What is the Upper Limit to Commercially Relevant Body Weight in Modern Broilers?

Bryan I. Fancher, PhD
VP Global Technical Operations
Aviagen Group



Agenda



- The modern broiler
  - Realized progress & benefits?
  - Expectations for the next 10 years?

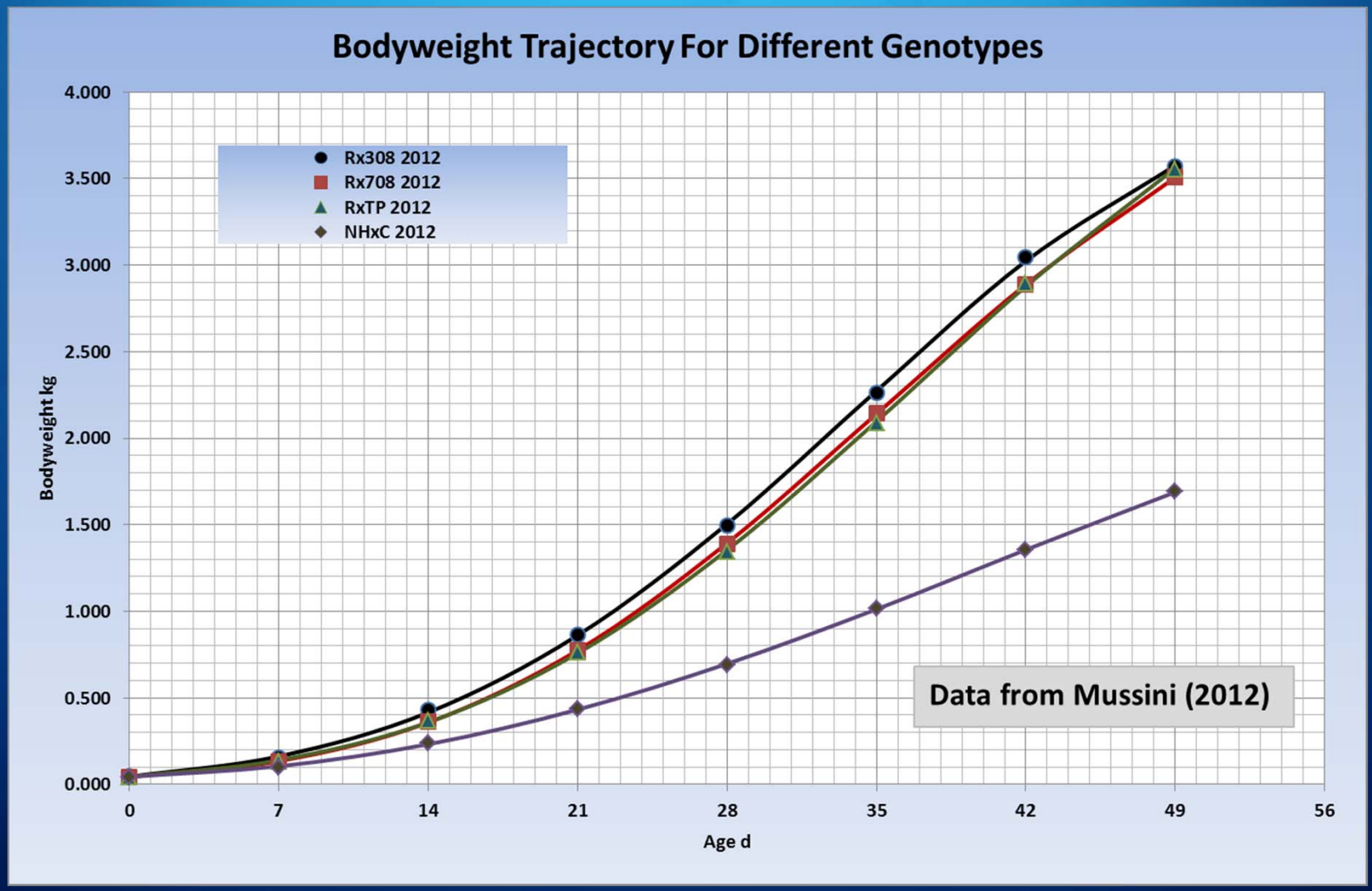
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The Modern Broiler
Realized Progress & Benefits



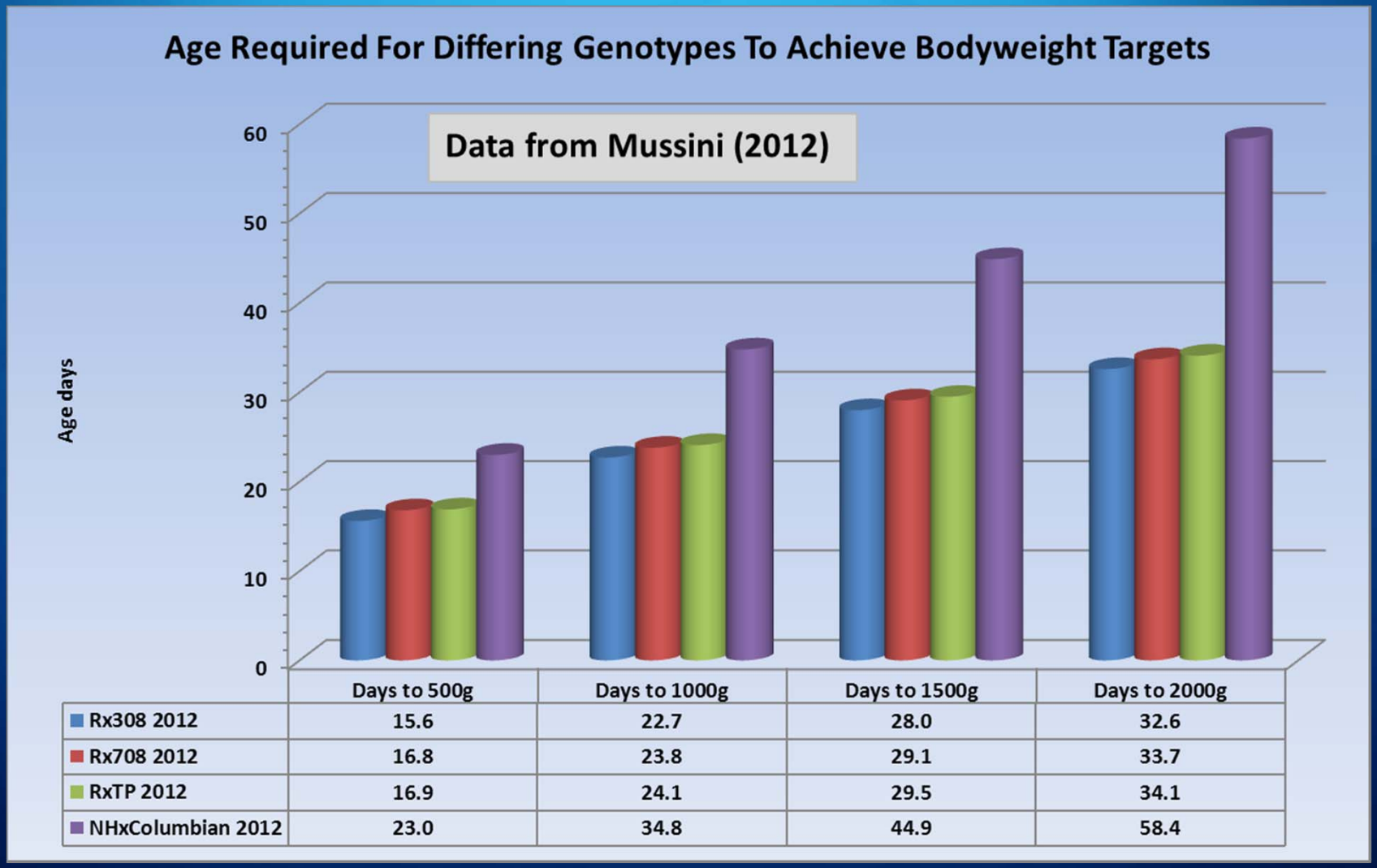
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Broiler Trait Progress - Live



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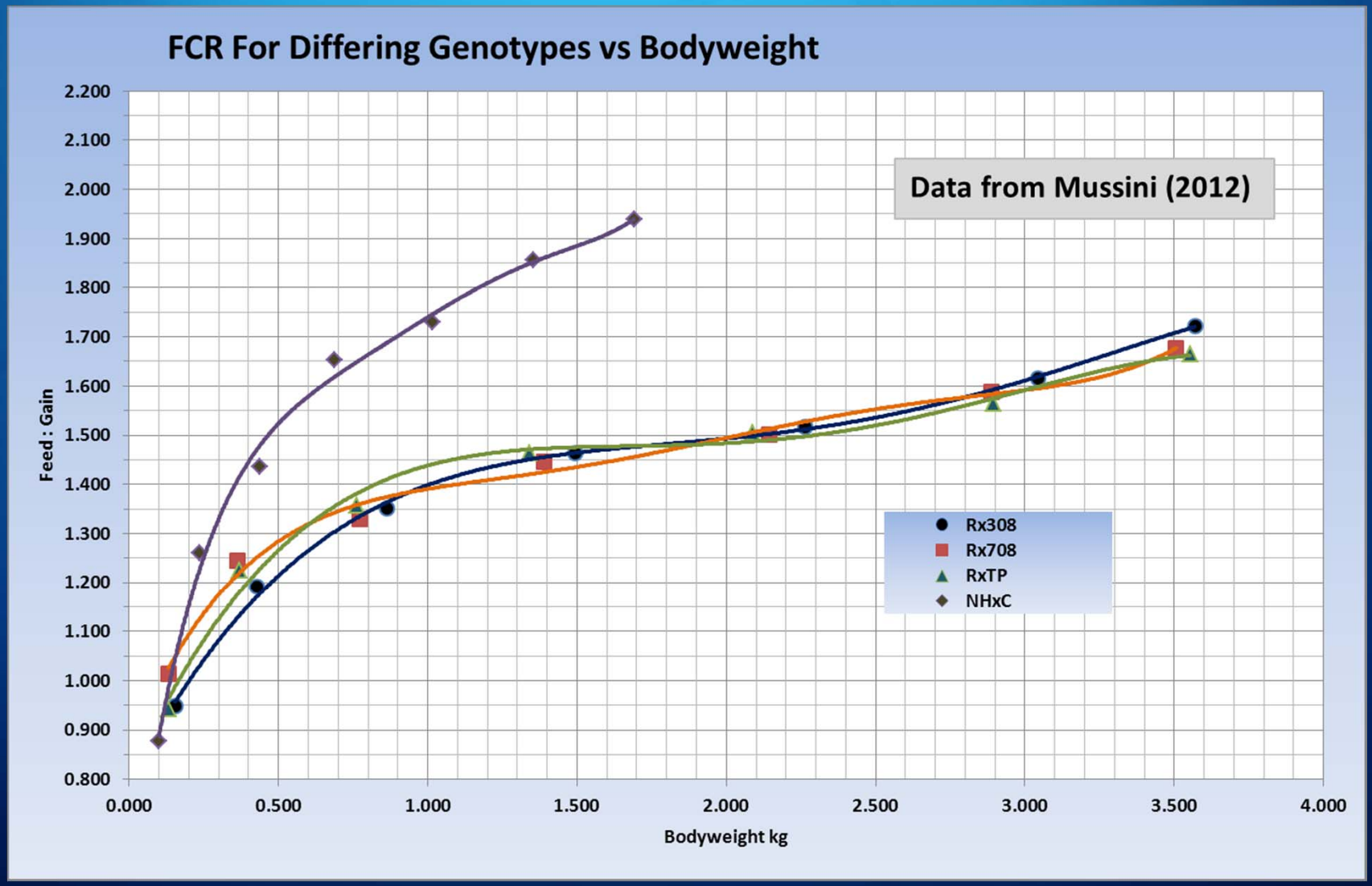
Broiler Trait Progress - Live



	Days to 500g	Days to 1000g	Days to 1500g	Days to 2000g
Rx308 2012	15.6	22.7	28.0	32.6
Rx708 2012	16.8	23.8	29.1	33.7
RxTP 2012	16.9	24.1	29.5	34.1
NHxColumbian 2012	23.0	34.8	44.9	58.4

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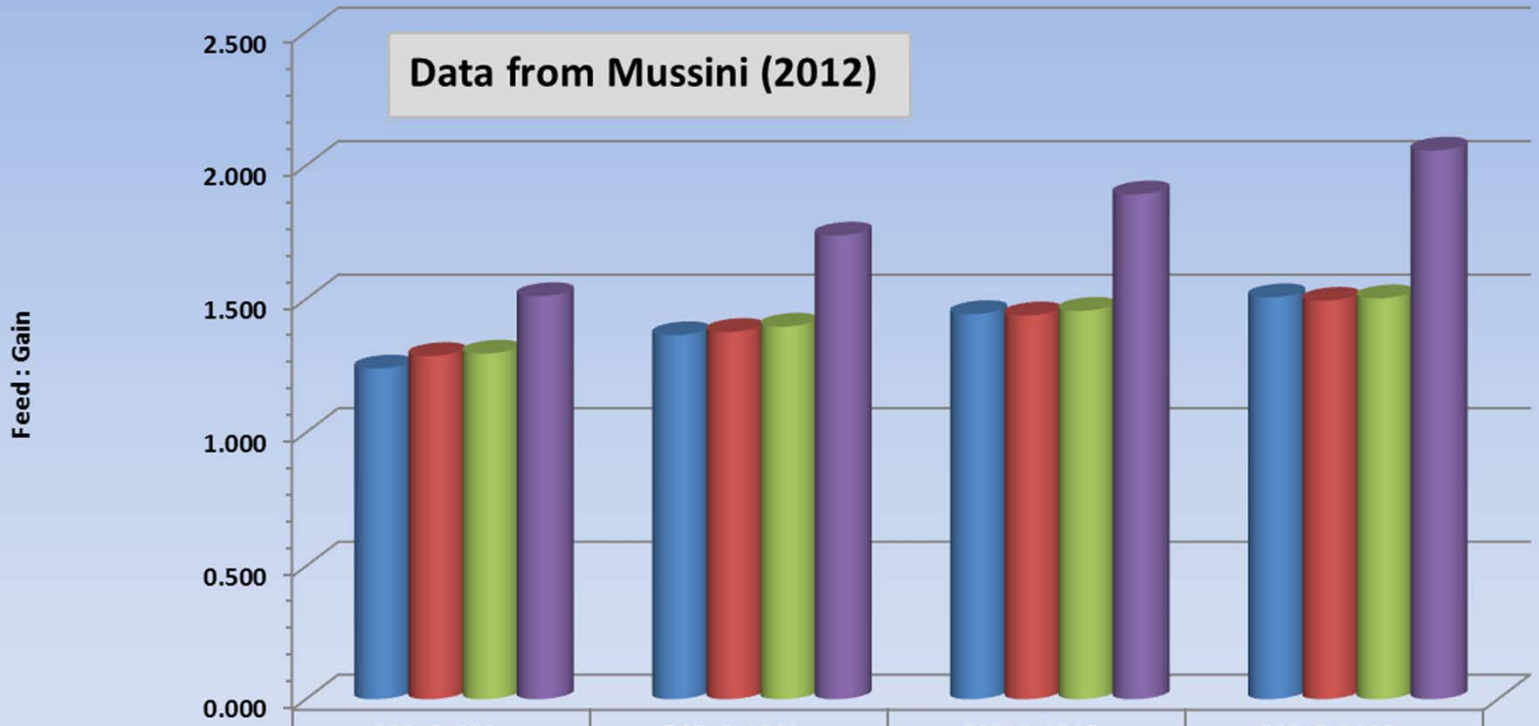
Broiler Trait Progress - Live



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Broiler Trait Progress - Live

FCR For Differing Genotypes At Different Bodyweight Targets



	FCR @ 500g	FCR @ 1000g	FCR @ 1500g	FCR @ 2000g
Rx308 2012	1.240	1.365	1.444	1.507
Rx708 2012	1.287	1.377	1.439	1.494
RxTP 2012	1.296	1.397	1.456	1.503
NHxColumbian 2012	1.511	1.738	1.892	2.056

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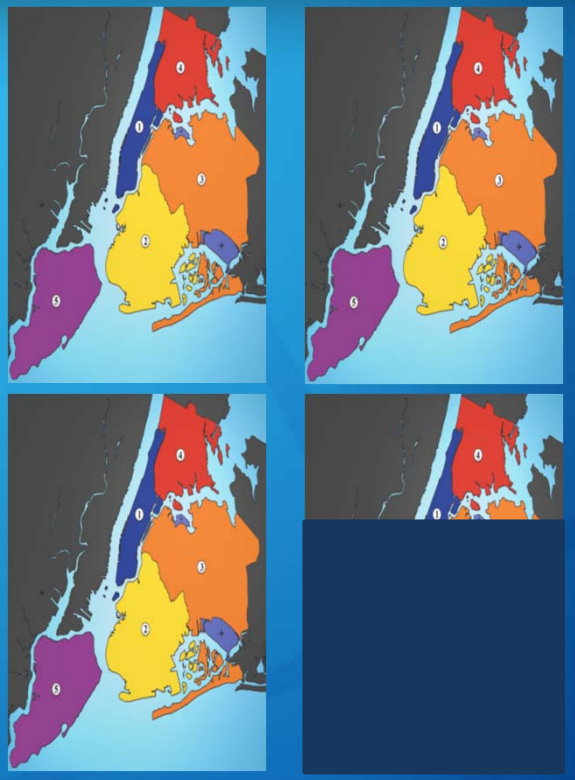
Impact of FCR Progress

- 2010 global broiler production:

  123.6 M tonnes live weight*

- Δ FCR = –0.015 kg/kg annually
- Reduced feed –0.015 123.6 M =
  - 1.85 M tonnes feed
  - 1.85 M tonnes feed/466 tonnes wheat/ km^{2*}
  - 4000 km^2 arable land per year
  - 3.3 NYC or 1.5 x Luxemburg

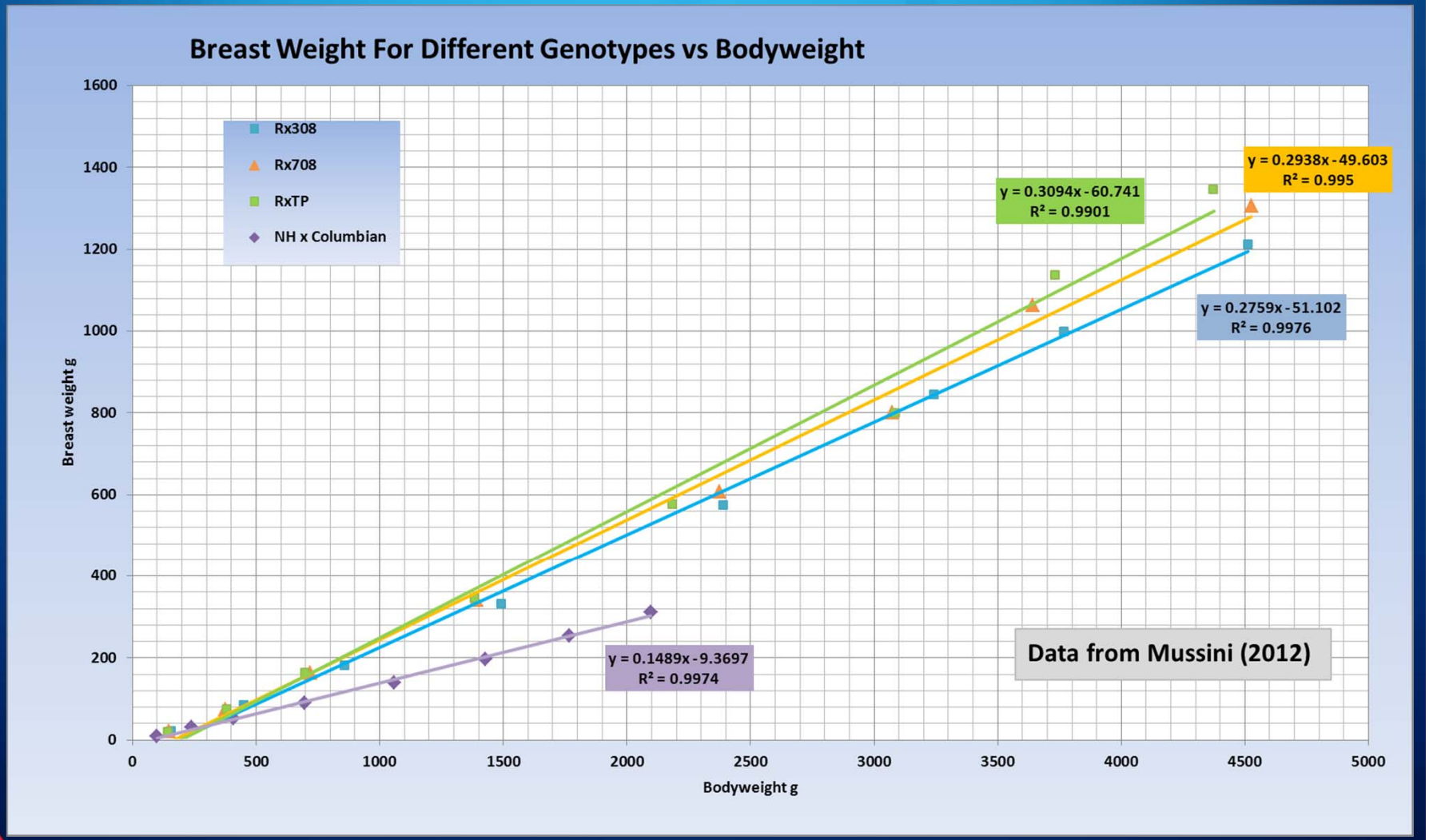
* faostat.fao.org





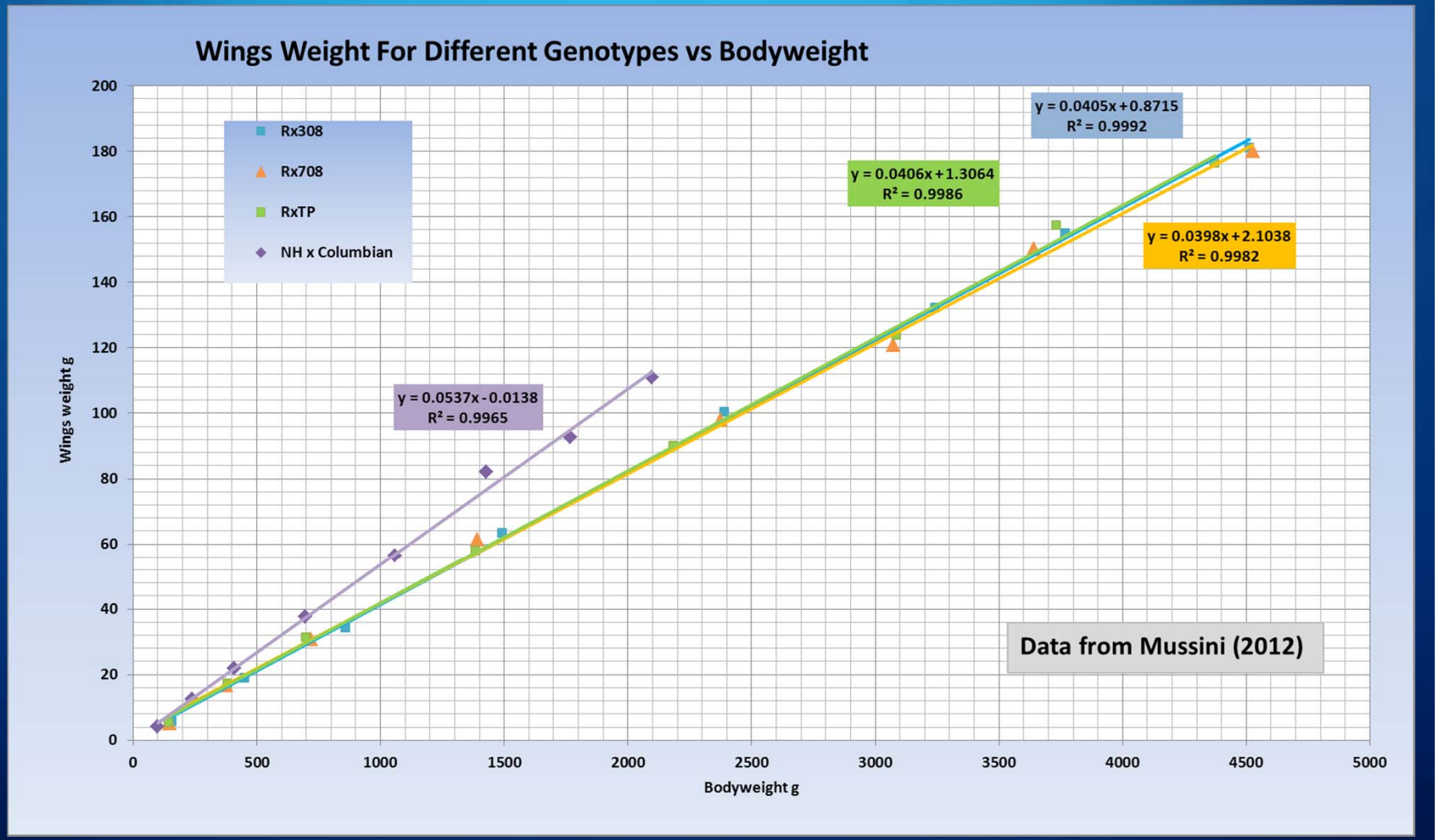
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Broiler Trait Progress – Processing



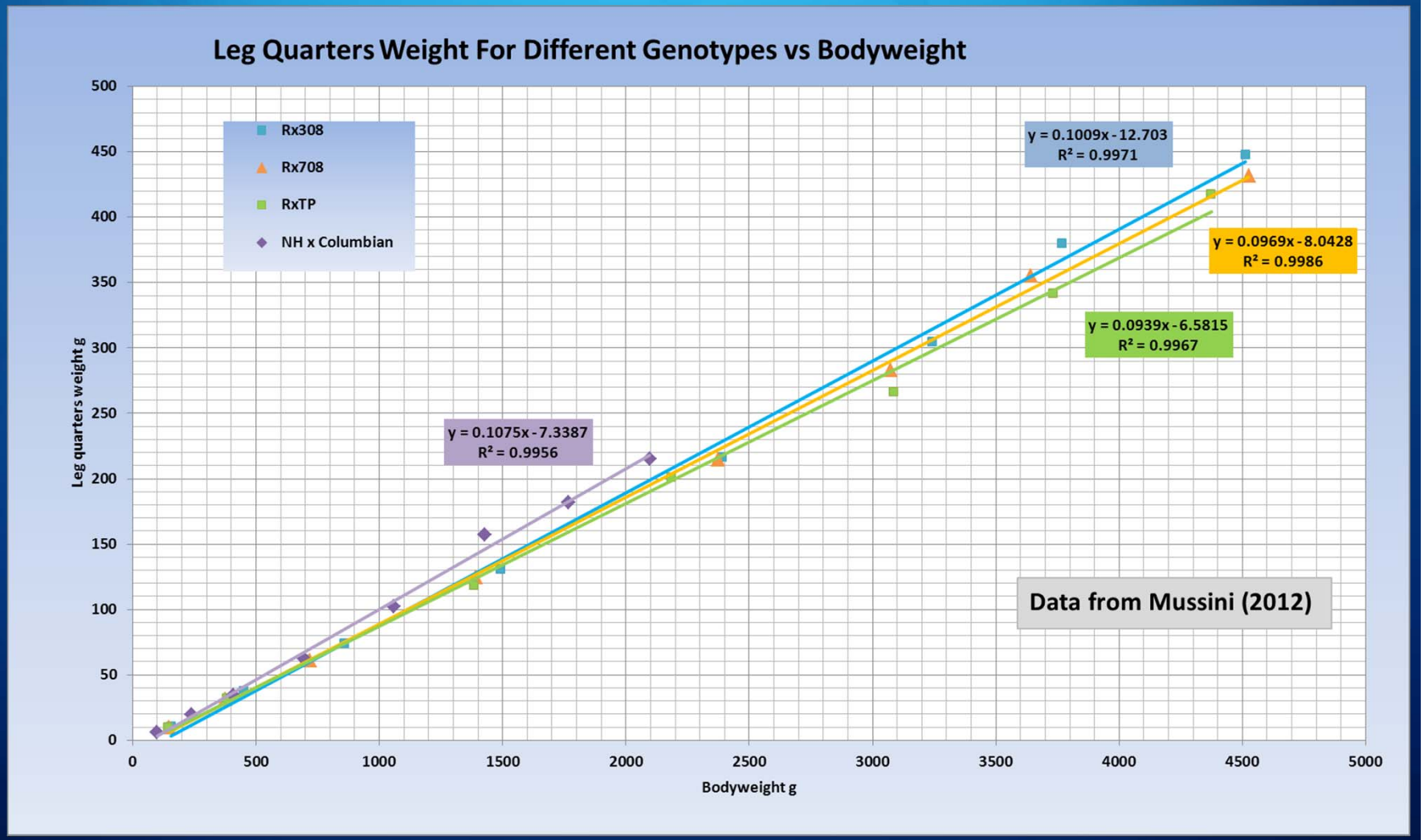
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Broiler Trait Progress – Processing



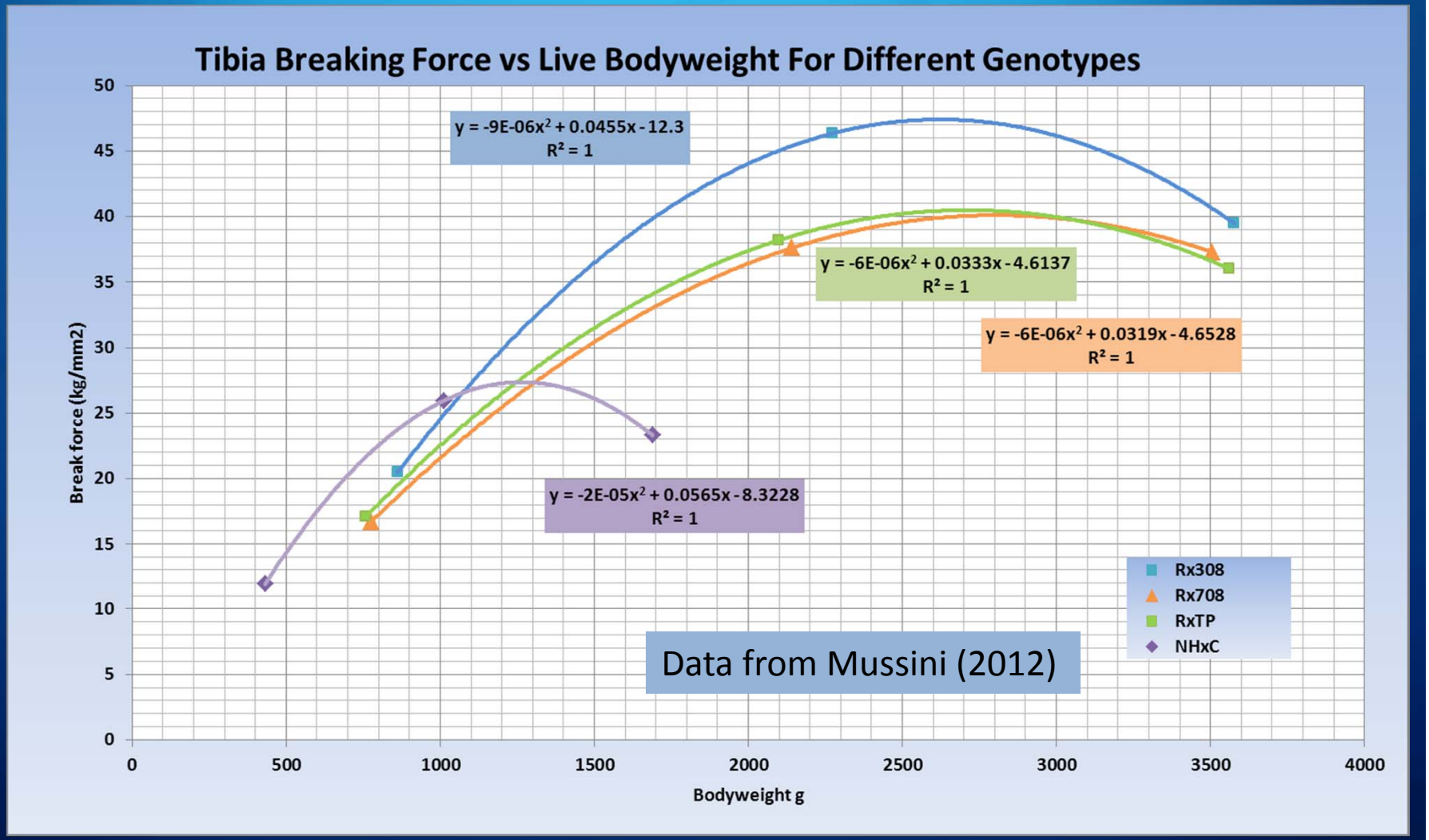
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Broiler Trait Progress – Processing



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Broiler Skeletal Strength – Changes



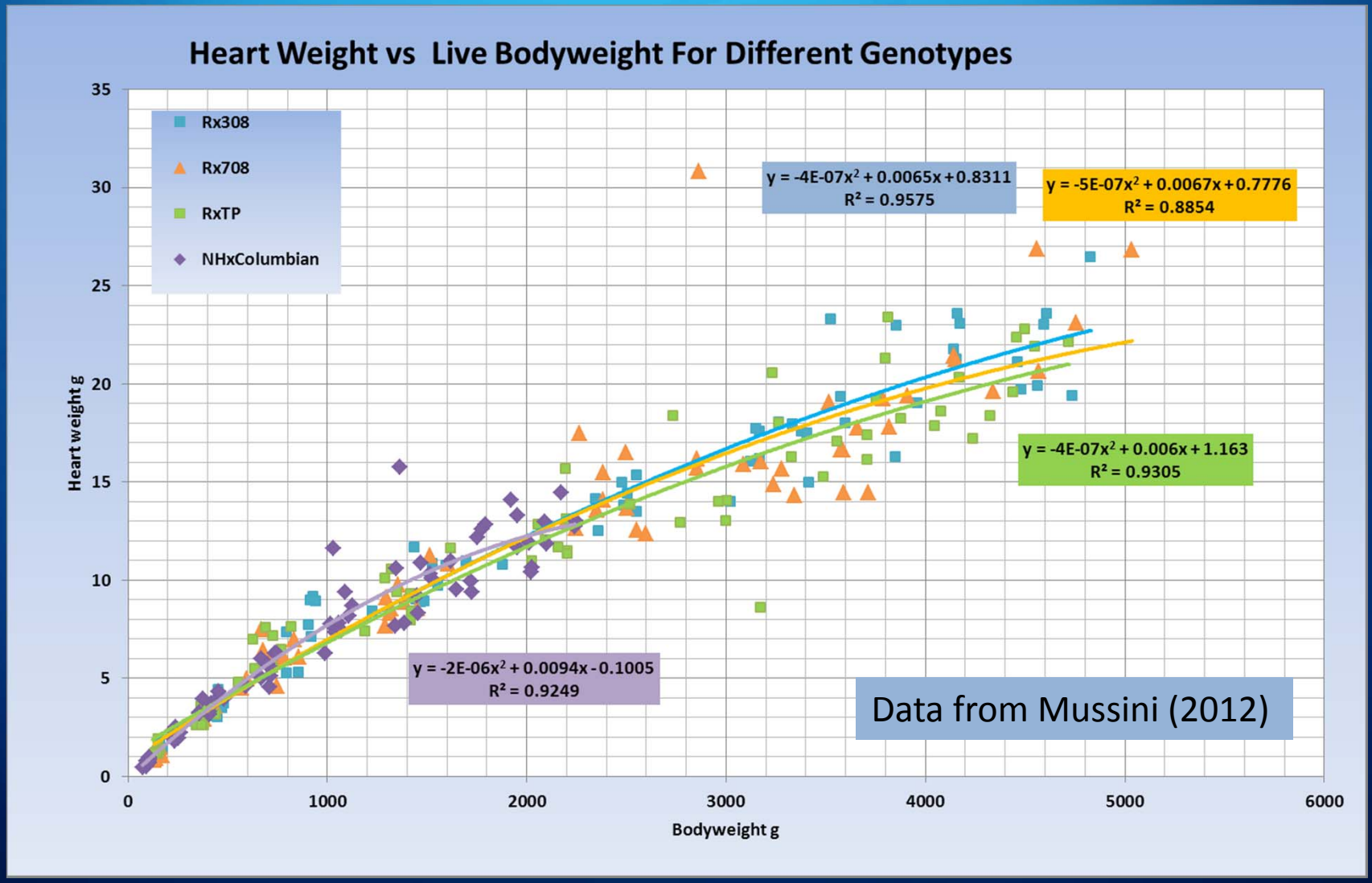
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Broiler Health & Welfare Progress

- Long term (25 yr) effectiveness of simultaneous selection for broiler productivity traits and leg health (Kapell et al., 2012)
  - long bone deformities, crooked toes, tibial dyschondroplasia, hock burn
- In contrasting environments, foot pad dermatitis reduced while simultaneously selecting for bodyweight (Kapell et al., 2012)

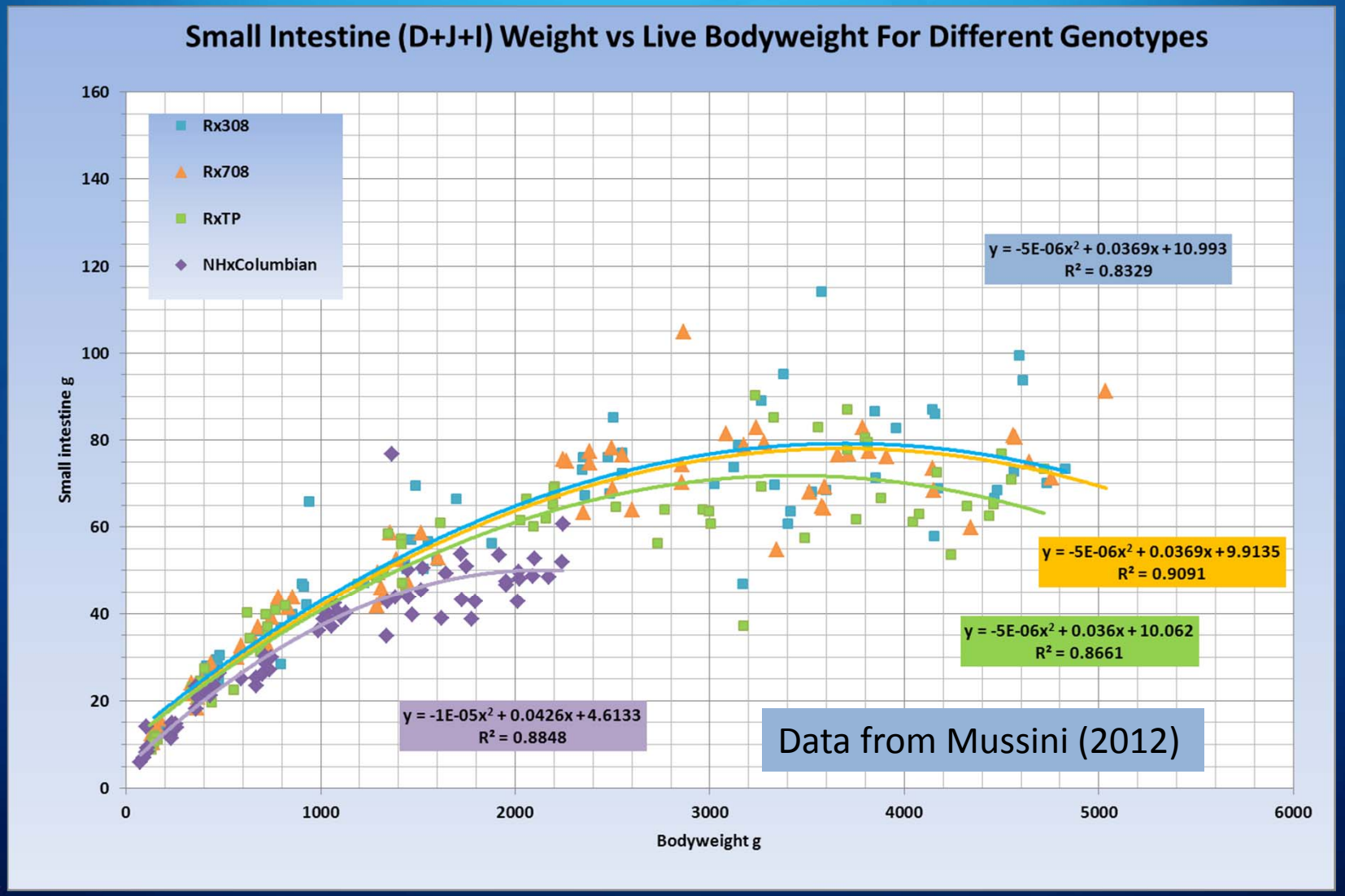
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Broiler Anatomical Changes



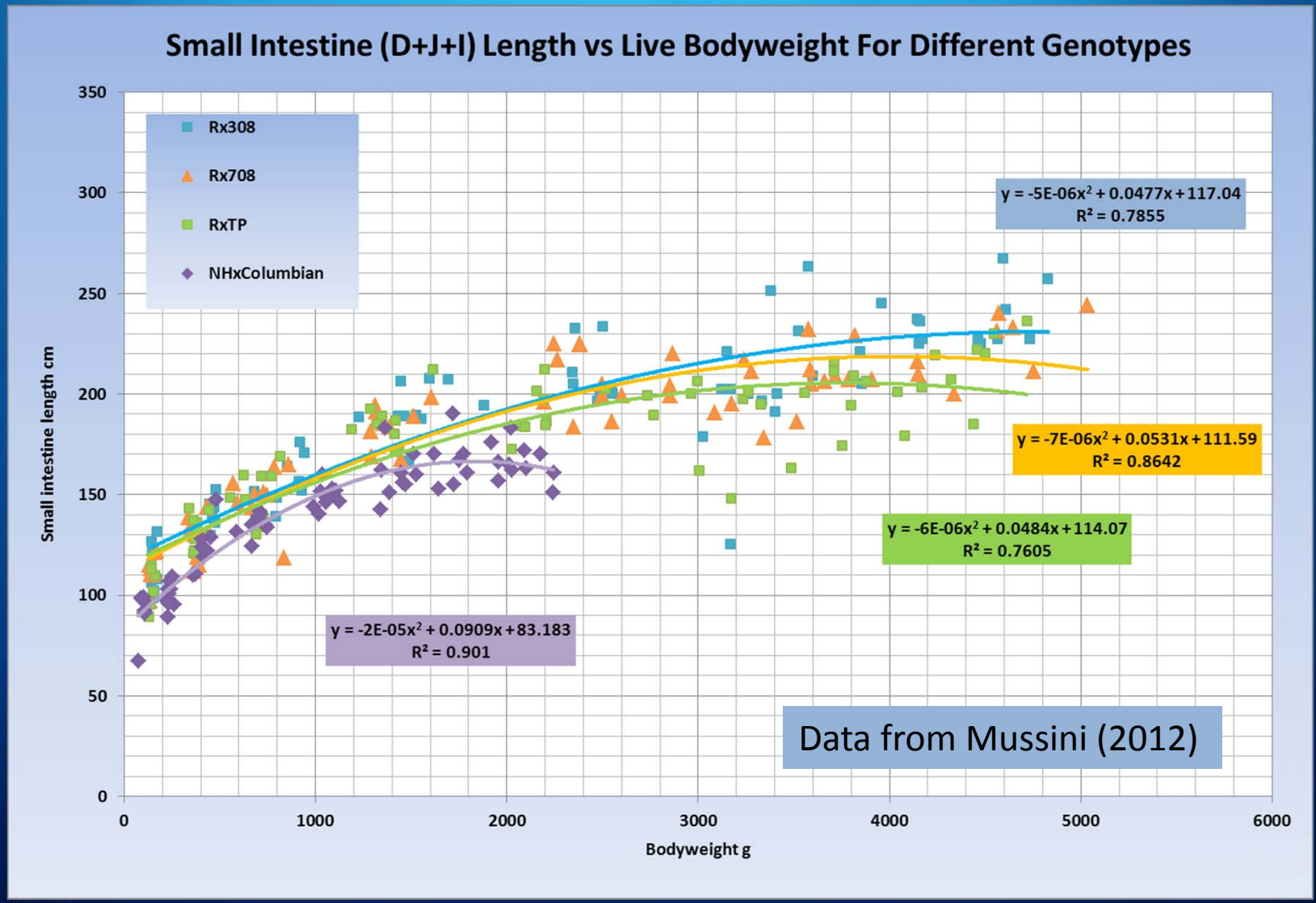
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Broiler Anatomical Changes



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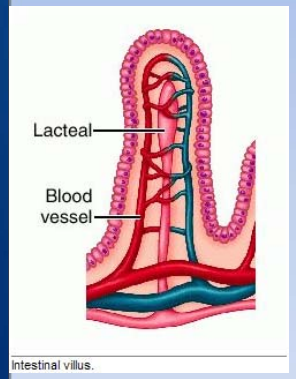
Broiler Anatomical Changes

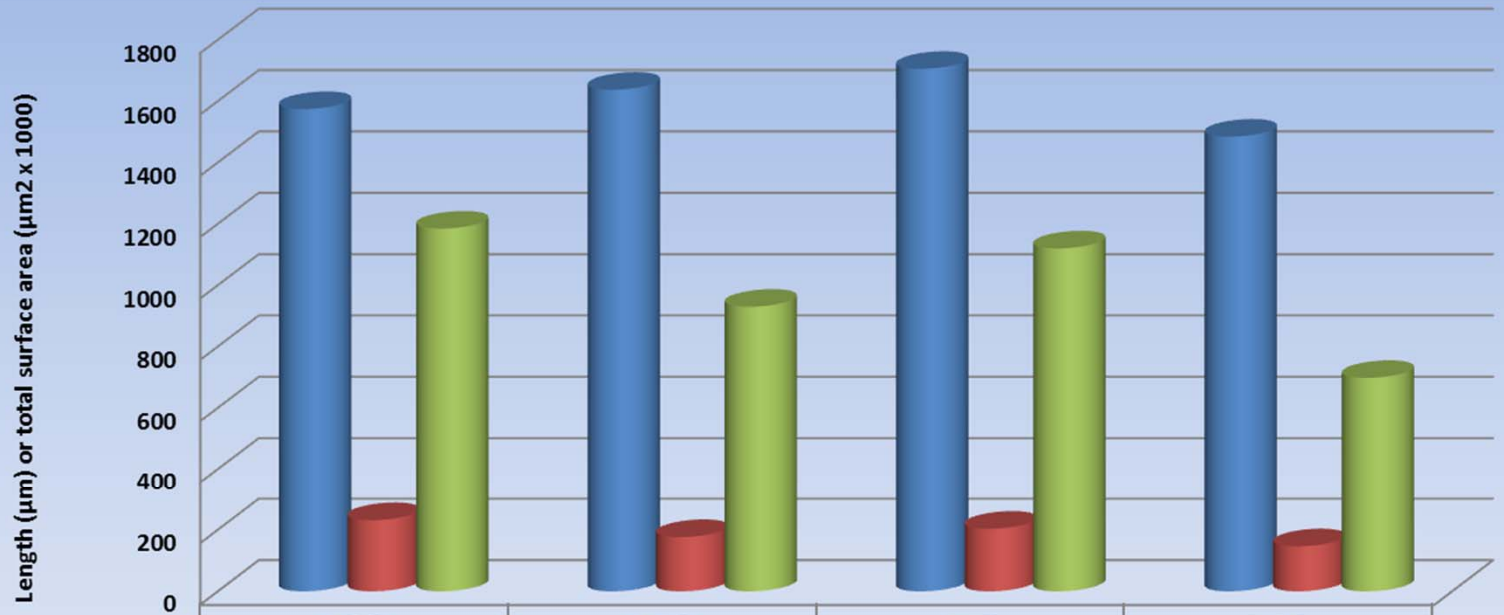


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Broiler Digestive Capacity Changes

Small Intestine Villus Morphometry (28 d) For Four Different Genotypes





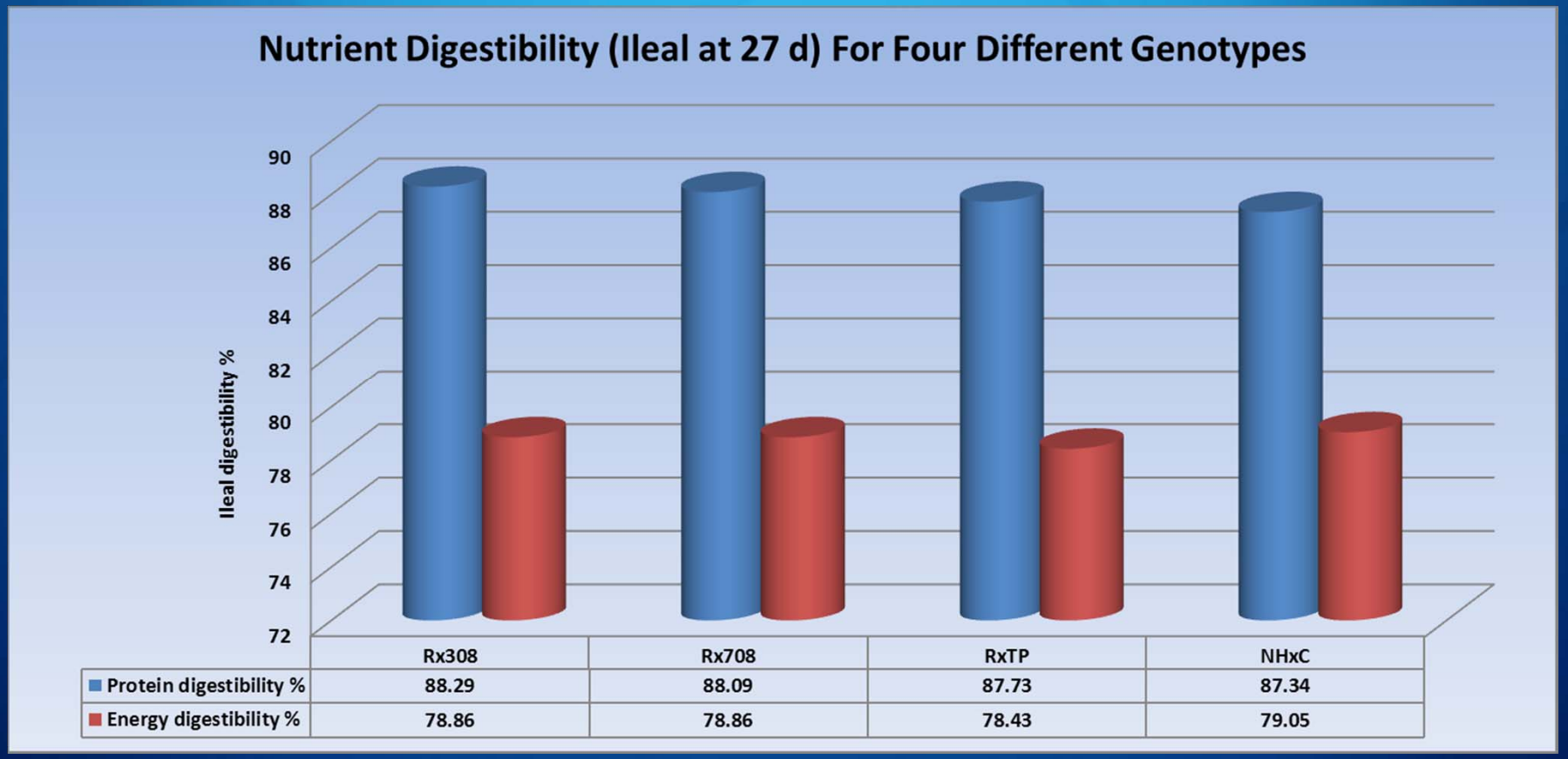
	Rx308	Rx708	RxTP	NHxC
SI villus length (µm)	1574	1637	1705	1484
SI villus width (µm)	231	176	203	146
Est. total surface area (mm2*1000)	1,184	929	1,120	697

On average – modern breeds ~55% more surface area

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Data from Mussini (2012)

Broiler Digestive Capacity Changes



	Rx308	Rx708	RxTP	NHxC
Protein digestibility %	88.29	88.09	87.73	87.34
Energy digestibility %	78.86	78.86	78.43	79.05

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Data from Mussini (2012)

Broiler Trait Progress

- Modern broiler much improved
  - ADG, FCR, Processing yield
  - Improved health & welfare
  - Greater total digestive capacity
    - Ability to consume & digest more feed allowing:
      - Faster growth rate - reduced days in field to achieve given bodyweight
        - » less days to feed bird for maintenance nutrient requirements – significant FCR advantage
      - Well equipped to express genetic potential
  - Achieved without transgenics or cloning

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Where Do We Go From Here?



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Genetic Variation

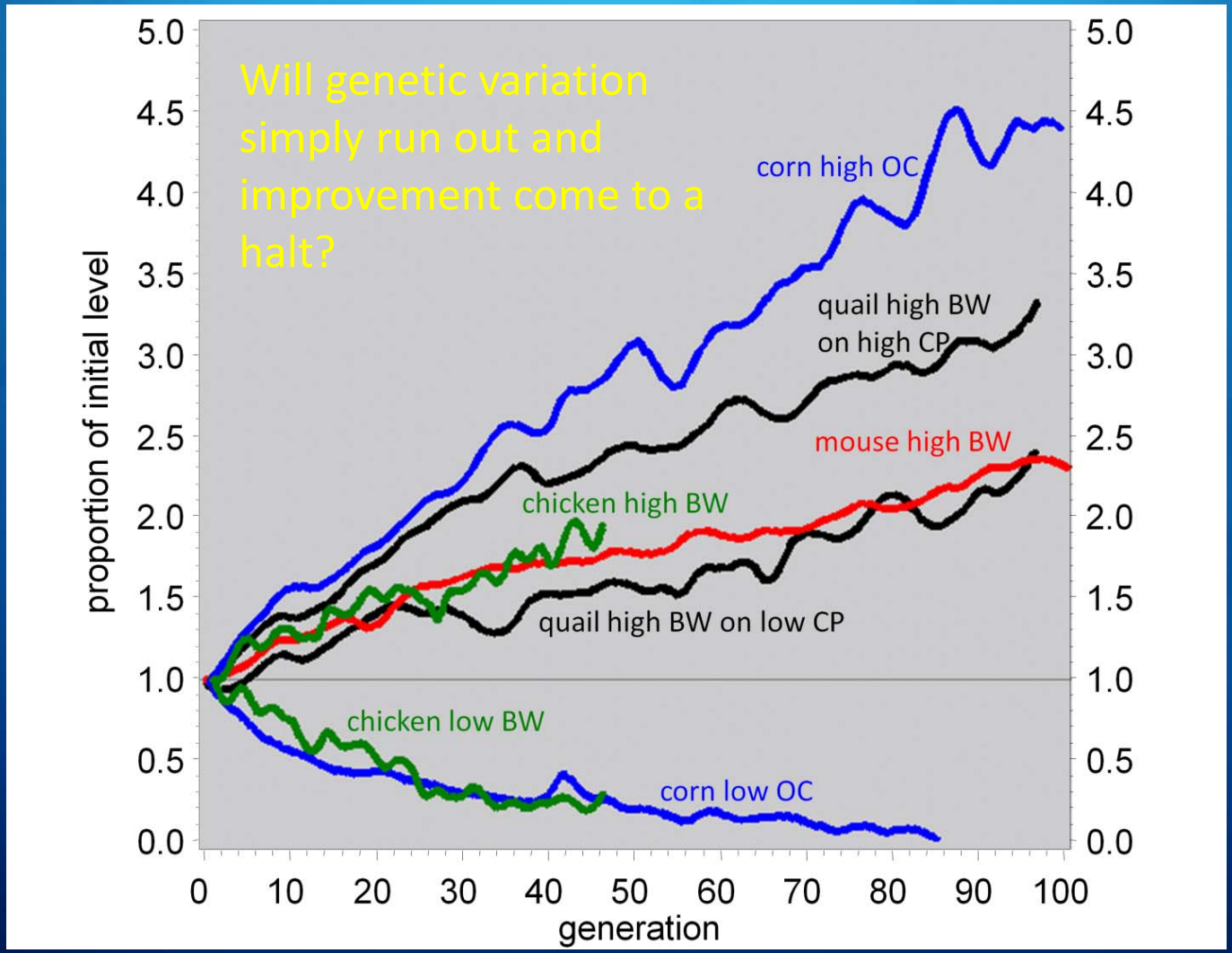
- Future genetic improvement depends on it
- Primary asset of a breeding company
- Must strike a balance between genetic improvement and inbreeding
  - achieved using optimization software to manage genetic contributions and mate allocation within populations
- Requires maintenance of genetic variation
  - Within breeding populations
  - Between breeding populations

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Maintenace of Genetic Variation

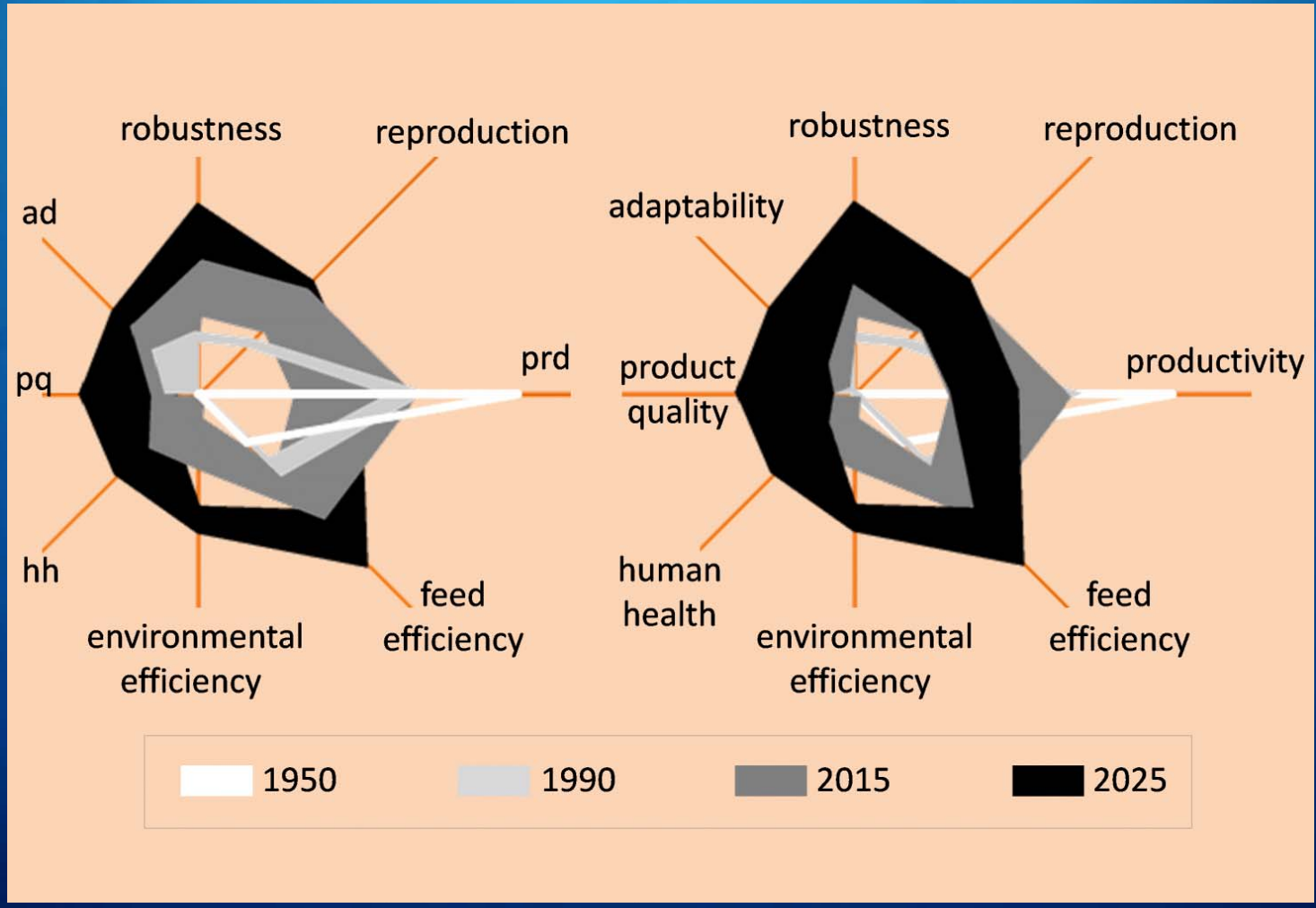


Phenotypic Trends in Long-term Selection Lines



Marks (1996), Renne et al. (2003), Dudley and Lambert (2004) and Johansson et al. (2010)

Evolution of Relative Importance of Elements of Poultry Breeding Goals



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Expectations For the Next 10 Years

Broiler Production Traits - Predicted Annual Progress For Next 10 Years vs USA Broiler Industry Trend		
Trait	Unit - predicted	Unit - USA broiler industry 1995-2012 actual
Bodyweight g	45 to 50	41
FCR	-0.02 to -0.03	-0.02
Mortality %	-0.05 to -0.10	-0.10
Eviscerated yield %	0.20 to 0.25	0.46
Breast yield %	0.25 to 0.30	0.49
Leg defects %	-0.20 to -0.30	
Continuous improvement of:		
Skeletal and cardiovascular system		
Robustness		
Note: > 163 billion broilers in 1995-2012 data set		

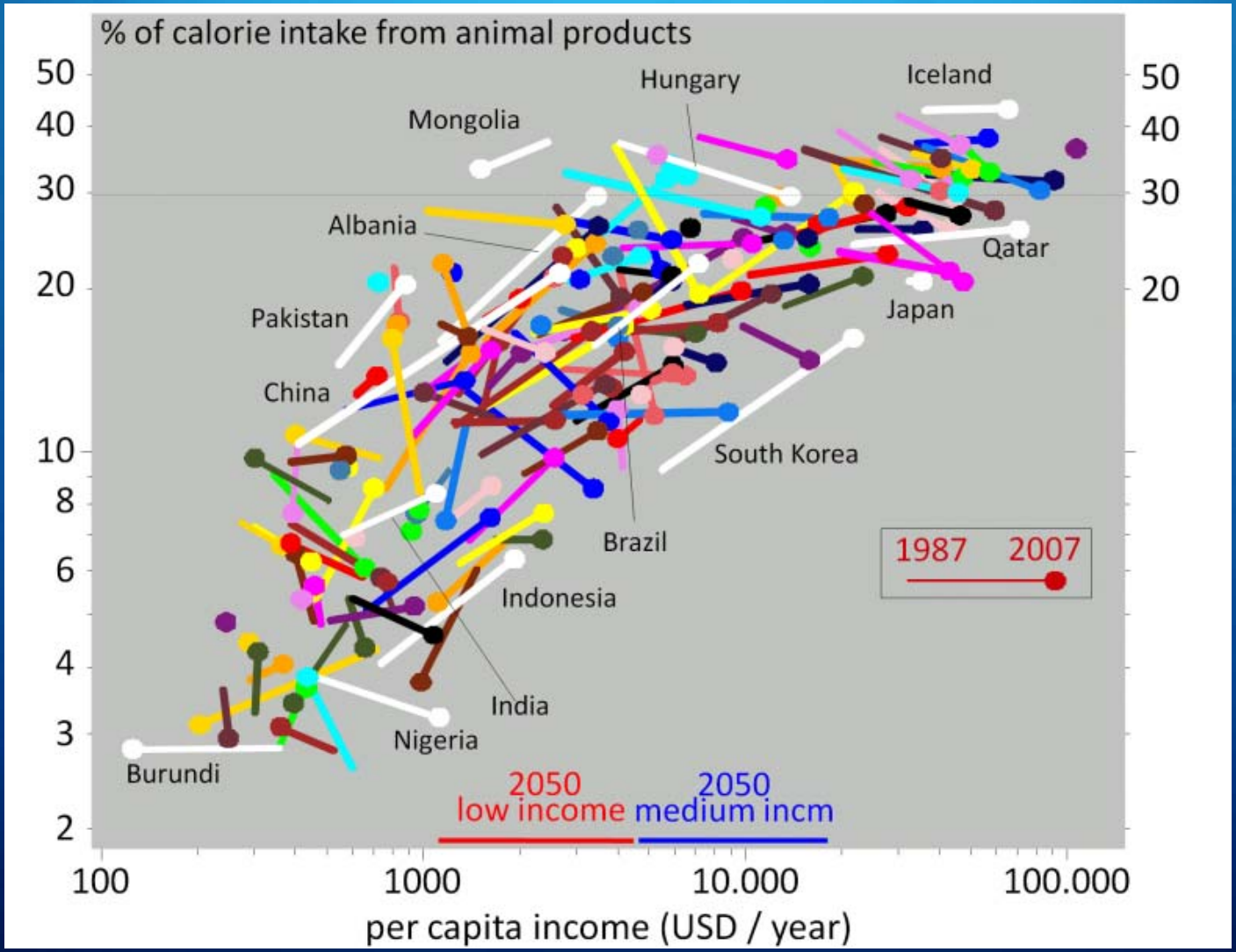
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However - We Know What We Don't Know

- Commercial breeding goals have to adapt to changes in:
  - market demands
  - public policy
  - scientific knowledge
  - technology
  - production management & meat processing conditions
- Natural business evolution

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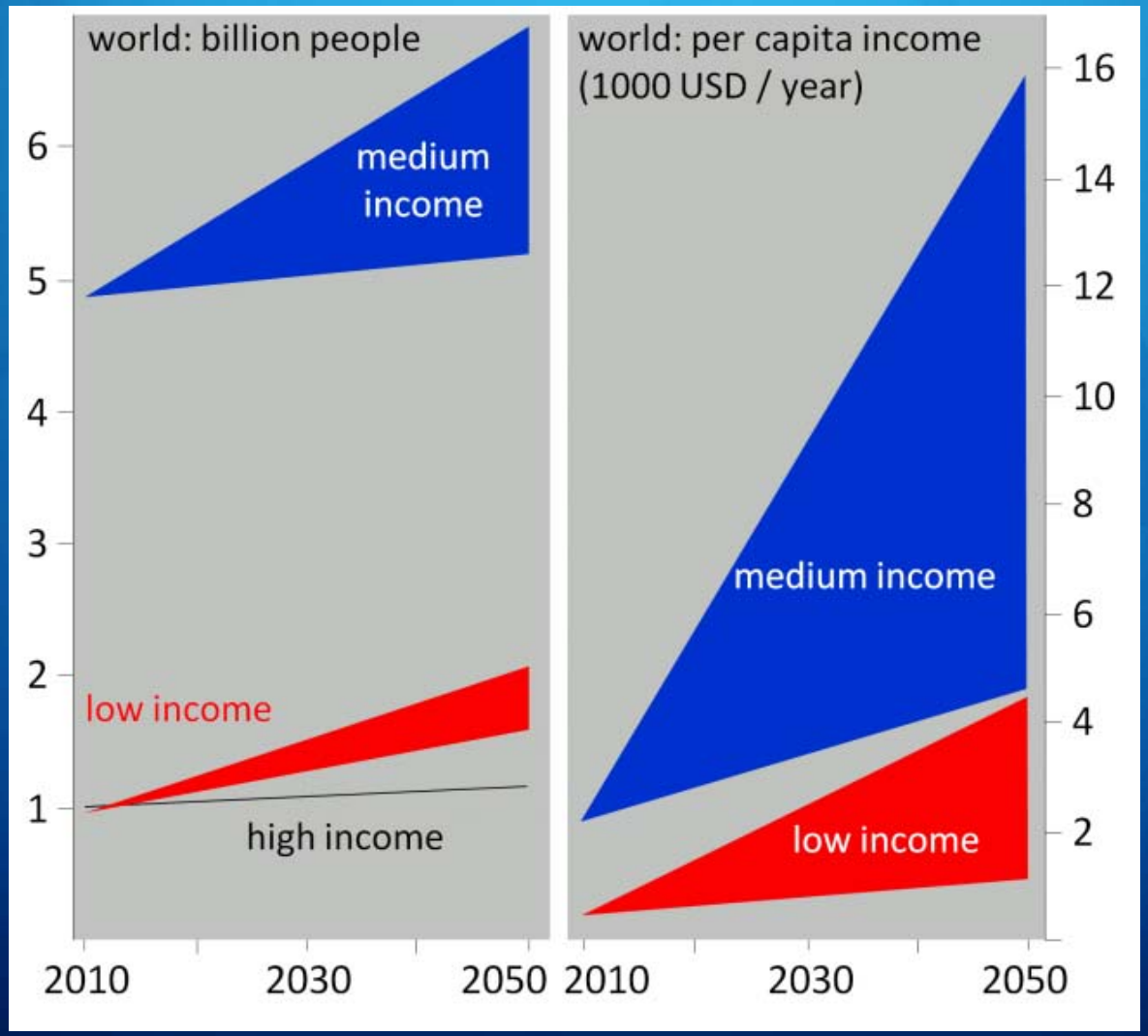
Global Population Dynamics



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Data sources: faostat.org, data.worldbank.org, www.oecd.org

Global Population Dynamics



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Nelson et al. 2010

Conclusions

- Primary poultry breeding industry successfully improving meat chicken traits over last 60+ years
  - Genetic progress has not been exhausted
- Collectively, the broiler chicken industry has been remarkably successful in supplying our world with economical and high quality protein
- Tremendous progress has been achieved in poultry meat production efficiency, bird health and welfare while reducing the environmental impact
- The future requires us to become even more creative

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