

## Evaluating Comparative Broiler Performance through Trials

### INTRODUCTION

Carefully planned broiler trials will allow the customer to clearly evaluate the effect of the treatment, be that breed, feed, management procedure or environmental factor, and provide valuable information on product performance. Trial protocols must be designed with a clear focus on ensuring all treatments are handled similarly and that variation is minimized. Failure to properly plan a trial may result in increased sample variation and incorrect data, which can ultimately lead to incorrect decisions and economic losses for the customer.

The information and procedures in this article focus on whole-house trials. Pen trial procedures are likely to differ to those discussed here, although the principles remain the same.

### KEY CONSIDERATIONS

When planning a trial, it is essential to define a clear objective, change only the attribute you are interested in testing and always have a control treatment (a standard group with no changes made). It is recommended to use paired house testing, and the more paired houses used, the more reliable the results will be (**Table 1**).

- Multiple paired placements can be made over time, removing any farm bias.
- The houses used should be side by side on the same farm and have similar house design, equipment and stocking density.
- Feeding, lighting, ventilation, management practices, etc. should be the same, unless specifically outlined in the protocol.

In order for trial results to be consistent, it is strongly recommended to run multiple trials (at least 5 trials in a series) testing the same parameters, before final conclusions are made. After 6 paired house comparisons, the accuracy increases, but at a lower rate.

**Table 1.** The greater the number of paired houses used, the smaller the difference between treatment and control that can be measured. This table shows the effect of the number of paired houses required to detect a statistically significant difference between control and test treatments.

Statistical Difference	Number of Paired Houses Replications Included in a Treatment								
	2	3	4	5	6	7	8	9	10
Difference in 2kg weight (g)	90	73	63	57	52	48	45	42	40
Difference in 2kg FCR	0.03	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01
Difference in mortality (%)	4.0	3.3	2.8	2.5	2.3	2.1	2.0	1.9	1.8

Communication in trial work is essential. All personnel involved, including the hatchery manager, farm manager and plant manager must be informed as to the objective of the trial and must understand and follow procedures.

Trials should:

- Use blind testing (when the specific breed is unknown to the grower and service personnel) to remove any bias toward one breed over another.
- Have recorded measurements of live weight and mortality recorded at selected intervals during grow-out. This can be weekly or at a feed change, depending on the normal procedures of the operation. Unless there is the ability to accurately measure feed intake on a periodic basis into each test house, feed conversion ratio (FCR) will normally be measured over the entire growing period.
- Avoid broiler flocks with multiple breeder sources. If testing a breed, then a single source flock of each breed should be used. If testing another parameter, all trial houses should be supplied from the same flock or flocks.
- Maintain and confirm breed cross integrity. Has the flock experienced male replacement with a different strain of male than the original placement? Are all the females the same breed cross? If there are questions as to the integrity of the source flock(s), the trial should not proceed.
- Control factors such as hatching conditions, housing conditions, farm management, nutritional program and withdrawal time.
- Ensure the source flock age of each breed cross is not more than  $\pm 2$  weeks. Ideally chicks should be sourced from flocks post-peak and before male replacement (if applicable), to reduce the chances of mixing male parents.
- Have trial houses that best represent a commercial program in terms of equipment (i.e. manual or automatic feeders/drinkers, negative or positive pressured ventilation, open or dark house, etc.).
- Record feed delivery, body weight and mortality on each house separately so that feed conversion and livability can be calculated by breed or treatment. Avoid the use of houses that share feed bins with other houses; these houses cannot be used for the calculation of FCR values.
- Hatch chicks in the same hatchery and provide the same hatchery services (chick treatments and vaccinations).
- Determine if the flocks had any problems in the field such as poor livability, disease, feed / water issues or wet litter. This could provide valuable information if issues are seen during the trial.
- Never use sick or injured birds for processing.
- Deplete and process trial houses on the same days.
- Have the same feed withdrawal time for trial broilers.
- Ensure that the processing plant will be able to process the entire trial within a shift.

If issues such as water leaks, feed problems, electrical malfunctions, etc. occur, it is best not to proceed with the field trial. Doing so may provide erroneous data and can be expensive for the customer.

## MEASUREMENTS DURING GROW-OUT

### Recording Live Weight

During grow-out it is recommended that sample weighings at selected intervals are conducted. This information will provide not only weight-to-age comparisons of the treatments, but will serve to alert potential issues with the trial flocks. Selected ages for sample weighing will depend on the trial protocol and final processing age, but it is recommended that weights be taken at days 0 and 7. Subsequently, weights can be sampled on the usual ages for the operation, either weekly or on feed change days. Increasing the frequency of weighing and the number of birds weighed will provide more accurate measurements and predictions of live weight and uniformity (CV%). The calculations for CV% can be found in **Appendix 1**.

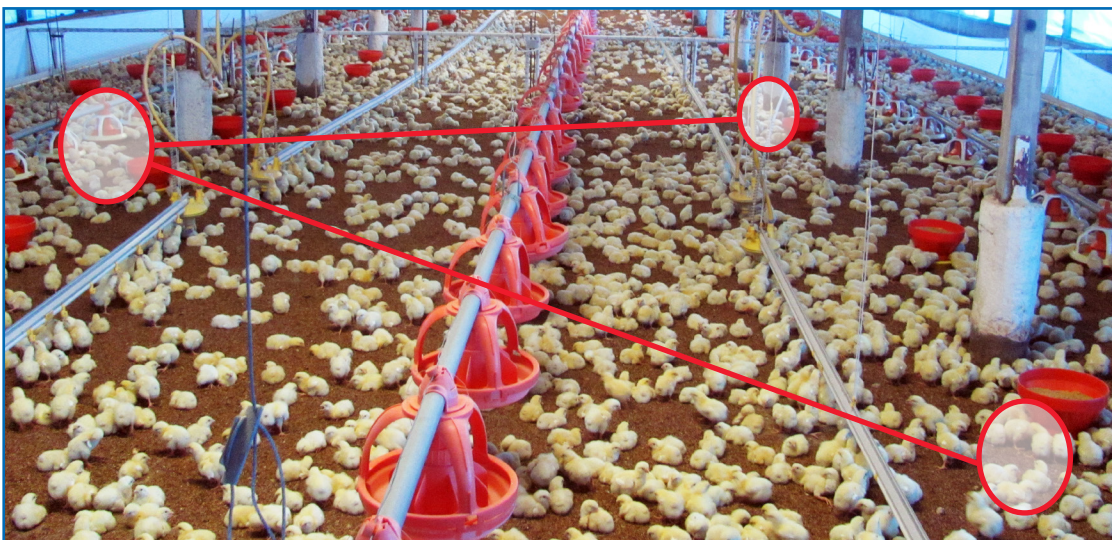
Between 0 and 21 days, birds should be weighed as a group (bulk weighing), provided that uniformity is not of interest. If flock uniformity is needed, individual weighing is required. An absolute minimum of 100 birds (or 1% of the population) should be weighed at each specified age. Birds should be caught using a catching frame or pen and all birds caught should be weighed. This ensures samples will be as representative as possible and estimates of body weight will have better accuracy.

When weighing birds:

- Equal-sized samples of birds should be taken from **at least three** locations (away from doors and walls) in each house (**Figure 1**).
- Good bird welfare must be considered at all times; catching and handling should only be performed by trained personnel.
- Birds can be weighed manually using dial type [to an accuracy of  $\pm 20$  g (0.04 lbs)] or electronic [to an accuracy of  $\pm 1$  g (1 oz)] weighing scales. Either type of weighing scale can be used successfully, but the same scale should be used each time for reliable repeat measurements.
- Unexpected changes in live weight may be indicative of scale error or malfunction and should be investigated immediately. Prior to every weighing, scales should be calibrated against known standard weights for accuracy and repeatability.

From approximately 21 days on, or to determine weekly flock uniformity, individual birds should be weighed. For more information on weighing procedures, see the **Broiler Management Handbook, Broiler Management How To 05: How to Bulk Weigh Broilers Between 0 and 21 Days**, and **Broiler Management How To 06: How to Individually Weigh Broilers From 21 to 28 Days Onwards**.

**Figure 1.** Example of bird sampling points.



## Determining FCR

The lower the FCR, the more efficient the bird, or sample of birds, is at converting the feed they consume into live body weight. Feed in a broiler operation will account for between 50 and 80% of total production cost so correctly measuring FCR will provide information on flock cost and/or profit. To determine FCR, it is necessary to have an accurately measured quantity of feed consumed by the birds. For calculation and examples, see **Appendix 1**.

For trials, it is necessary to keep the feed deliveries between the houses separate and record information about the delivery, such as the date, quality, feed type and feed form. To accurately determine FCR, the amount of feed delivered into each house must be measured precisely. For this reason, each of the paired houses must have its own feed bin and the amount of feed delivered to that bin weighed exactly- not estimated. If the feeding equipment is not able to accurately measure the amount of feed moved from the feed bin into the feeders, it will only be possible to determine FCR over the entire growing period.

## Thinning

In companies that practice thinning, it is not recommended to thin trial flocks; the broilers must be grown to either the thin age or the grow-out age only. FCR is significantly affected by the percentage of birds thinned and also the thinning age. If it is not possible to avoid thinning, the percentage of birds thinned must be the same in each house on trial and they must be thinned at the same age.

## Mortality

Mortality records should be kept daily, beginning at placement, and be recorded separately by house. Where possible, mortality should be recorded by sex, with actual numbers and percentages. Any euthanized broilers should be recorded separately from mortality and, if possible, the reason for euthanasia recorded. If higher than expected mortality occurs, it will be necessary to investigate possible causes.

## PROCESSING THE TRIAL

### Collecting Sample Birds for Processing

One of the most important aspects of conducting a successful trial is the correct sampling of the broilers for processing. Birds should be **chosen at random**, and enough birds should be sampled so that an adequate representation of the flock population is achieved. **The sample size should be at least 100 birds per house (50 males and 50 females)**. This sample size ensures that there are enough birds in the sample to account for mortalities, and still have good representation of the flock (**Table 2**). The greater the size of the sample taken, the closer to the “true” average the results will be. As with weighing, birds should be sampled from at least three evenly distributed locations throughout each house, with sample points away from doors and walls (**Figure 1**).

Before arriving at the farm, label coops or crates with identification that represents each house by sex and treatment combination. Ideally each house/sex/treatment combination will have a unique range of barcoded or numbered bands (bands may also be different colors for an extra level of identification). Each bird will be banded most commonly around one leg or in the wing (**Figure 2**). Record date, house number, flock identification, sex, breed, number of birds sampled, number of birds banded, time of loading at farm, time of arrival at the processing plant and number of dead on arrivals (DOAs).



**Table 2.** The effect of bird sample size on the ability to detect a statistically significant difference between treatments.

Statistical Difference	Number of Birds Sampled from a Treatment					
	10	20	100	200	500	1000
Difference in 2kg eviscerated yield (%)	4.5	3.2	1.4	1.0	0.6	0.4
Difference in 2kg breast meat yield (%)	1.8	1.3	0.6	0.4	0.3	0.2

**Figure 2.** Example of a band with a unique barcode and number used for sampling.



Options for sampling, banding and weighing live broilers are as follows:

- **Sampling Option 1:** Construct a single holding pen to hold all sample birds for all breeds involved in the trial. This can be achieved by stretching a net or plastic curtain across the end of the house and securing it with zip ties, rope or nails in a manner allowing birds access to feed and water. Move birds to be sampled into a catch pen. Band, sex (if appropriate) and weigh all the birds in the catch pen and record their weights to unique band numbers (**Table 3**); place birds in the holding pen. With this single holding pen, the catching crew will be able to easily load the entire sample into a single live transport cage which is clearly identified and allows for complete sample randomization.
- **Sampling Option 2:** This is similar to Option 1, except birds are loaded directly into a live transport crate rather than a holding pen. After catching, sexing (if appropriate), banding and weighing (weight recorded to band number), place birds into a single live transport crate. The live transport crate must be clearly identified in many locations with bright markings to ensure correct identification at the plant.
- **Sampling Option 3:** Identify and clearly mark one crate, module or set of crates, as coming from a particular house or pen. Transport the crate to the plant where the birds are sexed, banded by strain, and weighed (recorded to band number). This option provides the advantage of taking into account live weight changes during transport and holding. Once banded, birds should be mixed in a single crate. To ensure all sample birds have similar feed withdrawal times and are processed under similar conditions, all banded birds should be transferred together from a single crate to the processing belt.

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**Table 3.** Sample body weight recording chart. This should be used for each house/breed/sex combination. This example represents one house/breed/sex combination from a farm with 4 houses used for the trial (100 birds/house).

House	Breed	Sex	Bird #	Band #	Weight (g)	Bird #	Band #	Weight (g)	Bird #	Band #	Weight (g)	Bird #	Band #	Weight (g)
1	A	F	1	9851	1546	26	9876	1555	51	9901	1666	76	9926	1576
1	A	F	2	9852	1470	27	9877	1365	52	9902	1834	77	9927	1680
1	A	F	3	9853	1410	28	9878	1749	53	9903	1728	78	9928	1884
1	A	F	4	9854	1712	29	9879	1360	54	9904	2072	79	9929	1759
1	A	F	5	9855	1192	30	9880	1269	55	9905	2012	80	9930	1960
1	A	F	6	9856	1415	31	9881	1745	56	9906	1701	81	9931	1750
1	A	F	7	9857	1390	32	9882	1245	57	9907	1665	82	9932	1558
1	A	F	8	9858	1539	33	9883	1623	58	9908	1942	83	9933	1746
1	A	F	9	9859	1537	34	9884	1549	59	9909	1883	84	9934	2036
1	A	F	10	9860	1730	35	9885	1615	60	9910	1909	85	9935	1723
1	A	F	11	9861	1205	36	9886	1438	61	9911	1449	86	9936	1804
1	A	F	12	9862	1301	37	9887	1616	62	9912	1723	87	9937	1858
1	A	F	13	9863	1431	38	9888	1604	63	9913	1851	88	9938	1950
1	A	F	14	9864	1662	39	9889	1254	64	9914	1572	89	9939	1749
1	A	F	15	9865	1401	40	9890	1396	65	9915	1752	90	9940	1983
1	A	F	16	9866	1448	41	9891	1671	66	9916	1882	91	9941	1791
1	A	F	17	9867	1059	42	9892	1594	67	9917	1980	92	9942	1368
1	A	F	18	9868	1556	43	9893	1500	68	9918	1724	93	9943	1463
1	A	F	19	9869	1711	44	9894	1468	69	9919	1638	94	9944	1605
1	A	F	20	9870	1268	45	9895	1597	70	9920	1896	95	9945	1725
1	A	F	21	9871	1676	46	9896	1362	71	9921	1575	96	9946	1981
1	A	F	22	9872	1377	47	9897	1329	72	9922	1797	97	9947	1757
1	A	F	23	9873	1556	48	9898	1559	73	9923	1617	98	9948	1801
1	A	F	24	9874	1570	49	9899	1572	74	9924	1918	99	9949	2012
1	A	F	25	9875	1417	50	9900	1554	75	9925	1811	100	9950	1883

### Processing

Once broilers have been sampled they should be processed the same to obtain reliable yield results.

- The processing plant receiving the trial broilers should be notified beforehand with the exact protocol describing detailed processing instructions.
- All personnel working on the processing line should be aware that trial birds are being processed and that they should be processed as a group and kept separate and identified from other birds on the line.
- Inform the inspector that a trial is being processed and that birds have been banded for identification.
- Air chilling is recommended over water chilling as water chilling can result in variable water uptake between birds, by as much as 15%.
- When air chilling is used, trial birds should be removed from the evisceration line before entering the chiller to ensure that they are kept separate from other birds being processed.
- In plants that use water chilling, if possible use a chill room within the processing room to air chill the birds. If it is only possible to water chill, it is essential to weigh the carcasses before they are chilled and as soon as they are removed from the chiller to determine the amount of variability.
- After chilling, test carcasses should be collected in tubs or vats for further deboning and yield evaluation.

### Cutting / Deboning

The number of trained personnel needed for evaluation will vary according to the specifications in the protocol, but as a general rule, a group of 6 people (2 trained cutters/deboners, 1 assistant and 3 data recorders) using 3 sets of scales is needed to evaluate approximately 500 birds/shift. If it is not possible to fully process all trial birds in one day, it is recommended to send all birds through first processing on one day and debone all birds the next day. If data is missing or the carcass band number is incorrect, that bird and its measurements must be discarded from the trial.

During the evaluation, data collected should either be captured electronically with barcode readers (preferred method), or recorded on a data collection form similar to the one in **Table 4**. If data is to be recorded manually, special care will need to be taken so as not to introduce human error.

**Table 4.** Example of a yield data collection form.

Complex/Farm:					Date:				
Band #	Breast	Thigh	Drumstick	Eviscerated	Band #	Breast	Thigh	Drumstick	Eviscerated
9851					9867				
9852					9868				
9853					9869				
9854					9870				
9855					9871				
9856					9872				
9857					9873				
9858					9874				
9859					9875				
9860					9876				
9861					9877				
9862					9878				
9863					9879				
9864					9880				
9865					9881				
9866					9882				

## DATA COLLECTION

Data should be collected on an individual bird basis and weights for the whole carcass and the carcass components of major economical importance to the customer.

All carcass and component weights should be recorded in grams (most common) with accuracy to the nearest gram, and recorded back to the individual identification of the bird. Scales used for weighing should be calibrated annually by the manufacturer and checked with a test weight prior to each use.

Specific cuts should be reflective of the product mix of the company (**Figure 3**), and components of the individual bird can be calculated as a percentage of live weight. Whole carcass without giblets evaluations can either be done with the abdominal fat removed or with it left intact (whatever is standard for the customer) – as long as it is made clear in the protocol. For air chilling systems, carcass weights will be taken after the carcasses have exited the chilling system.

Cuts can vary dramatically between deboners and it is strongly recommended that each deboner be given an equal quantity of each treatment combination of birds in order to remove any possible bias.



**Figure 3.** Example of carcass cuts and weighing.



## Data Analysis

There are a number of ways to analyze trial data once it has been collected; however, it is important to remove any incorrect data or outliers before calculating the final statistics for each breed evaluated. Some things to consider are:

- Data from trials or houses with known issues (disease, incorrect feed, water line issues, etc.) should not be used for analysis.
- Values exceeding  $\pm 3$  standard deviations from the mean should be excluded from the data set; these are outliers. If the live weight exceeds the cut offs then the entire record should be removed, otherwise individual parts can be removed. Once any outliers have been removed, the mean, standard deviation and CV% should be recalculated for all data collected.
- FCR should be adjusted to a common weight either for each sex or straight run, depending on the desired result. For calculation and examples, see **Appendix 1**.
- Processing data should be entered into an Excel spreadsheet and referenced to wing band.
- Parts yield should be calculated as a percentage of live weight, with results of the mean, standard deviation and coefficient of variation (CV%) identified (**Table 5**).

**Table 5.** Carcass parts represented as a percentage of live weight.

House	Breed	Sex	Wing Band	Live Wt.	Whole Carcass without Giblets (%)	Fat (%)	Thigh (%)	Drum (%)	Wing (%)	Tender (%)	Fillet (%)	Total White Meat(%)
1	A	F	9851	1546	68.24	1.23	12.16	9.19	8.67	3.88	14.55	19.60
1	A	F	9852	1470	70.95	1.84	12.72	10.07	9.05	3.47	13.95	18.44
1	A	F	9853	1410	70.21	1.21	12.91	9.65	7.94	3.83	14.61	19.86
1	A	F	9854	1712	68.87	2.45	11.92	9.52	8.47	3.39	14.66	19.10
1	A	F	9855	1192	67.95	1.34	11.83	9.73	8.81	3.52	12.84	17.87
1	A	F	9856	1415	69.19	2.05	11.94	10.18	8.62	3.68	14.06	18.94
1	A	F	9857	1390	69.64	1.44	12.59	9.42	8.20	4.10	15.11	20.72
1	A	F	9858	1539	67.25	2.34	11.83	9.10	7.99	3.51	13.97	18.58
1	A	F	9859	1537	70.59	2.08	14.38	9.43	8.26	4.49	14.77	20.43
1	A	F	9860	1730	68.44	1.39	12.37	9.83	8.61	3.53	13.99	18.50
1	A	F	9861	1205	68.80	1.99	11.54	9.96	8.30	3.82	14.11	19.17
1	A	F	9862	1301	68.56	1.85	13.45	9.15	8.46	3.84	12.76	17.37
1	A	F	9863	1431	68.20	0.77	13.49	10.06	9.02	3.42	13.28	17.26
1	A	F	9864	1662	69.86	1.99	13.42	8.97	8.00	4.69	14.14	19.56
1	A	F	9865	1401	70.38	1.93	13.28	9.57	7.92	3.71	14.28	19.42

Rounding numbers can have an impact on results; live weights should be reported to the nearest gram, and carcass yield should be reported to at least 2 decimal places. The deviation due to rounding error can create differences when analyzing the data further.

## CONCLUSIONS

A well-planned and executed commercial trial can provide valuable economic information, as well as assist the company in making important economic decisions. Some important points to remember are:

- Handle and test all birds in a similar way to avoid introducing bias to either sex or breed.
- Pay attention to detail throughout the trial.
- Communication between all parties involved is essential to the success of the trial and the reliability of the results.
- Random sampling, sufficient sample size and consistent testing procedures will help to ensure reliable data.
- Correct data collection and analysis procedures will allow direct comparisons of different breeds.

## APPENDIX 1

### Feed Conversion Ratio (FCR)

$$\text{FCR} = \frac{\text{Total Feed Consumed}}{\text{Total Live Weight}}$$

e.g. A sample of 10 birds has a total live weight of 29480g and they have consumed a total feed amount of 45807 g. The average feed conversion for this sample set would be calculated as follows:

$$\text{FCR} = \frac{45807}{29480}$$

**= 1.554**

### Adjusted Feed Conversion Ratio (Adjusted FCR)

$$\text{Adjusted FCR} = \text{Actual FCR} + \frac{\text{Target Body Weight} - \text{Actual Body Weight}}{\text{Factor}}$$

Depending on the units of measurement used, the factor in the above equation will change. For AH, a factor of 4500g should be used, depending on the unit of measurement. This equation provides a good estimation of adjusted FCR for broiler performance comparison. However, it is important to note that adjusting FCR to target weights beyond +/- 227 g of the actual weight can distort the comparison.

**e.g (Unit is in g)**

$$\text{Adjusted FCR} = \text{Actual FCR} + \frac{\text{Target Body Weight} - \text{Actual Body Weight}}{4500 \text{ g}}$$

$$\text{Adjusted FCR} = 1.215 + \frac{1350 \text{ g} - 1290 \text{ g}}{4500 \text{ g}}$$

$$= 1.215 + (60 \text{ g}/4500 \text{ g})$$

$$= 1.215 + 0.013$$

**= 1.228 Adjusted FCR**

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