Using PigPulse to Monitor Grower Herd Production.

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Summary

- Growth and Fatness was studied in a piggery producing 240 pigs per week.
- Growth rate from 0 to 22 weeks of age is negatively related to fatness (p=0.01).
- This relationship changes with time and strengthens when fat rapidly increases or decreases.
- Growth from 12 to 22 weeks is most important in determining fatness (p=0.01) followed by 3 to 8 week growth (p=0.05).

Introduction

Pigmeat processors provide producers with comprehensive feedback about carcase weight and fatness. This data is very valuable as it determines income, but it is also very retrospective as once the pig is dead there is no opportunity to change the result.

This paper presents a case study of an on farm monitoring process intended to investigate pig growth from weaning to slaughter. Ultimately the objective is to control each phase of production to ensure that carcase weight and fatness achieve production targets.

What is PigPulse?

PigPulse is a computer program that analyses trends in pig production traits. It acts to identify significant changes in performance for managerial investigation. The intent is to:

1. Nip problems in the bud and quickly return to target production levels.
2. Gauge responses to deliberate managerial intervention (see if it works).

PigPulse achieves this graphically by plotting a stepped line through weekly data. Each step represents a significant shift of mean performance with respect to the prior step. Thus, these steps act to group weeks of similar performance. As steps are significantly different, management may be confident that there is a "real" reason for the performance change identified.

PigPulse is routinely used on a weekly basis and is highly automated to analyse many traits simultaneously; it then selectively reports only those traits detected to have changed in the current week. It is a "real time" system designed to promptly take management to the scene of the accident before the evidence disappears or memories fade.

Method

Fifty six week's data was sourced from a commercial piggery selling an average of 240 pigs per week. Piglets are weaned at 3 weeks of age and are then moved to a nursery shed and are held there for 5 weeks. Once a weekly batch of pigs is formed, they remain as a group until consignment. Nursery groups are then moved to a weaner shed and are then held there for 4 weeks. They are then moved to a grower shed and are then held there for 11 to 12 weeks. Movements into the nursery, weaner and grower sheds are weighed (the entire week's pigs are all weighed).

A recording board migrates with each group to collate weight data. Upon consignment, carcase weights are transformed into 22 week liveweights upon a 76% dressing percentage. Approximately 10% of sales can be derived from fast growing pigs of a prior week group, or less frequently, from slow growing pigs from a latter week group. Thus there is some exposure to error in transforming 22 week liveweights for collation with the groups prior weighings. Carcase backfat is corrected to a constant liveweight of 100kg at the rate of 1mm per 10 Kg liveweight.

Thus the following rates of gain can be calculated; ADG 0-3 wks, ADG 3-8 wks, ADG 8-12 wks, ADG 12-22 wks, ADG 0-22 wks and Corrected P2 Fat.

Data is collated by week group and posted for reporting by week of birth. Thus when interpreting PigPulse graphs, groups' traits of the same week of birth relate to each other as being derived from the same group of pigs across time. PigPulse uses a YYWW labelling format where 9748 is week 48 of year 1997.

Discussion

Figure 1 presents carcase fat data showing an initial downward trend followed by a marked upward trend. This herd has demonstrated the potential to produce 12mm carcases at 76 Kg dressed weight (100 Kg Liveweight) for an 11 week period ending 9811. This is not a chance occurrence. From 9811 there are one or more factors at work influencing carcase fatness. Each of the four successive steps represent the effect of a new factor(s) upon fatness or a significant escalation of an existing factor already influencing fatness.

As this study was conducted retrospectively, these factors remain unknown. Housing is the only factor known to remain constant, leaving management, nutrition health, season, genotype and fat measurement as possible factors. If this study was conducted in real time, each successive step would have motivated an investigation of causes and effects. The small arrow on each step signals the first point in time when there was sufficient evidence to detect a significant change in performance.

The financial impact of carcase fatness on price (12.1mm vs 15.3mm) is modelled on present day values to cost 15 cents / Kg (Price = 95.89 + 15.56 P2 - 0.75 $P2^2$). Thus the change arrow on the ninth step at 15.3mm is indicating that this step is worth $24,624 to investigate and resolve (9 weeks x 240 pigs x 76 Kg x 15 c/Kg).

The income forgone in fatness is only part of the problem in this instance. Figure 2 presents over life growth rates (ADG 0-22 wks) for the same period. Note that the trend in ADG 0-22 wks inversely mirrors Corrected P2 Fat. When growth is slow, fat is high and visa versa.

For a six week period this herd has demonstrated the potential for 680 g/d growth from 9747 to 9752. Three significant downward steps have reduced growth by 68 g/d to finally stabilise at 612 g/d. Over a 22 week lifespan this amounts to forgoing 10.5 Kg LW per pig sold. This values the final step at $49,987 to investigate and resolve (15 weeks x 240 pigs x 10.5Kg x 0.76% x 1.74 c/Kg).

Figure 1. PigPulse Analysis of Carcase Fatness.

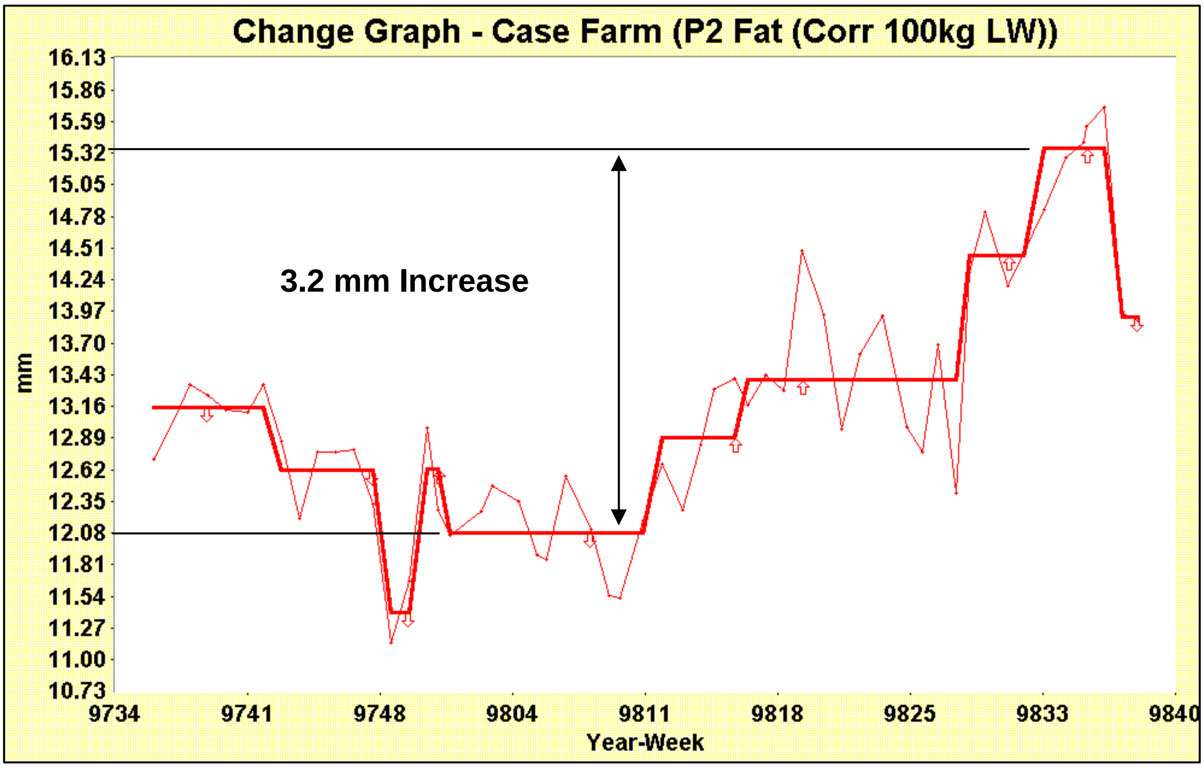


Figure 2. PigPulse Analysis of Over Life Growth Rate.

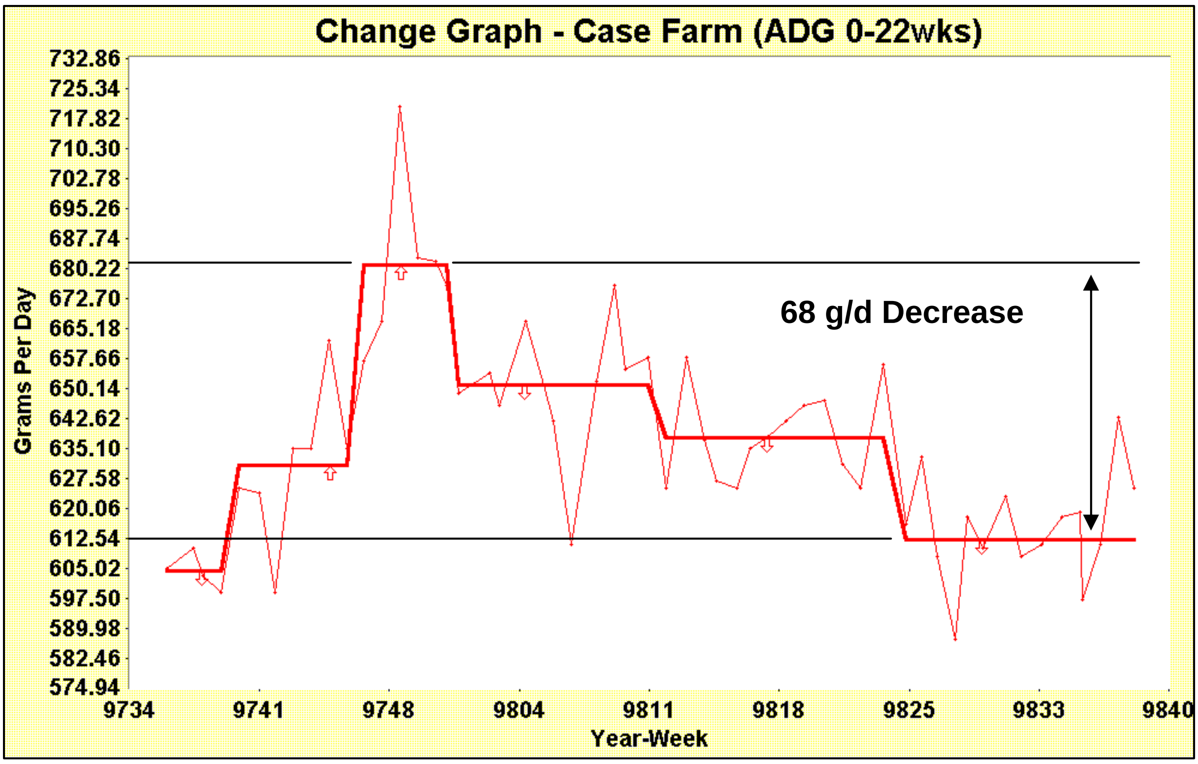


Figure 3. Relationships Between Growth Phase and Overlife Growth Rate

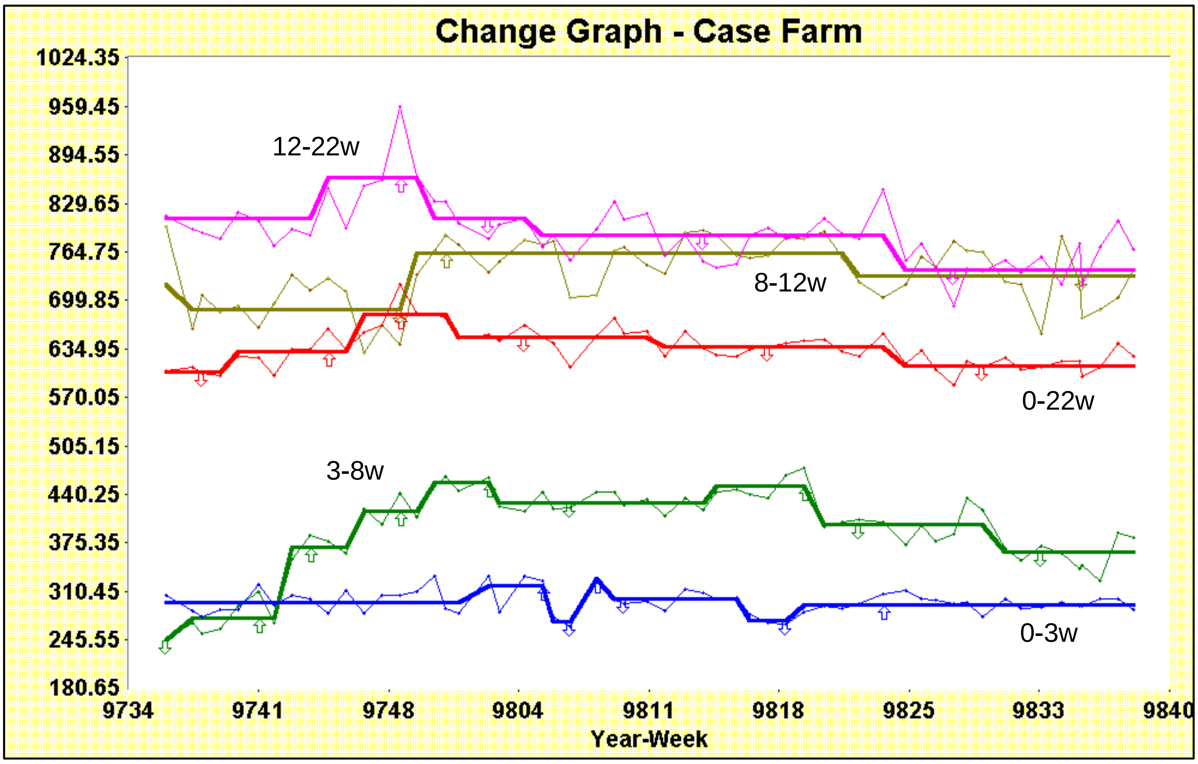


Figure 3 jointly presents four stage growth rates 0-3wks, 3-8 wks, 8-12 wks and 12-22 wks to explain the variation observed in overlife growth rate ADG 0-22 wks. The true variabilty of ADG 0-22 wks is exposed and accounted for by the variability within the four respective growth phases across time.

Weeks vertically aligned in figure 3 are directly related. Taking the first week (9736) for example, the group of pigs grew at 305 g/d to 3 weeks, 245 g/d from 3 to 8 weeks, 798 g/d from 8 to 12 weeks and 813 g/day from 12 to 22 weeks to culminate in an overlife growth rate of 605 g/d from birth to sale.

Thus the initial two step rise in ADG 0-22 wks to 680 g/d is explained by four succesive rises in ADG 3-8 wks from 245 g/d to 453 g/d (amounts to an extra 7.3 Kg liveweight at 8 weeks of age of predominantly lean growth). This critical phase can thus independently result in ultimately moving a carcase into a more lenient grading category at slaughter.

Additively, ADG 12-22 steped up from week 9744 from 810 g/d to 862 g/d to induce the second rise in ADG 0-22 wks from 635 g/d to 680 g/d. ADG 0-3 wks and ADG 8-12 wks remain relatively stable during the period and do not contribute significantly to the change in ADG 0-22 wks.

Other observations of interest:

- Weak evidence of compensatory gain is indicated at 9818 where ADG 0-3 wks declines and ADG 3-8 wks increases (not reproduced under similar circumstances in week 9807).

- ADG 0-22 wks follows ADG 12-22 wks very closely as would be expected.
- The decline in ADG 3-8 wks detected (arrow) in week 9833 may be implicated in the sudden rise in carcase fatness (reverse of the scenario described in weeks 9736 to 9752).
- Fast ADG 3-8 wks tends to accelerate subsequent ADG 8-12 wks (9750 to 9820).
- The last two weeks 9837 to 9838 show early signs of a recovery in ADG 0-22 wks driven by ADG 3-8 wks and ADG 12-22 wks (two successive weeks above the current step). Interestingly, Corrected P2 Fat declined significantly in these same two weeks.

Table 1. All Data (56 weeks 9736 to 9838) sig r=0.263 (p=0.05,*), r=0.341 (p=0.01,**).

Trait	ADG 0-3wk	ADG 3-8wk	ADG 8-12wk	ADG 12-22wk	ADG 0-22wk
ADG 0-3wk	1.000				
ADG 3-8wk	0.092	1.000			
ADG 8-12wk	0.030	0.430**	1.000		
ADG 12-22wk	0.152	0.128	-0.297*	1.000	
ADG 0-22wk	0.335*	0.611**	0.079	0.809**	1.000
Corr P2 Fat	-0.246	-0.316*	-0.130	-0.520**	-0.588**

Figure 4. Relating ADG 0-22 wks to Fatness over the entire data set.

Table 1 presents a matrix of correlation coefficients relating growth to fatness derived from the entire data set analysed.

ADG 0-22 wks displays the strongest relationship to Corrected P2 Fat Depth, followed by ADG 12-22 wks and ADG 3-8 wks.

Figure 4 shows that 35% of the variation observed in fatness is explained by over life growth rate.

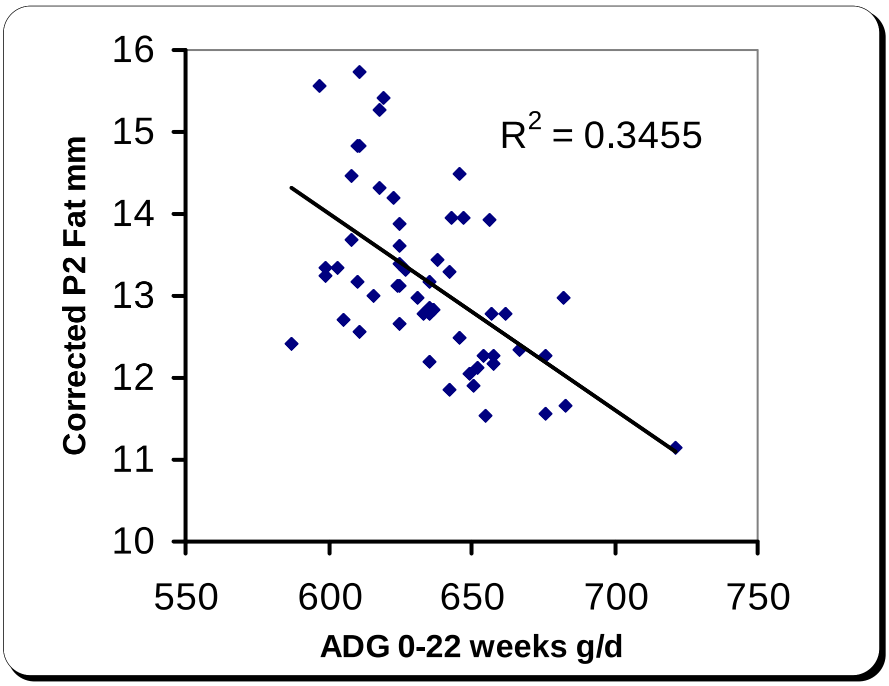


Table 2. Corr P2 Steps 1,2,3, (15 weeks ending 9750) sig r=0.497 (p = 0.05, *), r=0.623 (p = 0.01, **).

Trait	ADG 0-3wk	ADG 3-8wk	ADG 8-12wk	ADG 12-22wk	ADG 0-22wk
ADG 0-3wk	1.000				
ADG 3-8wk	0.297	1.000			
ADG 8-12wk	0.170	-0.324	1.000		
ADG 12-22wk	0.177	0.724**	-0.329	1.000	
ADG 0-22wk	0.294	0.910**	-0.294	0.926**	1.000
Corr P2	-0.449	-0.781**	0.060	-0.825**	-0.887**

Figure 5. **Relating ADG 0-22 wks to Fatness when Fat is decreasing rapidly.**

Table 2 presents a similar correlation matrix, but it is restricted to the first 15 weeks of the data set. These weeks correspond to the first three steps in declining fatness.

This time span demonstrates similar relationships between Corr P2 Fat and ADG but they are much stronger and ADG 3-8 wks is playing a more influential role in subsequent growth and fatness

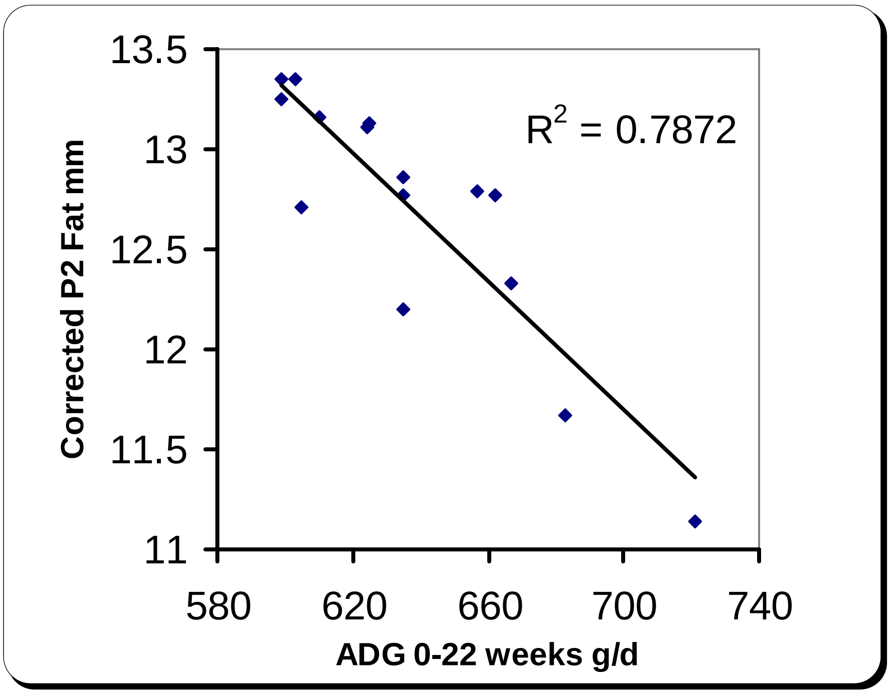
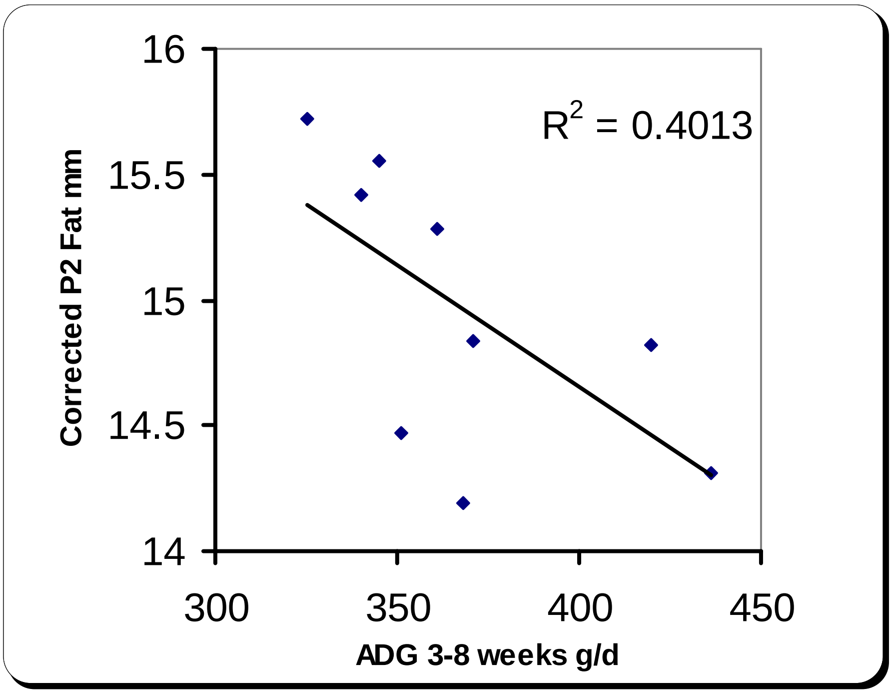


Table 3. Corr P2 Steps 8,9, (9 weeks ending 9836) sig r=0.602 (p = 0.05, *), r=0.735 (p = 0.01, **).

Trait	ADG 0-3wk	ADG 3-8wk	ADG 8-12wk	ADG 12-22wk	ADG 0-22wk
ADG 0-3wk	1.000				
ADG 3-8wk	-0.349	1.000			
ADG 8-12wk	-0.081	0.543	1.000		
ADG 12-22wk	0.216	-0.266	-0.346	1.000	
ADG 0-22wk	0.424	0.225	0.508	0.429	1.000
Corr P2	0.031	-0.633*	-0.306	0.101	-0.413

Figure 6. Relating ADG 3-8 wks to Fatness when Fat is increasing rapidly.

Table 3 focuses the correlation matrix at the two highest Corr P2 Fat steps (steps 8 and 9) spanning 9828 to 9836. Figure 6 presents the only relationship to remain significant between ADG 3-8 wks and Corr P2 Fat. This indicates that this phase of growth may solely explain the change to the highest step of fatness (from step 8 to step 9).



Figures 1,2 and 3 indicate some anecdotal evidence suggesting the patern of growth influences resultant carcase fatness. Tables 1,2 and 3 provide further substantive evidence of this relationship and that it is variable with time. Figure 2 higlights two pairs of successive weeks (circled) exhibiting extreme fatness (9749 & 50 = 11.4mm, 9835 & 36 = 15.7mm). The average growth curves of these paired weeks are presented in figure 7.

Figure 7. Growth characteristics at extremes of Fatness

Figure 7 shows the major difference between growth resides in the 12 to 22 week phase. The net effect is 480 pigs averaging 11.4 mm at 116.5 Kg LW ($155.66 / pig) verses 480 pigs averaging 15.7 mm at 98.2 Kg LW ($115.91 / pig).

The scaling of this graph is visually misleading and conceals differences at 8 weeks of age.

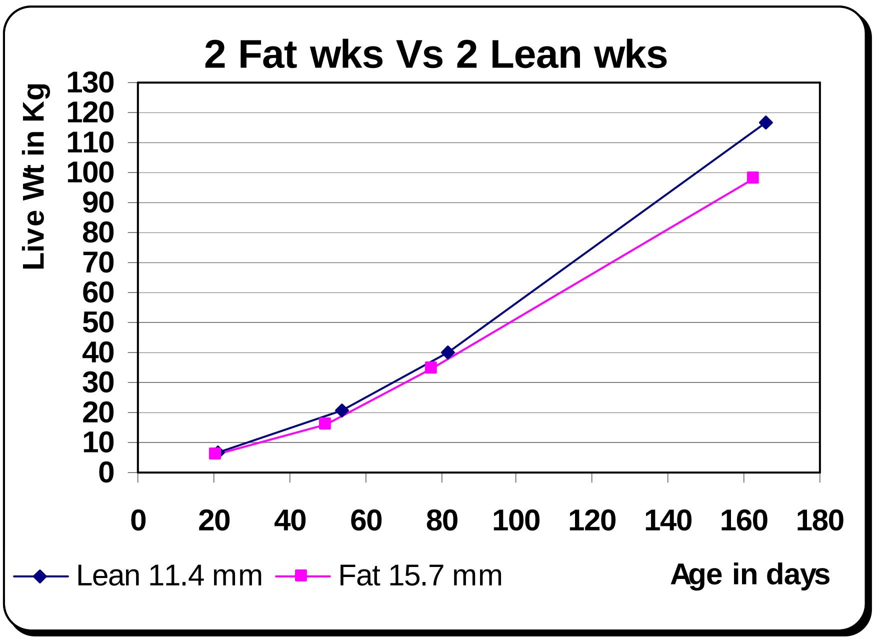
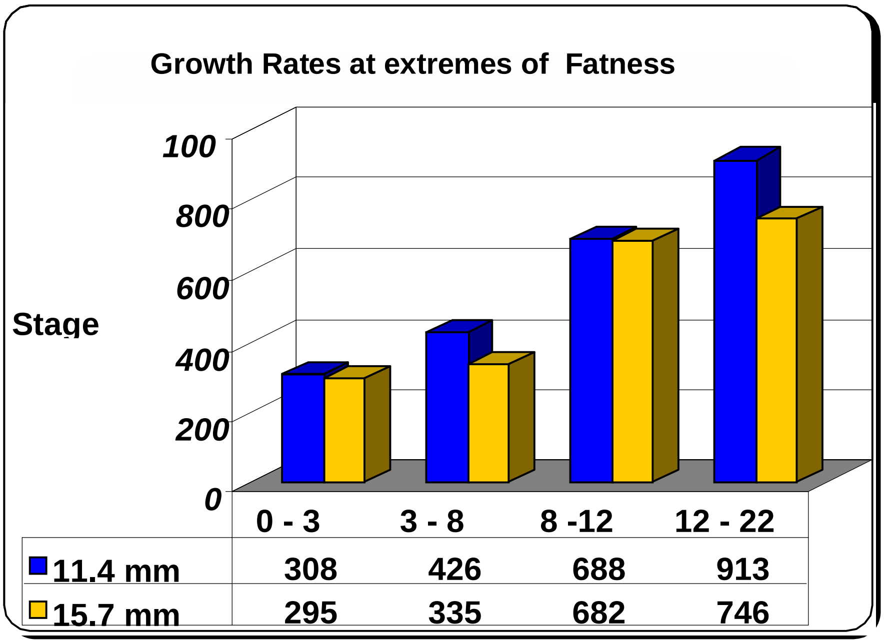


Figure 8 Comparison of Growth Rates at extremes of Fatness.

Figure 8 looks at the same data as figure 7, but is scaled by rate of gain. The fat group has suffered a 91 g/d set back in the 3-8 week phase and also again in the 12-20 week phase (167 g/d).

The fat group started at lighter weaning weights (6.05 Kg vs 6.45 Kg) and were 2.5 Kg lighter at 50 days of age (18.2 Kg vs 15.7 Kg).



In a more conservative evaluation of growth and fatness, an 11 week period of stable fatness in step 5 ending 9811 (Lean Period) is compared to a 9 week period of elevated fatness in steps eight and nine ending 9836 (Fat Period). Table 4 summarises the results showing that slow growth during the 3-8 week and 12-22 week phases results in fatter carcases.

Table 4. Mean performance comparison of Lean and Fat periods

Production Trait	Lean Period	Fat Period	Significance
Corrected P2 Fat	12.08	14.96	P = 0.001
ADG 0-3 Weeks	301	292	N.S.
ADG 3-8 Weeks	435	369	P= 0.001
ADG 8-12 Weeks	748	723	N.S.
ADG 12-22 Weeks	800	747	P = 0.001

Table 4 indicates that a 66 g/d (15%) setback at 3-8 wks together with a 53 g/d (7%) setback at 12-20 wks jointly increased fatness by 2.9 mm. In relative terms, the 3-8 wks setback is twice as severe as the 12-22 wks setback (15% vs 7%).

Conclusion

The financial effects of variable growth and fatness are substantial and warrant managerial control. This production unit has invested much capital and labour to capture production data and measure performance. The analysis and interpretation of data has historically presented a barrier to understanding production trends and serves to confound decisions of "when to act" and "what intervention is required" to redress the situation. Incorrect actions serve only to confuse interpretation and inject more variability into a system spiralling further out of control.

PigPulse provides a simple system to automatically inform management of the state of the production system on a shed by shed real time basis. The effort spent in retrospectively analysing 56 weeks data for this case study would have been more productively employed in investigating the most recent change in fatness detected in the last week 9838. Something good is happening and unless the investigation proceeds promptly the evidence will again disappear and another opportunity to capture knowledge from the production system will be forsaken.

This study has shown that the 3 to 8 week growth phase is critical in determining subsequent fatness. ADG 12-22 wks is a more important determinant of fatness, but is more expediently addressed as it resides at the end of life. The 3 to 8 week phase is deemed critical as it lays the foundation for subsequent growth and takes a further 14 weeks to be expressed in financial terms. PigPulse has a particular role to play in nipping problems in the bud in the nursery shed. Protracted problems in the nursery growth phase may justify nutritional correction in later phases. Sentinel groups weighed and back fatted at 16 to 18 weeks would provide further useful information to management in this regard.

Sentinel weighings must be timed late enough to enable indicative fat deposition to be measured and early enough to allow management sufficient time for corrective action (feed silos to be emptied or consumed and replacement diets formulated and delivered).

Under stable conditions when fat resides within predictable limits, 18 week sentinel measurements are preferred to maximise the predictive value of fatness and minimise management response time. When fat measurements are suspected to be increasing, routine sentinel measurements may be advanced to 17 or 16 weeks. If sentinel pigs are individually identified they may be re-measured 3 to 4 weeks later to confirm rising fatness or responses to managerial intervention.