Information and Communication Technologies (ICT)
Contribution to Broiler Breeding
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Abstract

Breeding broiler chicks for meat production comprises three main unique production stages. This complicated production sequence is dictated by the fact that the modern broiler chick is a cross between four genetically different poultry lines. The first stage involves the selection and breeding of the four basic lines. The second involves the cross breeding between the four lines in order to get an optimized breeding combination of the industrial modern broiler. The third stage is mass growing of those broiler chicks for duration of 6-7 weeks until their slaughter and processing for the meat market.

A typical “Integration for poultry meat production” includes breeding the “Grandparents” of the broilers to produce the “parent” breeders and in turn growing these breeders to produce the broilers. A typical “Integration” includes also the necessary facilities such as hatcheries, broiler growing farms, broiler processing facilities, feed mills, laboratory and marketing outlets. This paper outlines the crucial, indespensible contribution of Information and Communication Technologies (ICT) for the various broiler meat production stages.

Background - Computerizing broiler breeding

Modern breeding or genetic selection is a very complex endeavor. It is complicated due to the need to breed genetic lines simultaneously for several, sometimes conflicting characteristics. It becomes evermore complicated due to the fact that attaining economically beneficial characteristics can have a negative genetic correlation with other characteristics involved in the breeding process.
Synchronizing the process involves advanced biometric procedures which in turn are dependent on manipulating large data sets – feasible only with powerful computing capacity. This in turn makes such expensive breeding without ICT inconceivable. For a perspective review of Poultry Genetics see Hunton, 2006. For a popular review from a farmer’s perspective see Porterfield, 2006.

Before availability of computing capability, selection’s calculations were done manually and needed a large number of scientists. The introduction of computers made genetic selection more efficient and enabled introducing more advanced and complicated selection models and data management programs. The future of poultry breeding is claimed to improve selection by “genetic markers”, a technique that is totally dependent on powerful computing capacity. The poultry breeding in this sense is in many respects similar to the modern procedures used for cattle, sheep, and other breeding programs.

The brooding and growing process

The modern broiler breeding comprises three genetic stages within a three generations sequence. In each of the three breeding stages there is a need to brood chicks, raise the pullets till maturity and while fertile harvest their egg production.

When hatched these eggs are the next generation of cross-bred chicks. The final product of this process – is the broilers marketed to the meat industry and market.

The management of this three stages process was relatively simple and straightforward at the beginning of modern poultry cross breeding - during the "forties" and the "fifties" of the 20th century. The farmer's role was confined to the providing of food, water and supplementary illumination when necessary.

Over the following 70 years, as a result of the successful genetic selection for faster growth rates and higher meat yields, the chickens became more sensitive to their environmental needs. Poultry farmers defined the situation by asserting that the modern broiler breeder and broiler are "unforgiving" to even small deviations from their optimal growing conditions. In practical terms the modern chicken became in many ways more dependant on the grower than it was even only twenty years ago. This dependence on a multitude of optimized production factors in fact dictated ICT support for integrating input complexity and environmental considerations. This was by far more than the "simple" equation above of "providing food, water and supplementary illumination when necessary".

This integration dictate was enforced by an ever growing need for management improvements just to maintain the results of e.g. 20 years ago – which in turn again increased the dependency on ICT. In essence it became necessary to keep running faster forward just to keep from sliding back (Eitan and Soller, 2004). The following details the dependence of successful growing of the modern broiler and parent chickens as expressed in various technical factors and ICT's contribution to their optimization:

a. Temperature

In the past routine there were pre calculated recommended temperature requirements for brooding day old chicks with quite broad margins. They were adjusted during the day calculated chick's stages of growth. At present the modern broiler chicks have become more sensitive to even small deviations from the recommended temperatures while the optimal growing temperatures are confined to narrower safety margins. Much of the sensitivity to heat is the outcome of increased body heat produced during the incubating and the growing process and a diminished body ability to get rid of it. Excess body heat is a cause of illness, of a higher rate of mortality and disturbed eating ability and is apparently over time a factor affecting the chicken's laying ability and loss of fertility. Such heat related problems are augmented by excessive eating - characteristic to the modern broilers. In order to at least alleviate these problems it is imperative to monitor and control the temperature in the chicken growing facilities during the chick brooding and growing.

This new reality, together with the growing need to control the light intensity and its duration during growing and egg production, created a worldwide trend to concentrate the modern poultry production in climate controlled, and eventually environmentally controlled buildings. In such buildings internal heat control is dependent on advanced ventilation systems which maintain optimum temperatures and humidity. The external temperatures outside the buildings and the internally generated heat from the chick/pullets/chickens are factored into this process.
Monitoring and maintaining the desirable heat and humidity levels involves integrating multiple systems which include various monitors, ventilators, sprinklers,

opening and closing of windows, curtains, heating elements and proper heat dissemination facilities. Advanced ICT is essential in order to monitor the relevant variables in order to assure the necessary safety margins. These results can only be attained by using computers and computerized controllers. Monitoring the data generated enables the farmer to follow the peculiarities of each flock in each building and adapt the climate control systems accordingly. These are constantly update to adhere to the strict temperature, climate and environmental safety margins which are optimized to the biological requirements of each flock of broilers.

b. Feed intake limitation

Past practice included free access to an unlimited feed supply. This was based on the assumption that individual feed intake would be subject to and regulated by each chick according to its individual needs. As a result of breeding for large and fast growing broilers the modern broilers were genetically inclined towards uncontrolled eating, unchecked by the natural “feeling” of satiation. The destruction of satiation and feeding control mechanisms seriously affected laying ability, fertility and even the hatch of fertile eggs. The introduction during the last 15 years of intense selection for a higher meat yield and a larger breast component in each broiler changed the breeder flocks physical characteristics. Physical deviations from past standards had additional implications serious affecting mating ability.

From the early 1970s it became clear to growers that in order to maintain an acceptable level of laying ability the feed intake of pullets designated for breeding flocks has to be controlled from an early age throughout their productive cycle. Consequently feed restriction was derived from comparison of an optimal weight chart and feeding schedules with actual body weight measured manually or by automatic weighing unit.

With time the success of breeding for a faster growing and heavier broiler made feed intake control of the broiler parent flocks in general a critical issue as well. This in turn dictated the need for a daily controlled and uniform flock feed rationing. With the continuing success of the selection programs the difference between the recommended restricted feed allotment and every new generation’s growing appetite became bigger. To maintain the balance between growing appetites and the optimal feed ration the time allotted daily to consume the feed ration was shortened. For this purpose specialized feeders were developed to ensure a uniform and rapid feed rationing. Initially they were based on balancing the weight of feed portions. This proved to be inadequate technically and not accurate enough for the industry’s growing efficiency standards. The manually supervised rationing was replaced by computer controlled electronic devices. Their additional advantage was online, real time reporting of feed delivered, consumed and consumption rates.

Breeder males were diagnosed as suffering from similar symptoms as the females and from too heavy breasts since the 1980’s. It became clear that in order to get proper fertility they need their separate feeder and different quantities of food compared to the females. Later, the continuing genetic changes caused a more dramatic drop in fertility and forced the “spiking” of breeder flocks with young males in the middle of the productin season. The decisions connected with this “spiking”, including number of needed young males, their feeding schedule and their effects on fertility and hatchability became much more available by using ICT.

Current studies indicate that feed intake control is necessary not only for the proper production of the broiler “parent” flocks but for the broiler offspring themselves. It was found that in order to get the best broiler results it is best to ration their food intake too. This helps to avoid increased health deterioration caused by excessive eating during their critical first weeks. Management and control of feed rationing and precise feed allocation distribution in all stages of broiler growing became complicated. Labor constraints, labor efficiency and the need to produce broilers in larger production facilities made dependency on computers unavoidable and a critical success factor in broiler and broiler breeder flocks.

c. Limiting water intake

In the past, water intake was unrestricted with unlimited access to water. As breeding became more sophisticated it became apparent that water intake must be controlled as well. The severe feed intake restrictions in the broiler breeder flocks induced excessive drinking to counter the feeling of hunger, and it began to appear in broiler flocks too. Excessive water intake is detrimental to health due to an unbalanced feed utilization and excess discharge of liquids and minerals. This in turn results in continuous problems of damp litter which aggravates existing health problems and introduces additional dampness related as well.

One practical solution was to develop a new nipple drinker to dispense the allotted, limited water rations to the broilers. Another preferable solution which was adopted was to schedule and restrict the drinking hours in the breeder flocks. Monitoring water availability periods and water quantities were consequently computerized. This in turn, as with feeding monitoring, provided real time data of water consumption and rate of consumption. Over time it was realized that monitoring the amounts of water consumed provided an indication of health disorders and/or flock management problems.
In order to make water control easier, a new parameter was developed which is the relation between the average daily water and feed intake. This relatively new parameter is fluctuating less than the actual daily water consumption, and make decisions about “drinking hours” according to age and temperature much easier. Consequently controlling water consumption became an important management tool supported with ICT supplied data sets. It became unfeasible in modern production units to make water related management decisions without them.

d. Sharing data and information

In the past an imperative need for transferring data and sharing information between farmers and the poultry farm managing directors was minimal. Data about the number of eggs laid and hatching statistics were sufficient. Integrated production in the poultry meat industry and the ever growing practical problems caused by the genetic selection programs changed this situation.
There was a growing need for stronger interaction between the grower, the professional staff and management teams. ICT provided the solution with data and information sharing tools – both in real time and later in the day.

e. A practical example

The firm for producing day old broilers that I work for, can provide an example for the above mentioned steps.

Initiating feed restrictions of breeders during the “seventies” dictated changing the actual feeding facilities – mainly feeders and using “electric watches”. Later new feeders were bought as feed restrictions became more severe by reducing the daily feed allotment from about 70% of Ad. Libitim fed breeders to less than 50%. Feed was given by allocated quantified “meals”. The exact timing of the meals for every building, together with the new need to feed the males with separate feeders on a different schedule and all on a uniform way, made the dependence on many more such “watches” impossible. The solution was dependency on an “electronic controller” and later on a computer.

Roughly the same process was used for the other changes. Examples include the change in managing drinking water’s hours and quantities, light availability and especially with the growing need for climate controlling. The “electronic controller” and later the computer embedded controller became a must.

Since proper management is based on online data supplying, we passed to use the internet connection which lately was changed to the modern “wide channel” (Pas Rachav) connection. The manager can easily enter the farm’s computer system in order to understand better the problem he faces and solve problems from his office or home. This process is pushed up also by the growing labor cost. With proper ICT, the needed data can be available without investing too many hours in the farm.

In the current broiler meat production, technology and practice monitoring of so many parameters in breeder flocks such as climate control, feed and water intake, egg production and body weight became essential. It has become apparent that in order to enable optimal decision making the ongoing, real time collection of this data during all stages of broiler breeding and growing is imperative. This data collection involves a relatively large number of production areas and buildings – often in spread out geography. It is conditional that the data collection should not interfere with growing and production processes and employee work routines. Computerization enables circumventing such interruptions while providing real time data and information. These in turn facilitate ongoing consultations between growers, their consultants and their managers.

Computerizing the incubating process

During the last decade a new constraint in broiler incubation had been identified. An excess of heat generated by the new genetically bred broilers while incubating, caused dramatic changes in hatcheries. Once again the genetic changes caused by breeding created an urgent need to change the management procedures. This time the dictate for this change was the result of increased heat generated by the embryos in the eggs. The remedial changes in incubation facilities were focused on the ventilation procedures while incubating the modern broilers. Other changes included were changes in planning the daily temperature schedules in the hatching chambers, monitoring the CO_2 levels during incubation and the weight loss of the hatching eggs during their incubation period. The former setter machine with the fixed temperature during the first 18 days of incubation, faced too many unsolved problems.

To cope with these changes innovative incubators were developed and named a “Single Stage Incubating System”. In this procedure each incubating batch includes eggs of only one setting date instead of having the “multi stage” cabins with eggs of different entering dates. The goal was to maintain a uniform and better controlled heat level in the hatching chambers to attain an optimal hatching rate – compatible with the embryos excess energy production and their sensitivity to temperature deviations. The ever growing heat production in the hatching chambers enforced a change in the incubation schedules as well. These were changed from maintaining a constant uniform three week temperature to an almost daily temperature management program.

It is hard to conceive proper control of the modern incubation complexity including heating, cooling, ventilation and humidity control in the new incubators without computerization of all routines and procedures. The resulting precise data collection and accurate data recording facilitated a learning process resulting in new formulas how to optimally operate each incubator for each batch of hatching eggs. Operating the new incubators, collecting relevant data, processing it and deciding on the proper feedback to operators was and is totally dependant on ICT.

Computerization as a tool for industrialization of meat production

Utilization of computers for transfer of knowledge from the farms is increasing due to the importance of implementing the severe restrictions embodied in “Bio security” rules. Industrializing poultry meat production has elicited stricter control of production conditions which facilitate transmission of diseases between farms. One effective measure was the isolation of farms and hatcheries to an extent that entrance to them is limited only to a small number of specific laborers. As a result the only feasible option for constant real time accessing of flock data is via computerized remote data gathering (numerical, visual, etc). Such computerization enables sharing of critical information and involvement of specialists in real time decisions necessary in the modern breeder and production flocks.

An additional ICT contributory element is derived from the increased complexity of these decisions. An example would be the daily / weekly decision of the feed ration for a breeding flock which is dependant on the following input:

- automatic individual weighing
- averaging weight of individuals in the breeders flocks;
- adjusting feeding time duration;
- actual water consumption;
- calculating the average egg weight;
- monitoring the daily number of eggs laid.
- monitoring daily mortality, temperature, eating duration and other necessary details for veterinary surveillance.

It is very common in commercial practice to get a booklet of “management guide“ from management specialists employed by the few largest breeding firms. As they admit, their recommendations are based on a computerized analysis of ongoing real time data sets collected from hundreds of “good” flocks rather than relying on data sets gleaned from pre designed experiments. During the last decades, this data analysis has been performed in the U.S by private firms specializing in statistics and data collection. Usually their recommendations are the only source of up to date information available for daily decisions made by growers.
One example is the “COBB 500 Management Guide” which is updated once in 1-2 years. The “Management Guide” includes directives for properly growing the day old chicks, the growing pullets and the breeders while in lay, for all the parameters like feed, water, weight and light etc. The complexity of proper managing cause it to become thicker every few years..

The dependence on statistics for writing those “Management Guides” eventuality is the result of the fact that applied scientific research can not keep pace with the rapid changes imposed by the pace of the genetic selection programs and because of financing problems. This drawback illuminates the importance of ICT in obtaining shared and up to date information from grower and market sources.

A value added to sharing information and decision making is worker involvement in the production process – a human satisfaction factor critical to production success. It is important to emphasize that transfer of information is multi directional. It includes a flow of information from the grower and sending news of innovations and study results from specialists directly to the grower’s computers. Knowledge becomes available to all those responsible for all aspects of breeding and growing broilers. The “decision making” deliberations that were delegated by growers to specialists, are partially returning to the grower by ICT implementation, interaction with other farmers, feed back to and within the broiler industry information systems.

ICT Implementation

The readers of this article might think that ICT is a must for a poultry farmer raising broilers everywhere on the globe. This is not necessarily so, for several reasons:

The first reason is that the modern lines for meat production are not economically suitable for all growing conditions. The modern and efficient broiler can only thrive in optimal conditions in which it’s excellent growth rate and amazing feed efficiency can be exploited. In many countries farmers prefer buying lines from an “older” genetic generation or lines that are genetically selected for different characteristics than the mainstream modern broiler. The outcome is a more robust and less “sensitive” breeder and broiler that can survive in sub-optimal environments.

A second reason is the availability of inexpensive labor. Where semi skilled workers can be hired cheaply part of the computerized tasks can be done manually without a major loss of reliability.

Other reasons for not adopting ICT or suggesting slow and inefficient ICT implementation for broiler meat production include: Lack of farmer training, better alternatives, cost constraints, unsuitable ICT and unavailability, illiteracy and other personal farmer impediments. Alleviating these problems depends on national ICT priorities, “top-down” commercial interests, international involvement including loans, training and close, online guidance.

An issue of extreme importance is the rate of ICT Adoption. Empirical evidence time and again shows that an ICT’s proven economic viability is not necessarily a guarantee for its adoption. Anecdotal evidence identifies a wide range of reasons influencing this rate. Among them are adoption only after proven reliability of the ICT supported innovation - “I’ll install it after I see it working on my neighbor’s farm”; delay in identifying a locally perceived need; dependency on overall renovation/expansion/development schedules with ICT supported equipment and/or related systems appended to them; human factor elements such as acceptance, reluctance to innovate, illiteracy, loss of social positioning e.g. “being replaced” by a computer, conservatism; changes dictated by requirements of new genetic lines; cost and availability of the innovation; past failures in adopting earlier ICT versions, and more. In summary planning adoption of a “good, economically viable, and/or beneficial” ICT supported system must consider the above constraints for its successful and timely implementation.

It can be assumed however that in a free and secure market the comparative advantage of the advanced broiler genetic lines with their superior feed efficiency will stimulate if not dictate ICT adoption. It is a prerequisite for their successful breeding, growing and marketing.

Summary

The availability of computer supported data collection, its integration including newly available and calculated parameters enables more precise and updated decision making by a wider range of decisions makers. Adoption of computers into poultry breeding and production routines was the result of the need to monitor and control production variables and manage large amounts of data and information. These are indispensable for the viability and success of modern poultry breeding and production.

The various ICT tools to exchange, deliver and/or access written, graphic and real time data optimizes the circle of involved professionals, simultaneously. This in turn enables their inspection and control of the breeding process, provision of advice, instructions and feedback. The easy accessing of data and ease of processing data and information inherent in modern computers enables analysis of parameters that in the past were not monitored carefully if at all. Recent examples which have almost become a daily routine in many firms include

- following the daily average loss of egg weight during incubation,
- monitoring the rate of daily changes in water consumption in breeding flocks,
- analyzing the implications of different restricted feeding programs on production parameters in breeder flocks and more.
- monitoring of CO_2 ratios and humidity in the incubating chambers,

Without the advanced utilization of computers and computer embedded monitors chicken breeding would have regressed to much lower levels without being able to exploit the tremendous advancements made in the genetically improved broiler stock. For example the female breeder would be laying less eggs and the male would be less fertile.

Computers enable achieving production parameters equivalent to the past with genetically improved broiler stocks attaining almost the same production level with less chickens and with improved meat quality.

References

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