Feed Efficiency in Beef Finishing Systems

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Feed costs

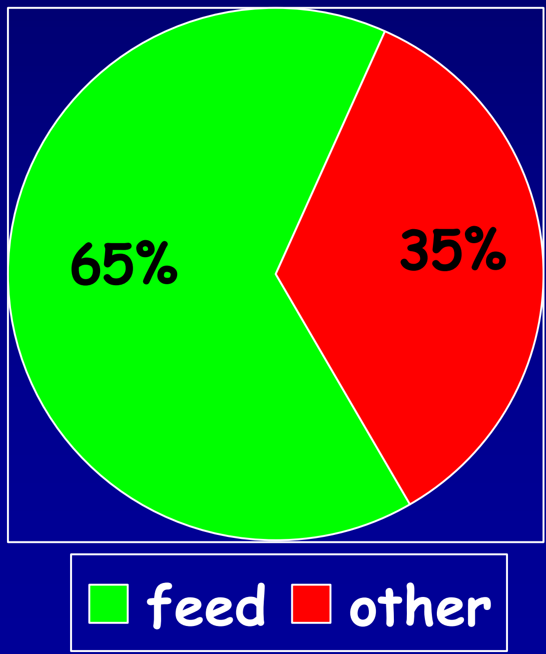
- *"Conversion of feed to product"*

- Providing feed - particularly during the indoor winter period - is the LARGEST variable cost in BEEF production:

  70%+

Variable costs

Grange suckler calf-to-beef system



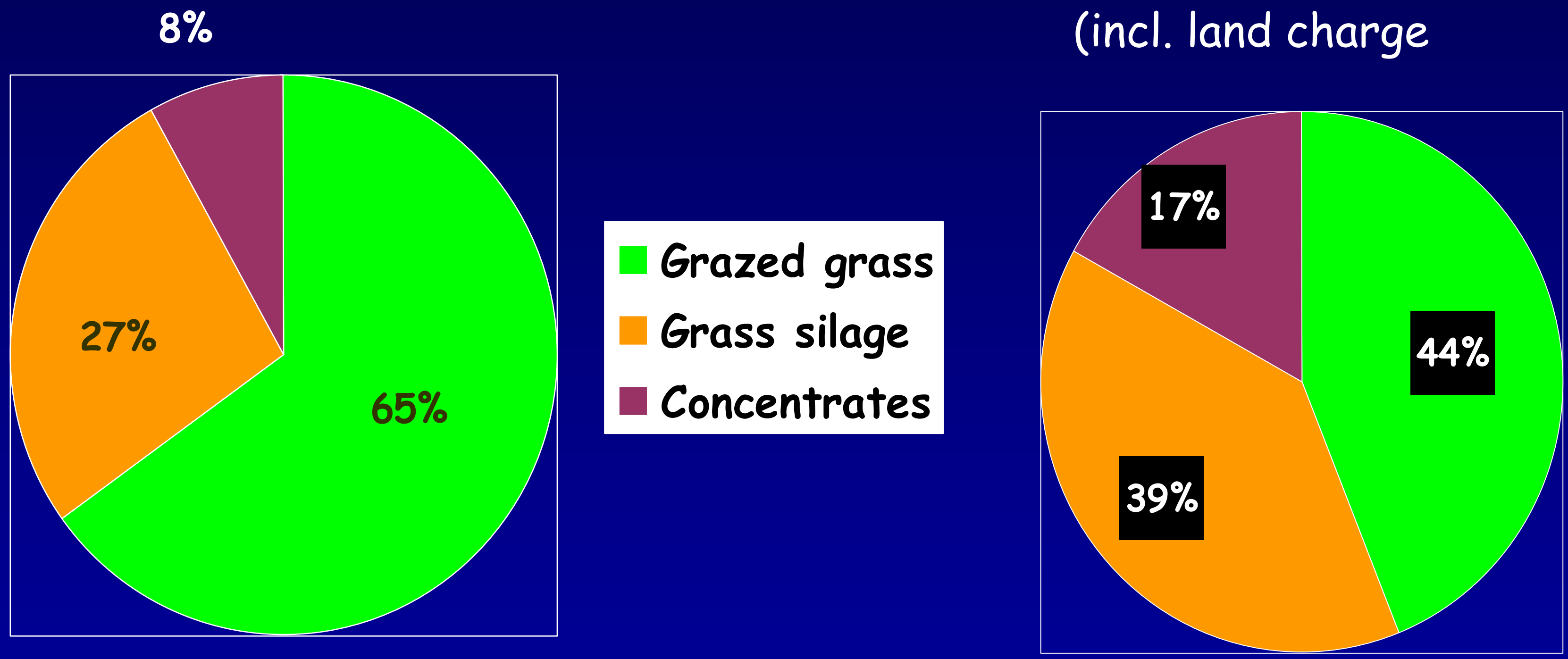
Annual Feed Budgets (/cow unit)

Suckler calf-to-Beef: 24 mth steer

DMI

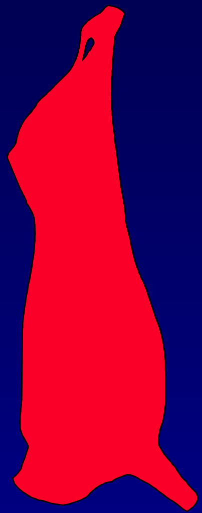
€

(incl. land charge



Optimising the contribution of grazed grass to the lifetime intake of feed and provide silage & concentrates as efficiently and at as low as cost as feasible

Profit € = Income - Costs



Feed costs

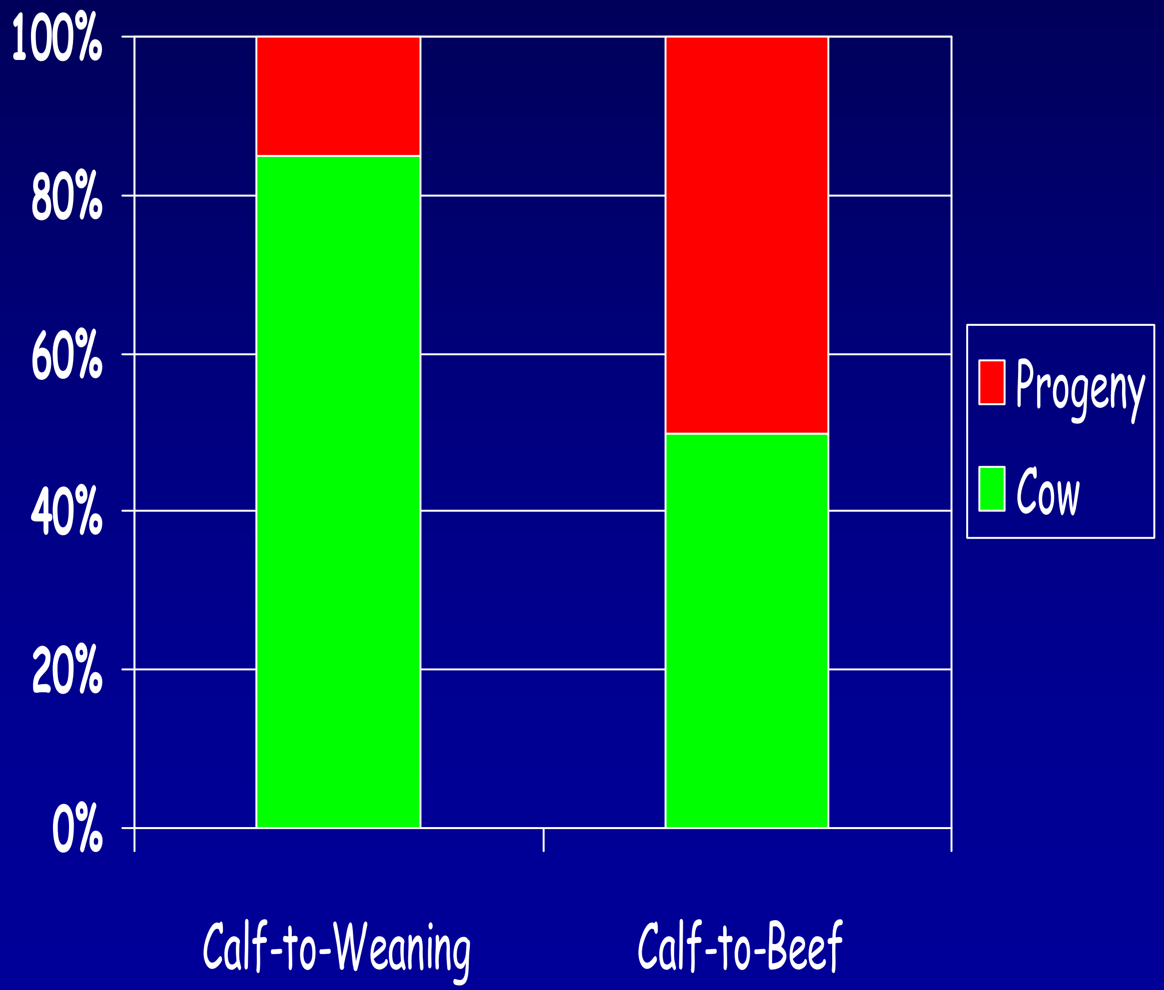
Cow Herd

Progeny

Improvement in feed efficiency is worth **<u>4-8 times more</u>** than an equivalent increase in growth rate (Gibb and McAllister, 1999; Okine et al., 2004).

High maternal cost to Suckler beef production

Cow Feed Requirements



In beef production

Maintenance Reqs.
= ~70%
of total
feed energy
requirements

Feed efficiency

- Traditionally, expressed

$$\boxed{\text{FCR = feed intake : weight gain}}$$

Selection for FCR

- Similar to selection for growth rate
- Improves FCR in growing animal

BUT

↳ Increase in cow size

↳ Increase in maintenance requirements

↳ Increase costs € & Environment

Improve the efficiency of growth / finishing phase

BUT not necessarily the entire production system

Increasing cow size?

- France:
  - "Frame size of beef cows increased during the last 25 years – genetics + feeding"
    - e.g. carcass weight of cull cows increased from 357 to 408 kg (Lherm et al., 2004).
- UK:
  - "Avg. cow live weight….considerably higher than 20 years ago, probably as a result of genetic selection for higher body weight"
    - 680 kg vs. 434 – 560 kg (Hyslop, 2006)

Residual Feed Intake (RFI)

Alternative measure of feed efficiency <u>independent</u> of growth & body size

Expected requirements for maintenance & growth

RFI = animals actual intake - predicted intake

Assume:

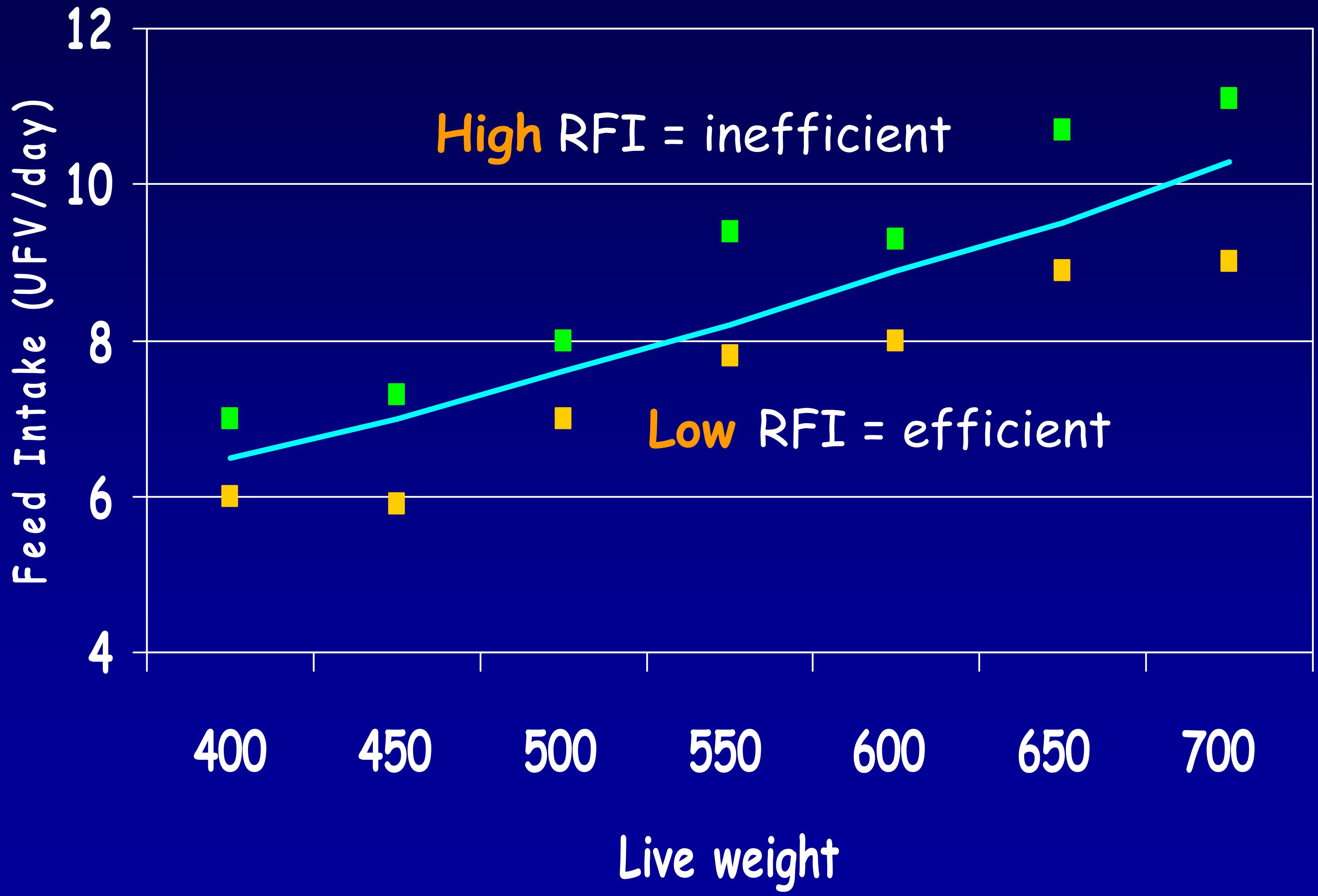
- 2 steers: LW = 600 kg: ADG = 1..0 kg
  - EXPECT them to eat 10 kg DM/day
    - BUT one eats 11 kg DM & one eats 9 kg DM

Steer eating 1 kg <u>more</u> than expected = RFI (+1) = <u>High</u> = less efficient

Steer eating 1 kg <u>less</u> than expected = RFI (-1) = <u>Low</u> = more efficient

Therefore, negative or lower RFI values are better

Residual Feed Intake



In any population of cattle, within breed, = >LARGE variation in Feed Efficiency

Table 1: Intake and performance of beef cattle with high (Inefficient), medium and low (efficient) RFI

	RFI[1]				RFI[2]				RFI[3]			
	High	Med.	Low	Sig.	High	Med.	Low	Sig.	High	Med.	Low	Sig.
DMI (kg/day)	6.3	5.9	5.5	***	10.2	9.6	9.0	***	7.3	6.8	6.2	***
Live weight (kg)	316	327	330	NS	522	523	512	NS	254	255	252	NS
ADG (kg)	0.60	0.61	0.60	NS	1.66	1.63	1.53	NS	1.52	1.49	1.54	NS

Source: [1]Lawrence et al., 2012; [2]Fitzsimons et al., 2014; [3]Kelly et al., 2010

Top 1/3 vs Bottom 1/3

15%

13%

18%

Scope: Breeding more feed efficient cattle!!

Factors affecting Feed Efficiency

Live weight & live weight gain

Table 2: Theoretical energy requirements of finishing bulls (UFV/day) at different weights and growth rates

Maintenance

Average daily gain (kg)	Live weight (kg)				
	450	**500**	**550**	**600**	**650**
0.0	*4.4*	*4.8*	*5.1*	*5.5*	*5.8*
1.0	6.0	6.5	6.9	7.4	7.9
1.2	6.5	7.0	7.5	8.0	8.6
1.4	7.0	7.6	8.1	8.7	9.4
1.2 vs. 1.4	**0.5**	0.6	0.6	0.7	**0.8**

Source: INRA

Feed efficiency is better with light, fast growing animals

Duration of finishing

Daily gain (kg) by finishing Interval

Interval (d)	Silage	+ 6 kg Conc.
0 - 147	**0.65**	**1.10**
0 - 56	0.80	1.43
56 - 98	0.59	1.02
98 - 147	0.54 (-33%)	0.79 (-45%)

Rate of live weight gain is NOT constant over the finishing period

- Initial increase in gut fill,
- Fixed/declining DMI relative to increased weight (& Reqs)
- Increased fat deposition (much less efficient)

Effect of Feeding Period on live/carcass weight gain & FCR

Charolais xbred steers: High concentrate diet

Finishing period	0-12 wks	12-23 wks	
Live weight gain (kg/d)	1.42	1.16	
Carcass gain (kg/d)	1.04	0.84	-19%
Concentrate intake (kg DM/d)	10.2	11.4	+12%
Feed efficiency (Conc DMI:gain)			
Live weight	7.2	9.9	
Carcass	9.9	13.6	-38%

Guidelines for duration of Finishing Period on ad libitum concentrate

	Days	ADG (kg)
• **Heifers**	60-80	1.10-1.30
• **Steers**	70-90	1.25-1.45
• **Bulls**	<180 (80-120)	1.70-1.90

Duration of Finishing Period

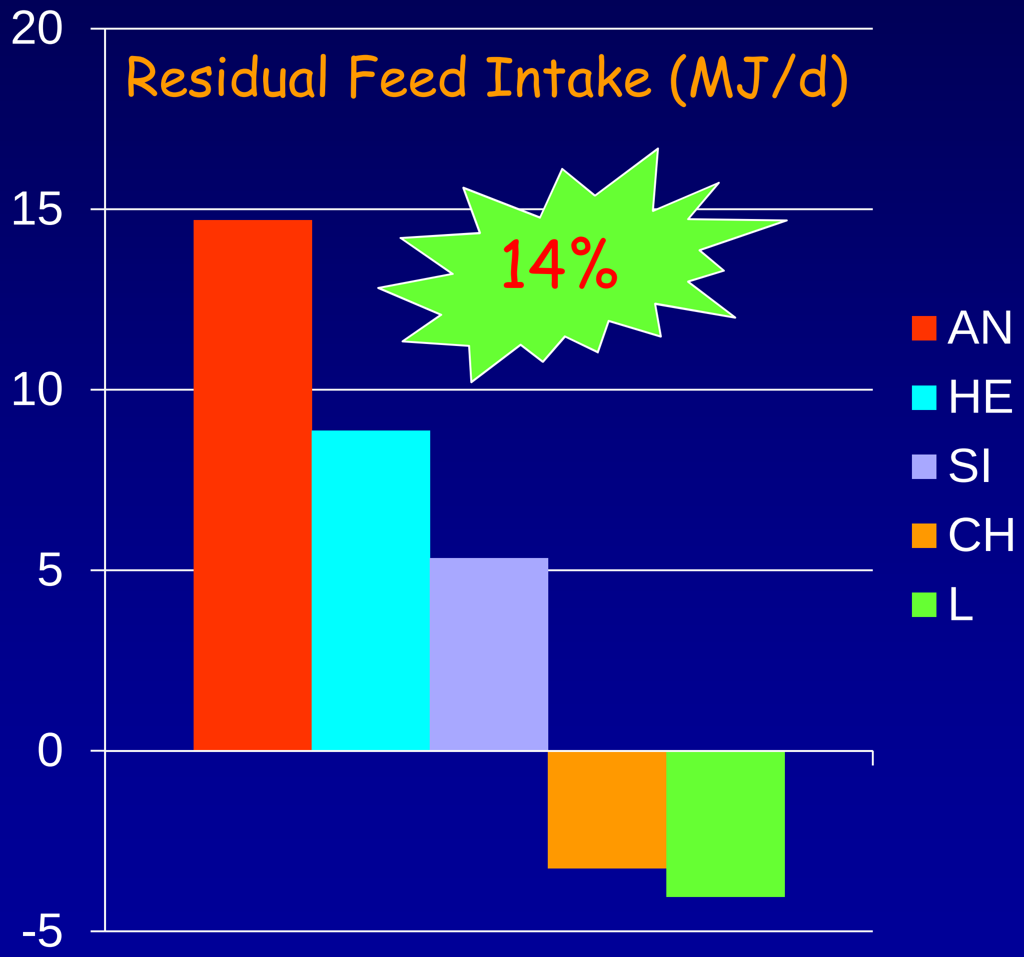
Avoiding excessively long finishing periods & minimising carcass fatness at slaughter (without impairing carcass value)

are ways to

reduce feed requirements & feed costs associated with finishing cattle.

Breeds:

Beef



Source: Crowley et al. 2010

Dairy vs. Beef

Finishing period:

Compared to dairy breeds, beef breeds had:

- **+23% LWG** per unit of energy consumed

BUT with higher KO% & greater proportion of meat in carcass

- **+51% meat** per unit of energy consumed

Source: Clarke et al. 2009

GENDER:
Bulls vs. comparable steers

- **Grange data:**
  - ~ +8% ADG
  - ~ +9% carcass wt
  - ~ +20% lean meat yield
- **NI data:: (/kg feed eaten)**
  - ~ +10% ADG
  - ~ +14% carcass wt
  - ~ +20% lean meat
  - ~ +17% saleable meat
- **USA data:**
  - ~ +17% ADG
  - ~ -35% fat
  - ~ +13% feed efficiency
- **Europe data:**
  - ~ +1% higher intake
  - ~ +20% ADG
  - ~ -20% fat
  - ~ +17% feed efficiency

Indoor Finishing

Grass silage

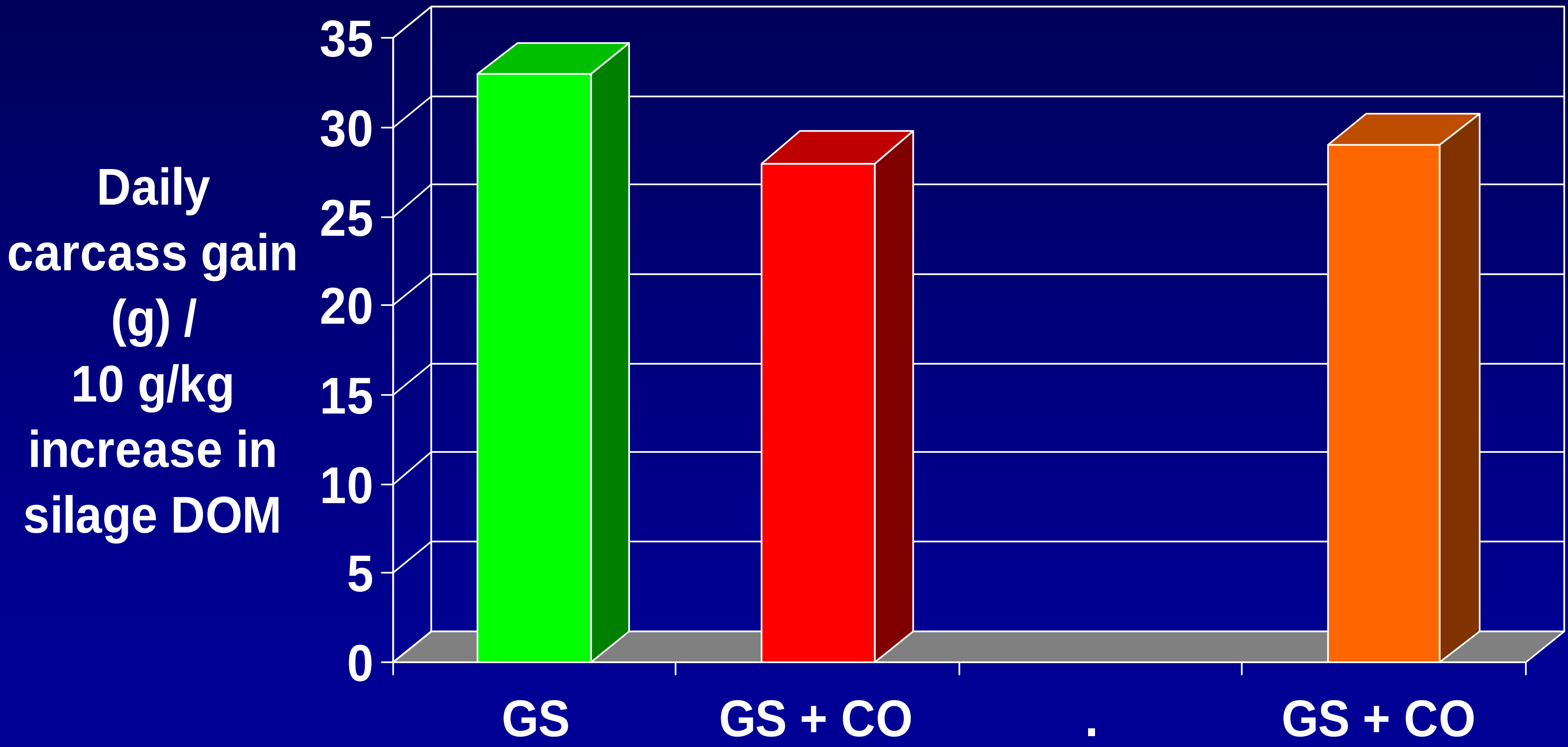
- Grass silage - primary forage for feeding cattle over winter.
- Digestibility (DMD): primary factor influencing the nutritive value of grass silage & consequently,
    - the performance of cattle offered grass silage-based diets.
- Both intake & animal performance increases with increasing digestibility.

Silage Digestibility - what difference does it make?

DMD %	75	70	65	60
Harvest Date	20 May	2 June	15 June	30 June
Silage DMI *Kg/day*	9.0	8.3	7.6	7.0
Animal gain *(kg/day)*				
Live weight	0.83	0.66	0.49	0.31
Carcass	0.51	0.39	0.27	0.15

Source: *Teagasc, Grange*

Effect of silage digestibility on carcass gain



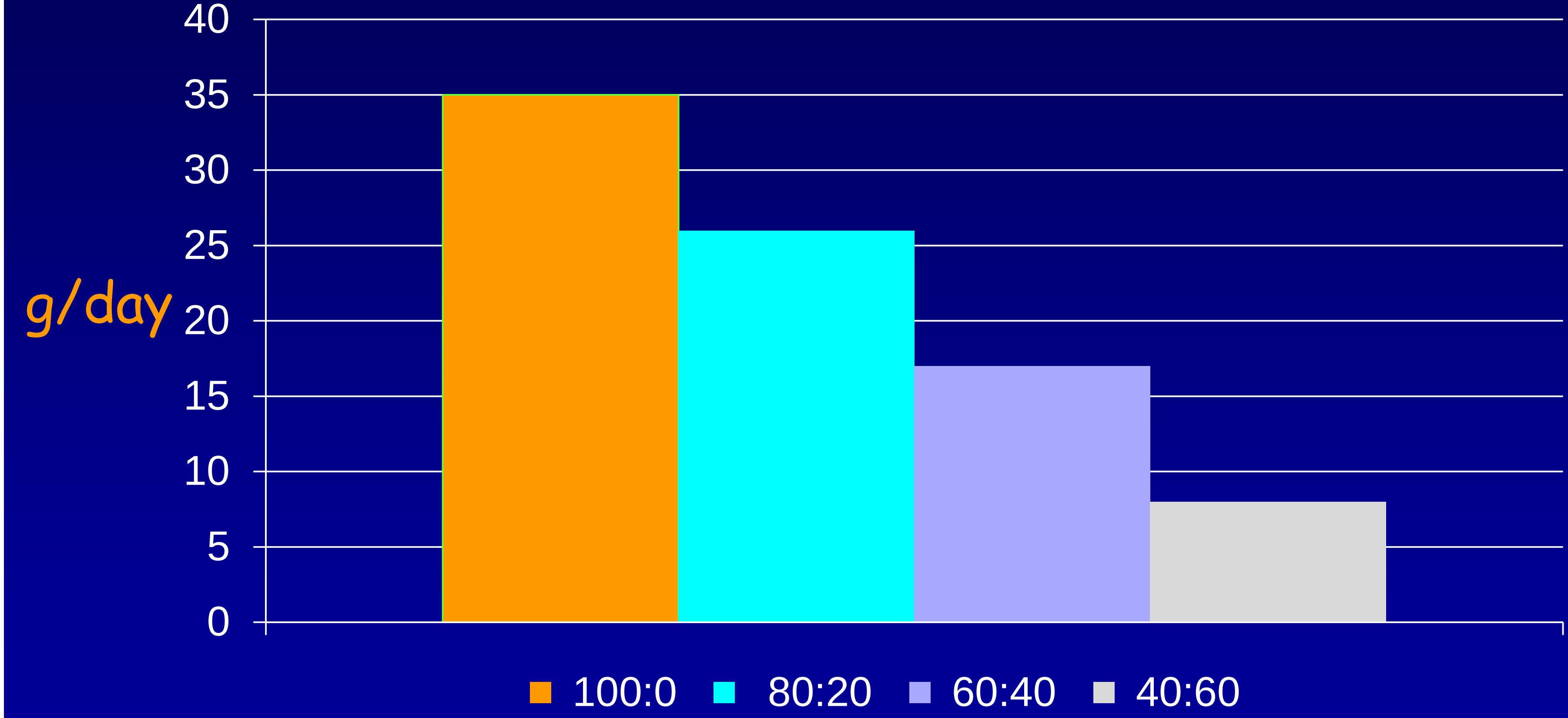
0.2-0.37

0.2-0.4

Steen, 1988

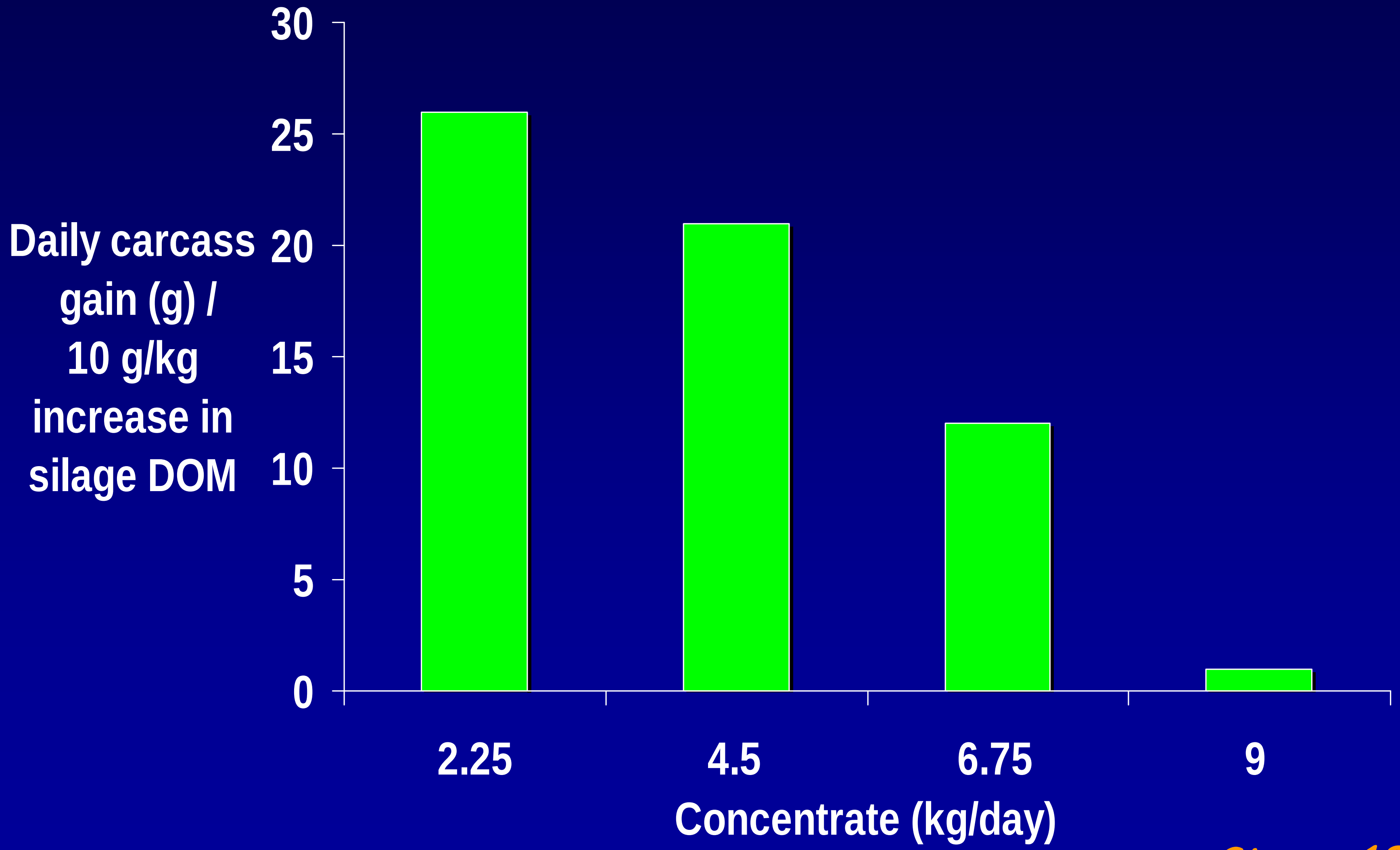
Steen et al. 2002

Response in carcass gain to a 1% unit change in grass silage digestibility at various forage:concentrate ratios



Keady et al. 2013

Effect of silage digestibility & concentrate level on carcass gain



Steen, 1998

Silage Digestibility

- **Implication**

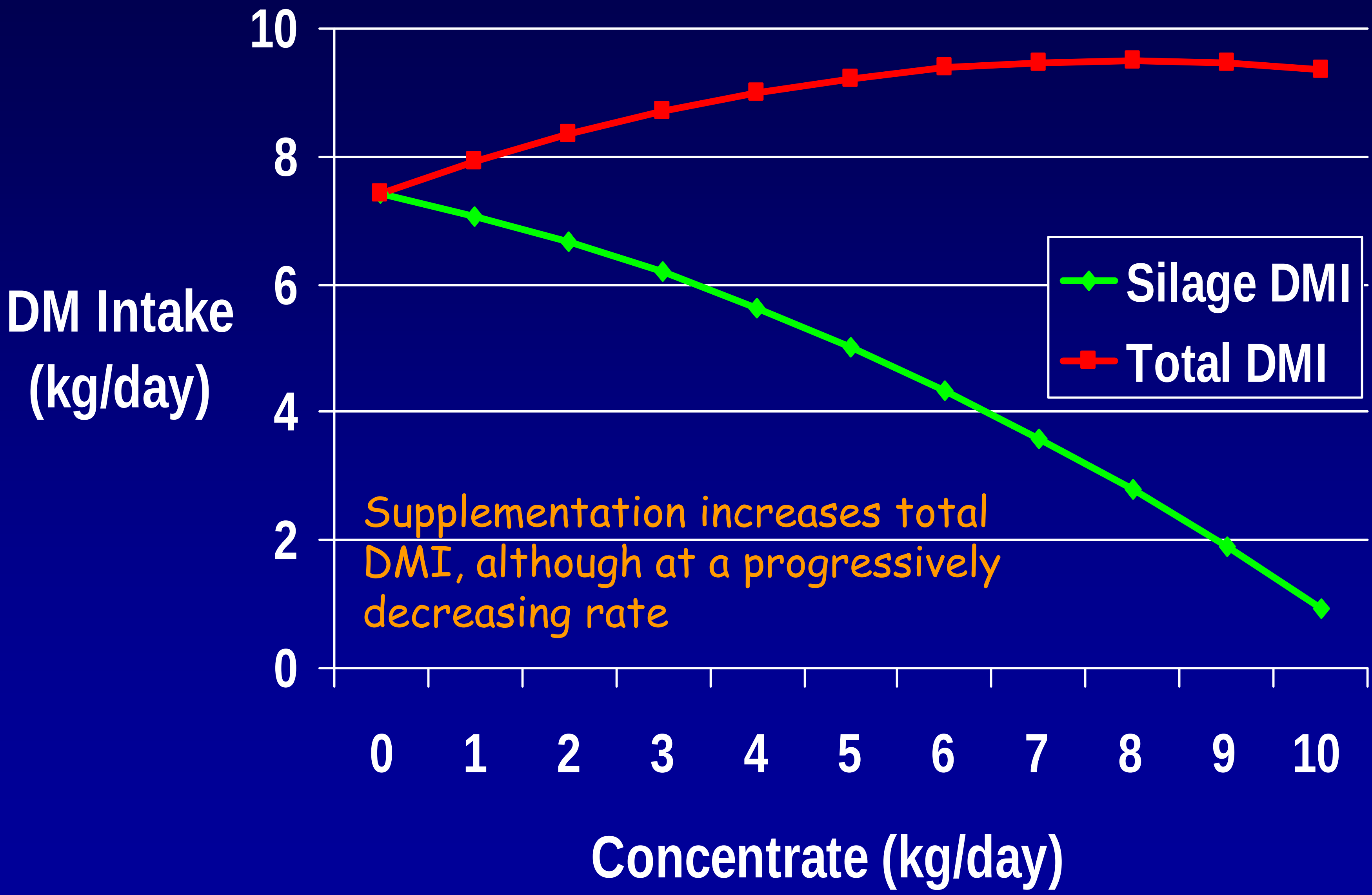
- Low DMD grass silage means that higher levels of supplementation are needed to maintain performance

  - Each 1-unit decline in digestibility requires an additional ~0.4 kg concentrate daily to sustain performance in finishing cattle (Keady et al., 2013)

- At high levels of concentrate feeding, silage digestibility had no effect on carcass gain

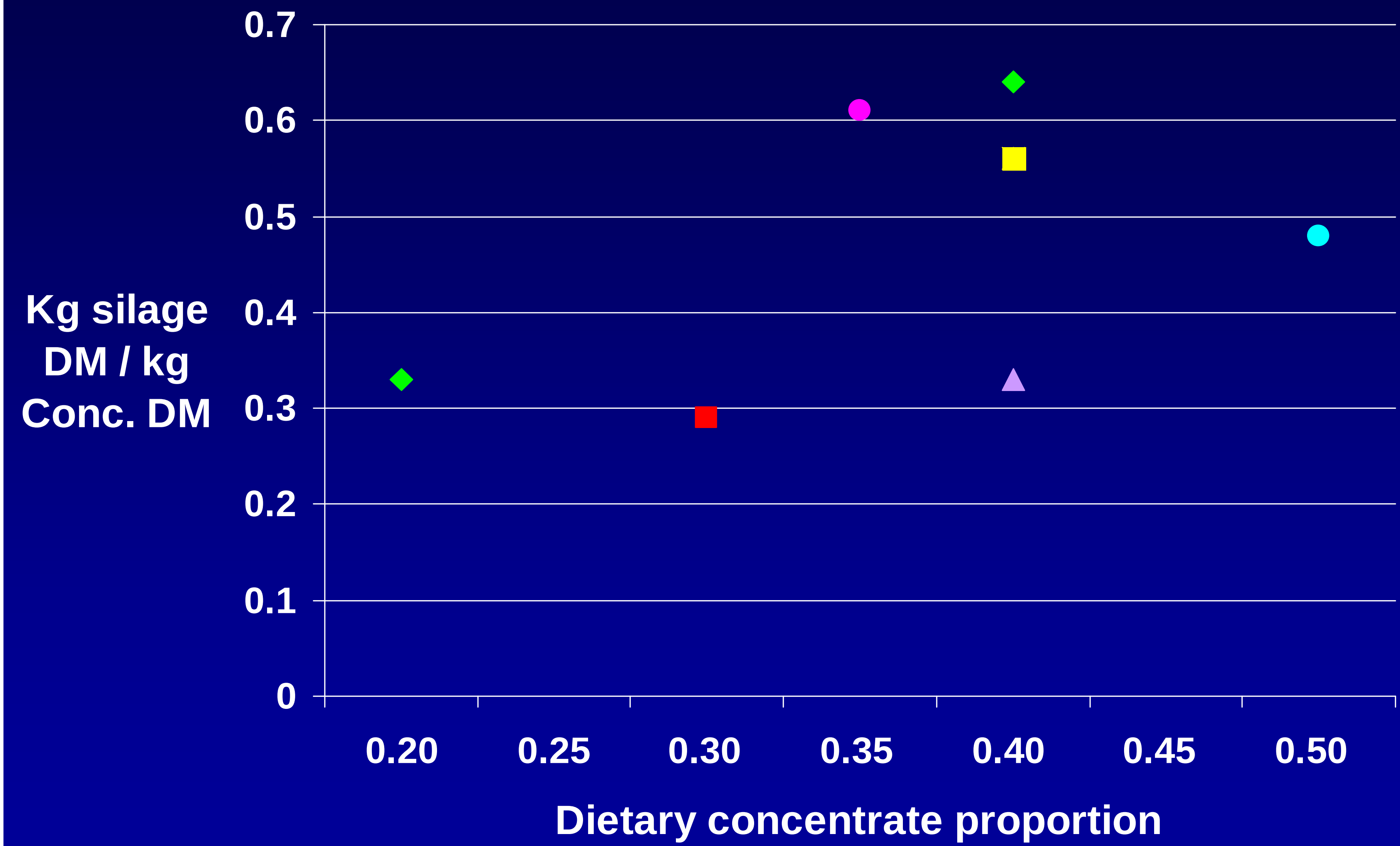
Silage Intake
&
Substitution rate

Intake & concentrate supplementation



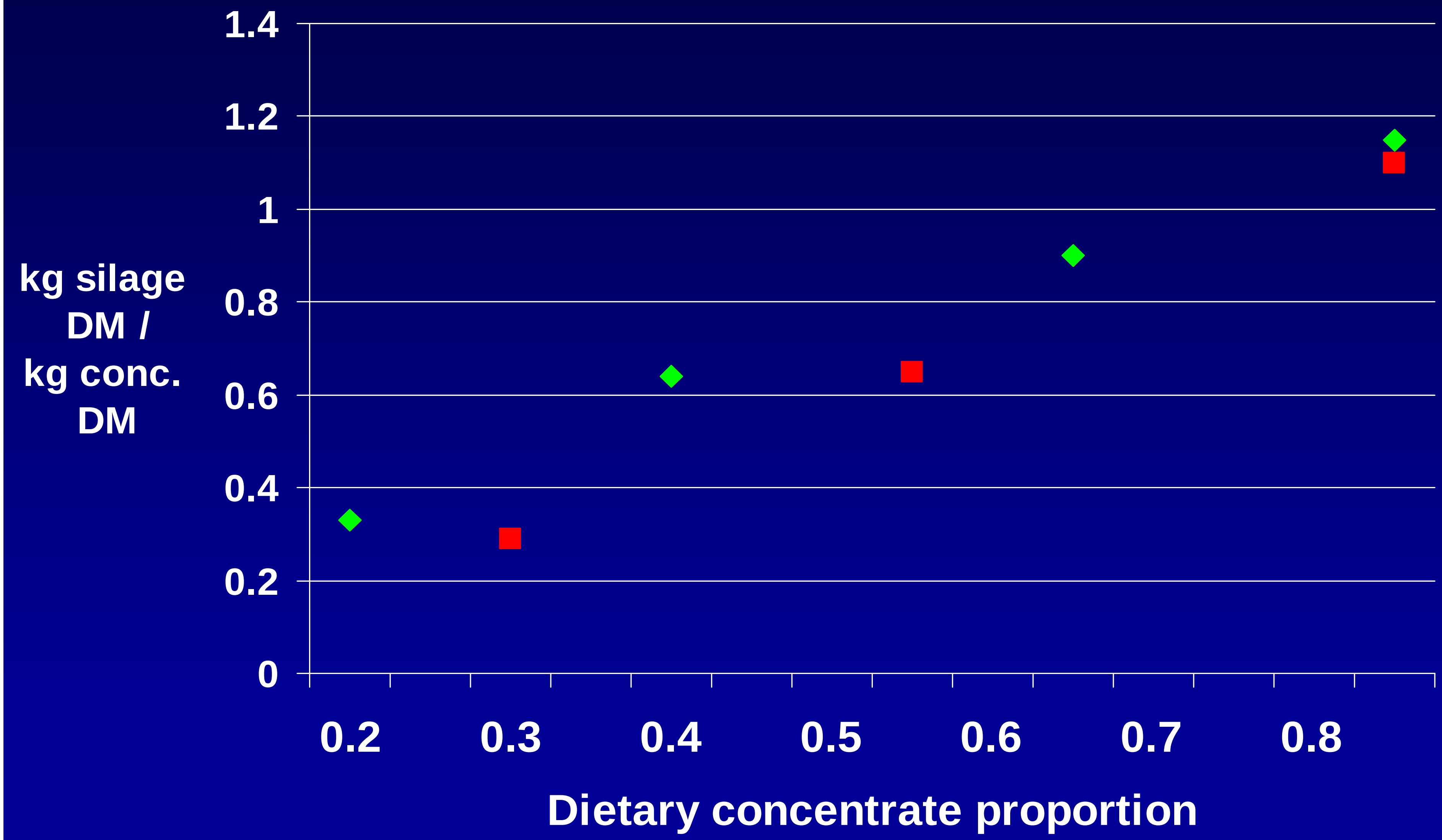
Source: Teagasc, Grange

Substitution Rate - High Digestibility Silage



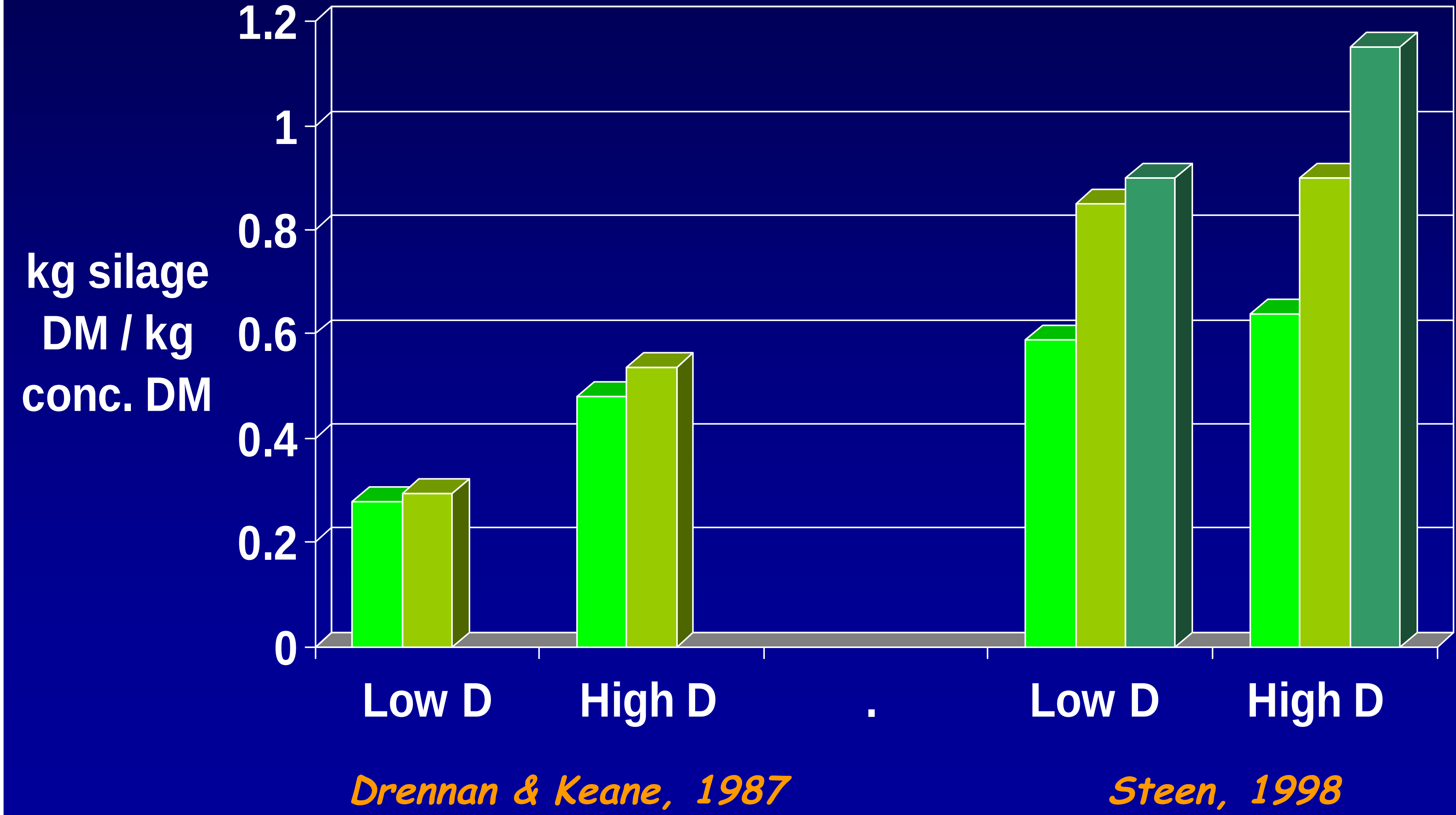
Steen; 1998; Agnew & Carson, 2000; Steen & Kilpatrick, 2000; Patterson et al., 2000; Dawson et al., 2002; Caplis et al. 2005

Substitution Rate - High Digestibility Silage



Steen, 1998; Caplis, 2004

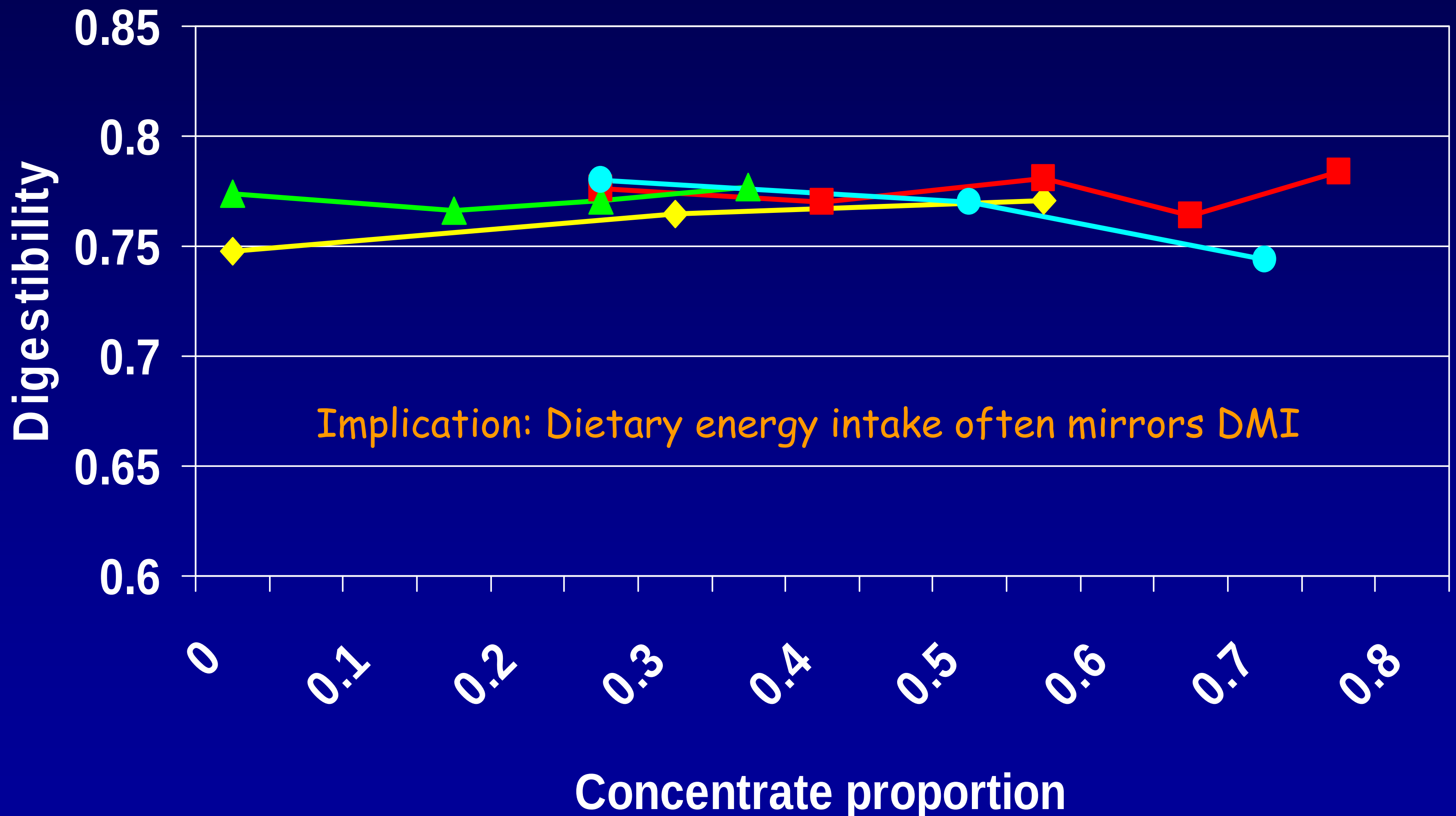
Effect of silage digestibility on substitution rate



Effect of energy supplement type on substitution rate

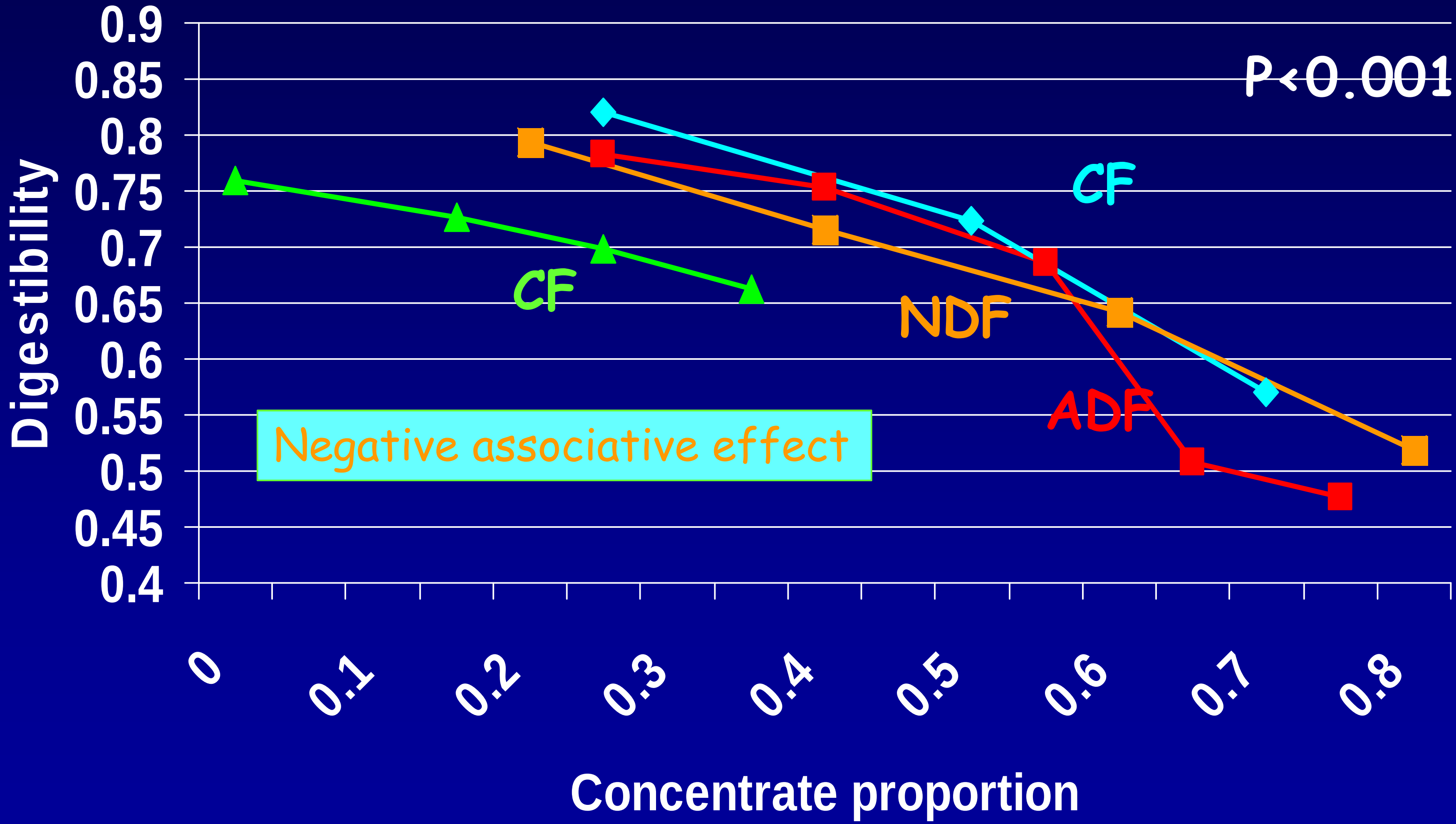
- **Finishing Cattle**
  - **Starch = Fibre = Sugar** *(Moloney et al. 1993)*
  - **Starch = Fibre** *(Steen, 1995; O'Kiely & Moloney, 1994)*
  - **Starch < Fibre** *(Moloney, 1996)*
  - **Starch < Fat** *(Steen, 1995; Moloney, 1996)*

Effect of dietary concentrate proportion on diet digestibility



Steen & Robson, 1995; Steen & Kilpatrick, 2000; Patterson et al., 2000; Caplis, 2004

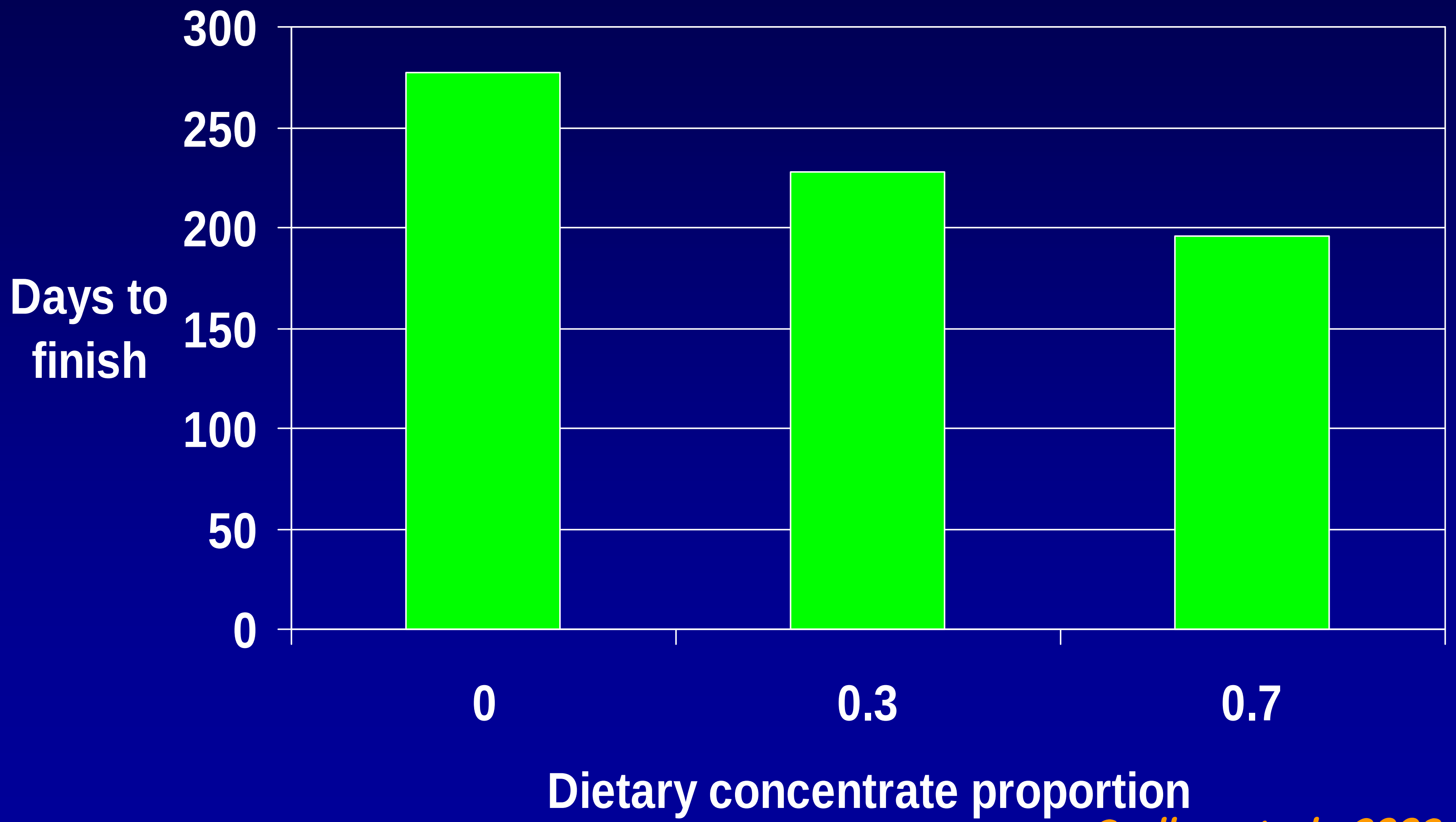
Effect of dietary concentrate proportion on fibre digestibility



Steen & Robson, 1995; Steen & Kilpatrick, 2000; Patterson et al., 2000; Steen et al. 2002

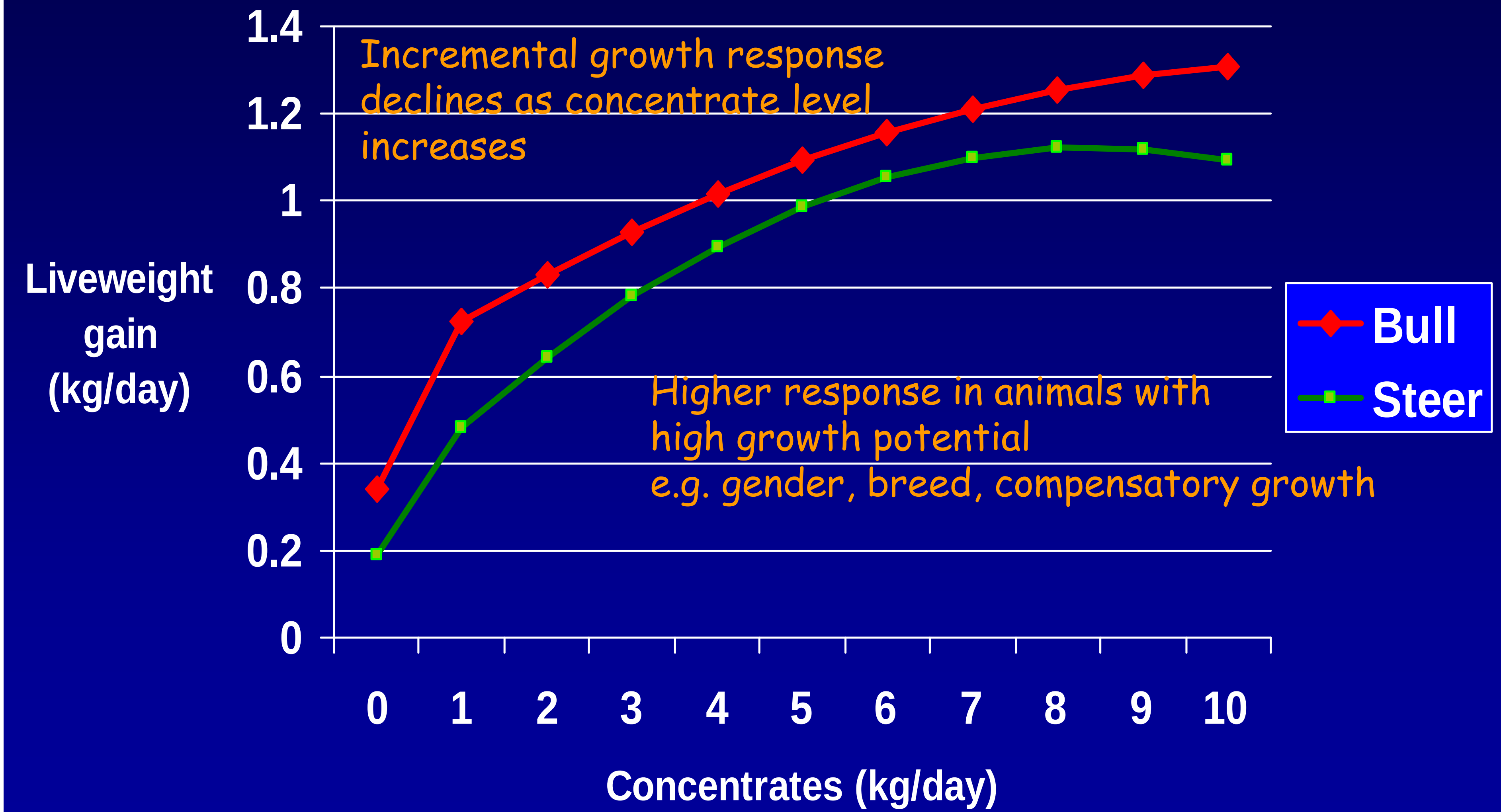
Production response to concentrate supplementation

Concentrate supplementation - finishing cattle



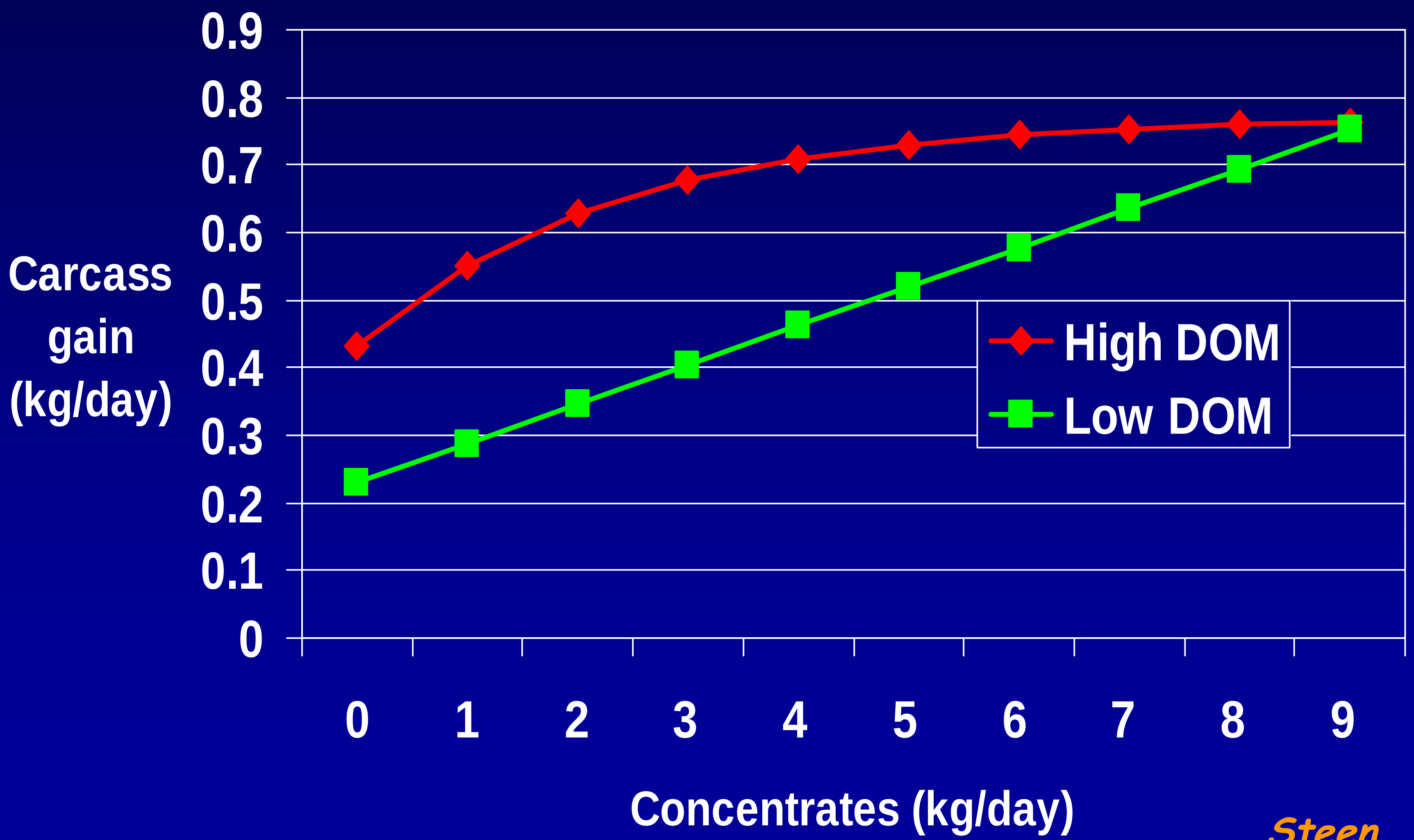
Scollan et al. 2003

Effect of concentrate supplementation on growth response - steers



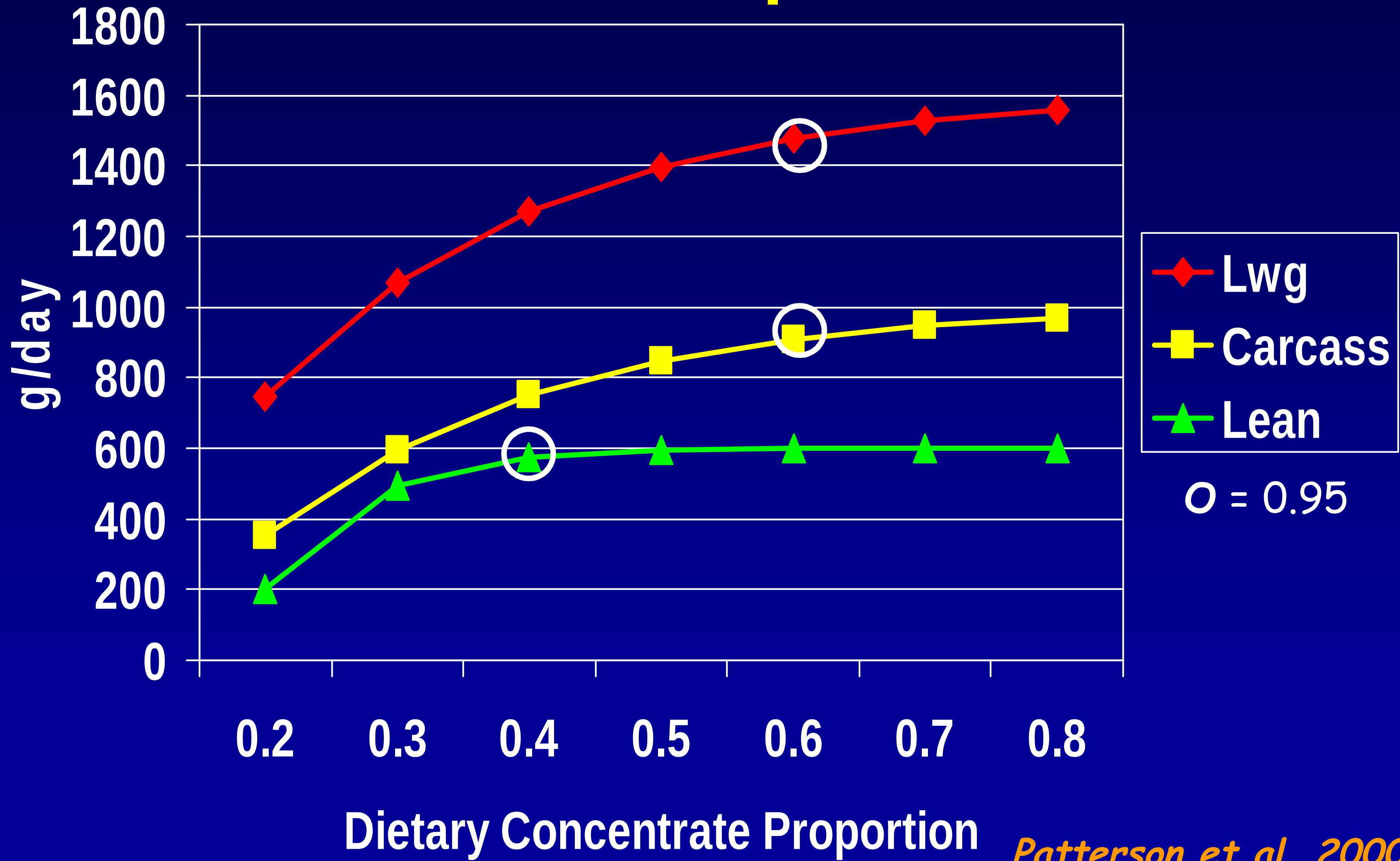
Source: Teagasc, Grange

Effect of silage digestibility on carcass growth response to supplementation



Steen, 1998

Concentrate supplementation & Growth response



Patterson et al. 2000

Optimum level of concentrate feeding?

Table 4: Cost (c/kg) of carcass gain for steers

Feeding level	**Concentrate costs (€/t)**					
(kg/day concentrate)	**175**	**200**	**225**	**250**	**275**	**300**
3	117	147	178	209	239	270
4	119	155	190	225	261	296
5	124	165	207	249	290	332
6	159	214	268	323	378	433
7	172	242	312	382	452	522
8	180	280	380	480	580	680

Silage substituted valued at 15.0 cents/kg DM

Ad libitum feeding of concentrates for finishing cattle

- Considered when
  - Silage digestibility is low
  - Animal growth potential is high
  - Especially where silage supplies are in deficit

- Critical to ensure:
  1. gradual adaptation to the concentrates,
  2. minimum roughage inclusion (~10% of total DM intake) in the diet for rumen function,
  3. that meal supply never runs out
  4. that a constant supply of fresh water is provided.

Ingredient Composition

Concentrate Energy source & Growth response

Supplements to grass silage

- Wheat = Barley *(Steen, 1993; Drennan et al. 2006)*
- Sugar-based = Starch-based @~0.2 DMI
  (Drennan, 1985; Moloney et al. 1993; Chapple et al. 1996)
- Starch-based > or < Fibre-based
  (Moloney et al. 1993; O'Kiely & Moloney, 1994; Steen, 1995; Moloney, 1996; Moloney et al. 2001)
- Fat-based < Starch or Fibre-based
  (Steen, 1995; Moloney, 1996)

Concentrate type

- 4 rations x 2 feeding levels
  - Ration
    A. Rapidly fermentable starch - RFS (Barley-based)
    B. Slowly fermentable starch – SFS (Maize-based)
    C. RFS + digestible fibre - RFS+F
    D. Digestible fibre-based - Fibre (Pulp)
  - Concentrate feeding level
    - Ad libitum
    - 5 kg per head/day
- Formulated: ~ same Energy & Protein concentration

Concentrate type

	Ration Type				
	RFS	SFS	RFS+F	Fibre	Sig.
Intake (kg DM)					
Silage	3.8	4.0	3.8	3.6	ns
Conc.	6.5	6.5	6.9	6.5	ns
Total	10.2	10.5	10.7	10.1	ns
Daily gain (g)					
Live weight	1043	985	1032	911	ns
Carcass	582	570	584	520	ns
KO (g/kg)	*537*	*541*	*540*	*539*	*ns*
Fat	*3.5*	*3.4*	*3.5*	*3.5*	*ns*
FCE *g carcass / kg DMI*	56.8	54.6	55.6	52.0	ns

McGee et al. 2006, 2009

Concentrate type: Maize meal

Dairy bulls 170 days

Ration Type	*Barley-based*	*Barley/Maize-based*	*Sig.*
Intake *(kg DM)*	9.21	9.54	*
Live weight gain (g/day)	1697	1745	ns
Carcass wt (kg)	275	279	ns
Carcass Fat (1-5)	*2.98*	*3.09*	*ns*

Keane, 2008

Response to protein in Finishing Cattle
High concentrate diet

Gender	Bulls		Heifers	
Protein	+	-	+	-
Start wt (kg)	331	332	288	286
LWG (kg)	1.58	1.55	1.25	1.22
Slaughter wt (kg)	572	568	470	463
Carcass wt (kg)	319	315	255	253
Kill-out (g/kg)	558	555	542	547
Intake (kg DM/d)	9.4	9.1	8.0	7.7

Composition (g/kg) of diets for bulls & heifers

Protein	+	-
Rolled barley	875	945
Soya-bean meal	70	-
Molasses	40	40
Mins/vits	15	15
CP (g/kg DM)	143	116

Response to protein in Finishing Cattle
Grass silage + concentrates

- Finishing steers / heifers / bulls
  - Barley-based conc. + Protein:
    - High DMD silage = X
    - Low DMD silage = ✓
  - Low crude protein grass silage = ✓

% CP in Dietary DM	
Bulls: growing	13-15
Bulls: Finishing	12-13
Heifers/Steers	11-12

Implications

- With low DMD & low CP grass silage
  - Higher CP % required in concentrate [~11-12% to ~14-20%, depending]

Thank you