

Biotechnology for Animal Agriculture: Needs and Opportunities



James D. Murray

Department of Animal Science

Department of Population Health and Reproduction

University of California

Davis CA 95616 USA

Updates coming on:

Cloning

Gene Editing

GE animals around the world

But first, transgenics and cloning you know, but what is gene editing?

Gene Editing

Uses designer enzymes to cut DNA

Can be used either to:

introduce site-specific mutations

or

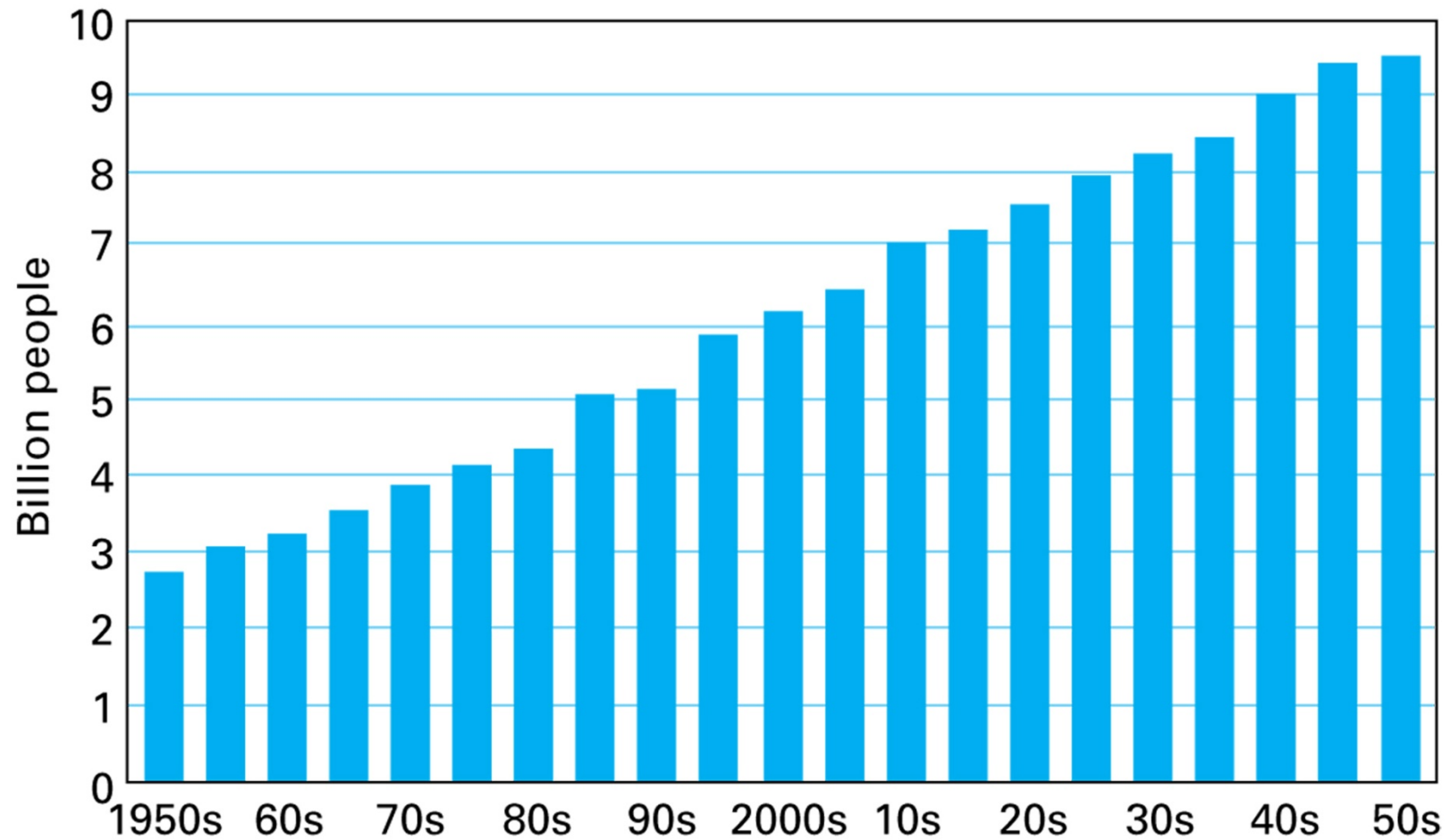
introduce DNA (transgenes) to specific sites

Shifting the paradigm

Excitement – as you will see later – is because gene editing enzymes will likely increase efficiency to point where these modifications become routine

**Why does agriculture world-wide need
biotechnology**

The need is obvious



Past, present, and projected world population. *Source:* U.S. Census Bureau.



The wave of global hunger



In the year **2050**,
world **population**
will require



100%
more **food**,^{1,2} and



70% of this
food must come from
efficiency-improving
technology³

Slide from Justin Chesnut, Bio Livestock Summit 2012

The Three Rights: Food, Choice, Sustainability

Even now

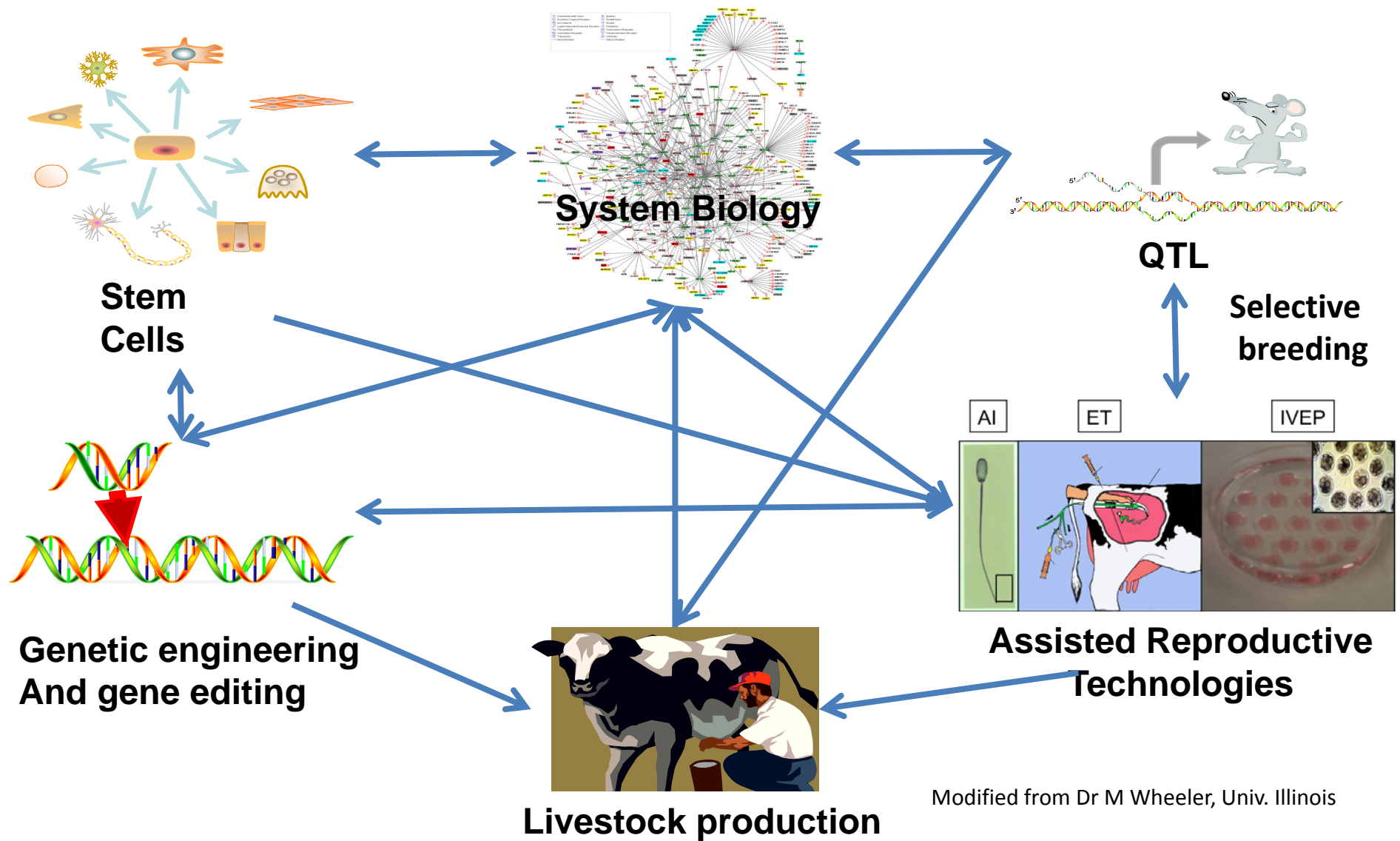


**One child dies every 5 seconds
because of hunger.**

The imperative is simple:

- **Increasing animal production must be done with less land, less water, and in an environmentally sustainable manner**
- **We need to use all tools available: nutrition, management, vaccines, ART (including cloning), selective breeding, genetic engineering and gene editing!**

We need to use all technologies



Modified from Dr M Wheeler, Univ. Illinois

World use of animals for food

National Geographic, May 2011

POPULATION

Food for Thought

There will soon be seven billion humans on Earth, but how does that number compare to other species on the planet? We are certainly outnumbered by ants. Harvard biologist and ant expert Edward O. Wilson has estimated that there are a thousand trillion to ten thousand trillion ants at any one time.* That would be about a million ants for every one of us. And doesn't it seem like that when they invade our kitchens?

Estimating animal populations, especially wild ones, is hard, but here's a look at one category of animals we can count: the ones we eat. —Nigel Holmes

SEVEN BILLION

Number of animals killed for food Worldwide, 2009

1.7 million camels

24 million water buffalo

293 million cows

398 million goats

518 million sheep

633 million turkeys

1.1 billion rabbits

1.3 billion pigs

2.6 billion ducks

52 billion chickens



*And they're edible. Ants are a good source of protein and are considered a delicacy in many parts of the world.

ART: NIGEL HOLMES. SOURCE: FAO

Application of biotechnologies can:

- **conserve/preserve genetics**
- **decrease the environmental footprint of production**
- **increase efficiencies of production, thus sustainability**
- **increase disease resistance/resilience**
- **decrease spread of zoonotic diseases**
- **increase the nutritional value of food**

AquAdvantage Salmon

A perfect example of one such technology that is NOT being used!



BIOTECHNOLOGY IS NOT THE BOTTLENECK

- **We can now, and indeed have, produced genetically modified livestock for food**
- **The applications of this technology and potential benefit to animal agriculture, including improving animal health and welfare, decreasing the environmental footprint, and improving human health is real.**

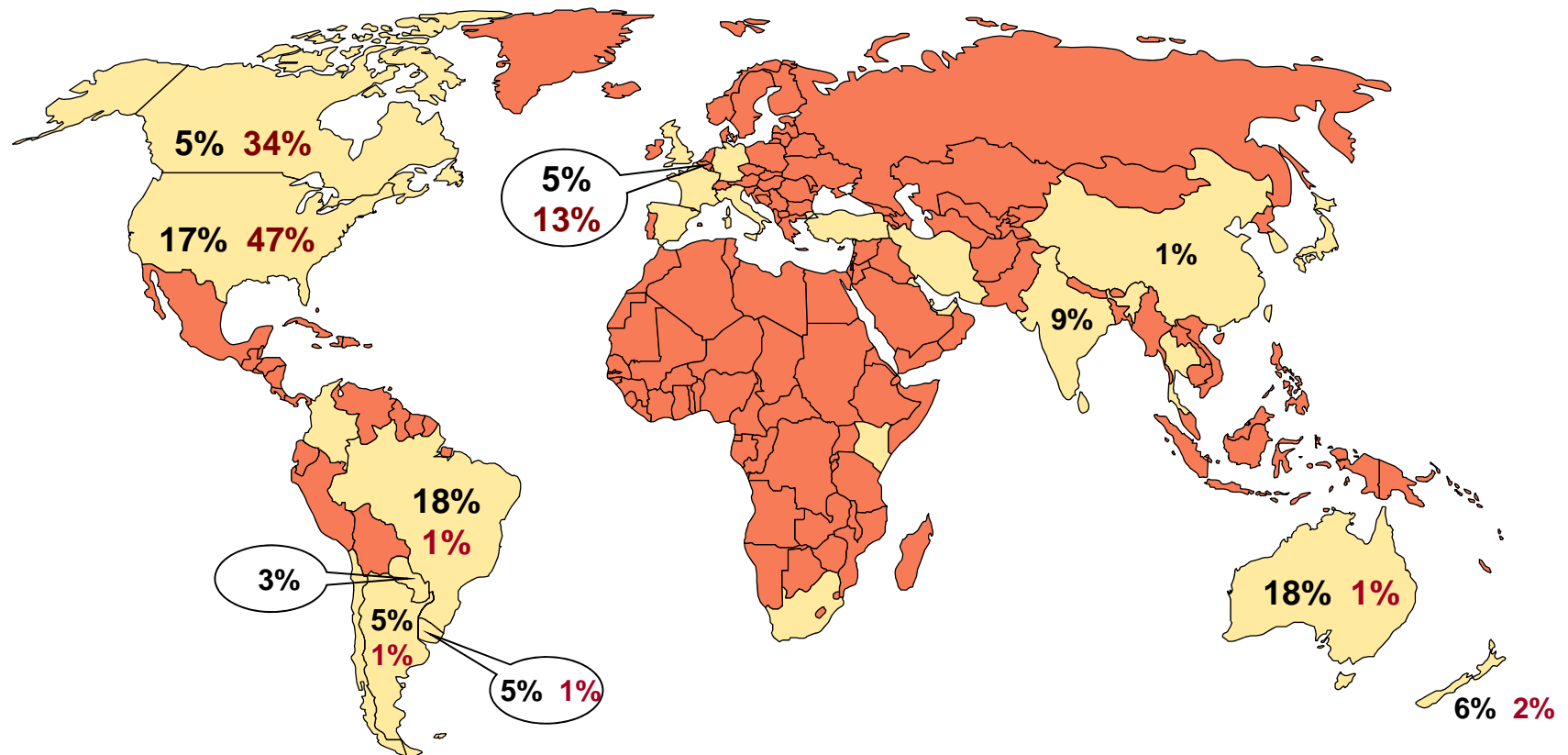
Transgenic animals produced in one year at Texas A&M University

**62 transgenic animals representing cattle (8),
goats (12), sheep (24) and pigs (18).**



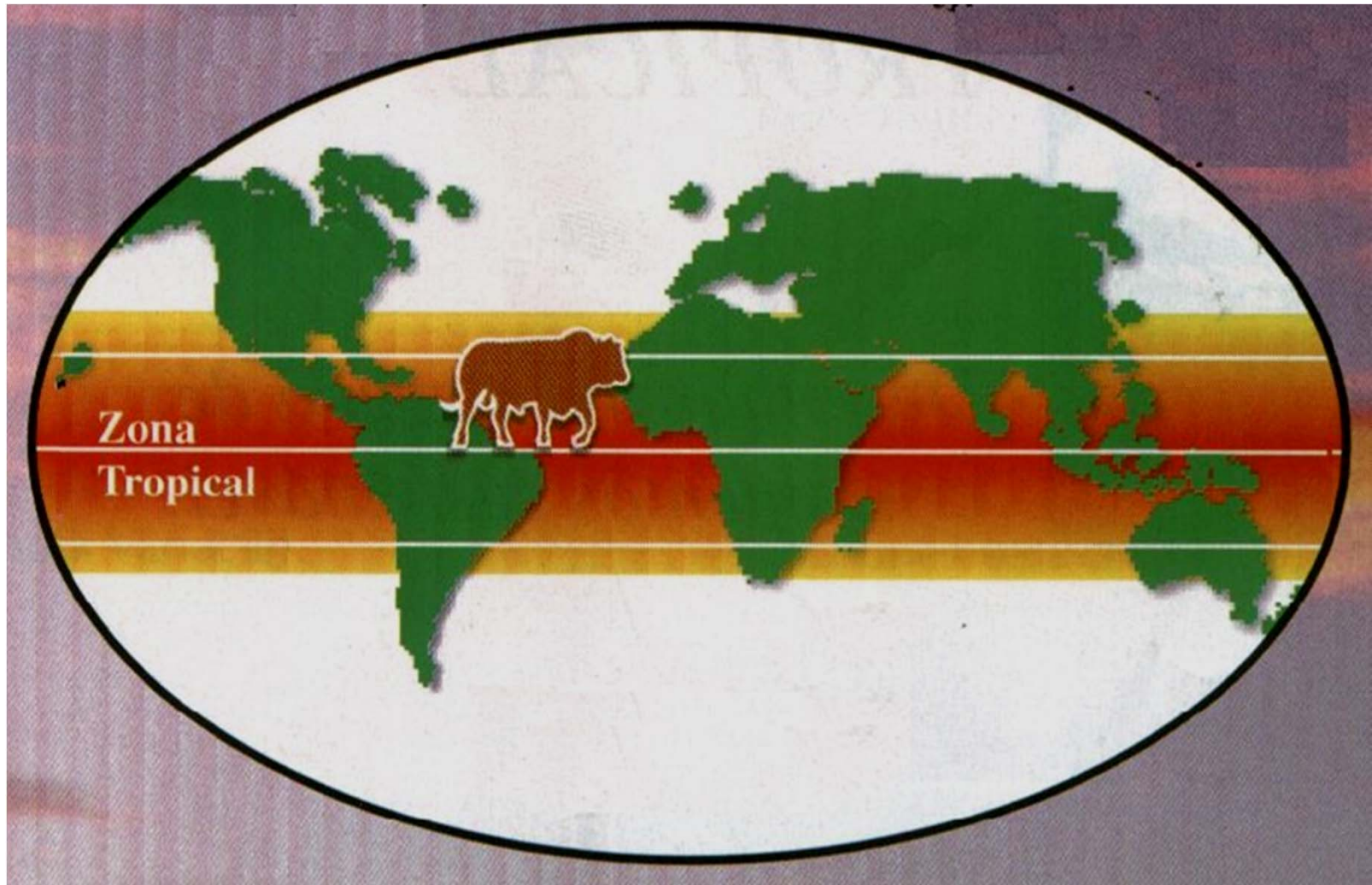
Courtesy of C. Long & M. Westhusin

Livestock Cloning Used Globally



Can Transgenesis Produce Similar Milk Yields or “Better” Milk?

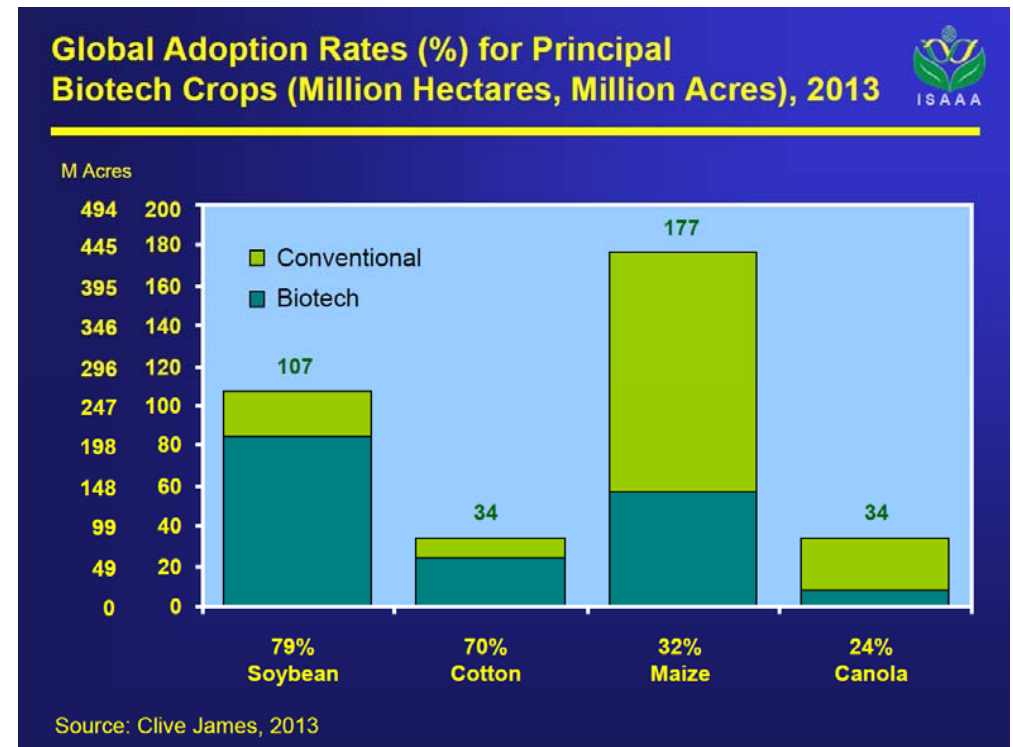




**Tropical zone holds 70% of the cattle of the world
and most of the people**

World-wide experience with GE crops shows:

- GE in and of itself is not harmful to people; it is safe
- GE can increase efficiency of production and decrease the footprint of agriculture



As I see it:

Compared to plants, GE livestock and poultry (but not necessarily fish), pose essentially zero threat to the environment and biodiversity.

Experience with GE plants, and our knowledge of GE animals, indicate they pose little food safety risk to people.

The use of GE crops is widely embraced and their products have been consumed in billions of meals.

Yet we cannot get approval of any GE animal for food

- **Developers and industry need a functioning regulatory and international trade environment in order to move forward**
- **In the absence of such we will forego, or significantly delay, the benefits of a powerful tool**

Risk Assessments of Animal Clones by Country

US (FDA)	Japan (FSC)	Australia & NZ (FSANZ)	NZ (NZFSA)	Australia	Argentina	China	EU (EFSA)	France	UK
2008	2009	2003			2012	?	2008 (x 4)	2005	2010

Clones

Food Safety: safe as food from conventionally bred animals	yes	yes	yes	yes	yes	yes	yes	yes	not accessed	yes
Labeling:	none	voluntary		none	none	none	none	?	N/A	
Tracing:	Industry (not now)	yes		National registry		none	none	?	yes	
Moratorium for food:	voluntary	none			includes 1st generation	none	none		yes	

Offspring

are not clones

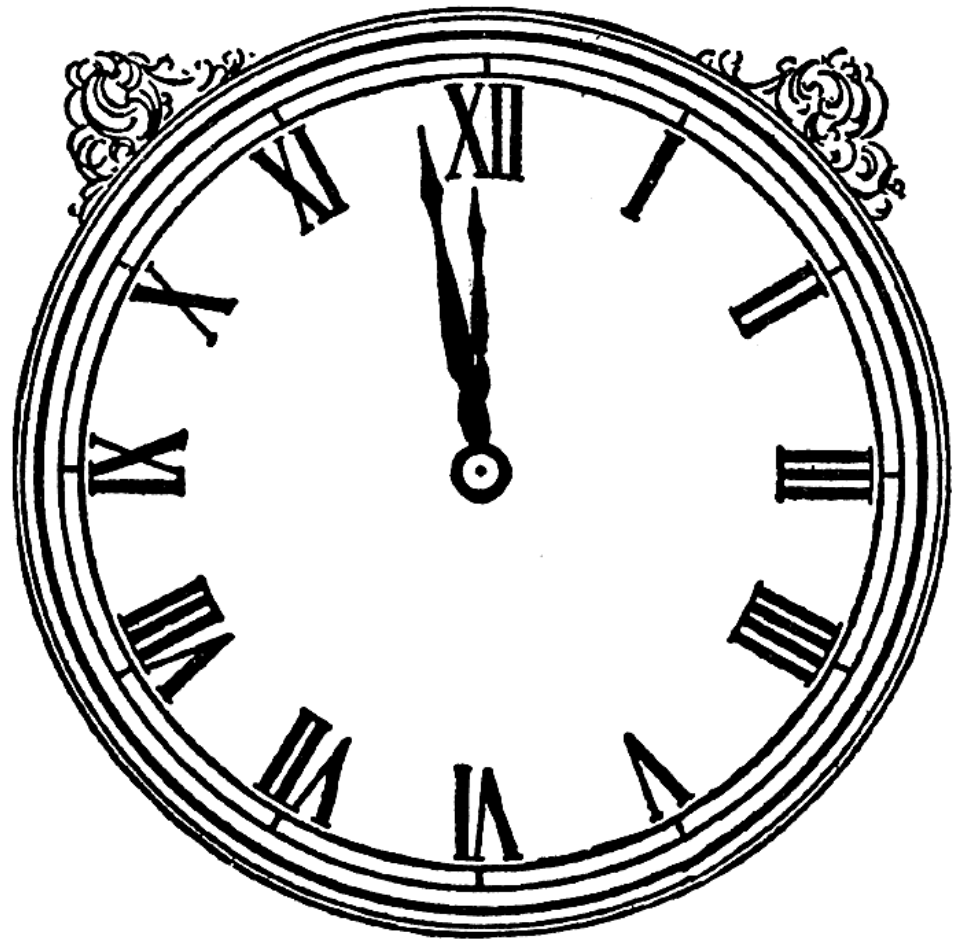
Food Safety: same as other sexually reproduced animals	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Tracing:	none	none		none	1st gen.	none	none	?	none	

**The challenge for policy makers and regulators
is there**

The clock is ticking

**The need to move
forward is urgent**

**Keep in mind the
generation interval
for large animals**



Peace cannot be found on a empty stomach. -Norman Borlaug

