2018 ICBF and Sheep Ireland Genetics Conference – 20th Anniversary

Genetic Improvement of Cattle and Sheep
Focus on The Future

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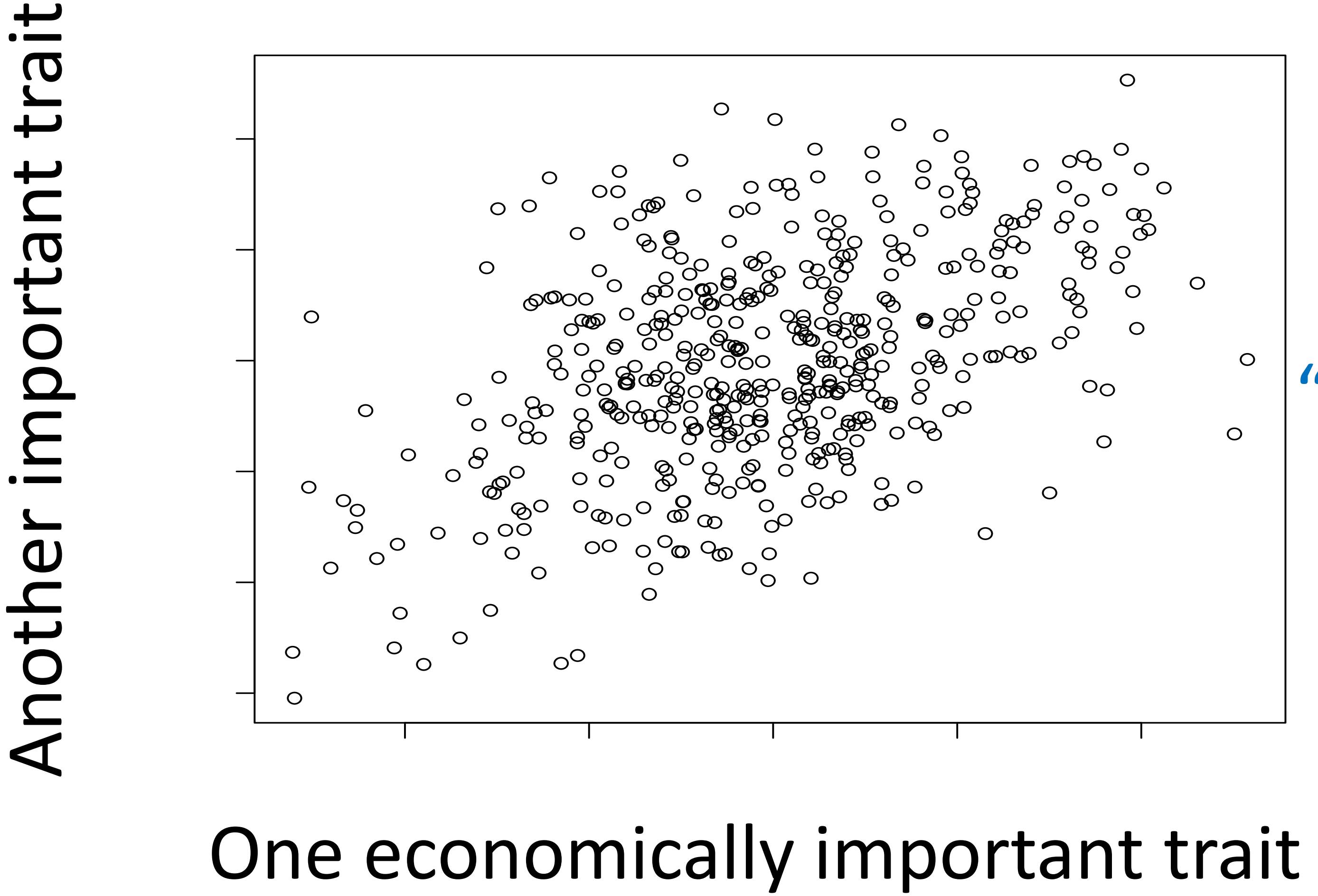
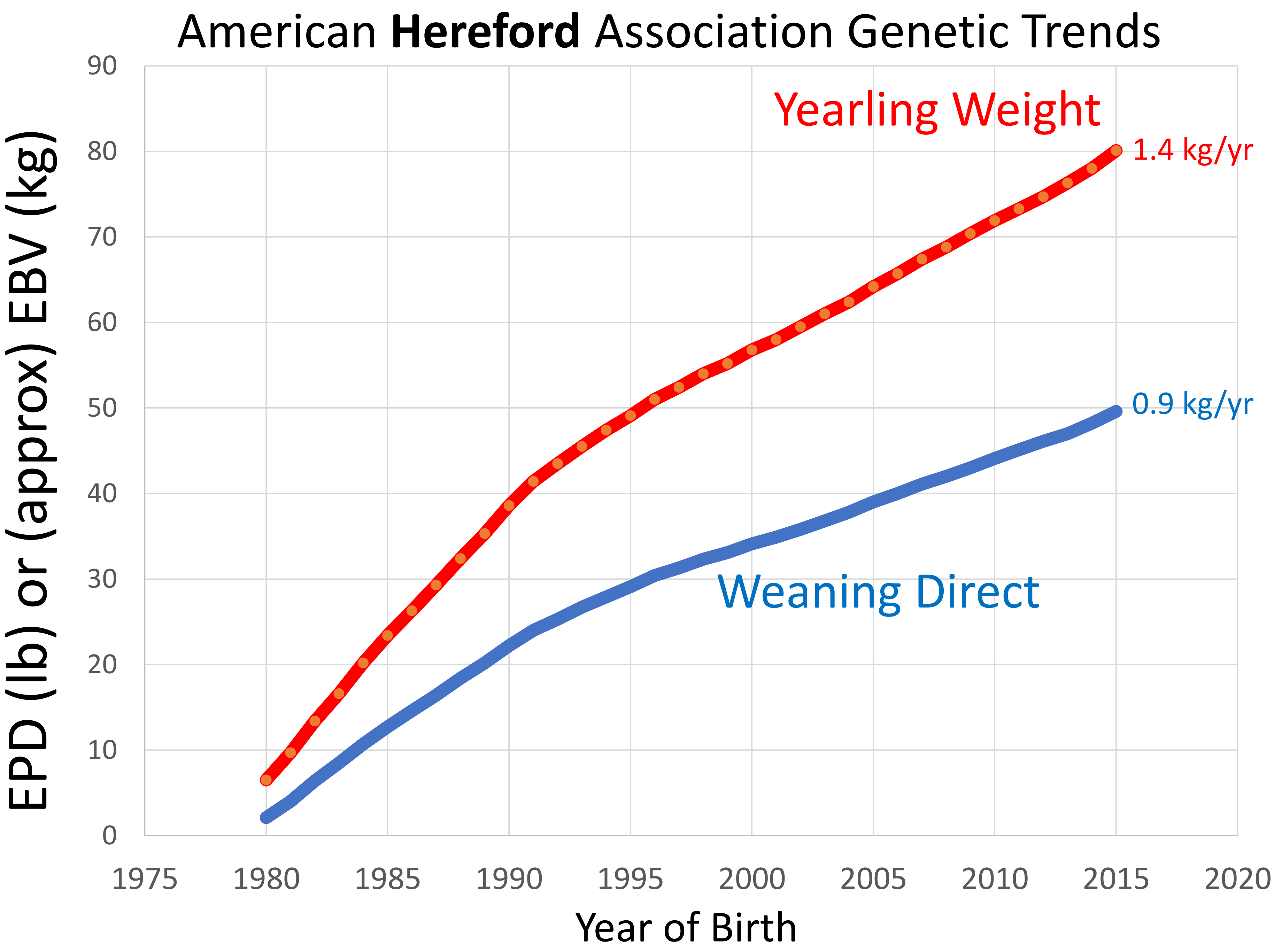
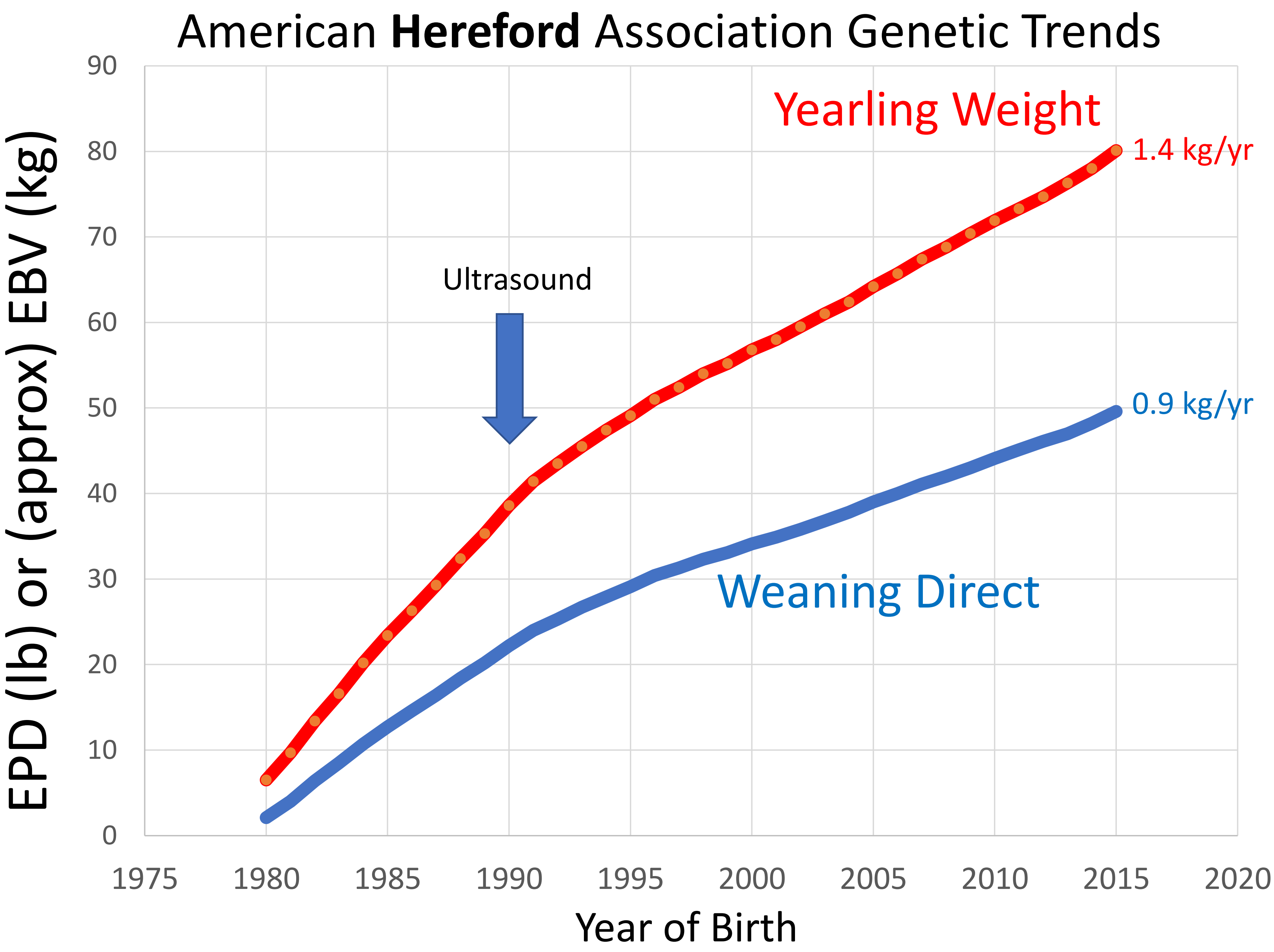
A Pool of Selection Candidates



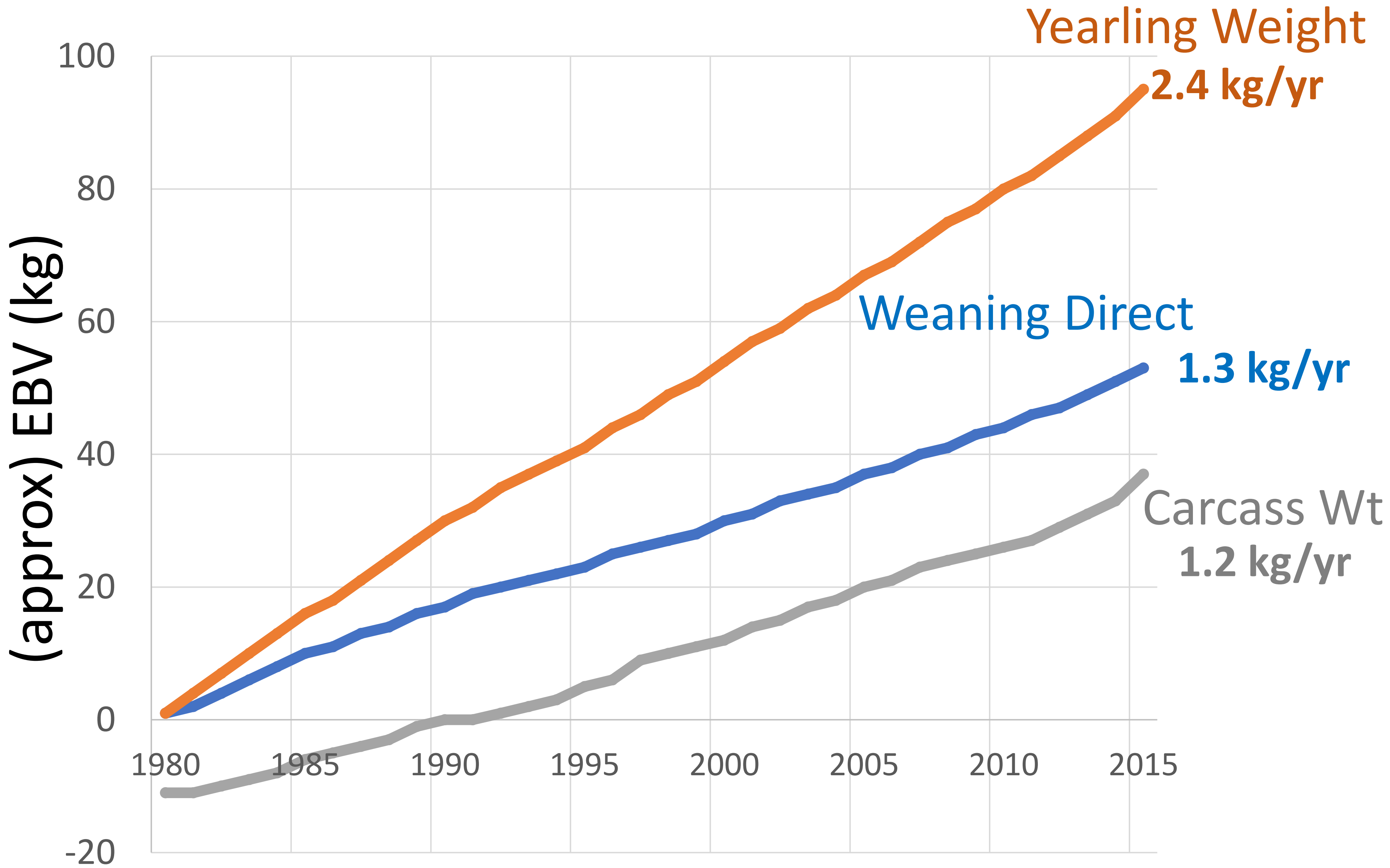
Selection
“moves the cloud”

Genetic change in offspring performance only occurs if Breeding Values (BVs) of parents are not average

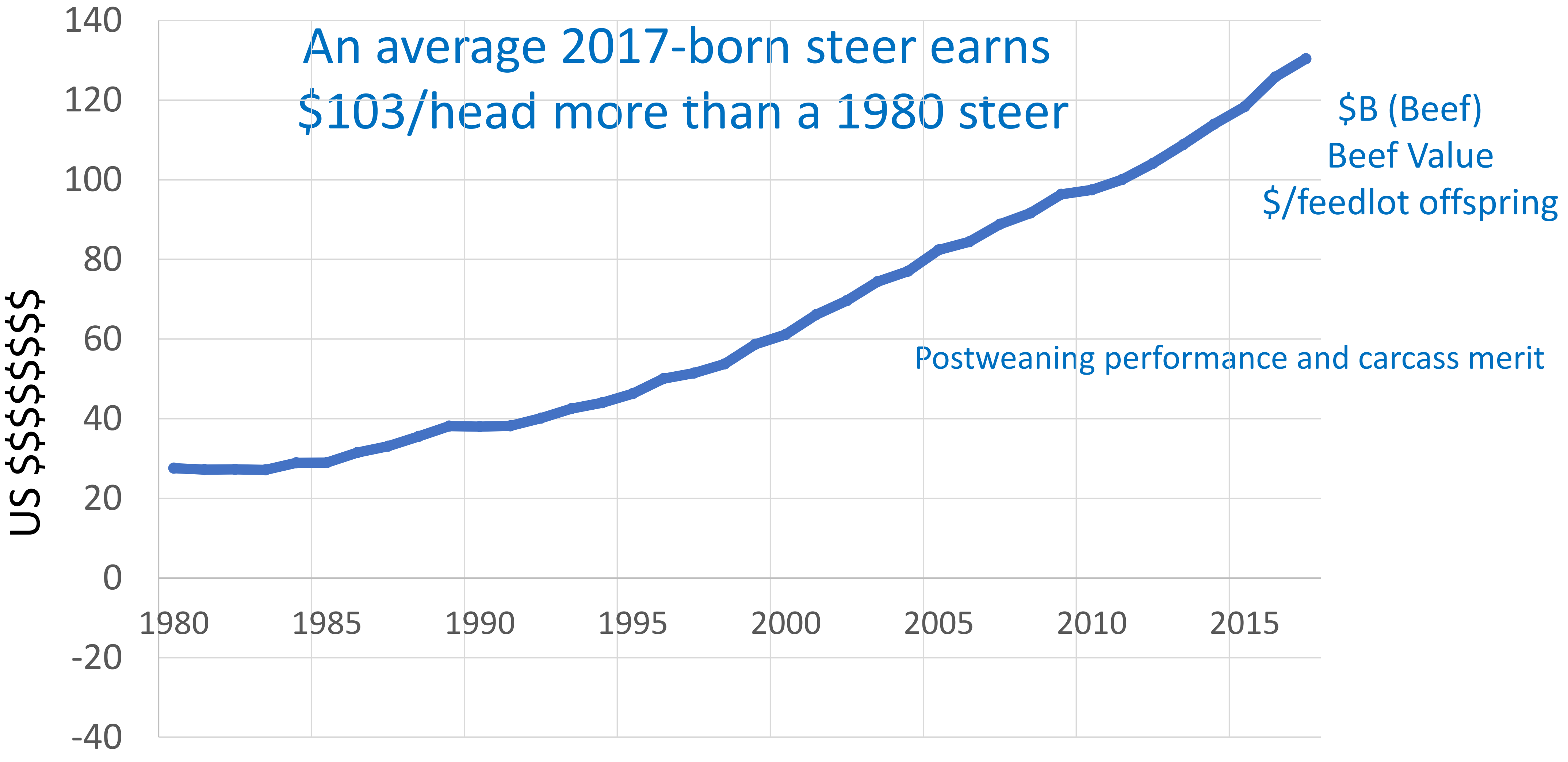

American Hereford Association Genetic Trends
Yearling Weight
1.4 kg/yr
0.9 kg/yr
Weaning Direct
EPD (lb) or (approx) EBV (kg)
Year of Birth
0
10
20
30
40
50
60
70
80
90
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020


American **Hereford** Association Genetic Trends
Yearling Weight
1.4 kg/yr
Ultrasound
Weaning Direct
0.9 kg/yr
EPD (lb) or (approx) EBV (kg)
Year of Birth
0
10
20
30
40
50
60
70
80
90
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

American **Angus** Association Genetic Trends



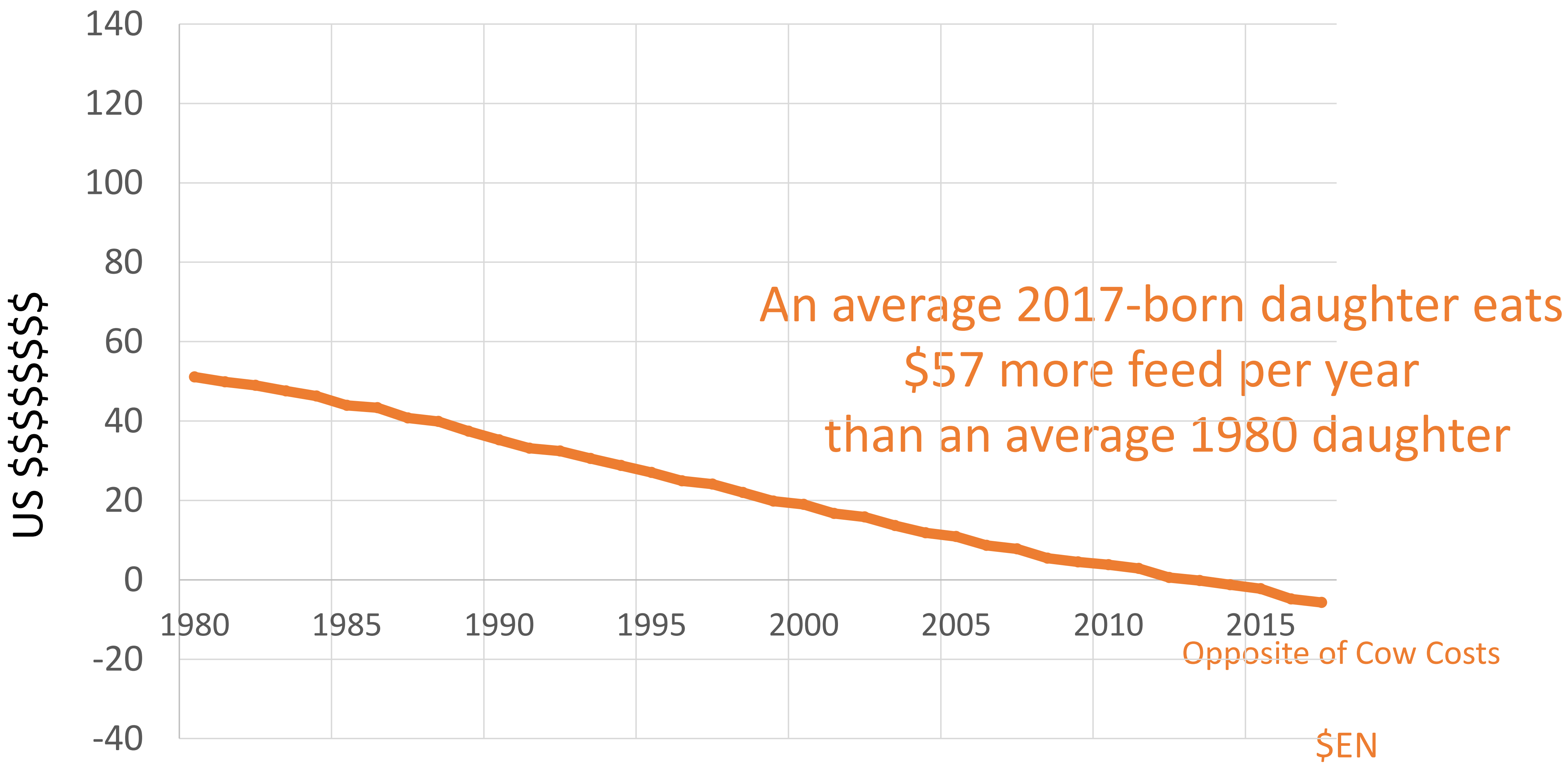
American **Angus** Association Genetic Trends



June 2018

Admirable progress on terminal traits

American **Angus** Association Genetic Trends



$EN
Cow Energy Savings
$/daughter/year

June 2018

Undesirable progress on maternal traits

American Angus Trends for cow-calf system

- An average 2017 daughter eats $57 more feed per year than an average 1980 daughter
  - Heavier liveweight
  - Higher milk production
  - Higher maintenance requirements
  - All of these costs are carried by the cow-calf operator
- An average 2017 feedlot offspring earns $103 more at slaughter due to improved postweaning performance and carcass characteristics
  - But cows don't produce feedlot offspring every year!
  - At least some of this benefit is captured by the feedlotter
- Collectively, for the cow-calf operator this is genetic change not improvement

What do you measure?

- Calving Traits
  - **Calving Ease** and **Birth Weight**
- Early Growth Traits
  - **Weaning Weights**
  - **Yearling Weights**
- Reproduction
- Ultrasound predictions of carcass traits
- Mature Cow Weights and Condition Scores
- Actual Carcass Characteristics
- Actual Feed Intake

Decreasing numbers of records

Measure it

Store it

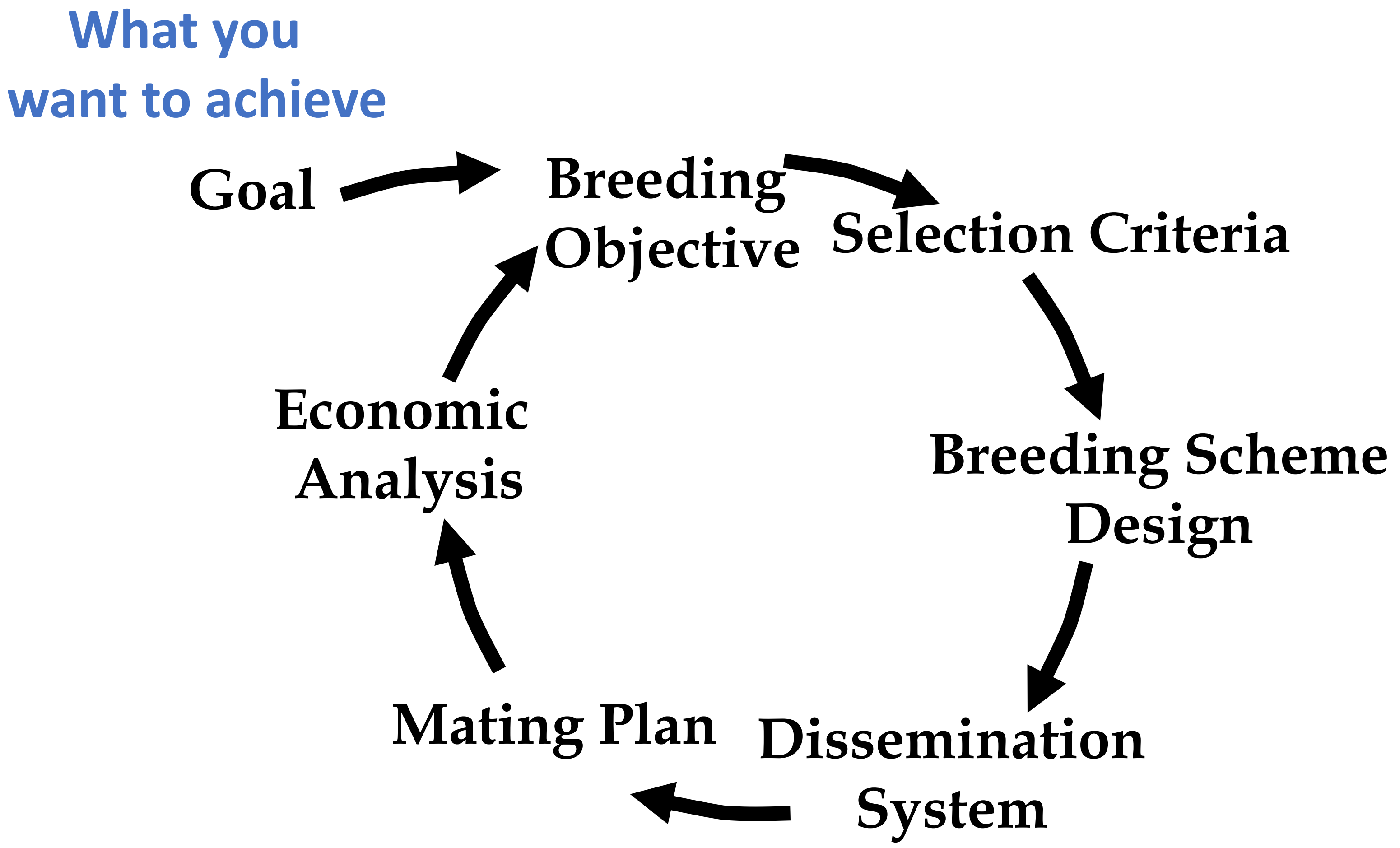
BLUP it

Report it

Market it

Principally tangible traits that are easy to measure and heritable so see in the next generation

Logical Approach to Design of a Breeding Program



Goal

If you’re not farming for profit, we’d like to wish you well with your hobby

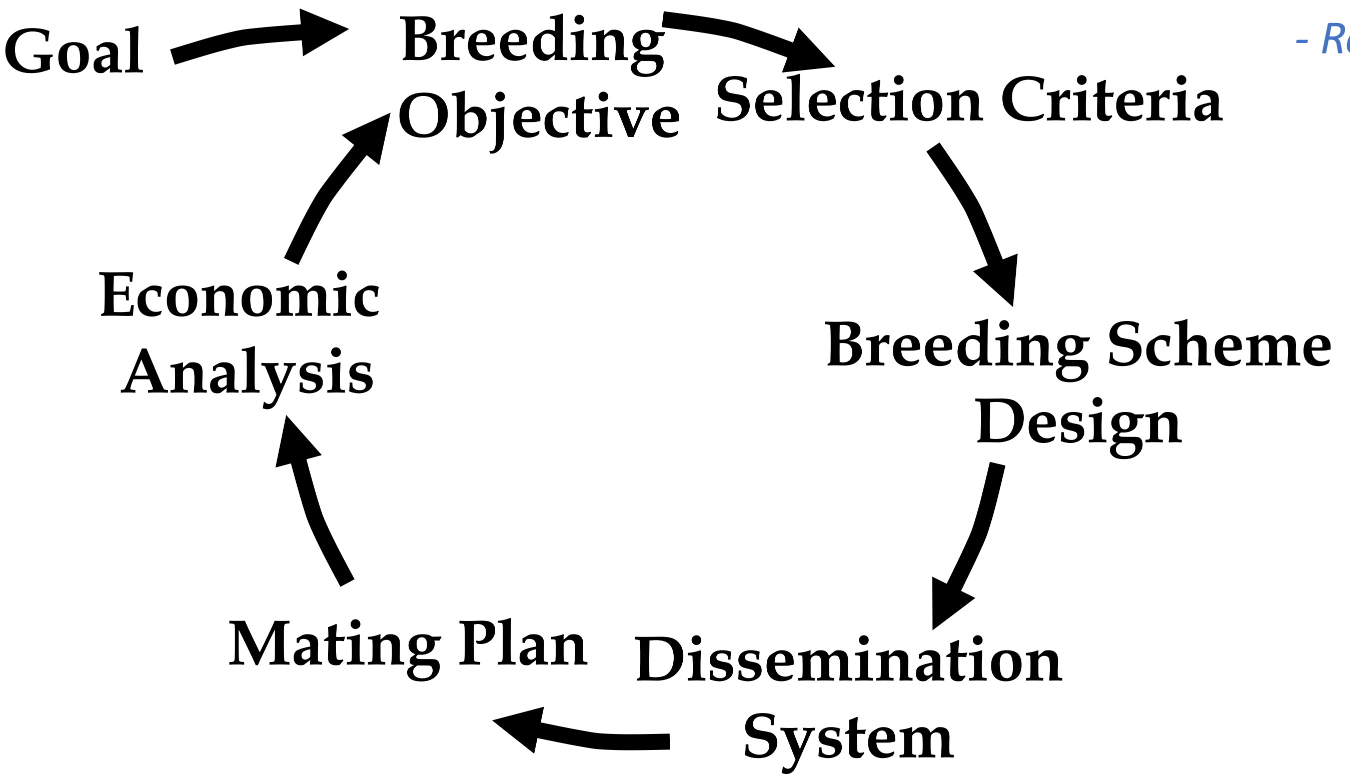
Livestock Improvement Corporation (LIC) in 1990’s

Goal

If you're not farming for sustainable prosperity, do something else

Logical Approach to Design of a Breeding Program

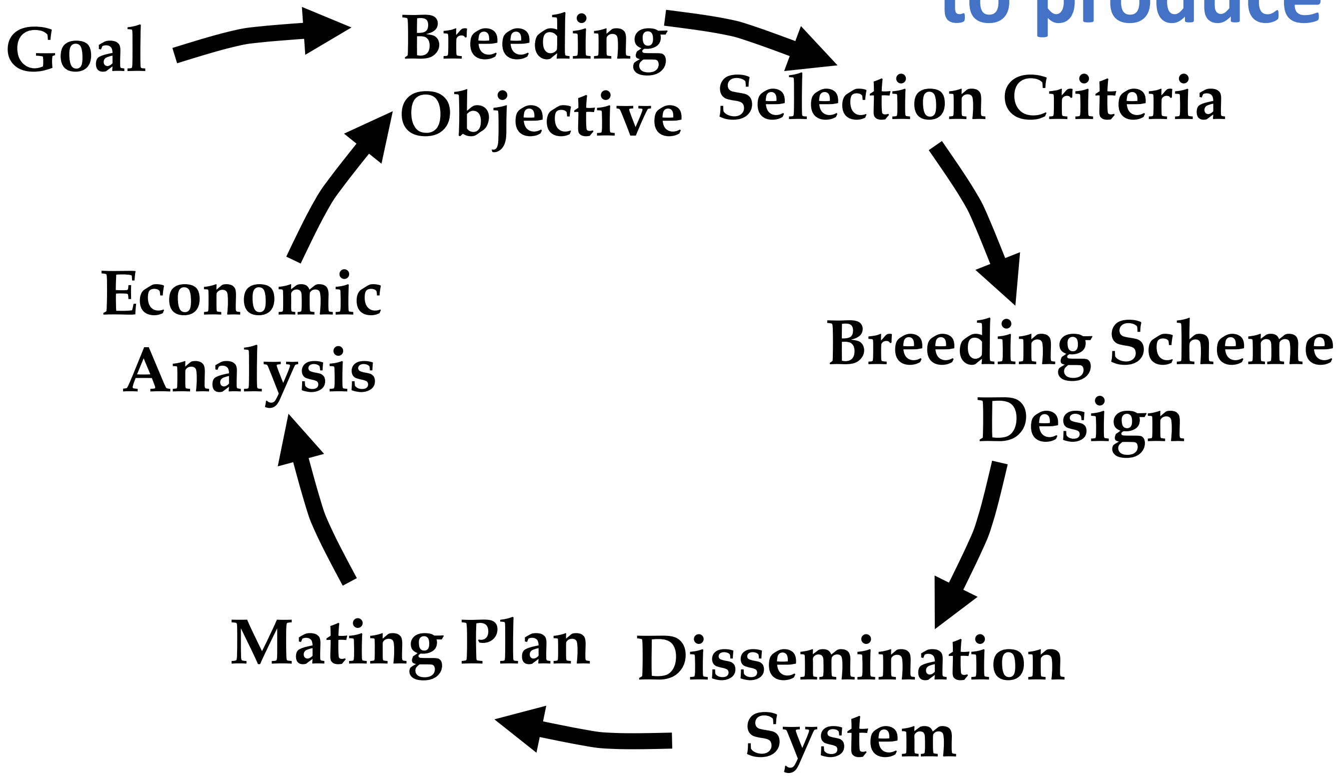
What you want to change



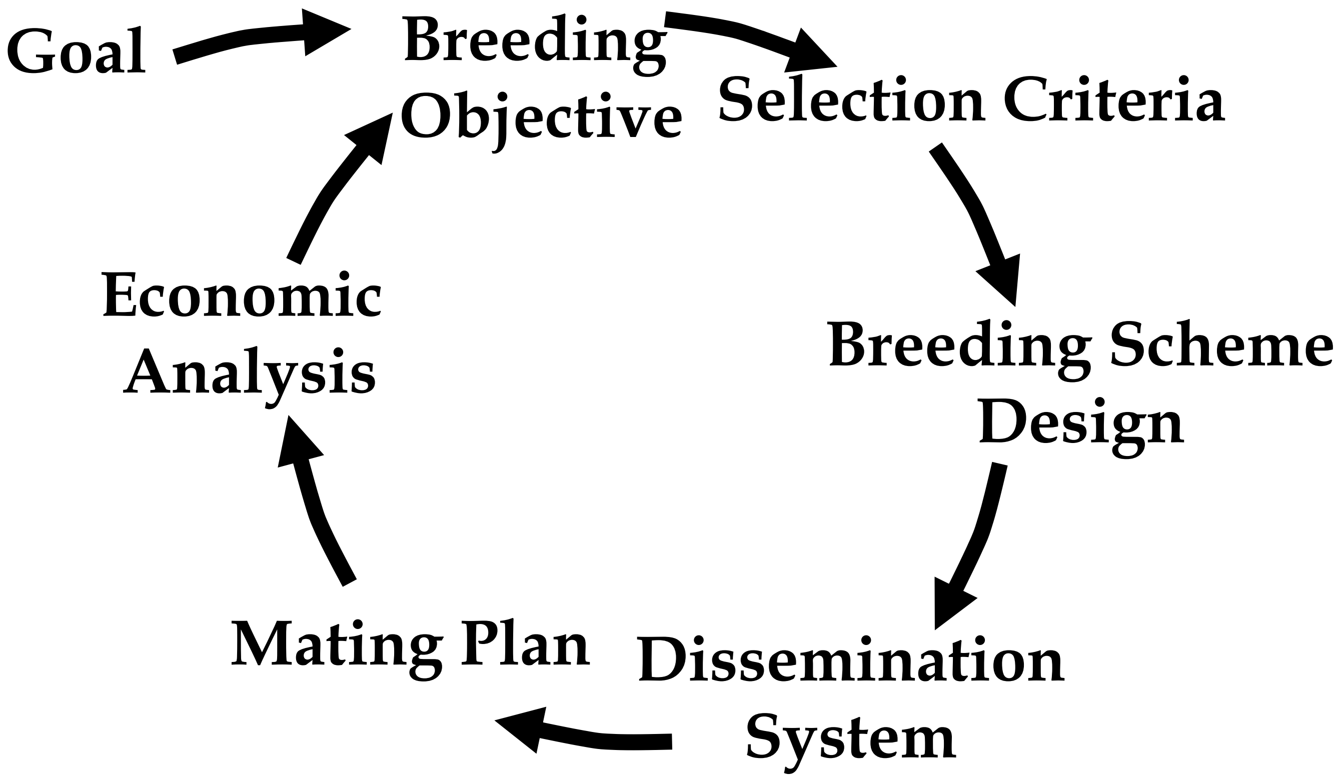
Comprises a:
- List of traits (these will be the EBVs) and their
- Relative Emphasis (these define the index)

Logical Approach to Design of a Breeding Program

What you measure to produce the EPDs

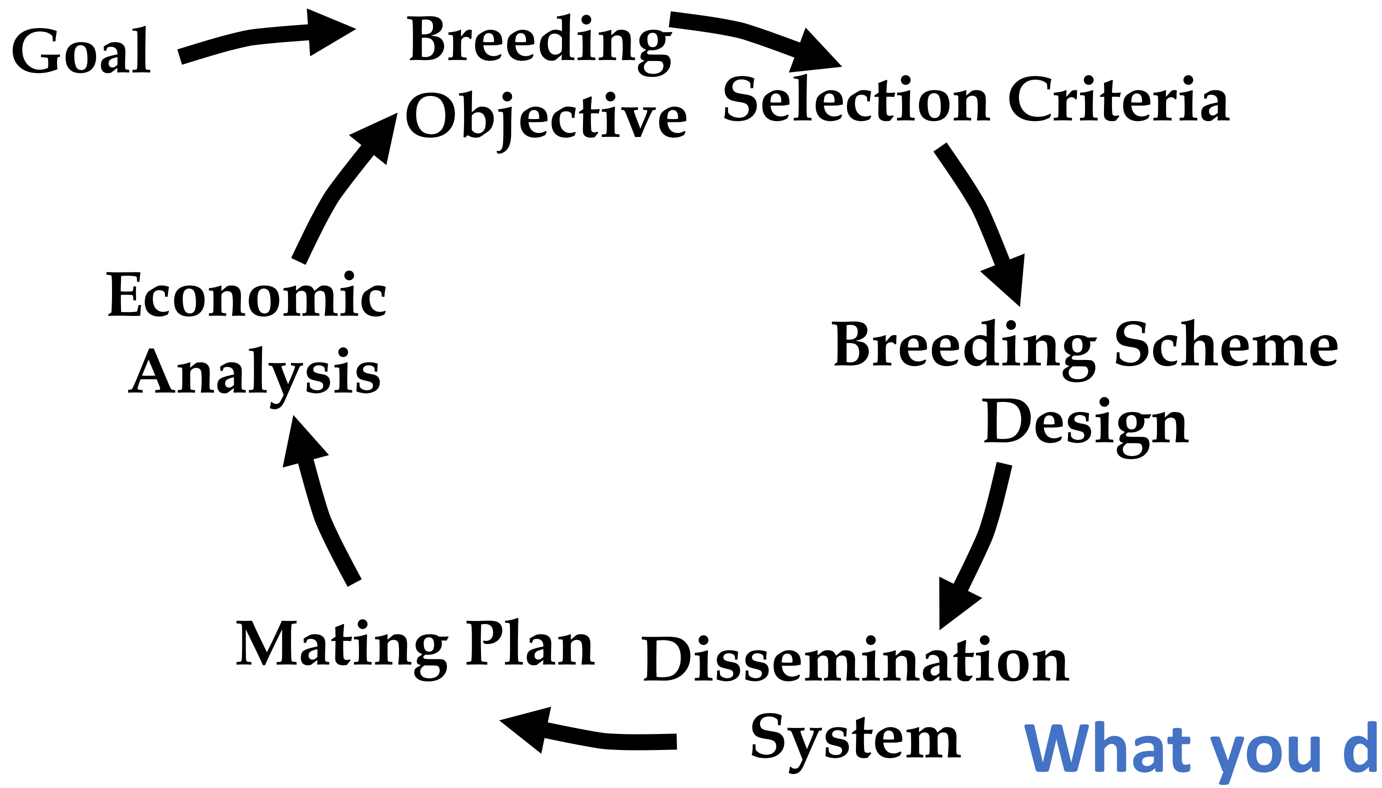


Logical Approach to Design of a Breeding Program



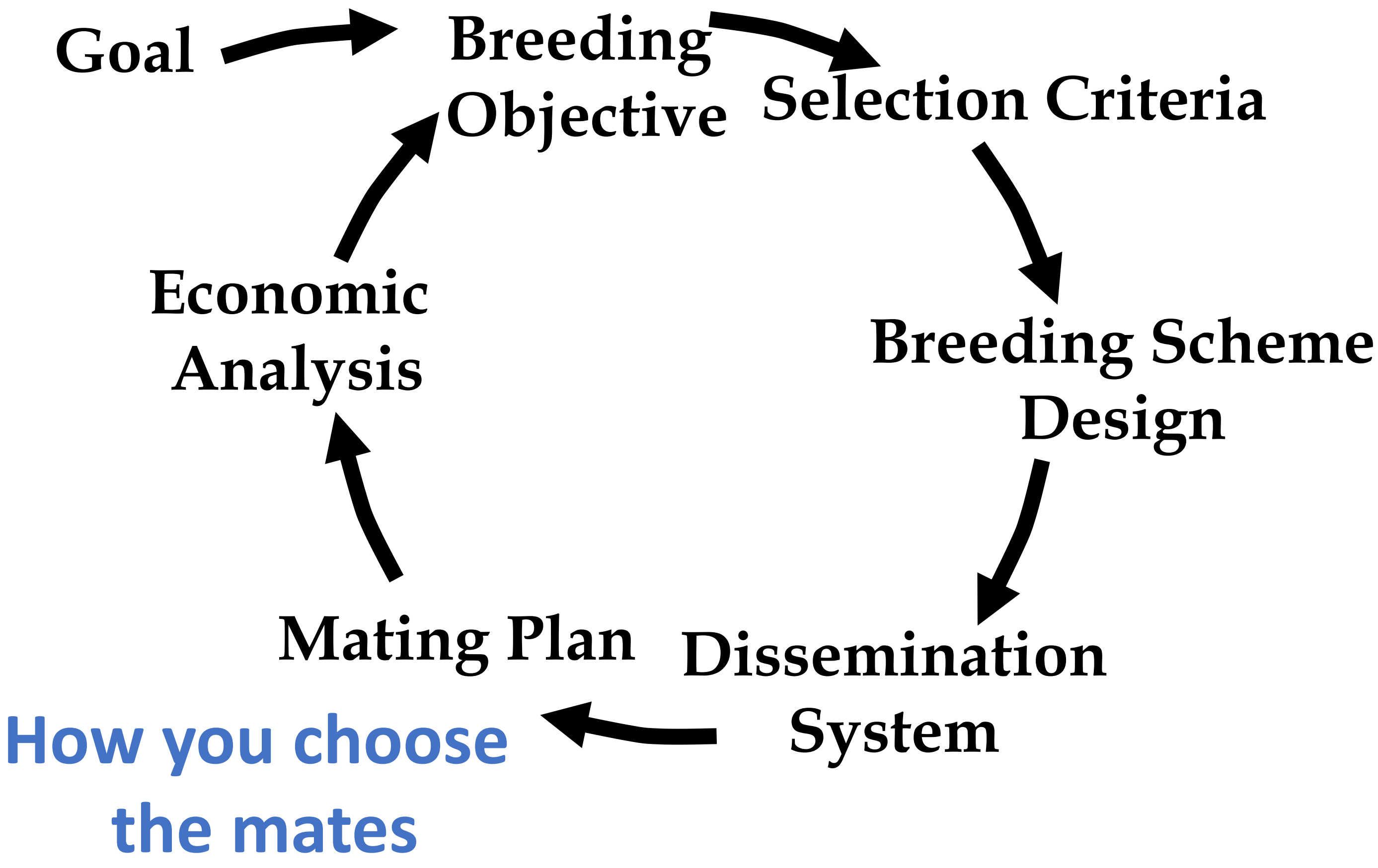
Who you measure to produce the EPDs and generate selection candidates

Logical Approach to Design of a Breeding Program

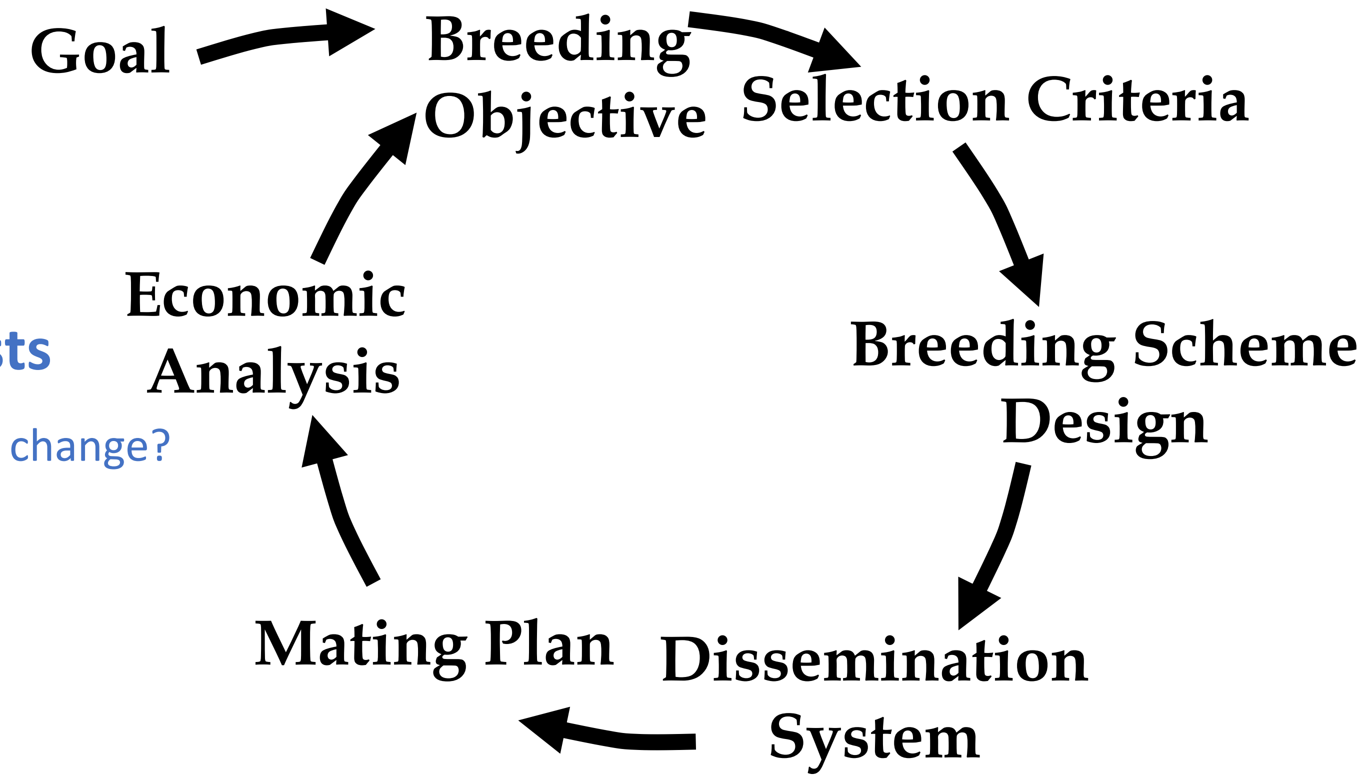


What you do with the ones you select

Logical Approach to Design of a Breeding Program



Logical Approach to Design of a Breeding Program



What are the overall benefits and the overall costs

Who are the beneficiaries of change?
Who pays to achieve it?

Breeding Objective - Traits we want to change

- Reproduction and longevity

- Income over feed costs
  - Growth (Sheep & Beef Cattle)
  - Milk (Dairy Cattle, Dairy Sheep)
  - Food Product Quality
    - Eating quality including meat tenderness
    - Human healthfulness of meat or milk
  - Maternal, terminal and replacement feed costs

- Animal welfare

- Environmental “hoof”print

Traits we are doing a good job of selecting

- Reproduction and longevity

- **Income** over feed costs
  - **Growth** (Sheep & Beef Cattle)
  - **Milk** (Dairy Cattle, Dairy Sheep)
  - Food Product Quality
    - Eating quality including meat tenderness
    - Human healthfulness of meat or milk
  - Maternal, terminal and replacement feed costs

- Animal welfare

- Environmental “hoof”print

Traits we are doing a **better** job of selecting

- **Reproduction** and **longevity**
- Income over feed costs
  - Growth (Sheep & Beef Cattle)
  - Milk (Dairy Cattle, Dairy Sheep)
  - Food Product Quality
    - Eating quality including meat **tenderness**
    - Human **healthfulness** of meat or milk
  - Maternal, terminal and replacement **feed costs**
- **Animal welfare**
- **Environmental "hoof"print**

Why aren’t traits being adequately considered?

- Not selecting on the total merit indexes (e.g. for maternal systems)
- Not measuring enough of the less tangible attributes
    - Cannot be measured in production setting (e.g. carcass on breeding animals)
    - Hard to measure in production setting (e.g. intermittent disease)
    - Too expensive or too labor intensive?
        - New devices (Internet of Things – IoT) will change this
    - Don’t see a demand for them?
    - Don’t believe in them?
    - Don’t see the value proposition?
        - But prepared to invest in testing for genetic defects, or for genomic prediction

Value Proposition

- Among the ram or bull breeding sectors
  - Too many animals being recorded
  - Not enough traits being recorded
    - Traits not being measured or recorded accurately or with enough precision
  - Not being rewarded by ram or bull buyers – market failure
    - In terms of price or demand for less tangible traits (e.g. efficiency and consumer quality)
  - Breed Association structure might be impeding innovation
    - Routine EBVs provided on all animals regardless of phenotypic measurement or not
      - Exacerbated by use of genomic prediction relative to pedigree parent-average EBV
    - Disincentive for individual breeders to be an early investor in infrastructure

How might more balanced selection occur?

- New technologies for measuring
- Subsidies by government or levy payers (e.g. Australia, Canada)
- Local Regulations
  - Such as nutrient excretion limits or welfare codes
- Market Requirements
  - Specifications for access to markets (especially export markets)
- New business structures to capture value
  - Small collectives of like-minded entrepreneurs
  - Vertical integration

Traits we are doing a **better** job of selecting

- **Reproduction** and **longevity**

- Income over feed costs
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  - Food Product Quality
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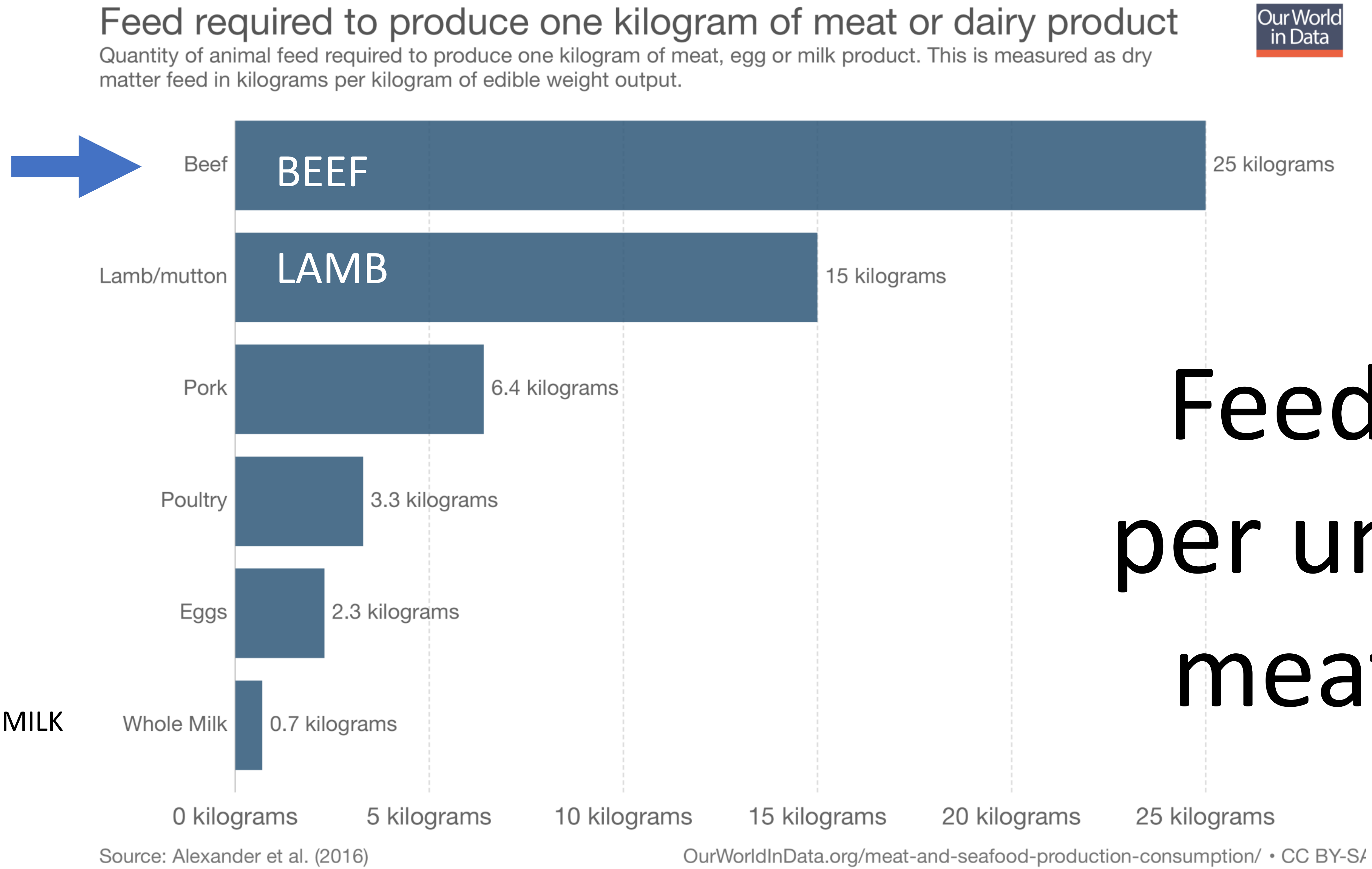
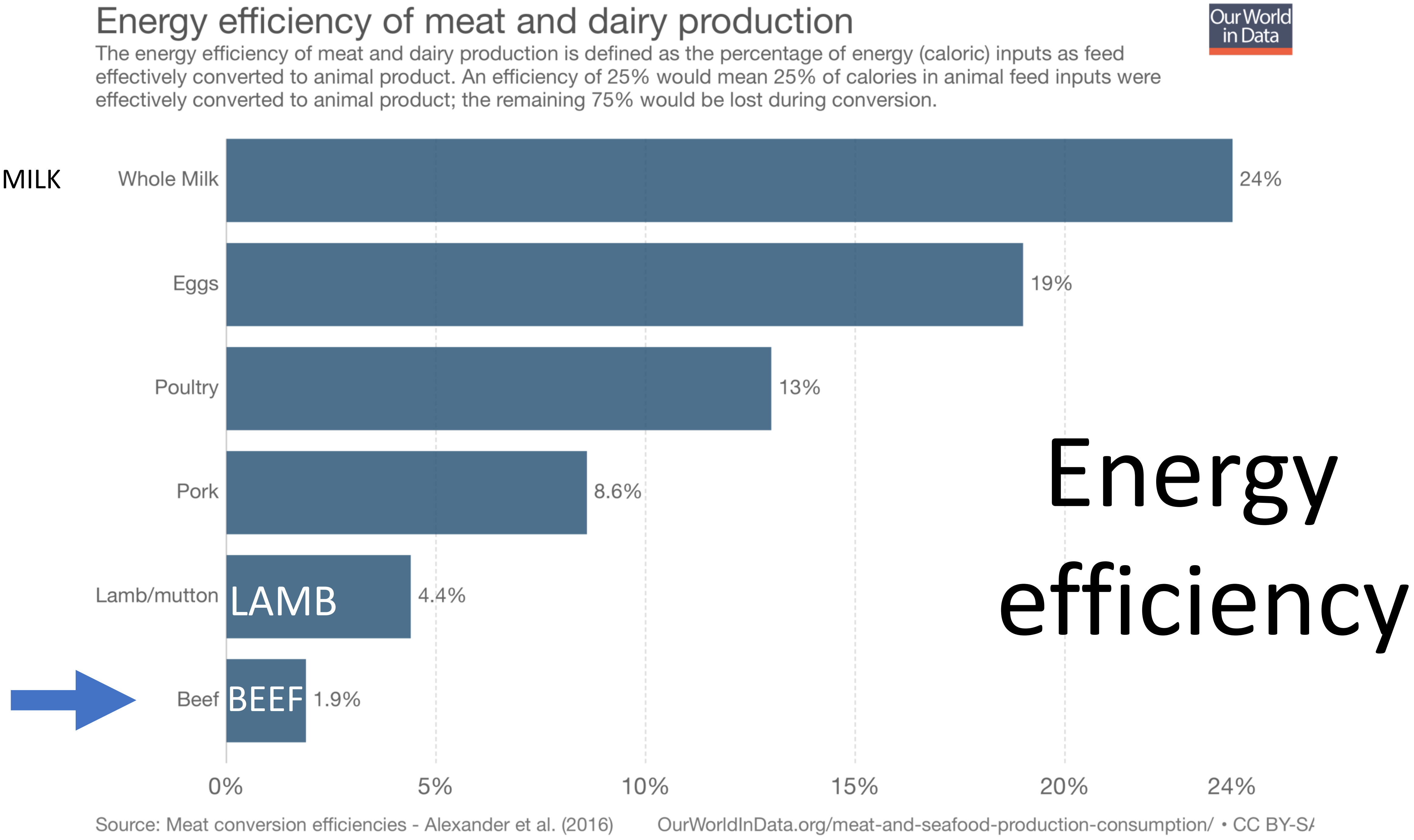
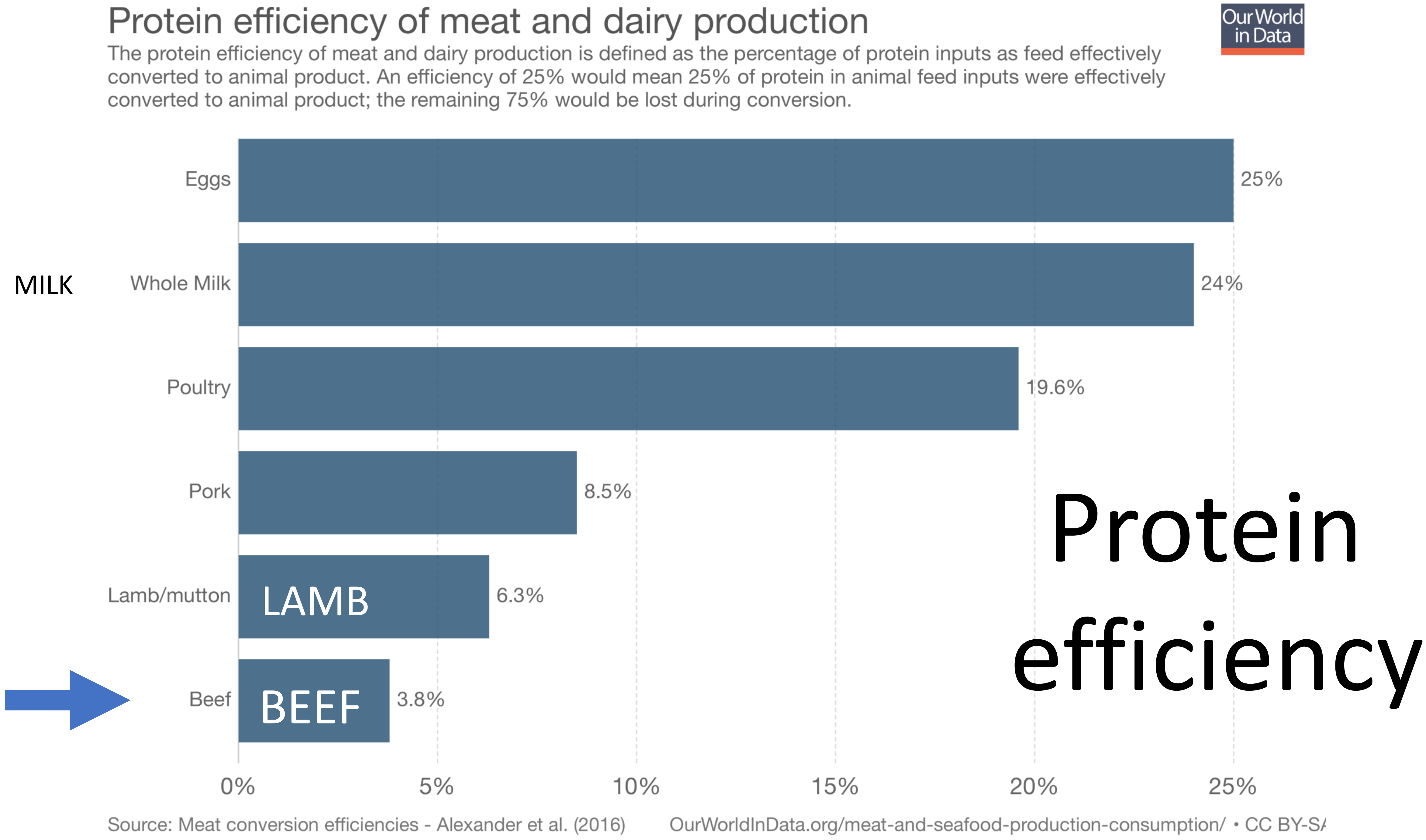
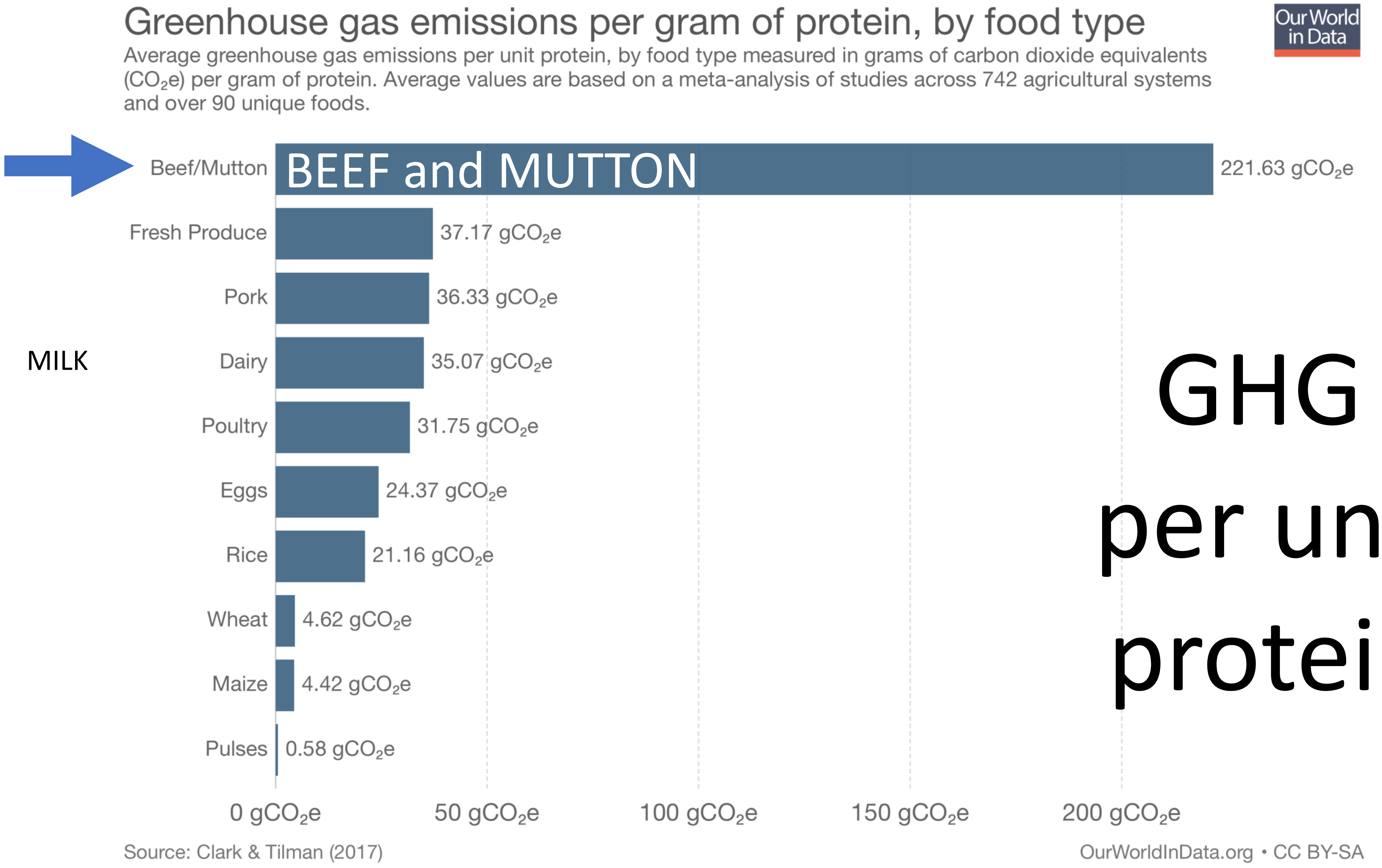
- **Environmental “hoof”print**



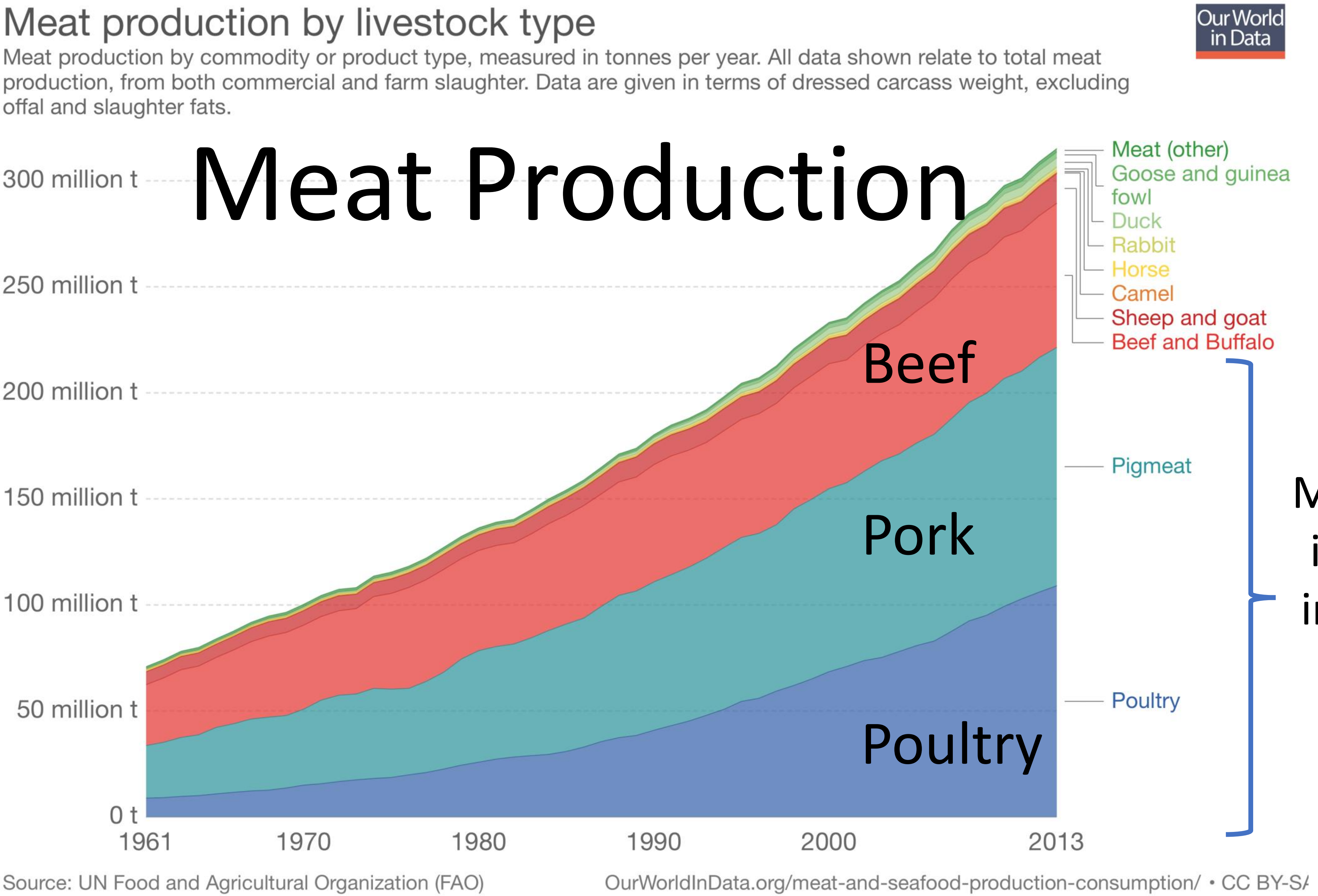
Feed per unit meat


Energy efficiency of meat and dairy production
The energy efficiency of meat and dairy production is defined as the percentage of energy (caloric) inputs as feed effectively converted to animal product. An efficiency of 25% would mean 25% of calories in animal feed inputs were effectively converted to animal product; the remaining 75% would be lost during conversion.
Our World in Data
MILK
Whole Milk
24%
Eggs
19%
Poultry
13%
Pork
8.6%
Lamb/mutton
LAMB
4.4%
Beef
BEEF
1.9%
0%
5%
10%
15%
20%
24%
Energy efficiency
Source: Meat conversion efficiencies - Alexander et al. (2016)
OurWorldInData.org/meat-and-seafood-production-consumption/ • CC BY-SA

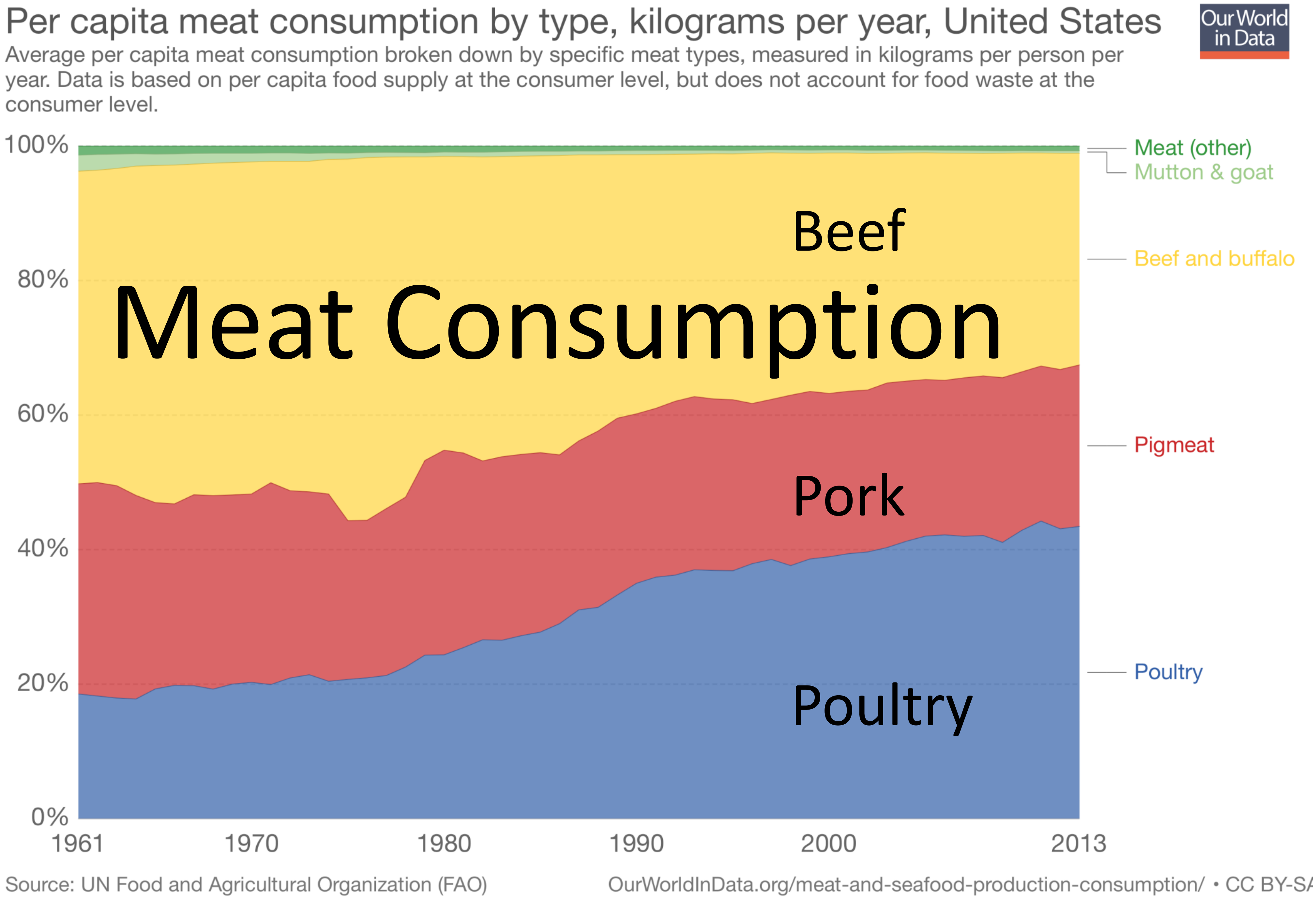

Protein efficiency of meat and dairy production
The protein efficiency of meat and dairy production is defined as the percentage of protein inputs as feed effectively converted to animal product. An efficiency of 25% would mean 25% of protein in animal feed inputs were effectively converted to animal product; the remaining 75% would be lost during conversion.
Our World in Data
Eggs
25%
MILK
Whole Milk
24%
Poultry
19.6%
Pork
8.5%
Lamb/mutton
LAMB
6.3%
Beef
BEEF
3.8%
Protein efficiency
0%
5%
10%
15%
20%
25%
Source: Meat conversion efficiencies - Alexander et al. (2016)
OurWorldInData.org/meat-and-seafood-production-consumption/ • CC BY-S/


Greenhouse gas emissions per gram of protein, by food type
Average greenhouse gas emissions per unit protein, by food type measured in grams of carbon dioxide equivalents (CO_2e) per gram of protein. Average values are based on a meta-analysis of studies across 742 agricultural systems and over 90 unique foods.
Our World in Data
Beef/Mutton
BEEF and MUTTON
221.63 gCO_2e
Fresh Produce
37.17 gCO_2e
Pork
36.33 gCO_2e
MILK
Dairy
35.07 gCO_2e
Poultry
31.75 gCO_2e
Eggs
24.37 gCO_2e
Rice
21.16 gCO_2e
Wheat
4.62 gCO_2e
Maize
4.42 gCO_2e
Pulses
0.58 gCO_2e
0 gCO_2e
50 gCO_2e
100 gCO_2e
150 gCO_2e
200 gCO_2e
GHG per unit protein
Source: Clark & Tilman (2017)
OurWorldInData.org • CC BY-SA

Meat Production



Most of the increase is in pork and poultry


Per capita meat consumption by type, kilograms per year, United States
Average per capita meat consumption broken down by specific meat types, measured in kilograms per person per year. Data is based on per capita food supply at the consumer level, but does not account for food waste at the consumer level.
Our World in Data
Meat Consumption
Beef
Pork
Poultry
100%
80%
60%
40%
20%
0%
1961
1970
1980
1990
2000
2013
Meat (other)
Mutton & goat
Beef and buffalo
Pigmeat
Poultry
Source: UN Food and Agricultural Organization (FAO)
OurWorldInData.org/meat-and-seafood-production-consumption/ • CC BY-SA

NZ Meat Consumption Trends – last decade (kg carcass weight equivalent)

Per capita consumption

CWE (kg)	2006-7	2017-17	10 years
Beef	28	17	-39%
Sheep	11	6	-41%
Pork	21	24	+10%
Poultry	35	47	+35%
TOTAL	95	94	-1%

Retail Price US$

2007-8	2017-18	Increase
$8.40	$11.90	42%
$8.05	$10.50	30%
$8.05	$8.40	4%
$5.60	$5.60	0%

NZ has had 41% domestic population increase (immigration)

Moving the Cloud

- **Reproduction** and **longevity**
- **Income** over feed costs
  - **Growth** (Sheep & Beef Cattle)
  - **Milk** (Dairy Cattle, Dairy Sheep)
  - Food Product Quality
    - Eating quality including meat **tenderness**
    - Human **healthfulness** of meat or milk
  - Maternal, terminal and replacement **feed costs**
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Summary

- We really need to improve efficiency of sheep and cattle production
  - Reproductive Efficiency
  - Birth to Finish Efficiency
  - Doing so involves a number of traits, many not being adequately considered
- Selection is a proven and cost-effective mechanism for improvement
  - Needs to be based on whole-system index(es)
  - Comprising EBVs for economically-relevant traits based on sensible phenotyping strategies combined with the use of genomics
  - Will need to be led by organisations like ICBF & SI and innovative breeders