Advances in Beef Research as it Relates to Production Alternatives/Systems

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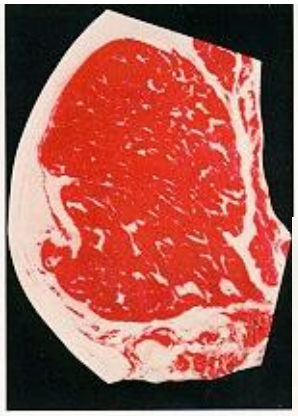
US Quality Grade – Marbling Score System

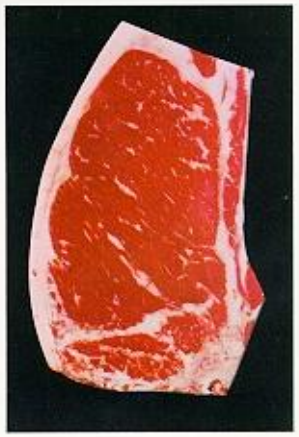
Prime, $2.39/lb ($5.28/kg) HCW

Moderately Abundant

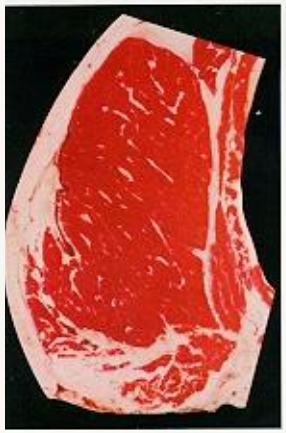


Slightly Abundant

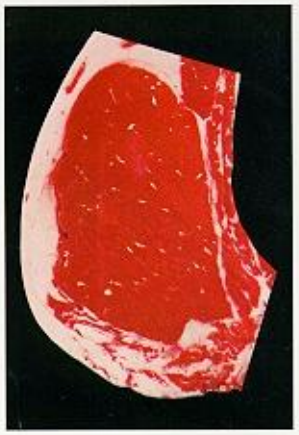
Choice, $2.24/lb ($4.94/kg) HCW



Moderate



Modest



Small

Select, $2.14/lb ($4.72/kg HCW

Slight

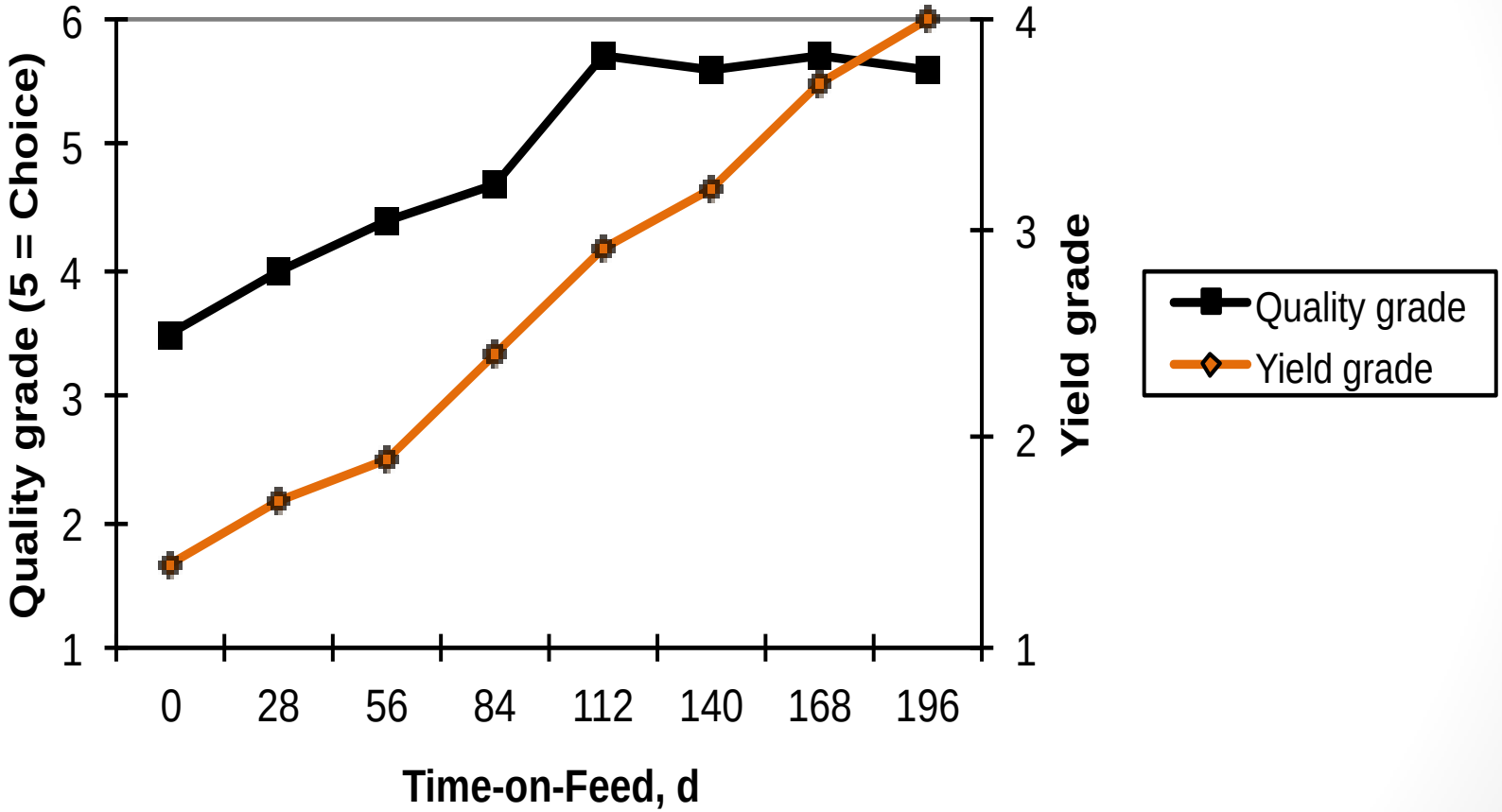
Certified Angus Beef (CAB)

U.S. Beef System

- We want marbling (intramuscular fat) and are rewarded for Choice, CAB and Prime carcasses.
- We do not want excess external fat (subcutaneous fat) and are discounted for yield grade 4 and 5 carcasses.
- Question:
  Can we have one (marbling) without the other (external fat)?

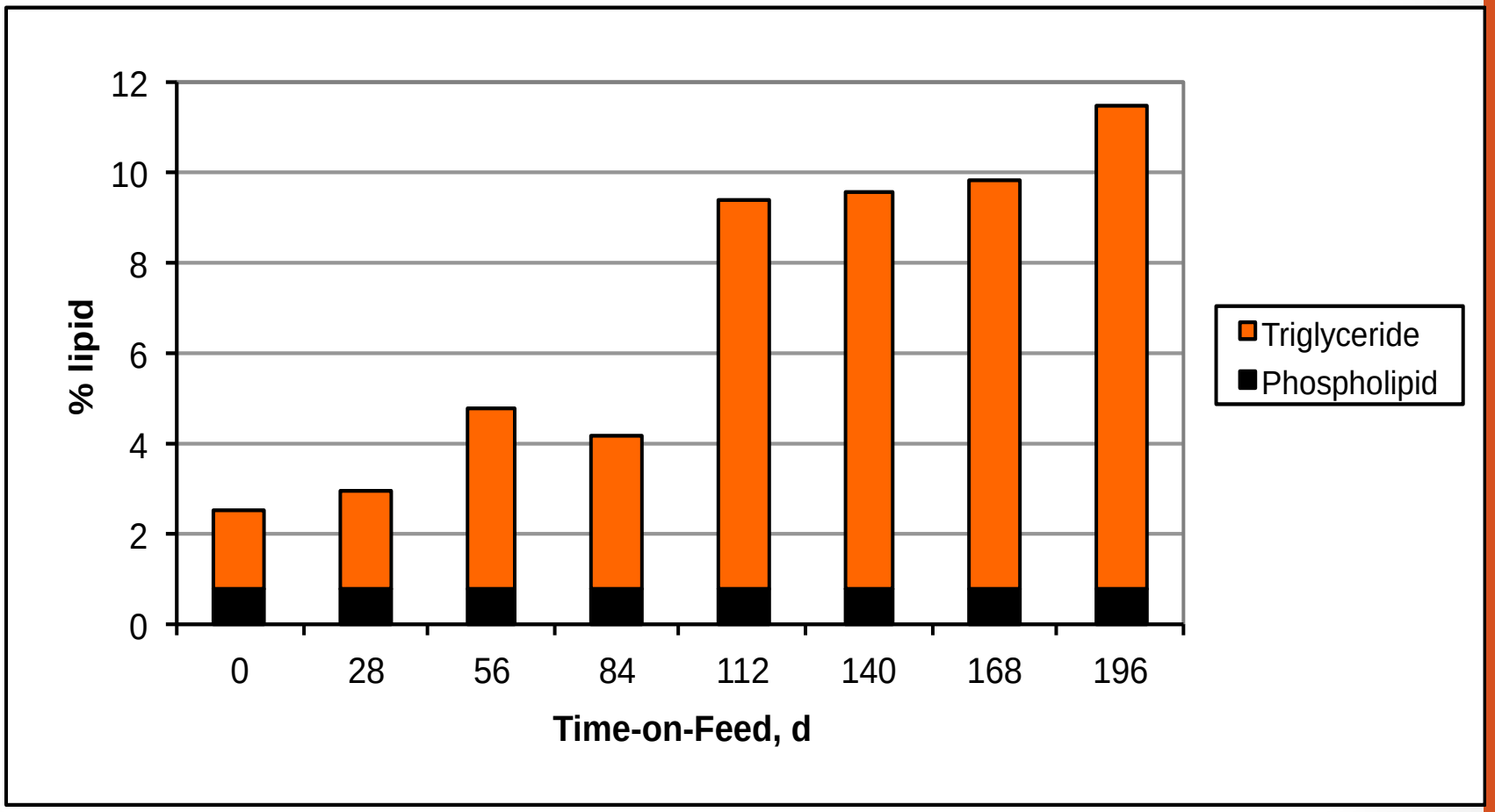
Changes with High Concentrate (Corn Grain) Feeding

Fat Deposition - Feedlot



Duckett et al. (1993) J. Anim. Sci. 71:2079

Intramuscular Fat Deposition



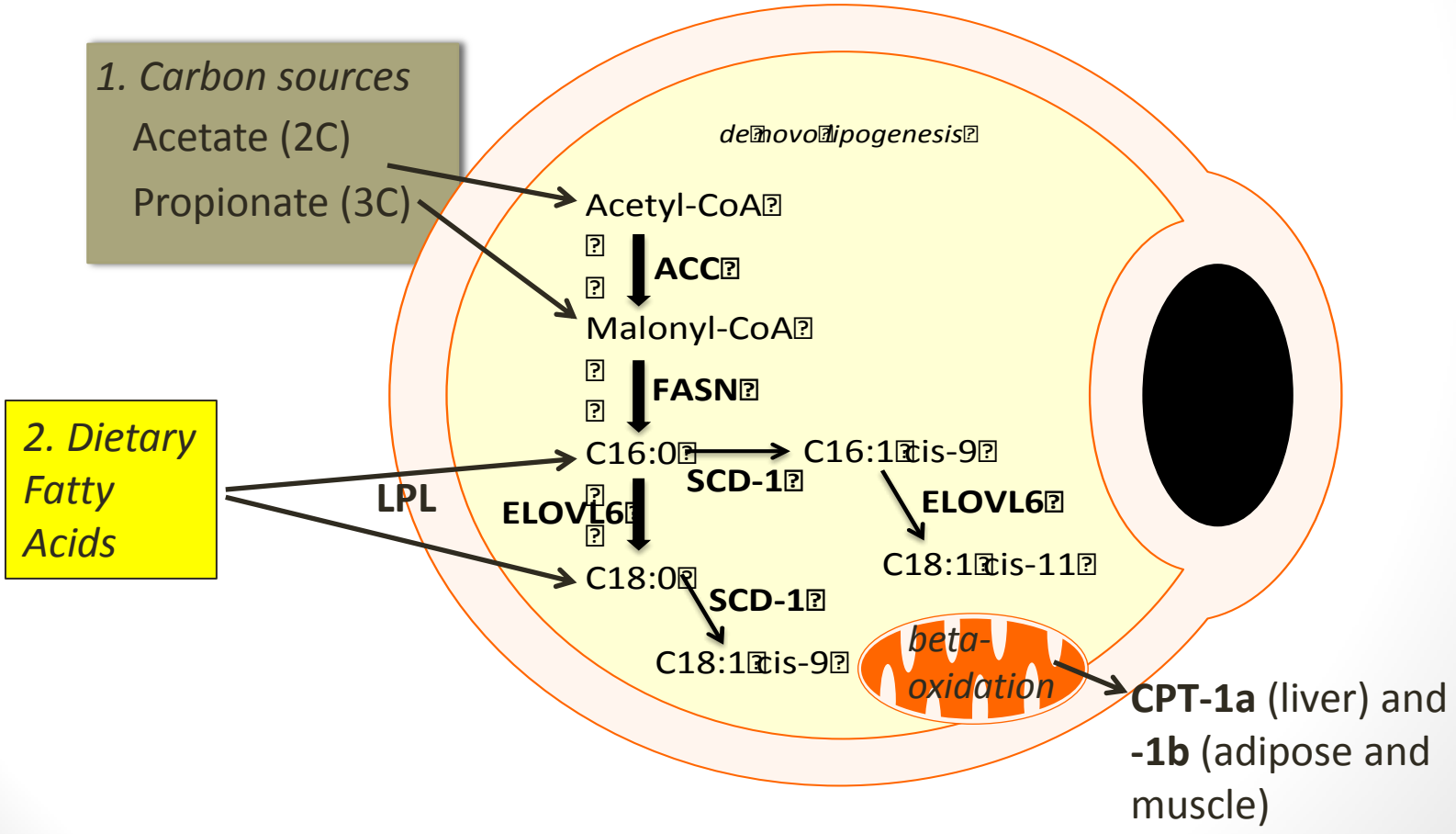
Duckett et al. (1993) J. Anim. Sci. 71:2079

Adipocyte size and number

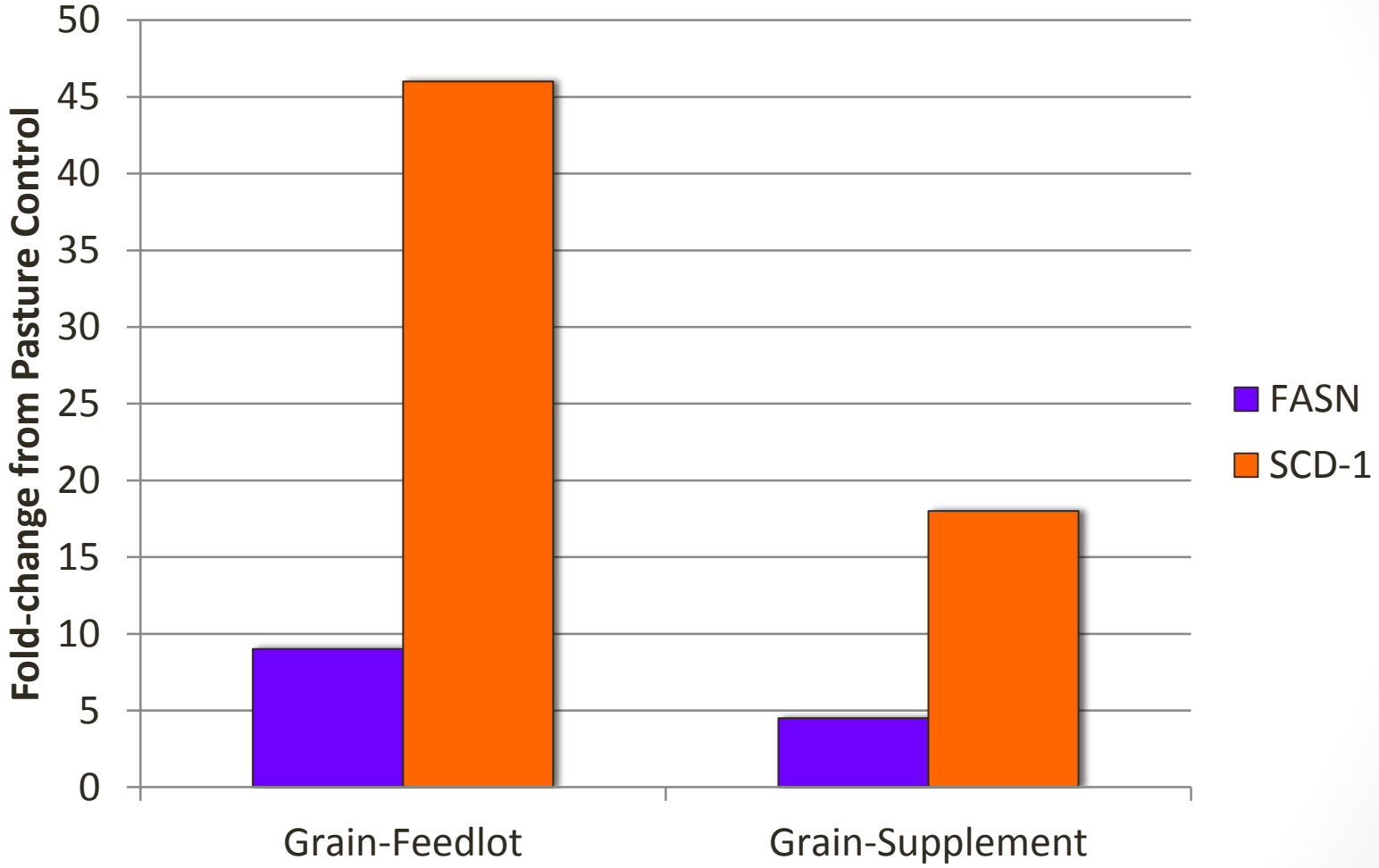
- Lipogenesis
  - Over 95% occurs in adipose tissue of ruminants
- Postnatal adipose tissue growth is result of combined hypertrophy and hyperplasia (Robelin, 1984)
  - **70%** due to increase in cell diameter and volume
  - 30% due to increase in cell number
- Grows in waves
  - Increase in cell number
  - Followed by an increase in volume

Filling the Adipocyte

Two Sources of Substrates to fill the adipocyte and increase marbling



Up-Regulates Lipogenic Genes



Duckett et al. (2009) J. Anim. Sci. 87:1120

What if we started earlier with Grain?

- 40 steers
  - Phase 1 (about 30-d post weaning; Nov. to Feb. 19)
    - Feedlot (**F**; n = 20; 75% concentrate and 25% silage)
    - Pasture (**P**; n = 20; novel endophyte tall fescue, winter annuals)
  - Phase 2 (Feb. 20 – May 28)
    - All on Pasture (**P;** alfalfa, cowpea)
  - Phase 3 (June 1 – 568 kg LW)
    - Feedlot-Pasture-**Feedlot** (**F-P-F**)
    - Feedlot-Pasture-**Pasture** (**F-P-P**)
    - Pasture-Pasture-**Feedlot** (**P-P-F**)
    - Pasture-Pasture-**Pasture** (**P-P-P**)

Overview of the treatments

Phase 1: Oct - Feb

Feedlot (F; n =20) | Pasture (P; n =20)

Phase 2: March - May

Pasture (P; n = 40)

Phase 3: May – 568 kg

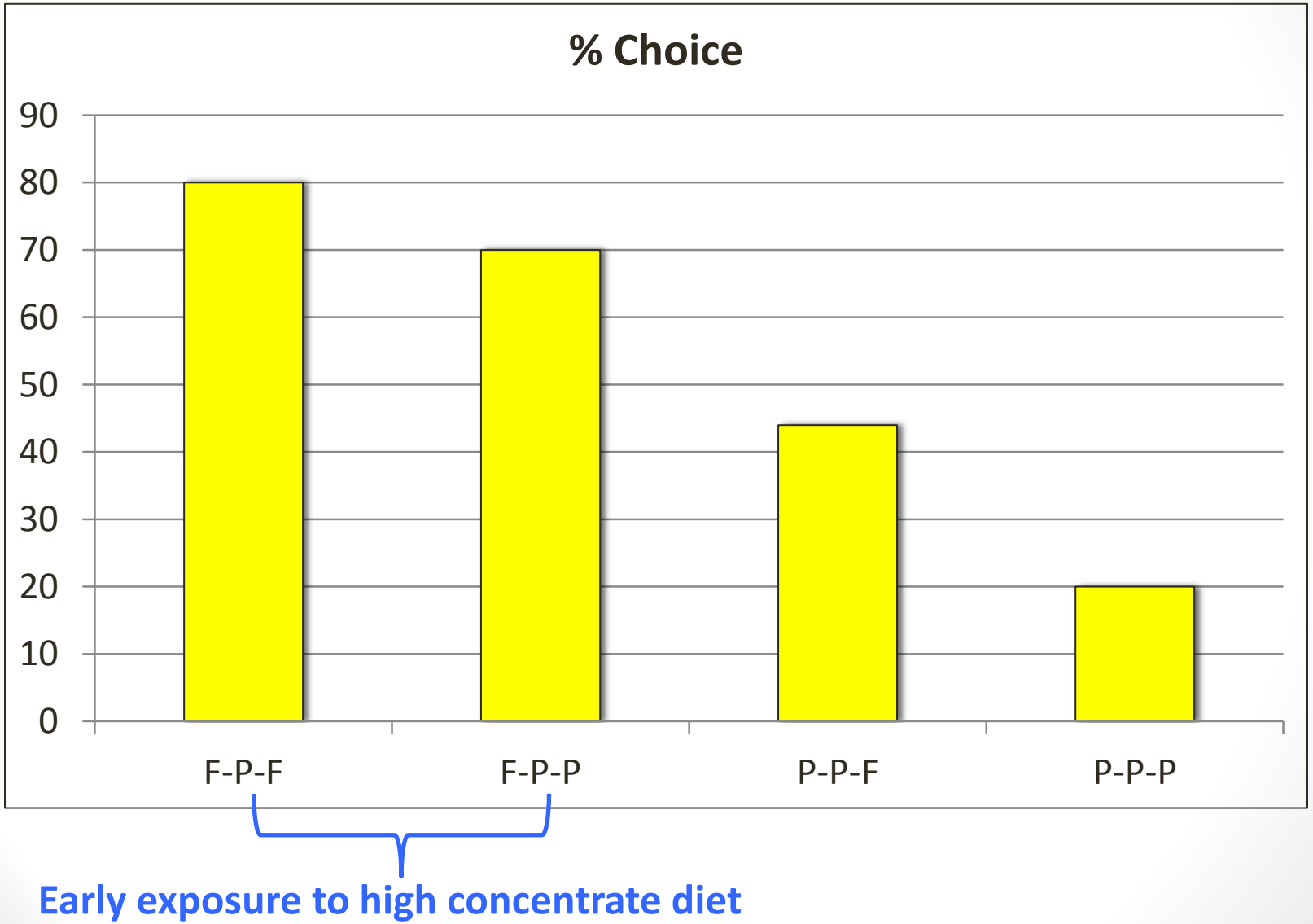
F-P-F | **F-P-P** | **P-P-F** | **P-P-P**

Carcass Data

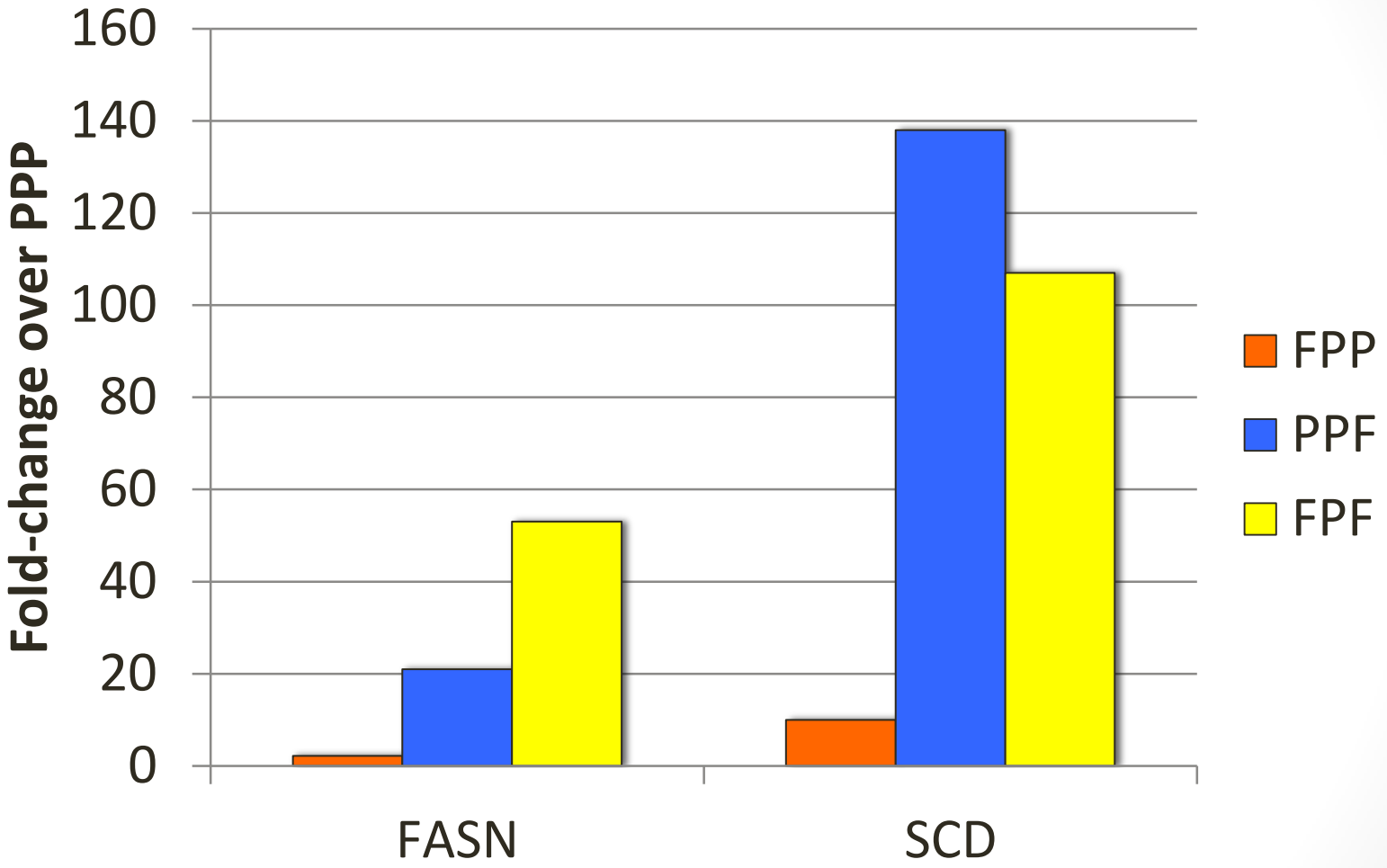
Phase 1	**F**	**F**	**P**	**P**
Phase 3	**F**	**P**	**F**	**P**
Treatments	**F-P-F**	**F-P-P**	**P-P-F**	**P-P-P**
Days to 568 kg target#	286	342	300	342
Live weight, kg	575	562	581	557
Hot carcass weight, kg+	326	308	323	297
Overall ADG, kg/d+	1.10	0.84	1.08	0.81
Fat thickness, cm+	1.09	0.89	1.32	0.81
Ribeye area, cm^{2}#	82.4	72.1	76.7	75.8
Marbling score*+	580	536	508	472
% Choice	**80%**	**70%**	**40%**	**20%**
Yield grade#	2.65	2.76	3.17	2.34

* Phase 1 ($P < 0.05$)
\+ Phase 3 ($P < 0.05$)
\# Phase 1 x Phase 3 Interaction ($P < 0.05$)

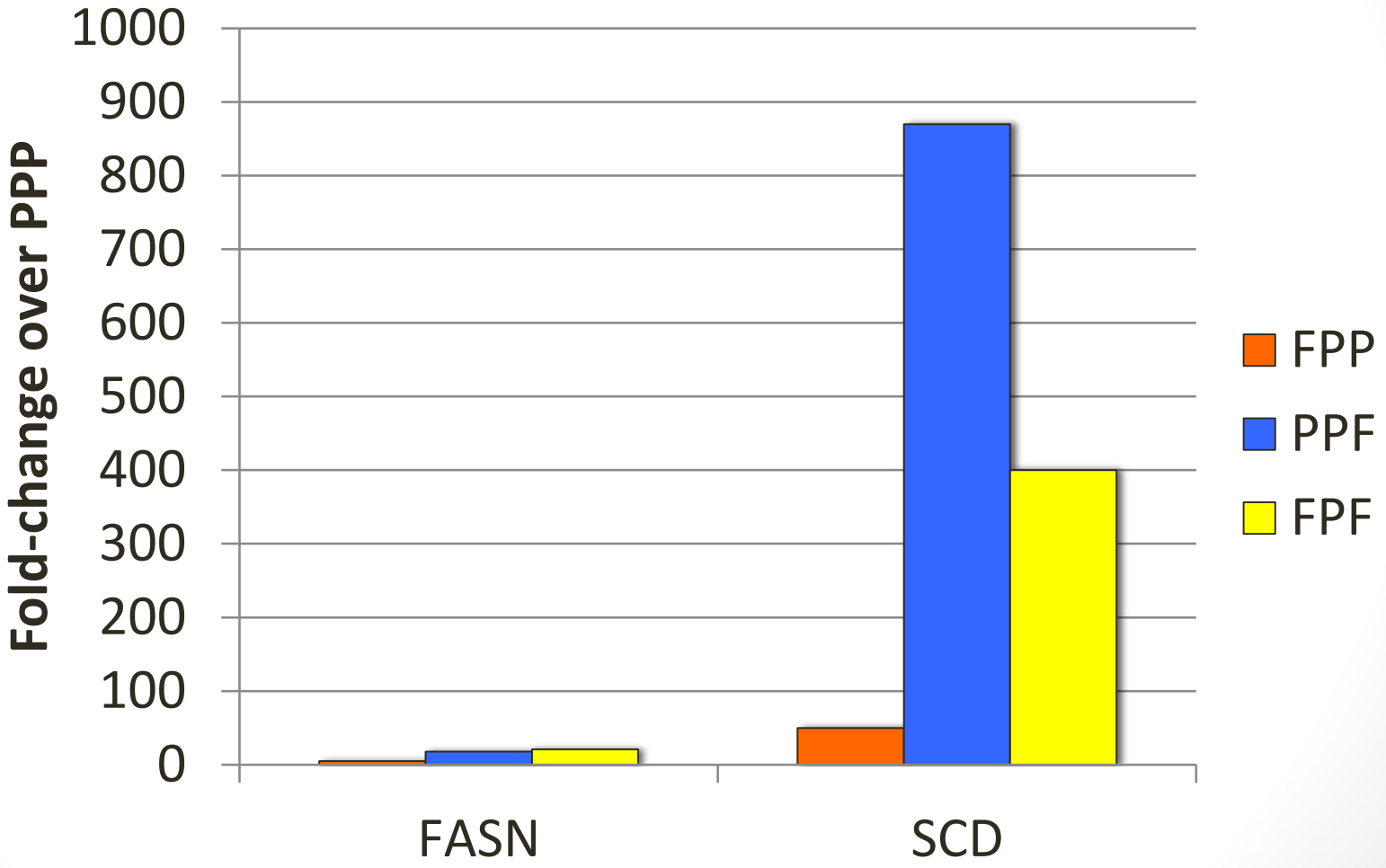
Percent Grading Choice



Changes in Lipogenic Genes



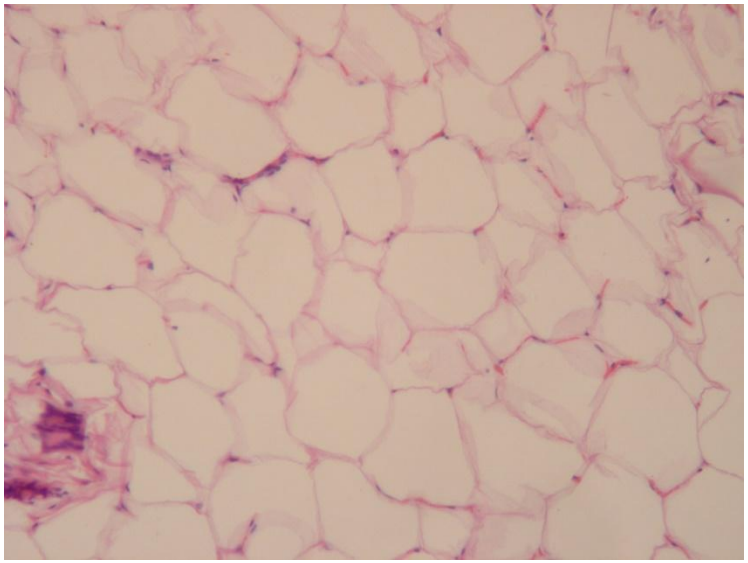
Changes in Lipogenic Genes – Argentina



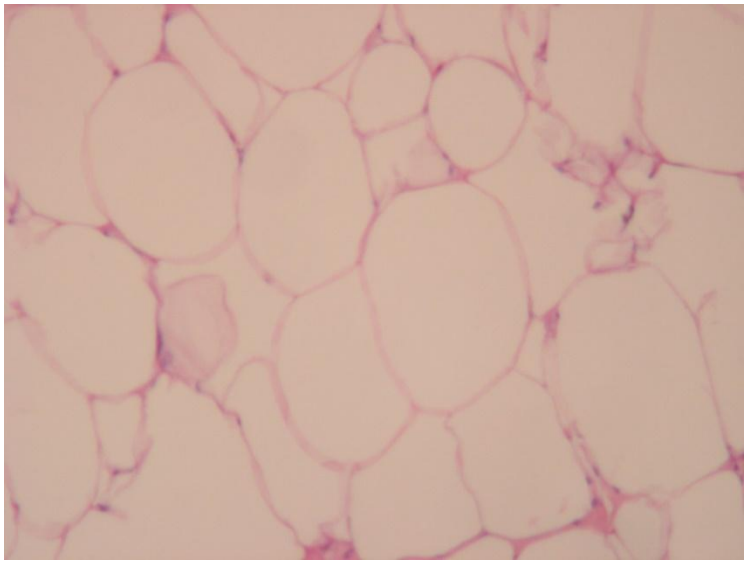
Testa and Pavan, 2015

Turns on Fat Synthesis

Pasture



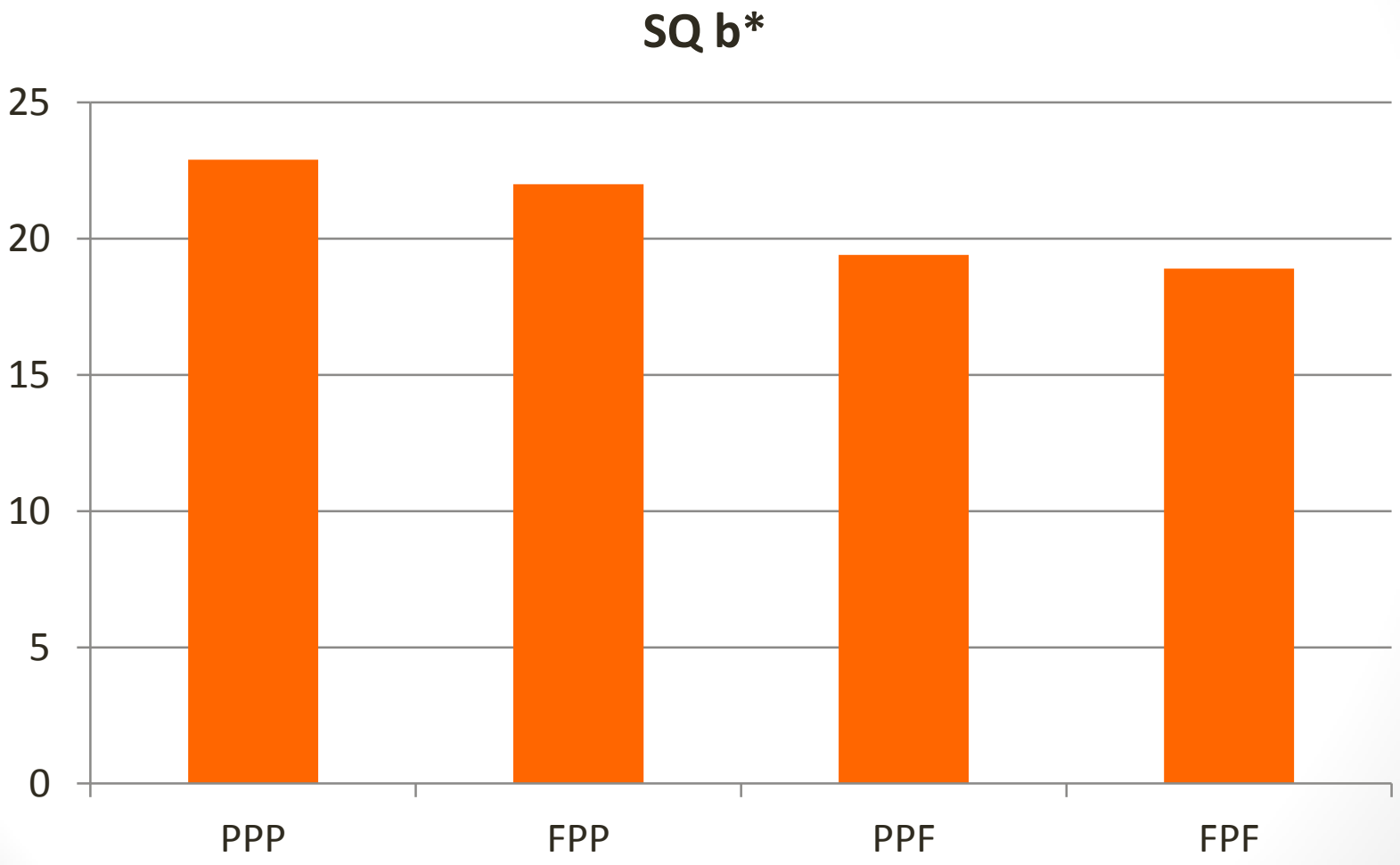
High-concentrate



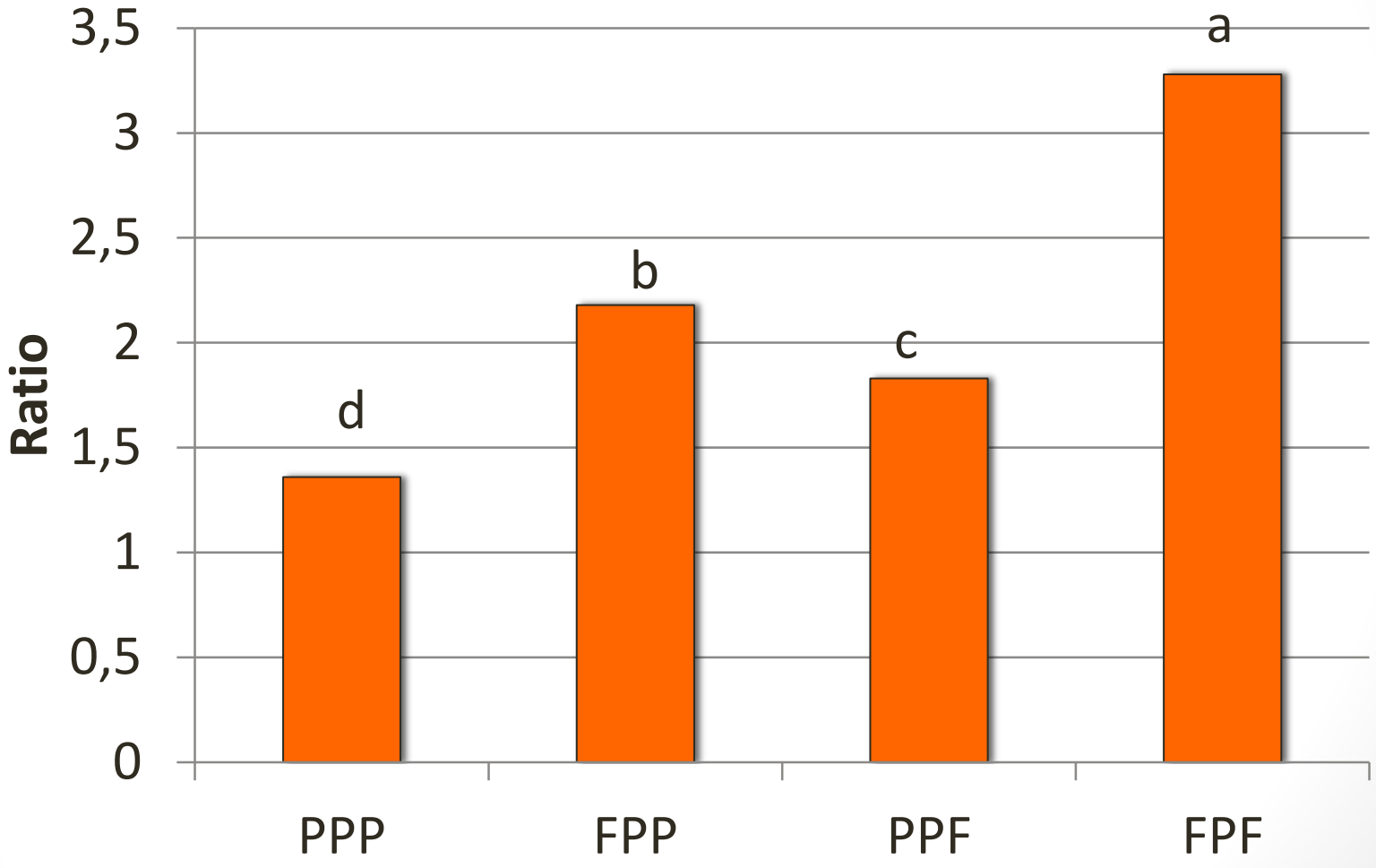
Enlargement of the Fat cell

Testa and Pavan, 2015

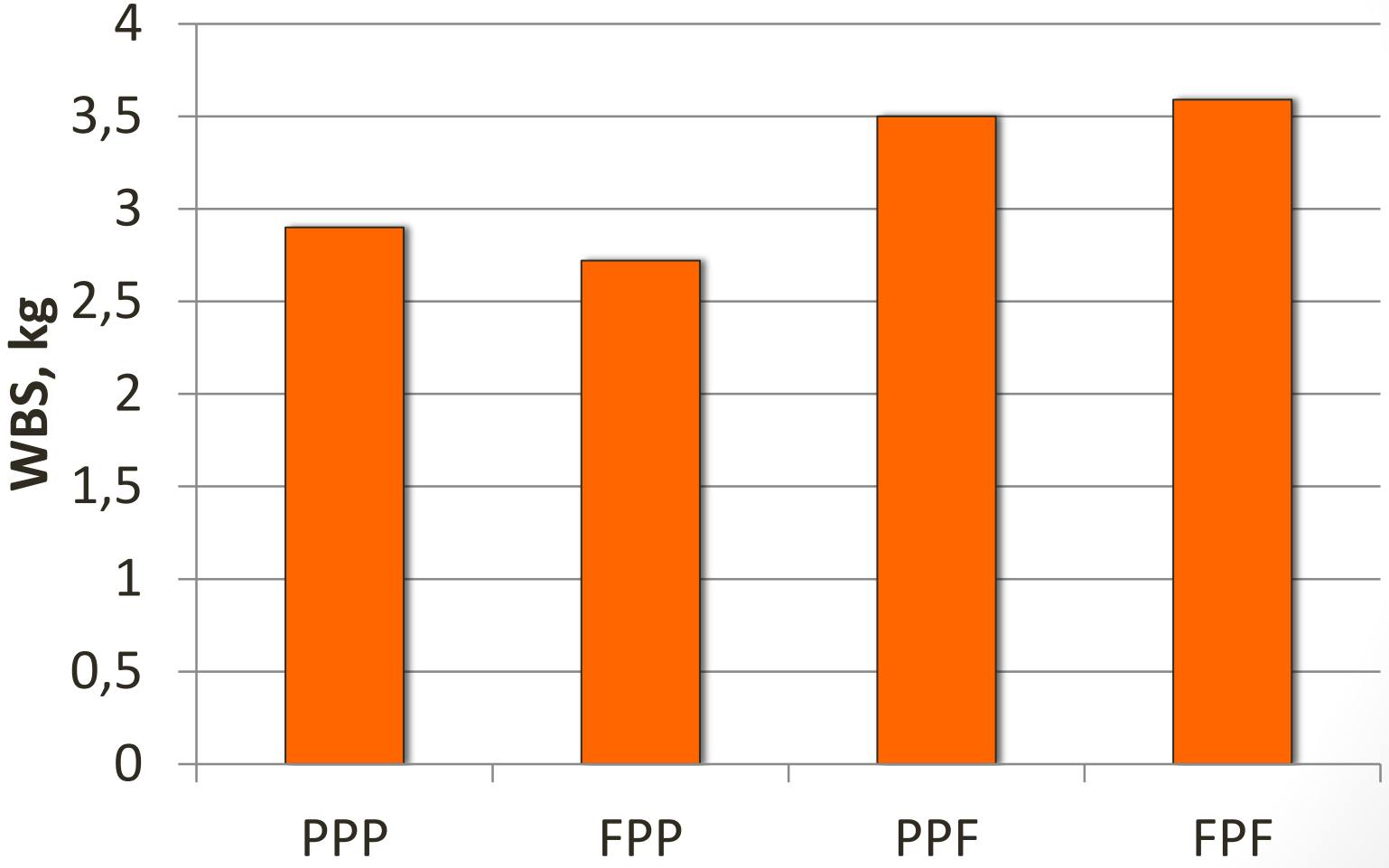
Color de la grasa



Ratio of Omega-6:Omega-3



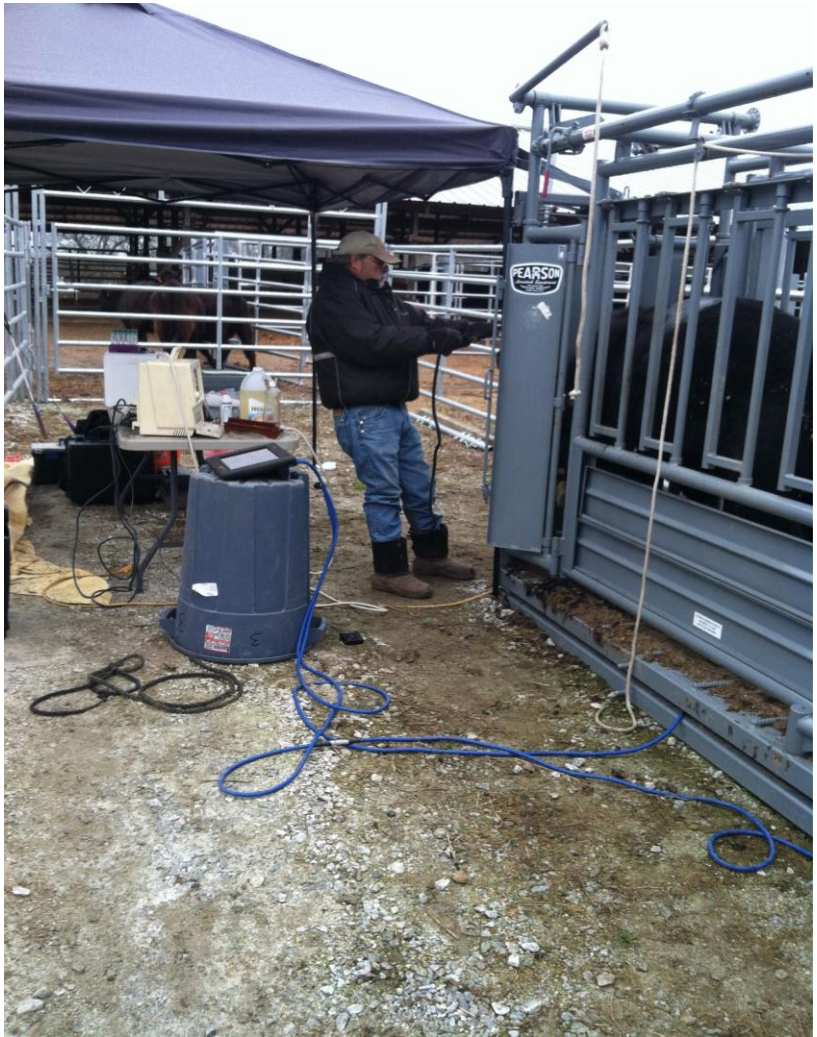
Warner-Bratzler Shear Force



Choice
Yield grade 2
318 kg HCW

F-P-P

What happened during this early time period – PHASE 1?



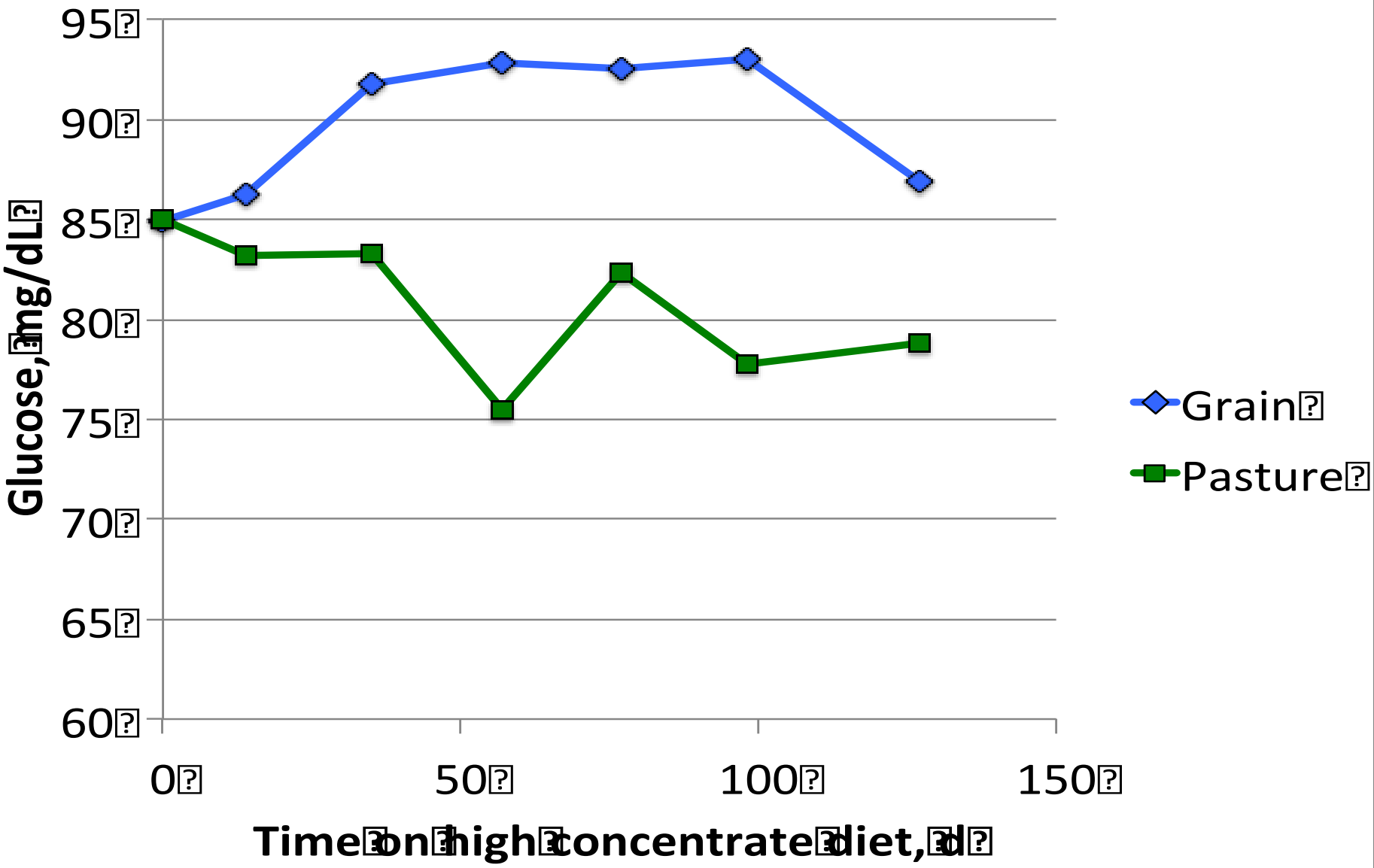
Phase 1 – Early Exposure to Grain

- Repeat Phase 1 experiment, **127 d**
- 20 Angus steers
- Postweaning (8 mo of age)
- Two treatments:
  - 1) pasture only
  - 2) high concentrate diet (90% grain/10% grass hay)
- Blood samples, ultrasound measurements over time
- Carcass data and composition at 127 d on feed(pasture)

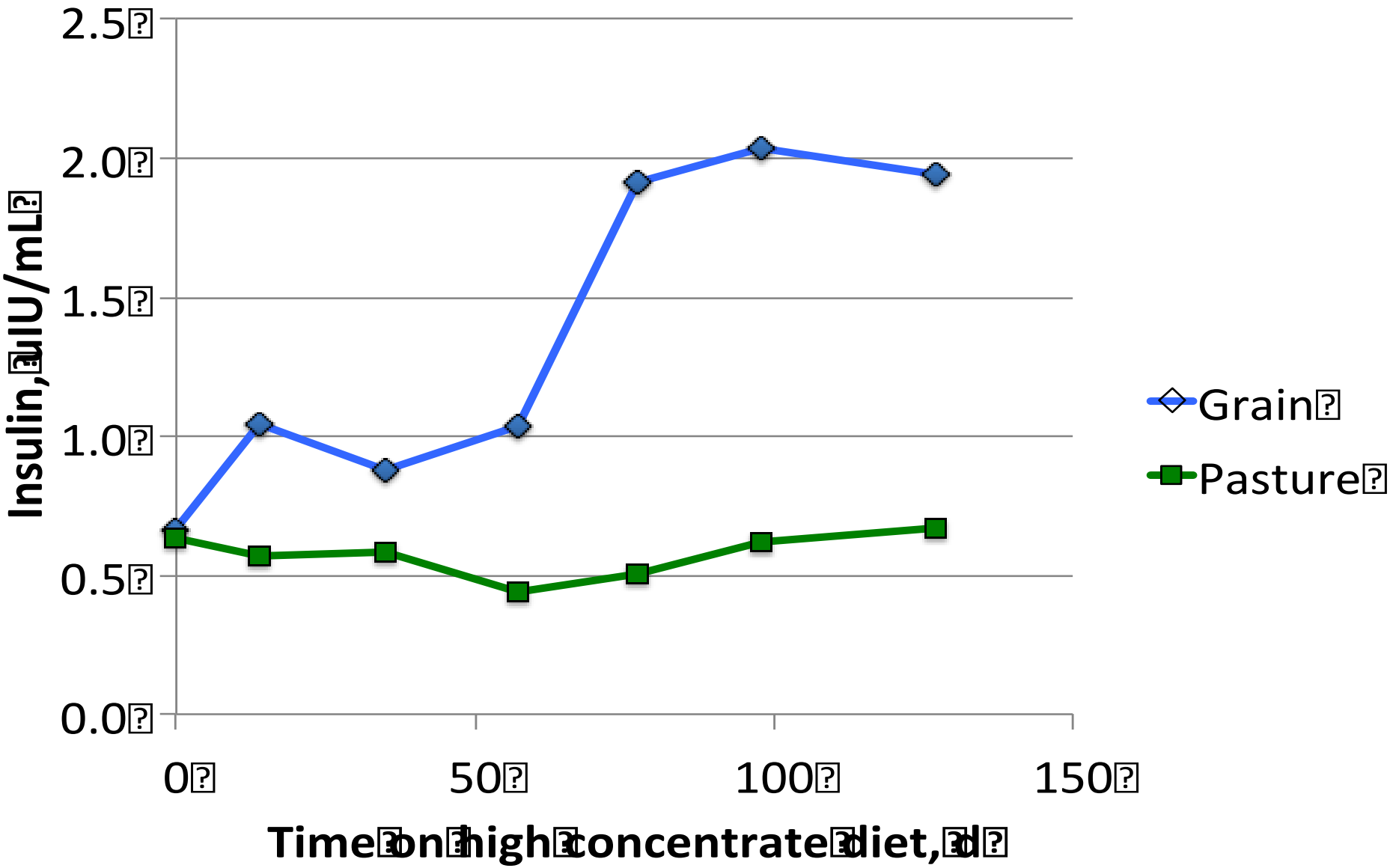
Performance

	Pasture	High Concentrate
Initial Live Weight, kg	260	261
Final Live weight, kg	338	422
Average Daily Gain, kg/d	0.69	1.57
DMFI, kg/d	-	8.4
Feed:Gain	-	5.38

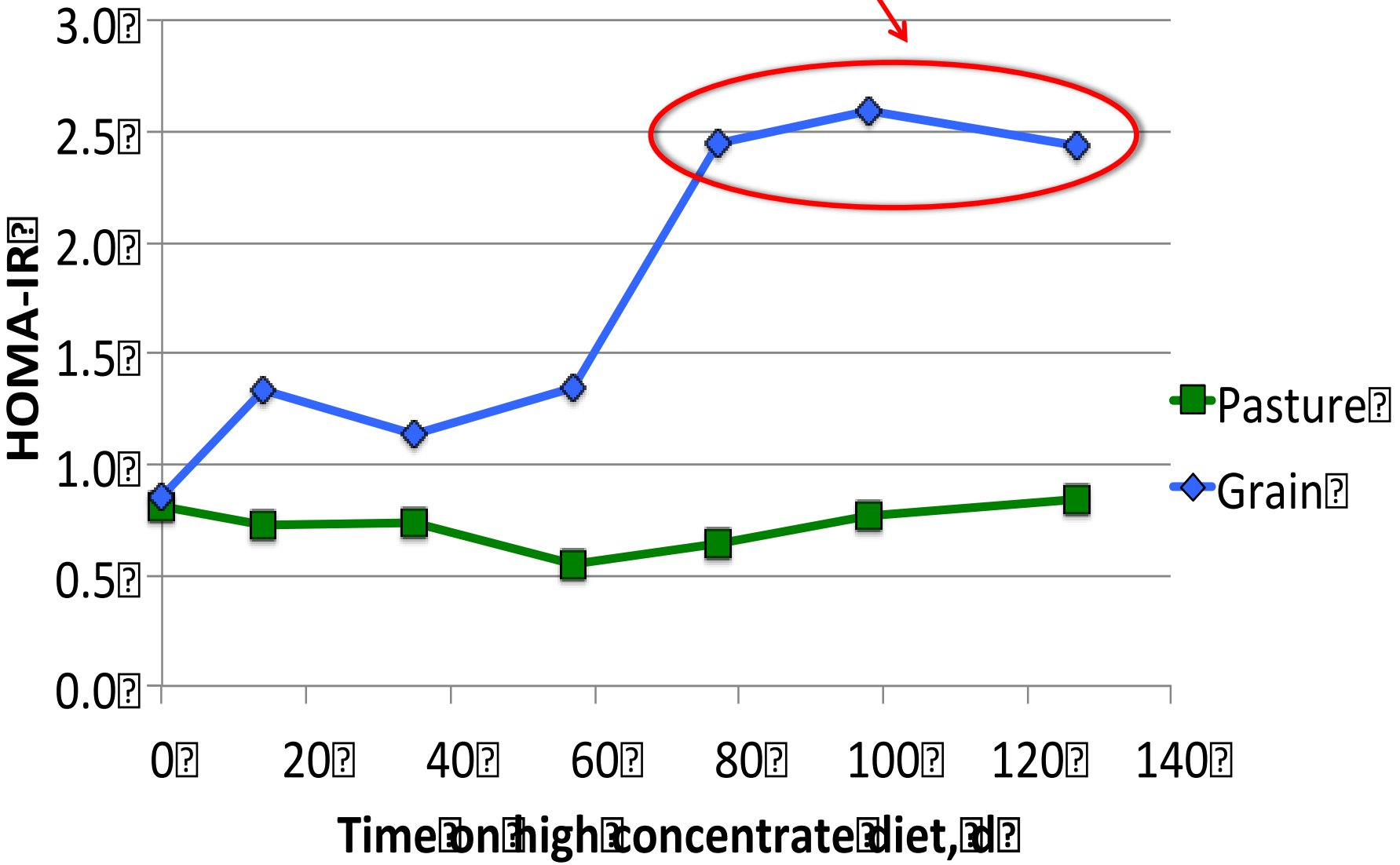
Glucose Response



Insulin Response



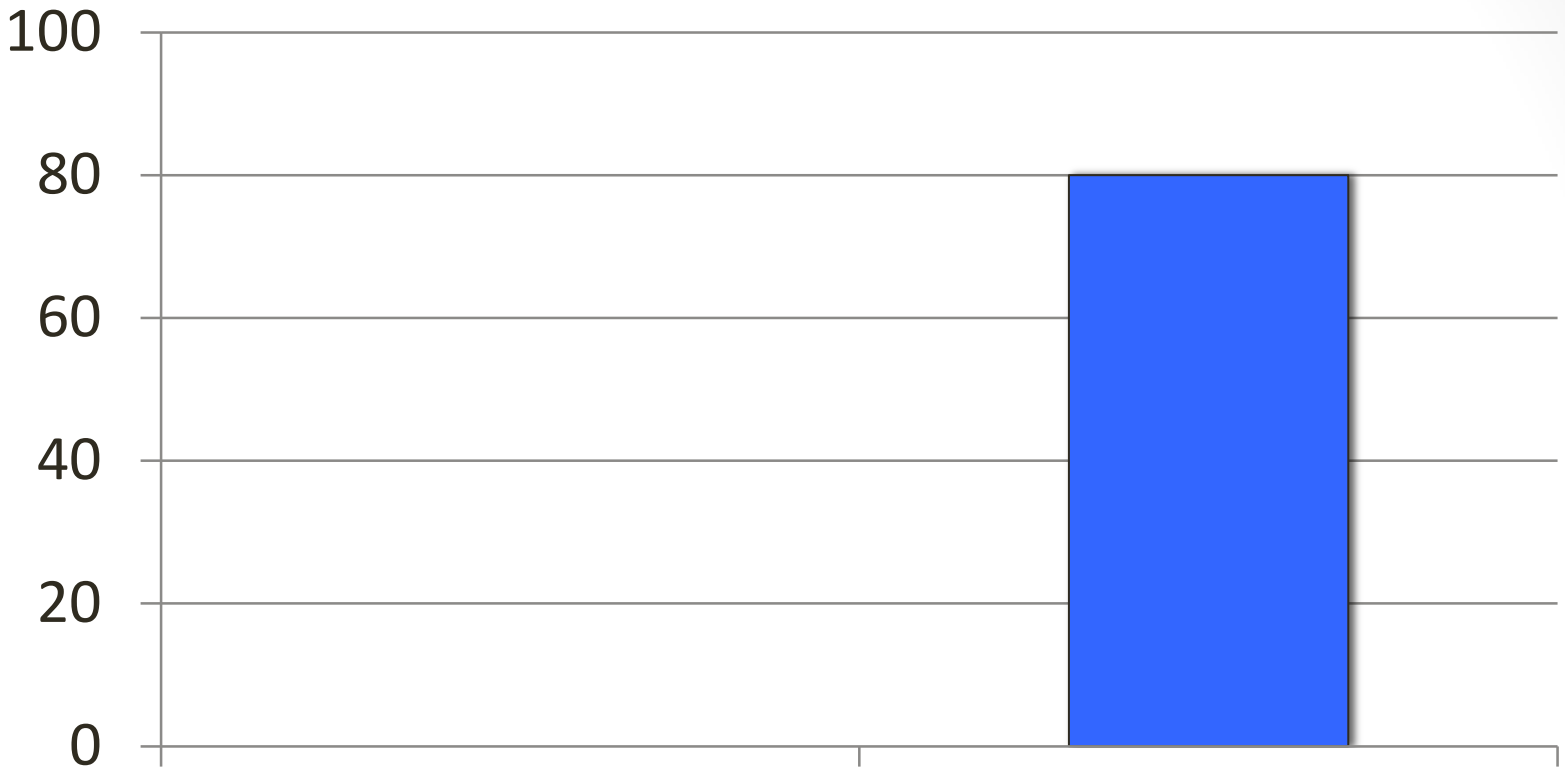
Insulin Resistance



Carcass Quality Results

	Pasture	High Concentrate
HCW, kg	179	248
REA, cm^2	57.9	72.3
Fat thickness, mm	0.8	4.5
Yield grade	1.7	1.9
Marbling score	340	548
Quality grade	Standard	Choice

Percent Grading Choice

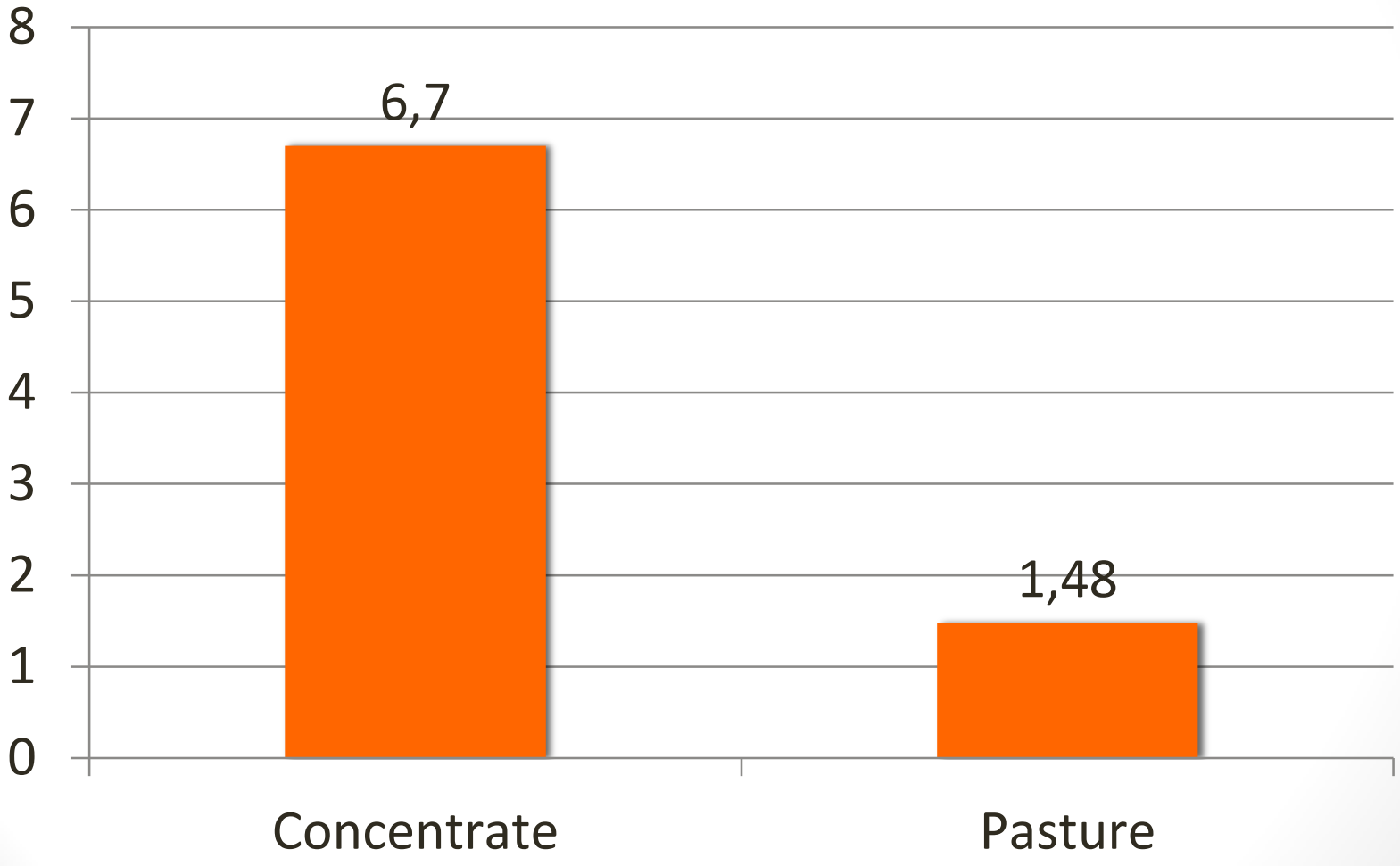


178 kg HCW
0.88 mm FT

248 kg HCW
4.5 mm FT

127 d

Ratio of Omega-6 to Omega-3



Conclusions

- Exposure to high concentrate, corn grain rations after weaning
  - Increases marbling deposition
  - 80% Choice after 127 d on feed
  - Marbling remains high after 200 d on high quality forage (FPP)
  - High feed efficiency during this time period 5.38 feed:gain

- Steers appear to develop an insulin resistant state after about 77 d on feed
- Marbling deposition follows this
  - Humans with Type-2 diabetes have increased intramuscular fat stores
- Exposure to high corn grain diets
  - increases expression of genes involved in fat synthesis
  - Turning the fat cell on and increasing in size (diameter)
- Increased marbling with less external fat deposition
  - 80% Choice with 4-8 mm fat thickness