Feed Intake Inhibition due to high temperatures

Summary

1 Intake is inhibited once room temperature reaches a certain point, and remains inhibited until temperature returns to an acceptable level.
2 The degree of inhibition is dependent on temperature.
3 Inhibition due to temperature is indicated by a negative curve in feed intake - the "double hump" syndrome. This may not be obvious in feed systems, due to their method of operation.
4 Water intake directly correlates with feed intake. It can be assumed that a negative curve (double hump) in water use indicates feed inhibition.
5 Once feed intake has been inhibited by high temperature, the effect lasts several days beyond the removal of high temperatures.
6 Significant economic benefits may be achievable by development of strategies to avoid or minimise such effects in the order of $10 per finishing pig place. Research aimed at achieving such improvements is strongly indicated.

Background

It is well known that excessive temperatures inhibit daily feed intake. At high temperatures, finishing pigs are unable to get rid of the byproduct heat from digestion, and therefore reduce their feed intake accordingly.
Pig models - which calculate the overall heat balance of the pig - are general models only. They predict the overall heat balance based on total daily intake, and heat loss models over a 24 hour period.
It is not normally possible to see temperature effects in dynamic terms - that is in terms of immediate effects.
Using the Dicam Barn Report system, feed intake is measured by detecting and counting the running time of the augers. There is good evidence to suggest that auger running time is a reasonably accurate means of measuring feed use.
In most feed installations, the auger system and control are such that feed is delivered in a quasi-random or periodic way. That is, there are arbitrary time lags and switching sensitivities, and in some cases augers are only enabled at certain times of the day. This means that the auger may run at a different time, and for a different period, compared to the actual intake. Although the total running time (say, over a day) is directly related to intake, this is not so in the short term, and it is difficult to tell exactly when or how much pigs are eating in a 24 hour period.
With water, it is much easier to see intake patterns as there are virtually no time lags, it is permanently enabled, and switching differentials (if present due to header tanks) are constant.
In this case study, the operation of the feed system is such that the feed is delivered virtually "on demand" in much the same way as water is delivered through a meter. Therefore, it is possible to see (in relative terms) the actual pattern of feed intake by the pigs, in both time of day and relative quantity.

Although most people may think in terms of hot weather or cool weather - such as summer and winter - as if they were stable alternatives, climate is inherently unstable. Around any average or typical level for a time of year, conditions either side of this norm are liable to remain only for a period of 5 days or so. For example, if the mean temperature for a time of year is 13ºC, then this is liable to be made up of periods around 18ºC, say, followed by say periods around 13ºC, with a return to 18ºC, or maybe 8ºC.
The result of this is that higher temperatures come in "bursts" of around 5 days, followed by a return to slightly lower temperatures.

With normal ventilation and regulation systems (if they work properly), outside temperature only has an impact on inside temperature once it gets close to set temperature (normal inside target temperature). For example, if set temperature is, say, 18ºC, then this temperature will be maintained (approximately) until outside temperature reaches about 15ºC. After this outside temperature is reached, inside temperature simply tracks outside temperature, but a few degrees above. (A typical ventilation design specification is for inside temperature to be 3ºC above outside temperature at maximum stocking rate.) So if it reaches 21ºC outside, it will be 24ºC inside. If it gets to 24ºC, it will be 27ºC inside, and so on. The temperature lift above ambient depends on the ventilation system specification and stocking rate. In ACNV systems - where ventilation rate is determined by wind speed - there may be a much greater or smaller temperature lift from time to time.

In most cases, there is also an ambient diurnal temperature range. For example, the mean daily temperature might be 18ºC, being a range of 12ºC to 24ºC. Ventilation and regulation systems can produce approximate target temperatures only when the daily range always falls below the value determined by temperature lift.

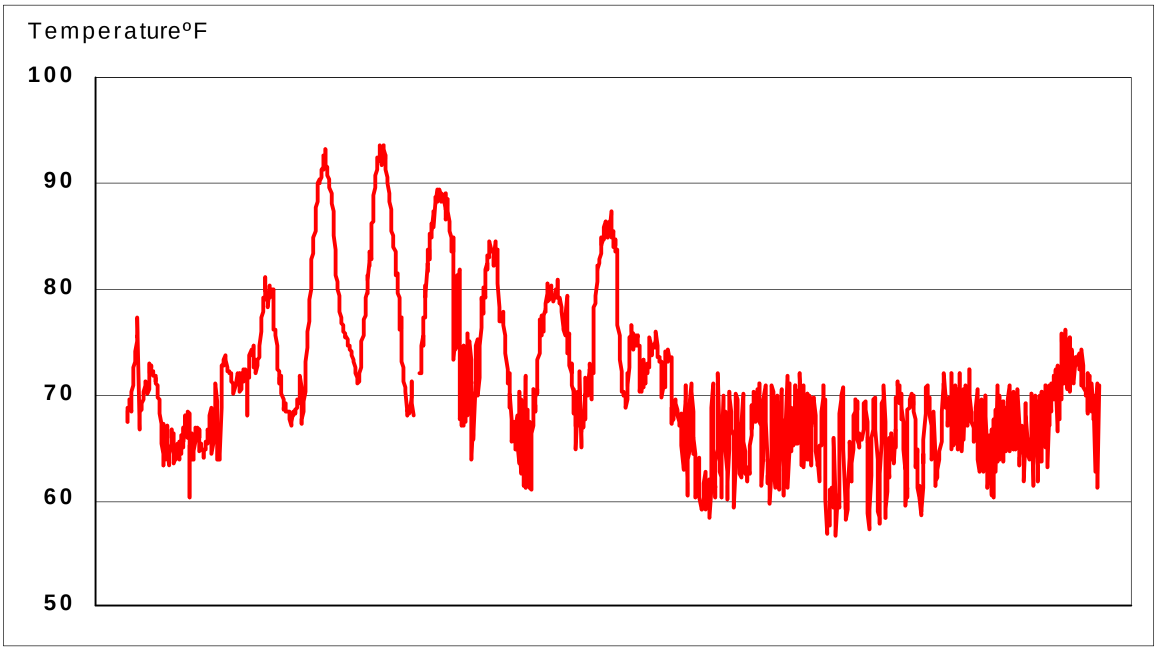
Focussing once again on the area of interest - high temperatures - the result of these periodic factors is that pigs spend periods when temperature is approximately constant, with periods of a few days when room temperature goes higher than set for a variable period of a few hours, by a varying amount.

In this case study we are looking at a period of 16 days in a US finishing building holding about 1000 pigs. For part of this period, daily temperatures were significantly above set temperatures for part of the day. We will look at the impact this has on feed and water intake.

Note : There is a regrettable loss of data for a few hours around Day 4 of the study, but this does not affect the overall conclusions.

Temperature

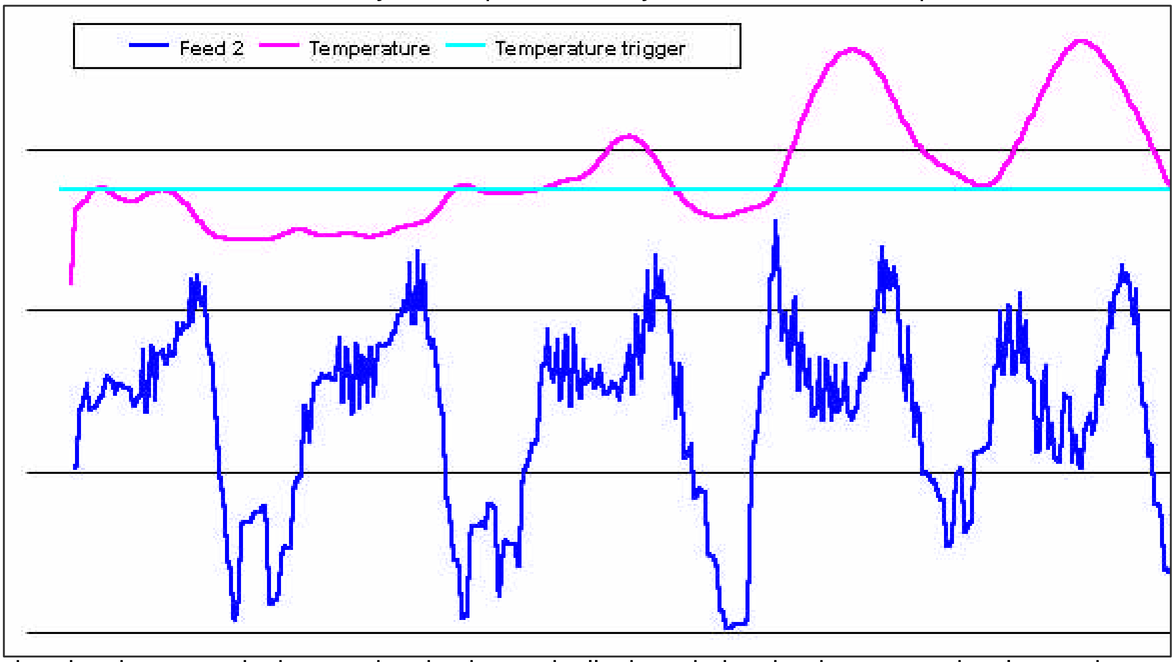
The notional (set) temperature is around 64ºF (18ºC). It's worth pointing out that the ventilation control system (not provided by Dicam) is not very stable, though quite typical of the type of system usually installed in such buildings. It tends to produce significant short term swings in temperature which are not due to ambient temperature - i.e. due to instability in the control system itself. To what degree this has an impact on pigs is not certain, though it is probable that more stable operation is desirable.



This shows inside temperature over the period.
Temperatures started at about set temperature. For 7 days temperatures rose significantly higher for part of the day, then returned to normal.

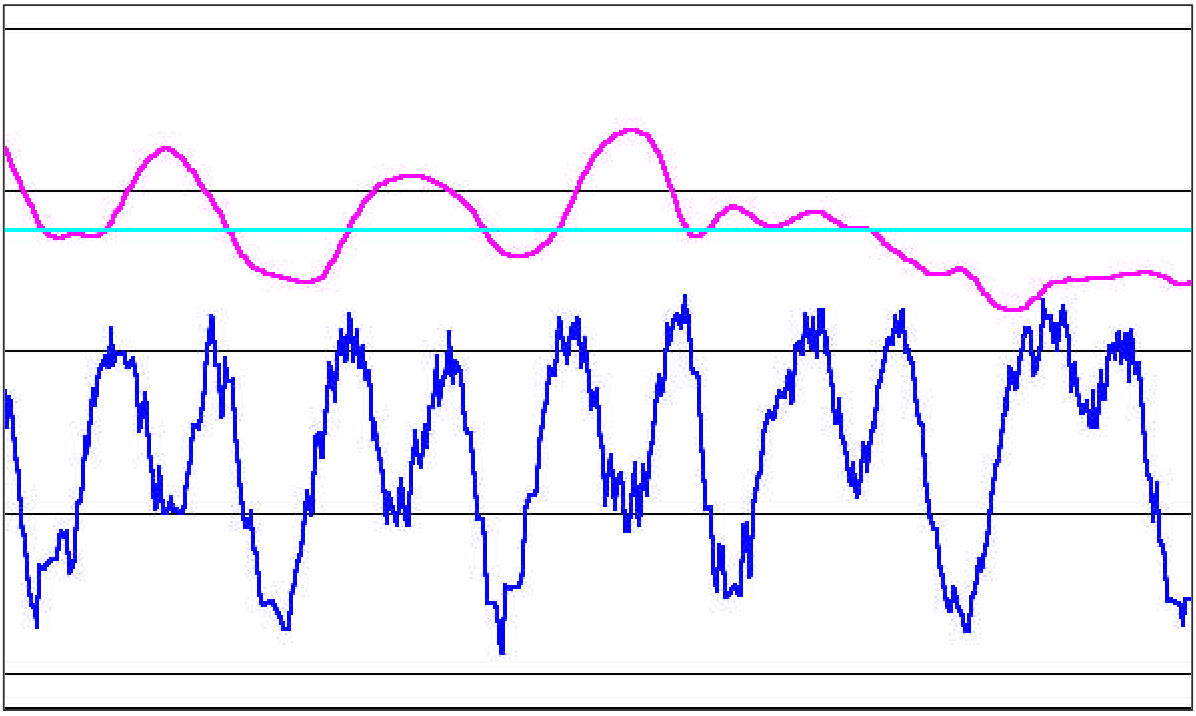
Feed Intake

This chart shows the first few days of the period. Initially, feed intake follows a pattern

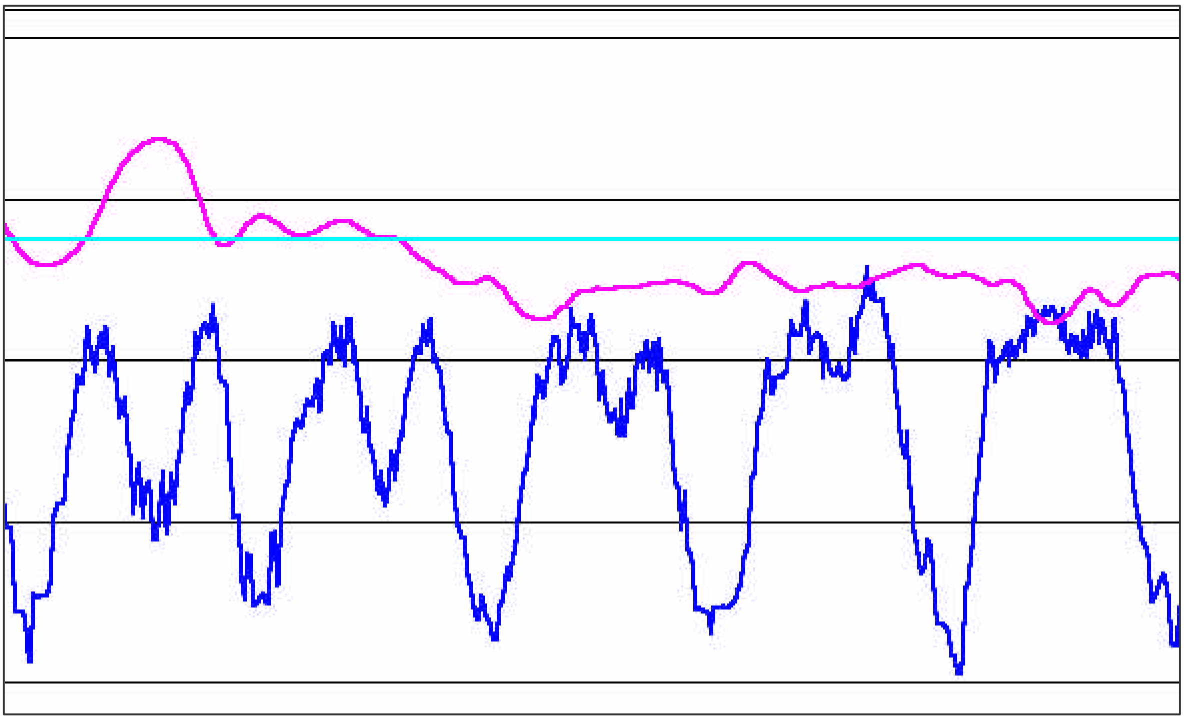


whereby pigs get up in the morning, intake gradually rises during the day to a peak value, and falls abruptly at sundown. On the 4th and 5th days, feed is reduced considerably during the middle part of the day when temperatures are higher.

The "Temperature Trigger" line is an approximate value where it seems that feed begins to be reduced. In this case, the value is only 72ºF (22ºC).

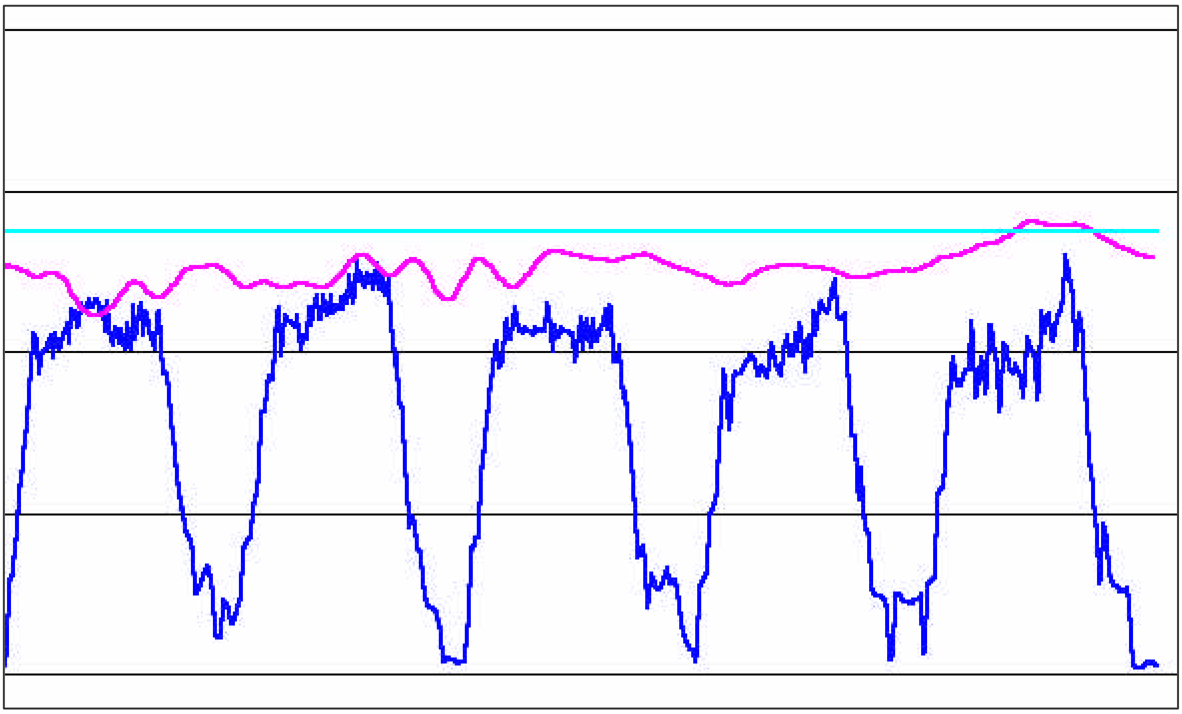


On subsequent days, this pattern is repeated - feeding is more in the morning and the late afternoon - a distinct dip in the middle of the day when it is hotter - the "double hump" pattern. You'll notice that feed intake now does not go down to zero - there is some degree of feed intake shift to the cooler period in early morning.

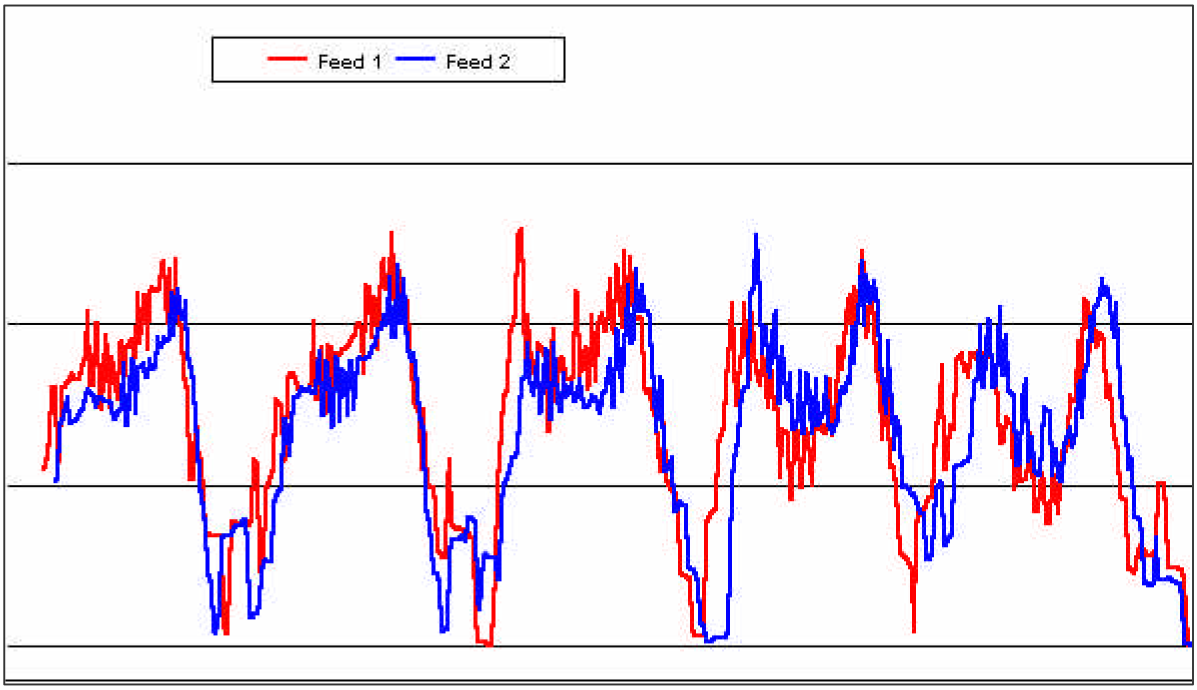


Even after temperatures drop (so the higher peak in the middle of the day is lost), it takes several days for intake pattern to return to normal.

Thereafter, feed intake pattern returns fully to the previous "sawtooth" pattern and you can see there is once more a clear zero (no intake point) in the trace.

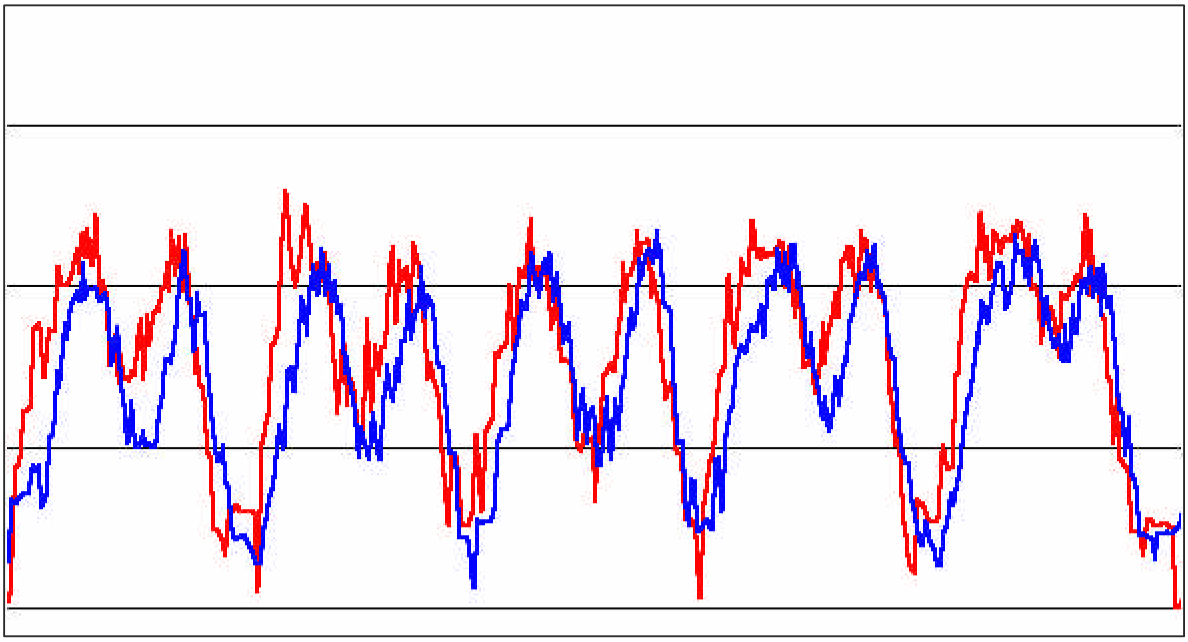


Auger 1 and Auger 2

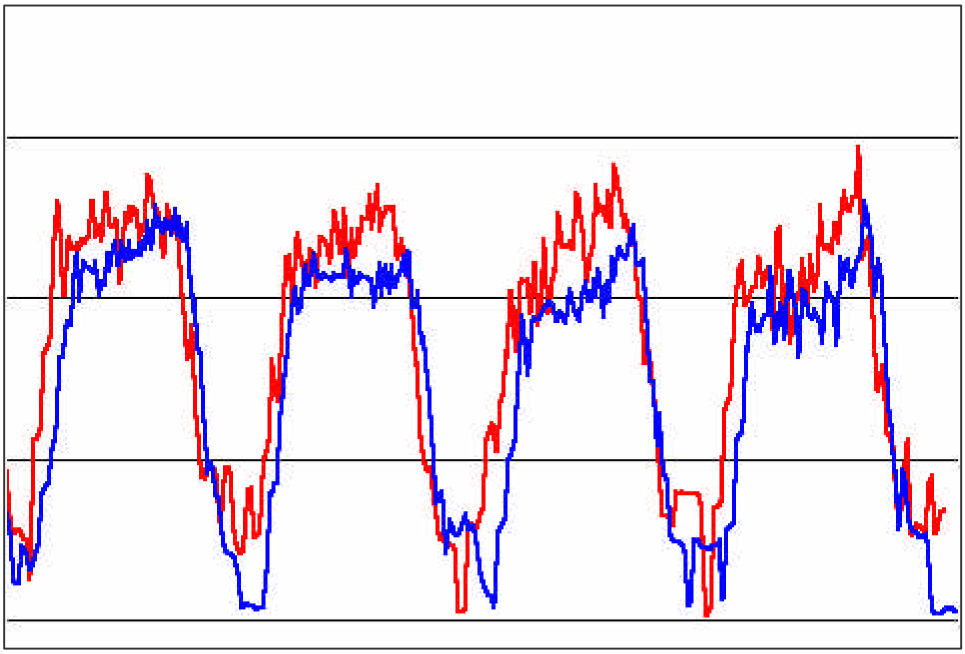


Up until now we have looked only at the operation of Feed Auger 2. Here we can see Auger 1 (supplying pigs on the East of the building) compared to Auger 2 (West). This shows that pigs on the east (which gets sun earlier in the morning) wake up and start eating half an hour or more earlier, but, correspondingly, go to bed slightly earlier. Looking at Day 3 in this chart - the first on which temperature rises significantly - this appears beneficial as the eat more before intake inhibition sets in.

In the middle period when intake inhibition is at its greatest, this effect is even more marked.



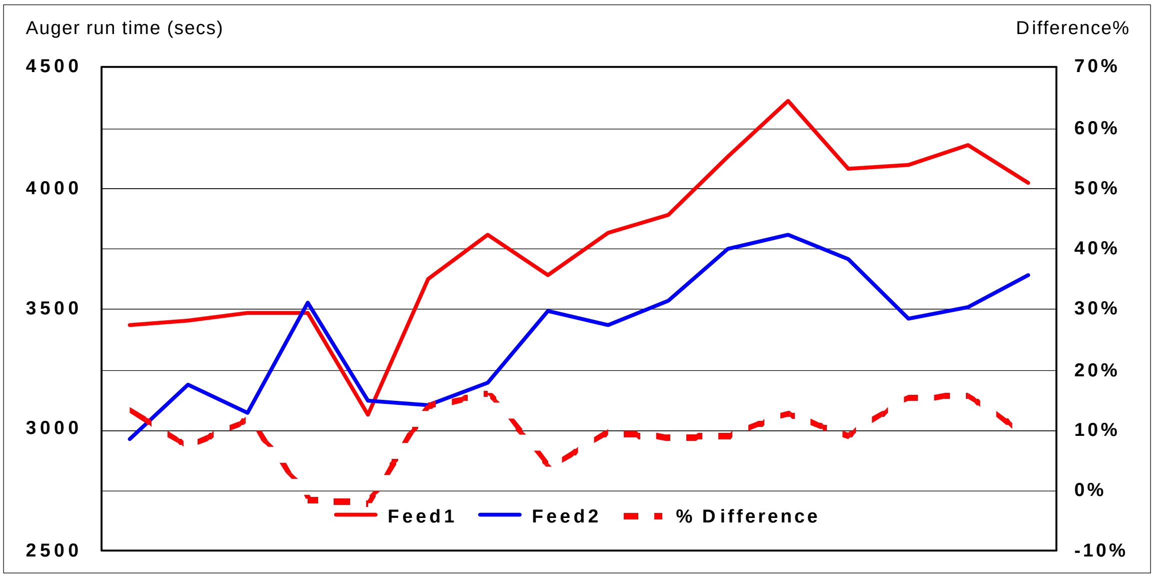
Feed intake appears to recover sooner, and inhibition is not so great . Taken together, these suggest that light levels may be a factor.



After intake returns to normal it can be seen clearly that auger 1 (East) runs more than 2 (West). In fact this is so throughout , except at the onset of high temperature. (See chart on following page.) This may be simply because this auger is less efficient (i.e. it has to run longer to deliver the same amount of feed), or that there are more pigs on this side of the building. However, the difference appears to increase marginally over the period. This suggests the pigs on this side are eating more because they are bigger.

If so, it would suggest a cumulative effect of higher intake on the East side of the building, perhaps due to pigs on average waking earlier and suffering less from the effect feed intake inhibition during the hotter part of the day.

Where sites are laid out with buildings North-South, one might expect better results on average on east side of the most easterly building, and the worst results on the west side of the most westerly.
This would be worth investigating. If this proved to be the case, then it would suggest that waking pigs earlier at the onset of hot weather might be beneficial. One approach might be to switch on lights so as to create a "false dawn".



[Daily total auger operation for augers 1 and 2, and difference in running time. Feed intake increases over the period in both cases. Difference typically 10 to 15%.]

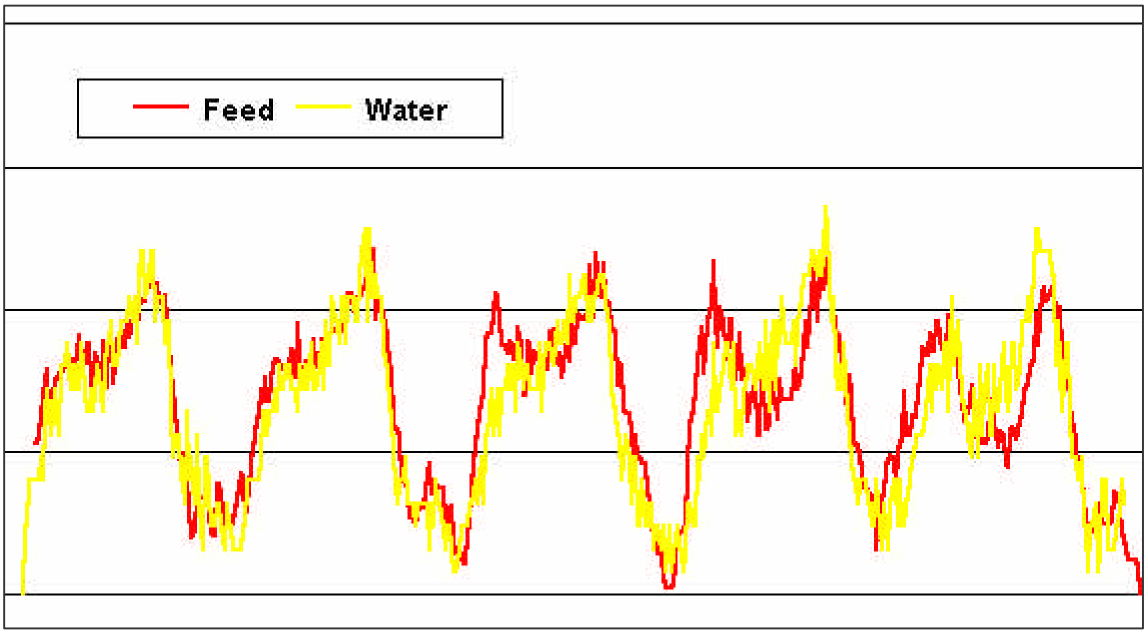
The data shown earlier suggests that getting up half an hour earlier has an effect. Similarly, the easterly pigs seem to go to bed earlier - i.e. stop eating sooner - presumably because it gets darker earlier on that side. This suggests that lengthening the day (by lighting) might also be a useful strategy to extend the eating period.

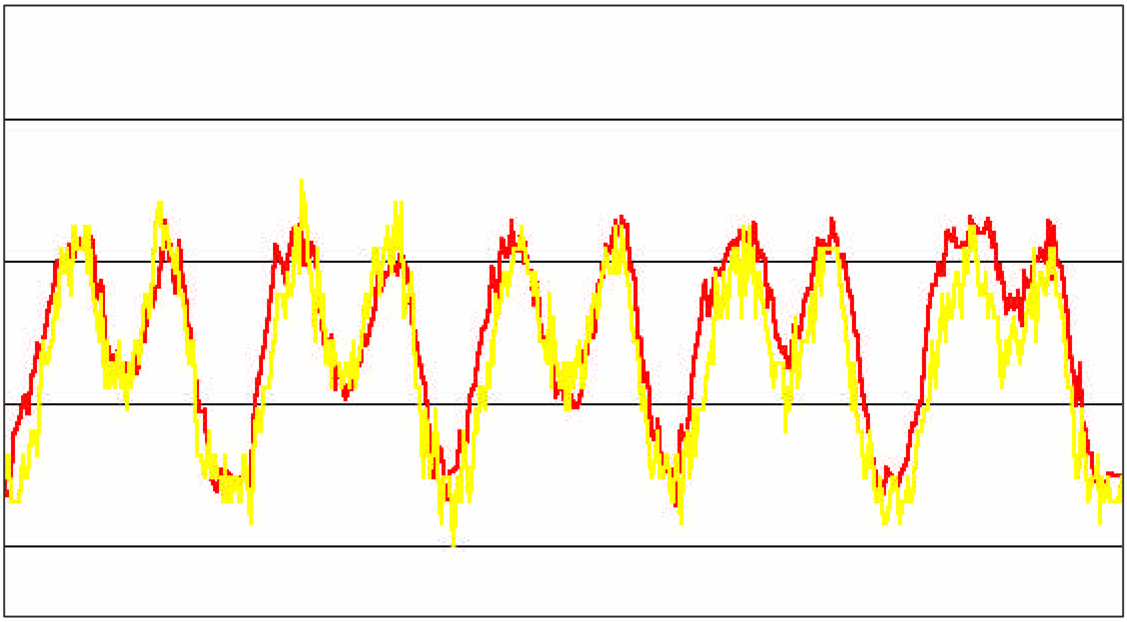
Pigs quite clearly have a circadian rhythm - an in-built body clock. This shown in other studies where a daily cycle can be seen even when kept totally in artificial light, with lights on 24 hours. It may be that what we saw earlier as "night time consumption" during hot weather is actually an overlap of one day with another.

The chart above shows a flattening off in the feed intake at the start of the hot weather, though it recovers before the end. This suggests that the pigs are "getting used to the hot weather". That is, they develop a strategy for coping with it, perhaps by getting up earlier. But nevertheless, there appears to be some loss of feed intake, and thereby loss of growth and FCR. This suggests there would be an economic benefit in helping pigs to develop this strategy at an earlier stage.

Water

Water tracks feed very closely, as can be seen in the following charts.



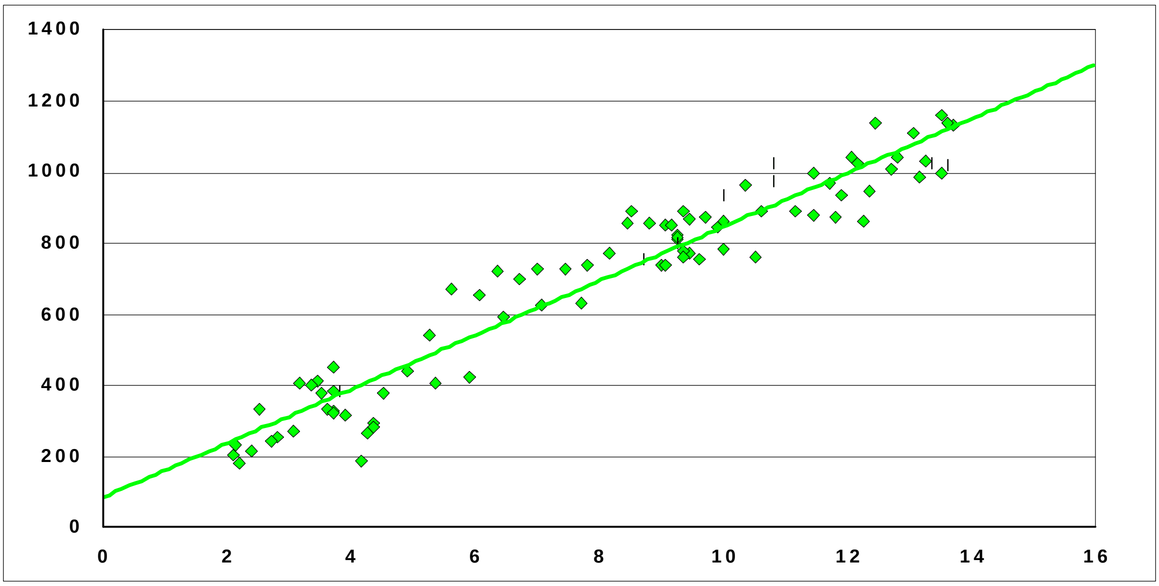


Whilst there may be marginal timing differences, it is clearly the case that water intake pattern is the same as feed intake pattern. That is, the timing of water intake can be taken as the timing of feed intake.

This is important , because the way that most feed augers operate means that we cannot normally see the feed intake pattern very clearly. If we assume this association between eating and drinking to be normally the case, then it means that - in ordinary cases - we can see feed intake through water intake pattern (which is much easier to measure and see in Barn Report and other analyses).

In other words, the appearance of the "double hump" in the water trace gives a clear sign that feed intake is being inhibited.

This chart shows the correlation between feed (seconds of run within 15 minute period)) and water intake (gallons in 15 minutes) on a particular day.



This charts total daily use over the whole period.

Although water intake is marginally higher in the hotter period (possibly due to greater evaporation from the lungs in the drier air), the overall trend is upwards for feed and down for water. That is, progressively less water is taken in relation to feed as the pigs grow. Although water pattern can be taken as representative of feed pattern in the short term, the total daily volume is not representative of feed intake in the longer term.

Effects on growth and FCR

Pigs are good at converting feed into meat. However, they can't convert what they don't eat, and much of they do eat is used merely for maintenance.

We can be reasonably sure that a reduction in voluntary intake will mean lower growth and a higher FCR. The degree of worsening depends on the degree of reduction and the "normal" intake in terms of xM (times Maintenance ration).

For example, if the pig is eating 2M (twice maintenance requirement), then - assuming the maintenance requirement is the same - a 10% reduction in Feed Intake means a 20% loss of growth, and correspondingly a 20% worsening in FCR on that day. If the pig is eating 1.5M then a 10% intake reduction means a 30% loss in growth and FCR.

Discussion

The data shows that higher temperatures have an effect on feed intake at a relatively low value - only a few degrees above that at which they are normally kept.

In this case, being normally about 68ºF, their intake is affected at only about 72ºF. Above this value, it appears that feed intake is inhibited in relation to the extent it is over 72º. This is a much lower value than generally expected (or predicted by UCT calculations).

Whether this is an "absolute" value - for this age and size of pigs - or whether it is caused by a change in temperature from they are used to is not clear. For example, if they were kept at 64ºF, would the inhibition have kicked in at 68º.

Clearly, if it were a relative effect - due to the change - it would be better to keep temperatures up in warm weather, rather than the (common) reaction of stockpersons to turn temperatures down. Similarly, if it is relatively short term changes in temperature which have the effect, then it would count strongly against control systems which (as is often found) tend to "hunting" (swings in temperature), and stability of temperature should be sought.

In the system being studied, more detailed temperatures show that the system is very prone to instability - swinging between 60ºF and 70ºF rapidly and repeatedly, although the mean may be adequate. This could be expected to have an effect on feed intake.

Whichever, it is clear that there is a strong "immediate" effect - i.e. within a very few minutes of temperature rising, intake drops. Whether or not pigs learn to get used to it, there will remain a shortfall in feed intake. There is no clear indication that this shortfall is made up at a later time or a later date.

The fact that - in normal circumstances - water intake is so closely related to feed intake is a "useful" feature, since it means we can detect onset of feed intake reduction fairly easily (using Barn Report).

How the intake reductions happens is not clear. We don't know whether the intake reduction means that marginally fewer pigs decide they want to eat, or whether the pigs that do eat decide to eat a little less, or a combination. This could be clarified by research on detailed monitoring of individual drinkers. We can reasonably guess that a pig eats and then drinks (or perhaps vice versa). Close monitoring could show both the quantity drunk at any visit and the number of visits. Thereby, it would show whether the number of visits changed, or the quantity at each visit.

In discussions with the author, various pig industry personnel have suggested that the "double hump" water intake pattern (remarked on in other documents) is not only often seen, but normal and positively desirable. (Probably based on experience with young children, who seem to need a nap in the afternoon.) The data presented here strongly indicates that it is not "natural" except in so far as it is a natural reaction of the pigs if they are to hot, nor yet is I desirable because overall it indicates reduction in feed intake potential.

It is probably the case that the trigger value temperature will vary, depending on the size of the animal. It is likely that heavier pigs will trigger a reduction at a lower temperature than lighter ones, and given they are eating less in terms of x Maintenance, the economic effect will be greater.

The heavier and older the pig, therefore, the greater should be the efforts to avoid feed intake inhibition, the greater the efforts to keep temperature down. This is somewhat the reverse of typical on farm approaches where a great deal of general effort and attention is often expended on younger pigs, whilst heavier pigs tend to be given less time.

Clearly, there is a great potential economic benefit in avoiding or minimising feed intake inhibition. Correspondingly, it may be worth spending significant sums of money in pursuit of this aim.

The Future

What strategies would be effective, and where should money be spent?

Firstly, of course, it seems to make sense to spend time and money on investigating the problem further. Not least, to investigate specific economic effects so as to find out the financial limits on investment to correct or ameliorate the problem. To put this another way, it is worth spending a little money to find out how much money it is worth spending.

Clearly, it would be worthwhile to investigate more specifically the trigger temperatures, and the amount of reduction.

(Whilst the author hopes that this document gives some kind of lead into the areas that might be investigated, it is only an initial case study, after all, and compares itself with itself over a relatively short period.)

Without pre-empting a detailed analysis, a rough calculation is possible - suppose a pig is typically exposed to 4 incidents during which it loses an average of 20% over 5 days. This would amount to 4 extra days added to the end - let's say an extra 28 lbs. of feed = about $2.25 per pig. Supposing a particular change or update is expected to reduce this to 2 days on average, then the value is $1.12 per pig. A breakeven figure (over 5 years, based on 10 batches) is therefore around $9,000 on a typical 1000 head barn.

Ideally, comparisons should be made between batches of pigs which experience temperature rise issues with those that don't, but there are several difficulties.

Whilst a large amount of information can be drawn from Barn Report (see note at the end), general supporting information is often lacking - even to the level of proper determination of age or number of pigs, let alone size.

The effect of reduced growth is to extend finishing dates (since pigs are grown to a certain weight, not a certain age) and effects are cumulative. Hence, pigs of a certain age may be of different weights, and if pigs of the same weight, may differ in physiological development.

Many other factors will affect overall growth and FCR. It is unlikely that a formula will be so simple as correlating feed intake with mean daily temperature, for example, desirable though that might be.

Unless refrigeration is used (which is unlikely to be cost effective), it will not be possible or practical to keep pigs below the temperatures at which feed is likely to be inhibited all the time. However, nor yet is it suggested that - because of the large economic cost/value - producers should merely accept this loss of production.

Clearly, many strategies are possible, some of which may be economically practical or beneficial, and some not. It is not so much a question of what methods might be used to reduce temperatures, as which methods will achieve the desired result (i.e. maintaining feed intake) to some degree, with economic return.

The strategy of merely dropping set temperatures in the summer (as suggested by another author, elsewhere) is - at best - a very limited and over-simplistic approach, which may well cause as many problems as it alleviates (i.e. in reducing comfort by even larger daily temperature swings).

The data presently suggests that getting pigs up earlier, and perhaps keeping them from bedding down so early, may be a useful approach. Whether successful, and which method might be the most effective is worth investigation. Several methods might be tried - ranging from lighting, water sprays, through to music or other types of noise. It may be cost effective to increase levels of insulation or shading on the west side of buildings.

Factors which might raise (or lower) the trigger temperature should be investigated. For example, various ways of using water sprays, or how to us them most cost effectively. The data here suggests that using water sprays sooner rather than later is desirable.
Since there is such a good feedback mechanism of the onset of feed intake inhibition (i.e. through the water intake trace in Barn Report), there is plenty of opportunity for investigating different methods at relatively low cost in the farm context at very moderate cost.

The building in question is fully slatted, and - since slats improve heat loss from the pig - it can be assumed that solid floors would mean much lower "trigger" temperatures. Even with slats, these are already much lower than generally thought. Feed intake inhibition may be common, but should not be regarded as normal, since it indicates temperature beyond the pig's tolerance. Accordingly, solid floors should be regarded as detrimental to comfort in finishing pig buildings.

Conclusions

Room temperature inhibits feed intake and thereby worsens FCR at a much lower temperature than generally thought. Light and/or solar gain may be a factor.
Barn Report offers a cost effective indicator and measure of reduced feed intake via water monitoring. Since it is essential to see pattern, not just daily total, daily water use metering on its own gives insufficient information for assessment.
Water monitoring through Barn Report should be regarded as being as important as temperature, or equipment operation information.
Temperature rises are cyclic - most last 5 to 7 days - and the most crucial part is taking action before the onset of intake inhibition. Taking action after a few days - as normally done - is insufficient and may even be detrimental, as pigs might have adjusted by this time.
It is not possible or practical to prevent raised room temperatures in warm weather, but there may be ways of reducing the effects, or speeding up the pigs' own adjustments.
Rough calculations reveal a high potential value and return on investment in this area, but significant expenditure may be needed in researching the issue.