A Daring Future Awaits

Strategic background, the meaning of food, supply and demand issues, environmental dominance, the “rise of the machines”-AI, and coming supply chain issues are just the beginning

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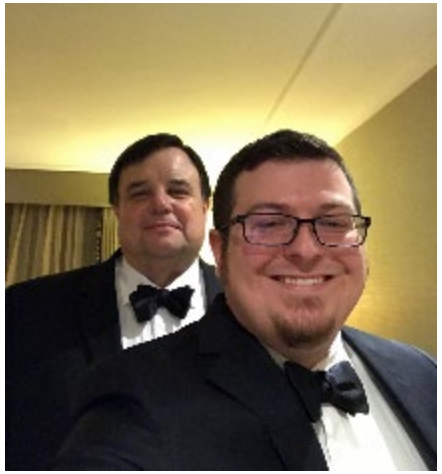

Dennis DiPietre, PhD, Economist
Lance Mulberry, BA, Economist

Characteristics and Challenges of the New Food Environment

I. The meaning of food is changing

II. Rising per capita income means more meat demand

III. Increasing and highly volatile input costs however reduce profits and eventually push down quantity demanded

IV. Temporary unavailability of key inputs

V. Market disruptions and closures (including export/import) and shipping ports and narrow straits (e.g., the Panama and Suez Canals)

VI. China's Future (looking not so bright) is a big Wildcard

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VI. China's Future (looking not so bright) is a big *d*

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How meat production is evolving with changing demand

Illustrated with pig production but is the SAME for all meat production

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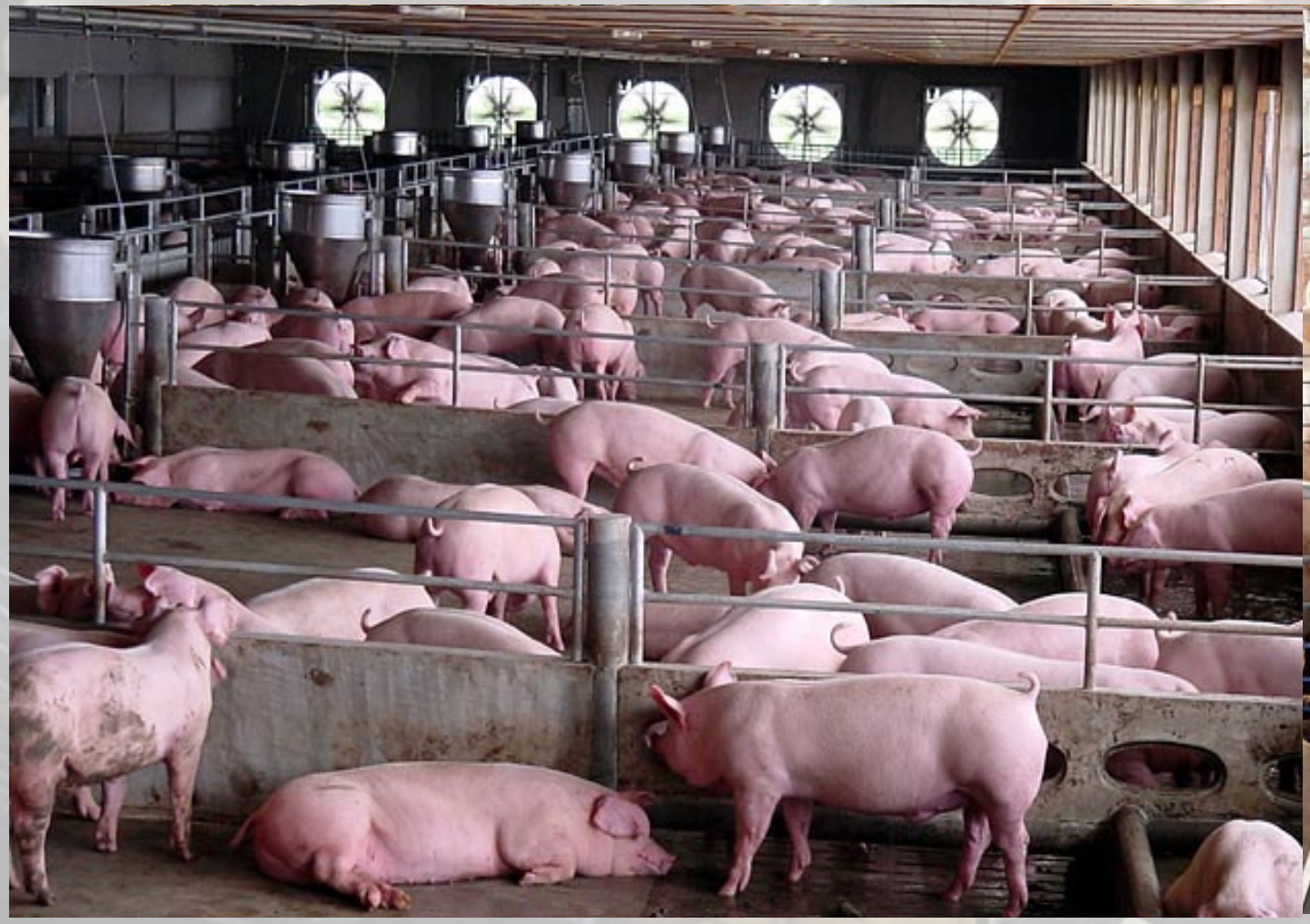
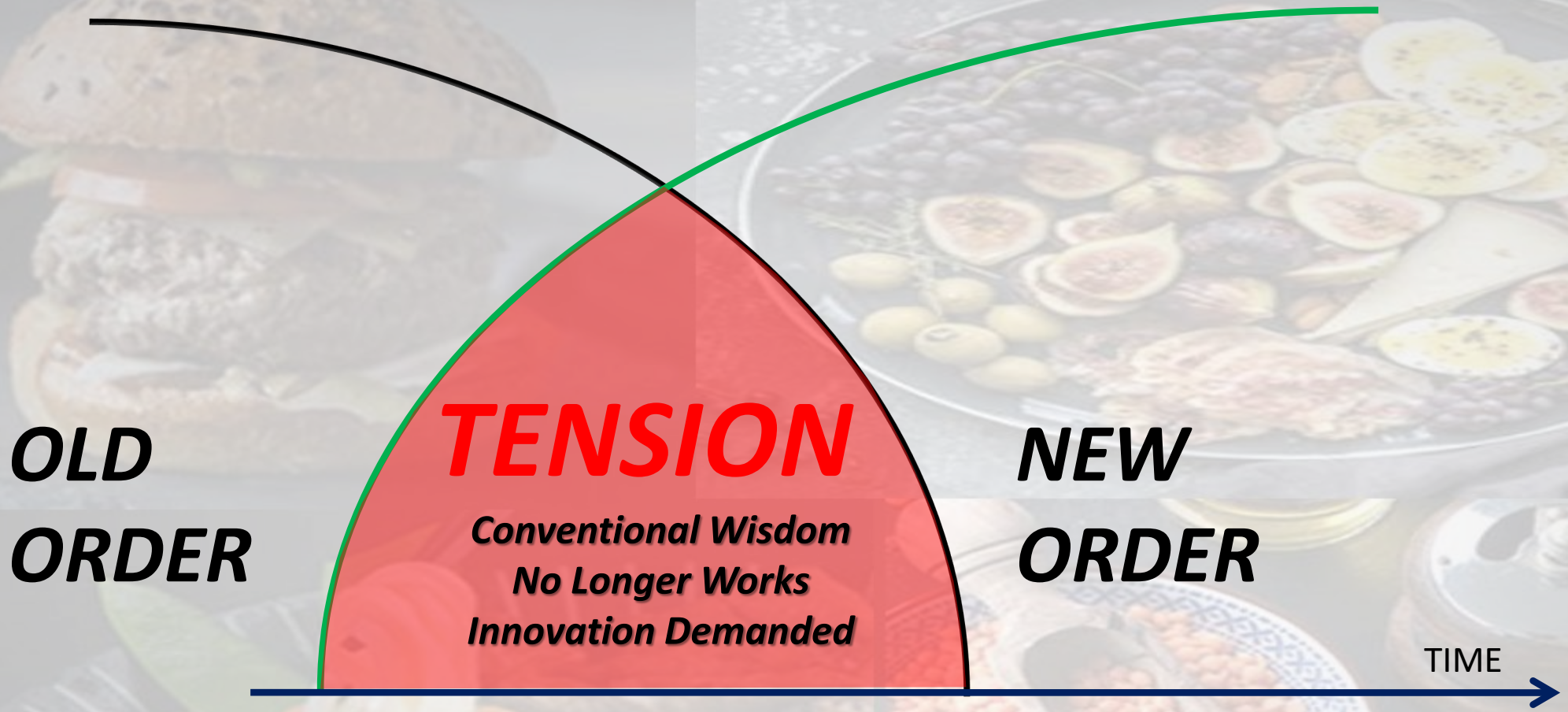
Mega Trend Shifts Since 1990

Mega Trend Shifts Since 1990



Mega Trend Shifts Since 1990



Pigs Meat Food Attributes

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The Next Megatrend?

Food Company Attributes

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Food Company Attributes

- Locus of Control and Influence Moves to Governments Acting Through Large Food Companies who Cooperate to Maintain Access
- ESG; (E)nvironmental, (S)ocial, and Corporate (G)overnance are three overarching company policy attributes which are believed to attract future investors and government blessings. There is a rush to complete a full blown, individualized expression of this by a large number of food and other companies.
- Will the close cooperation of governments and the global pork industry be producer friendly? Not likely.
- Companies will enforce government demands by forcing the requirements “downstream” as a condition of producer sales.

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Politicization is also changing consumer views

- “EFFICIENCY” No Longer ONLY Consideration
- Externalities Must Be Internalized
- The Rise Of Ethical Arguments
- Ethics Trumps Science; Science hijacked to support ethics
- Climate, Slow Food, Obesity, Sustainability, Carbon Footprint, Community and Worker Impact, Systemic Racism, Intersectionality, The Five Freedoms, Market Structures, Animal welfare
- Justice Issues

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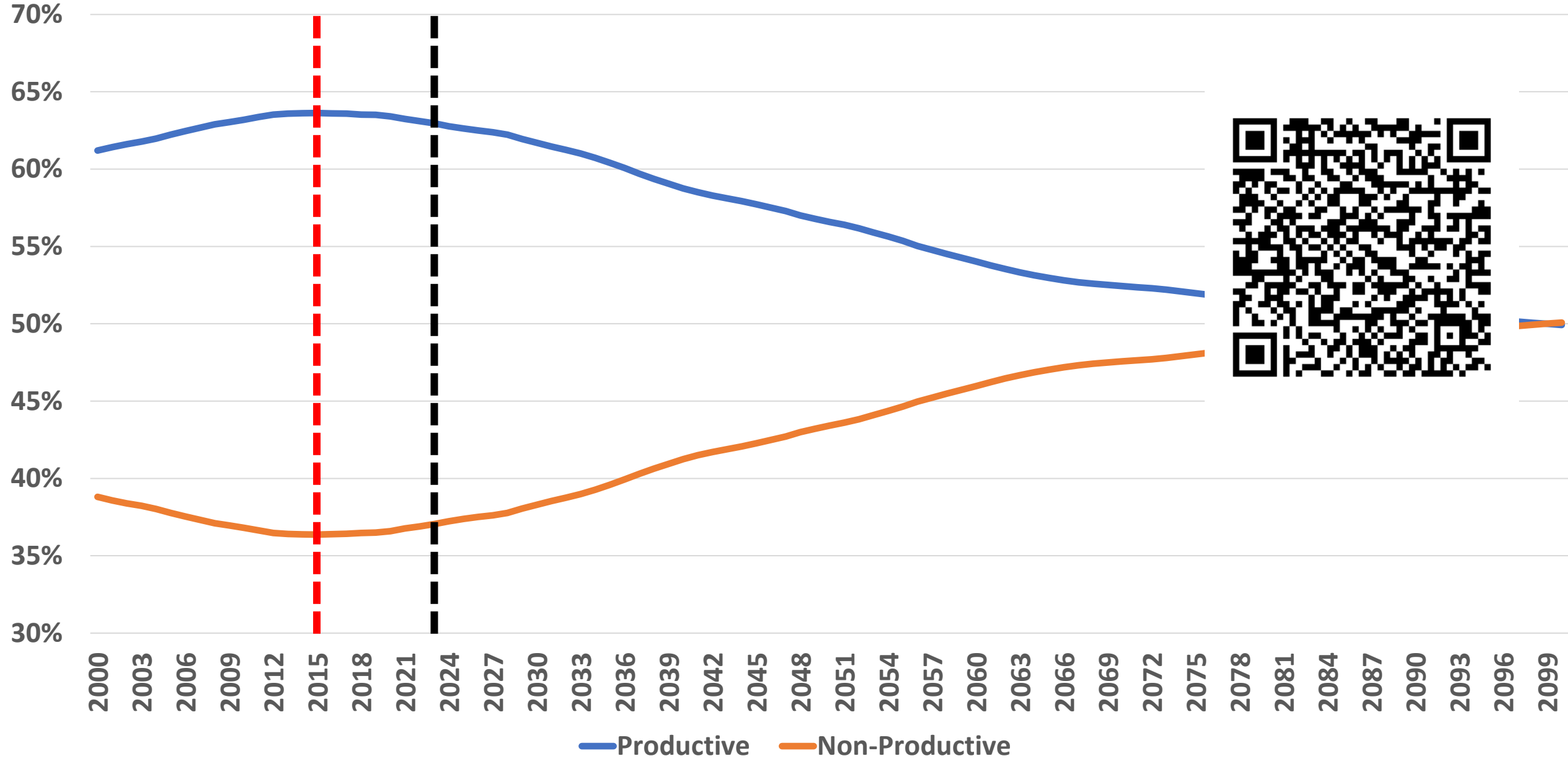
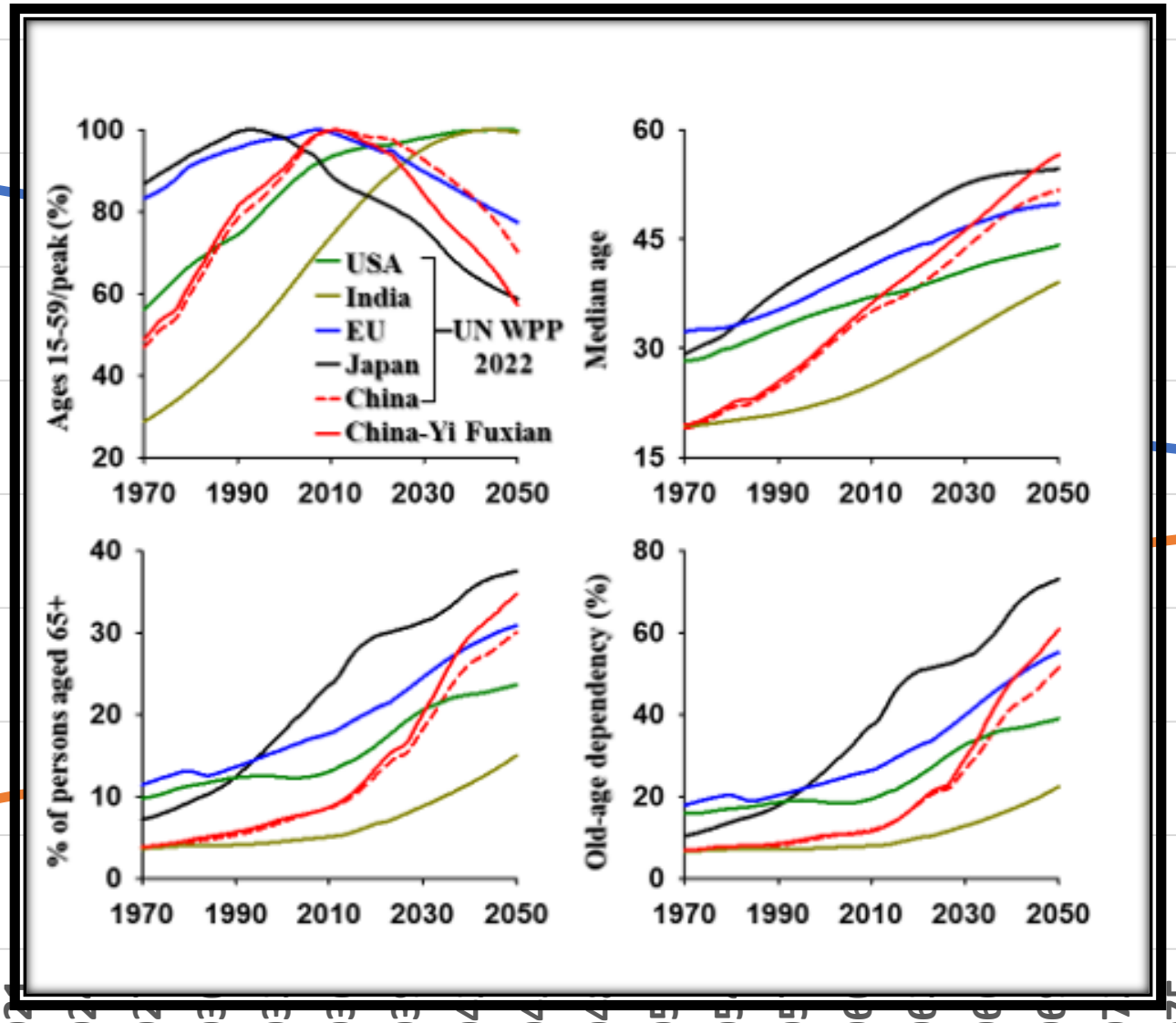
Rising Incomes NOT rising populations
create more demand for meat
AND
Age demographics from the major importing countries
favors less purchases over the next few decades

The Problem of Future Demand

Percent of Population at Productive Working Ages
Top 5 Importers of Pork Outside of NA



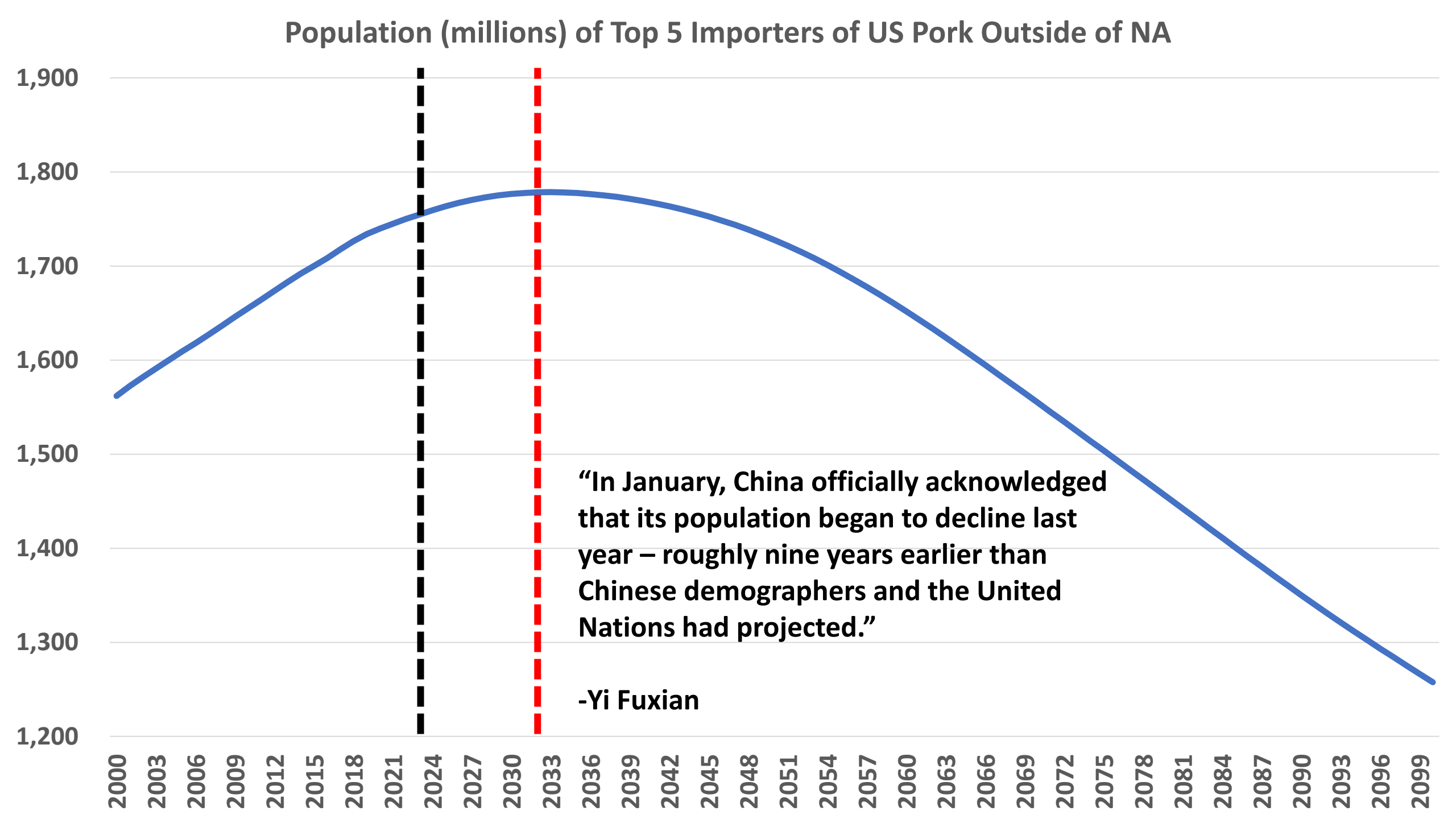
Percent of Population at Productive Working Ages
Top 5 Importers of Pork Outside of NA

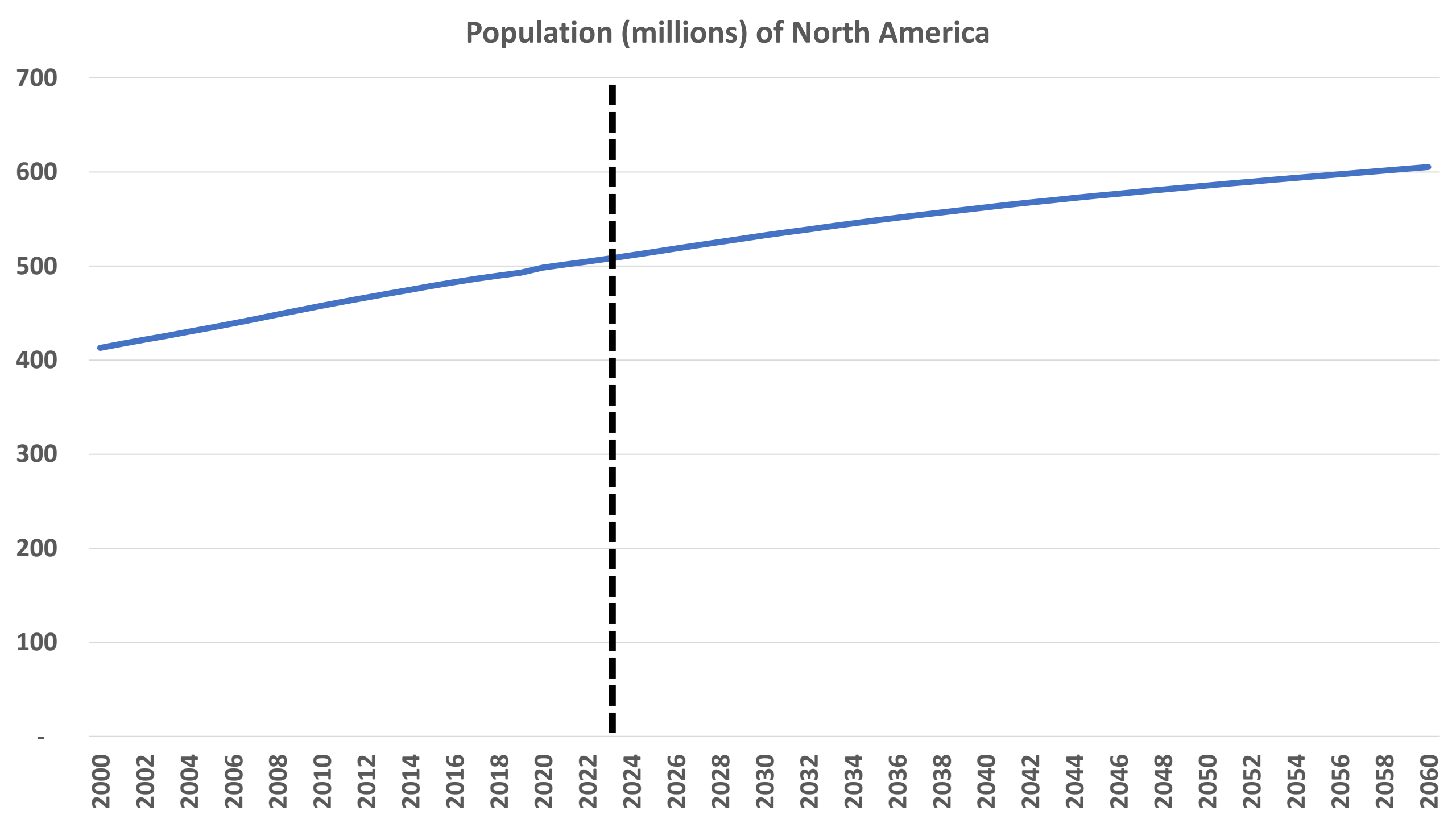


70%
65%
60%
55%
50%
45%
40%
35%
30%

2000 2003 2006 2009 2012 2015 2018 2021 2024 2027 2030 2033 2036 2039 2042 2045 2048 2051 2054 2057 2060 2063 2066 2069 2072 2075 2078 2081 2084 2087 2090 2093 2096 2099

Productive
Non-Productive


Population (millions) of Top 5 Importers of US Pork Outside of NA
1,900
1,800
1,700
1,600
1,500
1,400
1,300
1,200
2000
2003
2006
2009
2012
2015
2018
2021
2024
2027
2030
2033
2036
2039
2042
2045
2048
2051
2054
2057
2060
2063
2066
2069
2072
2075
2078
2081
2084
2087
2090
2093
2096
2099
“In January, China officially acknowledged that its population began to decline last year – roughly nine years earlier than Chinese demographers and the United Nations had projected.”
-Yi Fuxian


Population (millions) of North America
700
600
500
400
300
200
100
-
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
2024
2026
2028
2030
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2050
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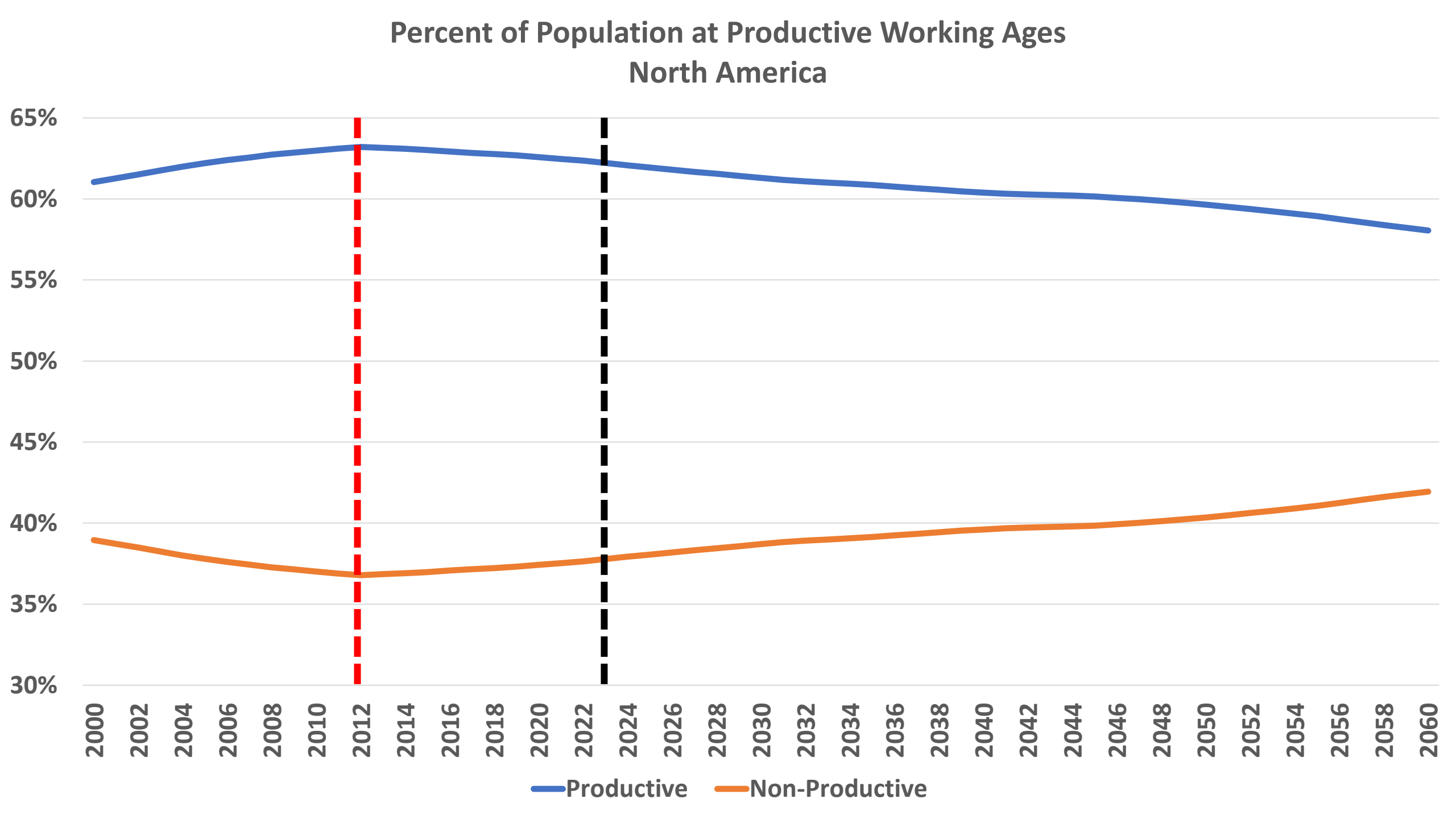
2054
2056
2058
2060


Percent of Population at Productive Working Ages
North America
65%
60%
55%
50%
45%
40%
35%
30%
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
2024
2026
2028
2030
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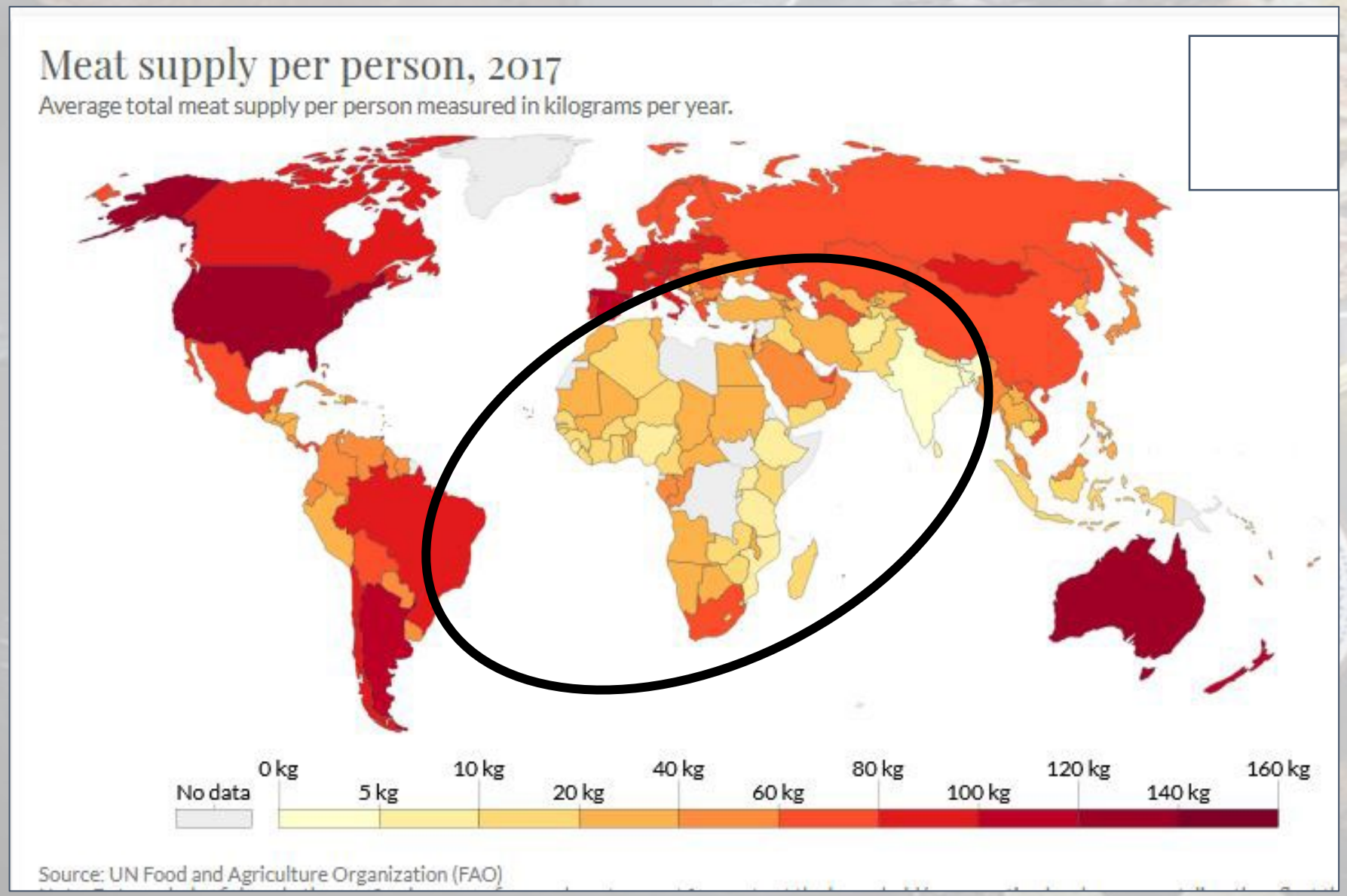
2056
2058
2060
Productive
Non-Productive

Population Growth Rates

Rate of natural increase by country (2018)

Source: Populationeducation.org

Meat Supply/Capita



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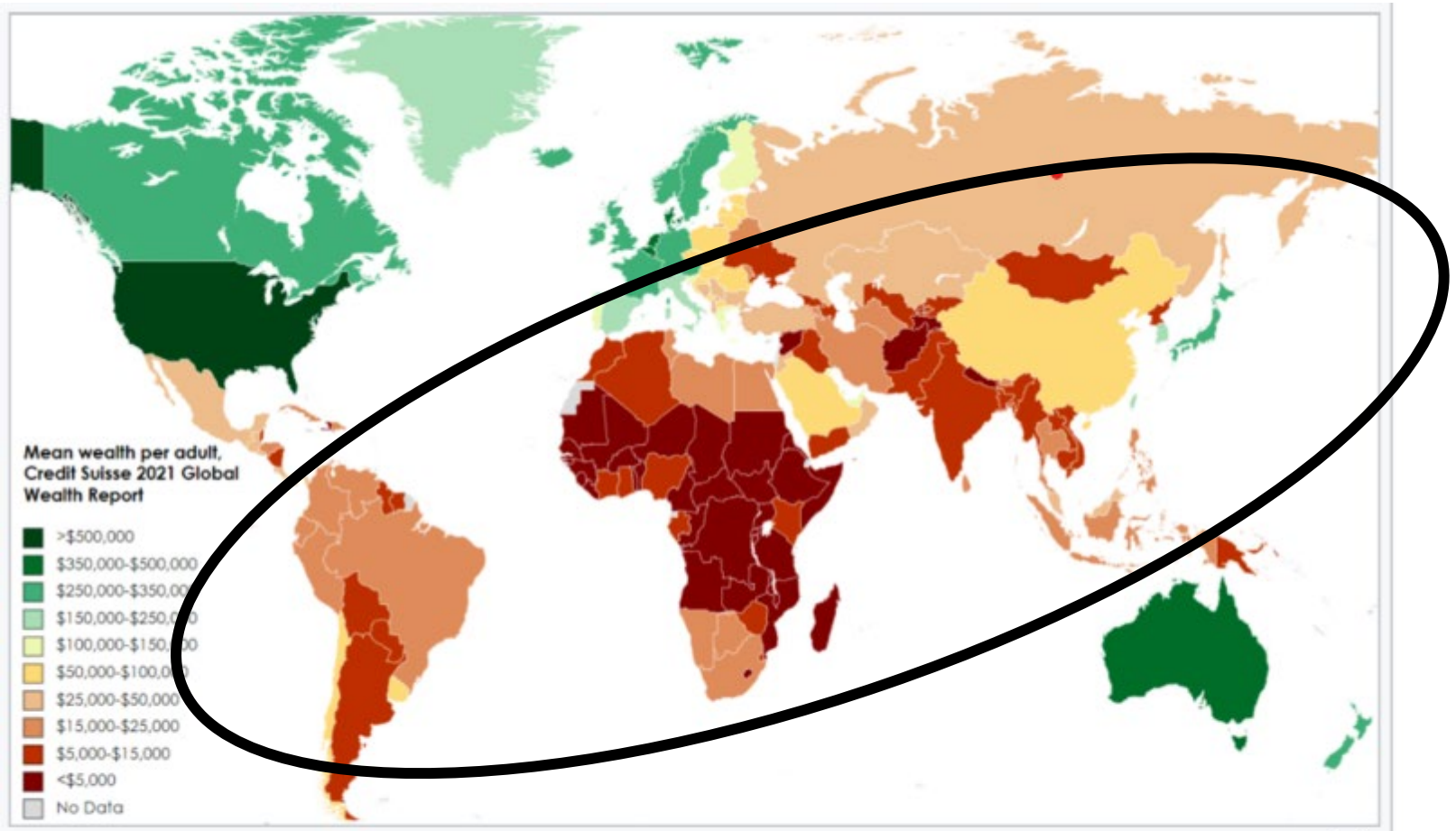
Mean Wealth Per Adult, 2021



Countries by **mean** wealth (US dollars) per adult. From 2021 publication of Credit Suisse.

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How most of the world builds the essential amino acid requirements of their diet without meat

A legume and a source of carbohydrates

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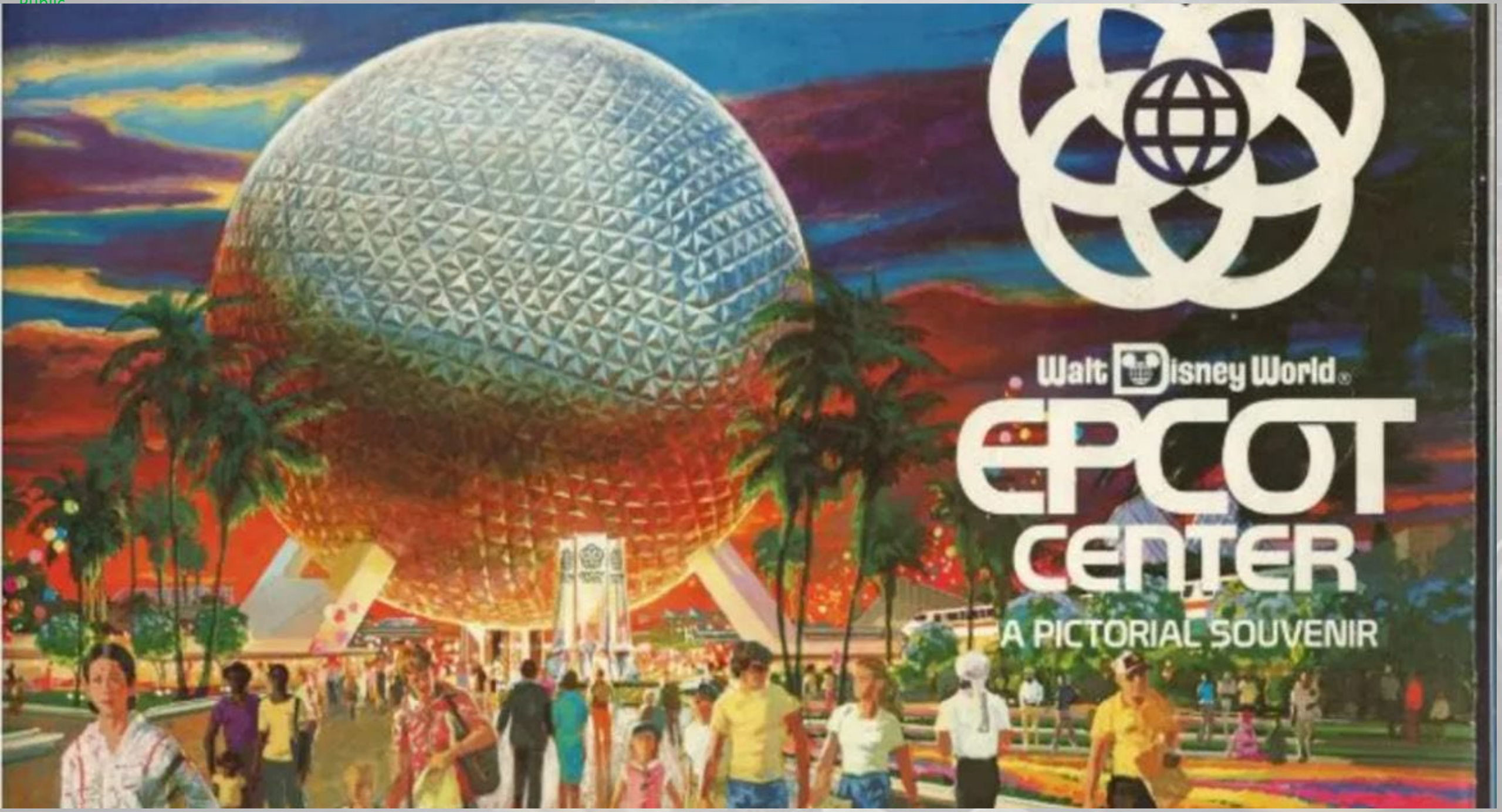
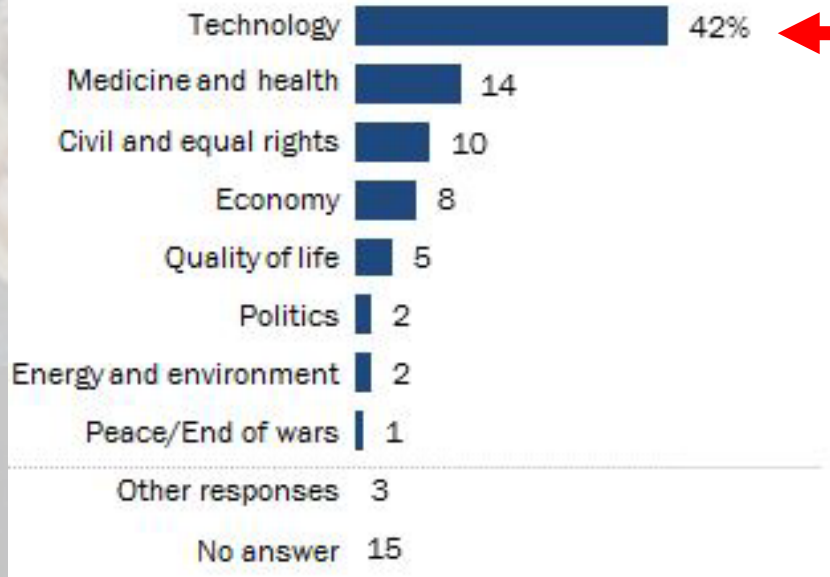
Our changing view of science and technology



Looking back: Biggest improvement to life in the past 50 years

% of U.S. adults who said the biggest improvement to life in America over the past 50 years or so was related to ...

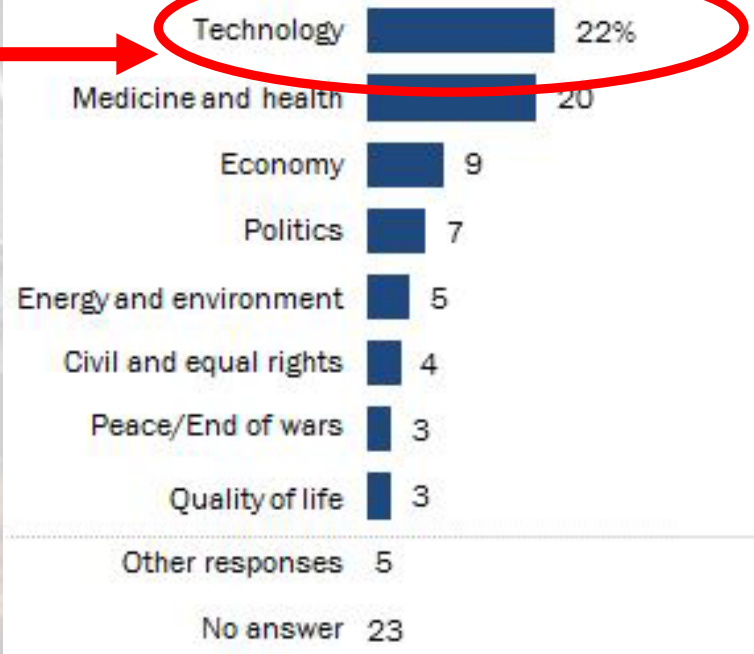


Note: Verbatim responses are coded into categories; figures are based on combining related codes into NET categories. Figures add to more 100% because multiple responses were allowed.
Source: Survey of U.S. adults conducted May 30-June 12, 2017.

PEW RESEARCH CENTER

Expectations for the biggest improvement to life in the future

% of U.S. adults who said the biggest improvement to life in America over the next 50 years would be related to ...



Note: Verbatim responses are coded into categories; figures are based on combining related codes into NET categories. Figures add to more than 100% because multiple responses were allowed.
Source: Survey of U.S. adults conducted May 30-June 12, 2017.

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Industrial production giving way to precision and regenerative technologies which support ESG goals

Visions of the Future are Changing

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Industrial Vs Precision Models

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Source: USDA

Industrial Vs Precision Models

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Source: USDA

Tomatoes grown by WDW Epcot Center for restaurants on-site using precision tech

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The Meaning of Food

Alternative protein makers are positioning their products in the meaning of food

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Chinese companies are rolling out fake meat mooncakes this Mid-Autumn Festival

Source: Quartz Online

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Animal Sentience (EU 1999)

This changes everything and is positioned as compelling by Alternative protein makers

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The Five Freedoms Forming the basis of Animal Welfare Policy by the EU

- **Freedom from hunger and thirst** - access to fresh water and a diet for full health and vigor,
- **Freedom from discomfort** - an appropriate environment with shelter and comfortable rest area,
- **Freedom from pain, injury and disease** - prevention or rapid treatment,
- **Freedom to express normal behavior** - adequate space and facilities, company of the animal's own kind,
- **Freedom from fear and distress** - conditions and treatment which avoid mental sufferings

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Risky pathways of the modern meat industry in response to animal welfare criticism

- If next technology lowers cost, it automatically is welfare superior
- Rearranging housing and equipment (gestation crates, broiler density, battery cages, free range, etc.) will largely solve the problem
- Meat industry participants cannot articulate a fundamentally coherent ethics of modern meat production and consumption

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Message to the Consumer

*Industrial scale animal agriculture **is** cruelty to animals*

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Anti-Industrial Strategies Focus on Outlawing the Underpinnings of Scale

- **Use of Technology** (Animal Welfare, GMOs, etc.)
- **Use of Antibiotics** (Catastrophic Disease)
- **Use of Business Structures** (Packer Ownership Ban, COOL, Contracting, Captive Supply Contracts)
- **Use of Labor** (Selective Immigration Enforcement)
- **Use of Resources** (Manure As a Hazardous Waste)
- **Use of the Global Marketplace** (Carbon Footprint, Exports Cause Global Warming, Energy Use, Water Use)

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Traditional Meat branding

- Branding around technology
- Branding around assurances about no contamination
- Branding assurance regarding organic attributes
- Branding around origins (appellations) or genetics (Duroc)
- Branding around other attributes such as scale of production

uroc)

duction

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Newly available methods provide dramatic improvements in forecasting using prior data

The rise of machine learning/artificial intelligence

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Machine Learning

Algorithms* that can learn and adapt *without following explicit instructions*,

Using statistical models to analyze and draw inferences from patterns in data.

*set of rules to be followed in calculations or other problem-solving operations

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Precision Livestock Farming:

Economic Significance of Weight Variation and its Mitigation

PLUS

Optimizing Most Performance Metrics as Distributions Vs Single Pig Calculations

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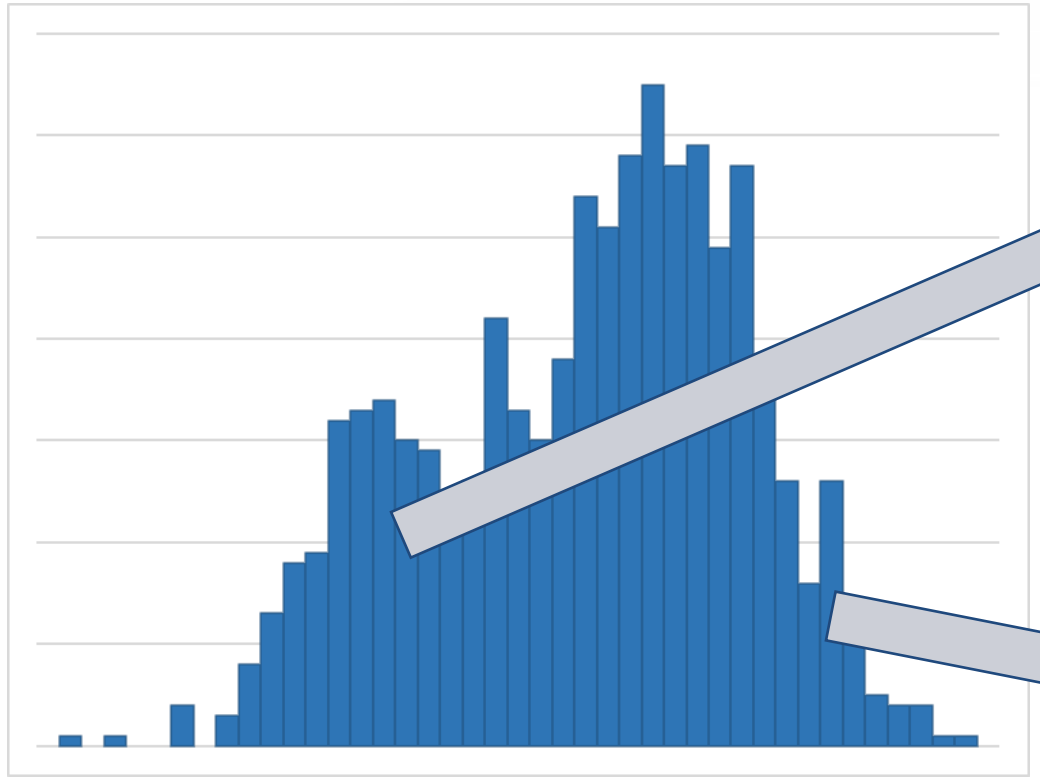
Profitability

The combination of asymmetric pricing structure and weight subpopulations allows for the accurate modeling of the cost of disease.



Typical Distribution of Finishing Pig Weights at First Marketing

Low Wgt	High Wgt	Discount
-	139	$ (18.71)
140	146	$ (14.62)
147	155	$ (11.82)
156	163	$ (8.08)
164	171	$ (3.37)
172	178	$ -
179	186	$ -
187	194	$ -
195	202	$ -
203	209	$ -
210	218	$ -
219	225	$ (1.33)
226	233	$ (2.67)
234	240	$ (4.67)
241	248	$ (7.00)
249	255	$ (9.00)
256	263	$ (10.67)
264	271	$ (12.67)
272	500	$ (15.28)

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Primal Weight Distribution Created by Carcass Weight Variation

HAM	*HAM*	*Frequency*
25	25	0
27	27	0
29	29	0
31	31	0
33	33	2
35	35	32
37	37	141
39	39	633
41	41	1893
43	43	3045
45	45	2730
47	47	1132
49	49	324
51	51	57
53	53	4
55	55	2
57	57	2
59	59	0
61	61	0
	More	3

LOIN	*LOIN*	*Frequency*
25	25	0
27	27	0
29	29	0
31	31	7
33	33	36
35	35	185
37	37	731
39	39	2021
41	41	3172
43	43	2487
45	45	1048
47	47	257
49	49	46
51	51	3
53	53	2
55	55	2
57	57	0
59	59	0
61	61	0
	More	3

SHOULDER	*SHOULDER*	*Frequency*
20	20	0
22	22	1
24	24	2
26	26	11
28	28	49
30	30	293
32	32	1168
34	34	2975
36	36	3386
38	38	1602
40	40	42
42	42	73
44	44	8
46	46	3
48	48	2
50	50	1
52	52	0
54	54	0
56	56	0
	More	3

BELLY	*BELLY*	*Frequency*
10	10	0
12	12	0
14	14	1
16	16	6
18	18	46
20	20	438
22	22	1976
24	24	3957
26	26	2736
28	28	721
30	30	102
32	32	11
34	34	3
36	36	0
38	38	0
40	40	0
42	42	0
44	44	0
46	46	1
	More	2

CARCASS	*CARCASS*	*Frequency*
115	115	0
120	120	0
125	125	0
130	130	1
135	135	0
140	140	2
145	145	2
150	150	6
155	155	6
160	160	21
165	165	44
170	170	103
175	175	167
180	180	400
185	185	664
190	190	1007
195	195	1433
200	200	1640
205	205	1498
210	210	1166
215	215	811
220	220	491
225	225	262
230	230	137
235	235	79
240	240	37
245	245	14
250	250	6
	More	3

Deep analysis using AI allows

- The introduction of sensors and other individual animal data measurements
- Massive volumes of data, heretofore unusable, to produce a precision analysis of the production system
- The emergence of targeted interventions vs. whole barn treatments
- For farm specific optimization of processes now simply managed to industry-wide benchmarks
- Precision culling of breeding stock and prediction of the future need for replacement breeding stock
- Many other cost reduction and income enhancing actions

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Using AI to Understand Disease as a Dynamic Event Rather than a Static State

- ***Economics of Disease is rarely calculated correctly***
- ***It is usually more accurate to say that disease "emerges" in a farm rather than disease "breaks".***
- ***Disease emerges in a region, a building, a site, etc.***
- ***Disease emerges within an animal causing widely differing consequences over different time horizons***
- ***Disease can have different consequences by Parity of Sow, by birthweight within a litter, or sow condition for instance.***

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Subpopulation discovery and analysis facilitated by Machine Intelligence

An Example

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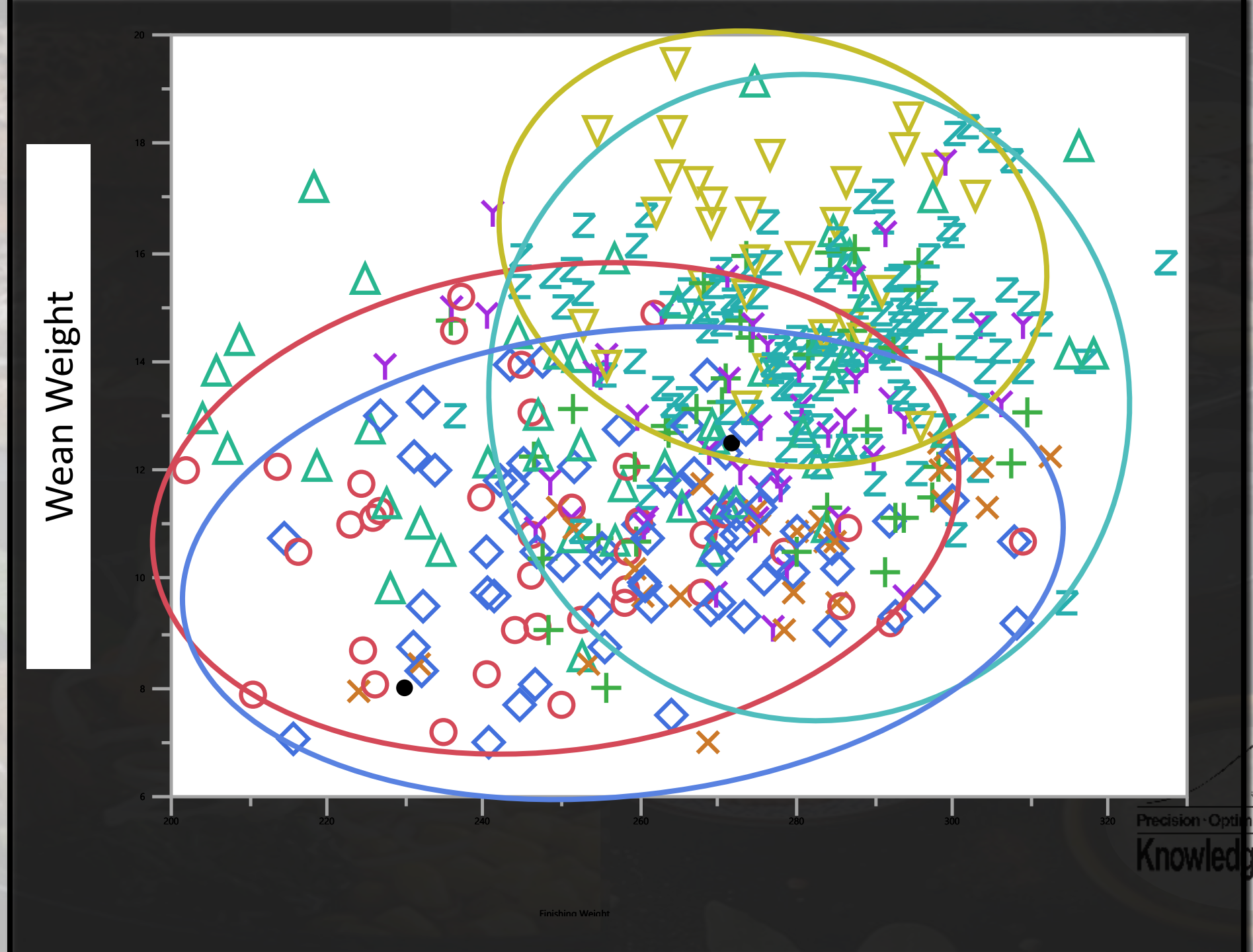

Data Issues Blocking Full Value of AI in Pig Production Systems

- Critical Data NOT Collected
- Critical Data UNABLE to be Collected because of SOP entrenchment
- Data is Being Fragmented and Made Unavailable by Capture in Diverse Technologies Which Manage One Aspect of Production
- Data Organization by Record Systems and Technology Providers Typically Push Out Summaries and Averages and Proprietary Reports
- Data Warehouse Concepts Not Well Developed or Deployed Yet
- Data Still Mostly Used for Reporting Functions Rather than Optimization

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Problems with How Data is Typically Used

- Data is often collected in order to solve a single specific problem
  - Example: Feed data used to indicate when to order more
- Frequently segregated in a way that makes cross referencing a challenge
  - Because data is collected for single purposes it is often stored separately and has no reference points for connecting them together
    - Example: Breeding and finishing data
- Saved in ways that make using them difficult to use
  - Handwritten records that are then stored in a filing cabinet
- Heavily summarized
  - Even when detailed data is collected (individual sow data), managers typically only see performance monitors or dashboards that aggregate everything into weekly or monthly averages

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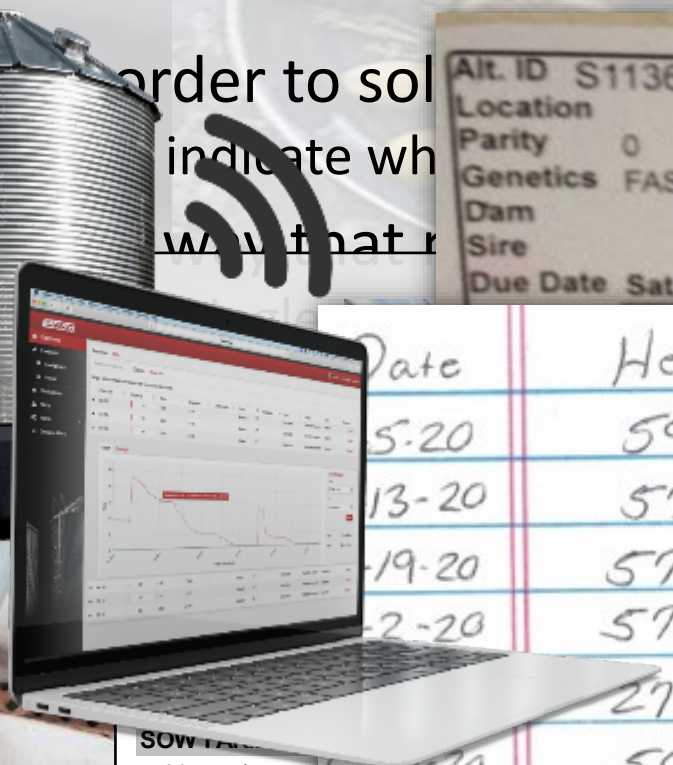
Problems with How Data is Typically Used

- Data is often col… order to sol…
  - Example: Feed … indicate wh…
- Frequently segre… w… that r…



Date	Head	Wgt	Ave	Age
5-20	582	36,879	63.40	10 wk
13-20	576	31,784	55.18	9 wk
19-20	576	28,627	49.69	9 wks
2-20	576	32,525	56.46	9 wks
	272	11,258	41.38	8 wk
20	504	19,807	39.29	8 wk
6-22-20	675	24,219 (Feeder Pigs)	35.88	8 wk

Alt. ID S1136
Location
Parity 0
Genetics FAST
Dam
Sire
Due Date Sat, Jun 02, 18

Boar Info.
02 01
Genetics FAST
Service Date Feb 07, 201…
Mating Group 18-06

	Gest Lgth	Born Alive	Brth Wght	Stl Born
Avg	115.3	14.2	1.5	0.8

Litters / mated						
Litters / female						
Pigs weaned						
Pigs weaned / female / yr (PWFY)	25.4	26.5	26.9	27.1	26.8	30.1
Pigs weaned / farrowing space / yr (PWCY)	154.7	161.2	165.1	164.6	162.9	183.4

Decision Power, Inc. 6_Default SFC SWINE (SwineBooks Pro)

Summary

- Rising cooperation between large oligopoly producer/processors and governments. Oligopolies develop ESG plans to assure governments and buy cooperation
- Meat demand is changing to support rising belief systems among the young. Attributes of Food Companies will be next big influencer
- If China growth continues to slow, worldwide demand will slow and bring global recession (meat demand stagnates)
- First efforts at fake meat were largely unsuccessful but firms have not given up! (The have insects and other (tissue cultured protein coming)

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Summary Continued

- Branding around food and food company attributes will rise and provide LARGE profitable niche opportunities
- Traditional meat production systems (especially large scale ones) will be under increasing pressure to reduce size and increase technological/innovation investments
- Climate mitigation and Animal welfare actions will bring hard decisions for producers and global (even intra-country) trade
- Machine algorithms (AI primarily neural nets) will provide stunning insight and pathways into cost reduction and income enhancement not currently available by standard analysis/records management etc.
- Most farms not ready for biggest advantages of AI due to chaotic data collection and management

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Thank you!