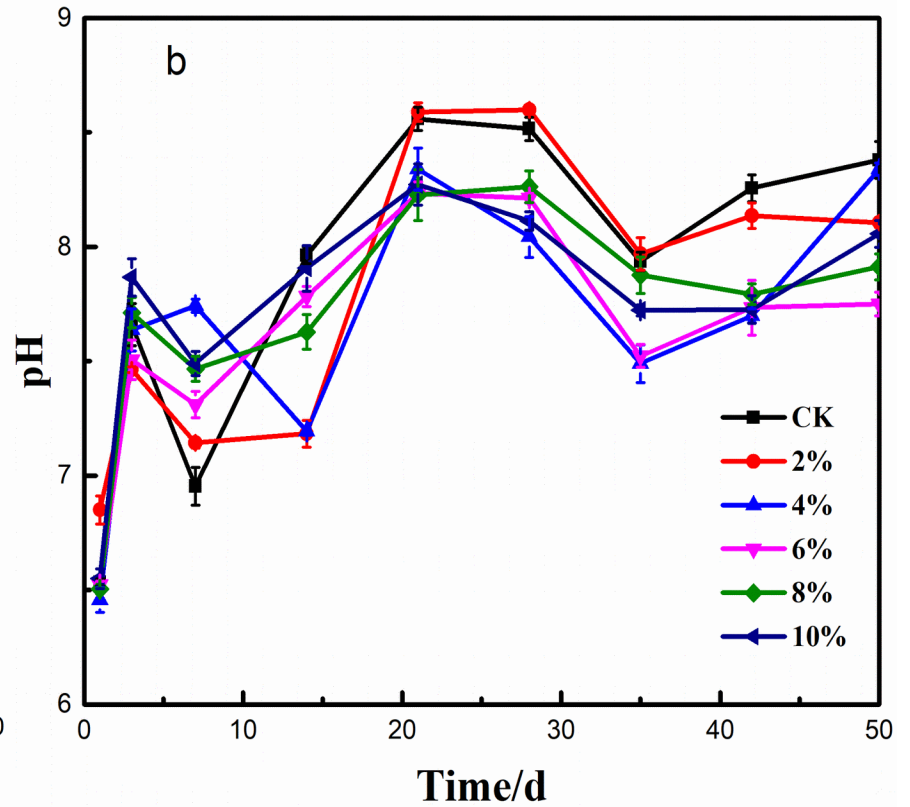
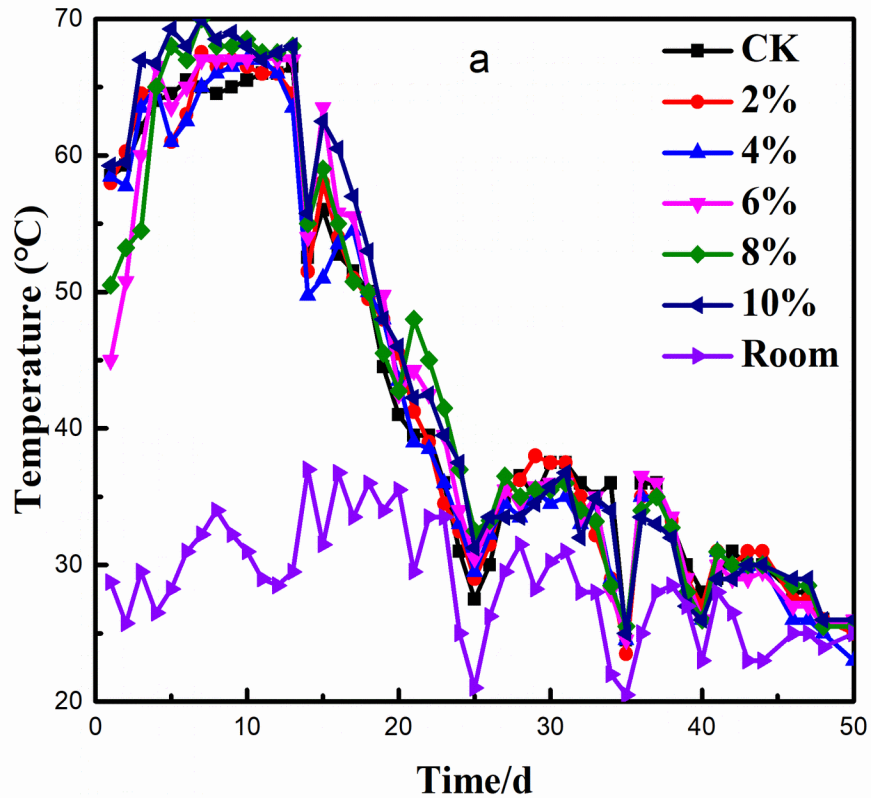
Phase of Composting



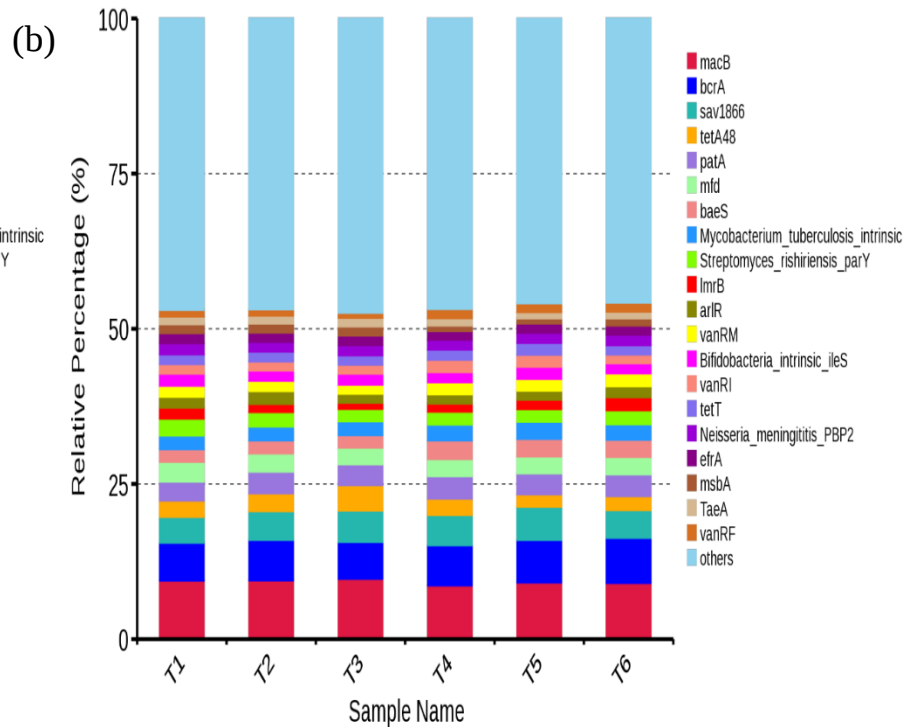
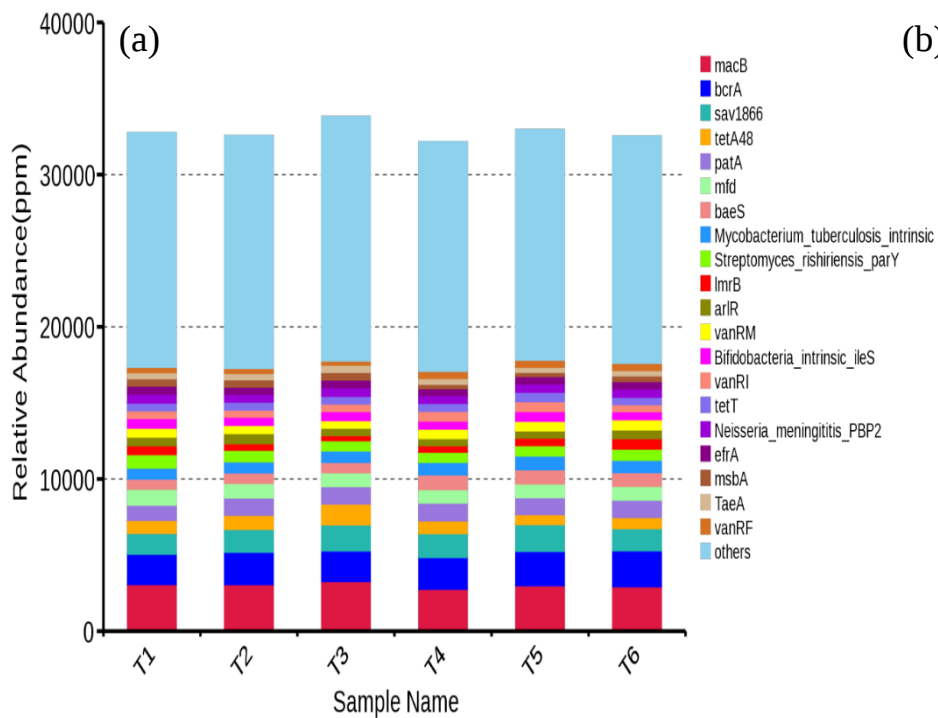
Reduce the Antibiotic
resistant bacteria Abundance



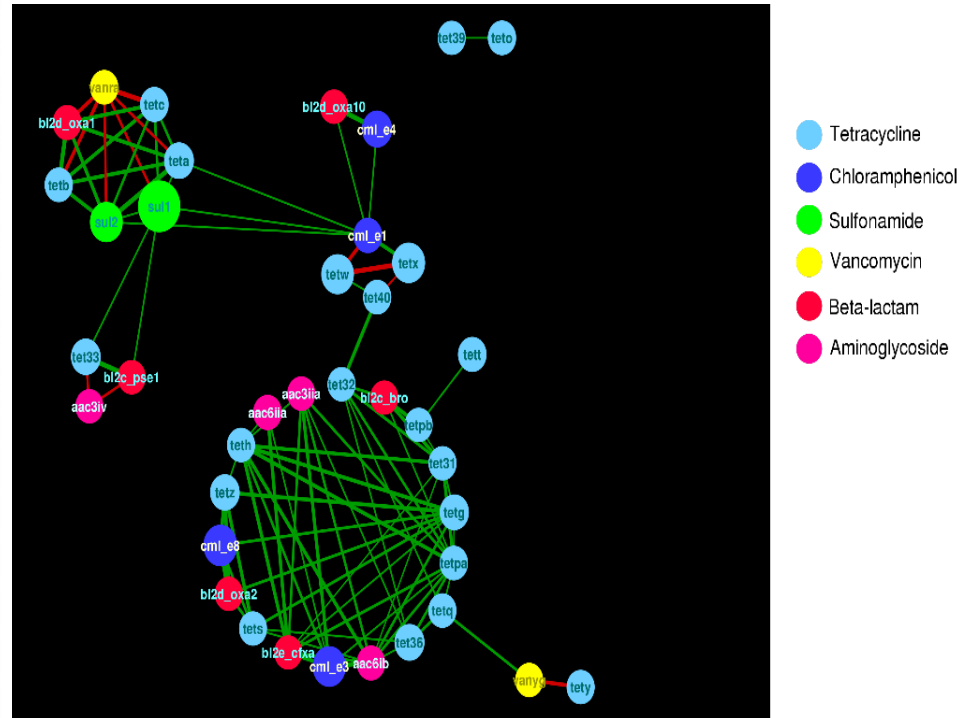
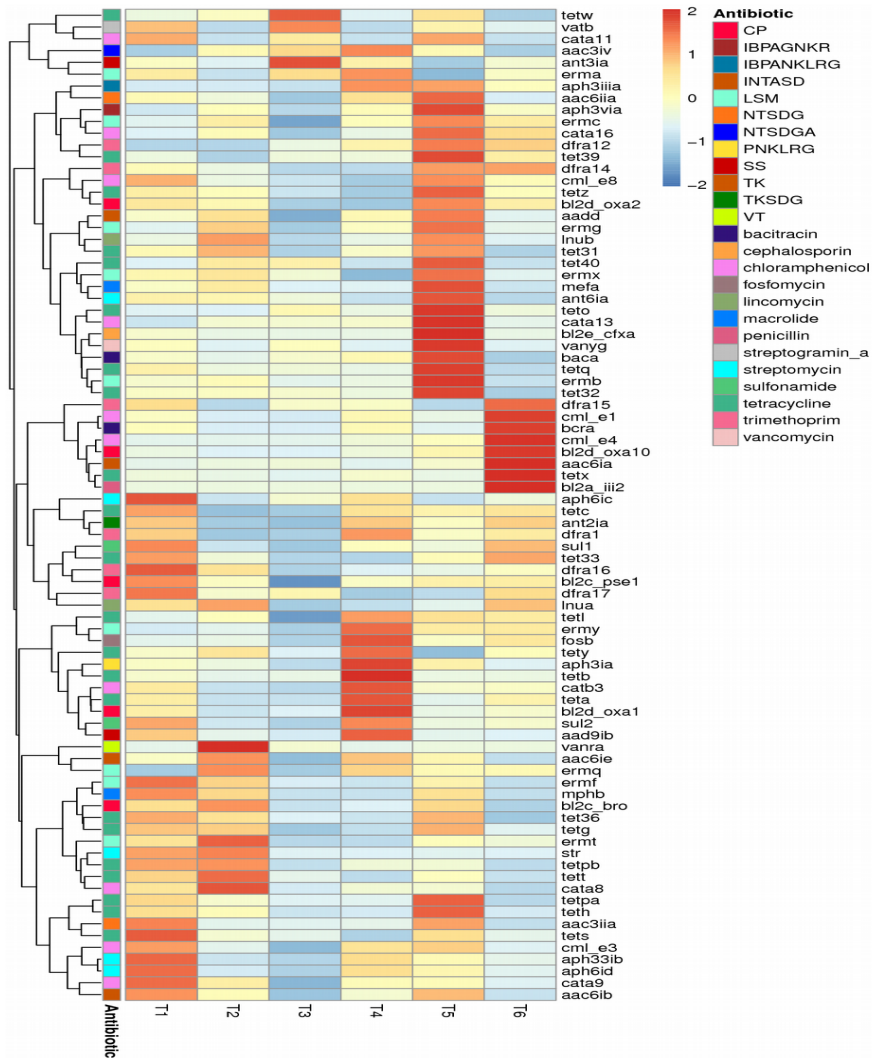
The change of temperature (a) and pH (b) during the composting



Relative abundance of antibiotic resistant genes



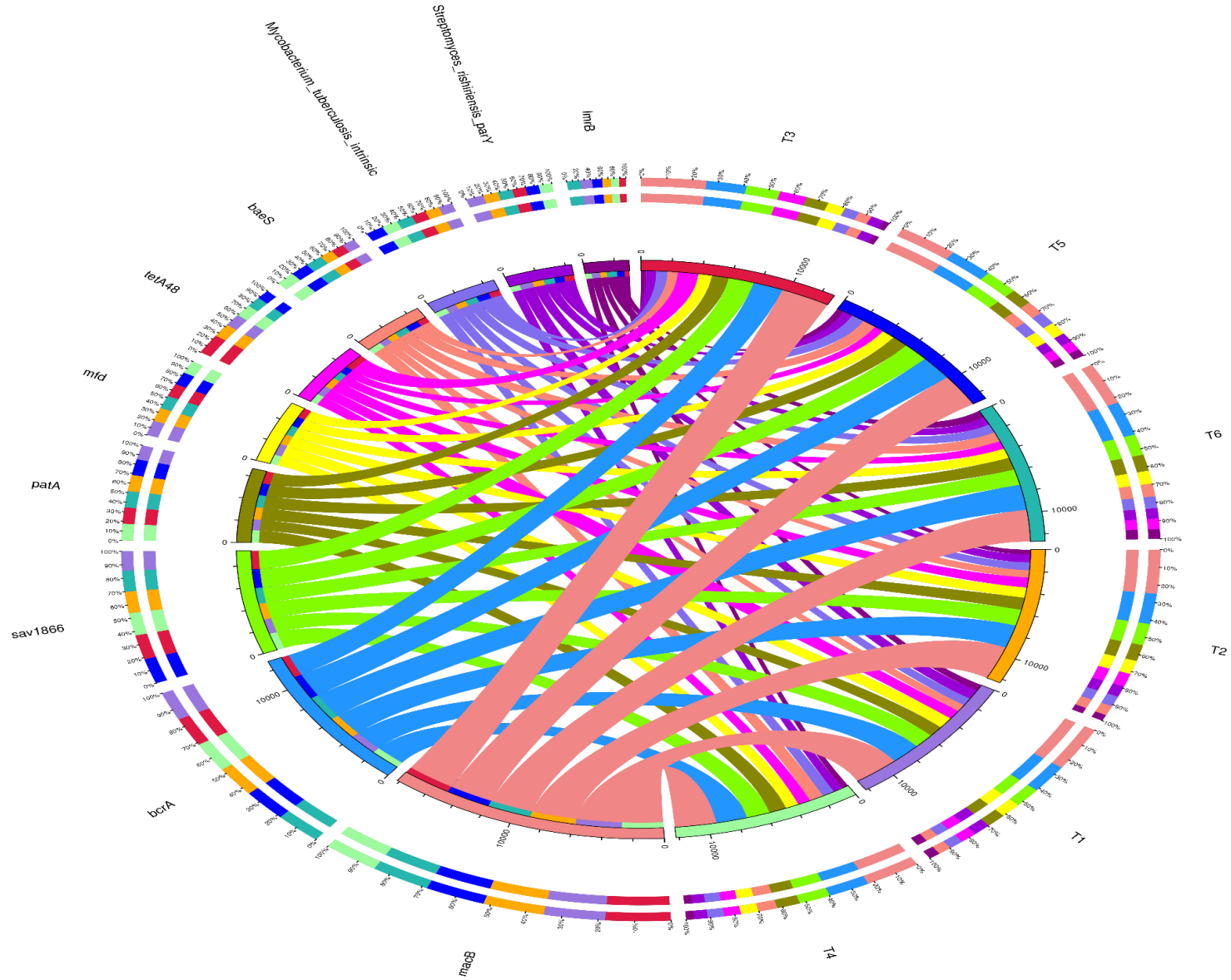
Heat map and Network analysis



Network analysis of the co-occurrence patterns of ARGs and mobile genetic elements. Nodes were colored according to types of antibiotic resistance. The linkage represents a strong (Spearman's correlation coefficient $r_2 > 0.85$) and significant ($P < 0.01$) correlation. The node size represents the total abundances of ARGs in all the samples.

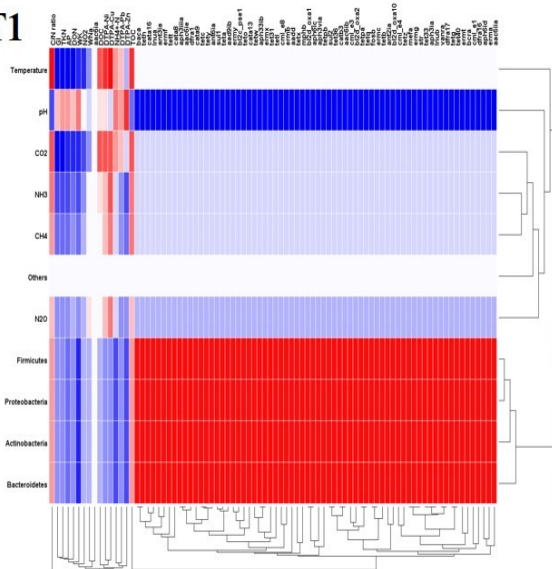
Heat map showing the fold changes in ARGs detected in chicken, pig, and bovine manure samples after industrial composting. CMC = chicken manure compost

Resistant genes circos overview

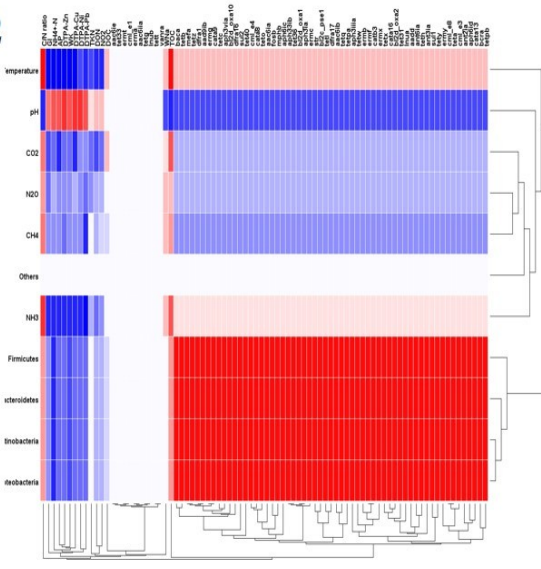


Correlation Heat map

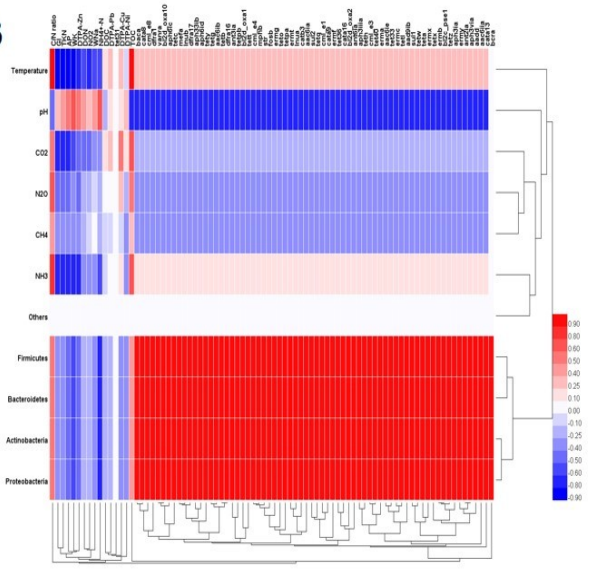
T1



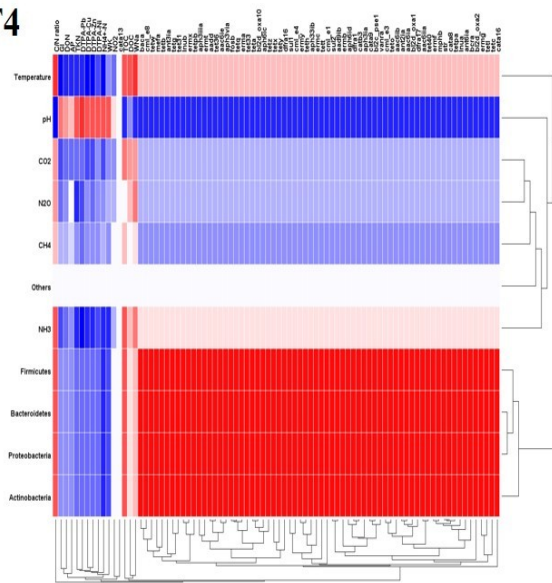
T2



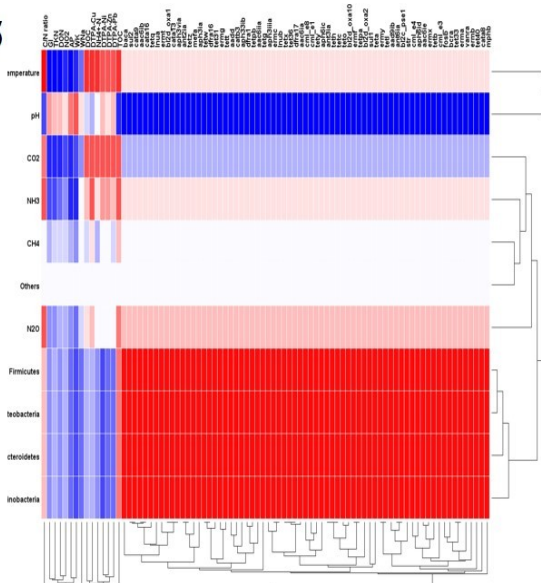
T3



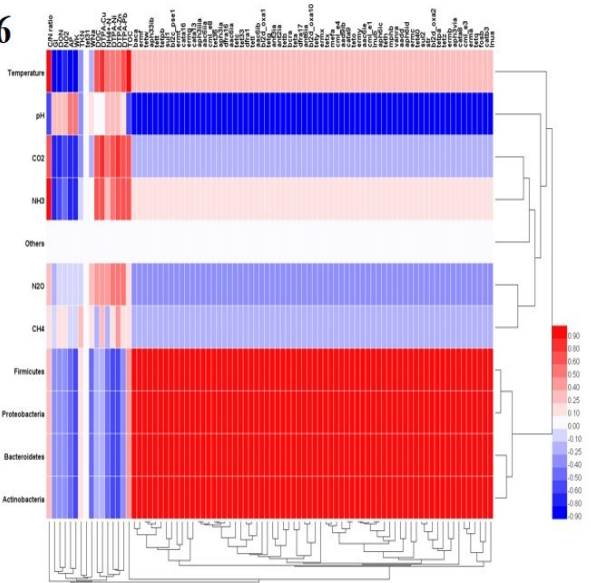
T4



T5



T6



Conclusion

- ❖ Hyper-thermophilic composting is much more effective to reduce the 25-28% antibiotic resistant bacterial genes.
- ❖ Improve the organic matter degradation and reduce the other pollutants
- ❖ Mitigate the soil and water pollution, which normally occurred by the application of manure and its compost.

ACKNOWLEDGEMENTS

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Questions?

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Thank You...