Life Cycle Assessment/Analysis

&

The Farrowing Rate

Before addressing the relationship between LCA and the Farrowing Rate% metric I want to begin with an introduction that I hope will become the established preface to further discussion as this series develops.

Introduction.

L C A is a dual acronym meaning either **L**ife **C**ycle **A**ssessment or **A**nalysis. It describes the methodology of understanding the impact associated with the inclusive elements of every specific stage of the life cycle of a commercial process, product or service. It involves a thorough index of energy and materials, as a resource within process, product or service; to understand the cumulative potential impact.

3E is the acronym for the cornerstone principle of economic, ethical, and environmental, efficiency and responsibility in livestock production, it is central to understanding the precision underlying 3E Metrics, and as these are developed, the 3E Husbandry Index.

This is the beginning of sharing a journey for everyone involved in HALE Intelligent Farming with anyone involved in the production process, product development, or customer service within the 'Pig to Pork - Farm to Fork' chain.

Welcome.

To understand the need for the adoption of Life Cycle Assessment or Analysis in the context outlined above, begins by looking within the evolution of the industry. It is important to consider the acceptance of the original integrity of each step along the way, as evolution reveals greater understanding to each new generation.

As an example of this; over the last 60 years the foundational increase in reproductive prolificacy through the influence of scientific R&D on genetic development has been a singularly successful achievement. I am concerned, however, having worked in the industry for most of that time, that the relationship of all vital genetic and physiological elements of the process of pig production has not been pursued and therefore maintained, in balance.

This is to some extent naturally understandable when considering the integrity of genuine incorporated ambition that continues to seek improved performance and reduced risk for its vital client base. In part because reproductive prolificacy produces a result through data analysis that is extremely favourable in the reporting of conventional per sow per year metrics, which are the conflation of a relationship limited to the metrics for the number of pigs per litter and the turnover rate of litters per year. The penetration of this single result to enable 3E precision metrics to report, depends on a statistical regression analysis that reports the breeding herd Sow-retention rate. It is worth including this definition of statistical regression analysis because it uses the words dependent and independent variables and this is what LCA is driving at.

Definition: *the analysis or measure of the association between one variable (the dependent variable) and one or more other variables (the independent variables), usually formulated in an equation in which the independent variables have parametric coefficients, which may enable future values of the dependent variable to be predicted*

I like the phrase 'which may enable future values of the dependent variable to be predicted', because it is inevitable that as pig farmers, and those who support you in your business, we have to understand the potential benefits of AI (artificial intelligence) within the technologies that can be adopted as system support, just as much as we appreciate the benefits of the 'other' AI (artificial insemination) which has long been adopted to support operational husbandry. It was a privilege for me to be involved (back then) in a role that delivered the other AI to the market, and it is a great encouragement to continue to be involved (today) through HALE's ambition to drive the benefits of collaborative technologies.

In the genesis of the development of 3E Precision Metrics it is becoming clear that the commercial benefit of certain favourable, conventional performance metrics is appearing increasingly exaggerated as LCA exposes the interrelationship imbalances. The 3E principle that includes economic, ethical, and environmental, efficiency and responsibility in the design of algorithms, penetrate existing conventional data, produced by proprietary pig performance recording systems.

By employing the 3E One-Pig Precision Husbandry report system based on LCA it is possible to implement existing data to increase client support to pig production businesses through further data interpretation beyond the limit of conventional metrics, herd profiles and task alerts.

One-Pig is so called because it includes the physical and economic outcome of the linear gilt development and individual and cumulative production cycles within the life cycle of one animal (as a statistical totem), and the data for this is calculated against an inclusive cohort of animals within the current continuous flow breeding herd. The potential One-Pig production cycle range is limited to 10, each completed at weaning. This cohort corresponds to the total herd population, the balance of which is made up of the subsequent replacement females that entered the breeding herd after the limit of the inclusive LCA cohort was defined. The LCA analysis will represent a greater share of the sows in the continuous herd population.

LCA & The Farrowing Rate.

Each production cycle representing the linear parity progression begins with the service (mating) of the replacement parent female. The first (outcome) metric of the production cycle is the Farrowing Rate as a percentage (FR%). A regression analysis of the FR% includes the re-service rate (RS%) as a factor of the outcome of the level of operational husbandry. (It will feature in the later development of the 3E Husbandry Index).

In a standard parity analysis report of continuous flow production, each parity column begins with the data count of the total number of services. This figure is significant if it includes the animals also included in the RS%.

I believe that in most proprietary pig recording systems this will be limited to the re-service that followed the previous service, and not a cumulative number of re-services that occurred before the subsequent farrowing relating to the current parity.

If this is the case, then the total numbers of services will be greater than the number of animals originally served at the start of the parity, unless the farrowing rate is 100%.

NB. *The standard continuous flow parity report is produced between two calendar dates selected by the system operator, usually monthly, quarterly, biennially or annually. This means that all of the animals reported in the Service section of the report will not be all of the animals reported in the Farrowing, and all of the animals reported in the Weaning section will not be all of the animals reported in the Farrowing section. The overall Production section, reporting the per sow per year statistics for continuous flow, will be reporting the complete production cycle of the animals in the Weaning section only. This explains the difference between the continuous flow and the LCA reporting.*

As an example, let us assume that in a rolling breeding herd population of 392[1] sows in production, management created and digitally identified an exclusive group of 125 replacement gilts between an opening and closing date period. The inclusive parity report for this 'herd within the herd' should, in the first production cycle, report 125 gilts served. (The service count is one per animal, the first serve. Further services at that time are counted and recorded, but only the very first serve is required by the calculated equation and reported). However, not all entered gilts get served depending on the period between the entry date which can vary due to the weight for age at entry. Therefore, the total number of original first services may be less than the total number of replacement gilts in the LCA cohort.

[1] *I have referenced this sized population because I know personally that the record keeping is authentic and is part of a multi-site breeding/feeding production business that is built on data evidence-based management strategies. The population could have been anything from 39 to 3,900 productive females, as it is the primordial LCA principle that informs precision husbandry, not the volume of animals analyzed.*

If the first reported service fails in conception, and the animal is given a 'repeat' or 'return' service this is counted and reported along with the original service. These additional services are included in the subsequent calculation of the farrowing rate based on the original first service. The additional return service is also recorded and reported as a new first service as the animal is moved in the database to a new service group.

Example 1.

Sow number 36 is served in Week 1 of the new year (2025) on Monday January 6th. Week 53 of 2024 began on Monday December 30th and therefore included the first five days of January. Sow 36 entered service group number 1 in 2025. However, she failed to conceive (hold to service) and was picked up returning to oestrus on Sunday the 26th of January, and was re-served. The database recorded her as a service failure in Service Group 1, and a first service success in Week 3 (Week Numbers Commence on Monday in this pig recording system).

Based on the 3E principle and LCA there is an energy, and a materials cost involved. This will be the case with every conventional metric. Both energy and material comprise the resource that is an element of the return on investment in resource (ROIOR) of 3Economics, 3Ethics, and 3Environment Precision Metrics. The conception failure requires a regression analysis in order to establish a measure of qualification on the 3E Husbandry Index.

These topics will be discussed further later in the series.

FR% & Reproductive Prolificacy

There is currently no meaningful interrelationship between the conventional FR% and pigs per litter metrics. This has obfuscated and protected the pigs weaned per litter per year result forever. 3E Precision Metrics expose this because it involves economic, ethical, and environmental efficiency and responsibility. LCA requires an adjustment of the pigs per litter metric because the interrelationship includes the 3E principle if a metric is to report the commercial reality to the business, and the husbandry index to the operational production team. Based solely on dividing the total (sum) number of pigs born alive by the combined total number of original first services and first return services the 125 replacement breeding gilts mentioned above with a farrowing rate of 89.6% would reduce the conventional metric of 12.47 pigs born alive to 11.36. This includes the following factors, The sow retention rate for parity 1 in this LCA cohort is 89.6% the number of replacement gilts weaned, and completing the first production cycle. That is why the retention rate mirrors the farrowing, remember that the report is not continuous flow it is following the same animals through every complete production cycle. The drop-outs were as follows 2 not served, 8 negative pregnancy results, 1 abortion, and 4 dead after weaning. Of the 8 negative gilts 4 were re-served, this reduced the total of original animals served to 119, 4 animals died out of a total of 19 animals removed, meaning 15 were culled, 6 of these after completing the first production cycle.

NB. *This equates to the retention rate of parity 1 being 89.6%. However, 106 of the original LCA cohort animals served into the second production cycle represented a retained to be served retention rate of 84.4%, a further drop of 5.2%. The LCA sow retention rate is the number of animals that complete a production cycle at weaning, and not the number of animals that start the next production cycle. The balance will be recorded in the weaned total at the end of the parity 2, and so on.*

Pre-Weaning mortality%, further reduces output per gilt[2] at weaning from the conventional metric result of 11.37 to the LCA metric result of 10.36.

[2] *You will discover if you continue through this series, that I regard the status of the replacement gilt as continuing as a gilt until she completes her second production cycle. My reasoning is a 60-year-old belief handed down to me by a farm colleague who had ploughed with horses when they were the age I was at when they told me this great truth of precision husbandry.*

In part 2 I will explain the factors relating to Farrowing, this will include understanding the most important date in a breeding females lifecycle as being the next production cycles' farrowing date, and the interrelationship with the service group reporting.