Climate Change: Knowing Enough?

John Gay, BSME DVM PhD DACVPM
Associate Professor of Epidemiology
AAHP Field Disease Investigation Unit
Washington State University

ANIM_SCI 280
Animal Science and Society
Current Topics

Last week Dr. Fox indicated:

Next week (1/30):
• The effect of global warming on livestock production

My approach:
• More ‘how to think’ about the problem than ‘what to think’ about it

The Reason: Continual advances lead to information obsolescence
Liz Wiseman, Oracle VP, Oracle U founder, 17 yrs, 2014 book:

Given that scientific information doubles every 9 months and decays at 15 to 30% per year, how long does one’s expertise last?
• ‘Only ~15% of what you learn today will likely be relevant in 5 yrs’

How do you avoid the trap of decaying knowledge?
• Ask good ‘why?’ questions frequently
• Identify what you don’t understand
• Use strong sources to fill in these gaps

So does global warming impact livestock production?

I predict that an approaching “perfect storm” will significantly impact livestock production

Warning:
My “Crystal” Ball is a Brunswick

Predicting the impact of this ‘perfect storm’ requires understanding multiple complex interacting systems

Big factors driving change
The Perfect Storm:
• Human Population Expansion
• Fresh Water Scarcity
• Soil Depletion
• Global Climate Change
• Emerging Infectious Agents
• Fossil Fuels as Carbon Sources
• Globalization
• Consumer Perception

Tough positive and negative feedback loops with time lags link all of these factors and problem solutions
We automatically construct and evaluate overly simplified mental models of systems and then apply our favorite solution

W. Edwards Deming quotes:
- You can't manage what you don't measure
- In God we trust; all others bring data
- Whenever there is fear, you will get wrong figures
- Learning is not compulsory . . . neither is survival

![Image](http://www.donellameadows.org/)
![Image](http://demingcollaboration.com/)

To make good decisions, we need science-based answers on two scales, local and at least national

**Broad scale** (circle of concern) - policy:
- What is "global warming"?
  - Or is it climate change?
- Is it occurring? How fast?
- What are potential risks from it? How likely are each?
- What are societies and their governments doing about these?
- What could they do? Likely to do?
- When?

**Individual scale** (circle of influence) - action:
- If it is occurring, how might it impact my operation?
- How likely? When?
- How might customer / consumer concerns impact my operation? Social concerns?
- How might it impact my kids?
- What can I do about any of these?
- When?

What level of certainty is needed before acting or when making decisions?

The goal is establishing and holding an informed opinion

How to evaluate whether or not you hold an informed opinion:
- Apply the 'Feynman Technique' (Google)
- Identify knowledge gaps by spending 30 minutes drawing a concept map of the topic
- Spend 10+ minutes explaining to someone the key concepts and their relationships, drawing a causal model

Can't do these, probably have IOED – 'Illusion of Explanatory Depth'
Don't fall victim to the Dunning-Kruger Effect

Our collective ‘Knowledge Illusion’ is a huge problem

For two great videos, Google:
- Fennbach TED talks
  - The Illusion of Understanding
  - IOED - illusion of explanatory depth
- Why do we believe things that aren't true?

For two readings on this problem, Google:
- Why Facts Don't Change Our Minds
  - The New Yorker 2/27/17
- People Have Limited Knowledge. What’s the Remedy? Nobody Knows
  - NYT Book Review 4/18/17
- Sloman Lab for more

Two good introductory books covering the science well

J Houghton
- Global Warming
  - The Complete Briefing
  - http://www.world-warming.com/

Vaclav Smil
- Complex Systems in Nature and Society
  - http://www.vaclavsmil.com/

The radiation physics has been well known for 150+ years

**The Discovery of Global Warming**
- Regularly updated on-line hypertext
- Google 'Spencer Weart'
- Local system interactions are well understood over short time frames (<30 d - weather prediction)
- Not well understood are the consequences of global scale system interactions over climate time frames (>30 yrs)

https://www.aip.org/history/climate/index.htm
Carbon-based fossil fuels are from ancient CO₂

Oil & Gas - Williston Basin Bakken Shale Formation
- Late Devonian (359-419M yrs old)
- Horizontal drilling with hydraulic fracturing
- 458k barrels per day

Coal - Powder River Basin Fort Union Formation
- Paleocene (56-66M yrs old)
- 1.3M tons per day

https://en.wikipedia.org/wiki/Bakken_Formation
https://en.wikipedia.org/wiki/Fort_Union_Formation

By digging up fossilized sunshine, we’ve sped up the slow side of the carbon cycle and disrupted the balance


The CO₂ change contribution is physically small but critical

1750 – 2005 change in radiation forcing


We are dealing with very complex biochemical systems interacting across wide geographic and time scales

http://faculty.yc.edu/ycfaculty/ags105/week12/biogeochemical_cycles_information/

Climate change consequences are already apparent in the Pacific Northwest hydrology

More winter precipitation
- More falling as rain instead of snow
- Increased winter streamflows
- Increased winter flood risks in transient (rain/snow mix) basins
- Reduced snow water storage, particularly in mid-elevations
- Earlier snow melt and peak runoff (10 to 30 days)
- Decreased late spring and summer streamflows

22% median increase in 20th century

> 30% decline above 6000 ft in 20th century

1.5°F temp increase 1920 – 2000

The Result: The paradox of more winter flooding and more summer drought

http://www.ei.org/westcoastclimate/D_PNW%20impacts.pdf

The biggest climate change impacts are the biological phenology disruptions

Mountain Pine Beetle Impact 2000-14
Understanding and mitigating climate change effects requires a systems thinking approach.

Careful critical thinking that:
- Is based on empirical scientific evidence
- Allows for the occurrence of unintended consequences
- Avoids the "silo effect"
- Avoids "framing"
- Detects "illusions of explanatory depth" (IOED)
- Includes all the relevant systems

Optimizing soil health is crucial to food production.

Increasing and maintaining soil organic matter is key.

Crop agriculture is more sustainable with re-integration of livestock, particularly ruminants.

David Montgomery
- Professor of Geomorphology, University of Washington
- 2008 MacArthur Fellow, $500,000 “genius” award
- Viewing soil as a biological rather than a chemical system
- Organic carbon from ruminant manures is more stable in soils than plant sourced
- We are currently using arable soil 20 to 100 times faster than natural processes produce it

IPCC: Intergovernmental Panel on Climate Change 5th Assessment Report

IMO: The future of livestock agriculture is good but how, where and how much we do it will change.

Who to trust on social issues and developing public policy impacting livestock agriculture?

Does agriculture contribute to global warming?

**DamIfIno**
(but most likely so!)

To see why this might be a problem, see ‘Earth From Space’
http://www.pbs.org/wgbh/nova/earth/earth-from-space.html
Many don’t understand the importance of the full scientific process

Six principles of scientific inquiry:
- Pose significant questions that can be investigated empirically
- Link research to relevant theory
- Use methods that permit direct investigation of the question
- Provide a coherent and explicit chain of reasoning
- Replicate and generalize across studies
- Disclose research to encourage professional scrutiny and critique (peer review)

Use Carl Sagan’s ‘Baloney Detection Principles’ (Google)
Michael Shermer’s version:
- How reliable is the source of the claim?
- Does this source often make similar claims?
- Have the claims been verified by another source?
- How does the claim fit with what we know about how the world works?
- Has anyone gone out of the way to disprove the claim, or has only supportive evidence been sought?
- Does the preponderance of evidence point to claimant’s conclusion or to a different one?
- Is the claimant employing the accepted rules of reason and tools of research, or have these been abandoned in favor of others that lead to the desired conclusion?
- Is the claimant providing an explanation for the observed phenomena or merely denying the existing explanation?
- Do the claimant’s personal beliefs and biases drive the conclusions, or vice versa?

Use sources that have undergone rigorous pre-publication peer review

Know the peer review processes for your sources
- Primary refereed scientific journals
- Scientific society consensus statements
- IPCC – Intergovernmental Panel on Climate Change

Further protections
Follow the supporting money back to it’s source!
- Does the research have funds from a faith-based organization?
- Where does most support for the work come from? What is the agenda of the supporters?
- Does the funding body support a wide variety of research?
- Does the funding body support a wide variety of fields?
- Does the funding body support a wide variety of applications?

Develop an understanding of the history and philosophy of science and the philosophy of knowledge (epistemology)

Take WSU classes in the history and philosophy of science to understand how the science process developed and how to better distinguish truth from pseudoscience, fake science and groundless denialism

Read the works of authors such as U Connecticut Philosopher Michael P. Lynch
- TED Talk “How to see past your own perspective and find truth”

Public (consumer) understanding is neither straightforward nor necessarily rational!

Which are the jackhammers and which are the cigarettes?

Emotional perception trumps rational science every time
Exploiting our cognitive biases and polarization is a profitable media industry

The Outrage Industry
JM Berry & S Sobieraj, 2014

The mass of domestic mammals far outweighs that of wild land mammals

To reach a common consensus on tough issues, use dialectic discourse

Flexible
Responsive
Lower costs
Social License
Aligned:
• Values
• Expectations
• Ethics
Self regulation

Rigid
Bureaucratic
Higher costs
Social Control
Gov. Regulation
Litigation
Auditing

Tipping Point
Single major event or impacts of cumulative events

Social License vs. control balance

Charlie Arnot - The social license vs. control balance

“Science tells us if we can do something. Society tells us if we should do it.”

Gaining a broader global perspective is most important

Practical terrestrial biosphere (zone of life) thickness = 0.0005 of earth’s radius

Look up; airliners fly at the upper biosphere boundary

Jetstream altitude is 23,000 to 52,000 feet

Jetstream from Space Shuttle

Upper biosphere boundary 
= 4 – 10 miles up horizontally the length of Pullman-Moscow highway!

This biomantle produces our food!
Realize that agriculture developed during a period of unusual climate stability

Historical Earth Temperature

A Big Problem: Global energy usage distribution inequity as shown by Earth at Night

https://www.nasa.gov/mission_pages/NPP/newsearth-at-night.html

Human population growth rates are highest in LDC’s

Realize that livestock population density mirrors human population density

Rule of 72: Population doubles in ~72 / (%rate)
Zimbabwe ~ 16 years, 9% ~ 24 years

Disease density mirrors population density in humans and livestock
Highest poultry densities are in the Pacific Rim

Avian Influenza H5N1 remains endemic in the small holder mixed species farms here

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Livestock producer education is poor in LDC's

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• 90% have a primary school education or less

Can LDC producers understand the “how” and “why” of climate change mitigation sufficiently to optimize their food production practices?

What happens if they don’t?

Projected global climate change by season has large areas of precipitation decreases

The dairy cow has the highest per lb water requirement of land mammals

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I predict that the biggest direct shocks on livestock production from climate change will be from livestock diseases

IMO: Vector-borne diseases will provide the nastiest surprises for livestock production

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Climate change will likely expand many vector-borne disease ranges

Small climate changes can:

• Markedly shift ranges of tick species
  – Ticks are vectors of nasty bovine disease agents
• Markedly alter mosquito populations and their range
• Reduce keystone species, destabilizing vulnerable ecosystems
  – Allows proliferation of invasive species

However, due to the many factors involved vector-borne disease ecology is very complex, making prediction difficult and uncertain!

"Prediction is very difficult, especially about the future"

Who said this?

Niels Bohr, Danish physicist

not

Lawrence Peter "Yogi" Berra

Always check your sources!

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