# Life Cycle Assessment/Analysis

&

The Digital-Pig

**Introduction.**

“The goal is to turn data into information and information into insight” is a quote attributed to Carly Fiorina a former CEO of Hewlett-Packard. That is, having first gathered the data. The ‘Digital-Pig’ is the data at the heart of this part (5) of the (LCA) Life Cycle Assessment / Analysis &’ series.

The digital-pig or 3E-Pig as I will call it in this part represents every data entry created in any operational technology within the nexus of the singularly attributed digital identity of an individual pig either a breeding (parent) male or female, or their subsequent progeny. This technology includes but is not exclusive to the following examples: pig performance herd recording programme, computerized feed system, health observations monitoring system, visual recording system, environmental control system etc.

My working life has been focussed on animal husbandry, specifically on the pig. It has also been a life of continuous education, and as such, by grace I have experienced significant periods of education working on farms, in breeding stock sales and service, operational genetic development, customer service design and execution, pig performance recording programme development, market start-up, sales and service, technical and analysis journalism, and production consultancy. It may seem to be a long list, it is because I am 71 years old and remain compelled by curiosity to learn, and to serve. Whether I have done any of the above tasks well is not for me to judge. But I want to share what I have learned, because others did this to help me gain my education.

One very important reason that compels me to share is the disruption that the misalignment of genuinely valuable ideas and development can create in relation to progress.

An example of this misalignment is the genetic development of reproductive prolificacy. I want to say first that over the last 60+years this development has created a sound genetic foundation in terms of potential output, and as a singular achievement, deserves to be universally lauded.

The misalignment is the result of exclusive consideration of an increase in numbers born and raised by each breeding female, as the ultimate goal benefiting commercial breeding herd production. Due to the algorithms developed to index reproductive prolificacy, selection of seed genetic potential led to an almost 100% turnover in the first (nucleus) production cycle of the maternal (Dam-line) great grandparent populations. Relegated animals may have produced one or two subsequent litters in multiplication populations, and their data retained to support the teaching of the algorithm, which today describes machine learning. However, the lifecycle of breeding females was not a focus throughout the same period. Proof of this is easily produced through the global data information on the herd sow retention rate.

As a consequence, reproductive prolificacy has become increasingly misaligned with the commercial reality of pig production. The large litter numbers become aligned within a healthily sustainable commercial reality, when the sow retention rate increases to the herd optimum at the completion of the fifth production cycle or parity (P5) circa 85%, and the elite performance of animals at this stage continues beyond this in herd retention, as an element of precision herd management. Another aspect of the current average sow retention rate that indicates a failure to focus on the alignment of genetic goals, is the level failure of herd replacement females in the first two production cycles. This leads to a slowly developing economic vortex in the return on investment of resource (ROIOR).

Alignment is a critical means of self-correction in the long-term development of Intelligent Agriculture, because it is about addressing process controls within an evolutionary process of known and unknown unknowns, in which we first define, then design the gathering of, in the form of data , which we turn into information and insight.

**The Digital 3E-Pig.**

There are two '3E Precision One-Pig' digital pigs the replacement breeding female and her progeny. In LCA one of the analysis categories is that of a 'Herd Within the Herd' (HWtH). We can learn from some examples of HWtH analysis, and how this gives us insight into how we can mitigate historic misalignment. These include the LCA cohorts of both the breeding and feeding herds, the 'Ghost' or non-productive herd, as well as the Gilt, Production, and Elite/Risk herds within the breeding herd. Within the feeding herd, as seen in the tables in part 4. There are several targets for HWtH analysis.

**Alignment.**

In the introduction I briefly discussed the increasing misalignment of reproductive prolificacy as a direct contrast with sow retention. This is because sow retention is the foundation of achieving the ultimate economic, ethical, and environmental efficiency and responsibility within commercial reality. The current unquestionable achievement of genetic development, in establishing consistent genetic improvement in the proliferation of pigs born per breeding female, is misaligned with the outcome.

To illustrate this fundamental misalignment Tables 1. To 1c. and table 2. have been included below.

The line of text immediately beneath table 2. reports the increase in Sow Retention (SR%) as 35.27% and the increase in Economic Output/Input balance ($ %) as 58.50%. This is the effect of the conflation of sow retention and the number of pigs (born/weaned/sold).

| Parity | PS/PC | £ Value +/- | PS/PC | £ Value +/- | PS/PC | £ Value +/- |
|---|---|---|---|---|---|---|
| **Table 1.** | | **A** | | **B** | | **C** |
| P1 | 10.00 | -$155.03 | 10.25 | -$104.71 | 10.50 | -$92.18 |
| P2 | 10.25 | -$14.66 | 10.50 | $86.93 | 10.75 | $111.99 |
| P3 | 10.50 | $137.30 | 10.75 | $291.09 | 11.00 | $328.68 |
| P4 | 10.75 | $300.83 | 11.00 | $507.79 | 11.25 | $557.90 |
| P5 | 11.00 | $475.95 | 11.25 | $737.01 | 11.50 | $799.65 |

PS/PC: Pigs per Sow PER Production Cycle

| Parity | PS/PC | £ Value +/- | PS/PC | £ Value +/- | PS/PC | £ Value +/- |
|---|---|---|---|---|---|---|
| **Table 1a.** | | **A** | | **B** | | **C** |
| P6 | 11.00 | $651.07 | 11.25 | $966.23 | 11.50 | $1,041.40 |
| P7 | 10.75 | $814.61 | 11.00 | $1,182.92 | 11.25 | $1,270.62 |
| P8 | 10.50 | $966.56 | 10.75 | $1,387.09 | 11.00 | $1,487.32 |
| P9 | 10.25 | $1,106.93 | 10.50 | $1,578.72 | 10.75 | $1,691.48 |
| P10 | 10.00 | $1,235.72 | 10.25 | $1,757.83 | 10.50 | $1,883.12 |

SOW RETENTION per 100 Females [Served-Farrowed-Weaned]

| **Table 1b.** | SR% | Exit/100 | **A** | **B** | **C** |
|---|---|---|---|---|---|
| P0 | 100.00 | 0.00 | -$3,303.41 | -$3,303.41 | -$3,303.41 |
| P1 | 89.01 | 10.99 | -$18,766.72 | -$9,319.92 | -$8,204.70 |
| P1 Total: | 89.01 | 10.99 | -$30,015.38 | -$12,623.33 | -$11,508.12 |
| P2 | 82.97 | 6.04 | -$1,653.90 | $7,212.29 | $9,291.27 |
| P3 | 72.25 | 10.71 | $13,491.15 | $21,032.30 | $23,748.04 |
| P4 | 62.09 | 10.16 | $25,402.15 | $31,527.37 | $34,638.95 |
| P5 | 49.73 | 12.36 | $32,187.01 | $36,647.91 | $39,762.92 |

SOW RETENTION per 100 Females [Served-Farrowed-Weaned]

| **Table 1c.** | SR% | Exit/100 | **A** | **B** | **C** |
|---|---|---|---|---|---|
| P6 | 35.99 | 13.74 | $31,866.88 | $34,773.63 | $37,479.05 |
| P7 | 17.58 | 18.41 | $19,479.06 | $20,798.63 | $22,340.65 |
| P8 | 6.59 | 10.99 | $8,667.22 | $9,145.62 | $9,806.49 |
| P9 | 2.75 | 3.85 | $4,135.79 | $4,337.14 | $4,646.92 |
| P10 | 0.00 | 2.75 | $0.00 | $0.00 | $0.00 |

**TARGET COMPARISON** SOW RETENTION (SR) per 100 Females
[Served-Farrowed-Weaned]

| **Table 2.** | SR% | Exit/100 | **A** | **B** | **C** |
|---|---|---|---|---|---|
| P0 | 100.00 | 0.00 | -$4,492.64 | -$3,303.41 | -$3,303.41 |
| P1 | 95.00 | | -$20,029.42 | -$9,947.00 | -$8,756.75 |
| P1 Total: | 95.00 | 5.00 | -$33,350.00 | -$13,250.41 | -$12,060.16 |
| P2 | 92.00 | 3.00 | -$1,833.96 | $7,997.53 | $10,302.84 |
| P3 | 89.00 | 3.00 | $16,618.22 | $25,907.31 | $29,252.53 |
| P4 | 87.00 | 2.00 | $35,594.48 | $44,177.39 | $48,537.45 |
| P5 | 85.00 | 2.00 | $55,020.22 | $62,645.65 | $67,970.44 |

| SR% | $ % | $ % | $ % |
|---|---|---|---|
| 35.27 | 58.50 | 58.50 | 58.50 |

**Alignment.** *Continued...*

There are various perspectives on the optimum pen population for the journey of the weaned pig through nursery, growing and finishing. I am going to propose a hypothesis of a 20-pig population per pen. The standard deviation of this is 2 pigs so as to give some flexibility on the establishment of the group at weaning, this is because the hypothesis includes further disciplines the next being whole litters, retained in 20 +/- 2 population at weaning[1].

Of course, this hypothesis will be instantly rejected!...

...No wean to finish accommodation exists in continuum on a single farm that could immediately adopt such a hypothesis.

We are discussing alignment, and this is another example of misalignment in commercial pig production. The reason is that the ultimate goal in the design and engineering of feeding herd system infrastructure of most production sites today was predominantly economic, with no long-term information that anticipated the evolutionary process, and included ethical or environmental considerations. This is totally understandable.

[1] *Alignment may need to be tempered with some 'wriggle-room' husbandry discretion.*

**Alignment & Opportunity.**

Obviously, there is an opportunity to pause, and consider greater alignment in design of the next generation of new site development, with the long-term prospect and potential of commercial pig production. Equally, there is an opportunity today to consider investment in collaborative technologies that help create the *Digital 3E-Pig*, on the road to strengthening the data-information-insight equation.

The dimensions of existing, and future population accommodation is only one consideration, as of the 3E principle that drives precision in livestock farming sector of intelligent agriculture.

NB: *The 3E principle focusses on economic, ethical and environmental efficiency and responsibility. There has, ultimately, to be a balance between truth and order in the commercial reality of the business of pig production. Freedom of expression and open dialogue help to maintain that necessary balance.*

The intersubjective relationship between economics, ethics, and the sustainability of the environment is important to the challenges faced by husbandry teams in pig production. The importance of data-evidence-based information that creates insightful innovation from the husbandry team and the allied, industry support is vital and imperative to precision agriculture.

An example of this is the hypothetical ‘optimum pen population’. In isolation, the economic considerations are the construction and running cost of the nursery, grower and finisher pig accommodation, and the turnover of the cash-flow. The intersubjective relationship with the ethics of pig production imposes the consideration of infrastructure design. Firstly, to actual pen dimensions, that bring order to the social behaviour of the individual pig to minimize threat and therefore stress. Stress being a potential threshold to pathogenic resistance, and possible economic loss. Secondly, infrastructure design, whose objective is to make the working environment for the husbandry team as comfortable and uncomplicated as possible.

Introducing a single intersubjective relationship for consideration demonstrates the unavoidable conflation of each of the 3Es. It is no wonder that the industry risks unconsciously becoming a talking shop predominantly focussed on potential.

Alignment is, in itself, an objective for now, today. My hypothesis is a wish. What it is trying to inform us is that the art and craft of the husbandry team is a spectrum of choice to consider, in so much of what we do every day.

If I consider my own hypothesis of pen population 20+/-2, I have one big challenge if… I am currently managing a nursery consisting of rooms that contain four pens designed to accommodate pigs graded by size into groups of 60 from weaning for four weeks, and then these are reduced to groups of 30 into grower accommodation, and finally moved into larger finishing accommodation pens, remaining in groups of 30…what can I do? (Hypothetically)

Make a relatively small financial investment in a technological retro-fit, as a significant investment in purpose.

This involves creating accommodation for a group of 60 digitally identified pigs in the nursery, that become two groups of 30 in growing and finishing, within the current continuous population. Install feeding technology that records each pig’s feed intake and weight at regular intervals. Install vision technology that records behaviour in the pen. Install environmental technology that records the thermal conditions 24/7.Manually record anecdotal information. For example, the original group of 60 pigs graded by size. Did the ration ever run out. Accumulate the data and make an initial analysis.  Repeat the process, with different grades of pig.

After 12 months from the point of beginning this trial, you will if you are in a weekly production system, you will possess (approximately)  26 consecutive groups of wean to finish data, 40 of grow to finish data and 48 of wean to grow. And, you will have a fully operational R&D facility based on analysing your feeding herd management strategy.

The information coming from the data you are gathering will give insight into what alignment is necessary within the husbandry management strategy to optimize the total breeding and finishing herd population and (possibly) retro-fit or new build within the current infrastructure. By employing 3E Precision Metrics to evaluate the true potential of the new order that can be developed through the Husbandry team's strategy, the true potential of genetics, nutrition, health care etc. can be capitalized upon, delivering an increased return on investment of resource (ROIOR).

To invest a large sum in a single building within an existing farm complex presents significant risk today in the business of pig production which has one of the highest revenue liabilities in industry, often balanced against a nominal asset value in terms of the specific requirements of production. Therefore, the alignment of investment projects is critical to stimulating a steady increase in a redeveloping business's agility to maintain its evolution, through the level of economic return.

Another example of alignment is the concept of single parity populations. This begins with the breeding herd. To make this alignment takes around two years. An example of this is a breeding herd that is based on a weekly management system. As previously outlined in this series 3E Precision Husbandry creates a service group report that regards each service group as an HWtH analysis. To create a single parity service group, the operation must take a full, service group (target) compliment of replacement gilts into the herd every 3-weeks. Over time with these groups will become totally single parity populations. This is incumbent upon successful management of (target) sow retention. The parity sequence over each 3-weeks is 1 & 5, 2 & 4, and 3 & 6. This then produces feeding herd groups of corresponding single parity origin.

**The Industry Nexus. *The Digital-Pig***

By connecting at least 85% of all sows to their progeny in each of her first five production cycles through the evolution of available technologies will create the equivalent of the extended wavelengths of colour between the colours of the rainbow that we see with the naked eye. The digital pig is a potential industry nexus, connecting the whole pig to pork, farm to fork interrelationship of conscious obligation to craft, care to constraint, and charcuterie to consumers. The *Digital 3E-Pig* is an agent of confidence to an increasingly regulated world.

The data that we urgently need to gather into authentic information that creates insight to guide us must come before the artificial intelligence (AI) that many are saying will guide us towards brighter horizons. The bias of emerging AI needs understanding before we submit ourselves unwittingly to it. *Digital 3E-Pig* would give us an opportunity to understand much of our current bias, and this is important to how we see the role of adopted collaborative technology in relation to Intelligent Agriculture.