NC STATE UNIVERSITY

Setting Eggs & Incubation Profiles

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Introduction

Modern poultry hatcheries aim to maximise chick number and quality. **To reduce costs, hatcheries often use larger incubators with more egg incubation capacity for cost-effectiveness. Using larger incubators often leads to the simultaneous incubation of mixed eggs from multiple flocks.**

Therefore, **variations in egg characteristics** (including size, composition, shape, eggshell thickness, porosity, heat, and water vapour conductivity), **result in differences in the embryo metabolic rate and physical incubation conditions, affecting hatching results** *(Brake et al., 1997; Decuypere & Bruggeman, 2007; Boleli et al., 2016; Tona et al., 2022).*

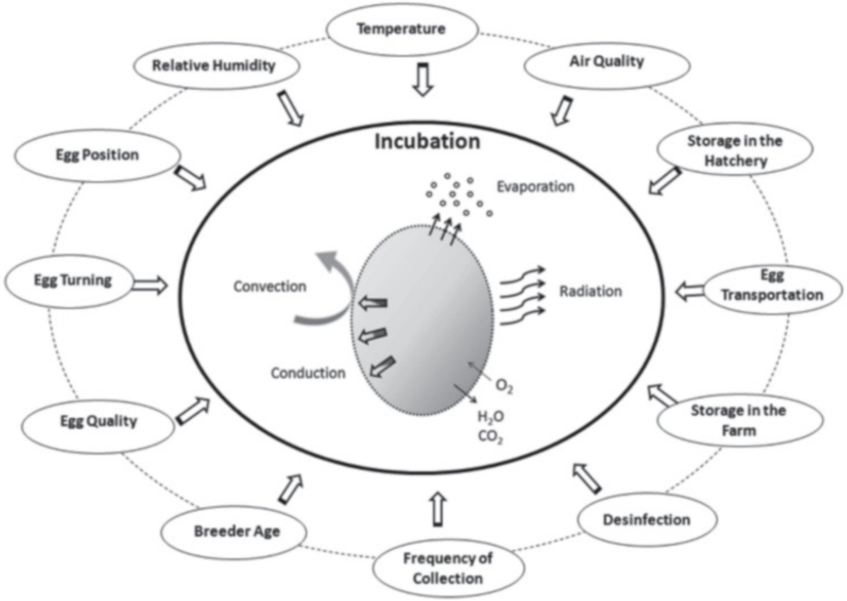


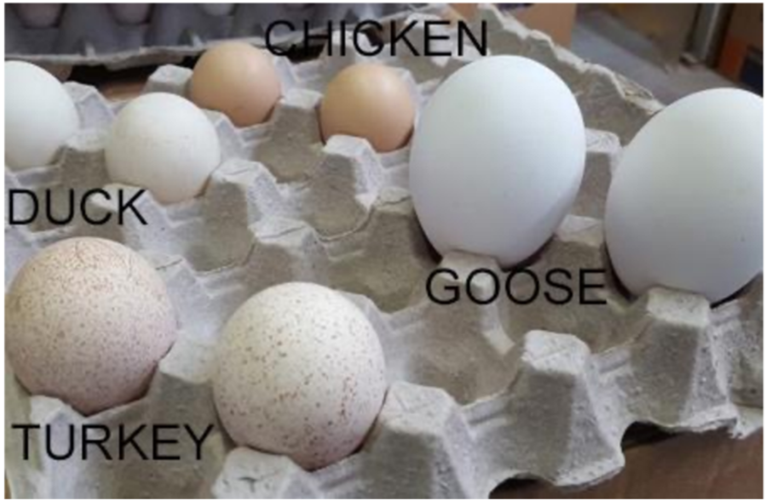
Figure 1. *Multiple influencing variables affect the hatching and chick quality results (Boleli et al., 2016).*

Incubators equipped with automated systems and sensors can adjust some influencing variables, such as egg turning, eggshell temperature, egg weight loss, and CO_2 levels. However, **these variables are interconnected and will mutually affect each other during incubation** (Figure 1).

Heat production in mixed eggs during incubation

Among all variables, **eggshell temperature is the most important during incubation** *(Lourens et al., 2005; Van Brecht et al., 2005; Romanini et al., 2013).* **The ideal temperature for incubation is between 37°C to 38°C,** as shown by various studies *(Decuypere & Michels, 1992; French, 1997; Hulet et al., 2007; Bergoug et al., 2013).*

In ideal conditions, all embryos develop and grow at the same rate, culminating in a chick hatching at 21 days in perfect synchrony between biological and chronological ages.



However, **embryo development rates depend on embryo temperature,** which is affected by breed, strains, lines, and many other factors. **The tolerance to temperature deviations during incubation depends on the exposure time and the stage of embryonic development with early incubation as a more susceptible period.** Therefore, getting a good start with appropriate incubation conditions is crucial.

Due to the selection process, **there are physiological differences between broilers and layers embryos and chickens.** Broilers are primarily bred for rapid growth and high meat yield, while layers are mostly bred for high egg production.

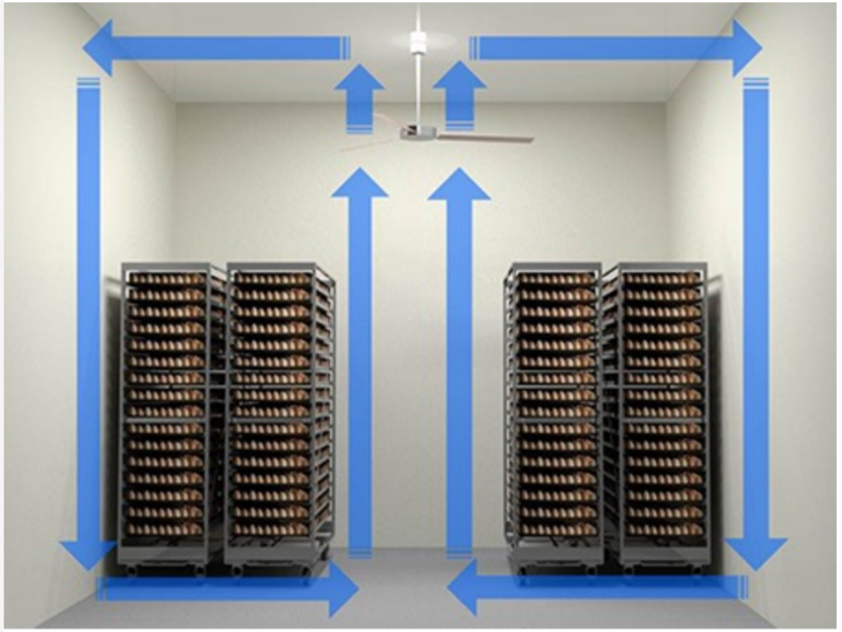
As a result, broilers and layers exhibit variations in yolk utilisation, yolk-free body mass, heat production, and incubation duration implying that they should be incubated separately.

- Even within the same chicken strains and under uniform incubator air temperatures, embryonic heat production during incubation is influenced by variations in egg composition, energy content and eggshell properties all affected by egg size, age of the breeder flock and egg storage *(Janke et al., 2004; Tona et al., 2010; Nangsuay et al., 2013, 2015).*

As a result, **temperature fluctuations within the incubator, as well as variations in eggs from various sources, can have a significant impact on eggshell temperature, affecting the ability of eggs to hatch and the quality of hatching chicks.**

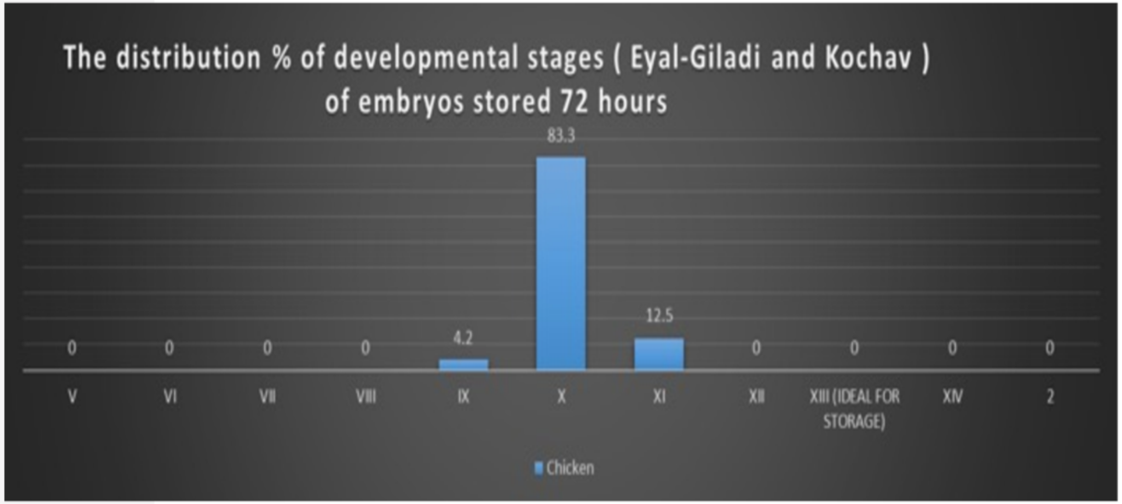
Best practices on setting eggs

It is known that incubated eggs constantly exchange heat with their environment. **In forced air incubators, air velocity has a substantial impact on the eggshell temperature.** Hence, best practices must be followed while mixing and positioning eggs from various sources in the incubator to improve temperature homogeneity *(Meijerhof & Van Beek, 1993; Elibol & Brake, 2008).*



- Broiler eggs laid by old breeder flocks, for example, are larger and heavier, with a higher yolk energy content that is required for embryo growth, resulting in more heat production, during the last days of incubation. So, **it is recommended to not incubate eggs from old and young flocks together and to avoid mixing eggs to avoid incubating mixed eggs with more than a 10-week age gap between flocks.** Furthermore, **variations in fertility should always be carefully evaluated** when mixing eggs for incubation as it indicates the number of eggs that effectively produce heat.

- **Prolonged egg storage reduces the number of viable embryonic cells, resulting in less heat.** Regardless of the number of days in storage, it is best to use SPIDES (short periods of incubation during egg storage) with dedicated machines (Petersime Re-Store) to achieve a more homogeneous embryonic stage at the start of the incubation and reduce the impact of varying heat load effects *(Dymond et al., 2013; Özlü et al., 2021).*



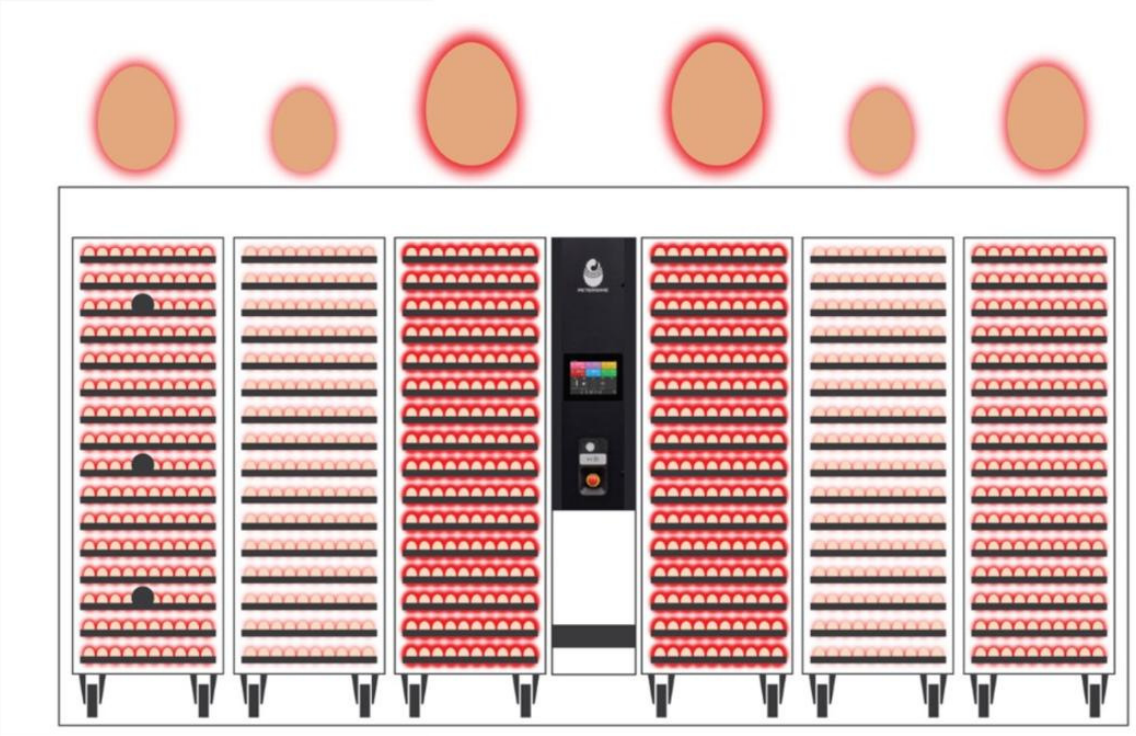
Additionally, **the eggshell temperature must be continuously monitored using embryo-response technologies** (Petersime OvoScan).

Managing eggshell temperature in real-time and choosing the eggs that represent an average heat production is crucial when mixing eggs from multiple flocks into one incubator *(Lourens et al., 2006; Tzschentke, 2008; Romanini et al., 2015).*

To summarise, **eggs that generate more heat should be placed closer to the central mixing fan to enhance heat transfer through air velocity. The middle trolleys are the most suitable positions for eggs with the lowest relative heat production,** such as eggs from young flocks or smaller eggs.

Adhering to these recommendations (Figure 2) will lead to the most efficient distribution of mixed eggs in the incubator, ensuring optimal thermal conditions.

Figure 2. *Correct egg setting pattern for mixed eggs with differences in heat production (Petersime NV).*



Adjusting Incubation Profiles

Incubators are often provided with a safety preloaded standard incubation profile. However, **it is advisable to adjust these profiles according to the hatchery targets and machine loading conditions for the best possible performance.**

However, all variables that could impact hatch results must be examined before adjusting the incubation profiles. Problems with poor farm management, improper egg storage, pre-heating or egg transportation, and many more examples exist.

After considering all these factors, **the problem is often that the incubation profile is not customised to the specific embryonic requirements of that specific batch of eggs.**

Evaluating embryonic mortality is the most effective method for improving hatchery results.

Therefore, **it is critical to employ a troubleshooting checklist** to examine unhatched eggs to classify patterns of embryo mortality (Figure 3) and determine the underlying causes that may link to breeder farms, pre-incubation, or specific incubation phases, such as unstable eggshell temperature increasing early deaths.

Hatcheries that neglect to conduct routine egg breakout analysis are effectively wasting valuable information that may help solve breeding farm and incubation issues *(Tong et al., 2016).*

Category	Sub-categories
Farm 	Cull eggs Farm cracks Eggs set upside down True infertiles (blasto disc) Contamination
Early mortality (1-7 days) 	24/48 hrs Blood ring (day 3) Black eye (day 5) Day 6-7
Mid mortality (8-14 days) 	Day 8-9 Day 10-14
Late mortality (15-21 days) 	Day 15-17 Day 18 day 19 Day 20 Transfer damage Malpositions
Malformations 	

***Figure 3.** Example of an egg breakout troubleshooting checklist*

Conclusions

Chicken embryo development, growth and hatching depend on several circumstances, including egg variability from different flocks in an incubator.

Although many incubation variables (air temperature, humidity, airspeed, egg turning, CO_2 levels) can be monitored and modified for target levels, **the multiple interactions pose a significant challenge in optimising incubation conditions.**

The eggshell temperature is the most important parameter to be controlled during incubation.

- Differences in egg characteristics, breed/strain, breeder flock age, and egg storage all have an impact on heat production as well as on the trajectory of embryo development and growth.
- Consequently, variations in the incubator's temperature linked to variations in eggs from various sources may have a substantial impact on the hatchability and chick quality results. When mixing eggs from different flocks into an incubator, **it is crucial to thoroughly evaluate the egg differences, follow best practices guidelines for egg setting and adapt the incubation profiles accordingly.**
- Hatcheries can acquire, retain, and use data from unhatched eggs and poor-quality chicks to fine-tune incubation profiles and transform assumptions into verifiable data, enabling consistent enhancement to the hatching results.

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Thank you!

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