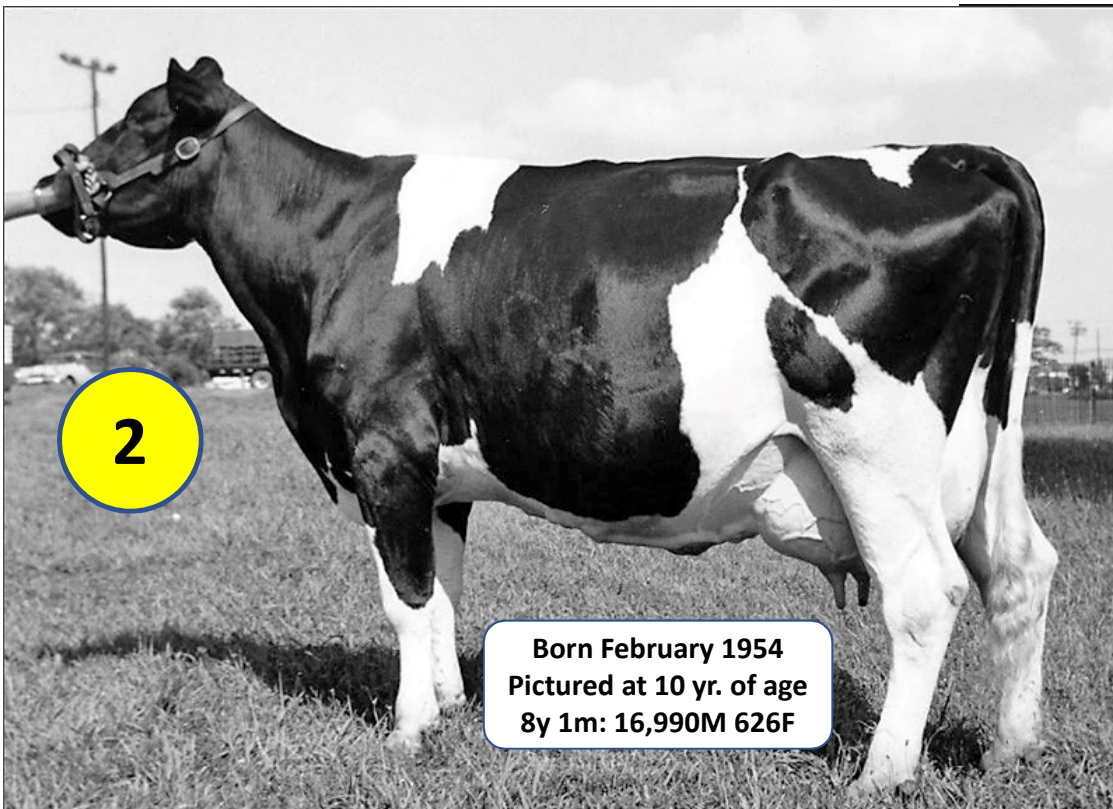


Genomic Revolution: The Next 10 Years
A vision for the future:
how will the dairy business look like in 2029?

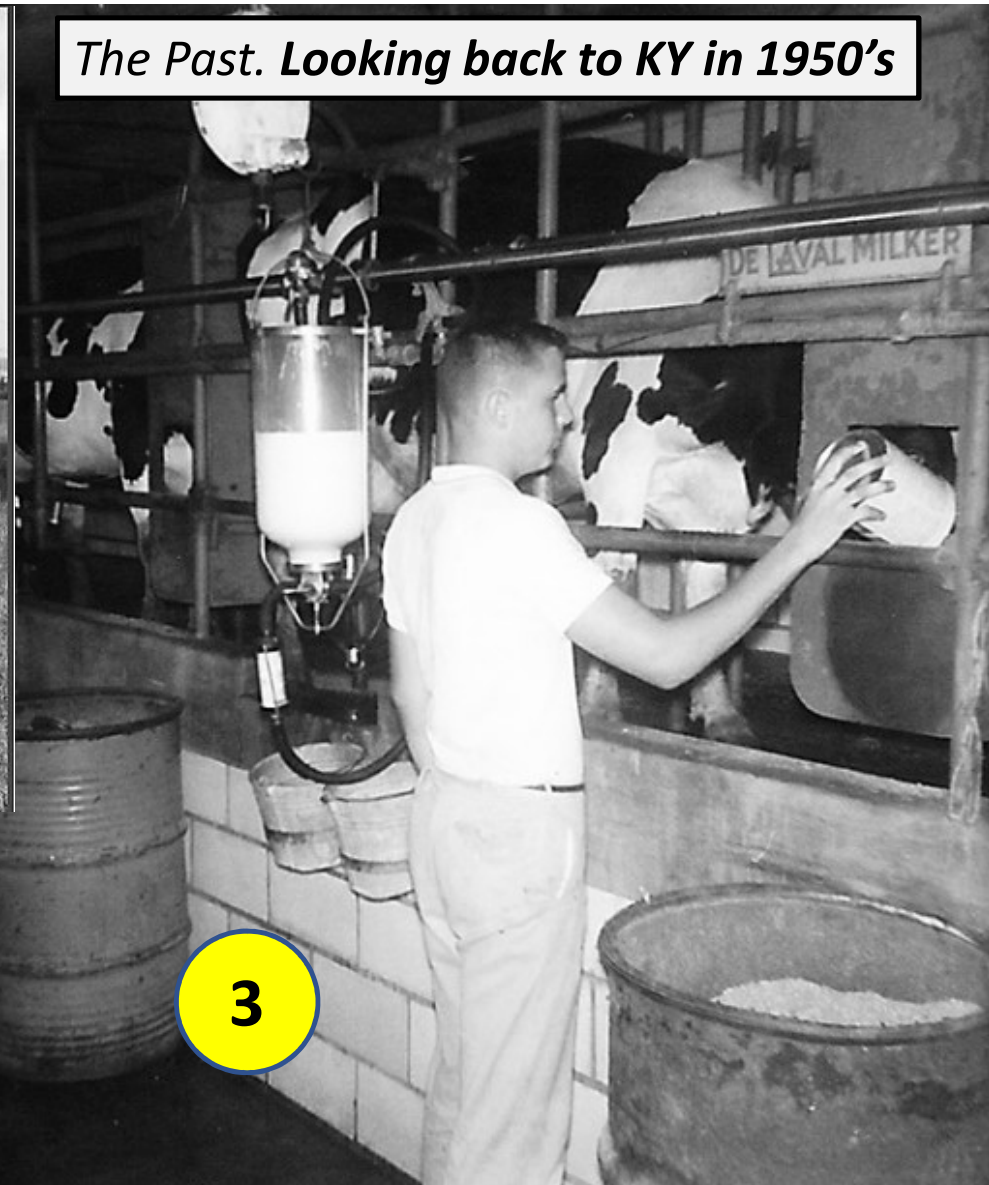
1

Jack H Britt <> Council of Dairy Cattle Breeding <> February 25, 2019

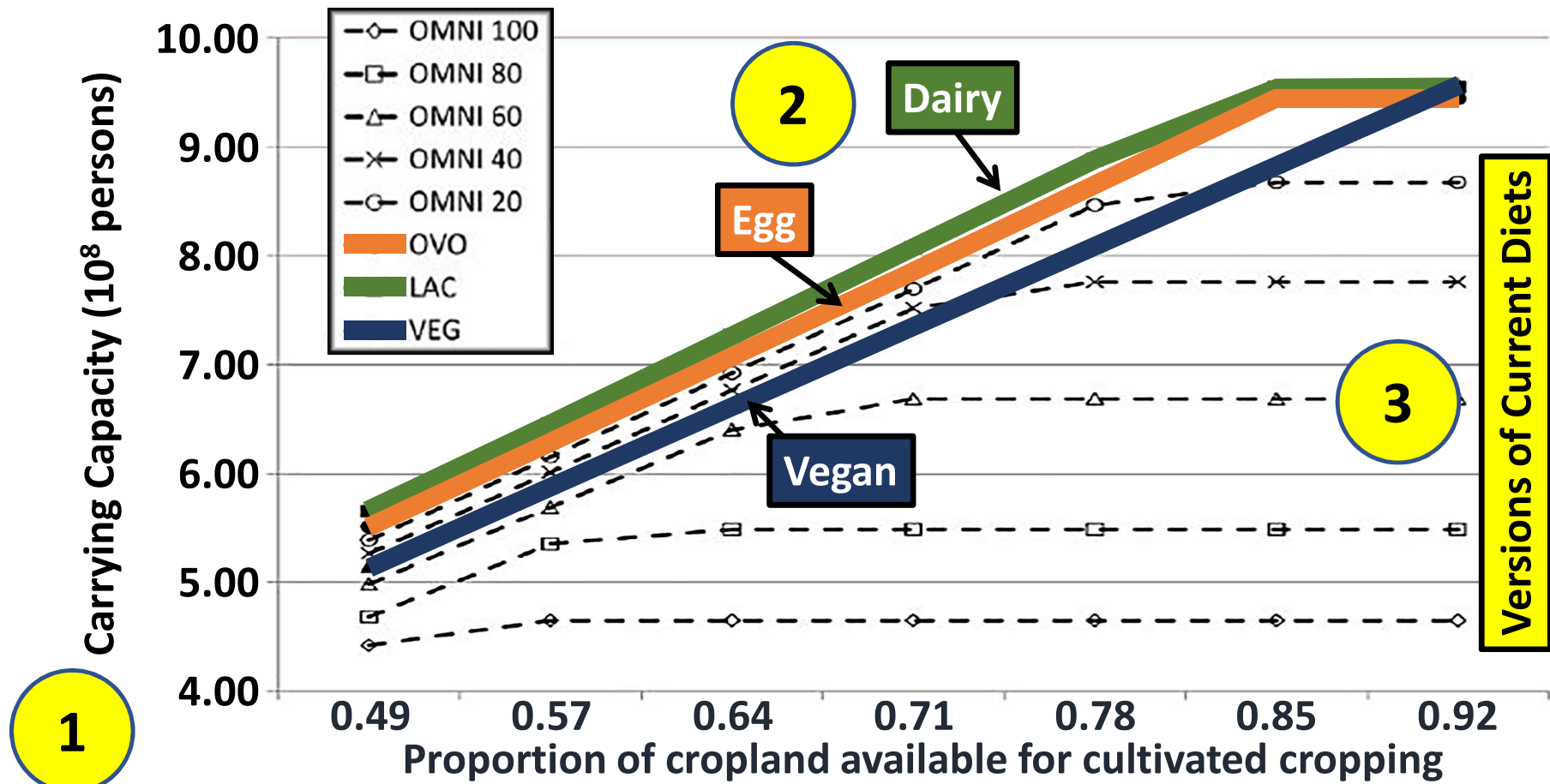
Expert Forecasters: Mike Hutjens, IL; Gordie Jones, WI; Jeff Stevenson, KS; Pam Ruegg, MI; Chad Dechow, PA; George Seidel, CO; Bob Cushman, NB; Tony McNeel, MI; Louise Holt, VT; Hilary Dobson, UK; Martin Sheldon, UK; Patrice Humblot; SE



The Past. Looking back to KY in 1950's



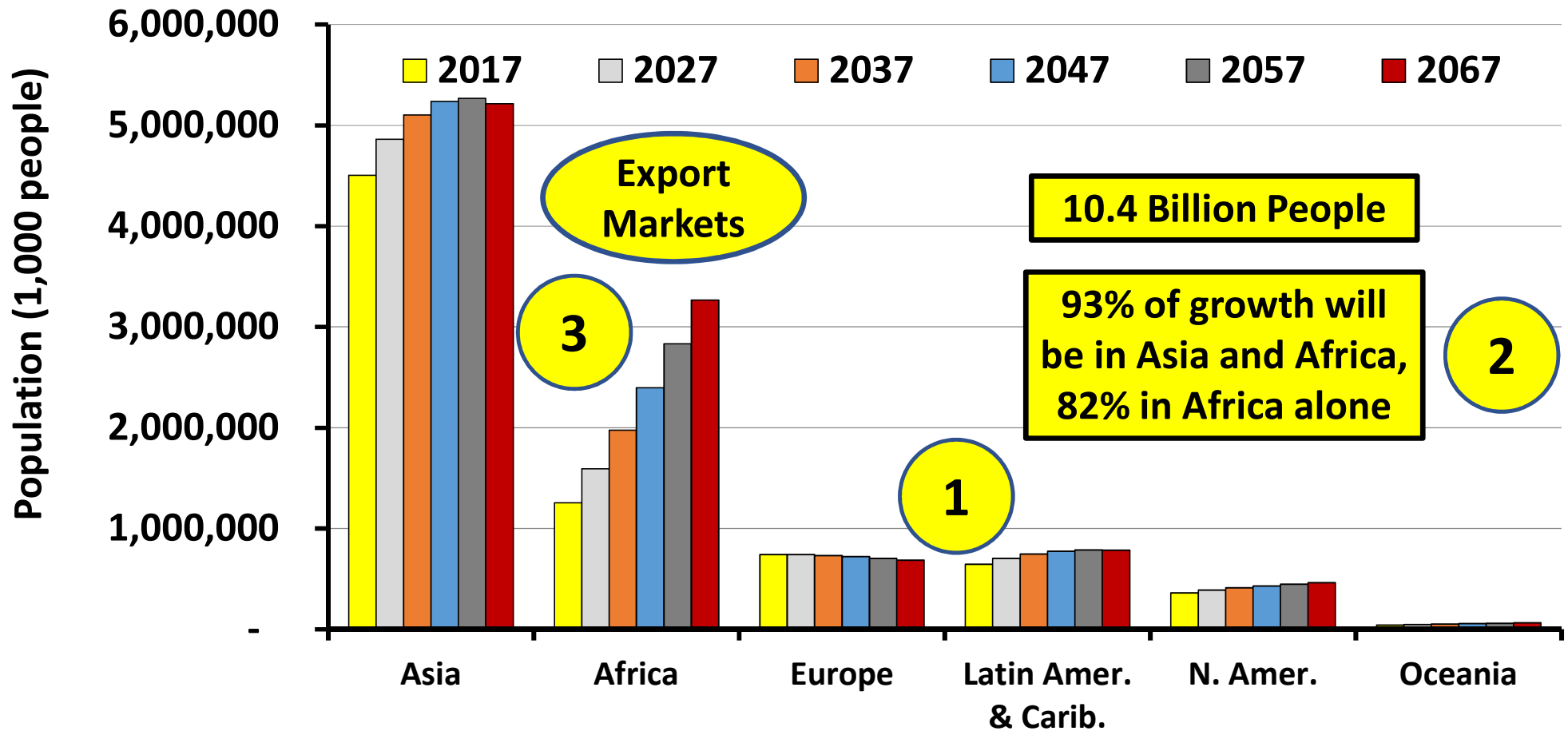
USA findings: Dairy feeds most people from USA land base



Peters, Christian J., Jamie Picardy, Amelia F. Darrouzet-Nardi, Jennifer L. Wilkins, Timothy S. Griffin, Gary W. Fick. 2016.

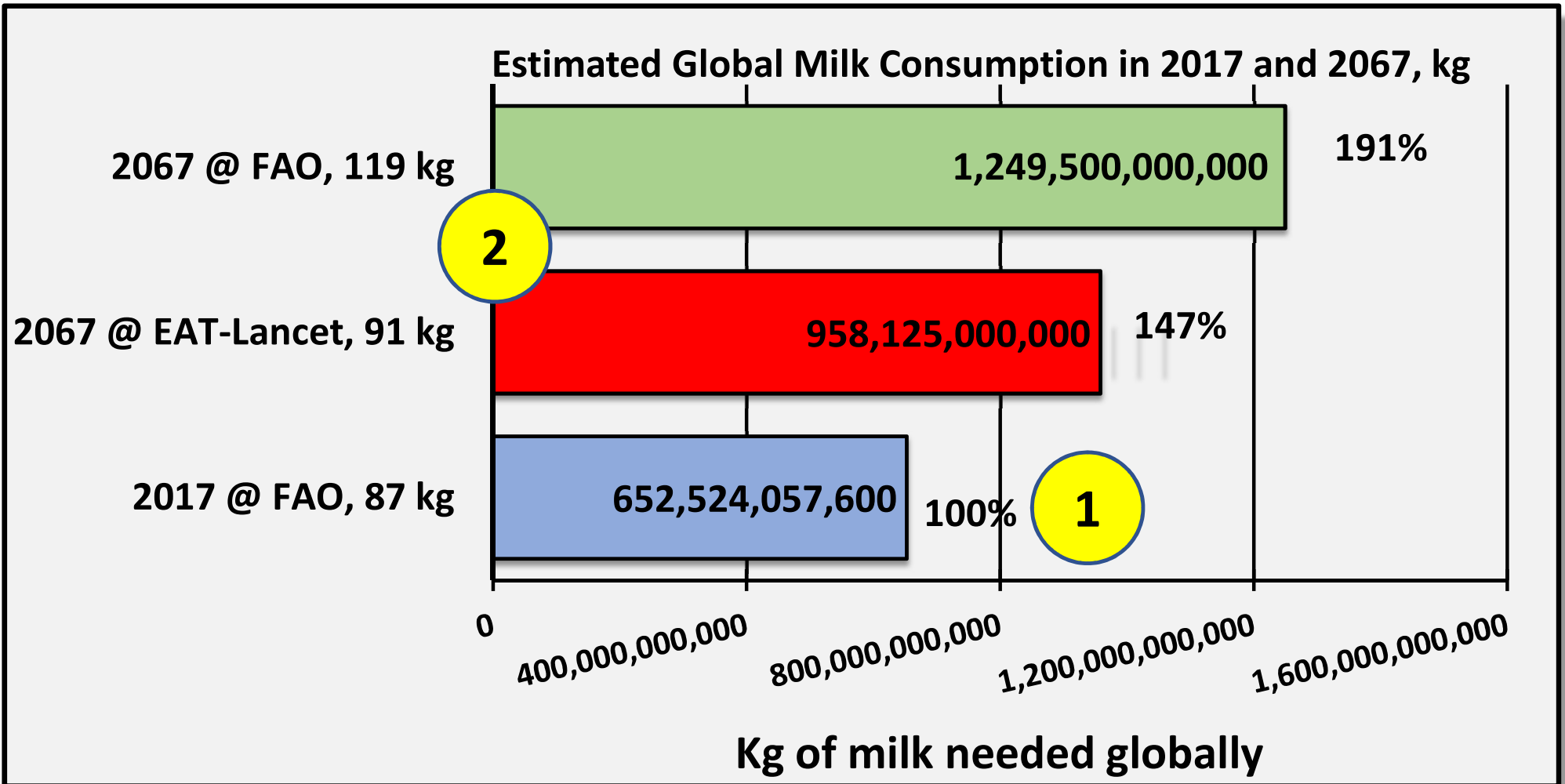
Carrying capacity of U.S. agricultural land: Ten diet scenarios. *Elementa: Science of the Anthropocene* • 4: 000116 • doi: 10.12952/journal.elementa.000116

World view: Growth of population will be in Africa and Asia



Britt et al. 2018. J. Dairy Sc. 101 (5): 3722-3741. Data source: FAOSTAT 2017.

World view: Demand for dairy will be strong



World view: How many dairy cows to meet demand

Average Yield Per Cow in 2067

1.25% increase/yr

249,500,799

1

2X of 2017 Average

262,657,953

2017 Average

1

525,315,906

Dairy Cows Needed in 2067 with
Different Milk Yield Averages

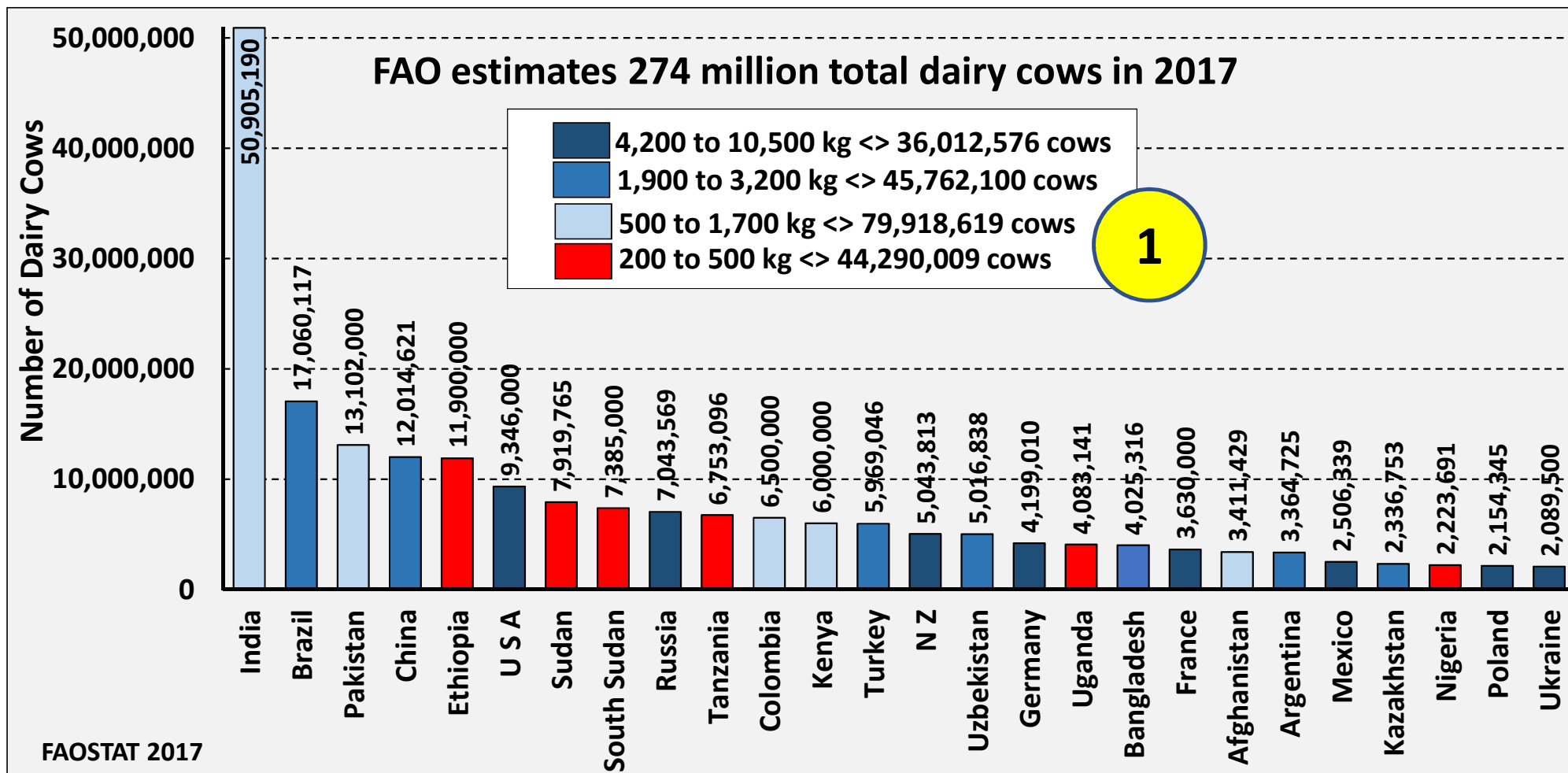
0

200,000,000

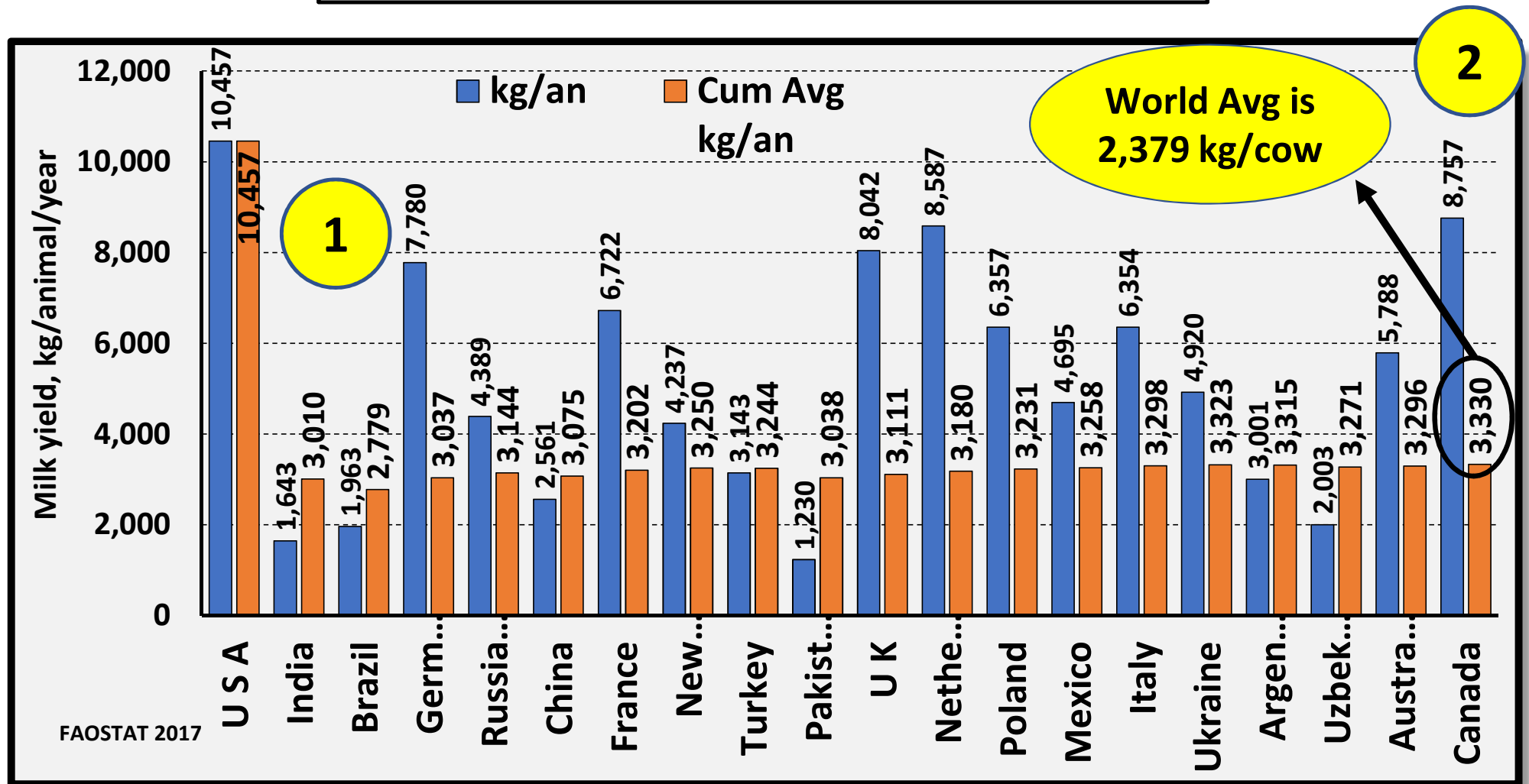
400,000,000

600,000,000

World view: 26 countries have 75% of dairy cows in world today



World view: 20 countries produce 75% of cow's milk



Current view: Cow's milk is mostly consumed in non-fluid forms in the USA.

1



56 billion lbs.

23% vs 77%

Milk vs Other dairy

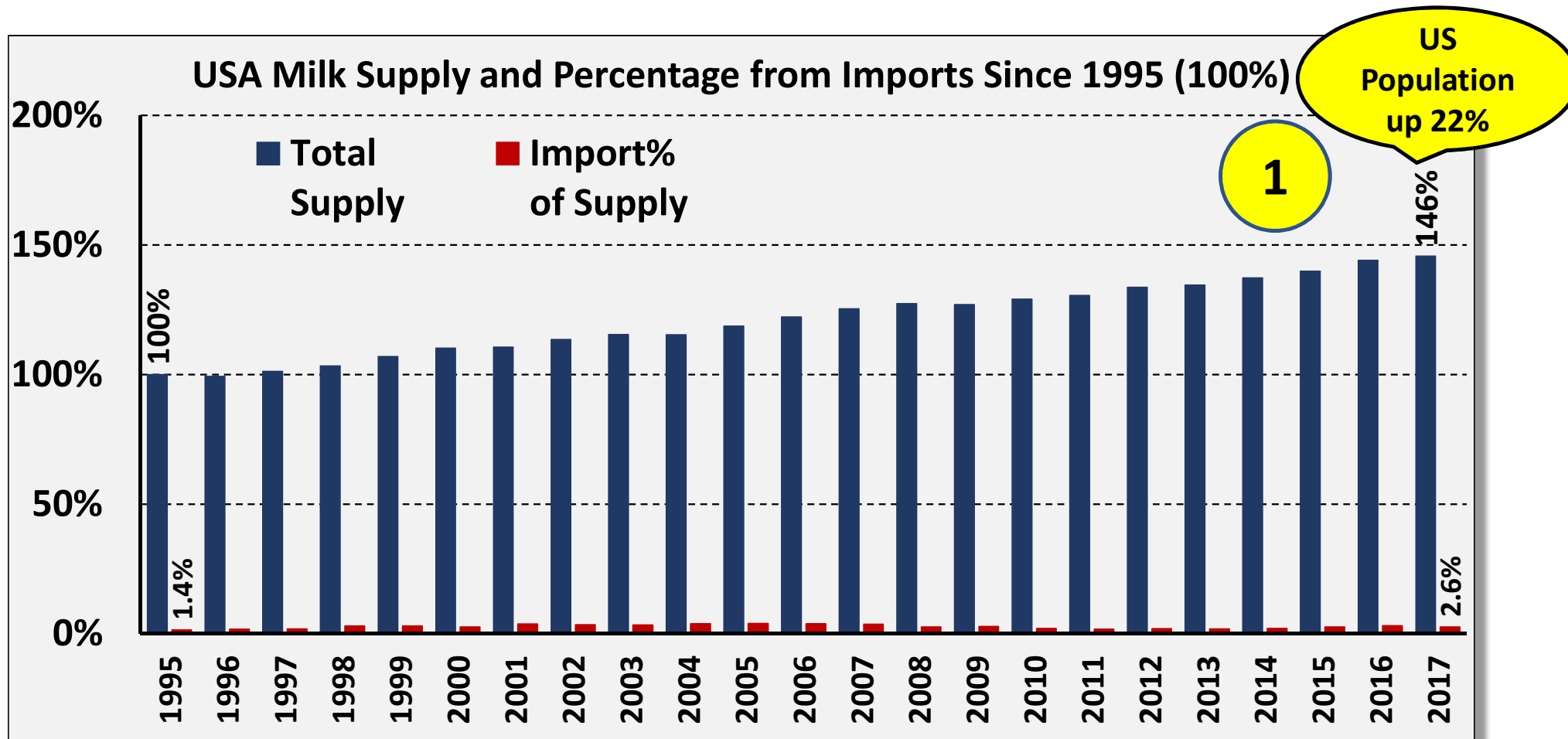


159 billion lbs.

2

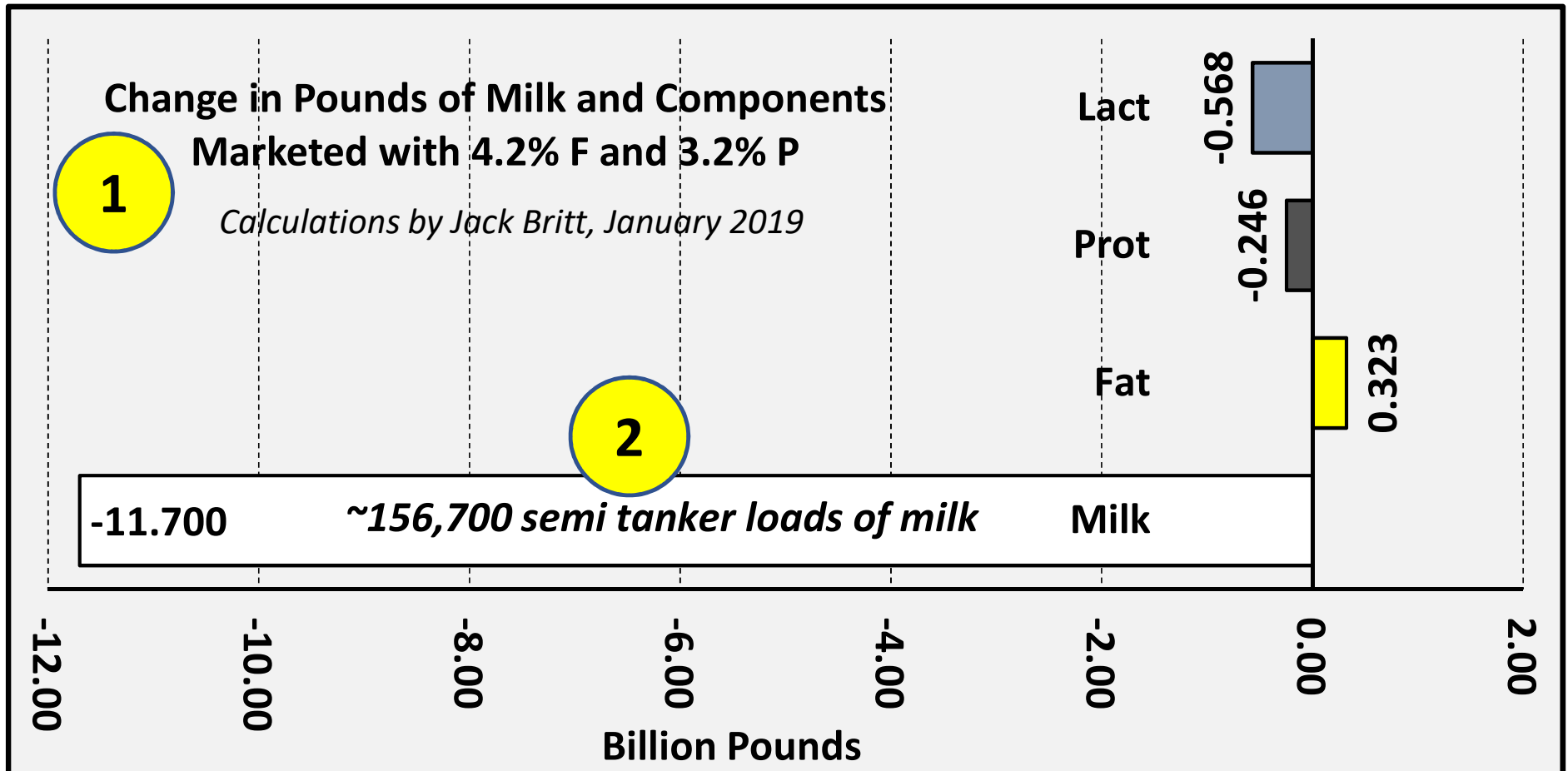
- **Caseins and other proteins:** *A1, A2, better cheese yields, etc.*
- **Fatty acids:** *Beneficial to health*
- **SCC:** *200,00 or lower*
- **Processing:** *Best for ultrafiltration, UHT, aseptic packaging*
- **New Products:** *USA seems to be lagging*

USA milk supply: Milk supply growth exceeds population growth.

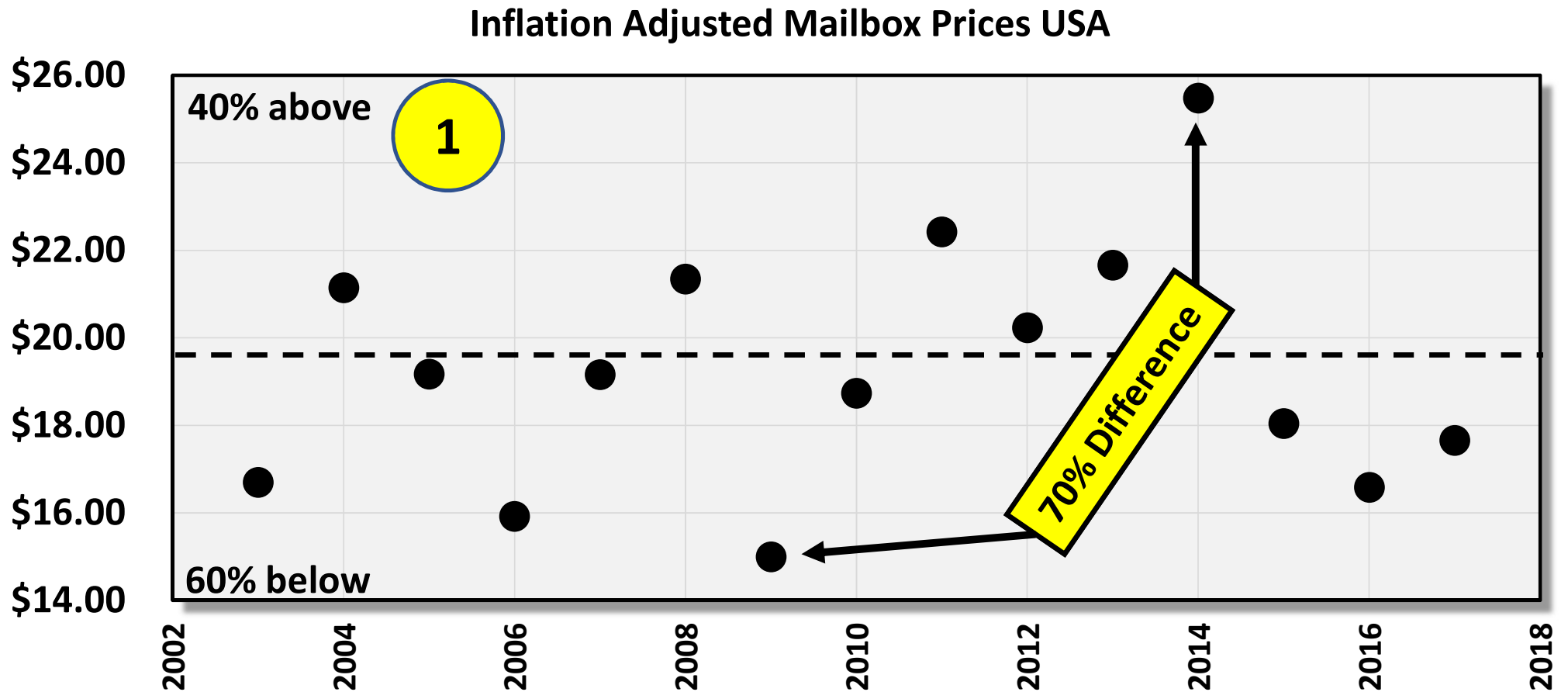


USDA estimated components of USA milk supply on a milk fat basis are 3.7% fat solids, 8.8% skim solids.

USA markets: **Balancing volume and components with % instead of pounds**



View ahead: Milk prices in USA will continue to be VOLATILE!



Original data: Hoard's Dairyman April 25, 2018, page 264.

Future: Shareholders and politicians focus on short-term results

THE WALL STREET JOURNAL. Tuesday, December 4, 2018 | R11

JOURNAL REPORT | THE YEAR AHEAD

ON BUSINESS | By John D. Stoll

It's Really Hard to Think Long Term

Companies have a tough choice to make: They want to implement strategies that may take years to pay off, but Wall Street doesn't always react too kindly.



APPLE INC. recently ended its practice of reporting quarterly sales numbers for individual units, saying a 90-day performance for Macs or iPhones isn't a proxy for the underlying strength of product lines.

That attempt to redirect the market's focus from short-term to longer-term trends was about as successful as Apple TV. Investors punished the stock, with shares shedding 6.6%, or \$71.19 billion in value, on Nov. 2, the day of the announcement.

Apple's decision is just the latest wrinkle in the showdown between short-term and long-term thinking on

ing they should be more patient than sell-side analysts. Mr. Koller says there isn't a lot of evidence that proves shareholders want executives to fixate on the short term.

Even so, the number of publicly traded companies is shrinking. That trend is partly driven by the increasing pressure on executives, reported in multiple studies, to put immediate performance before investing in the future. Business leaders are tired of feeling forced to make short-term decisions that could be to the detriment of their companies' long-term health.

This hits companies young and old. Barnes & Noble Inc. Chairman Leonard Riggio said in October the bookseller is considering going private because

Investor Warren Buffett and JP-Morgan Chase & Co. CEO James Dimon wrote an op-ed in this newspaper in July that urged companies to "show deeper commitment to each other." Mr. Dimon and Mr. Buffett also urged President Trump directed the Securities and Exchange Commission to study a move to six-month reporting following consultations with business leaders, including PepsiCo Inc. Chairman Indra Nooyi.

Change is difficult

But jumping on the long-term bandwagon is easier said than done. The three most valuable companies by market capitalization—Apple, Amazon and Microsoft Corp.—continue to give earnings guidance, a practice that has long helped investors frame out near-term expectations and has helped the executives gain credibility as they chart out longer-term plans.

Responding to Mr. Trump's move, Lawrence Summers—former Treasury secretary and economic adviser to President Obama—said in a Washington Post op-ed: "Reducing the frequency of corporate profit reporting would make major surprises and drastic market moves likely. It would also allow managers to wait longer before

WSJ
12/4/2018

Apple under CEO Tim Cook has pushed for a long-term perspective.

MICHAEL FREEDMAN/BLOOMBERG NEWS

Future: Population, land for food production and climate change.

**82% of people
81% of food
N. hemisphere**

1

Longer
growing
season

3

Longer
growing
season

Longer
growing
season

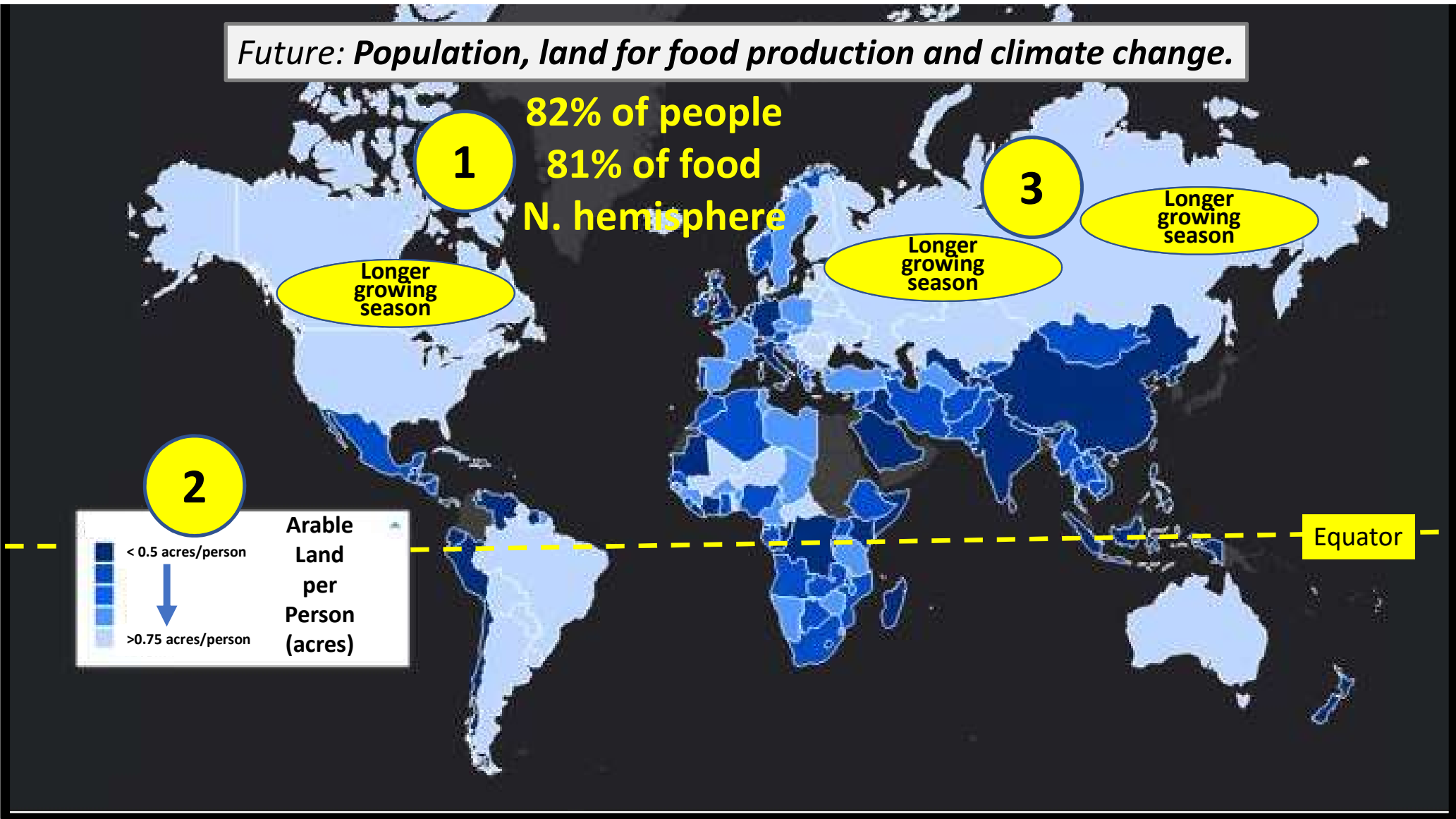
2

< 0.5 acres/person

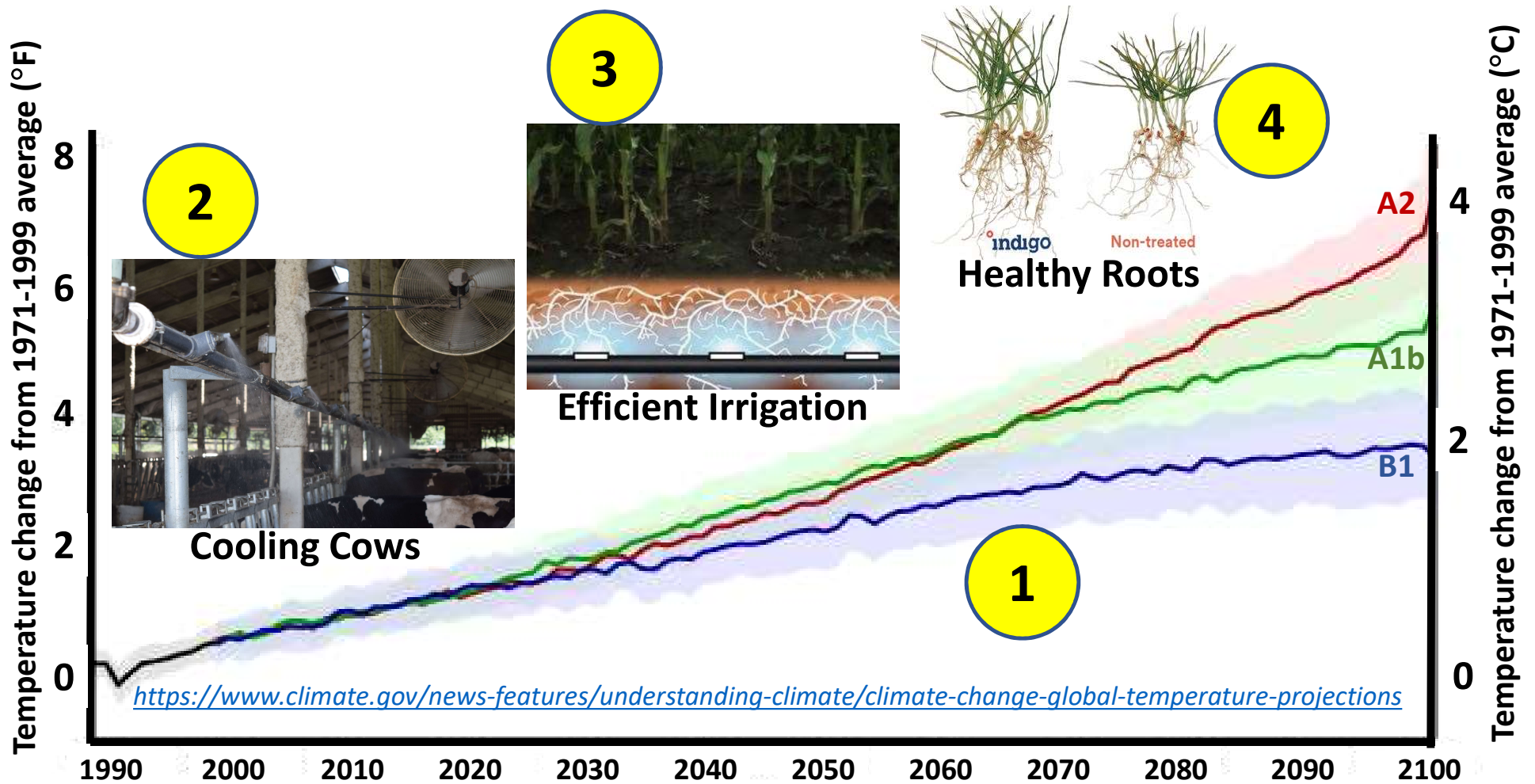
> 0.75 acres/person

Arable
Land
per
Person
(acres)

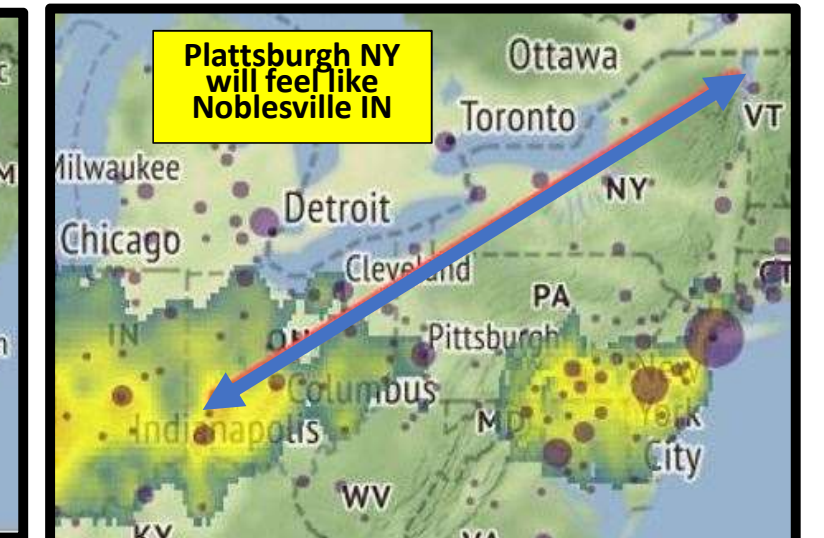
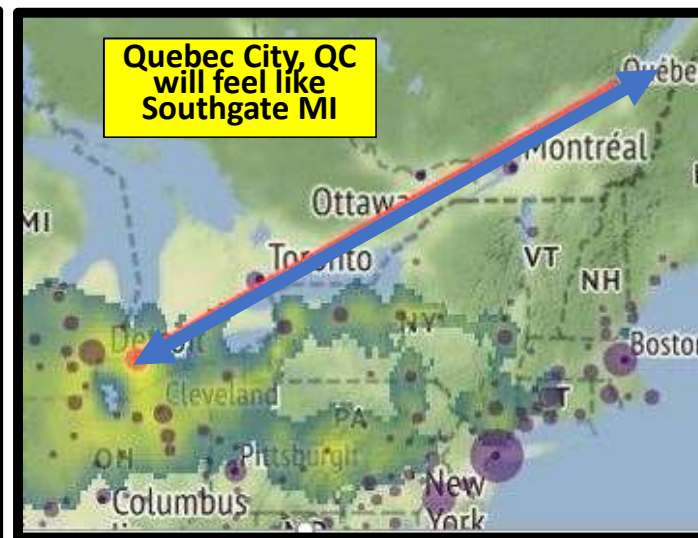
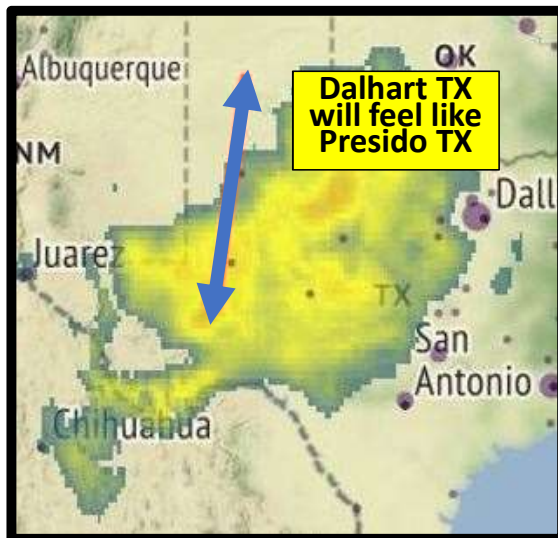
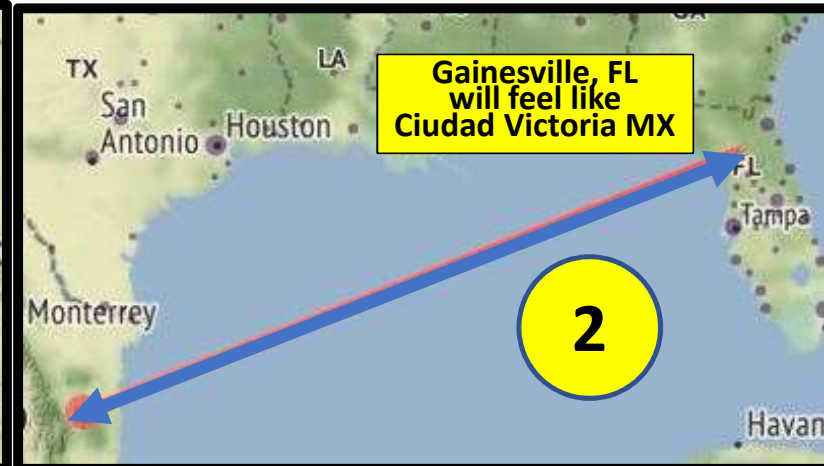
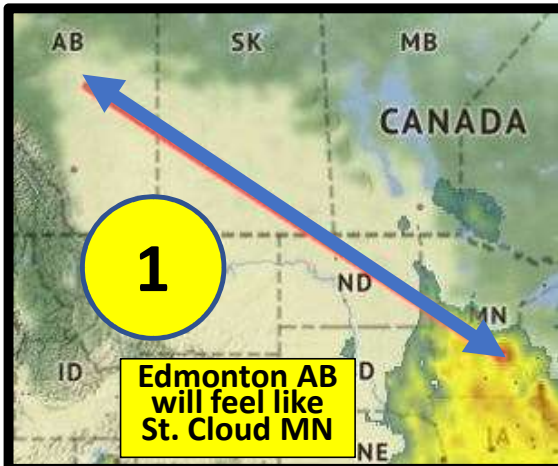
Equator



Future: Adapting to climate change on dairy farms



USA future climate examples: <https://fitzlab.shinyapps.io/cityapp/>



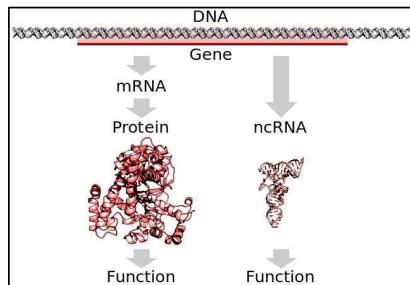
Looking ahead: Understanding the dairy herd as a SUPERORGANISM



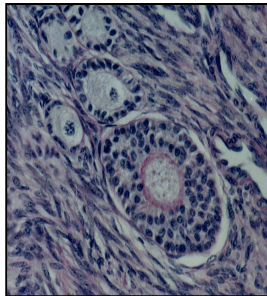
We cannot learn about *herds* by studying these:

1

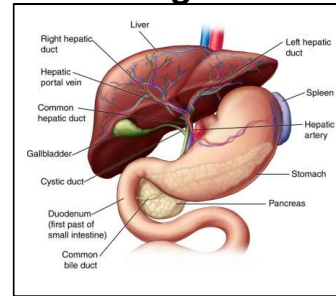
Gene



Cell



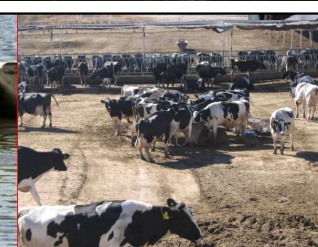
Organ



Animal



2



Herds in Close Proximity

8.5 mi

5.9 mi

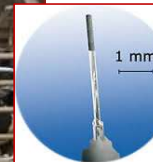
13 production units (herds)

- Study practices, trends, long-term
- Use sensors, surveys, samples
- Assess micro- and macro-environments
- What characterizes “good management”?
- Do herds behave as superorganisms?

1

Google

Sensors, automation, robotics, artificial intelligence



- Soils
- Crops
- Silo/bales
- Lagoon
- Natural areas
- Barns
- Milking center
- Personnel
- Equipment
- Commodities
- Robots
- Air
- Waterways
- Roads
- Vehicles

Data in the cloud & Blockchain

Integrated sensors

1

**Reliable
Repeatable
Precision-
Accuracy
Less labor**



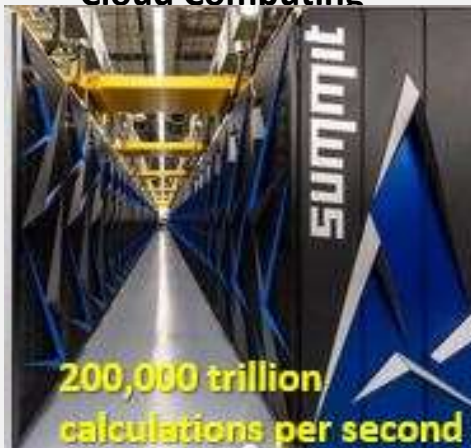
Disruptive: Open source research and dissemination
(Why do we need journals when our base is declining?)

1

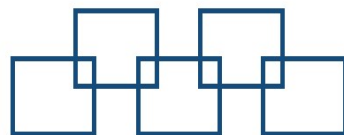
Dairy Farmers



Cloud Computing



Blockchain



Dairy Research Ctrs.



On-cow Sensors



USDA ARS Scientists



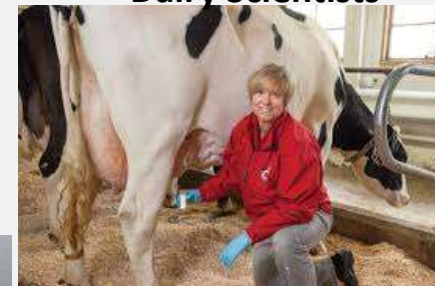
Data Centers



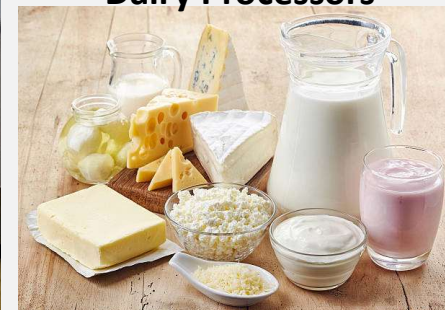
Parlor Sensors



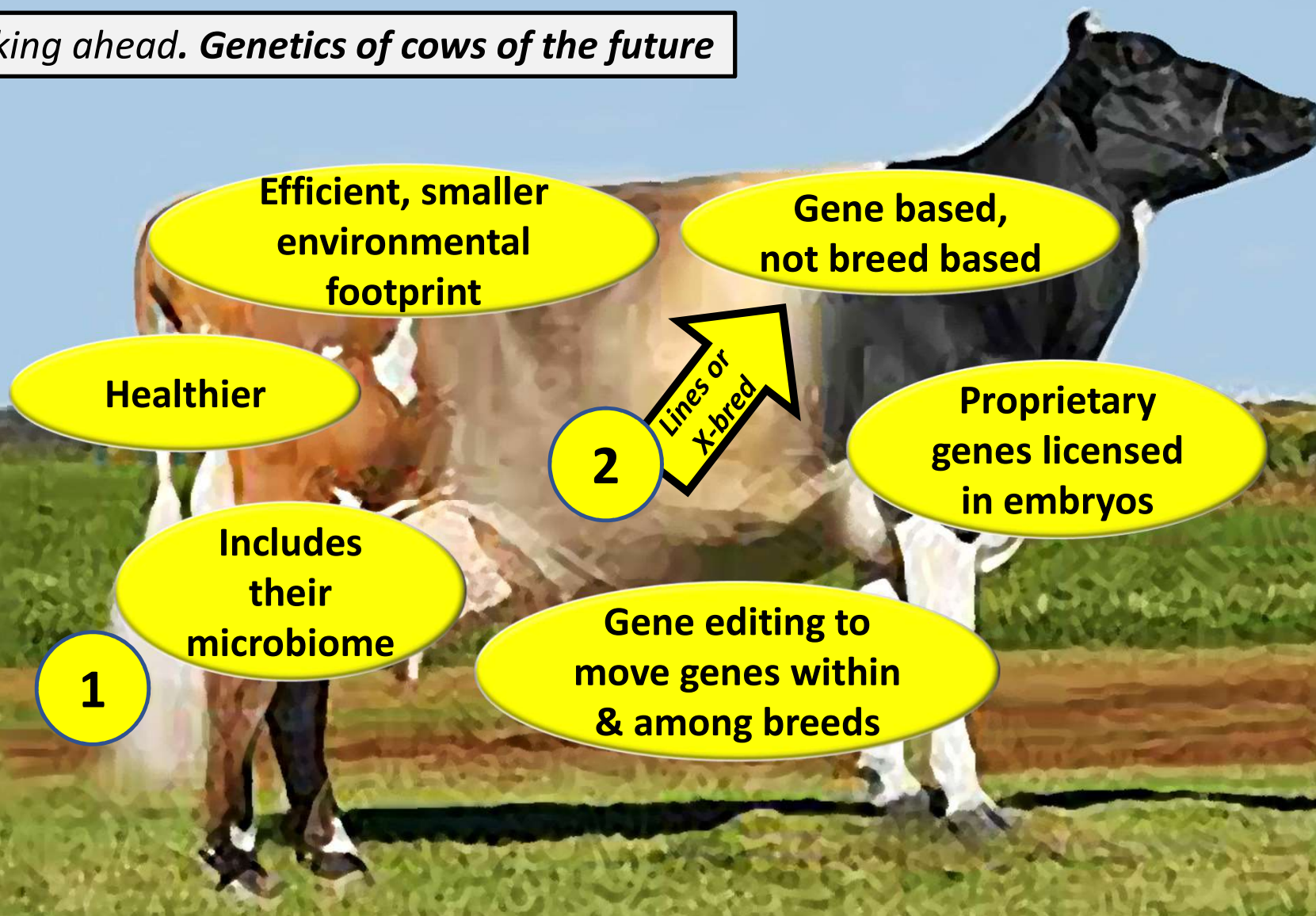
Dairy Scientists



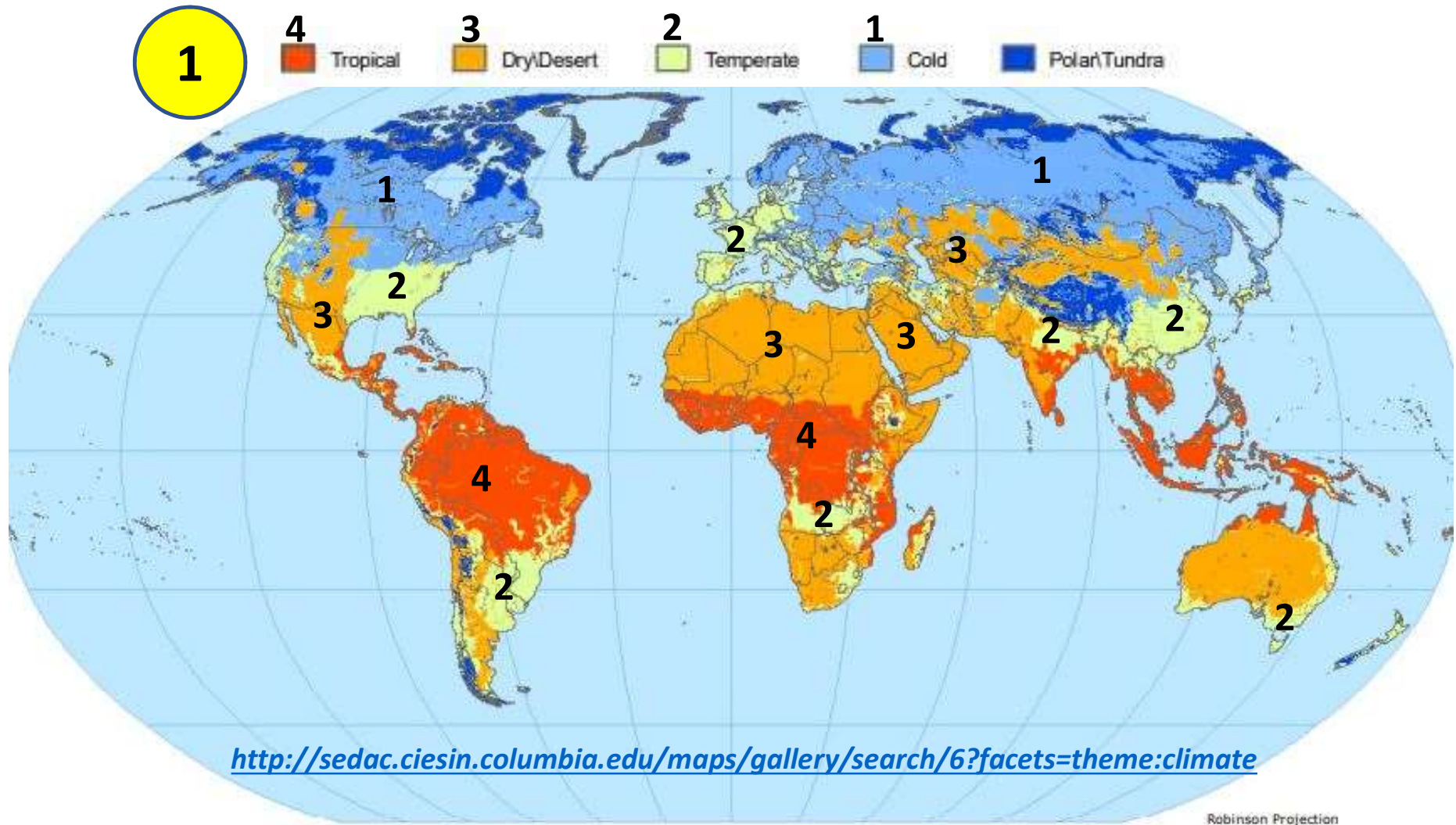
Dairy Processors



Looking ahead. Genetics of cows of the future



Genetics of the future: *Four global dairy cattle lines*



Genetics of the future: Focus shifts to understanding “epigenetics”

Environmental Action

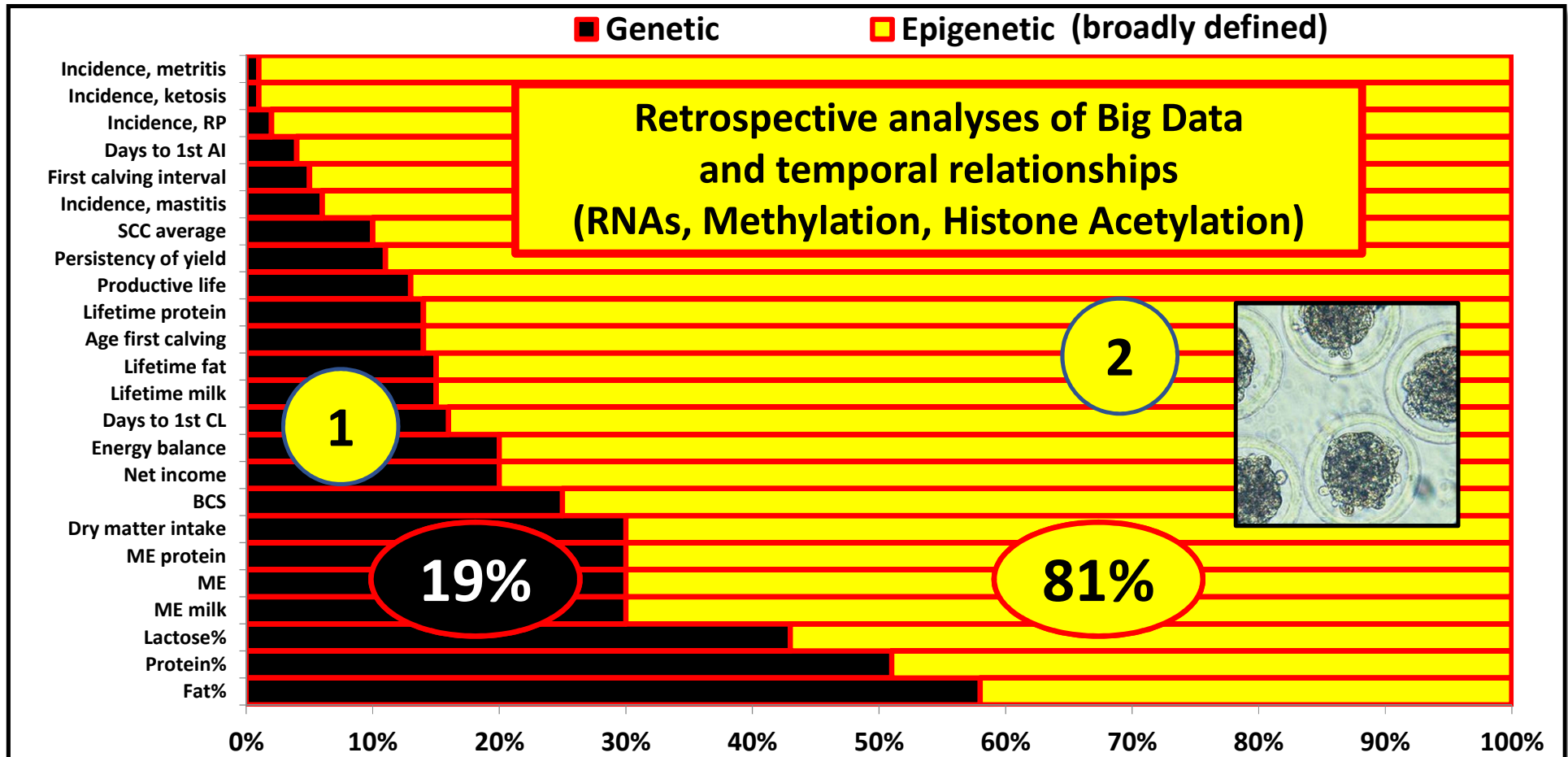
weeks, months, years

Observed Response

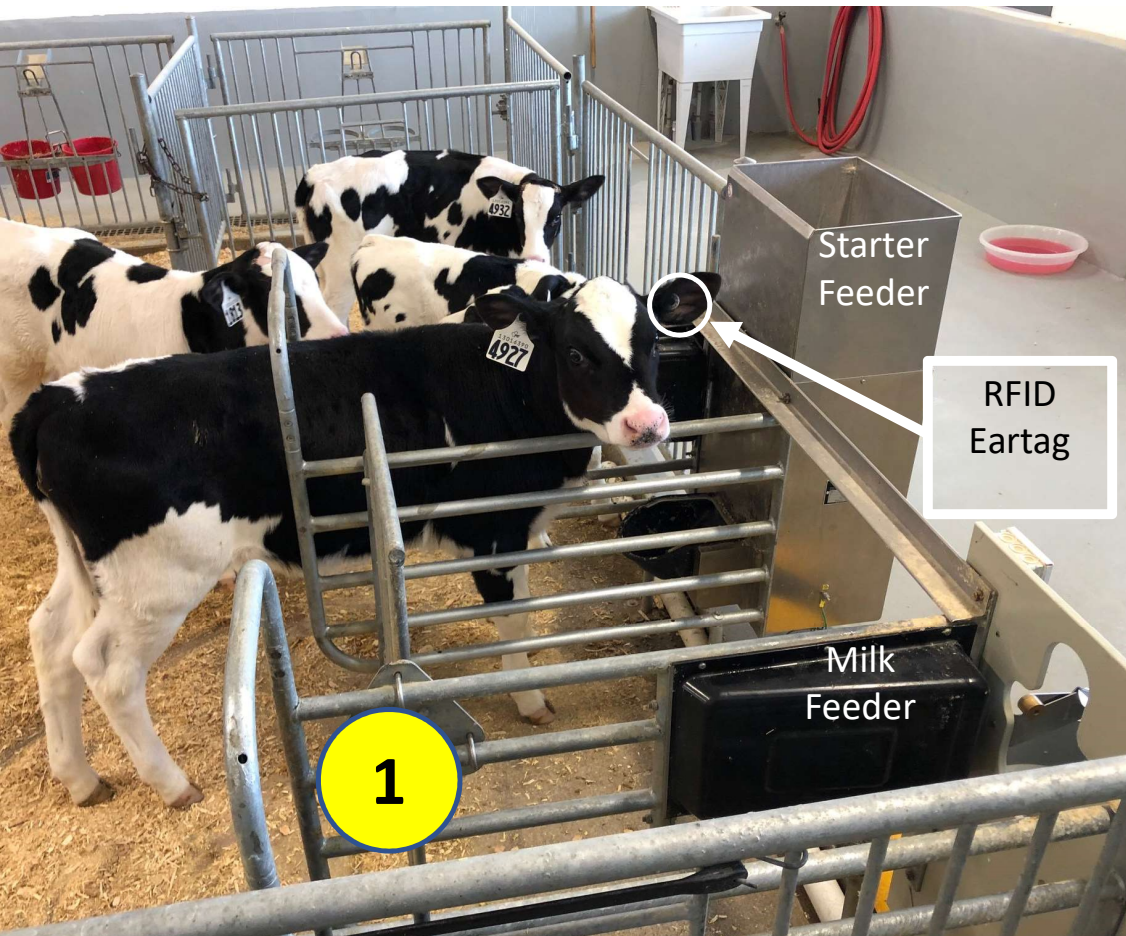
■ Genetic

■ Epigenetic (broadly defined)

Retrospective analyses of Big Data
and temporal relationships
(RNAs, Methylation, Histone Acetylation)



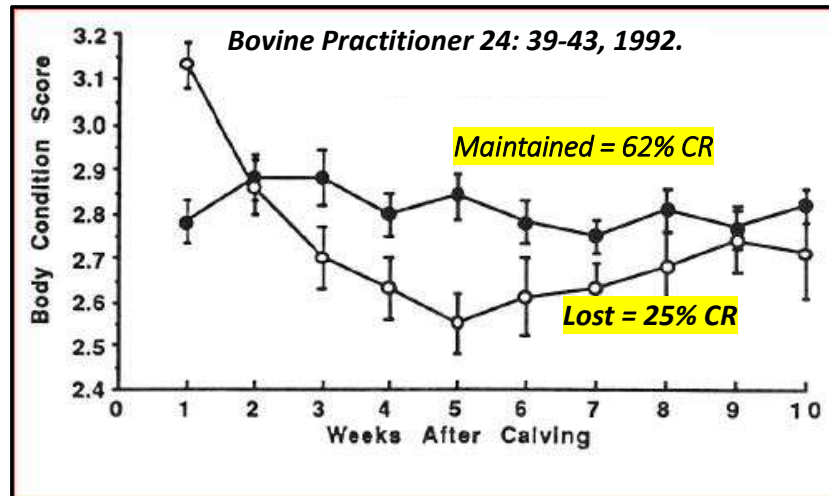
*Sensors and robotics: **Artificial Intelligence** in dairy management*



Mechanisms: How does weight loss affect fertility of a cow's eggs?

1

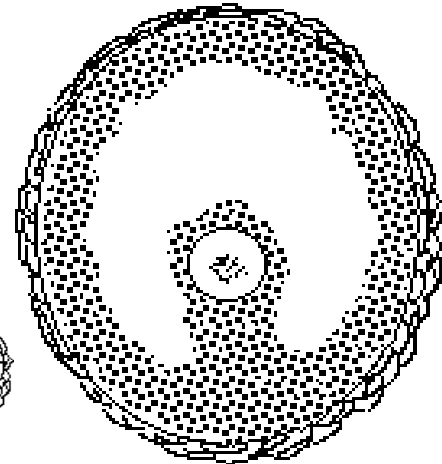
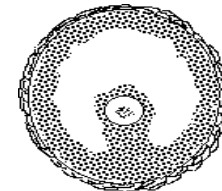
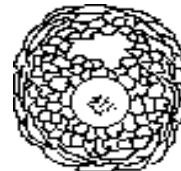
"Britt Hypothesis" Here's what observed.



2

Here's a diagram of our hypothesis.

Microscopic size



-21 Weight loss Environment +21

+35

+75

+80

101 Days

Days Before or After Calving

Primordial pool

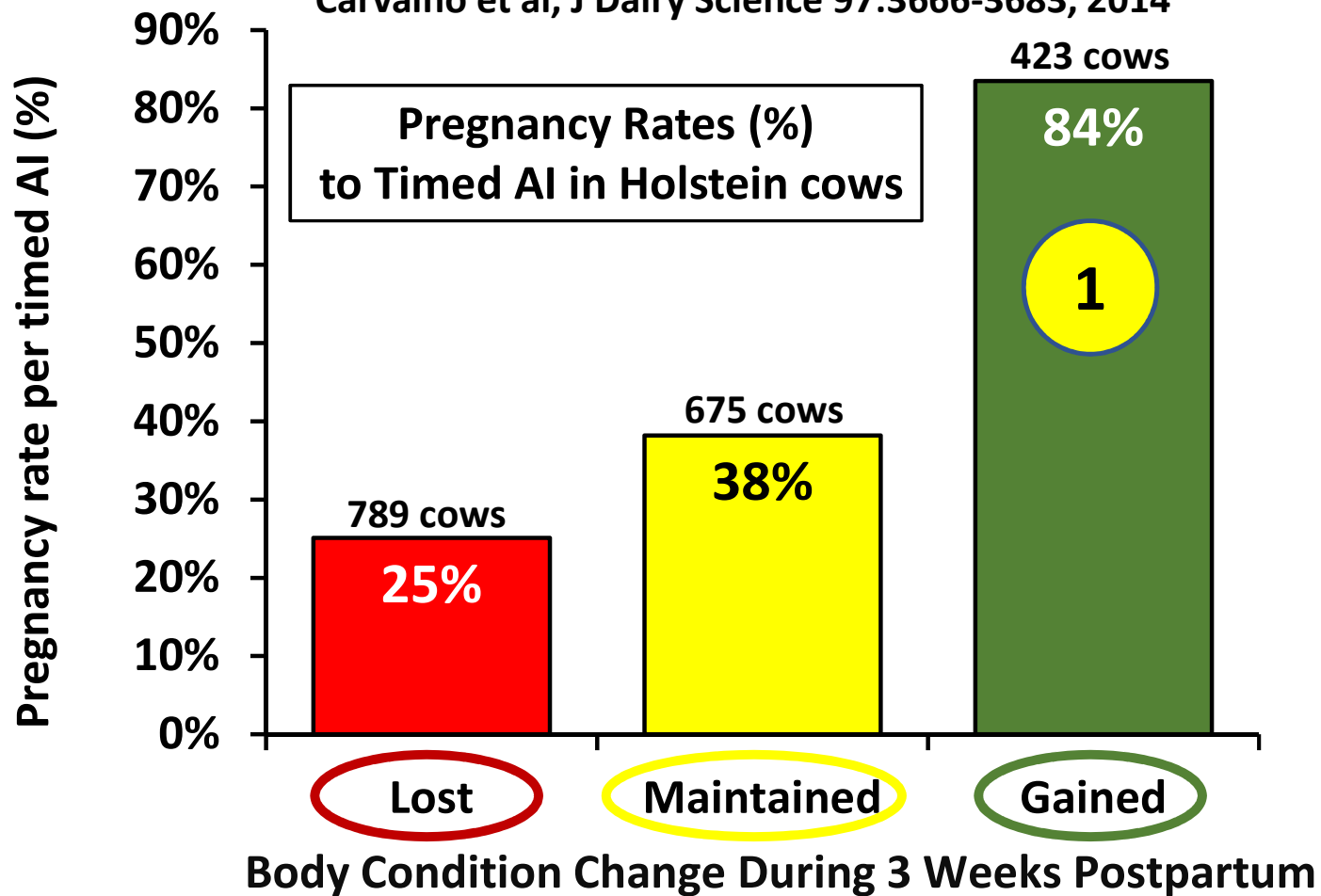
Activated oocyte from ovarian reserve

Ovulation of egg

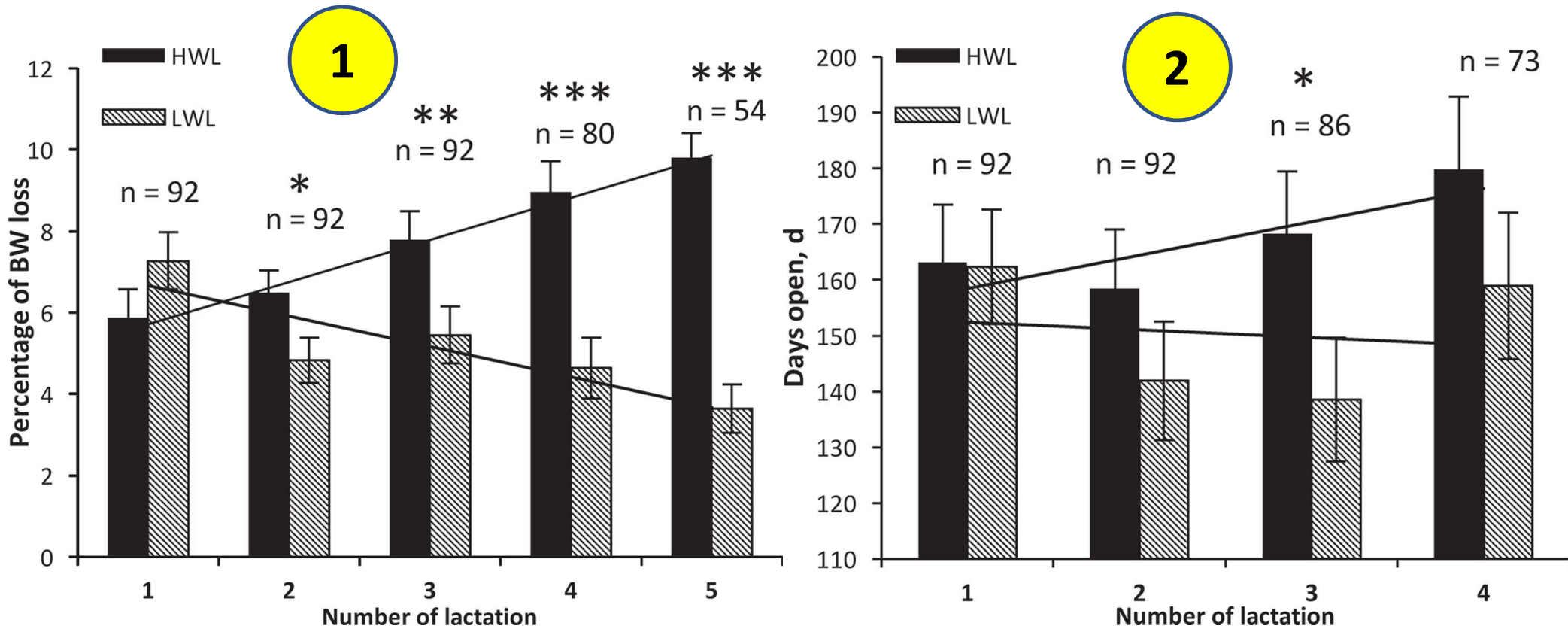
Ultrasound size

The Britt Hypothesis: 22 years later...

Carvalho et al, J Dairy Science 97:3666-3683, 2014

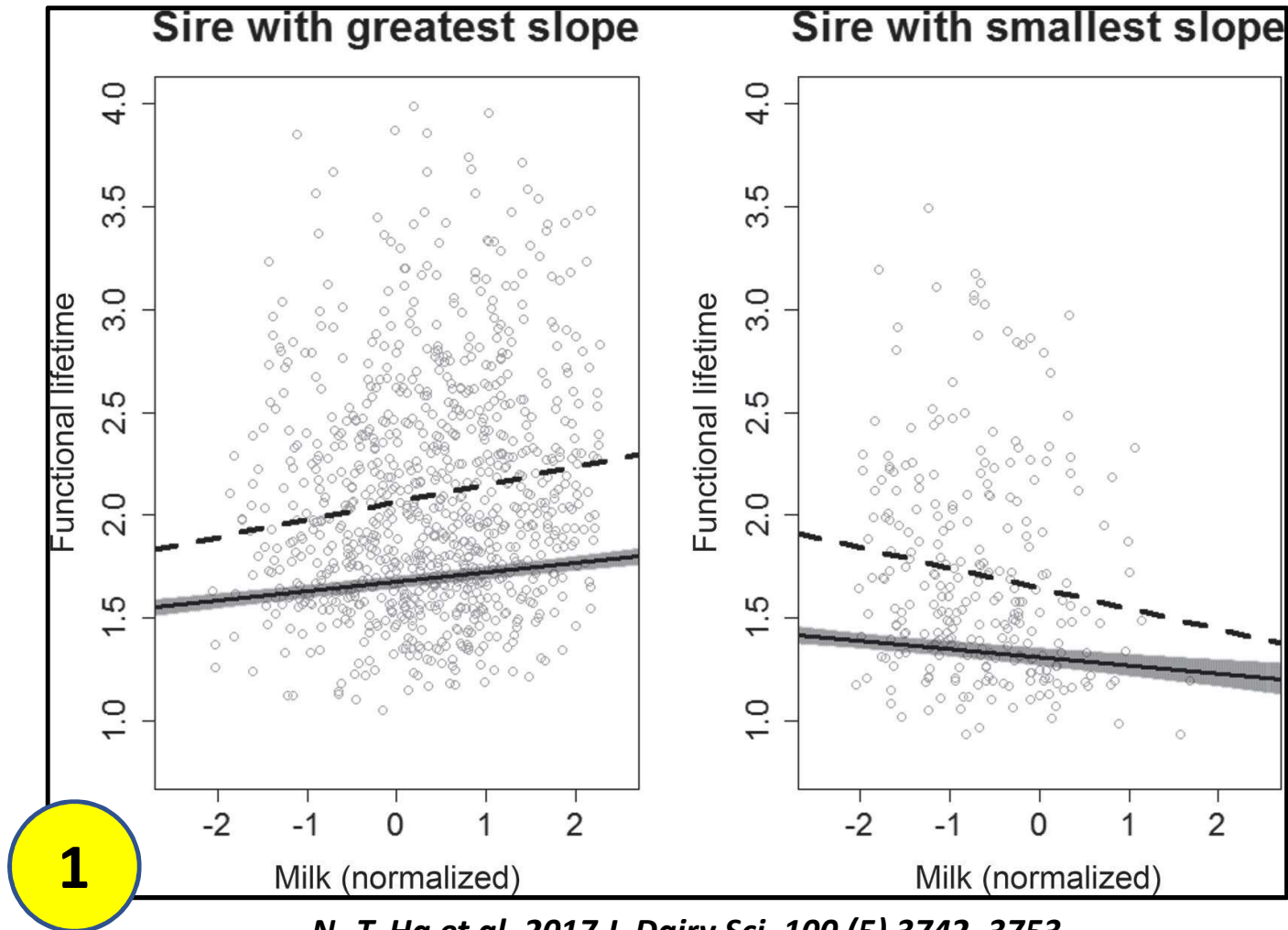


Future: Do cows have to lose weight to have high yields?



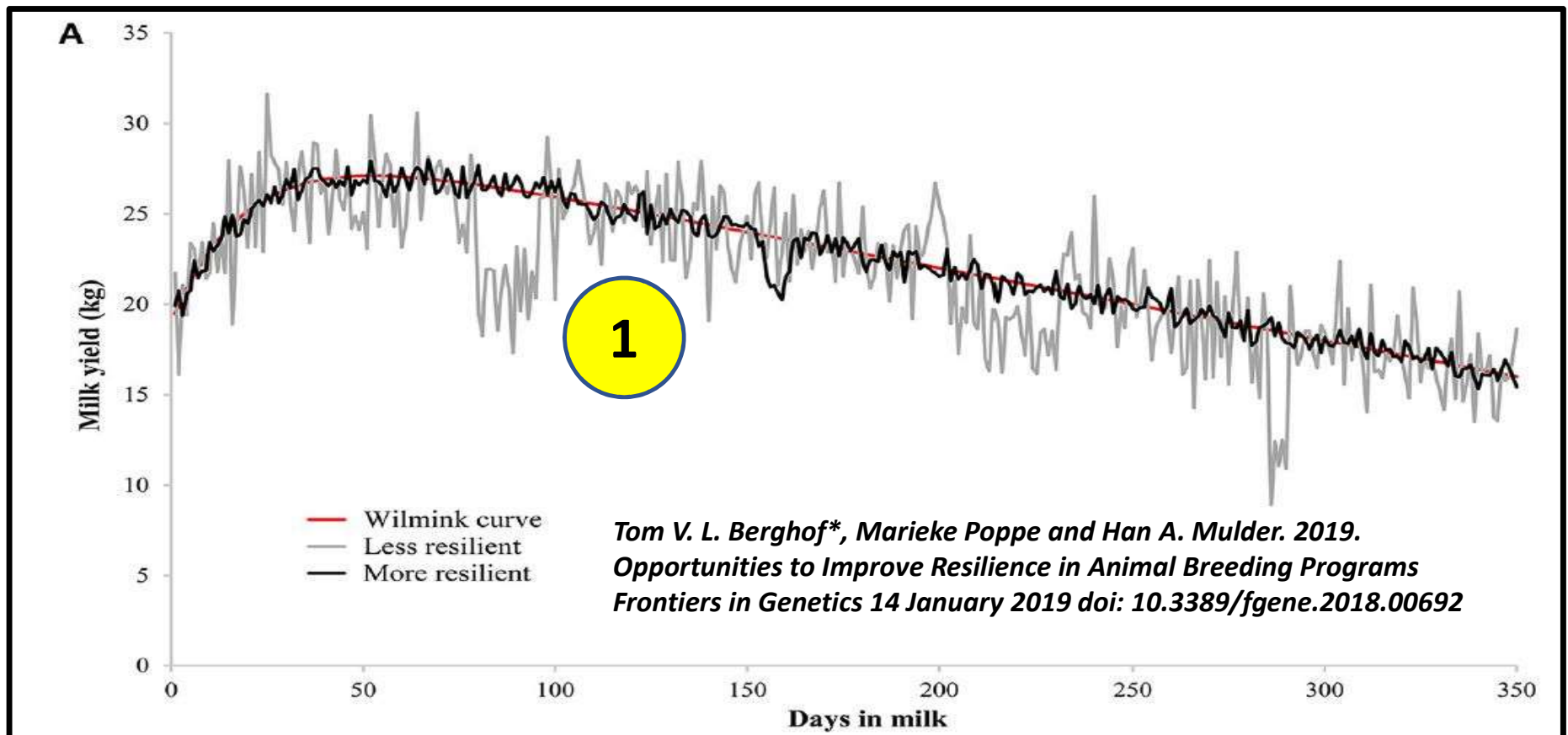
M. Zachut and U. Moallem. 2017. J. Dairy Sci. 100 (4) 3143–3154

Future: Will some bulls produce daughters that are more robust?



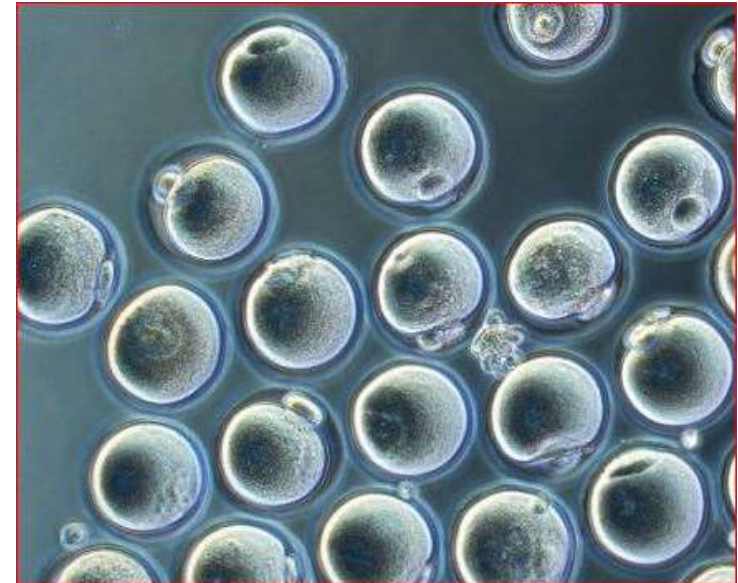
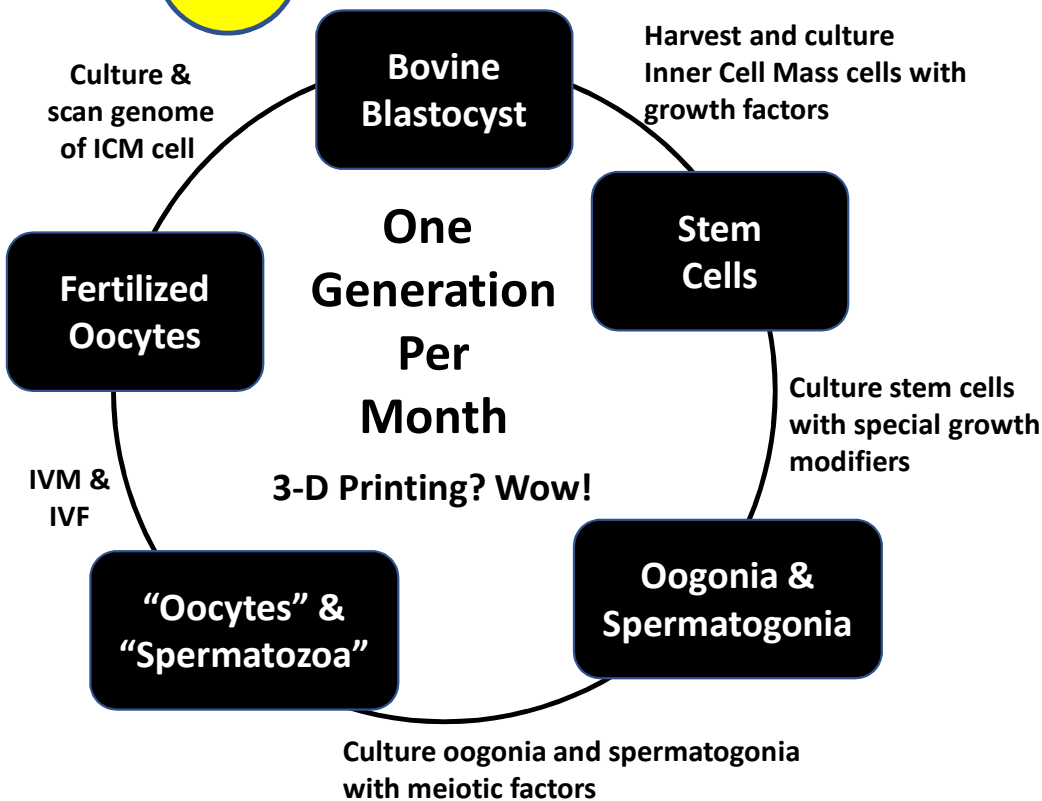
N.-T. Ha et al. 2017 J. Dairy Sci. 100 (5) 3742–3753.

Resilience: Example of genetic resilience through variation in a trait.



*Creating line: **Breeding in the petri dish?***

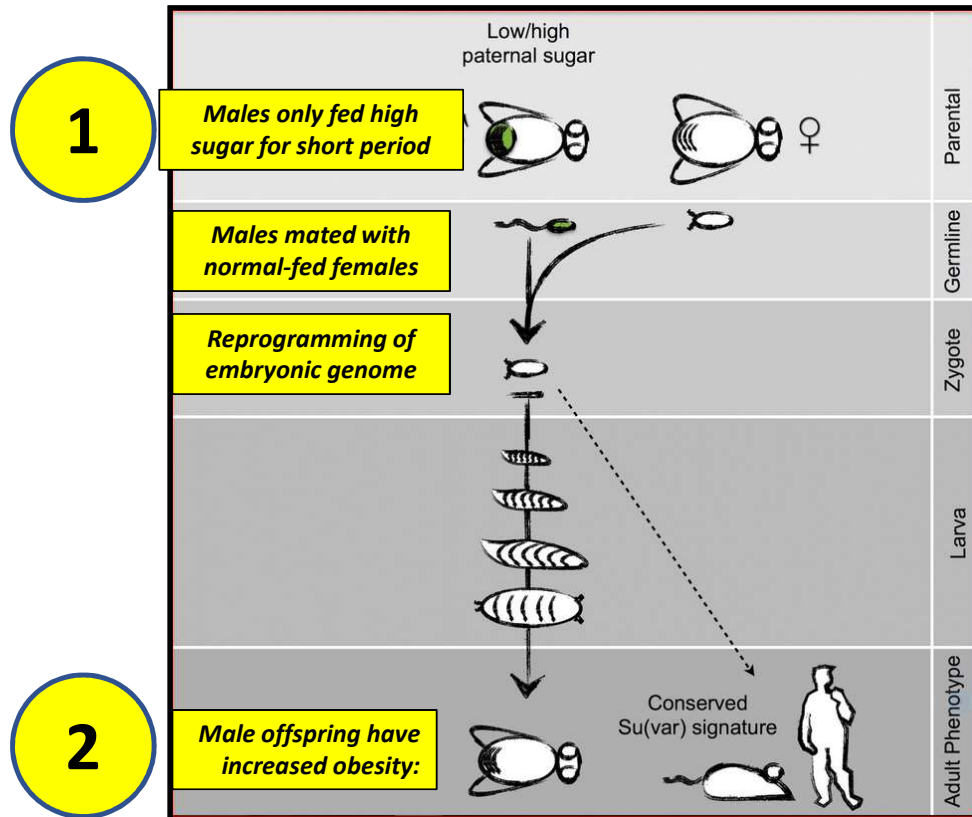
1



O. Hikabe et al. 2016. Reconstitution in vitro of the entire cycle of the mouse female germ line. Nature 539: 299–303

Source: <https://www.the-scientist.com/?articles.view/articleNo/47256/title/From-Stem-Cell-to-Oocyte-In-a-Dish/>

Managing epigenome: *Feed bulls differently in the future to affect progeny?*



Ost, A. et al (2014). Paternal Diet Defines Offspring Chromatin State and Intergenerational Obesity. *Cell* 159(6): 1352–1364.

Many epigenetic strategies

Precise
Nutrition

DNA
Regulators

Environ-
mental
Control

Stem Cell
Transfers

Looking ahead: Managing the microbiome to benefit crops and cows.

Agronomic



Environmental



Cow Specific



Therapeutic



1

Thank You for this Opportunity

