

# The importance of good early growth

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The young growing farm animal has very specific nutritional needs during the critical early days and this applies to lambs, calves, piglets and even chicks.

There are specific needs during the early days of life in terms of energy, protein and amino acids that are essential if the young growing animal is to get over this hurdle. Moreover, the vitamin and mineral requirements are crucial to establish a strong skeletal framework from which to allow the rapid development of lean tissue later on.

What has become obvious from work at a variety of research centres around the world is that when the young growing pig loses early growth because of under nutrition or due to sub-optimal health status, in many situations, it never gets this growth back. This is in contrast to ruminant animals that do show compensatory growth in early life.

Young ruminant animals such as calves and lambs can show compensatory growth to an extent which allows them to get back to their true genetic potential but even ruminants, if subjected to a severe loss of growth, will ever after remain on a lower growth curve. All of this means the number of days to slaughter is extended significantly.

Pigs are particularly adversely affected by loss of growth in the period immediately after birth and also in the period after weaning.

This latter phase when they have to make the difficult transition from sows' milk to a dry pelleted diet with different protein sources, is especially pivotal in growth terms. It is the purpose of this article to elucidate the relationships between early growth and growth to maturity in modern hybrid pigs

## Growth potential

In terms of growth potential the pig really can fly when we compare and contrast with other species. Humans take about three months to double their birth weights, whereas pigs will do this in the first week of life and then go on to reach 90kg in about 140 days of age with the right condi-

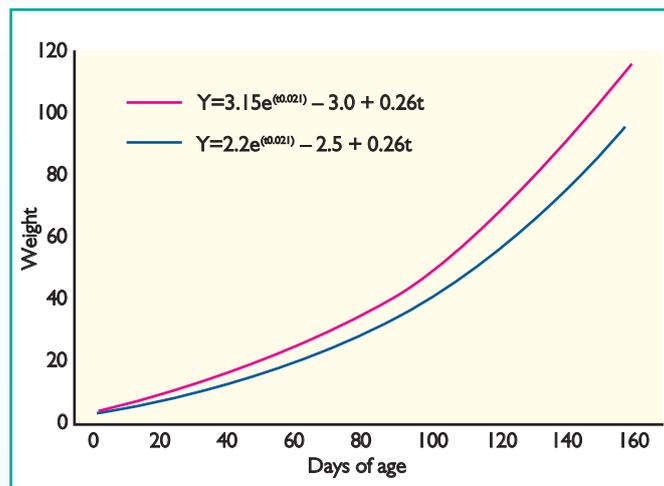


Fig. 1. Growth predictions.

tions of health status and nutrition. The actual growth rate at any given time is, to a large extent, determined by the actual growth or weight achieved at that point in time. In other words, there are fixed mathematical relationships involved which are the major drivers that set the growth level.

This is analogous to a snowball rolling down a snow-covered hill. When it is small it can only gather more snow at a rate determined by its circumference. When it gains mass and its circumference is that much the bigger, its actual rate of snow gain per unit of time becomes very large indeed.

It is no different to a growing piglet and if it is weaned at 6kg it has a limit on the accretion rate of lean tissue determined by its existing body mass (6kg). Its growth will be impeded after weaning because of its small body mass. If, however, we have a piglet at 8kg at weaning its growth potential is already much higher because of this.

At any stage of course, we can also encourage good growth by the application of good nutrition and a good health environment, but this highlights the need to understand growth and especially the growth in early life where the animal is to a good extent programmed to perform through its lifetime. At any stage if the piglet is allowed to under-

perform, then the consequences down stream are very significant indeed.

We have understood and applied these principles at SCA NuTec based in the UK throughout the life of the company and the range of nutritional and animal health products are targeted towards this.

We aim to promote a high weaning weight first of all with all the array of tools at our disposal and then we apply a precise feeding regime after weaning to ensure the early potential is reached.

In this way we can ensure that the pig at 70 days of age, at the end of the nursery or starter phase of growth, is around 32-35kg live weight and will reach slaughter at 100kg weight by between 135 and 145 days of age depending on the housing and management system.

In this article we will examine in detail those important relationships in growth performance for modern hybrid pigs and see where the inputs should be applied to maximise growth particularly in the early post-weaning phase of growth.

## Growth curves

Growth can be defined mathematically and in fact for a modern pig we can use the following equation to predict outcomes:

$$Y = Ae^{(Rt)} + k + Bt$$

Where:

Y = liveweight at time t in kg

t = age in days

e = is the exponential constant

R = the relative growth coefficient set by the genotype.

A, B and k are constants set by the environmental conditions and the genotype.

Using this equation, we can vary the coefficients and predict outcomes for varying farm conditions. A fairly average level of performance might be represented by the following equation:

$$Y = 2.2e^{(0.021t)} - 2.5 + 0.26t$$

A pig, however, given a highly digestible nutrition programme including a pre-weaning application of the appropriate creep feed will be on a totally different growth curve and in fact this will then be on a different programmed growth curve to slaughter because of this.

Growth on an SCA programme can be represented by the following equation:

$$Y = 3.15e^{(0.021t)} - 3.0 + 0.26t$$

## Fixed relationships

The outcome of these relationships is the important point to understand here but the fact is also that these same equations run and apply from birth to slaughter. Fig. 1 gives the predicted performance using the first two equations.

It can be seen from Fig. 1 that for the average and enhanced programmes respectively, the weights at three weeks of age were 6.3 and 7.3kg and the 70 day weights were 25kg and 29kg respectively and the groups at 140 days of age reached 75kg and 92kg respectively. In other words, because of the early advantage in growth the enhanced group grew through to slaughter weight in about 14 days less than the average group.

It is obvious that along the way factors such as disease status and disease outbreaks will modify the outcome and the quality of nutrition in particular may also modify these differences, but it is hoped that, to a

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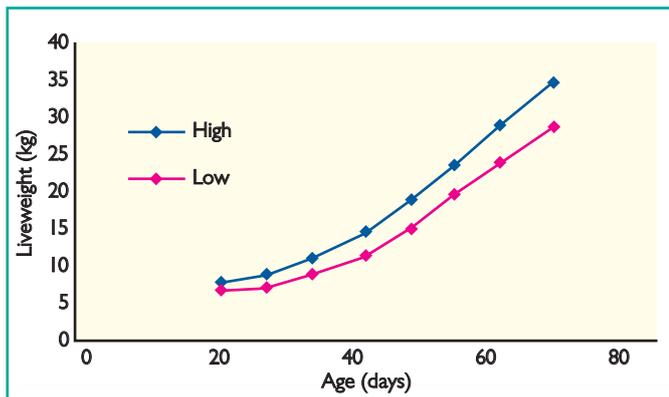


Fig. 2. Nursery performance to 70 days of age.

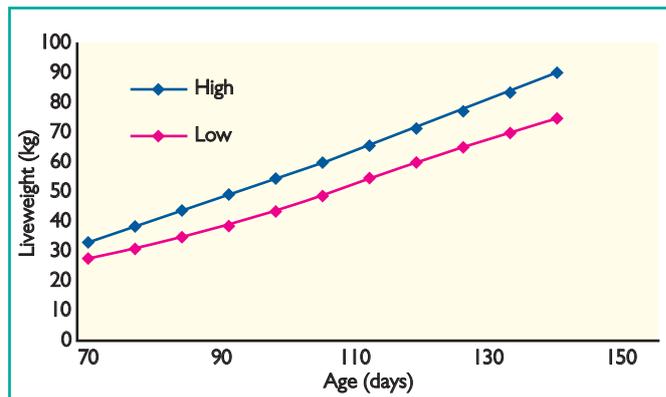


Fig. 3. Growth to slaughter.

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large extent, what we achieve at weaning and immediately after weaning has a huge bearing on performance outcomes all the way to slaughter weight.

These conclusions are supported by work carried out in this area at the SCA Feed Evaluation Unit, Green Hill Farm in the UK.

Fig. 2 shows data from a trial where we used a high or a low density specification starter feed programme during the nursery period to 70 days of age. At 70 days of age the High group had attained weights of 34kg, whereas the Low group were only 28kg on average. These pigs were then followed through until slaughter at 90kg live weight and the results were as shown in Fig. 3.

The data presented in Fig. 3 show clearly that the weight and growth advantage found in the early phase was amplified further to slaughter. At 140 days of age the High group had reached slaughter weight and were off the farm, whereas the Low group at the same age were still only around 73kg and still had some time on the farm before dispatch to slaughter.

## Targets for growth

When it comes to target weights for a modern hybrid on a good nutritional regime we can use this analy-

sis as a basis. In Fig. 4 is given a target growth curve from weaning to slaughter. This is based on three set points where we know what our expectation is. The first is at 28 days of age (weaning nowadays) where we expect to see a pig at about 8.5kg and at 10 weeks of age (70 days) we expect a pig to be around 32kg or higher. This will then take the pig through the growing finishing phase to reach just over 90kg at 140 days of age. Using these three basic reference points we then predict a growth equation that is given in Fig. 4 and all other points can be accurately predicted.

Similarly, we can make predictions of the likely FCR through the growth phases and this, in turn, can be used to predict the target feed intakes through to slaughter although this can also vary enormously from farm to farm and between batches.

Fig. 5 gives the expected FCR's through the growth phases.

Based on these data, Table 1 gives the likely and target performance parameters for both the nursery phase through to 70 days of age and also through to finishing.

## Loss of growth in early life

In most modern systems of pig production around the world and Europe is certainly no exception we wean piglets at between three and four weeks of age and the piglets are

transferred onto a dry starch based feed rather than the liquid lactose/casein based feed they were nurtured on whilst on the sow. This transition can cause havoc to feed intake characteristics particularly in the first week after weaning which results in growth rates that are at best static and at worst they lose considerable weight.

This so-called post-weaning growth check does have serious deleterious consequences on the rest of the growth cycle. This is illustrated from the data presented in Fig. 6. Growth curves exist in reality in nests of growth curves and when on a particular curve as in curves A to E in Fig. 6 this gives a pre-ordained growth trajectory through to slaughter.

What happens in a growth check situation is illustrated in Fig. 6 for growth curve E. Those piglets incurring a growth check actually jump from curve D to a new curve E just after weaning and then stay on this curve all the way to slaughter.

Because compensatory growth is not seen in young growing pigs, they can move down a curve but not up to a higher level later on. It can be seen also that pigs on curve E arrive at slaughter weight many days later than those on curve D!

There are many biological explanations for this but basically the pig is born in a physiologically immature state so any impediment in its early growth has serious implications.

The reduction in growth hormone and other related hormones such as the IGF (insulin like growth factor) series also impacts on the immune system and impairs its development. This is why good growth and good health status so often go hand in hand.

The simple answer to this problem is to make sure we offer a 'nature identical' post-weaning feed to the young piglets. This means using highly digestible cooked cereal blends, high quality fish meals and the inclusion of milk powder blends to provide the necessary proteins and the correct blend of amino acids. SCA nutrition programs have been designed for this purpose for over 25 years.

## Compensatory growth

There has been much on-going debate on the expression of the phenomenon of compensatory growth in the young pig. It is intended in this section to shed light and give evidence on this important topic.

Pig farming systems have not historically relied, as do ruminant animals, on the phenomenon of compensatory growth. Cattle and sheep during times of nutritional inadequacy will maintain or lose body weight, but when the nutrition is restored and they can eat at a high

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Fig. 4. Growth targets for growing pigs.

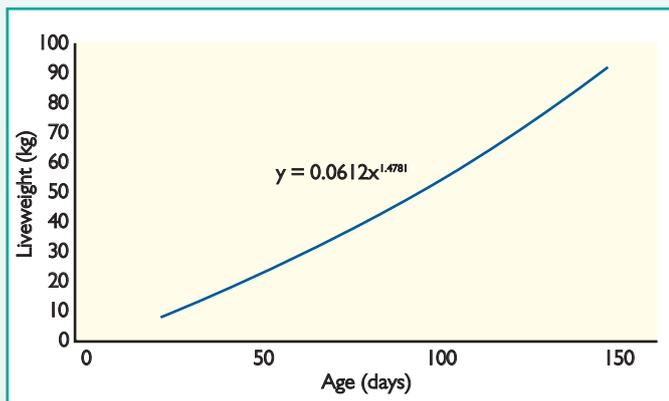
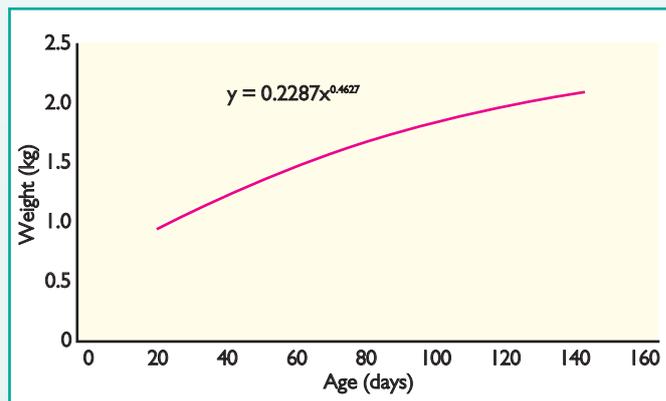


Fig. 5. Predicted FCR through to 140 days of age.



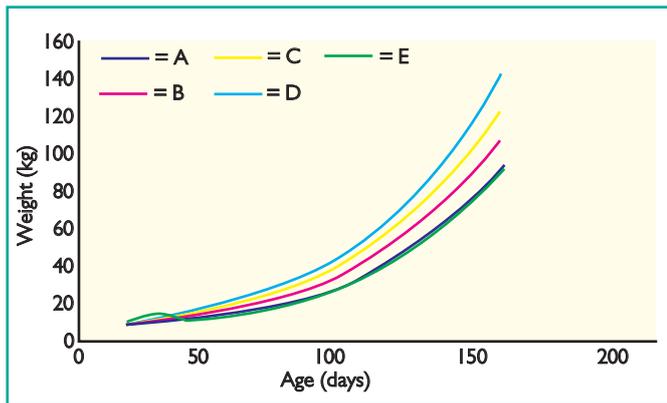


Fig. 6. Growth curves and the post-weaning growth check.

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level above basic maintenance again (re-alimentation), they will gain body weight very quickly and very efficiently. This process of rapid weight re-gain is called 'compensatory growth'. It is made possible by various physiological mechanisms such as the elevated production of growth hormone at re-alimentation.

Non-ruminant animals such as pigs are not so good at expressing compensatory growth, perhaps because they have evolved in a different nutritional environment with less variation in nutrient supply.

There has, however, been some considerable debate recently if pigs can show the phenomenon at all. This is especially important for the weaned piglet because many units experience a severe growth check and feed intake depression after weaning as shown above and the question is if the growing pigs can ever regain this growth.

Firstly, to elucidate the general principles of compensatory growth, this is well worked out. Fig. 7 shows a schematic representation of the 'sigmoidal' growth patterns of animals to maturity giving their weight for age relationship through to about 120kg live weight.

It can be seen from Fig. 7 that the red line represents maximum genetic potential, where the animal sees no growth restriction. The green and yellow lines in Fig. 7 rep-

resents the situation of a severe nutrition restriction at about 60kg liveweight associated with acute weight loss. Later on, however, when the nutrition was restored at about 140 days of age on the graph, the animals quickly re-gained the weight and make it back on to the red line.

They had, in effect, expressed good compensatory growth. The yellow line represents less severe weight loss but the animal again showed compensatory growth and ended up back on the red line at about 180 days of age. This is typically what growing cattle and sheep will do when fed lower levels of nutrition during the winter housing period in northern European conditions.

Fig. 8, however, shows typically what happens in pig growth terms when a similar restriction on nutrition is applied in its early life. Again the red line represents maximum growth potential.

The green line in this case represents early under or sub-optimal nutrition and at about 60–80 days of age the young animal is given re-alimentation and is offered a good feeding regime again.

It can be seen in this case from Fig. 7, that the pig growth curve never compensates back to the red line again and the growth potential is lost forever irrespective of the nutrition programme after 80 days of age.

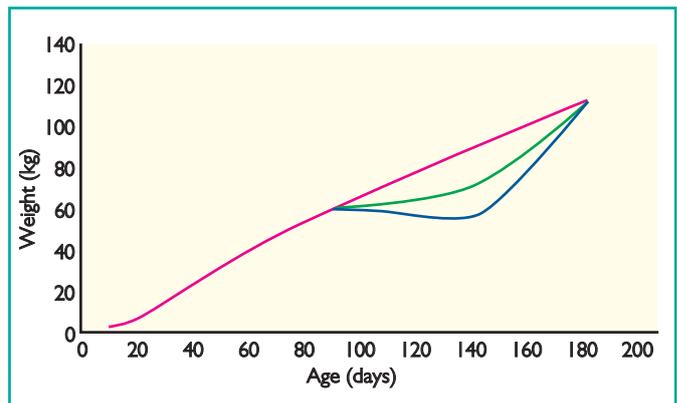


Fig. 7. Growth curves in animals.

The upshot of this is that if we assume that slaughter will take place at a fixed slaughter weight (90–100kg) then the time taken to slaughter (and the associated costs of production) will be significantly higher.

The responses at re-alimentation are well worked out by the growth physiologists working in this area and it is well understood that growth in this later phase is determined by the following:

- The age at restriction of growth.
- The severity of the growth restriction.
- The specific genotype.
- The specific nature of the restriction.
- The duration of the restriction.

The young piglet, therefore, which is born at a very young immature physiological age compared to sheep and cattle is disadvantaged in many of these respects and hence if we impose a restricted growth curve in early pre and post-weaning life, it will never compensate.

Post-weaning growth checks can also be very severe on some farms where a clinical appearance of diarrhoea is coupled with a poor nutrition programme.

If we can maintain gut health status and apply a high quality nutrition programme, we can go a long way to keeping the growing pigs well on the red line track.

There is much evidence for the

above relationships in the published scientific literature from universities and research institutes.

Fig. 9 illustrates, from work carried out at the University of Nebraska in 1990, this effect. Two groups of young pigs were either full fed on a high quality complex post-weaning programme or restrict fed on a poorer quality programme after weaning. Growth differences during the early phase were still highly evident at 126 days after weaning (16% different) even though from day 28 post-weaning to day 126 all pigs were on exactly the same programme.

Fig. 10 shows data from a similar study carried out at Kansas State University by Professor Tokash and colleagues where some pigs in the post weaning phase grew at either 0–150g/d, 150–230g/d or greater than 230g/d.

Again at 128 days post-weaning a large and statistically significant difference was seen in growth such that the slower growing post-weaned pigs took another 10 days to reach slaughter weight.

Other work carried out in the UK and other parts of Europe has given similar results.

Fig. 11 presents data from SCA's own trial farm in the UK where 5000 pigs were followed through to slaughter after having different growth curves up to weaning and

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Fig. 8. Growth curves in pigs.

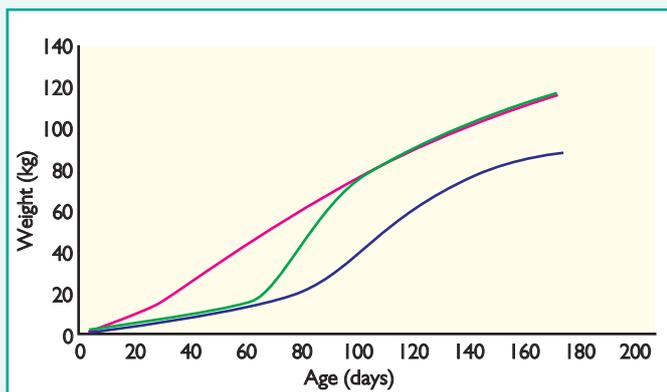
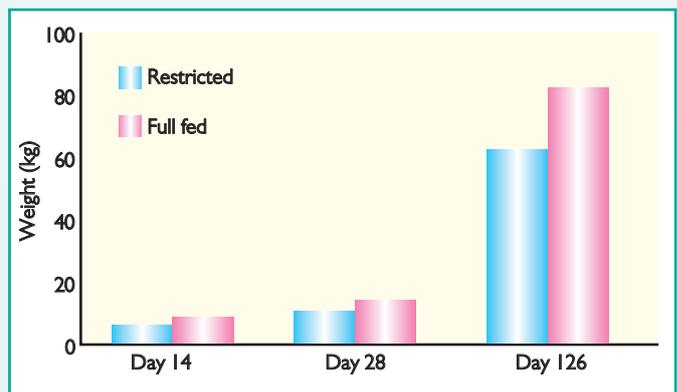


Fig. 9. Results of growth differences – University of Nebraska.



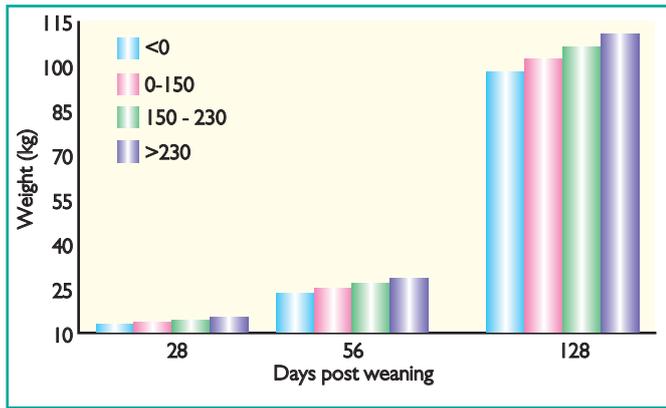


Fig. 10. Growth results – University of Kansas State.

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The larger weaners and the fastest growing pigs after weaning expressed significantly faster growth all through to slaughter.

The science and expression of compensatory growth in the pig is hence irrefutable.

The general conclusion in all of this was expertly summarised by Professor Colin Whittemore in a recent paper presented at a meeting of the British Society of Animal Science in the UK.

He said, quoting one of his earlier publications, “Tullis and Whittemore (1986) conducted a carefully constructed trial. Pigs on restricted

feeding (after weaning) from 25 to 55 days expressed reduced liveweights and little or no lipid gains but achieved no greater liveweight gains on re-alimentation, nor gains of differing composition than unrestricted pigs. Compensatory gains were not evident”

### Conclusions

There are some important practical conclusions from these observations.

Firstly, if young post-weaned piglets do experience a growth check after weaning or even arrive at weaning at light weights, then

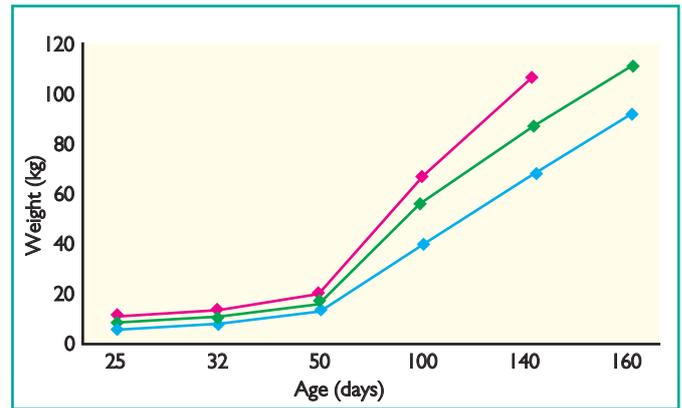


Fig. 11. SCA Green Hill farm data.

growth will be compromised all the way through to slaughter.

The corollary to this is that if pigs are very carefully managed and fed around and after weaning to avoid any growth check at all, we can take them to slaughter weight saving anywhere between 10 and 20 days.

The overall savings in feed costs and housing and other fixed costs are, therefore, quite substantial.

The feeding programme for a young post-weaned piglet is also only between 3 and 5% of the overall feed inputs for a finished pig at slaughter.

I would argue strongly, therefore, that the feed costs post-weaning should be considered an important

investment in the whole lifetime performance of the pig to finishing and econometric analysis on this always demonstrates that the investment made at the beginning pays for itself many times over by the time the pig arrives at slaughter.

We do have the nutritional technology to tackle this problem and even though the young weaned piglet at 3-4 weeks of age is biologically challenged because its immune and enzyme systems are immature and its feed intake characteristics can be difficult to deal with.

If, however, we use a highly digestible feeding programme we can circumvent these problems.

This is exactly the reason why the

application of sophisticated feeds, based on milk powder proteins and well cooked cereal blends with gut conditioning properties is the only way to feed the post-weaned pig.

Appropriate pelleting and manufacturing techniques are also important to conserve nutritional properties of the feeds themselves.

Compensatory growth is, therefore, a very real phenomenon as evidenced by any human coming off a well controlled diet. It is extremely easy to pack on the kgs of body weight again.

In the pig, however, it really does not exist in the same way and especially so for the young pig in its early stages of growth.

The calculated data presented in Table 1 are based on our knowledge and understanding of the growth characteristics and performance of modern hybrid pigs.

There will clearly be widely different observations on different farms and these data should be viewed and used in that context.

However, the hope is they should offer a guide to on-farm calculations and expectations when setting up and running new programmes.

These data are intended as benchmarks for performance using a well designed starter feed programme and not as a hard and fast target.

Some farms of course will perform way above these benchmarks but

others will fall below. It is our role to offer those farms falling below these standards a new improved programme to enable them to perform to target.

This article has, therefore, focused on the modern concepts of growth in young growing pigs.

We have seen the clear and definitive relationship between early growth and the growth to slaughter which highlights the necessity to maximise post-weaning growth through excellence in both nutrition and management.

Growth curves in young growing pigs are hence well understood.

It is our role as nutritionists to formulate and apply the products that

allow the pigs to realise their full potential all the way to slaughter weights.

It is also important in production terms to ensure a smooth transition from the pre-weaning phase to the post-weaning phase and we should provide the quality of nutrition that keeps feed intake and growth moving on up.

At the extremes of weaning weight (3 to 12kg), the difference in days from birth to slaughter was about 40 days in the SCA study (Fig. 11).

For a 1kg increase in weaning weight on average, another 100g/d increase in post-weaning daily liveweight gain was seen and this

reduced the age at slaughter by 10-12 days.

Clearly size and post-weaning growth were very important determinants of ultimate growth potential to slaughter.

The bigger the pigs at birth as a result of better sow feeding produced a bigger pig at weaning and this was helped by an appropriate creep feeding programme.

A high quality diet programme in the early days after weaning then represents a real investment to the business for the future growth and efficiency of the finishing pigs. ■

References are available from the author on request.

**Table 1. Targets for growth and FCR in growing pigs.**

Age (days)	21	28	35	42	49	56	63	70	77
Weight (kg)	6	8	12	15	19	23	28	33	38
FCR	0.94	1.07	1.18	1.29	1.38	1.47	1.56	1.63	1.71
Feed intake (kg/d)	0.327	0.446	0.558	0.668	0.777	0.885	0.992	1.099	1.205
Daily gain (kg/d)	0.350	0.417	0.471	0.518	0.561	0.601	0.638	0.673	0.706
Age (days)	84	91	98	105	112	119	126	133	140
Weight (kg)	43	48	54	59	65	72	78	84	91
FCR	1.78	1.84	1.91	1.97	2.03	2.09	2.14	2.20	2.25
Feed intake (kg/d)	1.310	1.415	1.519	1.623	1.726	1.829	1.931	2.034	2.136
Daily gain (kg/d)	0.737	0.767	0.796	0.824	0.850	0.876	0.901	0.925	0.949