I predict that a “perfect storm” approaching livestock production will drive big changes

Warning: My “Crystal” Ball is a Brunswick
And I may well be sawing my limb off

The big factors driving change that will surprise livestock agriculture are:

- Declining social perception of livestock agriculture
- Economic globalization raising **social economic status**
- Emerging infectious agents – Virus, Bacteria, Parasites
- Genetic diversity threats - Invasive, Extinction
- Increasing global climate variability and change
- Increasing regional fresh water scarcity
- Increasing petroleum scarcity and declining EROEI
- Regional population expansion
- Regional soil depletion and salinization

These interrelate in complex ways. Solutions to one problem often increase another.

Charlie Arnot - The **social license vs. control balance**

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

Center for Food Integrity

Why Science Isn’t Enough - What consumers need to trust animal agriculture (2012)
http://www.youtube.com/watch?v=l2qPmO5aHk

2014 Consumer Trust Research: Cracking the Code on Food Issues

Who is the public to trust on emerging social issues involving livestock agriculture?”

Who is the public to trust on emerging social issues involving livestock agriculture?

http://www.vaclavsmil.com/

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

http://www.snopes.com/photos/signs/pregnant.asp

Cigarette!

http://www.philiplymbery.com/farmageddon-facts/
Exploiting our biases and our outrage addiction is the most profitable media industry

For 10 weeks in 2009 coded:
* 10 top-rated cable news shows
* 10 top-rated talk radio shows
* 20 widely read political blogs

Found:
* 100% of cable news and 90% of talk radio shows contained outrage
* 80% of blog entries were categorized as outrage
* Outrage heard every other minute on Fox and MSNBC


“Framing” is repeatedly using the most positive or negative label to “spin” a concept

Liberal – George Lakoff
Conservative – Frank Luntz

How do you know you have an informed opinion?
Evaluate yourself for IOED – the “Illusion of Explanatory Depth”
* Spend 10 minutes explaining the key concepts & relationships to someone and note the gaps
* Take 30 minutes to map out what you know and what you don’t on a sheet of paper
* Ask “5 Whys” for root cause
Don’t fall victim to the Dunning–Kruger Effect

“I never allow myself to have an opinion on anything that I don’t know the other side’s argument better than they do.” — Charlie Munger (Buffett partner)

Humans perceive things best in our scales of size, distance, mass, and time
* Human scale
  * http://en.wikipedia.org/wiki/Human_scale
* We use technology to extend our perception to the telescopic, microscopic, in distance, and in time
  * Powers of Ten - https://www.youtube.com/watch?v=0KBIn0jyuY
* Our perception is easily deceived, particularly in un-natural scales
* Comprehension is difficult for us in un-natural scales
  * Geologic time scale - http://en.wikipedia.org/wiki/Geologic_time_scale

Look up; airliners fly at the upper biosphere boundary

Jetstream altitude is 23,000 to 52,000 feet

https://www.youtube.com/watch?v=xF27e59QU44
Do Livestock contribute to global warming?

Are you out of your mind?

http://m.beefmagazine.com/cow-calf/15-best-winter-ranch-photos

Are humans contributing to global warming?

DamIfIKnow
(but Probably)

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

Life dramatically affected earth history and geology

[Diagram of Earth history stages]

http://en.wikipedia.org/wiki/Great_Oxygenation_Event

We are dealing with very complex systems interacting across wide scales including time

Sulfur Cycles
WE Schlesinger, ES Bernhardt, 2013

The surface temperature key is the atmospheric energy balance, Wm⁻² in = out

http://climateprediction.net/content/basic-climate-science

Atmospheric CO₂ level is the primary focus of concern and for mitigation

Keeling Curve
Atmospheric components block outbound long wave radiation

The CO₂ change contribution is physically small

Agriculture developed during a period of unusual climate stability

World map adjusted for population

During your career, population will grow ~50%

Livestock are concentrated in regions
Domestic mammals far outweigh wild mammals

Data from Vaclav Smil's The Earth's Biosphere plus other sources

Highest poultry densities are in the Pacific Rim

Avian influenza H5N1 remains endemic here

Human population growth rates are highest in LDC’s

Zimbabwe ~ 4.4%

Rule of 72: Population doubles in ~72 / (% rate)
Zimbabwe ~ 16 years, 3% ~ 24 years

Livestock producer education is poor in LDC’s

Indonesia Livestock Producers

<table>
<thead>
<tr>
<th>Education Level</th>
<th>Number</th>
<th>Percentage</th>
</tr>
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<tbody>
<tr>
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<td>1 149 056</td>
<td>21.3</td>
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<tr>
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<td>1 833 111</td>
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</table>

• 90% have a primary school education or less

1. Can LDC producers understand the "how" and "why" of disease control or climate change mitigation sufficiently to optimize food production?

2. Can LDC government infrastructure compensate?

Global arable (cultivatable) land is declining

Arable land:
- 1.5 billion hectares
- Takes 0.25 hectares to feed each person
- Maximum in early 1980’s, now declining
  - erosion
  - salinization
  - desertification
  - diversion

Google “Outgrowing the Earth” to read the on-line version

Optimizing soil health is crucial to food production

Increasing and maintaining soil organic matter is key
Crop agriculture is not sustainable without re-integrating livestock, particularly ruminants

David Montgomery
- Professor of Geomorphology, U Washington
- 2008 MacArthur Fellow, $500,000 “genius” award
- Viewing soil as a biological rather than a chemical system

We are currently using arable soil 20 to 100 times faster than natural processes produce it

The future of livestock agriculture is probably excellent but where and how we do it will change

Global water situation is tight in some areas

Some high density populations have to “import water” as food

Climate change consequences are already documented in the Pacific Northwest
- More winter precipitation 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

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

Projected climate change yield impact varies

Ogallala-High Plains Aquifer useful life is declining

Higher intensity wx events > More runoff, less recharge
US energy sources to uses


Declining EROEI is biggest problem

EROI: definition, history and future implications
CAS Hall and CJ Cleveland, 2005 ASPO-US Conference

What happens if and when they catch up due to rising SES?

http://en.wikipedia.org/wiki/Image:PU200611_Fig1.png

World Oil Production

From my limb I predict that climate change will have the biggest impact on livestock through disease

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

Climate change will likely expand many vector-borne disease ranges

The dynamics of complex systems are difficult to comprehend without good models

Big factors driving change:
- Human Population Expansion
- Fresh Water Scarcity
- Soil Depletion
- Fossil Fuel Scarcity
- Globalization
- Emerging Infectious Agents
- Global Climate Change
- Genetic Diversity Decrease
- Social Perception

Tough positive and negative feedback loops with time lags link all factors and problem solutions

However, due to the many factors involved vector-borne disease ecology is very complex, making prediction difficult and uncertain!
Understanding these changes requires systems thinking rather than linear thinking.

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

"Prediction is very difficult, especially about the future"

Who said this?
Niels Bohr, Danish physicist

not
Lawrence Peter "Yogi" Berra

Always check your sources!

Earthrise

Apollo 8 - December 24, 1968