# THE IMPORTANCE OF MONITORING SHRIMP UNIFORMITY FOR BETTER PERFORMANCE IN THE PRODUCTION CYCLE

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***Uniformity of size in shrimp culture is an indication of good farm management, contributing towards increased productivity, predictability, consistency, and also importantly, better prices at the point of sale. Assessment of uniformity involves looking at the coefficient of variation (CV); percentage of uniformity; and class distribution in terms of length and weight. These assessments can be performed manually as well as using artificial intelligence, as outlined in this article which bases its observations on data extracted from production results recorded by a high-efficiency farm in Brazil.***


*Animal sampling for biometry*

Shrimp uniformity is one of the main considerations when it comes to characteristics related to product quality, from the beginning to the end of the production process. It is a measured trait with big influence at the hatchery stage, during the grow-out phase, and at the end of a cycle when harvesting the pond.

According to Newman (2023)[1], determining the size variability of a population along, and at the end of a cycle, is one of the most valuable tools for a farmer, as it can, in general, indicate how healthy the shrimp are.

Understanding concepts about uniformity, monitoring the animal's behaviour in relation to size distribution throughout the cycle and working towards enhancing better uniformity throughout the crop, can contribute greatly to its nutritional management and consequently result in a better product.

The uniformity of a sample can be assessed by the length and weight of the animals. There are three indicators that facilitate a broad reading of the condition of a batch: (i) coefficient of variation (CV); (ii) percentage of uniformity; and (iii) class distribution in terms of length and weight. These assessments can be performed manually as well as using artificial intelligence.

## Coefficient of variation

In shrimp culture, especially in the post-larvae stage, the coefficient of variation is the most used mathematical indicator. It allows one to analyze the characteristic distribution of the sizes in a selected batch.

The first step to quantify the distribution of a batch is to measure the size of each animal in a sample and then calculate the sample´s mean and standard deviation for that trait. To calculate the CV, the following equation is used:

CV=S/X*100 (where: CV=coefficient of variation, S = standard deviation and X= mean weight or length of the same population).

## Uniformity rate

For some producers, the CV may seem abstract and its information not easily interpreted. As an alternative way to read it, there is the Uniformity Rate (U%), an indicator that clearly shows, both in length and weight, the

[1] *Newman, Stephen. Cuáles son algunos parámetros que los camaroneros deberían monitorear regularmente? www.panoramaacuicola.com, june. 2023.*


*Individual weighing for uniformity*

situation of uniformity of a lot, in percentage. The Uniformity Rate is the coefficient of variation decrease, by 100%; i.e.:

U% = 100% -CV (where CV is the coefficient of variation of the population for size, in length or weight).

With this information, the producer or person in charge of the grow-out will be able to have a technical and strategic approach to monitor and specifically quantify the development of the batch throughout the production process.

## Class distribution

A third indicator of uniformity is the class distribution, which stands for the distribution of the animals of a specific population in groups (classes) of size (length or weight). Individual biometric analysis of a sample is carried out and the data is divided into groups of size (which are the classes) and at the end, the percentage of animals in each class is calculated. It can be carried out at any stage of cultivation. In the initial stages (hatcheries and nurseries) it is usually read by classes of length (in cm), but for grow-out it is more common to be done by weight. In some cases, the sizes are already distributed in the processing classification. Having knowledge about the class distribution from the early stages allows for efficient and gradual nutritional management in relation to pellet size, making it possible for smaller animals to have access to food according to their size.

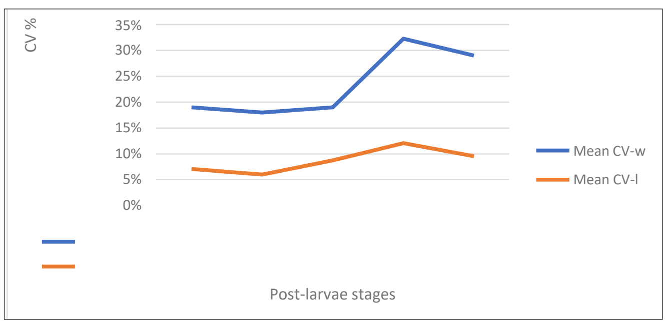
## The impact of uniformity in the production cycle

Starting from the perspective of the post-larvae stocked in a pond, uniformity could be considered an indicator of the quality of the animals that are entering the culture cycle, as it can reflect genetic traits, previous feeding management, occasional management fails during hatchery, and possible presence of diseases. An example of the latter is in the case of animals infected with IHHNV (infectious hypodermal and hematopoietic necrosis virus), which in *vannamei*, causes mainly reduced, irregular growth, leading to extremely uneven populations.

Historically, in hatcheries and nurseries, the coefficient of variation is used with length, which allows a partial reading of the uniformity of a batch. Field experience shows that the CV of the length is more related to the visual perception of uniformity of a population of post-larvae, which will affect the commercial acceptance of the post-larvae, for example. However, the CV of the weight will correlate more with this same population´s performance further on.

Currently, with the possibility of the use of artificial intelligence applications, it is possible to achieve a broader indication of uniformity, once it can be performed completely both by length and weight. As an example, in Figure 1 we can see clearly, how the CV for length (CV-l) and weight (CV-w) are very different for the different commercial post-larvae stages:

**Figure 1. CV evolution through post-larvae ages for weight (CV-w) and length (CV-l).**




| | 9 | 13 | 14 | 18 | 20 |
|---|---|---|---|---|---|
| **Mean CV-w** | 19% | 18% | 19% | 32% | 29% |
| **Mean CV-l** | 7% | 6% | 9% | 12% | 10% |

## During the grow-out phase

Moving on through the production cycle, the CV/uniformity for weight becomes greatly important and monitoring of uniformity becomes a fundamental indicator of the development of the animals. As Souza (2019) cites, a large variation in body size during grow-out can cause competition among shrimp (dominance hierarchies), which negatively affects growth rate, mortality, and feed efficiency .

**Figure 2. Evolution of CV during the shrimp production cycle**

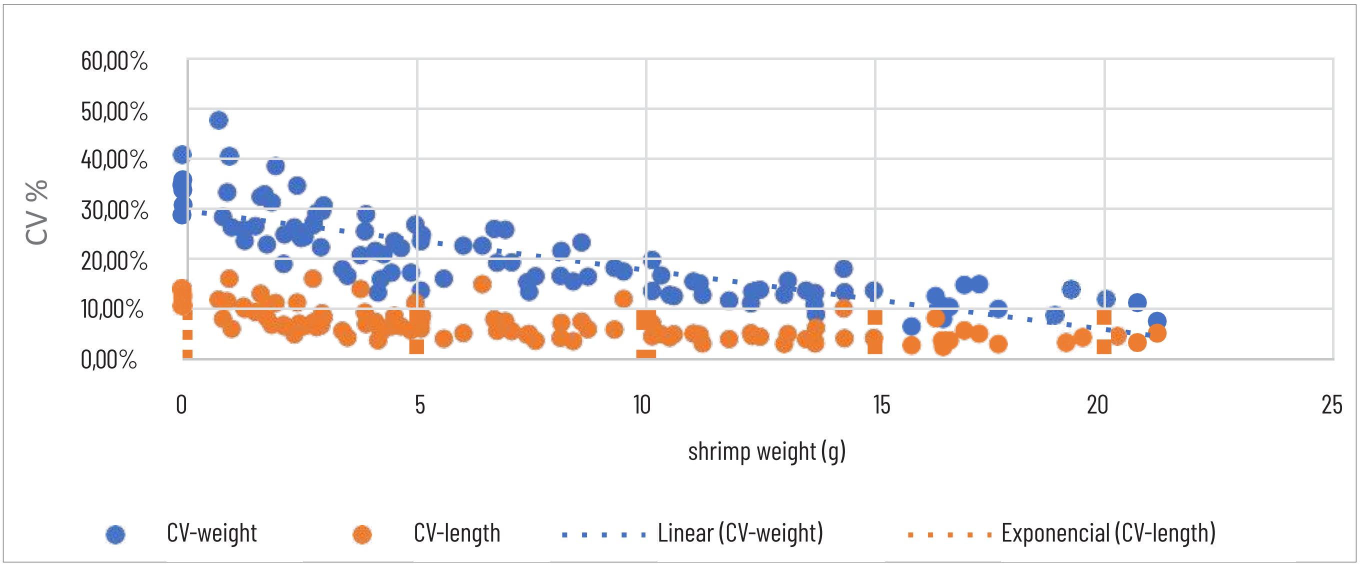
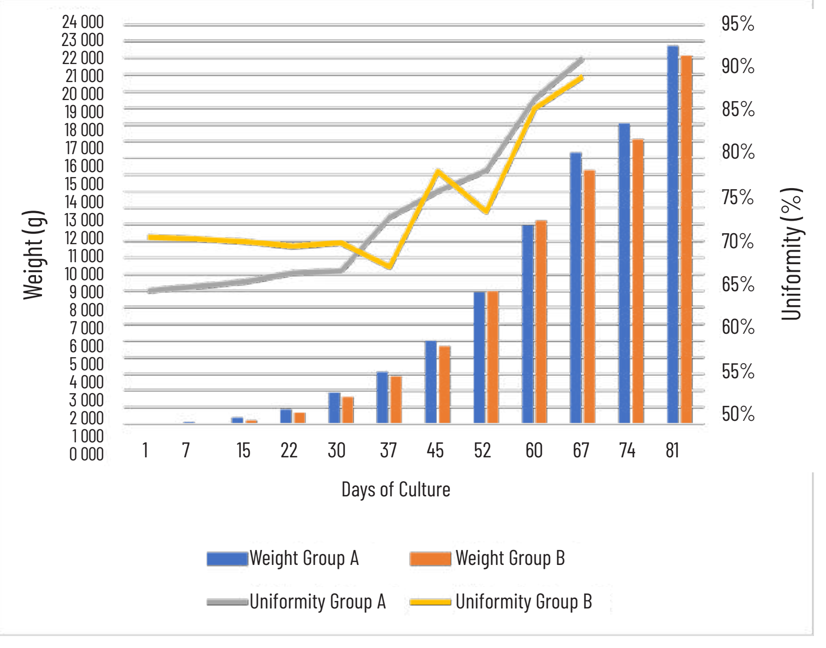



Figure 2 shows the progress of CV along a production cycle. Monitoring a batch weekly allows for the evolution or involution of the percentage of uniformity to be observed; and with this updated information, it can be used as a tool to give direction on the feeding management and thereby move towards the most optimally uniform population. It is the lack of uniformity that is responsible for lengthening the cycle while contibuting towards a decrease in the average weight of the shrimp.

It is important to know that a batch that has initial unevenness is not always doomed to failure at the end of the cycle. Rather, it is vital that the appropriate strategies should be adopted to address the lack of uniformity.

Regarding nutritional management, understanding the size distribution behaviour of the animals throughout the cycle allows one to have greater confidence in the mix and adjustment of feed pellets. The correct pellet size leads to less competition for food, increasing the possibility of recovery for smaller animals.

**Figure 3. Uniformity recovery during grow-out**




In Figure 3 we can observe the results of two groups of ponds stocked with different uniformities and how, through proper management, they became similar in terms of performance and uniformity.

Some other actions may be involved in a batch recovery process such as checking the health status of the animals through macroscopic evaluations, microscopic monitoring, and PCR tests. Also, it is important to monitor the environmental parameters in the ponds to make sure that they are within the ideal ranges for each factor. These data will allow for deeper understanding of the cultivation expectations which can be placed on the batch in question.

Gracia et *al*[2] describes how complex is the influence of different factors on uniformity, stating that "Weight uniformity depends on the sensitivity of an individual to macro-and micro-environmental factors. Macro-environmental factors are measurable factors such as temperature, seasonality, diet, and management, whereas micro-environmental factors are non-measurable animal-specific factors within a given macro-environment. A necessary condition to increase weight uniformity is the existence of genetic variance for response to such micro-environmental factors".

*[2] García-Ballesteros, S., Villanueva, B., Fernández, J. et al. Genetic parameters for uniformity of harvest weight in Pacific white shrimp (Litopenaeus vannamei). Genet Sel Evol 53, 26 (2021). https://doi.org/10.1186/s12711-021-00621-6*

**Figure 4. Report on shrimp measurements done by AI using specific software**


## At the point of harvest

When it comes to the impact on the final product, uniformity of size (or otherwise) is a primary determinant in sale negotiations, especially when the shrimp is delivered for processing. In other words, the lack of uniformity in a harvested crop can directly affect the financial viability of the production process.

Shrimp are graded according to their size and count per unit of weight. Prices between size categories vary widely, and a larger number of shrimp per weight unit (i.e., of smaller sizes) results in a price reduction, post-harvest. Analysis of class distribution may therefore be an interesting strategy for farmers to be able to make the best decision on how to work with their crops.

***Note:*** *The data used in this article was extracted from production results recorded by SynbiAqua Cultivos Aquáticos Ltda (Brazil).*


*Aerial view of the SynbiAqua farm*


*Part of the SynbiAqua culture ponds*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