

Firm foundations for the future – the role of genetics

It is estimated that by 2050 there will be about 9.8 billion mouths on the planet to feed (United Nations, 2017 Revision). The majority of the additional population will be in emerging economies in Asia, Latin America and Africa. As these economies develop, the percentage of the population entering the middle class will also increase.

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It is anticipated that the percentage of the world population in the middle classes will increase by approximately half between 2015 and 2030 to 64% of the global population.

The spending power of these people will almost double from \$35 trillion to \$64 trillion. The vast majority of this emerging middle class will come from Asia.

As income increases, the absolute spend on food increases, with meat reaching almost a quarter of all food spend when income level exceeds about \$5 per day. The increase in poultry consumption between 2017 and 2027 will be in the region of 19 million metric tonnes (MT), of which just over 10 million MT will be consumed within Asia.

While consumption, and therefore production, is expected to substantially increase over the next 10-30 years, the resources available to support this growth are dwindling on a per capita basis. It is anticipated that after 2035 no additional arable land will be available for cultivation, due to increased urbanisation, desertification, salt build up and erosion.

The availability of potable water will become more variable between world regions, with typically the dry parts becoming drier and the wet parts wetter, both bringing their specific challenges. In many respects, this scenario would be expected to drive higher output per unit of area, targeting increased yields through modern farming and agriculture systems. However, at the same time

there is an evolving consumer, increasingly concerned about a wide range of food product attributes.

These can include health perceptions; 'natural' foods; 'freedom from' products; welfare concerns; or sustainability issues, which are often combined in a 'good-feeling-food-box'. Many of these drivers lead to a demand for an increased variety of products and production methods.

Why poultry meat?

OECD/FAO estimated that chicken took over from pork as the most consumed terrestrial species in 2008. Contrary to other meats, poultry meat has no religious boundaries and except for dietary preferences (vegetarianism or veganism) consumption is expected to grow regardless of region and income level.

Chicken is perceived as a healthy (low fat, high protein) option, although this is highly dependent on the method of preparation (USDA, 2019). Entry into the poultry market can be a relatively low capital investment endeavour for investors and the production systems are quite straightforward to scale, compared to other species.

Add the short cycle time for return on investment along with relatively small land footprint for production facilities and poultry starts to look very attractive as an investment vehicle. Broiler chickens are the most efficient and environmentally sustainable of the terrestrial farmed species giving it a crucial role in satisfying the animal protein needs of a growing global population. Even in developed markets, the low price of chicken remains a significant driver of consumption.

Broiler meat can be easily enhanced by further processing, addition of flavourings and inclusion into high-end and/or convenient product offerings. Equally, the production system (conventional,



companies have had on performance over time.

Estimates are in the order of doubling growth rate, reducing FCR by around 70%, increasing breast yield by a magnitude of 4x, reducing mortality and increasing chick output by around 50%.

In 1994, Havenstein estimated that genetics had contributed 80-90% of the improvements in bird performance at that time, with nutrition having a smaller impact. This work shows the huge impact of genetics over time.

On the other hand, factors other than genetics contribute between 50-95% of the variation in performance.

So, while genetics can have a long-term cumulative effect, management can be more critical in enabling the expression of genetic potential on a day-to-day basis.

Current challenges for the global broiler industry

While bird performance and industry scale has dramatically increased over the last 70 years or so, access to an appropriately sized pool of management talent has not. Post baby-boomers, there has been a great deal of difficulty attracting skilled managers into the industry, as it is generally perceived in a somewhat negative light.

Investments in in-house training and development are therefore of growing importance. While there have been huge strides in technology in both house and equipment design, these currently struggle to match the ability of a skilled animal husbandry expert. Given the long term nature of depreciation of housing stock, many sheds built 20-30 years ago remain in operation.

While state of the art when they were designed and built, many are now below the requirements for the modern bird. When farms are built, attempts are usually made to make

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them relatively remote, in order to promote biosecurity. This is becoming more challenging as population centres expand and encompass farms. Finding areas where people are prepared to tolerate new build poultry farms is also becoming more challenging.

This can put additional disease pressure onto areas of high bird (and human) population. The use of vaccines can result in the development of new strains of viruses and overuse of medications in certain world areas can lead to antibiotic resistant bacteria. These highlight the need to educate and drive home the need for consistently excellent biosecurity and management.

Selection for the future

Selection objectives have broadened and evolved over time, as certain parameters increase in importance with the evolution of the global broiler marketplace. More and more biological attributes of the bird are simultaneously studied within the breeding goal, to achieve a holistic improvement of the modern bird.

Today, Aviagen selects for over 50 traits in each of its selection lines, and broadly selection efforts are split equally between fitness and welfare traits, reproductive traits and broiler performance/sustainability traits.

Poultry breeders now have a raft of tools available to improve not only biological efficiency and yield, but also fitness and welfare traits, such as skeletal integrity, footpad dermatitis, hock burn, walking ability and cardiovascular fitness.

Peer reviewed studies, along with field datasets, demonstrate the improvement in traits such as livability, leg health, walking ability and ascites resistance. These traits are crucial to the continued success of the breeding companies, both from a financial sense but more importantly, from the point of view of a social license to operate.

As an example, many years ago now, one British supermarket chain refused to utilise the product from a particular breeding company due to the perception of poor leg health in their products. I am pleased to say that this situation no longer exists!

Reproductive success is, and will continue to be, a significant financial driver within the industry. By increasing chick output we reduce the resources, including land, feed, medications, water, transport and so on, required on a per chick basis.

This directly contributes to the bottom line sustainability of the industry. Increasing demand for day-old broilers, with little to no increase in inputs for breeders, is the very essence of sustainability. Selection

for modern broiler breeders not only include egg production but also improvement of hatchability and fertility, in particular their persistency. In addition, optimal embryo development is targeted through the improvement of external and internal egg quality traits.

Data collection to allow selection of live performance traits, happens not only under the very best of conditions on the biosecure pedigree farms but also under lower-end, commercial conditions on 'sib test farms'.

Sib test farms are operations where brothers and sisters (siblings) of pedigree birds are held under a wide range of environmental challenges (lower density nutrition, sub-optimal management techniques, gut and immune challenges).

All of this is designed to allow identification of families that perform under optimal and sub-optimal conditions and to improve the overall robustness and environmental adaptability of the populations.

Specific challenges to mimic Asian or African conditions including hot and humid environments and temperature fluctuations (differences between day and night temperatures) have been added to these testing facilities. While growth rate remains an important factor for much of the world, improving feed conversion ratio (FCR) tends to have the greatest impact on both sustainability and financial return.

The use of radio frequency identification (RFID) technology to measure feed, and more recently water, intake on individuals in a commercial like environment has enabled a quantum shift in the way in which birds are selected for biological efficiency, allowing greater genetic progress than ever before.

It is estimated that two points (0.02) per year improvement in FCR in Asia will reduce the feed intake of the broiler industry in the region by 1.35 million MT per year, freeing up 227,000 hectares of arable land and reducing total water usage by 5.5 trillion litres. This is broadly equivalent to a 1.5-2.0% reduction in feed usage, at a time when the market is increasing with a Compound Annual Growth Rate (CAGR) of 2.5-3.0%. Bear in mind that these improvements are cumulative.

Selection for saleable meat yield also has a direct impact on sustainability. In addition to yield recorded in processing plants, over time we have developed a range of tools to predict yield in live birds including confirmation scoring, ultrasound measurements and more recently computed tomography (CT) scanning.

CT allows a 3-D visualisation of the live selection candidate and to 'virtually' cut it into portions, with

prediction accuracies above 95%. The implementation of CT also allows for novel ways of assessing leg health through the identification of microscopic tibial dyschondroplasia (TD) lesions. This allows a greater accuracy than previous x-ray technologies and gives the ability to select for sub-clinical leg health issues.

Recent technological advances

Genomics involves the study of the DNA and its function. In an animal breeding context, genomic information is used to predict genetic values with greater accuracy by combining it with performance and pedigree information. The use of genomic information for selection in broiler chickens is a reality and Aviagen was the first poultry breeding company to incorporate genomics information in routine selections.

Genomics information can be used to increase accuracy of selection in all traits in the breeding goal, but it is especially important in traits in which there is limited information at the time of selection, for example sex-limited traits like egg production.

Aviagen results indicate that genomics can increase selection accuracies by 20% to 50%.

There is no doubt that genomics information will contribute significantly to genetic potential, which will be expressed in the wide range of production environments worldwide. Along with the development of the genomics-based selections, other tools centred around the same technology have been developed. One of these is the paternity testing of chicks.

This allows for large numbers of males to be placed with a flock of females in a more commercial set up than previous natural mating technologies permitted. Not only does this allow for the number of chicks that each male produces to be calculated but it also permits the revealing of the impact of social networks and behaviour on mating success and flock fertility.

The responsibility of the breeding companies

There is a responsibility to ensure that breeding companies can consistently continue to supply a high value, quality product, which fulfils the demands of consumers and processors alike. It is crucial that multiple breeding bases are maintained in more than just one country as a contingency, in order to protect supply in the event of unforeseeable circumstances.

Biosecurity and the maintenance of the highest health status,

including but not limited to the accreditation of biosecurity compartments, give additional flexibility for selection and supply in times of notifiable diseases.

To this end, breeders must ensure the compartment status of their breeding programs is certified by high level audits from the appropriate authorities.

Receiving countries should understand the depth of the provided biosecurity and accept the concepts of compartmentalisation or regionalisation/zoning, and the breeding stock coming from these compartments or regions.

There must be a continued focus on welfare and sustainability – welfare and sustainability are not contrary to good business, they contribute to it. They give the industry the social license to operate and ensures that we maintain our industry for our children and grandchildren. A very wide pool of genetic material needs to be maintained, in order to give flexibility for changing market conditions and provide options for existing and upcoming production initiatives for any foreseeable future.

Within the Aviagen stable of lines there are strains that have not been selected since the 1970s, along with coloured options which grow at less than 35g per day, all the way through to the most rapidly developing, high yield lines for inclusion in products grown to over 4kg, for whole bird deboning.

This range of options allows the development of a broad portfolio to address the needs of the most discerning processor and end-user for the near future and beyond. Communication and transparency, liaising with all stakeholders in the industry to explain how modern poultry breeding works and incorporate feedback from all tiers in the industry, research organisations, NGOs, retailers and consumers, will be the new normal. This should be achieved in a coordinated manner both regionally and globally.

Finally, there is a requirement to continue to invest heavily in research and development, both in breeding programs and the industry as a whole. These can involve capital projects to improve the environment on farm, novel equipment, collaboration with institutions of higher education and development of in house systems.

All of which will ensure that the breeding companies of today, and the industries they serve, can continue to play a leading role in feeding future generations, by providing quality broiler breeding stock and producing a healthy and sustainable source of protein. ■

References are available from the author on request