That’s a lovely heifer calf, Barry !

You have to realise potential….
By itself potential means little.
Ask any Carlton fan how they think early draft picks have gone ! Then think of the Swans !

That’s a lovely Heifer calf Barry !

Now we can work on:

1- how the little girl will go as we grow her to herd entry , and

2- how she will then go once milking in the herd

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HEAPS GETS SET IN PLACE VERY EARLY ON INDEED

Accelerated development in calf feeding produces less outgoings long term, plus maximal revenue

1- what are we talking about with **accelerated programmes** in calf development ?

2- whats involved in the short term feed programme

3- why its both cheaper and better revenue so win win

What I got taught about calves!
(and its not good , but its still mostly there)

- Feed them 4 litres of milk/day at about 12.5% milk solids , or 500g/day calf milk replacer. The CMR will probably be 24% protein and 15-18% fat.
- Offer a calf starter of about 18-20% protein

- They wont get a lot of nutrients from the milk bit , so still be a bit hungry and will eat the starter

- That is cheaper, and gets the rumen going faster. They scour less !
- Here end'th the calf nutrition lesson 1987!!

Pity it doesn’t work that way in some ways, but be assured we miss out if we do this old way

- Put simply we limit nutrient intake in 0-8 week period and we do two things
- Firstly we limit the nutrients she has to grow towards her genetic potential
- Second , we actually suppress that genetic potential…we switch of or down regulate genes she carries. That’s called epigenetics. Nutrients as triggers

(now that is a right bugger if you got a heifer calf from a straw from a cracking bull , and you fully expect her to produce a big udder + milk right !!!)

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1- Accelerated calf rearing: meeting her more realistic needs , not the bare minimum

I like beer, it is very good .

I could have a bare minimum on a hot day , and have 1 or two. Thing is , its not really enough. 5 is a better number

Calf nutrients is like beer. Barely enough is not the best outcome for the calf. She will enjoy more and unlike us its actually very good for her

Our old plans kept them alive (sometimes just) , but not tracking really well or fast

What we should aim to do is get more nutrients into her early

- The first great outcome is that this switchs on all the genetic potential we have gone to a lot of trouble to put there
- Second thing is we now have the nutrients to meet that potential.

- Scientifically it is called the **Lactocrine Hypothesis**.

Milk born growth factors impact future tissue development and physiological function well into the future. Short changing her at 0-6 weeks has impacts over WHOLE OF LIFE irrespective of how you feed or treat her later

Basically building poor foundations that compromise a nice house

Even Colostrum is not just about immunoglobulins

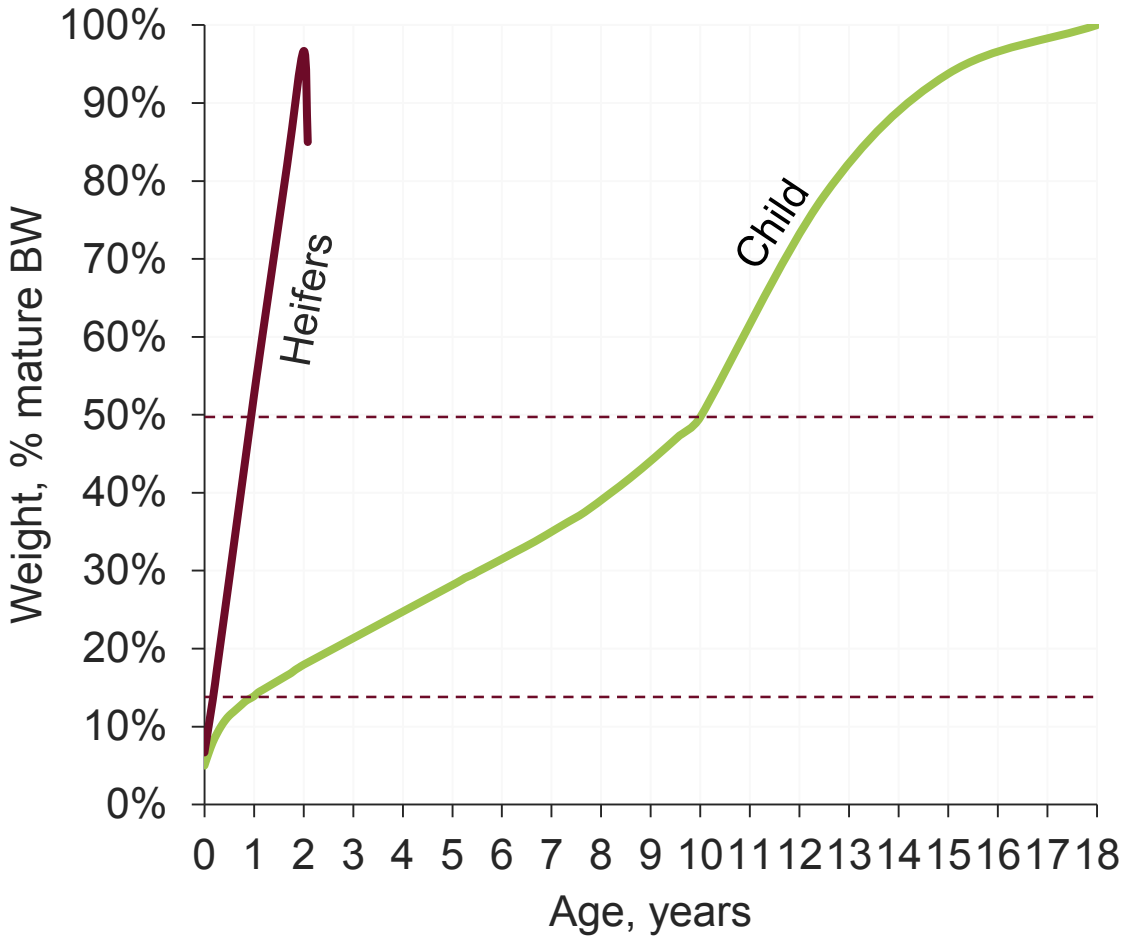
- Trial : Maternal colostrum with growth factors and immunoglubulins Vs synthetic colostrums that gave all the immunoglobulins , but not the growth factors (the triggers for future potential tissue and physiology)
- Same IgG status in calves was the outcome , but growth rates and feed efficiency even at day 29 were better for the maternal colostrum with factors
- Then we saw better pre pubital growth later in the “full colostrum” group even though nutrition was the same after 1 week.
- Immunoglobulin transfer only lasts 2-3 days max. Growth factors in milk keep crossing for uptake for weeks, and improving her prospects !!
- That colostrum impact is just the start of getting the superior outcomes going. The whole milk period is crucial

Table 1. Nutrients, energy, immunoglobulins, hormones, and growth factors in colostrum and milk[1]

Component	Unit	Colostrum	Mature milk
Gross energy	MJ/L	6	2.8
Crude protein	%	14.0	3.0
Fat	%	6.7	3.8
Immunoglobulin G	g/L	81	<2
Lactoferrin	g/L	1.84	Undetectable
Insulin	μg/L	65	1
Glucagon	μg/L	0.16	0.001
Prolactin	μg/dL	280	15
Growth hormone	μg/dL	1.4	<1
IGF-1	μg/dL	310	<1
Leptin	μg/dL	30	4.4
Transforming growth factor-α	μg/dL	210	<1
Cortisol	ng/mL	11.2	1.2
17β-Estradiol	μg/dL	3.3–4.7	0.54

[1]Sources: Baumrucker and Blum, 1993; Blum and Hammon, 2000; Bonnet et al., 2002; Blum and Baumrucker, 2008; Farke et al., 2011.

Healthy child X Healthy heifer growth curve: heifers are fast so we need to support that

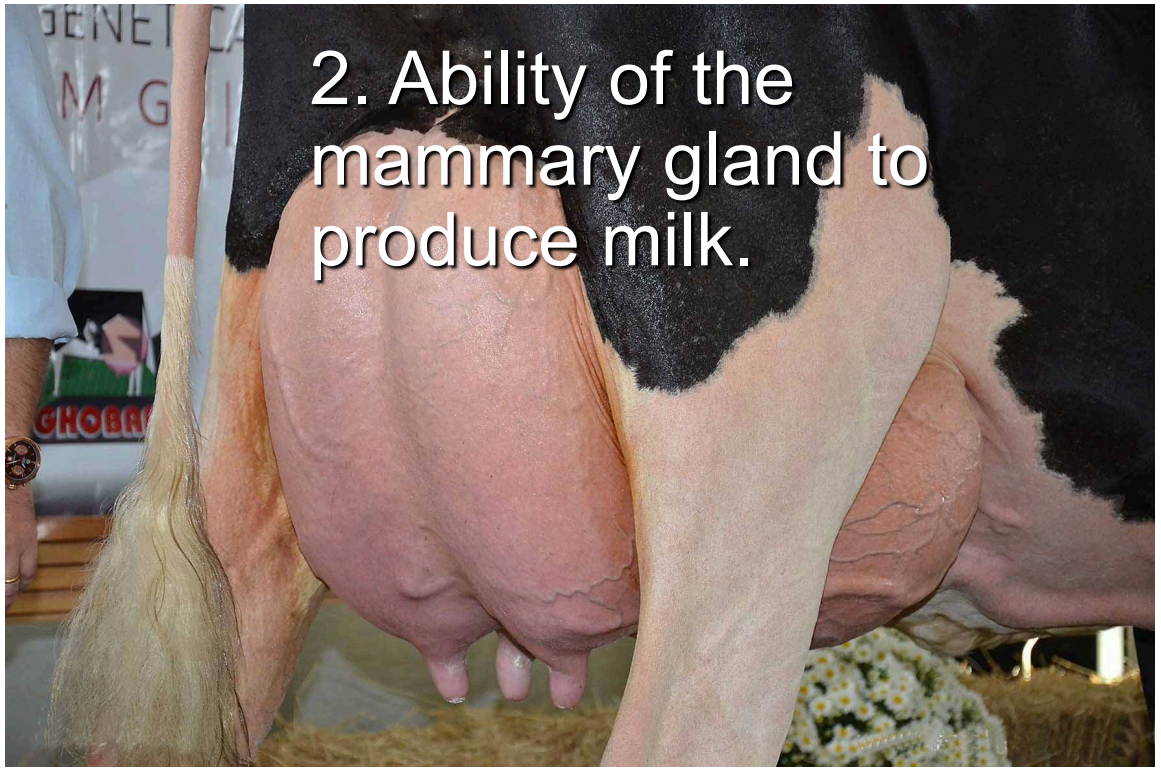


- Calves need to double in size in 60 d (one year in child).
- Heifers need to reach 50% mature weight in 12 mo. (10 year in child).
- In which species do you think early-nutrition in more important?

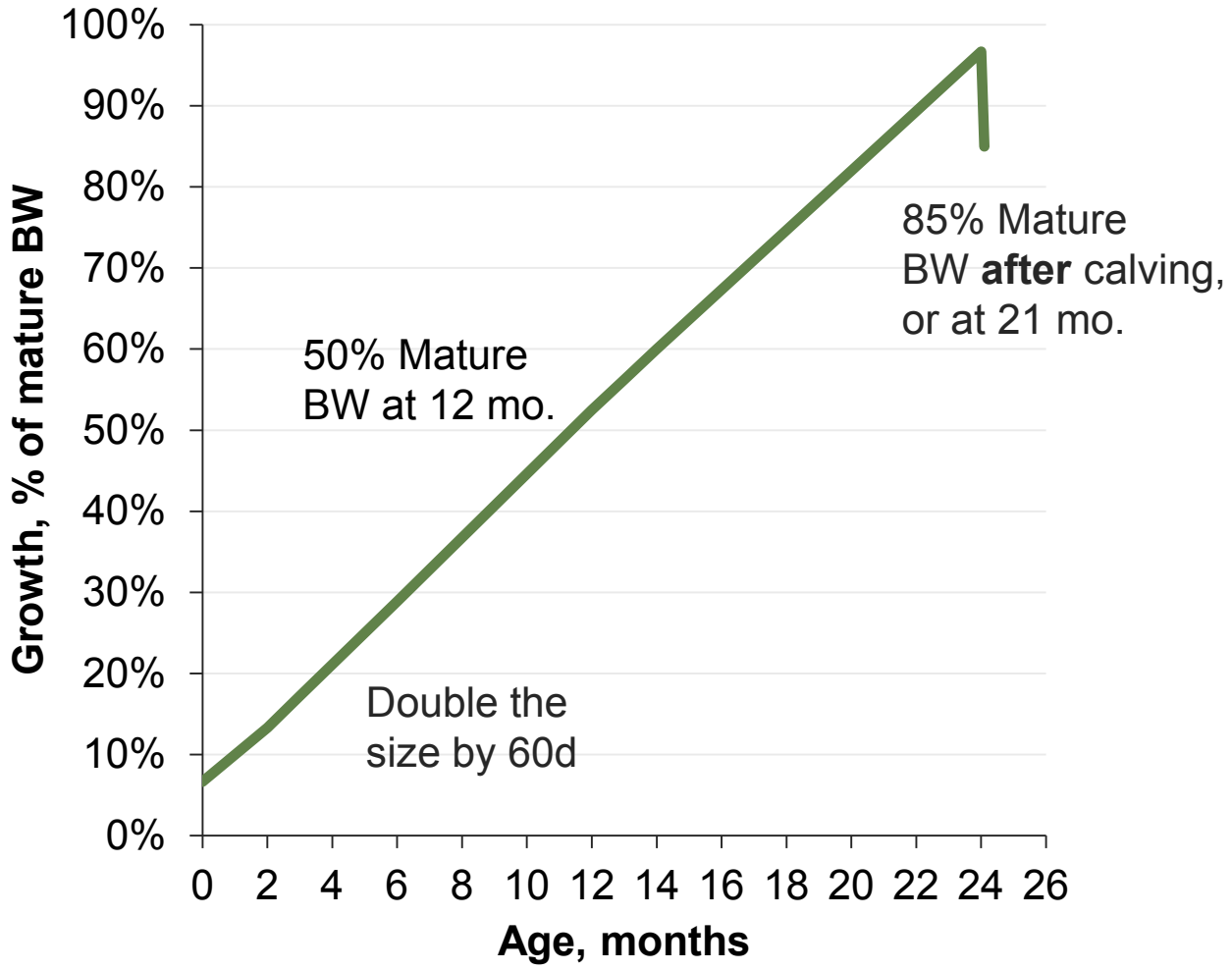
Heifer programs impact future productivity

Major factors affecting milk yield:

1. Ability of the cow to supply the gland with nutrients



The right trajectory : What is the optimal body size at first calving? Next slides support why we aim here



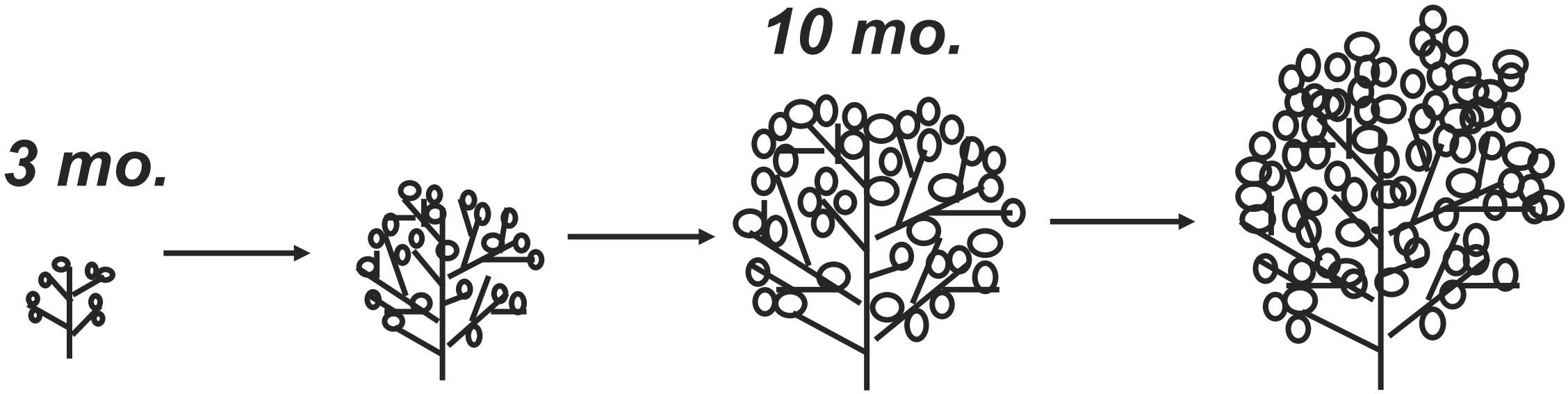
Age, mo.	Mature LW		
	500 kg	550 kg	600 kg
2	70	80	90
3	100	110	120
9	200	220	240
12	250	275	300
18	365	402	438
21	425	468	510
24 pre calving	**485**	**535**	**575**
24 post calving	425	468	510

Effect of nutrition on udder development

Objective is to raise a heifer with an udder capable of producing a lot of milk.

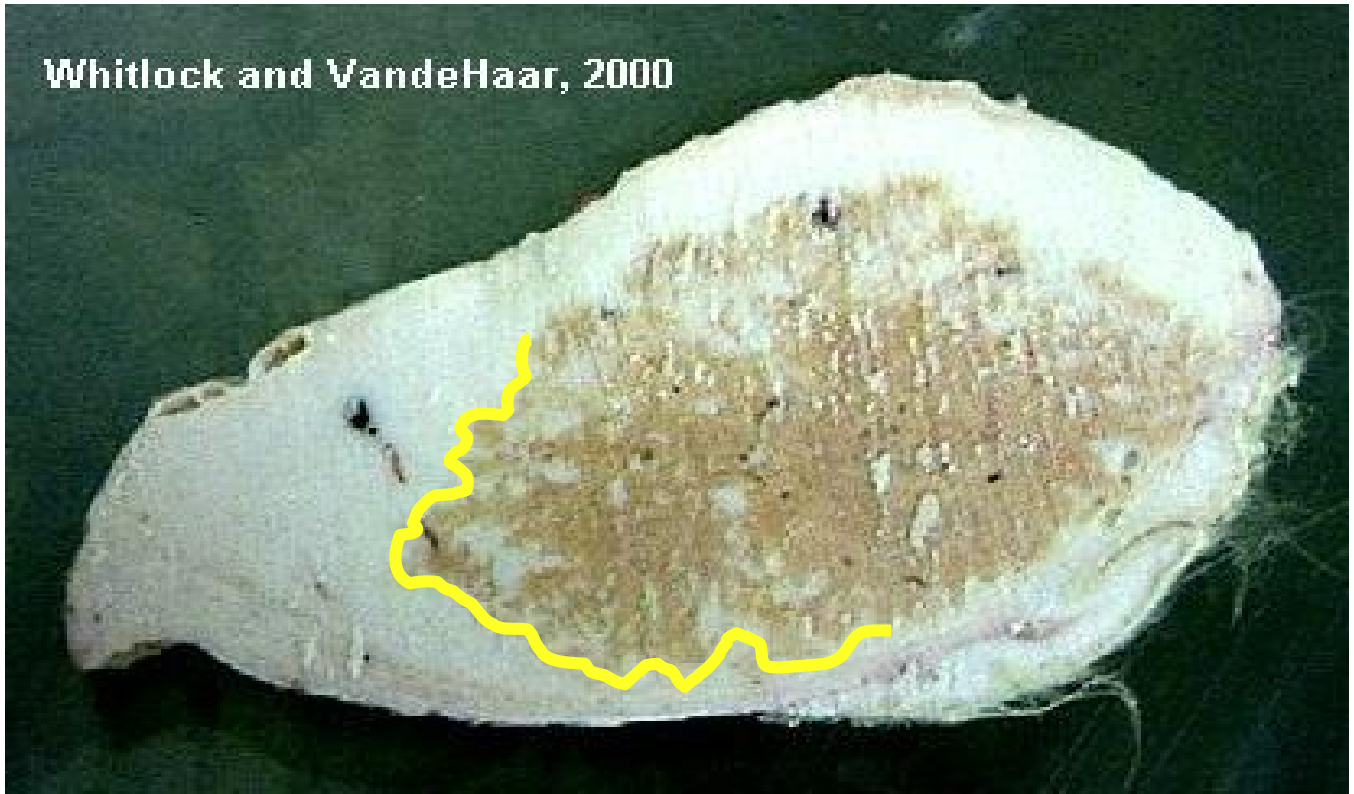
Does nutritional management affect udder development?

Development of the mammary gland



- The parenchymal tissue formed before puberty is the foundation for later growth.
- Milk production is partly dictated by the number of parenchymal cells at puberty.

Mammary development in heifers

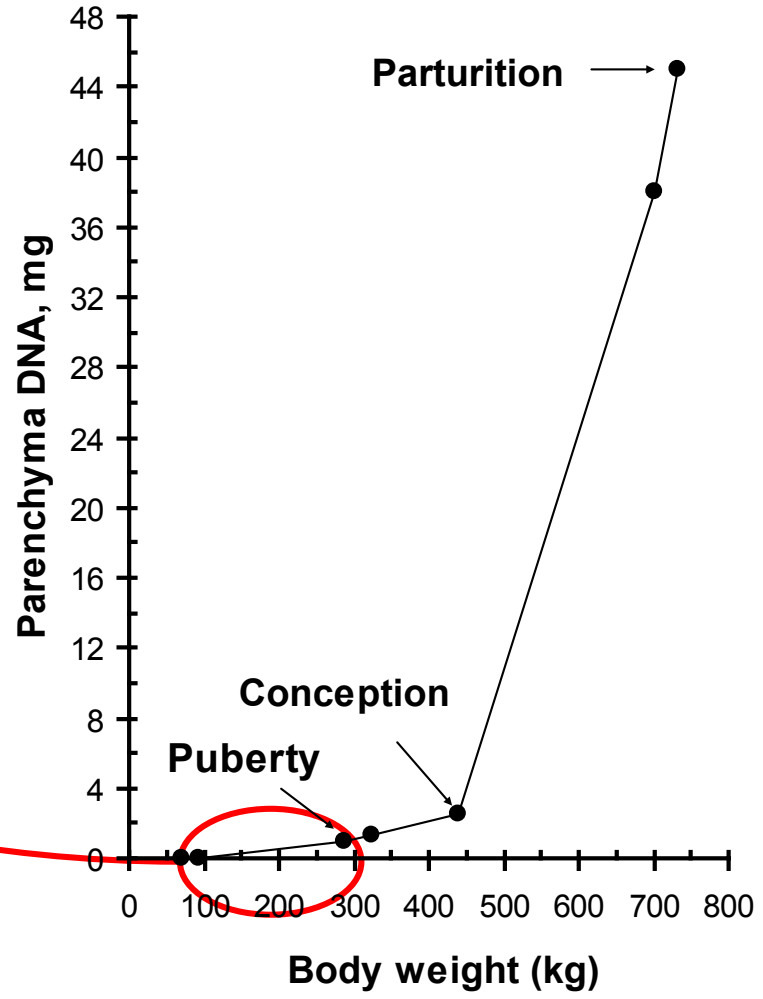


Measurements:

- Parenchymal mass
- Fat and protein
- DNA (cells number)

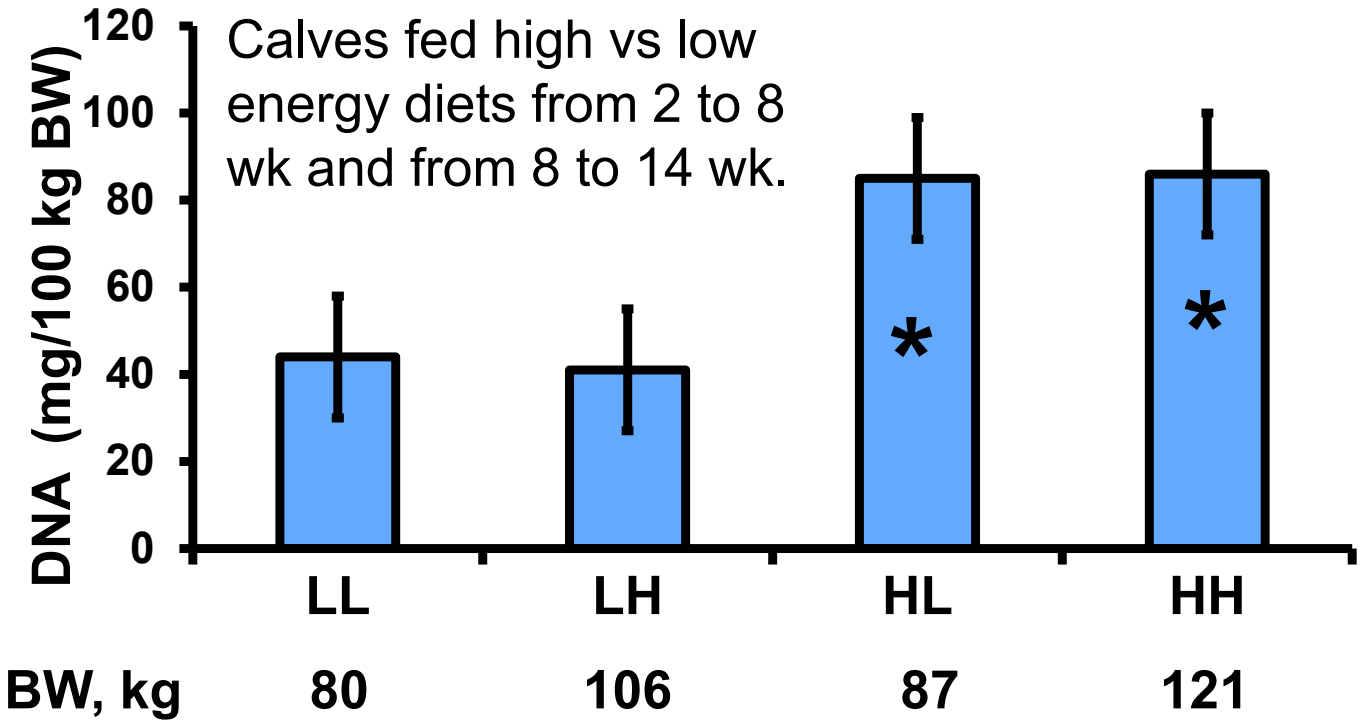
Total mammary DNA content in heifers

Prepubertal phase of growth is critical for future milk production



From: Capuco et al. (1997); Keys et al. (1989); Radcliff et al. (1997); Sejrsen et al. (1982); Tucker (1969).

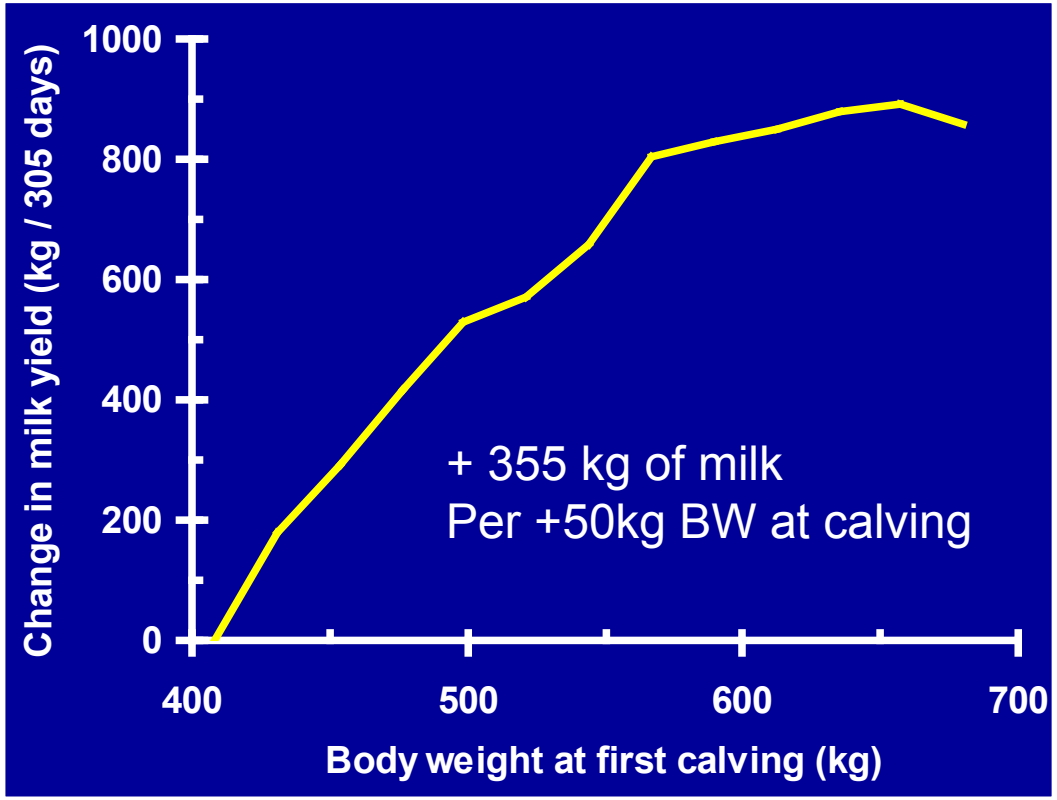
Rapid calf growth and mammary DNA hits early



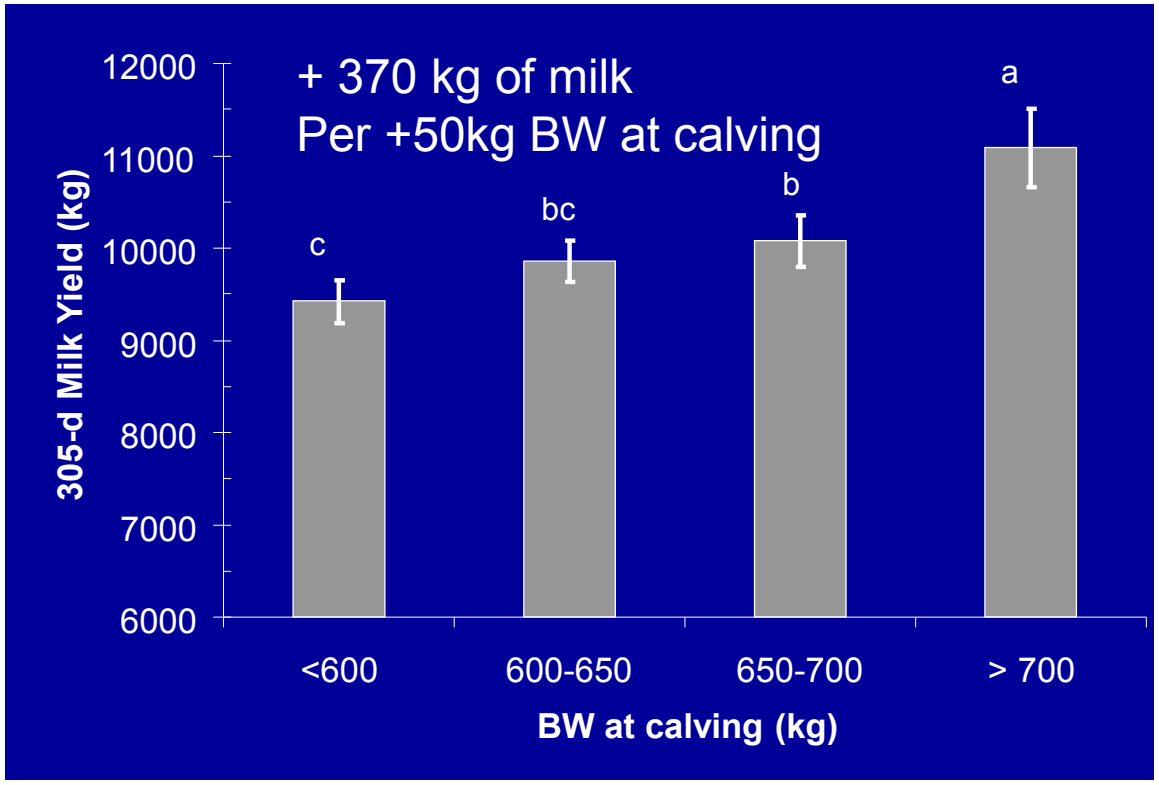
- High diet (milk powder at 2% vs 1% of BW) from 2 to 8 wk doubled parenchymal DNA per unit BW.
- High diet from 8 to 14 wk doubled both body and mammary gain, so no change in parenchymal DNA per unit BW.

Brown et al. (2005)

Paybacks: What is the optimal body size at first calving?

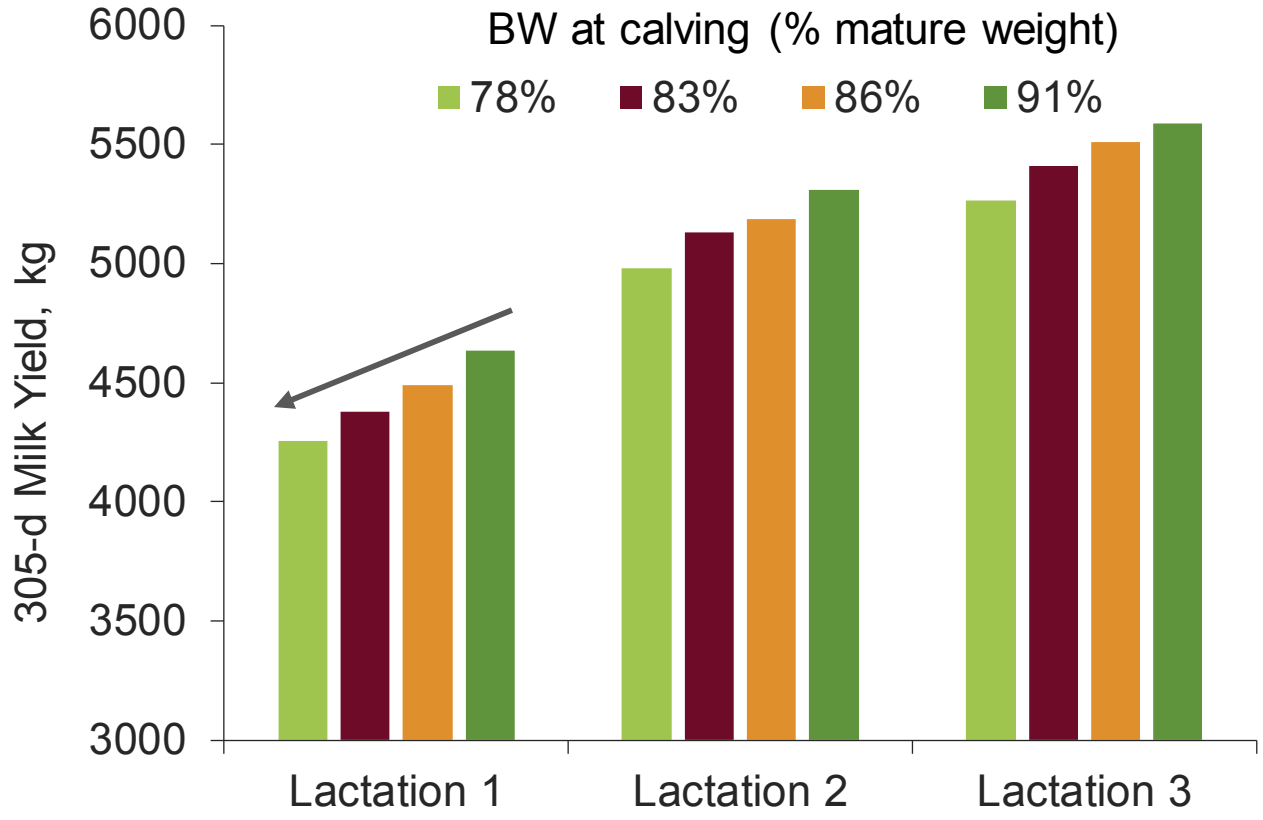


Keown and Everett (1986)



Data from Colorado farm (Brazil)

What is the optimal body size at first calving = extra milk?



Loss of 300 kg of milk (1st lact)
Per -50kg BW at calving

Loss of 720 kg of milk (3 lact)
Per -50kg BW at calving

*Archbold et al. (2012) – **pasture systems***

Yeah you say---that's all about year 1 to year 2 stuff… ….nope… a heap of future outcome relates back to VERY EARLY nutrition

- Really good research showed that:

every 100g/day extra average growth rate we achieved pre weaning , yields up 150 litres in first lactation (and more over 3 Lactations)

(Soberon and Van Amburgh 2013 Cornell University)

- The investment to achieve the extra growth is a very solid yielding one based on great science and dead set common sense

impacts of more nutrient intake pre-weaning on later life outcomes

Table 6. Milk production differences among treatments where these cattle, as calves, were allowed to consume more nutrients than the control calves before weaning from either milk or milk replacer

Study	Milk yield response,[1] kg
Foldager and Krohn, 1994	1,405[S]
Bar-Peled et al., 1997	453[T]
Foldager et al., 1997	519[T]
Ballard et al., 2005	700[S]
Shamay et al., 2005	981[S]
Davis-Rincker et al., 2011	416[NS]
Drackley et al., 2007	835[S]
Raeth-Knight et al., 2009	718[NS]
Terré et al., 2009	624[NS]

2- What's actually involved with accelerated programmes in the early bits pre weaning

- The difference between the old way , and the better way is not a lot

- We have typically already paid all the input costs for maintenance and just having the wee lassy there....the extra bit for the superior outcome is in fact pretty modest

Lets go to basic nutrition maths: dull but only for moment. Less interesting then epigenetics at IDW

- Nutrition is heaps of maths , so now we go to the maths to show you what I mean.
- Being a nutritionist is dry. Having a hobby may help folks like us … but better we do it so you don't have to right !

- Needs: Maintenance + surface area + correction for temp + nutrients for gain

- Supply: whats supplied nutrient wise by my milk replacer or milk volume

lostrum (Table 1). At birth, under thermoneutral conditions (e.g., 20°C), a 40-kg calf requires approximately 1.8 Mcal of ME per day for maintenance, and to meet the maintenance requirement of the calf under thermoneutral conditions (20°C), 1.4 L of colostrum must be fed (Table 2). For calves exposed to temperatures below

Body weight sets initial maintenance needs

The second calculation is to adjust for surface area to BW relationship of a calf to account for the rate of heat loss. To do this, the following equation: $0.14 \times BW^{0.57}$ (Brody, 1945) is used and the result is used as a multiplier to adjust the basal requirements: $(0.14 \times 40^{0.57}) = 1.16$. Thus, the maintenance requirement for the 40-kg calf is adjusted: 1.61 Mcal of ME × 1.16 = 1.87 Mcal of ME. This adjustment is very important for small-framed calves (e.g., Jersey), and this was

We then adjust for surface area to body weight (that can take maintenance up 10-20%)

required will increase (Table 2). For example, at 0°C, the same calf will require 2.7 Mcal of ME to meet the maintenance requirement, which can be met with ap-

Then we adjust for temp / cold/ heat that can see it go an extra 30%

placement calves are grown. Updated data allow for a comparison of the energy and protein requirements from more contemporary data and demonstrate a lower ME requirement for growth and a greater requirement for protein than the NRC (2001) model (Table 4; Van

Then we give what we need for a given weight gain

For a 4-6 wk period we need to calculate to do it with liquid, and dry starter feed is a useful bonus

labor (Kertz et al., 1979; Otterby and Linn, 1981). Encouraging rumen development is important for proper weaning efficiency; however, it is imperative that for at least the first 4 to 5 wk of life the requirements of the calf be calculated and supplied by liquid feed. This is especially important because it is difficult for young calves, under cold stress conditions, to meet their main-

A bit of a summary in powder terms!
50 kg calf. Thermoneutral = Tight 15-25 deg C

Table 4. Nutrient requirements of a 50-kg calf under thermoneutral conditions using equations developed from the body composition data generated at Cornell University and the University of Illinois[1]

Rate of gain, kg/d	DMI, kg/d	ME, Mcal/d	CP, g/d	CP, % of DM
0.20	0.55	2.36	94	18.0
0.40	0.67	2.89	150	22.4
0.60	0.80	3.52	207	26.6
0.80	0.96	4.36	253	27.4
1.00	1.12	4.83	318	28.6

[1]Data from Van Amburgh and Drackley (2005).

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500g powder equivalent / 4L milk wont cut it for much weight gain….especially if its cold.

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That's 10-20 MJ/day energy so a huge lift in energy. So fat content is important in your milk replacer for instance to deliver the energy

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Protein density also crucial to support growth , but also it contains many of the “future triggers”

A couple of considerations - Stress and temp !

- An animal that stress's or is transported / moved increases heat production for two weeks there after. That increase is equal to 100g/day extra powder or 900ml of milk….20% uplift in needs

- Outside temps can change nutrient requirement 30-50%

- There's an 70% uplift again. That's why they don't always grow

Table 2. The maintenance requirements (Mcal of ME, temperatures

BW, kg	Temp			
	20	15	10	0
25	1.1	1.3	1.4	1.7
30	1.3	1.5	1.6	2.0
35	1.4	1.6	1.8	2.2
40	1.6	1.8	2.0	2.4
45	1.7	2.0	2.2	2.7
50	1.9	2.1	2.4	2.9
55	2.0	2.3	2.6	3.1
60	2.2	2.4	2.7	3.3

How do I get the extra milk solids in to go from 500g/day to 700-750g/day powder equivalent

- 1- Feed two extra litres of milk if feeding milk. Go from 4L to 6L
- 2- Feed extra powder if doing CMR

- My suggestion on “fortified” milk either way. Feeding 4 Litres in volume tends to work , and we don’t overfill the calf gut. Less scours.

- 4Litres milk still , plus 200grams powder = 17.5% solids
- 4L volume with 175g/litre CMR

Fortify your brew solids %...but Stick below 18% solids per litre

- Milk is about 12.5% solids roughly.
- Safe “solids” content is up to about 18%
- Above 18% , the solids content changes the osmotic balance in the gut and changes water flows across the gut wall.
- Too rich a brew can CAUSE scours

- But we can manage what we want to do happily in the safe zone , and we can do it with either fortified fresh milk or milk replacer…so all farms can do this without increasing milk volume
- You can increase milk volume as an alternative if you choose of course ,and its cost effective

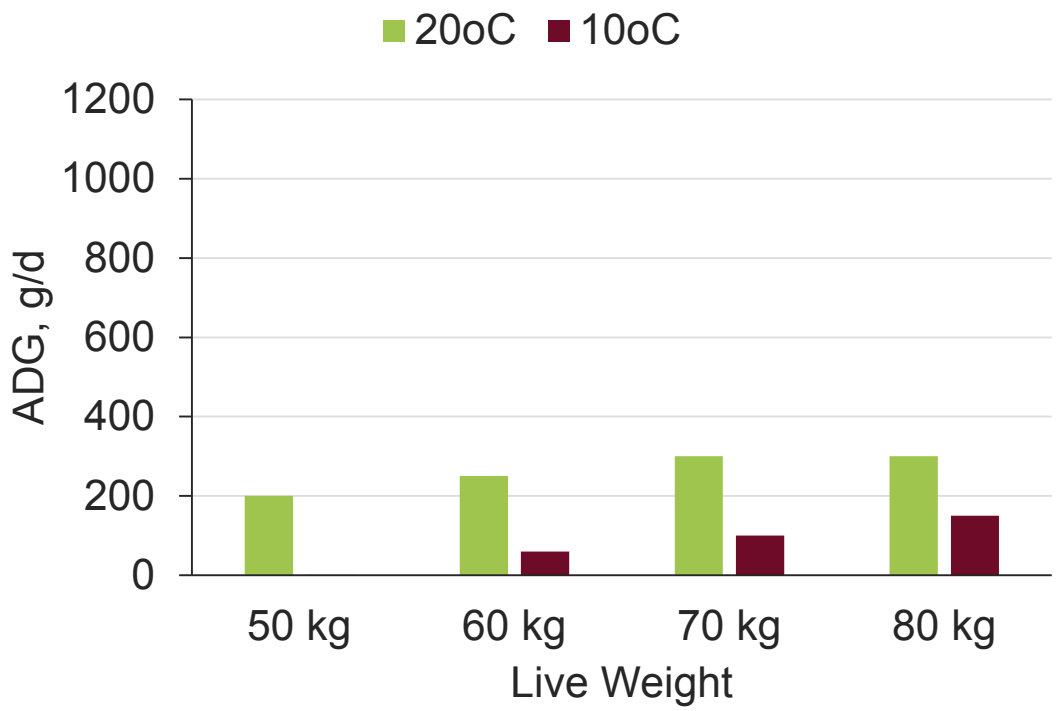
Step down Weaning when doing accelerated programmes not abrupt weaning

- Step down is a true “weaning off” the amount of milk solids fed, and do it over 7-14 days
- Allows the calf to transition onto higher amounts dry starter intake during that time , and have less weaning lag after extra milk powder intake

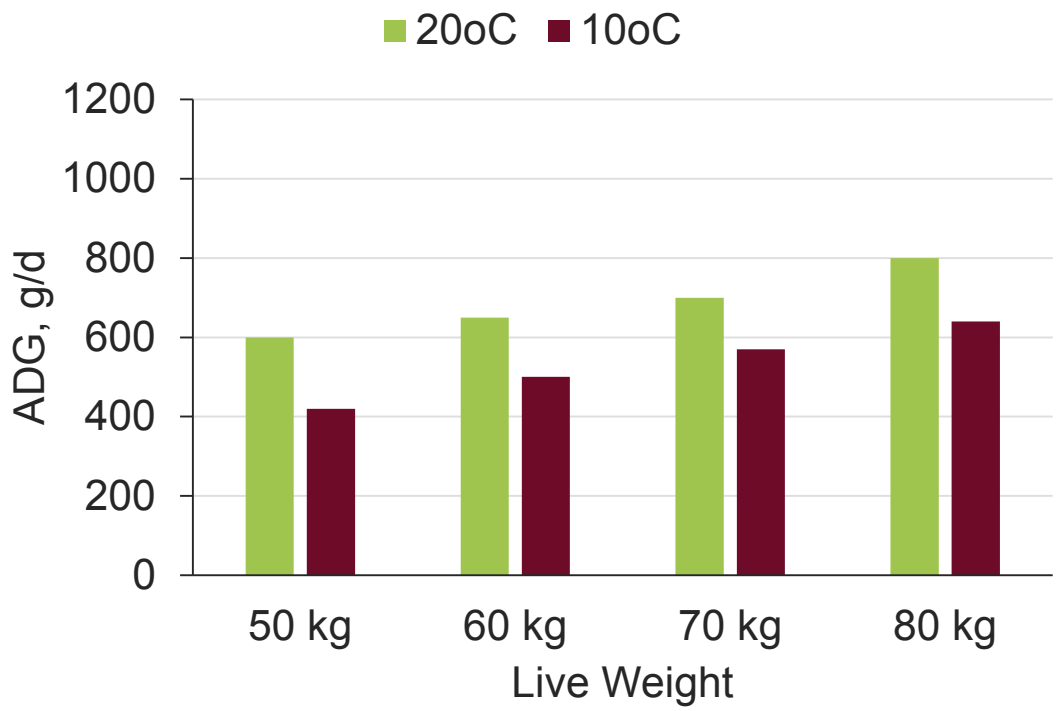
- But the extra powder up till then has whole of life benefits as already discussed

Nutrition of the milk-fed calf

Traditional view
1% BW of a 20:20 (CP:Fat) milk replacer



Modern view
1.5% BW of a 28:22 milk replacer



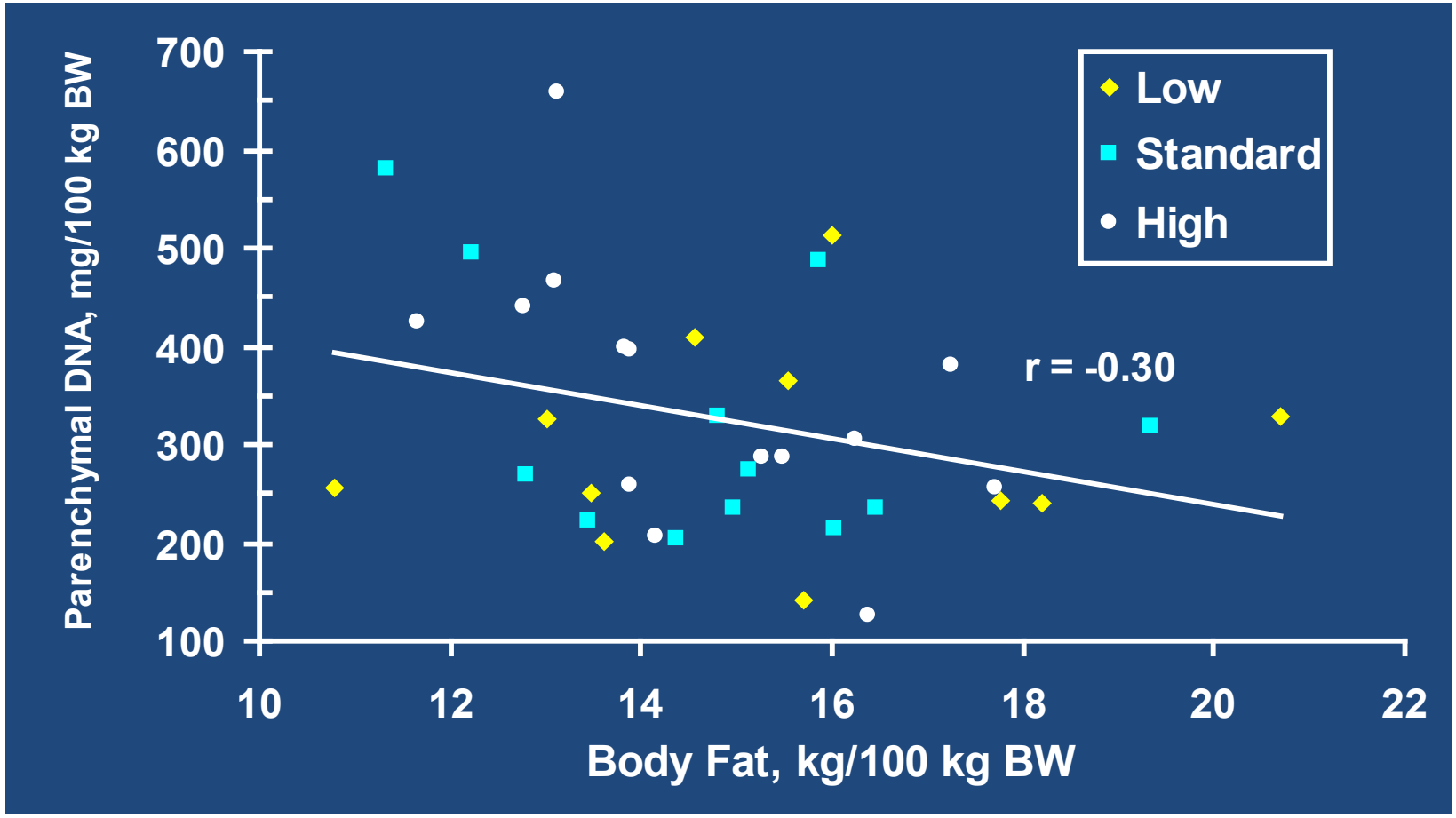
Feed efficiency increases as body gain increases

Powder g/d	Milk, L/d	Gain, g/d	Cost
500	4	200	2.50 kg powder/kg gain
750	6	600	1.25 kg powder/kg gain
1000	8	900	1.10 kg powder/kg gain

Temperature = 20^{o}C

No fatty boombahs though- so protein delivery at all stages is CRUCIAL to success here both pre weaning , and then very much post weaning

Body fatness at puberty reduces mammary development



Silva et al. (2002)

Parenchymal DNA/kg BW sources of variation

Source	DF	Type III SS	Pr>F
Treatment	2	64409	0.11
Body fat (Treat)	3	101374	0.08
Error	31	416536	

Factors that did not enter the model (P>0.50)

Silva et al. (2002)

Age at puberty (Treat)

BW gain before puberty (Treat)

Body Protein (Treat)

BW at slaughter (Treat)

Dietary protein and mammary development

B.K. Whitlock, M.J. VandeHaar, L.F.P. Silva, and H.A. Tucker - J. Dairy Sci. 2002. 85:1516–1525

	Dietary Treatments			
CP:ME (g/Mcal)	**11.4**	**13.5**	**15.7**	
Diet ME, MJ/kg:	12	12	12	
Diet CP, % of DM:	13.7	16.2	18.8	
Body weight gain, kg/d	1.14	1.17	1.18	
End body fat, kg/100 kg BW	15.4	14.7	14.4	
Parench. DNA, mg/100 kg BW	**595**	**619**	**670**	**+ 13%**
Parench. DNA at 250d, mg/100 kg BW	**542**	**616**	**808**	**+ 49%**

A word on calf starters: There is science here too

- Who here drives a TATA not a hilux, Ranger, BT50 ?

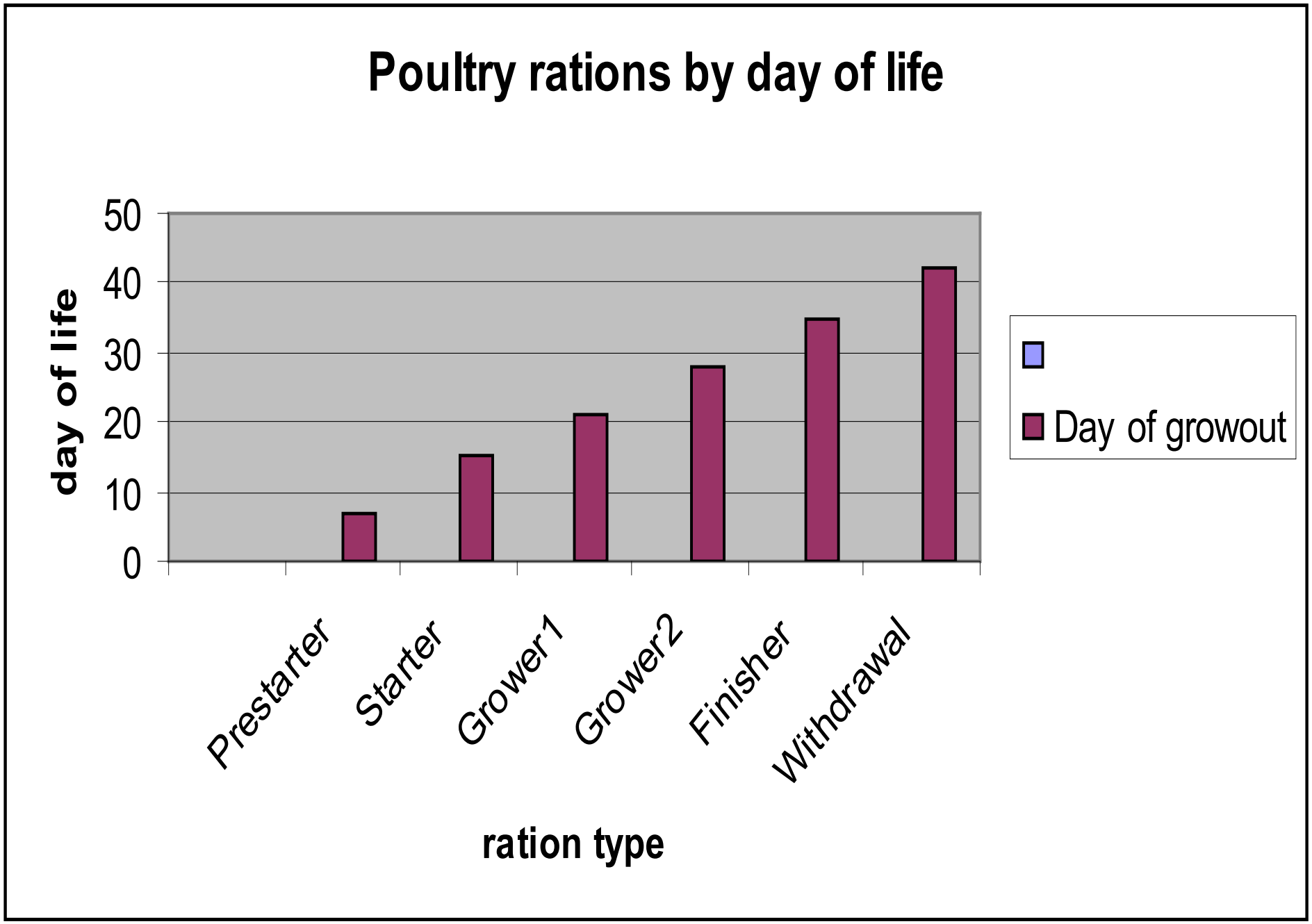
A word on calf starters: There is science here too

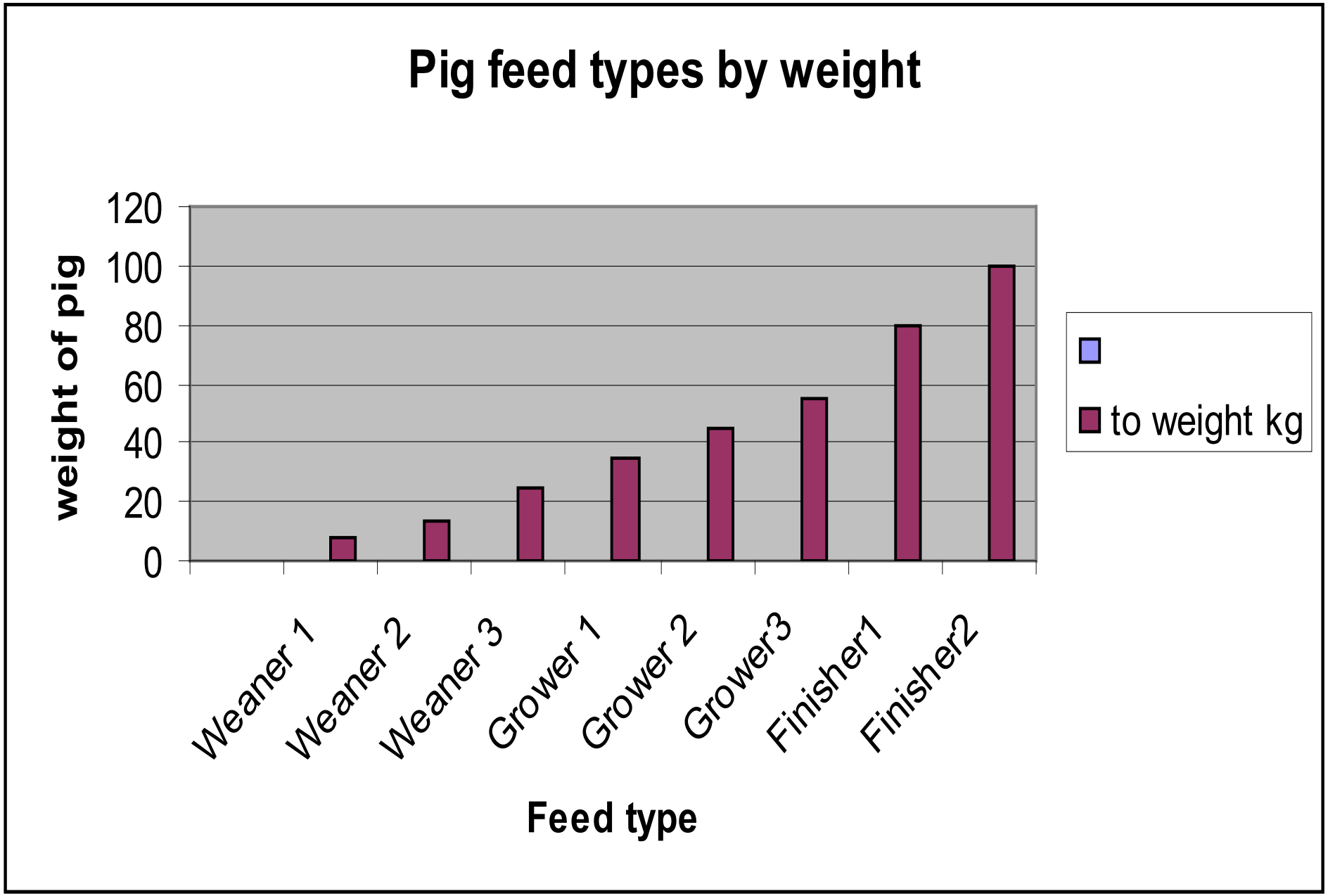
- Who here drives a TATA ?
- Don’t just buy your calf starter (or your CMR either) based on $/bag. Understand some specifications
- Specification details is why we sell lots of Hilux utes , and not many TATA’s…..because TATA’s sure are cheap vs a Hilux

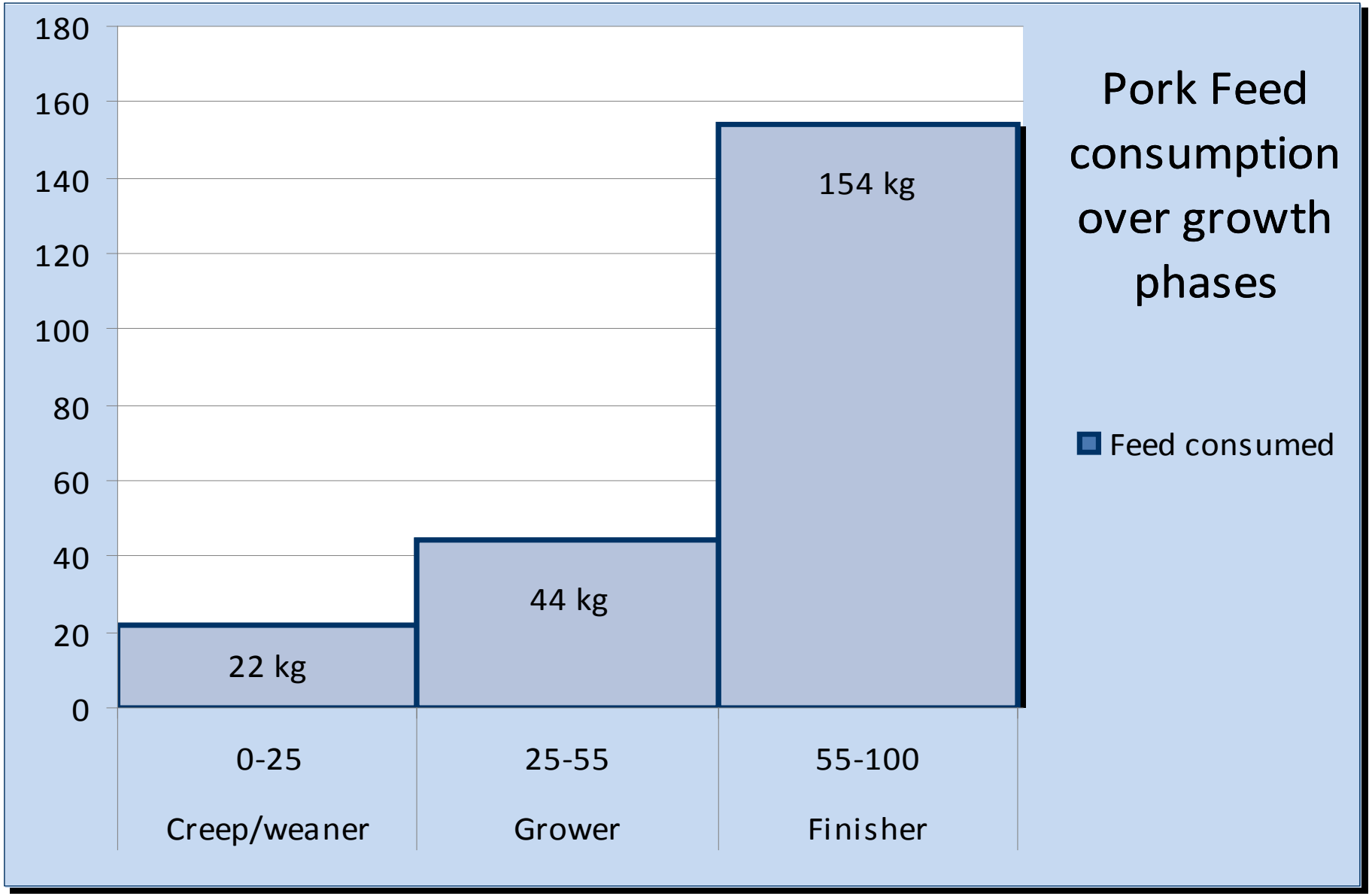
Don’t just ask is it 20% protein or 18% and how much is a bag…that’s like “does it have 4 wheels”

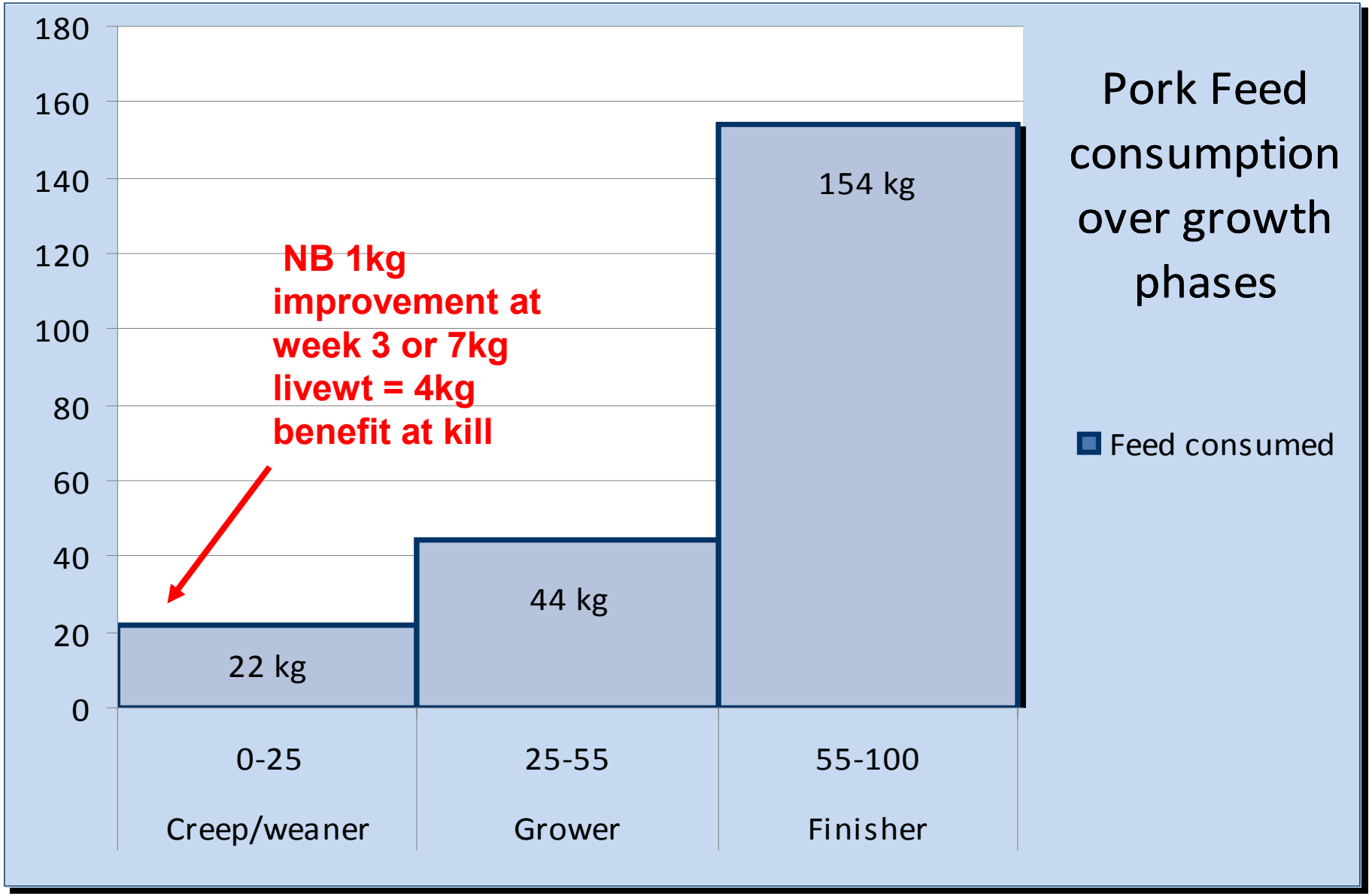
- Calves are all about palatability (so they eat) and then digestibility if we want them to harvest nutrients and grow
- Ask for Starch, sugar and NDF content. Also ask for ingredients list. Eg DDG or Palm kernel meal protein is not the same as Canola meal, soyabean meal or lupins protein.

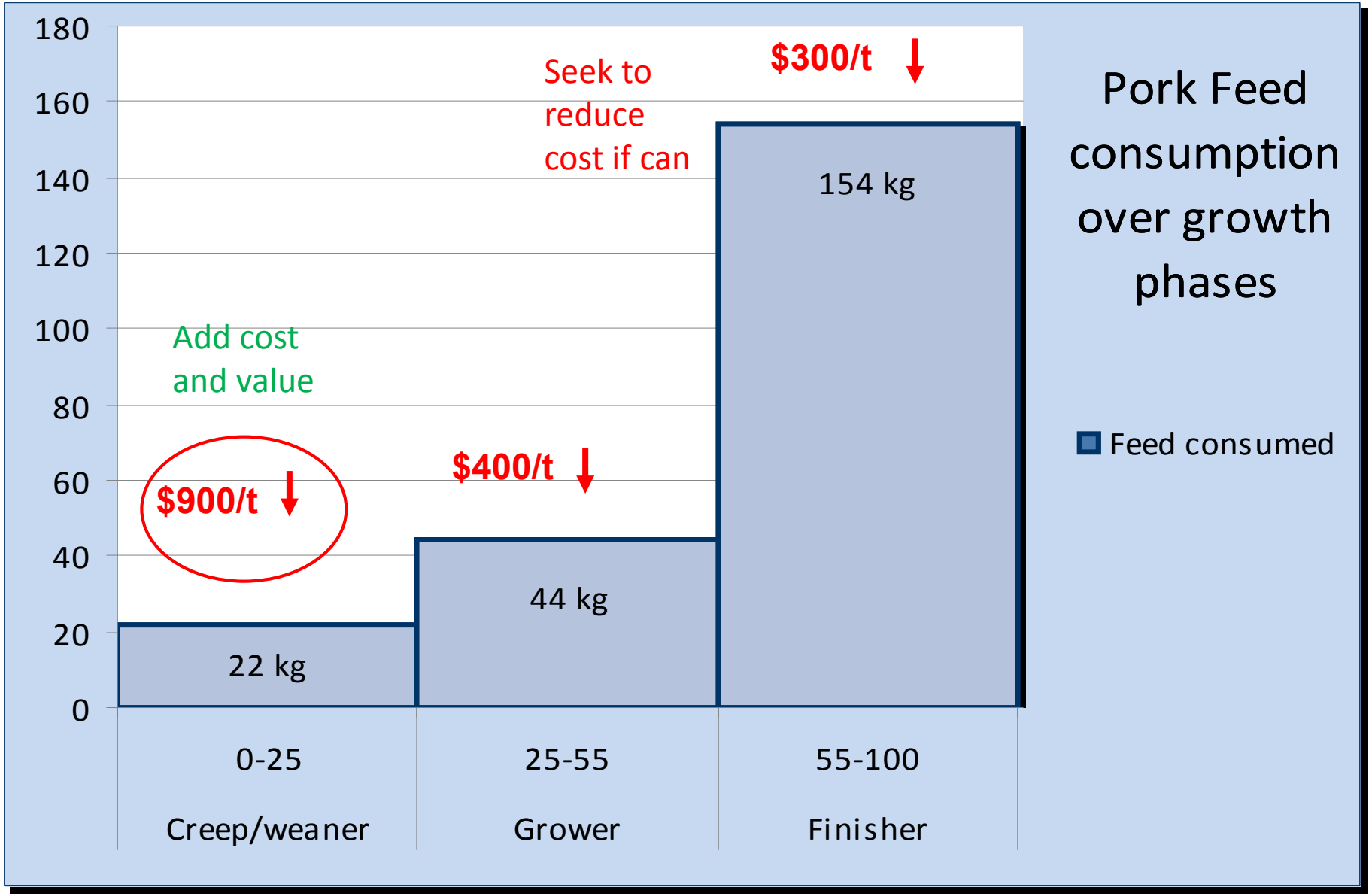
- The proportion of lifetime feed they eat pre weaning is tiny…yet has huge impacts. Don’t short change starter quality to focus on $/bag


Poultry rations by day of life
day of life
50
40
30
20
10
0
Prestarter
Starter
Grower1
Grower2
Finisher
Withdrawal
ration type
Day of growout


Pig feed types by weight
weight of pig
120
100
80
60
40
20
0
Weaner 1
Weaner 2
Weaner 3
Grower 1
Grower 2
Grower3
Finisher1
Finisher2
Feed type
to weight kg


180
160
140
120
100
80
60
40
20
0
22 kg
44 kg
154 kg
0-25
Creep/weaner
25-55
Grower
55-100
Finisher
Pork Feed consumption over growth phases
Feed consumed


180
160
140
120
100
80
60
40
20
0
NB 1kg improvement at week 3 or 7kg livewt = 4kg benefit at kill
22 kg
44 kg
154 kg
0-25
Creep/weaner
25-55
Grower
55-100
Finisher
Pork Feed consumption over growth phases
Feed consumed


180
160
140
120
100
80
60
40
20
0
Seek to reduce cost if can
$300/t
154 kg
Add cost and value
$900/t
$400/t
44 kg
22 kg
0-25
25-55
55-100
Creep/weaner
Grower
Finisher
Pork Feed consumption over growth phases
Feed consumed

Nutrient requirements of rations vary across life span

	Protein	ME	Fat	**Lysine**	**Methio-nine**	**Threo n-ine**	**Trypto phan**
Broiler starter	22	12.5	4	**1.15**	**0.51**	**0.73**	**0.21**
Broiler Withdr awal	19	12.5	4	**0.95**	**0.40**	**0.64**	**0.19**
Pig Starter	23	13.3	5	**1.4**	**0.42**	**0.84**	**0.26**
Pig Finish	13	12.5	3	**0.65**	**0.20**	**0.39**	**0.12**

Take home points on nutrition and udder development

- Feed newborn calves to gain a minimum of 600 g/d before weaning (1.5% BW). Adjust for ambient temperature. Goal is 80 kg at 60d!
- Faster growth of calves enhances mammary development and reduces health risks.
- Most important goal is 85% of BW at 21 mo (510 kg).
- High-energy diets (low true protein) before breeding will impair future milk production (left over from lactating cows!)
- Some heifers will grow faster then other, this is not a problem.
- Excessive body fatness is a better indicator of damage to the mammary gland than fast growth.
- Greater protein content during the 1st year can benefit mammary development.

3- Economic paybacks / implications

This all seems utterly logical , so why don’t we all do it ?
Answer is it costs money upfront , so people don’t do whats best !

How much ? 200g powder/day over 42 days= about 8.5kg CMR
This goes from 500g/day to 700g/day powder
Its about 1.5 extra litres milk 4 litres to 5.5 litres

Its about a $25-35 extra input. Lets round to $30 for today

Result is extra 300g/day weight gain, as all nutrient goes to gain

What do I get for my money ! How does it pay?

1. More milk from each heifer on herd entry
2. Heifers getting there on time entering the herd, so eating less feed overall to arrive at herd entry

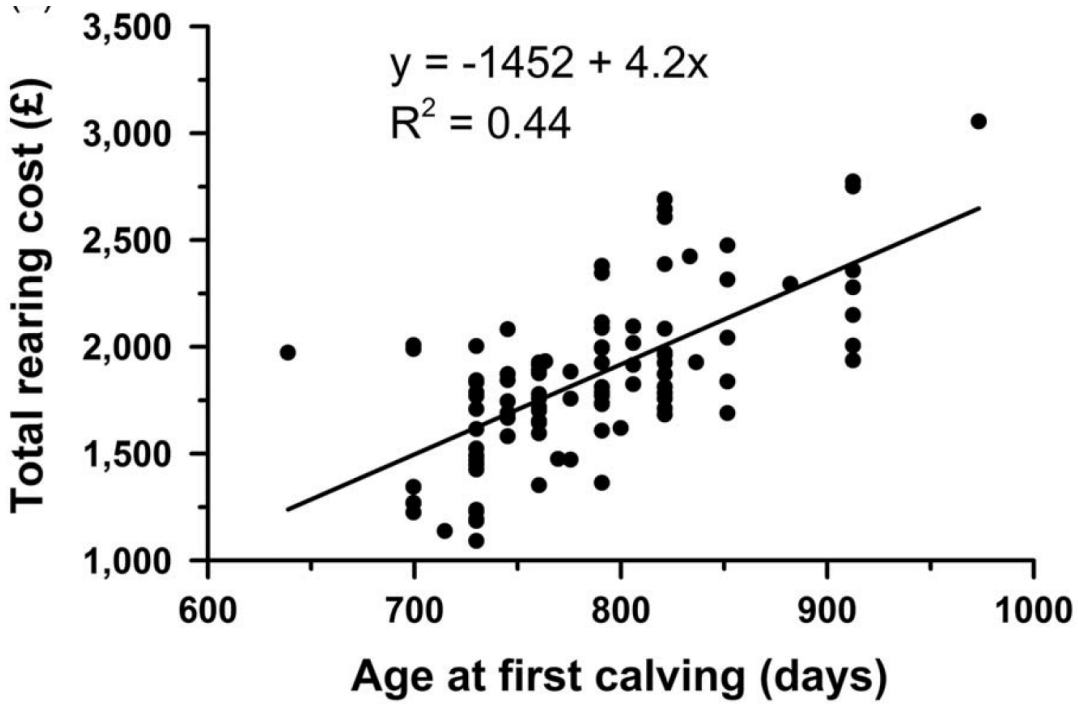
3. Carrying less heifers, so eating less feed (forage) overall…or …more heifers to sell as a profit centre not just a cost centre

Payback 1 on my $30= $120 more milk first lactation alone

- We gained 300g/day extra pre weaning, and that relates to 400-450L milk in first lactation
- Lets say 400L. Lets call it 30c/litre at early season prices so $4 MS.
- Payback on our $30 is $120 conservatively
- Breakeven is 100L milk ….not much

Influence of different variables on total cost of rearing

Variables	*F*	Prob. > *F*	Adj. R^2
Age at first calving (day)	53.7	<0.001	0.35
Seasonal calving pattern	10.3	<0.001	0.22
Time at grass (%)	23.3	<0.001	0.18
Bred	4.1	0.002	0.13
Region of UK	1.6	0.12	0.05
Calving rate (%)	1.6	0.15	0.03



Boulton et al. (2017) – ***101 farms at the UK***

Payback 2 on $30 : less feed eaten before herd entry. $180 less forage consumed

- She gets there “on time” to enter herd at 2 years. Good job.
- That means she avoids entry at next season calving ….min 180 days in batch calving herd
- She will be eating 10kg/day by that stage, and each kg is 10c/kg
- 180 days x 10 kg x 10c/kg = $180 payback on by $30

- Breakeven on the $30 is 30 days. IE if she is 30 days later entering the herd the money is paid back ie one month only guys !!!

So on that individual heifer we are $300 for our $30

Now we get to the big stuff, the structure of the herd

Heifer Herd Size for a 100-cow Herd

(Heifer cull rate = 10%)

Cow Culling Rate (%)	Age at First Calving (Months)				
	22	24	26	28	30
	← 2.4 per additional month →				
26	53	58	63	67	72
30	61	66	72	78	83
34	69	76	82	88	94
38	77	84	92	99	106
42	86	93	101	109	117
	← 3.9 per additional month →				

2.0 per additional percent

2.5 per additional percent

http://www.extension.org/pages/Heifer_Economics (May 2009)

So we have saved about 18 heifers per 100 cows based on age of herd entry

- We either save that cost of rearing them , or we sell them.
- $2000 each either way

- Probably we reduce herd cull rate with better heifers as well , so even more advantage not counted here
- Even on a 100 cow mob that’s $36,000 benefit

Net benefits in a 200 cow herd of growingout the right number of heifers in a great way

- Lesser number heifers required = $72,000 annually saved
- 65 heifers per year enter herd , and each paid back $300= $19,500

- $91,500 annually

- Investing about $2000 annually in superior calf nutrition