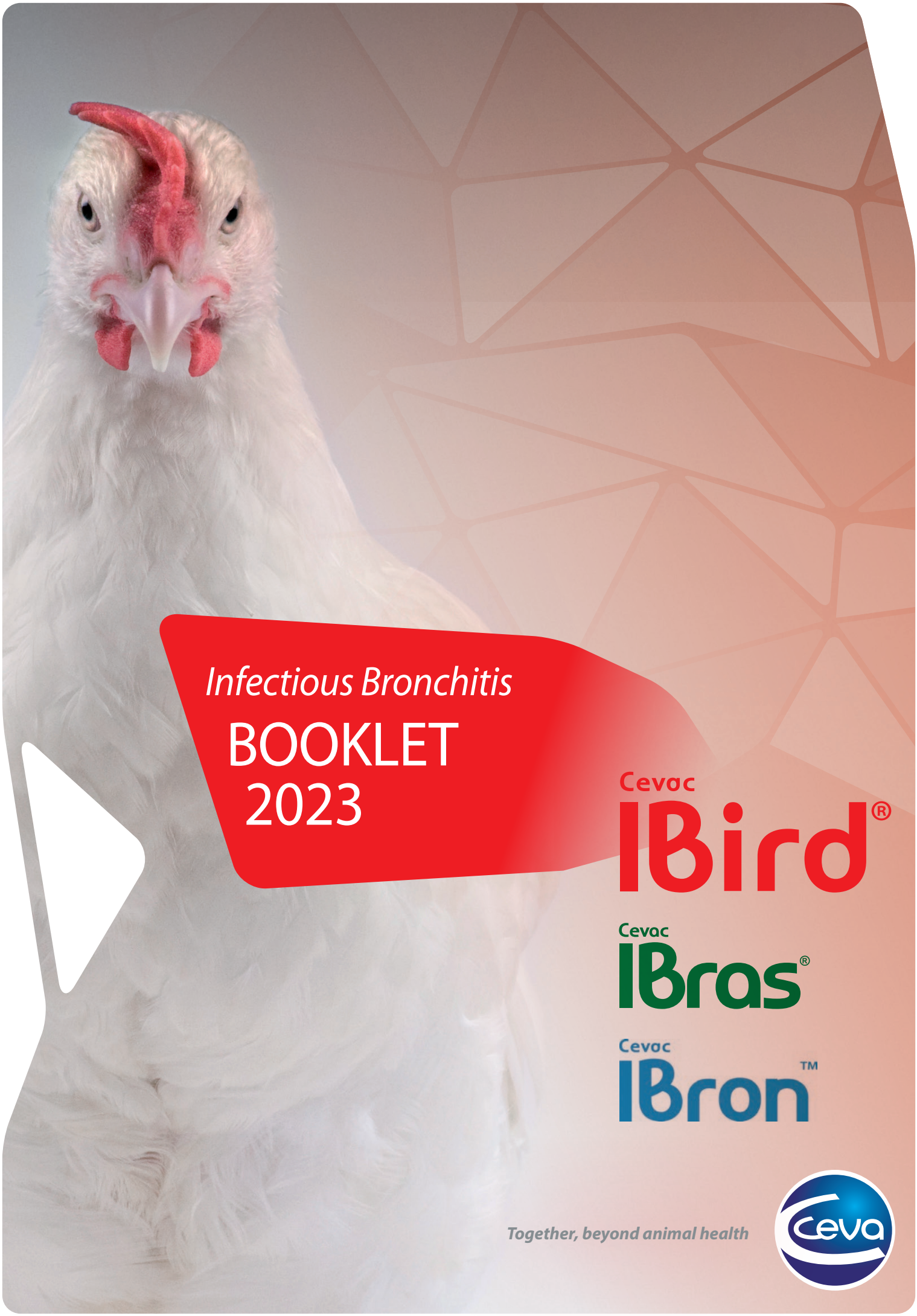


Infectious Bronchitis

BOOKLET 2023

Cevac IBird®

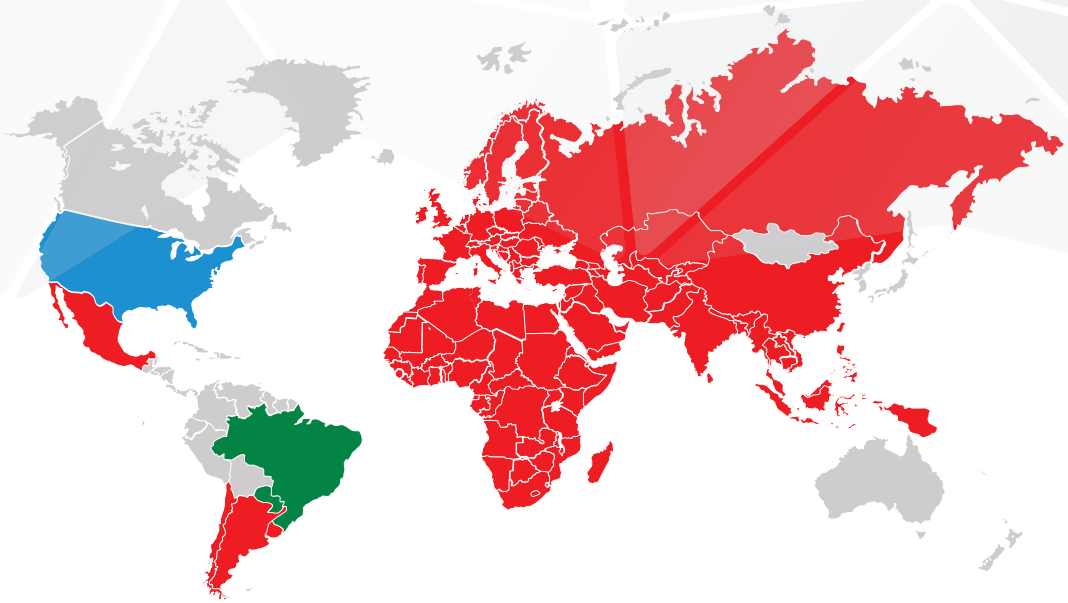
Cevac IBras®

Cevac IBron™

Together, beyond animal health

ceva

CEVA GLOBAL REFERENCE IN INFECTIOUS BRONCHITIS CONTROL

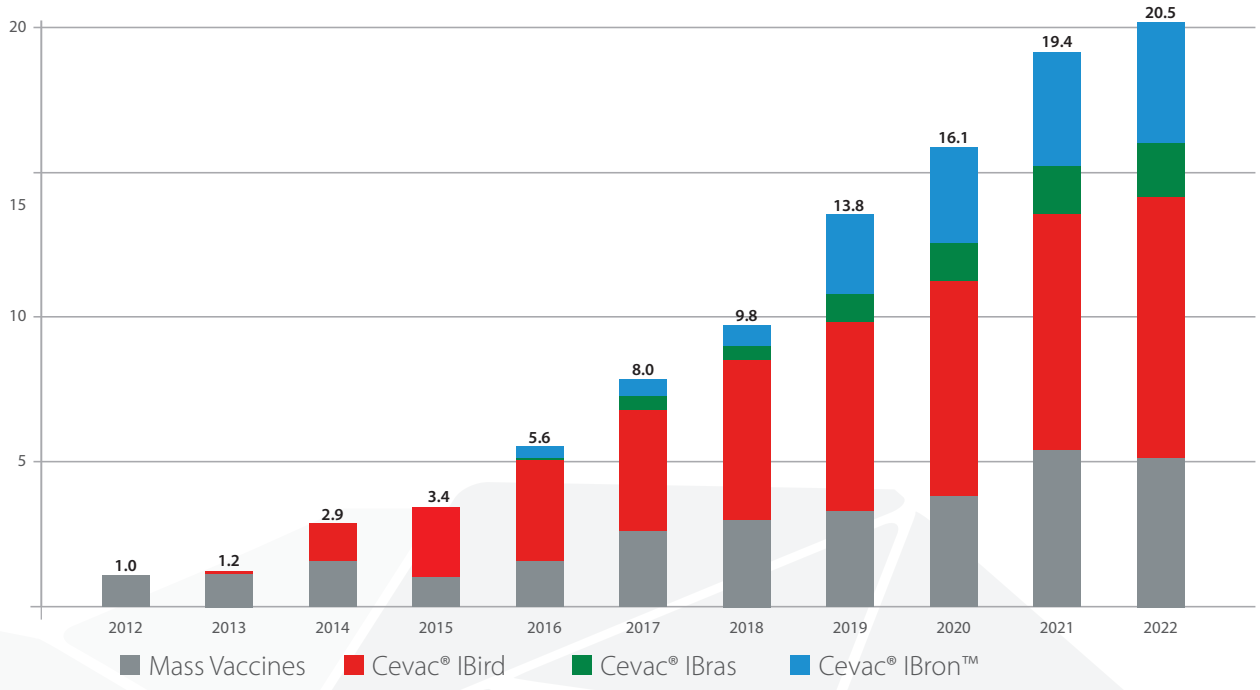


Cevac® IBird®

Cevac® IBron™

Cevac® IBras®

Billion doses of IB CEVA Vaccines applied every year



FOREWORD

Ceva Santé Animale in the last 10 years has contributed to the control of Infectious Bronchitis (IB)disease, thanks to the expertise of our teams, and with IB vaccine range developed to the poultry industry, as Cevac® IBird, Cevac® IBron™, Cevac® IBras, Cevac® MassL, Cevac® Bron120L.

Over 20 billion doses of Ceva IB vaccines were applied in 2022, bringing a large expertise and knowledge, and Ceva becomes the Global Infectious Bronchitis reference.

In this book you will find a technical-economical updated, containing all the concept required to understand the IB control, and several experiences.

To understand the current IBV challenge, a constant epidemiology survey is conducted by independent researchers and Ceva Santé Animale Vet Specialists around the world.

The benefits of the IB control was demonstrated in real world evidences performed in different countries worldwide where Ceva Santé Animale is present, representing: South & Central & North America, Europe, Middle East, Africa and Asia.

Each of the experiences shown includes an economic calculation, based on a specific and updated scale, which suggests the value of using IB Ceva vaccines.

Ceva Santé Animale is committed to sharing information and updated scientific data with partners and customers.

Enjoy your reading.

Please contact us should you require further information or explanation.

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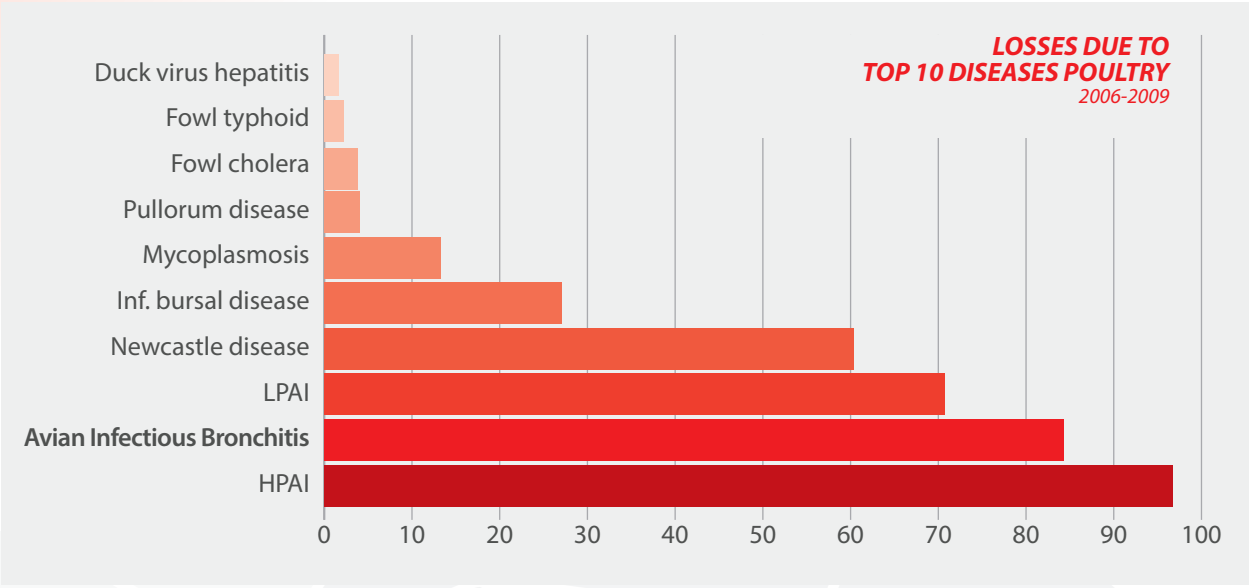
33500 Libourne
France

TABLE OF CONTENTS

1 What is Infectious Bronchitis?

Avian Infectious Bronchitis (IB) is probably one of the most widespread poultry diseases around the world, given its highly contagious nature. It is caused by a gamma coronavirus that affects the respiratory, urinary and reproductive systems of the chickens causing different disorders depending on the tissue tropism characteristics of the invading viral strain.

The induced losses are very costly, because of uneven growth, respiratory distress, high morbidity, secondary opportunistic respiratory infections (*E.coli*, avian metapneumovirus, H9N2 low pathogenic avian influenza virus, etc.) and related medication, egg drops, and/or kidney damage. According to the World Bank[1], it is ranked as the 2nd most costly poultry disease, after highly pathogenic avian influenza.



1 World Livestock Disease Atlas - A Quantitative Analysis of Global Animal Health Data (2006-2009). The World Bank, November, 2011. LSU: Livestock Unit.

1A

Infectious Bronchitis virus and strain classification

Marcelo Paniago, Vilmos Palya, Christophe Cazaban, Jessica Lee, Pascal Paulet and Yannick Gardin.

IBV belongs to the family Coronaviridae. It is an enveloped virus which contains club-shaped surface spikes that give to it a crown-like appearance and hence the name corona (Latin word that means crown).

It is well known that IBV is prone to mutation and recombination events. Actually, mutation rate is a reference to the intensity of nucleotide change appears in the population. The absence of a proof-reading mechanism in virus replication is one of the predisposing and determining factors of the IBV observed mutation rate of about 10^{-3}, which is similar to the influenza virus mutation (Caron, 2010).

In other words, a mutation rate of about 10^{-3} means that, from every thousand virus resulted during a replication cycle, one is different.

McKinley (2009), examining molecular changes to determine how rapidly IBV evolves and if recombination occurs, found that the viruses were evolving at evolutionary rates that ranged from 10^{-2} to 10^{-6} substitutions/site/year. As a consequence, whether as the result of mutations, recombination or both, new IBV variants continue to emerge, making its control very challenging.

Both for epidemiological investigation and vaccine efficacy assessment, classification of field isolates is necessary. Serotyping or genotyping are the two most common ways to classify the virus. The first involves cross-neutralization test and the latter the analysis of the S1 protein sequence.

For antigen type determination, there is no doubt the serotyping would be reference method and it can be done by virus-neutralization or haemagglutination inhibition (in this case, the virus needs to be treated with neuraminidase to acquire HA activity). However, these techniques are very labour intensive and require an extensive bank of antisera and known IB strains.

Consequently, serotyping has progressively been substituted by genotyping. Among the advantages of this method, it is very quick to be done and it detects a wide variety of IBV types which makes this molecular technique very suitable for epidemiological studies.

In general, there is a reasonable chance of a good level of cross-protection between strains with a high level of genetic homology. **In short, although not being an unaltered rule, strains of the virus that have greater than 90% amino acid similarity in the S1 gene, usually are serologically related.**

1B Economic impact of a poor control of Infectious Bronchitis

It is well acknowledged that, in breeders and in layers, Infectious Bronchitis virus (IBV) can cause reduction in the quantity and quality of the eggs and an increase of the mortality rate. In addition, in breeders, IBV can decrease the fertility (both males and females) leading to drop of the hatchability.

In broilers, this virus reduces the daily weight gain, increases the feed conversion rate (FCR) and induces mortality and secondary infections that lead to rise of the use of antibiotics. Finally, at processing plants, it increases the condemnation rates and reduces the efficiency of the process.

With this effect on chickens' performance, it comes as no surprise that this disease has a huge economic impact on the profitability of the companies. Additionally, IBV is able to spread throughout large areas within a considerably short time period. The spread of 793B variant strain in the 90's and the QX-like strains during 2000's in Europe and, more recently, the detection of variant-2 IBV strains in Middle East and North Africa illustrate this feature.

Finally, the constant pressure from consumers to reduce the residues of antimicrobials in chicken meat and eggs has increased the need for proper prevention of infectious agents, including IBV. However, this is not a simple task as the virus is prone to mutations and, very frequently, different variant antigenic types are present in the same region.

Field Case: Evaluation of the economical impact of IB virus on poultry industry

Chacon J. *et al.*, 2018. Subclinical losses caused by infectious bronchitis virus in broiler chicken flocks. American Association of Avian Pathologists (AAAP) meeting, Denver, CO, July 13-17.

MATERIAL & METHODS

Healthy broilers were monitored for the presence of IBV by serology (ELISA Idexx) and molecular analysis (RT-PCR) at processing age (around 42 days of age).

They represented a total of 109 flocks belonging to six Brazilian producing companies in the Southern States (three of them belong to the top 10 in Brazil).

Altogether, these 6 companies are producing 49.5 million chickens per month. Companies 1 to 5 used one Mass type vaccine at day-old, whereas company no.6 did not vaccinate at all against IB.

In addition, production performances were recorded.

RESULTS

Although they were apparently healthy, 72% of the flocks showed abnormally high late serological titers and/or molecular detection of IBV. A variant strain was identified to which Mass only provided poor protection.

The production performances could be recorded from companies 2 to 6, representing more than 4.3 million broilers. A comparison was done between IBV-infected and IBV-free flocks per company. The figures are reported in the tables below.

The impact of a poor control of a variant IBV on performances and economic return on investment could be summarized as follows:

	Company 2		Company 3		Company 4		Company 5		Company 6		Mean	
	IBV pos	IBV neg	IBV pos	IBV neg	IBV pos	IBV neg	IBV pos	IBV neg	IBV pos	IBV neg	IBV pos	IBV neg
FCR (adj. 2.7 kg)	1.668	1.638	1.806	1.795	1.678	1.576	1.846	1.750	1.763	1.694	1.752	1.691
Late mortality (>35d) (%)	1.38	1.12	0.64	0.21	1.71	0.64	2.93	1.12	2.21	1.82	1.77	0.98
ADG (g/d)	65.0	68.9	58.9	61.8	70.3	73.1	59.2	58.9	59.4	63.1	62.6	65.2
PI	351.6	374.1	316.8	309.7	387.3	414.7	303.3	339.0	311.0	337.7	334.0	355.0
Airsacculitis (%)	1.04	0.90	0.56	0.28	1.91	0.63	na	na	na	na	1.17	0.60

na: data not available

Impact of variant IBV on:	Performance loss	Economic impact (Euros/1,000 chickens)
FCR	+0.06	36
Late mortality (>35 d) (%)	+0.79	13
Final body weight (ADGx42)(g)	-109	35
Airsacculitis condemnations (%)	+0.57	12*

**Chacon J., pers. comm.*

Values used to evaluate the economic return: BW: 2kg, FCR: 1.6, Feed Price: 0.3€/kg, Live Bird Price: 0.8 €/kg

CONCLUSION

The financial impact of a poor control of variant IBV infection in more than 4 million commercial broilers was calculated to be worth 96€/1,000 chickens.

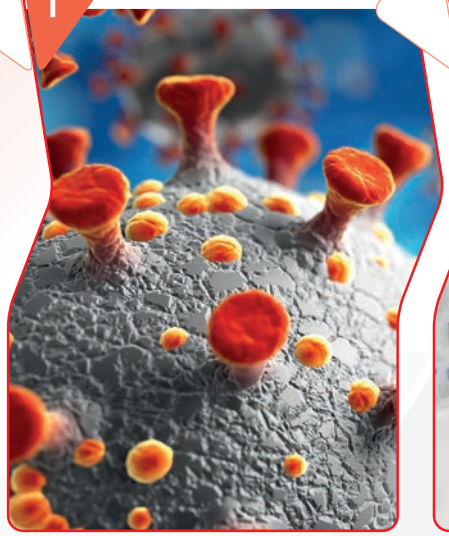
2 IBV survey and global situation

Ceva has been continuously performing diagnostic detections either in local, regional or reference institutes since 2020, demonstrating that IBV is in continuous evolution due to its tendency to evolve genetically overtime, either caused by mutations, recombination events or both. The detection rates vary depending on the geographical location, this being influenced majorly by migratory routes, trade and vaccine usage (Franzo, 2018).

The preparation behind these surveys requires an intensive investment in human resources and manpower and, on top of that, a very thorough organization.

CEVA WORKS AT 3 DIFFERENT LEVELS FOR DISEASE AND VACCINE INVESTIGATIONS:

1 Disease awareness
(epidemiological surveys in the field)

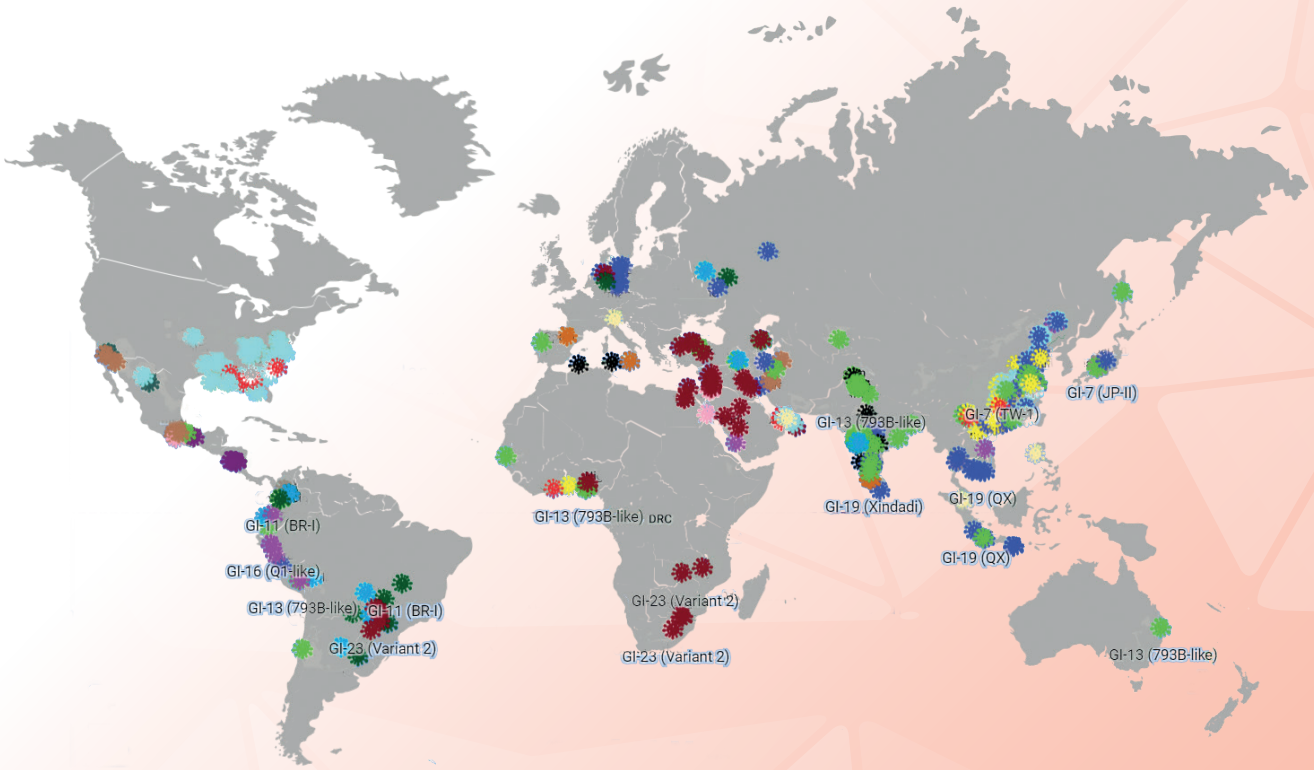


2 Vaccine detection & monitoring

3 Troubleshooting

In the field of disease awareness, it is important to remark that despite the availability of homologous vaccines in the market for several years (Variant-2, QX vaccines, etc.) wild-origin IBV variant populations remain present in the field (Legnardi, 2022), demonstrating that a homologous approach will not be effective enough.

The findings of the global IBV epidemiological survey run by Ceva and other researchers until 2022, are illustrated in the map below:



- GI-23 (Variant 2)
- GI-13 (793B-like)
- GI-19 (QX)
- GI-7 (TW-1)
- GI-1 (Mass)
- GI-9 (Ark99)
- GI-19 (Xindadi)
- GVI-1 (TC07-2)
- GI-11 (BR-I)
- GI-16 (Q1-like)
- GI-21(Italy02)
- GI-22 (HN-08)
- GI-24 (Indian variant)
- GI-28 (LDT3)
- D6754/5/22OM Variant
- D6782/1/22AE Variant
- GI-18 (JP-I)
- GI-19 (JP-III)
- GI-19 (LX4)
- GI-23 (IS/885)
- Other Variants

3 IB monitoring procedures

In order to monitor IB vaccines correctly, certain rules and standards need to be respected. There is a major difference between monitoring a vaccine and monitoring the epidemiological situation in the field. The previous section displayed epidemiological investigations; however, vaccine and immune response detection requires a rather different approach, especially in terms of sample numbers and collection technique.

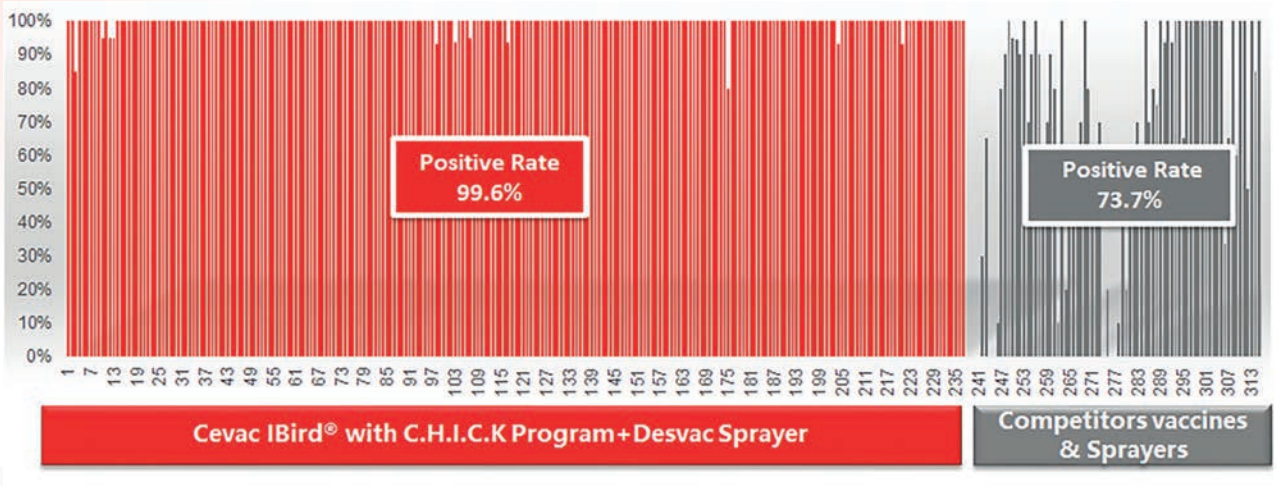
The Ceva experience throughout years are in favour of IBV vaccination at day of age in the hatchery combining Cevac® IBird and Mass-L.

In any case, there are 3 different levels to monitor in the hatchery and at farm level:

- **Proper vaccine preparation and application in the hatchery**
  (See Chapter 9 - Vaccination procedures, page 34);
- **Vaccine detection**
- **Detection of the appropriate immune response**

Vaccine detection

The first step to monitor a correct vaccination is to demonstrate that the vaccine used is replicating in the population. This evaluation consists of early nucleic acid detection of the vaccine strain in vaccinated birds (before it starts spreading within the flock) via RT-PCR. The equipment used and the preparation of the vaccine help ensure the replication of the virus in the birds to the desired level.



Comparison of the % of vaccine detection between Cevac® IBird + Mass-L and a competitor vaccine

How and when should the sampling for vaccine detection be performed?

You can use either mini-tipped swabs (small head size) for chicks, or normal sized swabs for larger birds. If the swabs are sent directly to the laboratory for just RT-PCR, it is recommended to send them as dry swabs (no medium/liquid added). If the swabs are intended for vaccine detection and virus isolation, they should be sent to the laboratory in a transfer medium, cool or frozen, avoiding several freezing-melting cycles. The swab heads should be aseptically cut into properly labelled safe-capped 2ml tubes.

Swab smears on FTA cards are accepted (n= 4 smears per FTA card per flock). Smears on FTA cards are easier to deliver to the lab, however the sensitivity of the detection is slightly lower.

VACCINATION	AGE	SAMPLE TECHNIQUE AND ORGAN	SAMPLE SIZE
Hatchery with Desvac® in Line Duo (via spray)	5 days of age (4-6 days is acceptable)	Choanal swabs [1]	n≥15 birds [2]

[1]Choanal swabs are the recommended sampling method, since it is as sensitive as tracheal sampling and respects animal welfare.

[2]For vaccine detection, DO NOT POOL the samples (neither at sampling, nor at testing), since vaccination assessment refers to a percentage of positive samples.

>70% positive RT-PCR detection of the 1/96 or M41 strains is expected

IF THE POSITIVITY RATE IS <70%:

1. **Check all the vaccination procedures**, from vaccine delivery/storage/thawing to vaccine administration
2. **Compare with any other available data** set for other vaccination protocols
3. **Repeat the samplings** when all the critical points have been double checked and corrected

Detection of the appropriate immune response:

After hatchery vaccination, and to double check if the birds have developed an adequate immune response, sera can be collected. Sampling chickens of good health is important, otherwise results can be misleading. The number of blood samples taken from a flock has a direct impact on the reliability of the results. The fewer the number of samples collected, the higher the risk of calculating an inaccurate mean flock titre.

What is the adequate sampling size?

23-24 sera are the minimum 'recommended' number to be collected for a meaningful appraisal of flock immunity or for vaccination date prediction. Minimum 'acceptable' sample size is 18 samples/flock (using 18 samples/flock allows sera from 5 flocks to be tested on each Elisa plate with no wasted wells). Once baselines are established, 15 samples can show trends, by detecting the most common titer groups, but this number is insufficient for quantitative analysis.

COLLECTION SITE	AGE	SAMPLE TECHNIQUE AND ORGAN	SAMPLE SIZE
Farm or Slaughterhouse	End of grow-out period or at slaughter	Blood: • Wing vein bleeding or wing vein puncture • Drops falling from the jugular veins into the tubes	n≥23-24 birds*

**** NOTE: Collect more serum samples than you plan to test. This allows lab technicians to use only the best quality serum samples for testing.***

100% ELISA positivity is expected

WHAT IF MY TITERS ARE NEGATIVE OR TOO HIGH FOR MY BASELINE?

Either no vaccination was performed, or challenge occurred:

1. **Check all the vaccination procedures**, from vaccine delivery/storage/thawing to vaccine administration
2. **Compare with any other available data** set for other vaccination protocols
3. **Repeat the samplings** when all the critical points have been double checked and corrected

In Ceva, we have drafted practical guidelines which migh help you interprete the titer levels obtained from the flocks that you are monitoring. Please be aware that you always need to adapt this titers to the epidemiological situation in your country or region, always depending on the density of farms, perceived challenge and presence of field virus.

GUIDELINES TO HELP YOU INTERPRETE ELISA KIT RESULTS WHEN USING CEVAC® IBIRD + MASS L

VACCINATION PROGRAM	LIMITS	BIOCHEK	IDEXX	ID VET
D1: Cevac® IBird + Mass L	Expected	2000-4000	>1500	3000-5000
D1: Cevac® IBird + Mass L	Field challenge	>3000(GMT) >4500(20%Ind)	>2500	>5000(GMT) >5000(Ind)

Minimal age 30 days old. Optimum 35-45 days old

A FIELD STUDY WAS OPERATED IN FRANCE BETWEEN JANUARY 2020 AND APRIL 2021:

- **133 flocks**
- Average slaughter age: **42 days**
- Vaccination program: **Cevac® IBird + Cevac® Mass L at Day 1**
- Sampling technique: **ELISA Biochek**

> 4500 **< 4500**

A flock is considered challenged when >20% of the birds in a flock show titers >4500

1 square = 1 flock; 1 bar = 1 or + serum (y axis)
Scale of the x axis is 500 units (0-500, then 500-1000…)

CONCLUSION

The serology monitoring can be used to understand the challenges in the field, and the immune response from the birds.

4

Infectious Bronchitis diagnosis

Legnardi M.[1], **Cecchinato M.**[1]
[1]*Department of Animal Medicine, Production and Health (MAPS), University of Padua, Viale dell'Università 16, 35020 Legnaro (PD), Italy*

Importance of a proper choice of test and of a correct interpretation of laboratory results

Infectious bronchitis virus (IBV) is a highly contagious, wide-spread pathogen that is responsible for severe economic losses for the poultry sector. Its control, mainly achieved by combining adequate biosecurity measures and vaccination, is frustrated by its high genetic variability, that elicits the continuous emergence of new pathogenic variants.

Since different IBV genetic variants could cause diverse symptoms and could require different vaccines, a continuous and attentive epidemiologic monitoring is crucial to know which variants are circulating within the area of interest.

Diagnostic means to identify an IBV infection should therefore be quick, robust... and possibly cheap

How to choose the most appropriated test for a correct interpretation of the laboratory results

Since clinical signs induced by IBV are not pathognomonic, laboratory tests are required to confirm an IBV infection. Several diagnostic methods are available, including viral isolation, serology and biomolecular assays. To properly choose which approach to use, **the purpose of the diagnostic should be taken into account**.

Viral isolation

Viral isolation is performed by inoculating a suspension of a field sample on SPF chicken embryonated eggs; eggs are incubated and after several passages, if the virus is present, it is possible to observe lesions caused by IBV on the embryos. IBV may also be successfully cultivated on chicken tracheal organ cultures (TOCs).

Different organs may be sampled, depending on which symptoms are predominant, and samples should be carefully stored at 0-4 °C and rapidly sent to the lab to preserve virus viability. Today, viral isolation is not routinely performed for diagnostic purposes because it is lengthy, laborious and has stringent requirements, but is still used for virus propagation.

Serologic tests

Serologic tests, such as enzyme-linked immunosorbent assay (ELISA) and haemagglutination inhibition (HI), enable the detection and the titration of IBV-specific antibodies, providing information about infections or on response to vaccination: practically, average antibody titers are interpreted as a normal response to vaccination, while lower seroconversion levels suggest that vaccination has not been properly done and higher titers are correlated to field virus exposure.

An example is shown in figure 1, which illustrates the results of ELISA tests conducted in several flocks vaccinated at hatchery with a combination of Cevac® Mass L and Cevac® IBird vaccines in France.

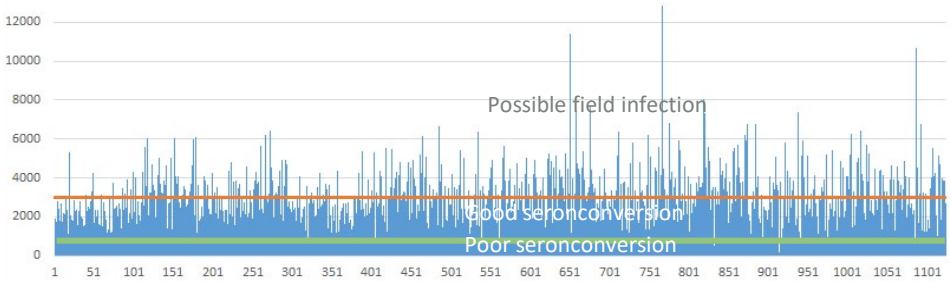


Figure 1:
Results of commercial ELISA tests conducted in flocks vaccinated at hatchery with a combination of Mass and Cevac® IBird vaccines (image courtesy of Paulet P.).

ELISA assays do not allow differentiation between antibody responses to different serotypes, while it is possible using HI. However, the reliability of HI serotyping may be affected by the possible co-presence of multiple field and vaccine strains, which could result in cross-reacting antibody responses. Moreover, the possible presence of maternally derived antibodies (MDAs) in young chicks further complicates the evaluation of vaccine intake.

Biomolecular techniques

Biomolecular techniques (mainly PCR-based), which allow IBV detection by evidencing the presence of viral RNA, are the most commonly used tests nowadays, either to confirm an IBV infection or to assess the administration of vaccines and indirectly their efficacy. One of the major features of PCR is the possibility to determine to which genotype a certain strain belongs to, a crucial information to plan an effective vaccination protocol. On the other hand, a PCR positivity doesn't necessarily mean that the virus is viable and an infection is occurring at the moment of sampling, so the interpretation of the results should be done carefully.

PCR ASSAYS: very effective means of IBV diagnosis, provided you make the right choice of sample processing methods

Several possible appoaches to consider for a proper interpretation of the results

Tests may be generic, targeting a genomic region that is common to all IBV genotype, or they may be specific for a certain genotype.

Since live attenuated vaccines are largely adopted in the field and can be detected by PCR for a long period after administration, the vast majority of samples usually proves positive to generic assays, whose usefulness (even for screening purposes) is therefore limited. Using a panel of specific assays gives more useful information about the genotypes that are searched for, but on the other hand it means that the unsearched strains won't be detected.

Another distinction is that some tests rely on classical RT-PCR, while others are based on real-time RT-PCR. Classical RT-PCR can be followed by sequencing, which allows gaining more precise information on the genome of the detected strains, while real-time methods provide data on the quantity of viral RNA that is present in the sample but do not consent sequencing. A generic RT-PCR followed by sequencing allows the detection and the characterization of virtually any IBV strain.

Unfortunately, co-presence of different genotypes (both field and vaccine strains) is quite common: in this case, only one strain (usually the predominant one or the one that has more affinity with the primers) would be sequenced with such an approach.

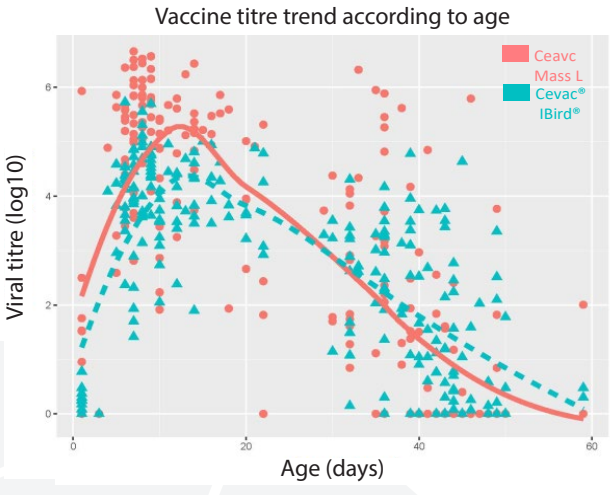
In general, when multiple strains are present and different tests are requested to different laboratories, the results may differ. In these occasions, which are not unusual, the choice of assay should be considered to properly interpret the results.

PCR assays enable the distinction between field and vaccine strains based on genetic differences: aside from indirect evidence (i.e. detection of a strain belonging to a certain genotype in a population that has not been vaccinated with a homologous vaccine), differentiation is based on phylogenetic analyses or detection of genetic markers that are found in vaccine strains compared to their progenitors.

Longitudinal studies to precisely assess vaccine kinetics

Another possibility offered by PCR is to perform longitudinal studies to precisely assess vaccines kinetics along the production cycle: knowing at what age the vaccine titers peak (normally at about 7-10 days post vaccination) and when they start to decline could prove really useful to evaluate the vaccine application procedures. For example, a recently published work by Tucciarone *et al.* reported the kinetics of Cevac® IBird and Mass vaccines when applied together at 1 day of age. Since a vaccine replication implemented in different combinations could show different kinetics it is important to evaluate all curves for all different protocols.

A longitudinal study approach, which requires a dense schedule of samplings, may also allow to determine the moment when field viruses appear in the flock, helping to identify possible weaknesses in biosecurity.



Mass and 1/96 vaccine titers relative to animal age. The two vaccines were administered together at 1 day of age. Dots and triangles represent the results of single samples, while the continuous lines depict the overall trends (Tucciarone et al., 2018, slightly modified).

PCR assays: the value of the results is closely linked to the quality and choice of samples

Suitable samples for PCR testing may be collected at oropharyngeal, tracheal, renal or cloacal level. Oropharyngeal and tracheal samples are recommended to detect field strains when an infection is suspected and to assess the vaccine take from 5 to 7 days after vaccination. Cloacal samples are preferred to detect some vaccine strains, which seem to replicate and persist for a long time in the caecal tonsils; however, the shedding at this level may be intermittent. Kidney samples are useful to detect the presence of nephrotropic strains, but they should be collected only when renal lesions are observed. The strains detected in different districts sampled at the same time may differ, since every genotype has distinct features in terms of organ tropism. Therefore, sampling and analyzing different sites is not redundant, in fact it should be done to gather as much information as possible.

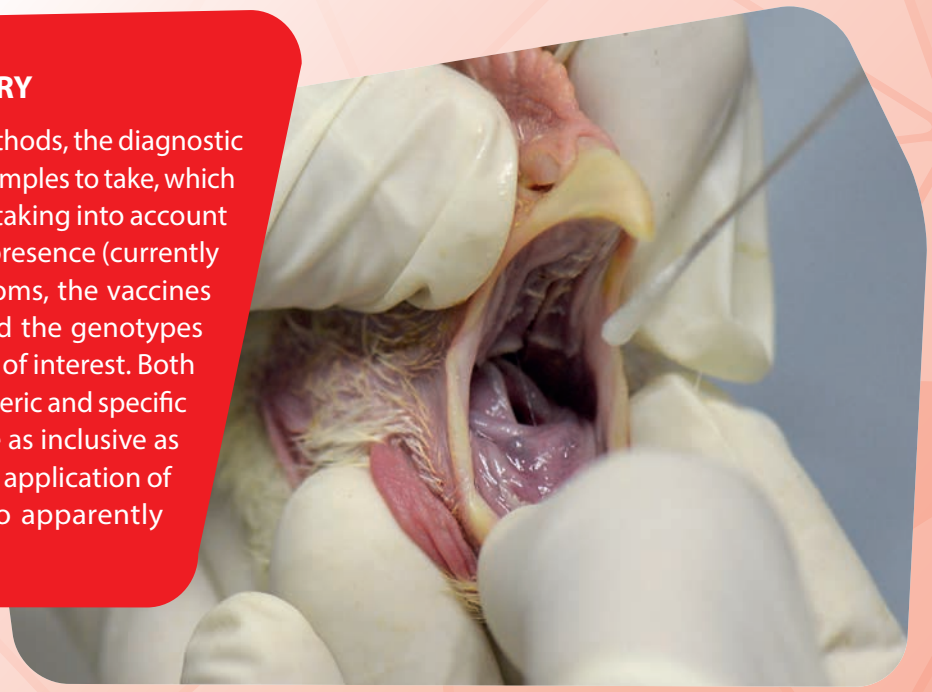
Samples are usually collected by swabbing, since the procedure is quite easy and dried swabs to use for molecular diagnosis may be stored for several weeks without being refrigerated. FTA cards are also very practical: they can be stored for several months at room temperature and sent by regular mail; however, their use may lead to a moderate loss in sensitivity. Another option is to collect organs from dead birds, but conservation and shipment are obviously more problematic.

Samples may be processed individually or they may be pooled: single samples are indicated to study vaccine coverage within a group of animals, while pooled samples are a cheaper, more used way to draw conclusions on the entire flock, usually to assess the presence of field viruses or the vaccine take. Ten swabs are commonly considered representative enough of the flock situation. Both healthy and symptomatic animals may be sampled.

For a better interpretation of the results, it would be ideal to share with the lab as much data as possible regarding the sampled animals (i.e. age at sampling, presence of symptoms, vaccination protocol, farm location).

IN SUMMARY

When relying on biomolecular methods, the diagnostic approach (which and how much samples to take, which assays to use) should be decided taking into account the age of animals, the possible presence (currently or in the past) of clinical symptoms, the vaccines that are being administered and the genotypes that are circulating in the region of interest. Both RT-PCR and real time RT-PCR, generic and specific tests should be combined to be as inclusive as possible, remembering that the application of different assays could lead to apparently contrasting results.



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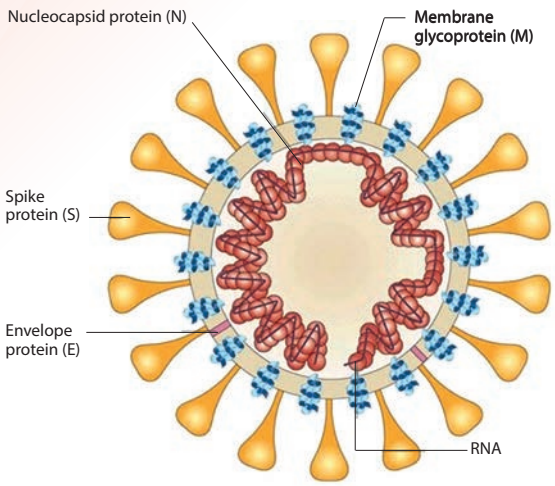
5 Cross-protection for IB virus

Dr. Mark W. Jackwood

J. R. Glisson Professor of Avian Medicine and Head of the Department of Population Health in the College of Veterinary Medicine, at the Poultry Diagnostic and Research Center, University of Georgia, Athens GA.

Avian infectious bronchitis virus (IBV) is a coronavirus that contains a single stranded positive sense RNA genome approximately 29 Kb in length. The genome is encased in a lipid envelope with glycoprotein spikes on the surface of the virus particle. Other structural proteins that make up the virus are the integral membrane glycoprotein, the envelope glycoprotein and the internal nucleocapsid protein that surrounds and protects the viral RNA genome.

It is the spike glycoprotein that induces the production of neutralizing antibodies against the virus. And since the spike glycoproteins are different for different types of the virus, the neutralizing antibodies induced by one virus type do not cross-react with other virus types.



However scientific experiments show that cross-reactions can occur even to the level where some protection can be realized

Various factors may induce cross-protection

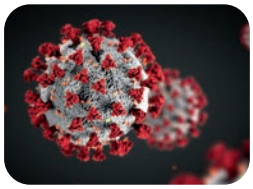
Although no one really knows the mechanism behind cross reactivity among IBV types, there is evidence in the literature that supports several theories.

Cross-protection and basic immune response

The simplest explanation involves an immune response against structural proteins that are similar among all IBV types, which include the membrane, envelope and nucleocapsid proteins as well as some conserved regions on the spike glycoprotein.

Another possible explanation involves the type of immune response elucidated in the bird wherein the cell meaded immune response has been shown to be cross-reactive between IBV types.

Since T-cells (specifically cytotoxic T-cells) react with viral protein fragments expressed in conjunction with surface proteins (MHC-class I) on the infected cell, they can contribute to the elimination of the virus during the acute phase of the infection.



Cross-protection and IBV vaccination

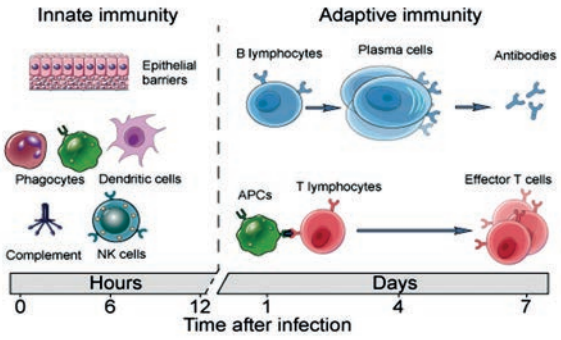
The simplest explanation involves an immune response against structural proteins that are similar among all IBV types, which include the membrane, envelope and nucleocapsid proteins as well as some conserved regions on the spike glycoprotein.

Engineering IBV vaccines that induce a strong T-cell response will likely result in better cross-reactivity and increased protection.

In addition, the genetic makeup of the chicken, referred to as theB-haplotype, can determine the strength of the immune response against IBV. Chickens with certain B-haplotypes will develop a more robust immune reaction that can result in better cross-protection.

Cross-protection and innate immune response

The innate immune response may also play a role in cross-protection. The innate immune response is the first response to any infection, and it is involved in direction of the B-cell (antibodies) and T-cell (cell mediated) adaptive immune responses. Although immunologists are still working to fully understand the innate immune response, it does provide a variety of effectors that can rapidly clear the virus regardless of IBV type. However, this first line of defense is often short lived and ultimately protection must come from the adaptive immune responses.



Cross-protection and antigenicity

Finally, the antigenicity and the level of attenuation or virulence of the vaccine strain can affect the strength of the immune response leading to a more cross-reactivity.

This is why 2 or more types of IBV are often included in the same vaccine. The increased variety of antigens presented to the immune system of the bird can result in a broader response. In addition, some vaccines have spike glycoproteins with strong B-cell and T-cell epitopes, which are those areas on the protein that stimulate an immune response. And, although strong vaccine reactions are not desirable, the virulence of the vaccine is important because a strong vaccine reaction will result in a strong immune response and consequently a more cross-reactive response.

The ttrick is to use a vaccine that will induce a robust immune response without causing a strong vaccine reaction.

Not all IBV vaccines are created equally. Some are more antigenic than others inducing a broader immune response and others are more virulent inducing a stronger immune response. Vaccines that induce a good cross-reactive immune response are both more antigenic and virulent.

TO CONCLUDE

Combining two vaccines, each with one of these qualities, or using a vaccine that is both immunogenic and moderately virulent will often induce a level of cross-protection that provides reasonable protection.

However, cross protection is not systematic. That said, some IBV types are extremely different from vaccines meaning that no matter how broad or how strong the immune response, no level of cross-protection can be induced.

And one last point, cross-protection cannot be predicted by genetic makeup of the virus or serology. At this time, vaccine-challenge studies in birds is the only sure way to confirm cross-protection between IBV types.

What are Ceva's IB solutions ?

6

Cevac IBird®

Cevac IBron™

Cevac IBras®

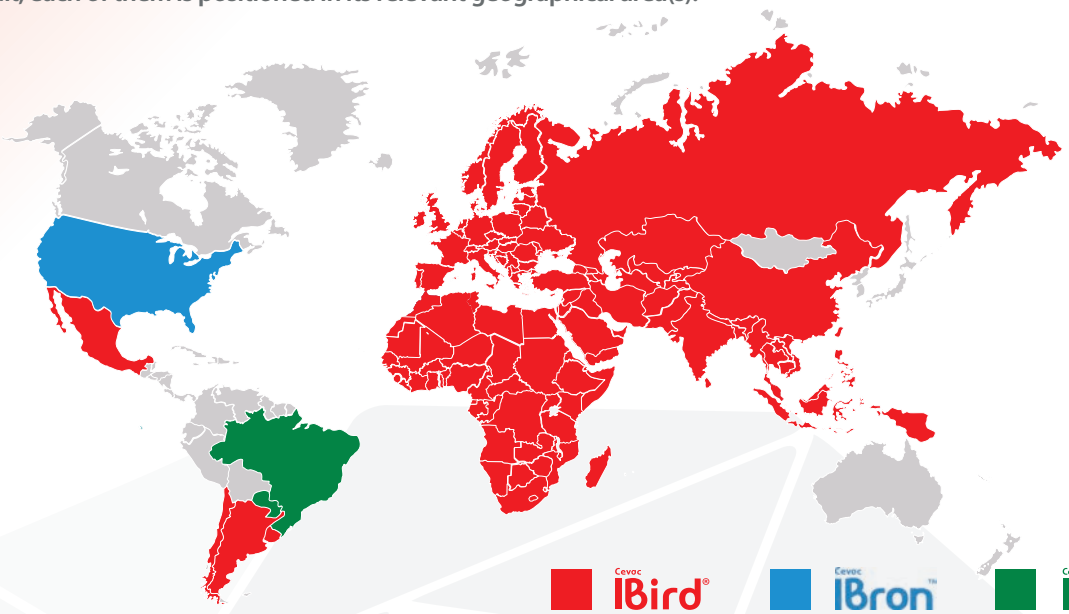
cevac MASS L

cevac BRON 120 L

Infectious Bronchitis under control for healthy birds

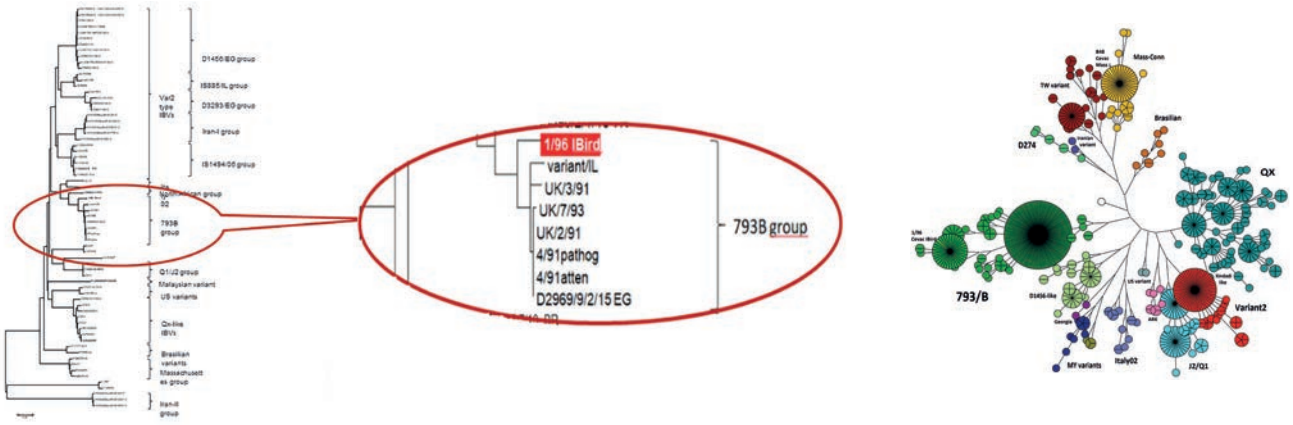
Ceva developed several live variant IB vaccines to address many different epidemiological situations.

As a result, each of them is positioned in its relevant geographical area(s).



Cevac IBird®

Cevac® IBird is a vaccine which contains the attenuated 1/96 IBV strain, classified within the 793B genetic group



Ceva® IBird is differentiable from field IBV strains

- **Clear view on epidemiology and challenge status;**
- **Clear identification of vaccine take;**
- **Better understanding of vaccination efficiency;**
- **Better undestanding on field challenge level.**

Applied together with a live Mass-type vaccine, Cevac® IBird provides a strong protection against Mass, 793B, QX, Q1, variant-2 (IS/1494), Italy-02, IS/885, D1456, Tunisian, Taiwanese and Malaysian IBV strains, including a reduction of the field virus shedding.

Through numerous laboratory and field trials, the safety and the efficacy of these vaccines, in combination with a Mass type live vaccine was demonstrated. Proper spray application protocols using Desvac® In Line Spray, and well defined post-vaccination monitoring procedures, help to achieve a high vaccination rate and a proper quality of application.

Cevac IBras®

Cevac® IBras is a IBV vaccine which contains the attenuated BR (Brazilian variant) IBV strain.

Cevac® IBras, which can be applied together with a live Mass-type vaccine, provides a strong protection against BR, Mass and 793B IBV strains, including a reduction of the field virus shedding.

Cevac IBron™

Cevac® IBron™ is a IBV vaccine which contains the attenuated GA08 (US variant Georgia 08) IBV strain. Cevac® IBron™, which can be applied together with a live Mass-type vaccine, provides a strong protection against GA08, Mass, GA13, DMV/1639/11, and Ark IBV strains, including a reduction of the field virus shedding.

Cevac® IBird provides a broad spectrum protection

In order to address Infectious bronchitis virus (IBV) diversity, it is common practice across the world to combine 2 different IB vaccine serotypes at Day 1 to achieve a broad protection against field viruses.

Ceva demonstrated that Cevac® IBird and Cevac® Mass L were fully compatible & safe when mixed for spray application in the hatchery, and provided protection against several challenge strains listed in the table opposite:

Challenge strain	Vaccination program
	Cevac® IBird + Mass at D1
793B	Yes
Mass	Yes
QX	Yes
Italian 02	Yes
Egyptian variant	Yes
Variant 2	Yes
Malaysian variant	Yes
Tunisian variant	Yes
Taiwanese variant	Yes

Cevac® IBird reduces the challenge virus shedding of vaccinated birds after field IBV challenge

Cevac® IBird in combination with Massachusetts vaccines was challenged against different strains, and the Infectious Bronchitis virus (IBV) shedding load was analyzed to verify the virus load reduction.

See in the table below the results according to the challenge strain:

Vaccine-strains	Application	Challenge Strain	IBV RNA load reduction
Cevac® IBird + H120	Hatchery	QX	4.8 $\log_{10}$
Cevac® IBird + Mass L	Hatchery	Variant - 2	3.9 $\log_{10}$
Cevac® IBird + Mass L	Hatchery	D1456 Middle-East	3.1 $\log_{10}$
Cevac® IBird + H120	Prime-boost	J2/Q1	4.1 $\log_{10}$
Cevac® IBird + Mass L	Hatchery	GA08	3.8 $\log_{10}$
Cevac® IBird + Mass L	Hatchery	Ark	4.6 $\log_{10}$
Cevac® IBird + Mass L	Hatchery	Tunisian	3.9 $\log_{10}$
Cevac® IBird + Mass L	Hatchery	Malaysian	4.6 $\log_{10}$

The treated group birds received the vaccines (Cevac® IBird + Massachetts) at day-old, challenged at 3 weeks of age, and evaluated 5 days post-challenge.

The control group was not vaccinated, challenged at 3 weeks of age, and evaluated 5 days post-challenge. The reduction was calculated based on the difference between the control and treated group.

The reduction obtained was between 3.1 to 4.8 $\log_{10}$ what means a reduction of 1,200 to 60,000 fold reduction of virus shedding

Systematic Cevac® IBird vaccination may reduce the environmental IB challenge and field virus presence

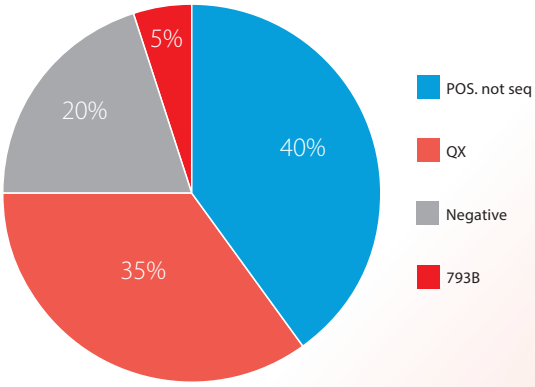
Field case 1

MATERIAL & METHODS

- The broilers flocks of a customer in Europe was monitored by PCR to check the Infectious Bronchitis virus (IBV) circulating on the farms.
- 20 broilers farms were monitored before and after the introduction of Cevac® IBird.

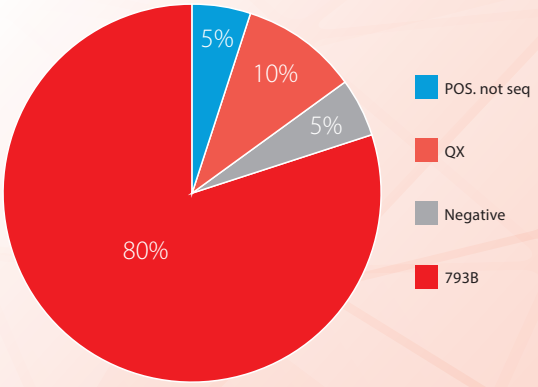
RESULTS

Before Cevac® IBird
(flocks vaccinated by other 793B program)



- Poor recovery of the widely used 793B vaccine applied.
- Wide presence of Qx field strain.

After introduction of the Cevac® IBird vaccination strategy



- Very good vaccine recovery.
- Reduction & displacement of Qx field strain.

CONCLUSION

Cevac® IBird vaccination is well tolerated by broilers and prevented the spread of the virus in the field.

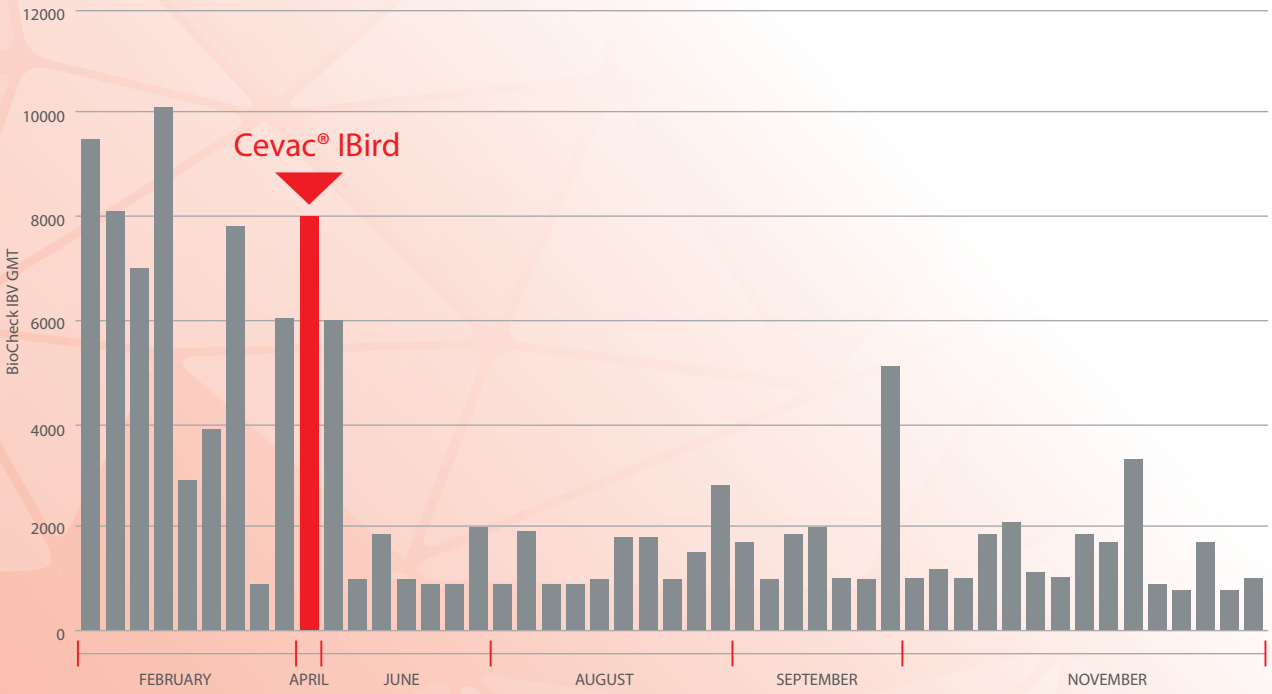
Field case 2

MATERIAL & METHODS

- Cevac® IBird in combination with Massachussetts vaccine was introduced in the vaccination program of a customer in Malaysia that was facing high titers of IBV in the broilers flocks serum samples at 36 days of age, that may indicate field virus challenge.

RESULTS

After the Cevac® IBird introduction, due a better IB control, a lower IB waschallenge, demonstrated in the graph below by lower titers.



CONCLUSION

After the Cevac® IBird introduction, due a better IB control, there is a lower IB challenge, demonstrated in the graph below by a lower titers.

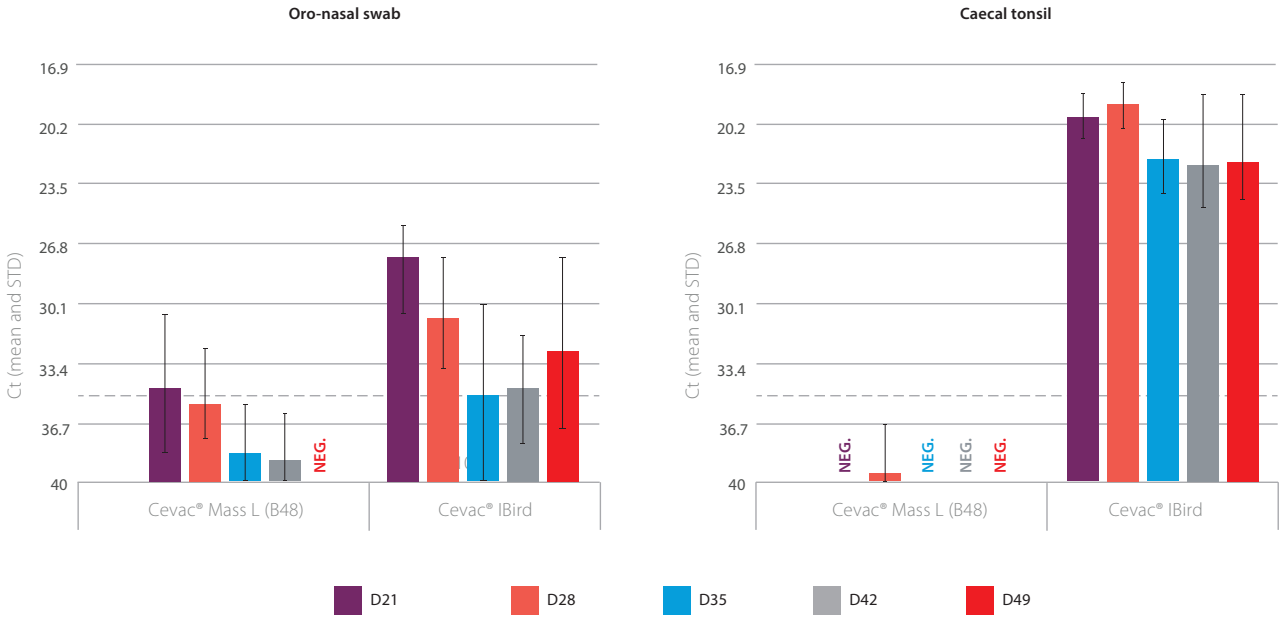
Cevac® IBird has long persistence in the vaccinated birds

FIELD CASE

Persistence of Massachusetts and 793B-type Infectious Bronchitis vaccine strains in commercial broilers following day-old vaccination

TATAR-KIS T. *et al.*, 2016. *9th Intenational Sympoosium on AVIAN CORONA- and Pneumoviruses and Complication Pathogens and 4th Annual Meeting of COST Action FA 1207, Utrecht (Leusden), The Netherlands, June 21_24.*

- Cevac® IBird in combination with Massachusetts vaccine was introduced in the vaccination program of a customer in Malaysia that was facing high titers of IBV in the broilers flocks serum samples at 36 days of age, that may indicate field virus challenge.
- The persistence of the virus by oro-nasal swabs, and in caecal tonsil, was monitored from 3 to 7 weeks of age.



CONCLUSION

The prolonged persistence of 793B type vaccines suggests that, long duration of immunity can be expected after a single vaccination at day-old with these vaccines.

Disease control & control of virus shedding

FIELD CASE

One of the roles of vaccines, besides protection, is to control the disease, including the control of dissemination of the virus..

Use of homologous and heterologous live attenuated vaccines to reduce Infection Bronchitis virus transmission

Robert Beckstead R. et al. *10th International Symposium on Avian Viral Respiratory Diseases, in Utrecht – Netherlands*

Live attenuated homologous and heterologous vaccines are used to control a variety of IBV circulating field viruses. Recently, DMV1639 variant IBV (GI17) became a critical threat to the US poultry industry.

This study tested if a live vGA08 (GI27), Cevac® IBron™, and Mass (GI1) vaccination in broilers would control disease transmission in the flock when half of the vaccinated birds were challenged with pathogenic GA08, Mass41 or DMV1639 isolate at 28 days post vaccination.

MATERIAL & METHODS

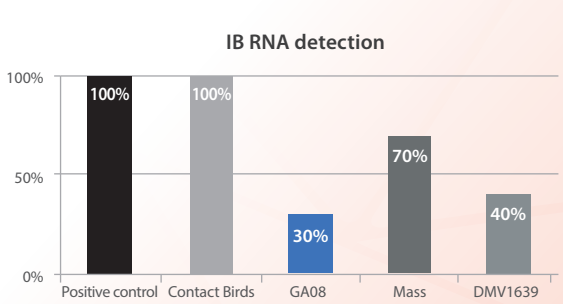
- Non vaccinated, challenged birds were used as positive controls. Non-direct challenged birds were added to the flock 1 day post challenge.
- Vaccine takes at 5 days post vaccination and viral shedding at 21dpc were ascertained by RT-qPCR of choanal cleft swabs samples from individual birds. Vaccine takes were 100% for vGA08 and 85% for Mass.

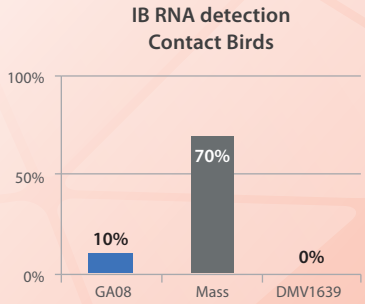
Day 1	Vaccination	Cevac® Ibron™ (GA08) + Mass
Day 28	Challenge	GA088 Mass 41 DVM 1639
Day 30	Monitoring	2 days post challenge
Day 35	Monitoring	7 days post challenge

RESULTS

2 days post challenge

- All non-vaccinated direct challenge birds and non-vaccinated, non-challenged contact birds were positive for IB RNA.
- Low levels of IB RNA were detected in 30% of the GA08 (Ct>30), 70% of the Mass41 (Ct>34), and 40% of the DMV1639 (Ct>35) vaccinated direct challenged birds.
- In the vaccinated contact challenged birds, 10% of the GA08 (Ct>38), 70% of the Mass (Ct>32), and 0% of the DMV1639 were positive for IB RNA.





7 days post challenge

- No virus was detected in the vaccinated contact challenged birds after 7 days post challenge (GA08) and 9 days post challenge (Mass).

CONCLUSION

Vaccination with vGA08 and Mass controlled viral shedding in both the GA08 and DMV1639 challenged and contact birds. Although 70% of the Mass41 challenged and contact birds were positive for IBV, a 3 Log reduction was observed when compared to the non vaccinated Mass 41 challenged control birds. This data supports the reduction of IB RNA detection and IBV transmission when heterologous vaccines are utilized in front of a DMV1639 challenge.

7

Cevac® IBird cross-protection

Timea Tatár-Kis, MSc
Head of trial unit in the Scientific Support and Investigation Unit (SSIU) at Ceva-Phylaxia, Budapest, Hungary

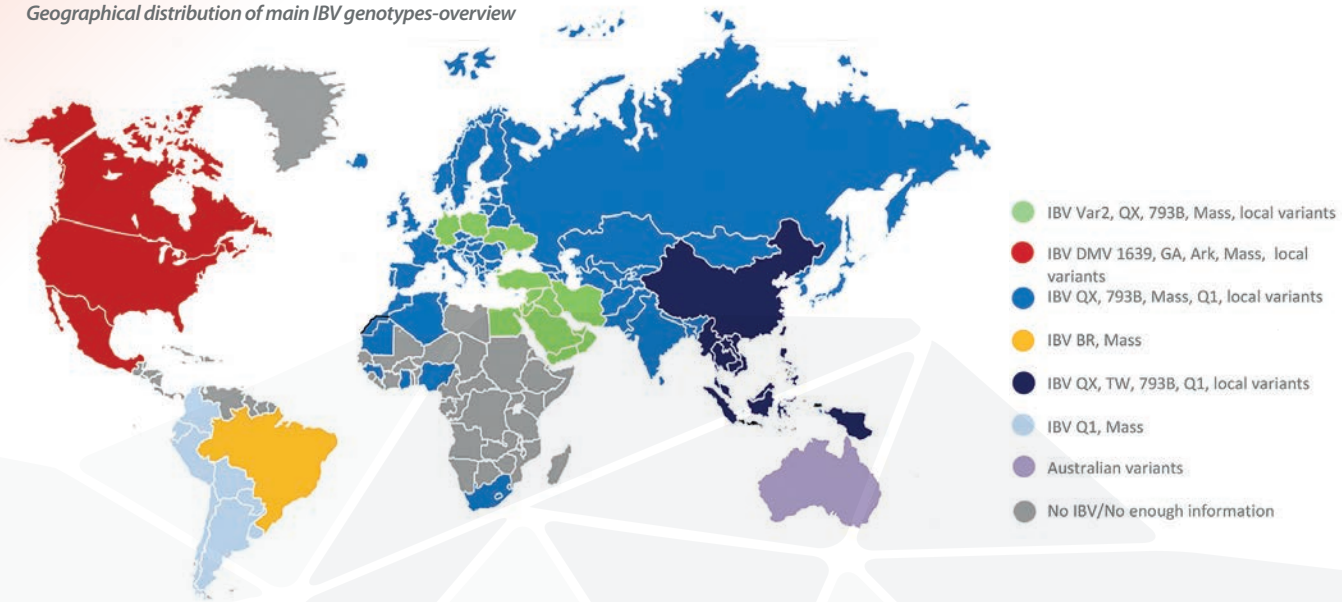
An effective and global response to Infectious Bronchitis

Infectious bronchitis virus (IBV) is a coronavirus, whose RNA-based genome is susceptible to frequent mutations that can induce variations in the sequence of the spike (S) gene of the virus. The S protein plays an important role in virus attachment and entry into cells, and it is targeted by the immune system, as well.

Due to these mutations, several virus serotypes are circulating around the world. In order to protect the birds, vaccination programs have to be adjusted to achieve relevant protection against the virus circulating in the area where the birds are located.

Epidemiological monitoring of the virus circulating in different parts of the world shows that most of the time there is more than one serotype circulating at the same time.

Geographical distribution of main IBV genotypes-overview



As the presence and persistency of a certain serotype in a region are unpredictable, it is quite difficult to develop and register a new vaccine for every new variant.

Cross-protection: the combination of Mass & 793 B vaccines has a positive effect on birds' protection against IBV

The concept of cross-protection by combining a Massachusetts (Mass) and a 793 B serotype vaccine was discovered in the 90's by Jane Cook in the UK (Cook & al. Avian Pathology, 28:5, 477-485).

Ceva has developed a 793 B vaccine, Cevac® IBird, and two Mass-type vaccines, Cevac® Mass L and Cevac® Bron 120 L.

TIn order to evaluate the cross-protective potential of the Cevac® IBird and Mass vaccine combination against field viruses circulating around the world, we have conducted several challenge studies at the Ceva scientific support and investigation unit based in Budapest, Hungary.

CHALLENGE STUDIES

1. Cevac® IBird and Mass-type vaccine were applied either combined at day-old (D1) or in a prime-boost regime with Mass-type vaccine application at day-old followed by a booster with Cevac® IBird 10 days later (D11).

2. 

IBV challenge was done between 21 and 30 days of age

3. Protection was evaluated at 5 days post-challenge based on prevention of ciliostasis (evaluation according the European Pharmacopoeia) and reduction of challenge virus replication in the trachea (measured by RT-real-time PCR).

PROTECTION RESULTS

The cross-protective potential of the combination of Mass-type vaccine (Cevac® Bron 120 L or Cevac® Mass L) and Cevac® IBird was assessed against representative genetic groups of variant IBV strains.

Genotype grouping is based on publication of Valastro *et al.*, Infection, Genetics and Evolution, 2016, vol 39, 349-364.

EUROPE

VACCINATION	CHALLENGE		PROTECTION		REFERENCE OF STUDY, PUBLICATION
	Genetic group represented by challenge strain		Protection against ciliostasis (trachea)	Reduction of mean virus load in trachea	
	Common name	Genotype			
Cevac® IBird & Cevac® Bron 120 L (D1)	QX	GI-19	100%	4.8 $\log_{10}$	*Ceva Phylaxia R&D, DV-110-2008*
Cevac® IBird & Cevac® Mass L (D1)	793B	GI-13	100%	4.1 $\log_{10}$	*Ceva Phylaxia R&D registration report DV-299-2014*
Cevac® IBird & Cevac® Mass L (D1)	M41	GI-1	100%	4.2 $\log_{10}$	*Ceva Phylaxia R&D registration report DV-301-2014*

AFRICA, MIDDLE EAST & EASTERN EUROPE

VACCINATION	CHALLENGE		PROTECTION		REFERENCE OF STUDY, PUBLICATION
	Genetic group represented by challenge strain		Protection against ciliostasis (trachea)	Reduction of mean virus load in trachea	
	Common name	Genotype			
Cevac® IBird & Cevac® Bron 120 L (D1)	QX	GI-19	95%	4.7 $\log_{10}$	*Ceva Phylaxia SSIU P048-2018*
Cevac® Bron 120L (D1) & Cevac® IBird (D11)	Q1 / J2	GI-16	100%	4.1 $\log_{10}$	*Ceva Phylaxia SSIU D1753-2011 VII. Int. Symp. on Avian Corona- and Pneumo-viruses and Complicating Pathogens, 2012*
Cevac® IBird & Cevac® Mass L (D1)	Var 2 (IS-1494)	GI-23	90%	3.9 $\log_{10}$	*Ceva Phylaxia SSIU SCI-205-2013*
Cevac® IBird & Cevac® Mass L (D1)	D1456 ME variant	Reassortant[1]	65%	3.1 $\log_{10}$	*Ceva Phylaxia SSIU SCI-205-2013*
Cevac® IBird & Cevac® Mass L (D1)	Tunisian variant	Unique variant	85%	3.2 $\log_{10}$	*Ceva Phylaxia SSIU SCI-259-2015*
Cevac® IBird & Cevac® Mass L (D1)	Moroccan variant	Unique variant	100%	3.8 $\log_{10}$	*Ceva Phylaxia SSIU SCI-117-2013*

[1] Reference to the characterization of this genetic group: Kiss et al., Virus Evolution, 2016, 2(2): vew021

ASIA

VACCINATION	CHALLENGE		PROTECTION		REFERENCE OF STUDY, PUBLICATION
	Genetic group represented by challenge strain		Protection against ciliostasis (trachea)	Reduction of mean virus load in trachea	
	Common name	Genotype			
Cevac® IBird & Cevac® Bron 120 L (D1)	QX	GI-19	95%	4.7 $\log_{10}$	*Ceva Phylaxia SSIU P048-2018*
Cevac® IBird & Cevac® Mass L (D1)	Taiwanese I	GI-7	85%	2.8 $\log_{10}$	*Ceva Phylaxia SSIU SCI-118-2016*
Cevac® IBird & Cevac® Bron 120 L (D1)	Taiwanese I	GI-7	100%	4.6 $\log_{10}$	*Ceva Phylaxia SSIU P049-2018*
Cevac® IBird & Cevac® Mass L (D1)	Malaysian variant	Unique variant	100%	3.9 $\log_{10}$	*Ceva Phylaxia SSIU SCI-260-2015*

NORTH AND SOUTH AMERICA

VACCINATION	CHALLENGE		PROTECTION		REFERENCE OF STUDY, PUBLICATION
	Genetic group represented by challenge strain		Protection against ciliostasis (trachea)	Reduction of mean virus load in trachea	
	Common name	Genotype			
Cevac® IBird & Cevac® Mass L (D1))	GA08	GI-27	65%	3.è $\log_{10}$	*Ceva Phylaxia SSIU SCI-207-2013*
Cevac® IBird & Cevac® Mass L (D1)	Arkansas	GI-9	70%	4.6 $\log_{10}$	*Ceva Phylaxia SSIU SCI-208-2013*
Cevac® IBird & Cevac® Bron 120 L (D1)	Q1 / J2	GI-16	99.5%	/	*GD Deventer 2014*

TO CONCLUDE

The combination of Cevac® IBird and Cevac® Mass L or Cevac® Bron 120 L administered at day one was able to induce strong clinical protection and a high reduction of virus replication against challenge with recent IBV isolates from around the world.

8 Infectious Bronchitis control strategy

Biosecurity is the unavoidable component of the prevention of any transmissible infectious disease. It can be defined as a comprehensive range of clear regulations, measures and procedures aiming at minimizing the possibility to introduce undesirable pathogens inside a defined compartment.

The second line of defend relies on vaccination. Primarily, the objective of vaccination against IB is to prevent (or reduce) direct losses attributable to the disease such as morbidity, mortality, drop in egg production, reduction of productive performances, increase in condemnation rates and others. Additionally, the vaccines have to be safe enough to avoid the negative impact of post-vaccination reactions on birds' performance. Finally, the vaccination procedures have to be adapted to the requirements of the modern poultry industry aiming at immunizing large populations in the hatcheries.

Viruses have preferential sites of replication and the vaccination route should be tailored for those preferences. As IBV, including vaccine strains, multiplies in the respiratory mucosa, the vaccination methods of choice are by eye-drop or spray routes. It is also important to consider that the efficacy of a vaccine can be greatly affected by the quality of its administration.

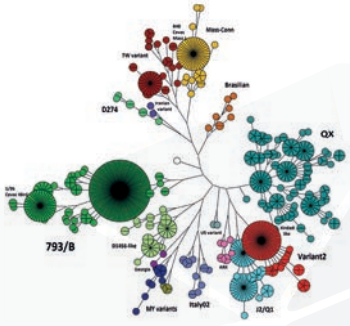
8 A Broilers

For broilers, the association of Cevac® IBird with a Massachusetts IB strains (Cevac® Mass L or Cevac® Bron 120 L) sprayed in the hatchery induces the necessary protection during the whole life of the birds as the duration of immunity is documented up to 9 weeks of age.

It is also common to associate Cevac® IBird with combined ND/IB vaccines (Cevac® Vitabron or Cevac® BI L).

Unquestionably, there is a worldwide trend to concentrate the vaccination of broiler flocks in the hatcheries and the vaccination against IB spearheads this tendency. The convenience and quality of hatchery vaccination as opposed to farm vaccination and the availability automated or semiautomated sprayers that allow vaccinating several thousands of day-old chicks per hour are the main driving factors of this trend.

Broad spectrum of protection
(QX, TW, Var2…)



Homogeneous administration

9 weeks protection in 1 shot

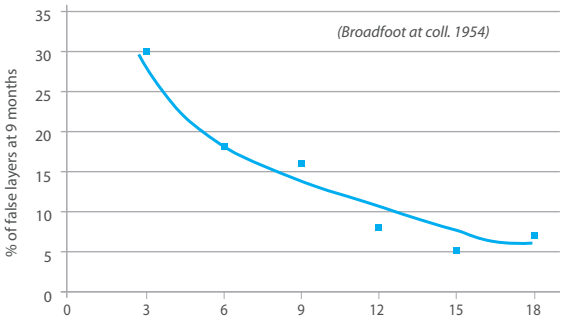
8B Breeders and layers

For long-living birds, the vaccination program also starts from the hatchery with a combination of IB vaccines, such as Cevac® IBird and Cevac® Mass L, which induce broad spectrum protection.

This approach is of paramount importance in areas where variant strains known to cause the so-called "false-layer" syndrome, circulate in the field: pullet infection in early days is directly impacting false layers prevalency (Broadfoot et coll., 1954).

After this priming vaccination in the hatcheries; two boosters with live IB vaccines, combined or not with ND vaccines, are usually done at different intervals.

Correlation between age at infection with IB and % of false layers

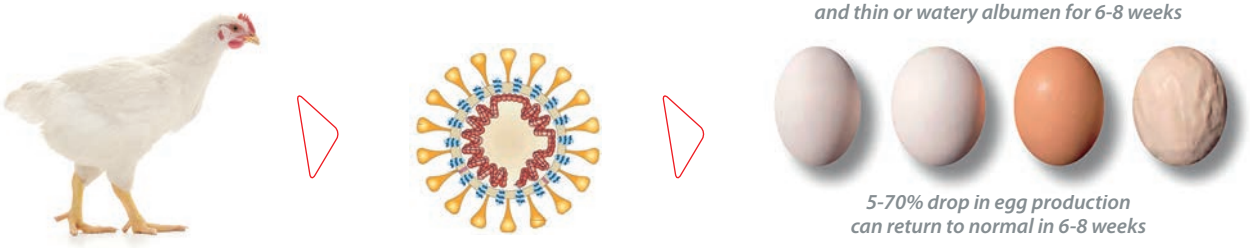


Preserving egg production

IB VIRUS REPLICATES IN CILLIAR CELLS OF OVIDUCTO

DROP IN EGG PRODUCTION

Thin-shelled, rough, pale and misshapen eggs, and thin or watery albumen for 6-8 weeks



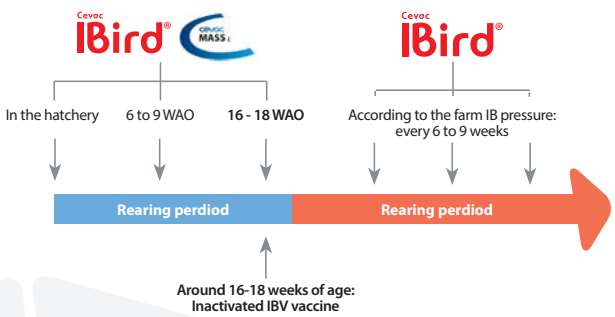
5-70% drop in egg production can return to normal in 6-8 weeks

Prior to the onset of egg production, inactivated IB vaccine, usually combined with other antigens such as Newcastle Disease virus, Egg Drop Syndrome virus, Gumboro virus, Avian Influenza and others, are routinely used in long living birds to boost the immune response. The majority of the inactivated IB vaccines are formulated with a Massachusetts virus.

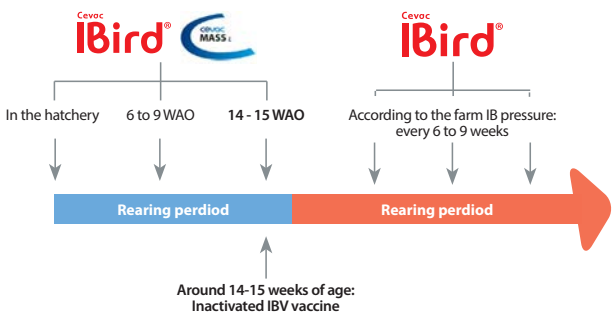
In some areas, live attenuated IB vaccines, are usually applied by drinking water during the laying period at intervals that vary from 6 to 9 weeks aiming at keeping the local immunity of the respiratory tract at a high level

Vaccination programs

BREEDERS PROGRAM



LAYERS PROGRAM



9 Infectious Bronchitus vaccination procedures

One of the most important points to achieve successful immunization of day-old chicks should be accurate application of the vaccine in the hatchery using advanced spray equipment, batch after batch, in addition to post-vaccination monitoring programs.

A high vaccination rate and good quality of application will over time control the Avian infectious bronchitis in the field, and its effects.

Spray vaccination

Spray vaccination at the hatchery is an established practice. A worldwide hatchery survey conducted in 2016 showed that 90% of the hatcheries use spray vaccination on a regular basis.

At first glance, spray vaccination seems to be a simple technique to master: select nozzle type and pressure to generate the right droplet size and then apply the spray to cover all the chicks in the crate and reach the upper respiratory tract.

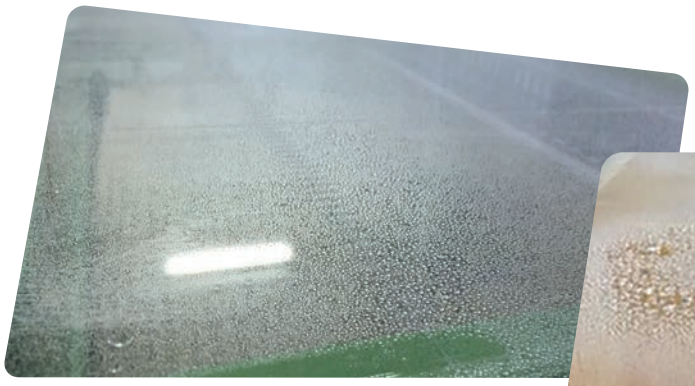
In reality, there are many variables that affect the quality of spray vaccination among different hatcheries, mainly due to the sprayer equipment technology in use.

What must hatchery spray equipment do?

There are 4 main considerations for good spray vaccination quality:

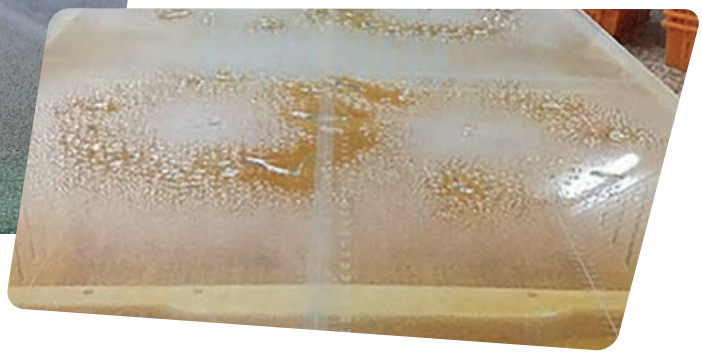
1 OPTIMAL CRATE COVERAGE

The entire crate surface has to be covered by the spray in order to guarantee that all the birds receive the proper IB vaccine dose. The nozzle technology varies depending on the type of sprayer being used. Historically, hatchery sprayers have been equipped with conical pattern nozzles. Obviously, it is impossible to cover a rectangle shaped crate by using 2 or 4 conical spray nozzles, as circular spray areas will overlap each other but leave the corners of the crate out of reach. However, by using current nozzle technology, such as a flat pattern nozzle, crates can be perfectly covered from beginning to end without missed areas.



Flat nozzle droplet size homogeneity

Conical nozzle droplet size homogeneity



2 UNIFORM DROPLETS OF THE RIGHT SIZE

The recommended droplet size to vaccinate day-old chicks is around 150 µm. Smaller droplet sizes increase the risk of post vaccination reaction. Bigger droplet sizes make it harder to target the upper respiratory track for an optimal immune response.

The droplet size is defined by two main parameters: nozzle type and air pressure. Air pressure control is something relatively easy to be managed, most of the current hatchery sprayers use a simple pressure regulator. However, not all nozzle technologies produce uniform droplets of the right size. Only flat nozzles can guarantee it. Conical nozzle generates significant droplet overlapping and, therefore, droplet size variations.

3 NO IMPACT ON THE CHICK DISTRIBUTION

The operation of many of the currently available vaccination sprayers could impact the distribution of the day-old chicks inside the crate. For example, sudden stops by the automatic conveyor before the crate enters the sprayer could cause uneven distribution of the chicks in the crate. In other cases, manual handling of the crates is too rough. Manual handling of the crates must be smooth. Uneven distribution of the chicks in the crate could cause vaccine waste (vaccine on areas with no chicks) and deficient vaccine delivery (birds receiving less vaccine than needed). **Avoiding vaccine wastage and delivering the right vaccine dose to every chick can be achieved by using well-designed automatic in-line sprayers.**

4 A CONSISTENT VOLUME

The vaccine volume sprayed into each crate must be consistent. The vaccine volume can be controlled by two types of systems. Some older sprayers use a pressurized vaccine system. Unfortunately, these systems are susceptible to variations in air pressure occurring inside the hatchery's main air supply system. **Vaccine volume variations up to +/- 50% of the desired volume can be observed.**

More recently, sprayers use a more reliable system consisting of an accurate syringe system. Normally, it is triggered by a pneumatic piston, allowing for direct control of the vaccine volume delivered to each crate with almost negligible variations.

Selecting spray equipment technology: which one?

Hatchery spray equipment can be categorized into 3 types:

1 MANUAL SPRAY CABINETS

These sprayers are better suited for small hatcheries (<200k DOC per week). The crates are manually placed and held in the spray area. Once the crate is detected, the spray is applied through 2 to 4 conical nozzles. The vaccination quality is totally dependent on handling by the operator, as the crate must be placed smoothly, and cannot be removed before the spray cycle is completed.

As previously mentioned, these conical nozzles do not guarantee optimal crate coverage and droplet homogeneity.

2 STOP & GO CABINETS

These sprayers are better suited for medium size hatcheries (200-500k DOC per week). They are integrated onto an automatic conveyor line. Most of the time, they are installed after the chick counter.

Once there, the crate is blocked by a pneumatic stopper, and then sprayed by 2 to 4 conical nozzles. Finally, the stoppers release the crate. Stop and go cabinets suffer from the same disadvantages as manual spray cabinets due to the use of conical nozzles. Besides, most of the time, DOC distribution in the crate is negatively impacted by abrupt stopping of the crate prior to spraying.

3 IN-LINE SPRAYER

This last category of sprayers offers the best vaccination quality. They are installed over the conveyor line right after the chick counter or as standalone equipment. They are well suited for medium and large hatcheries. The crate does not stop, so there is no waste of time and chicks' distribution in the crate is not impacted. The continuous movement of the crate allows the usage of flat nozzles: 100% coverage and perfect droplet homogeneity. In addition, with the Desvac IN LINE SPRAY, one device can spray two conveyor lines simultaneously, thanks to an independent double arm system.

IN SUMMARY

Coverage, droplet size uniformity, chick distribution and volume control are critical factors for the proper delivery of IB vaccines via spray. These 4 factors for success must be mastered and controlled during the whole vaccination process.

Today, only Ceva Desvac In Line sprayer can provide the best quality of vaccination with the best IB protection. Monitoring and regular maintenance are required to execute proper vaccination.

This is why hatchery vaccination monitoring such the C.H.I.C.K Program is key factor of success to assure the quality of spray vaccination.

Cevac IBird® Cevac IBras® Cevac IBron™

IMPROVEMENTS IN PERFORMANCE: FIELD AND PROCESSING DATA

In the following pages, several experiences covering the displayed geography will be described.

Malaysia(1)

13,640,000 DAY-OLD CHICKS,
1 FARM, 2 GROUPS,
MALAYSIAN TYPE 1 VARIANT IBV CHALLENGE,
HISTORICAL COMPARISON

GROUP 1: (CEVA) 9,520,000 BIRDS,
CEVAC® IBIRD AT DAY 1 BY SPRAY
(DESVAC IN-LINE SPRAY)

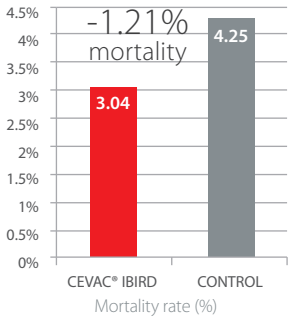
GROUP 2: 4,120,000 BIRDS,
ROUTINE VACCINATION PROGRAM

SLAUGHTER AT 36.6 DAYS OF AGE (GROUP 1)
AND 35.1 DAYS OF AGE (GROUP 2)

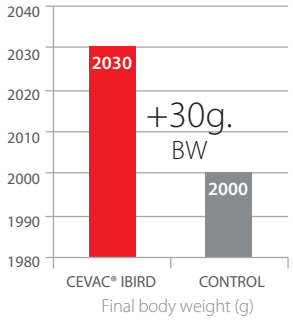
VACCINATION PROGRAMS

	GROUP 1 - CEVA PROGRAM	GROUP 2 - CONTROL
D1 (Hatchery)	Mass (B48)+ **Cevac® IBird (spray)**	Mass (B48) (drinking water)
D10-14	Mass (B48) (spray)	Mass (B48) (drinking water)

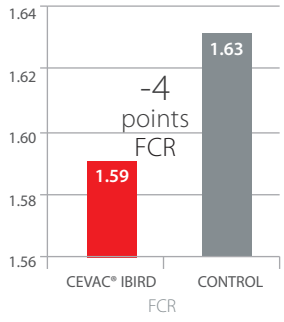
RESULTS & CONCLUSIONS



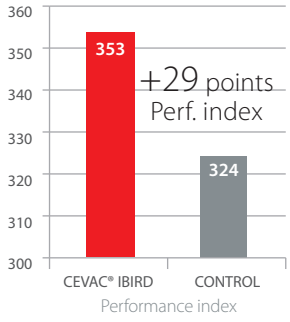
Mortality rate (%)



Final body weight (g)



FCR



Performance index

ECONOMIC EVALUATION

Based on cost-benefits calculation (mortality, body weight and FCR)

the extra revenues per 1,000 birds would be +67.20€

Source: Lee J.e. et al., 2018. A comprehensive approach to diagnose and control Malaysian variant infectious bronchitis virus. 4th World Veterinary Poultry Association (WVPA) Asia meeting, Kuala Lumpur, Malaysia, October 1-2.

Malaysia(2)

170,000 DAY-OLD CHICKS, 2 GROUPS,
MALAYSIAN TYPE 1 VARIANT IBV CHALLENGE,
CONTEMPORANEOUS

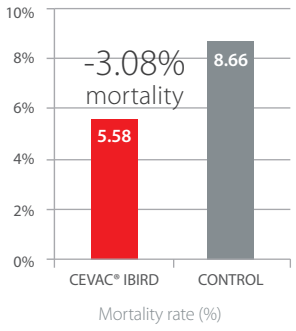
GROUP 1: (CEVA) 61,600 BIRDS
CEVAC® IBIRD AT DAY 1

GROUP 2: 108,100 BIRDS,
COMPETITOR 793B AT DAY 1

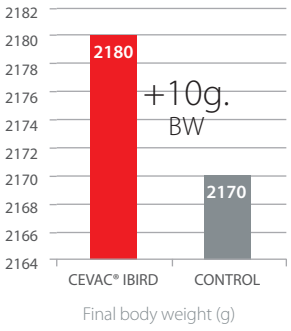
VACCINATION PROGRAMS

	GROUP 1 - CEVA PROGRAM	GROUP 2 - CONTROL
D1 (Hatchery)	IBD Immune-complex (subcutaneous) Live ND + IB Mass (H120) (spray) Killed ND (subcutaneous)	IBD Immune-complex (subcutaneous) Live ND + IB Mass (H120) (spray) Killed ND (subcutaneous)
D1 (farm)	**Cevac® IBird (spray)**	**Competitor 793B (spray)**
D10	Live ND (drinking water)	Live ND (drinking water)
D21	Live ND (drinking water)	Live ND (drinking water)

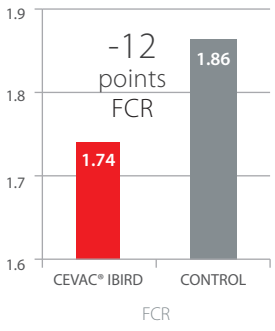
RESULTS & CONCLUSIONS



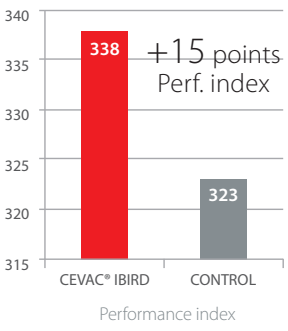
Mortality rate (%)



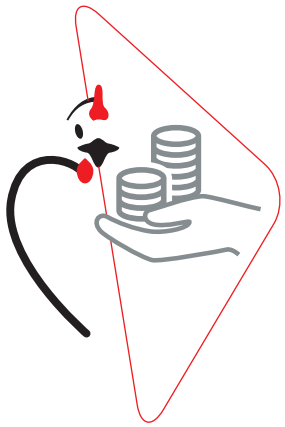
Final body weight (g)



FCR



Performance index



ECONOMIC EVALUATION

Based on cost-benefits calculation (mortality, body weight and FCR)

the extra revenues per 1,000 birds would be +105€

Source: Lee J.-e. 2016. Asian Veterinary Services meeting, January.

Philippines

650,000 DAY-OLD CHICKS,
1 COMPANY, 10 LOCATIONS, HISTORICAL COMPARISON

GROUP 1: (CEVA) 376,000 BIRDS,
CEVAC® IBIRD, AT DAY 1

GROUP 2: 277,000 BIRDS,
COMPETITOR 793B AT DAY 9

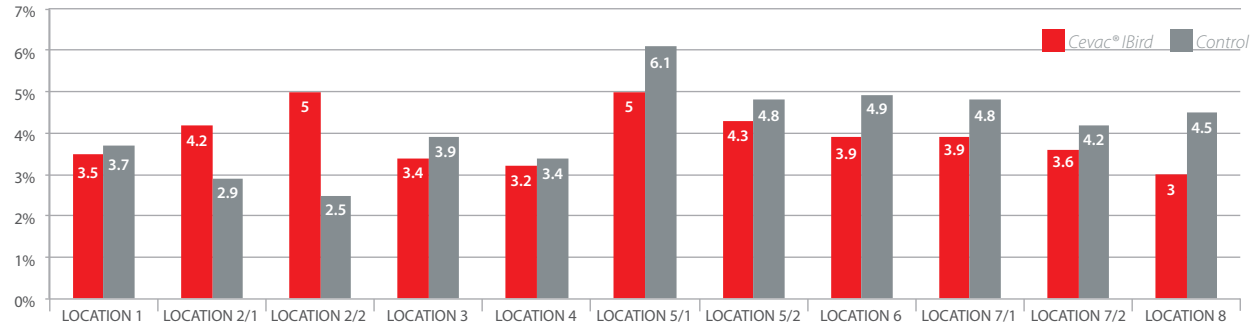
SLAUGHTER BETWEEN 32 AND 36 DAYS OF AGE

VACCINATION PROGRAMS

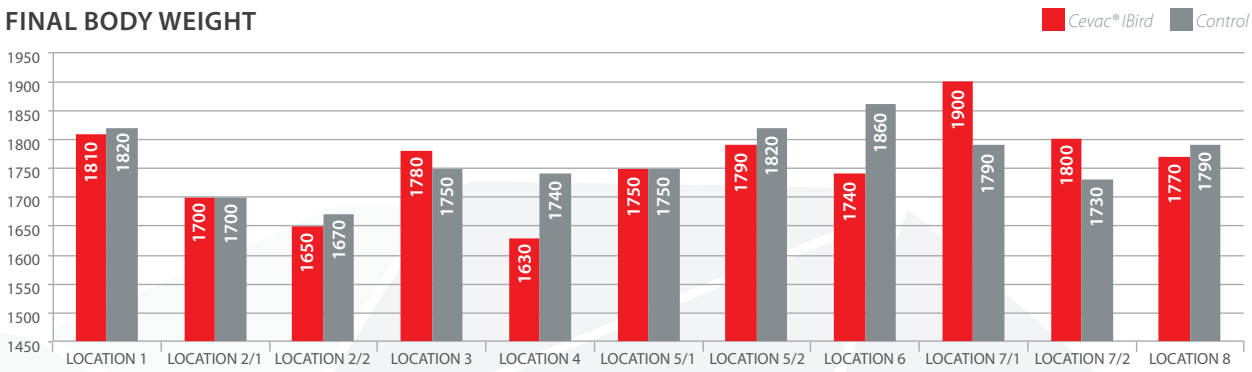
	GROUP 1 - CEVA PROGRAM	GROUP 2 - CONTROL
D1 (Hatchery)	IBD Immune-complex + rHVT-F (subcutaneous) Live ND + IB Mass (H120) **+ Cevac® IBird (spray)**	IBD Immune-complex + rHVT-F (subcutaneous) Live ND + IB Mass (H120) (spray)
D9	-	**Competitor 793B (spray)**
D14	Live ND (spray)	Live ND (spray)

RESULTS & CONCLUSIONS

MORTALITY RATE (%)

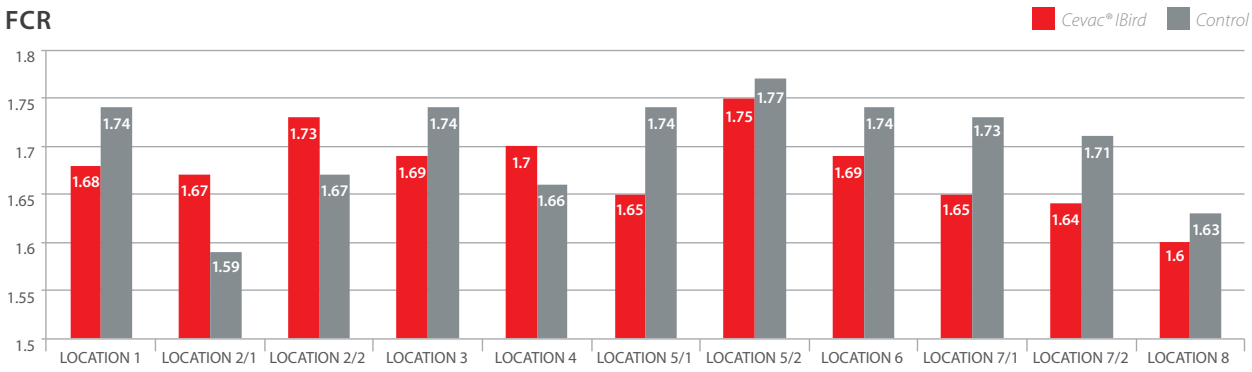


FINAL BODY WEIGHT



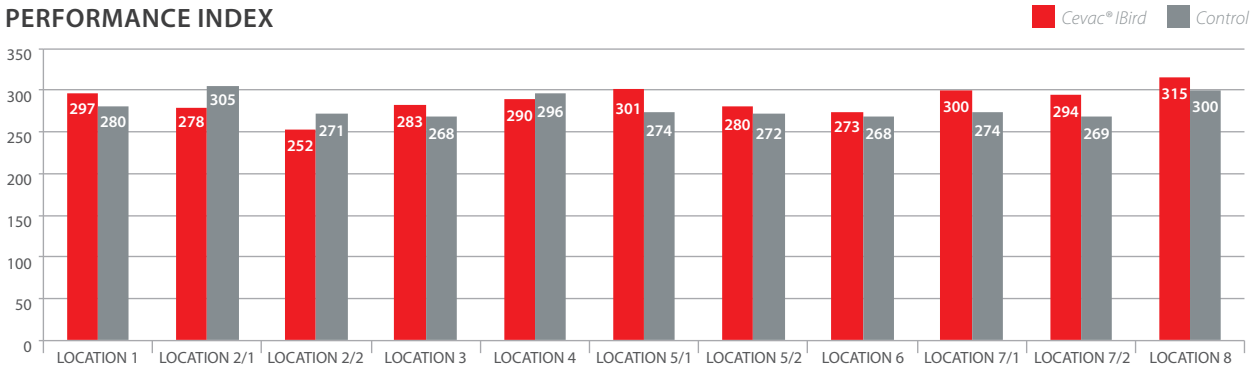
Better livability in Cevac® IBird on average

FCR



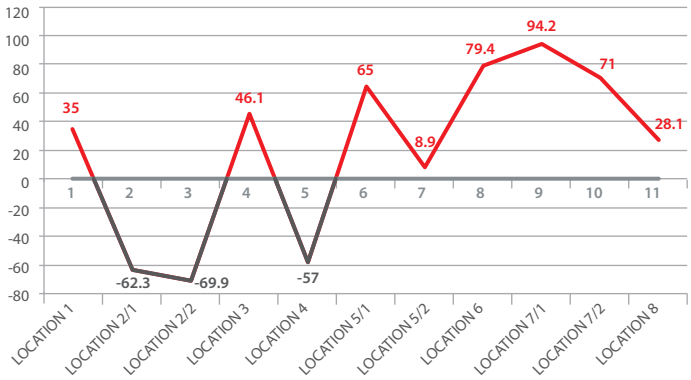
Lower FCR rate in Cevac® IBird group on average

PERFORMANCE INDEX



Better performance index in Cevac® IBird group on average

EXTRA INCOME USING CEVAC® IBIRD



ECONOMIC EVALUATION

Based on cost-benefits calculation (mortality, body weight and FCR)

the extra revenues per 1,000 birds would be +21.68€

Source: Gacad E. 2013, pers. comm.

Indonesia

1,110,000 DAY-OLD CHICKS
2 GROUPS CONTEMPORANEOUS

GROUP 1: (CEVA) 570,000 BIRDS,
CEVAC® IBIRD + MASS AT DAY 1

GROUP 2: 540,000 BIRDS,
MASS VACCINATION

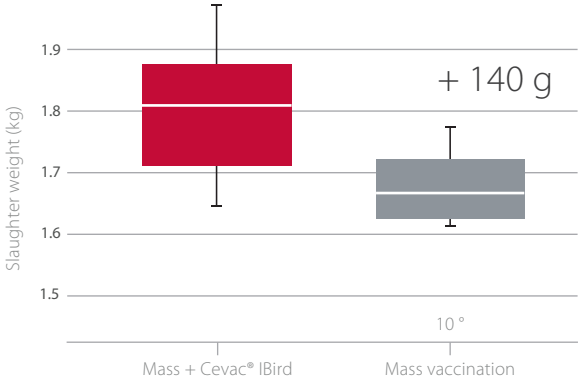
VACCINATION PROGRAMS

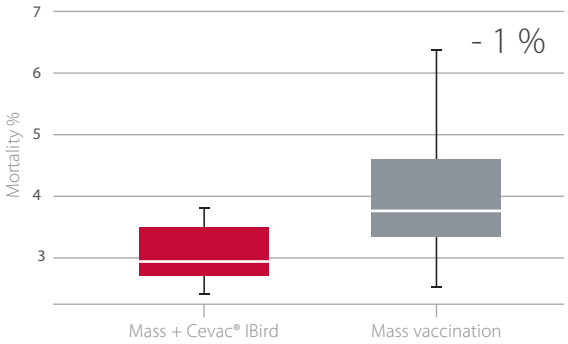
	GROUP 1 - CEVA PROGRAM	GROUP 2
D1 (Hatchery)	Transmune® Broiler - ND K NBL - New L Cevac® IBird	Transmune® Broiler - ND K NBL - New L

RESULTS & CONCLUSIONS

	GROUP 1 Cevac® IBird + Mass	GROUP 2 Mass	P. VALUE
Number of flocks	19	18	
Number of birds (assumption 30,000 b/flock)	570 k	540 k	
Slaughter age (d)	33.6	32.55	>0.05
ADG (g/d)	53.98	51.15	<0.05
Slaughter weight	1.80	1.66	<0.05
ADJ slaughter weight (32.95 d)	1.76	1.69	
FCR	1.63	1.64	>0.05
Adj FCR (32.95 d)	1.62	1.65	
Total mortality (%)	3.13	4.17	<0.05
Condemnation (%)	-	-	
EPEF	321	299	<0.05

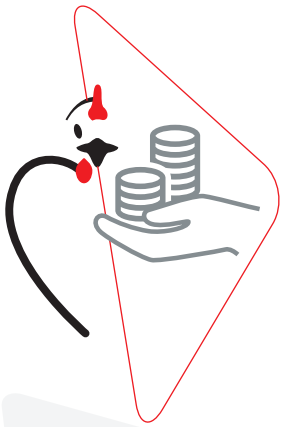
Source: Lee J.-e. 2016. Asian Veterinary Services meeting, January.





The group vaccinated with Cevac® IBird + Mass vaccine demonstrated a better slaughter weight, 1.80 kg against 1.66 kg, with statistical difference.

The mortality in the group vaccinated with Cevac® IBird + Mass vaccine was lower, 3.13% against 4.17% with statistical difference



ECONOMIC EVALUATION

Based on cost-benefits calculation (mortality, body weight and FCR)

the extra revenues per 1,000 birds would be +72€

Sri Lanka

600,000 DAY-OLD CHICKS,
1 COMPANY, 4 GROUPS, HISTORICAL CONTROL

GROUPS 1,2,3 : (CEVA) 462,000 BIRDS,
3 CYCLES, CEVAC® IBIRD + IB MASS (H120) AT DAY 1

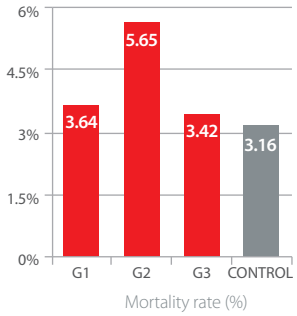
GROUP 4: 150,000 BIRDS,
LIVE IB MASS (H120) AT DAY 1

SLAUGHTER
BETWEEN 38.8 AND 41.2 DAYS OF AGE

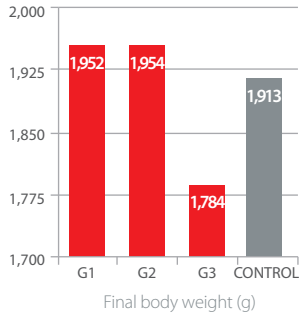
VACCINATION PROGRAMS

	GROUPS 1, 2,3 - CEVA PROGRAM			GROUP 4 - CONTROL
	(n=135,000 birds)	(n=161,000 birds)	(n=166,000 birds)	(n=150,750 birds)
D1 (Hatchery)	Mass (H120), **+ Cevac® IBird (spray)**			Live Mass (H120) (spray)

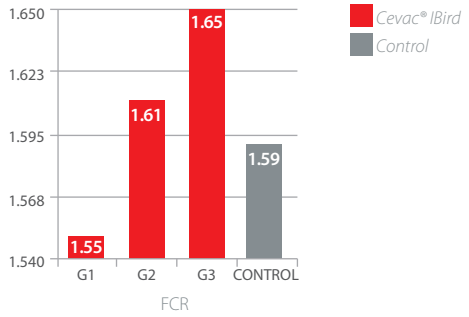
RESULTS & CONCLUSIONS



Mortality rate (%)



Final body weight (g)



FCR

Some management issues did significantly impact the results, since a ventilation failure was reported in cycle 2, and poor chick quality was delivered in cycle 3.
Interestingly, when comparison is made versus the starting phase without any IB vaccination, the recorded improvement was 165 g. more final weight (day 28), 0.13 lower FCR, and 1.46% lower mortality.

ECONOMIC EVALUATION

Based on cost-benefits calculation (mortality, body weight and FCR)

the extra revenues per 1,000 birds would be +146.86€

Source: de Silva N. pers. comm.

Italy

600,000 DAY-OLD CHICKS,
1 COMPANY, 4 GROUPS, HISTORICAL CONTROL

GROUPS 1,2,3 : (CEVA) 462,000 BIRDS ,
3 CYCLES, CEVAC® IBIRD + IB MASS (H120) AT DAY 1

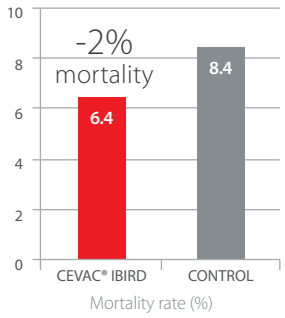
GROUP 4: 150,000 BIRDS,
LIVE IB MASS (H120) AT DAY 1

SLAUGHTER
BETWEEN 38.8 AND 41.2 DAYS OF AGE

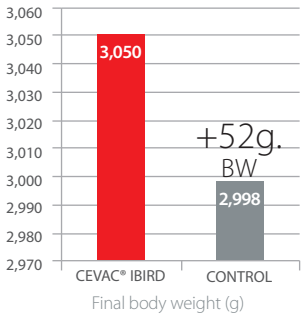
VACCINATION PROGRAMS

	GROUP 1 - CEVA PROGRAM	GROUP 2 - CONTROL
D1 (Hatchery)	**Cevac® IBird (spray)**	Competitor IB vaccination

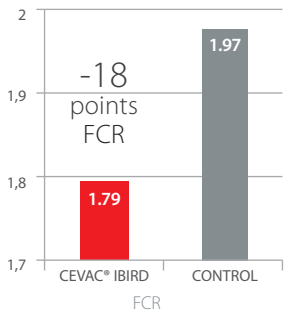
RESULTS & CONCLUSIONS



Mortality rate (%)

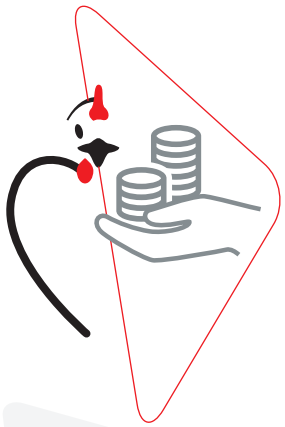


Final body weight (g)



FCR

IN GROUP 1,
-50%
ANTIBIOTIC USE
WAS REPORTED.



ECONOMIC EVALUATION

Based on cost-benefits calculation (mortality, body weight and FCR)

the extra revenues per
1,000 birds would be **+146.65€**

Source: Berto G. 2016. Europe Poultry Franchise meeting, Vienna, Austria, April 11-13.

Spain

1,600,000 DAY-OLD CHICKS,
49 FARMS, 2 GROUPS

GROUP 1: (CEVA) 929,875 BIRDS,
23 FARMS, CEVAC® IBIRD AT DAY 1

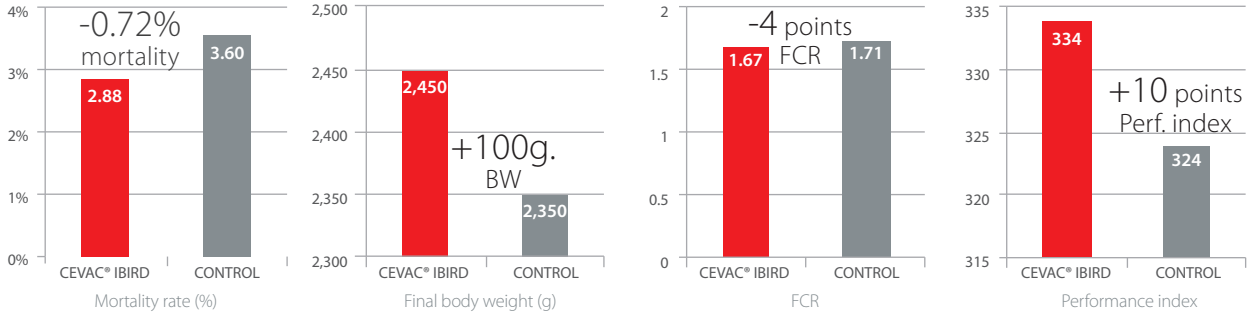
GROUP 2: 750,545 BIRDS,
26 FARMS, COMPETITOR 793B AT DAY 1

SLAUGHTER AT 40.3 DAYS OF AGE (GROUP 1)
AND 39.5 DAYS OF AGE (GROUP 2)

VACCINATION PROGRAMS

	GROUP 1 - CEVA PROGRAM	GROUP 2 - CONTROL
D1 (Hatchery)	**IB Mass + Cevac® IBird (spray)**	IB Mass + **Competitor 793B (spray)**

RESULTS & CONCLUSIONS



IN GROUP 1, **-0.30€/g.** ON MEDICATION EXPENSES WAS REPORTED.

ECONOMIC EVALUATION

Based on cost-benefits calculation (mortality, body weight and FCR)

the extra revenues per 1,000 birds would be **+38.60€**

Source: Sales R., 2013, pers. comm.

Russia

3,207,000 DAY-OLD CHICKS, 2 LOCATIONS, 2 GROUPS

GROUP 1: (CEVA) 1,069,000 BIRDS, CEVAC® IBIRD AT DAY 1

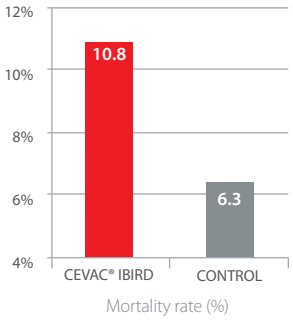
GROUP 2: 2,138,000 BIRDS, COMPETITOR 793B AT DAY 10

VACCINATION PROGRAMS

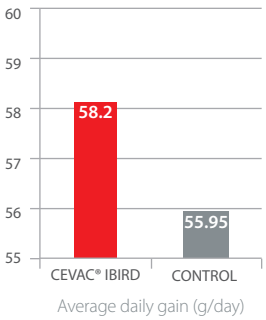
	GROUP 1 - CEVA PROGRAM	GROUP 2 - CONTROL
D1 (Hatchery)	IBD Immune-complex + rHVT-F (subcutaneous) Live ND + IB Mass (H120) **+ Cevac® IBird (spray)**	IBD Immune-complex + rHVT-F (subcutaneous) Live ND + IB Mass (H120) (spray)
D10	-	**Competitor 793B (spray)**
D15	Live ND (drinking water)	Live ND (drinking water)

RESULTS & CONCLUSIONS

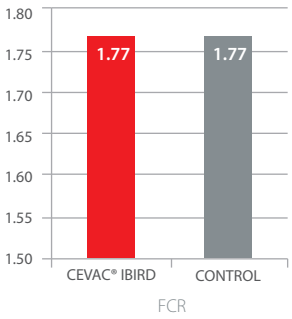
LOCATION 1



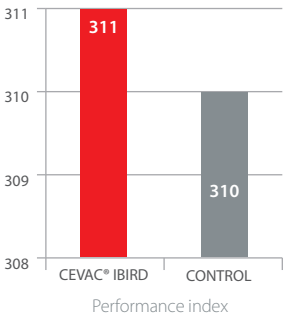
Mortality rate (%)



Average daily gain (g/day)



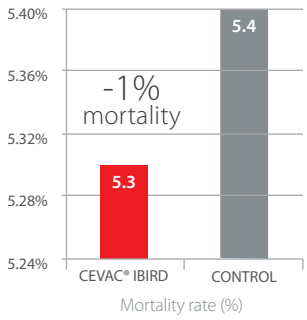
FCR



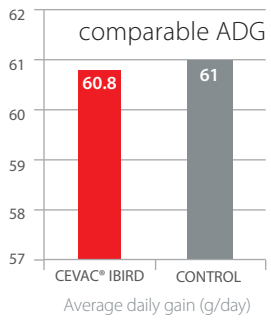
Performance index

In the first location, the two groups did achieve similar results, and extra-income could not be calculated.

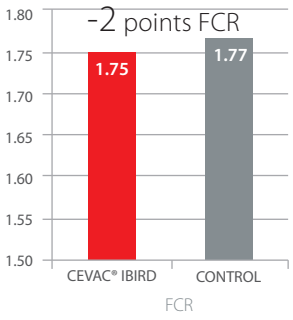
LOCATION 2



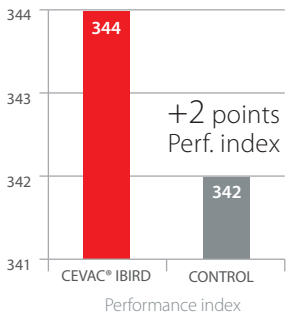
Mortality rate (%)



Average daily gain (g/day)

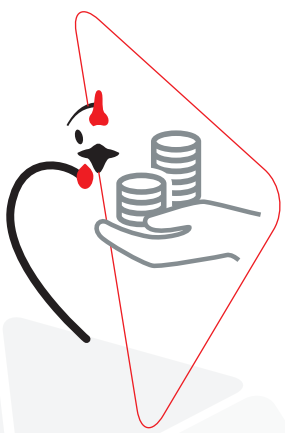


FCR



Performance index

In the second location, a better profitability could be demonstrated.



ECONOMIC EVALUATION

Based on cost-benefits calculation (mortality, body weight and FCR)

the extra revenues per 1,000 birds would be +12€

Source: Sheshenin D. 2013, pers. comm.

South Africa

1,300,000 DAY-OLD CHICKS PER WEEK,
1 COMPANY, HISTORICAL COMPARISON

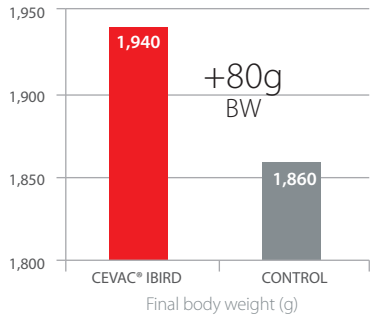
GROUP 1: (CEVA) 3 CYCLES,
CEVAC® IBIRD AT DAY 1

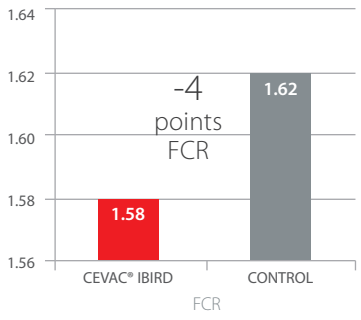
GROUP 2: 3 CYCLES,
COMPETITOR 793B AT DAY 1

VACCINATION PROGRAMS

	GROUP 1 - CEVA PROGRAM	GROUP 2 - CONTROL
D1 (Hatchery)	IB Mass + **Cevac® IBird (spray)**	IB Mass + **Competitor 793B (spray)**

RESULTS & CONCLUSIONS





ECONOMIC EVALUATION

Based on local market prices,

the extra revenues per 1,000 birds would be +83.62€

Argentina

3,000,000 DAY-OLD CHICKS, 2 COMPANIES UNDER Q1 IBV CHALLENGE, 3 GROUPS EACH

GROUP 1: (CEVA) 1,317,000 BIRDS, CEVAC® IBIRD AT DAY 1

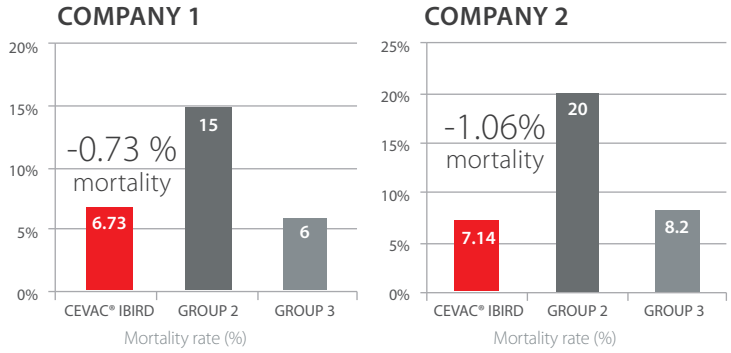
GROUP 2: CONTROL, DURING Q1

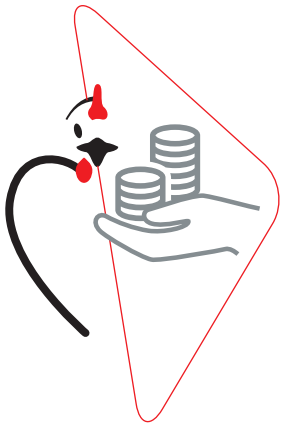
GROUP 3: 1,770,000 BIRDS, CONTROL, MASS VACCINE ONLY

VACCINATION PROGRAMS

	GROUP 1 - CEVA PROGRAM n company 1 = 1,100,000 birds n company 2 = 217,000 birds	GROUP 2 - DURING Q1 OUTBREAK	GROUP 3 - BEFORE Q1 n company 1 = 1,600,000 birds n company 2 = 170,000 birds
D1 (Hatchery)	Common vaccination program + **Cevac® IBird (spray)**	Common vaccination program	Common vaccination program

RESULTS & CONCLUSIONS





ECONOMIC EVALUATION

Based on cost-benefits calculation (mortality, body weight and FCR)

the extra revenues per 1,000 birds would be +91.30€ (company 1) and +141.90€ (company 2)

Source: Sesti, L. et al., 2014. Diagnostic, epidemiology and control of the Q1 infectious bronchitis virus (IBV) variant strain in Peru, Colombia, Argentina and Chile. VIII. International Symposium on Avian Corona- and Pneumoviruses and complicating pathogens, Rauischholzhausen, Germany, June 17-20.

Cevac
IBras®

Brazil

26,400,000 DAY-OLD CHICKS,
9 COMPANIES, 7 LOCATIONS, 2 GROUPS,
HISTORICAL COMPARISON

GROUP 1: (CEVA) CEVAC® IBRAS AT DAY 1

GROUP 2:
ROUTINE PROGRAM

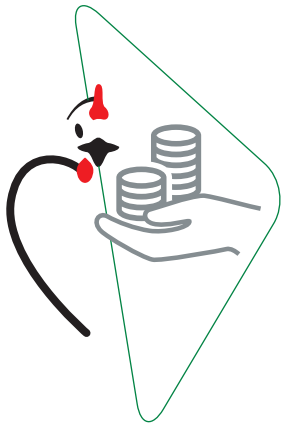
VACCINATION PROGRAMS

	GROUP 1 - CEVA PROGRAM	GROUP 2 - CONTROL
D1 (Hatchery)	Live IB Mass + **Cevac® IBras (spray)**	Live IB Mass (spray)

RESULTS & CONCLUSIONS

PARAMETER	PERFORMANCE IMPROVEMENT IN CEVA PROGRAM	ECONOMICAL BENEFIT (euros/1,000 birds)
Use of antibiotics	not applicable	+10.00
Total mortality (%)	-2.3	+25.30
FCR	-0.08	+48.00
Final weight (g)	+160	+51.20
Airsacculitis condemnation (partial) (%)*	-0.74	+12.19
Airsacculitis condemnation (total) (%)*	-0.11	+2.31
Colibacillosis condemnation (%)*	-1.38	+36.70

** economical valuation: J. Chacon, pers. Comm.*



ECONOMIC EVALUATION

Based on cost-benefits calculation (mortality, body weight and FCR)

the extra revenues per 1,000 birds would be +185.70€

Source: Chacon J. et al., 2018. Farm and slaughterhouse parameters affected by BR strain of infectious bronchitis virus. American Association of Avian Pathologists (AAAP) meeting,Denver, CO, July 13-17.

Cevac
IBron™

United States of America (1)

17,000,000 DAY-OLD CHICKS,
1 FARM, 2 GROUPS,
DVM1639 IBV CHALLENGE
HISTORICAL COMPARISON

GROUP 1: (CEVA) 9,268,385 BIRDS,
CEVAC® IBRON™ AT DAY 1

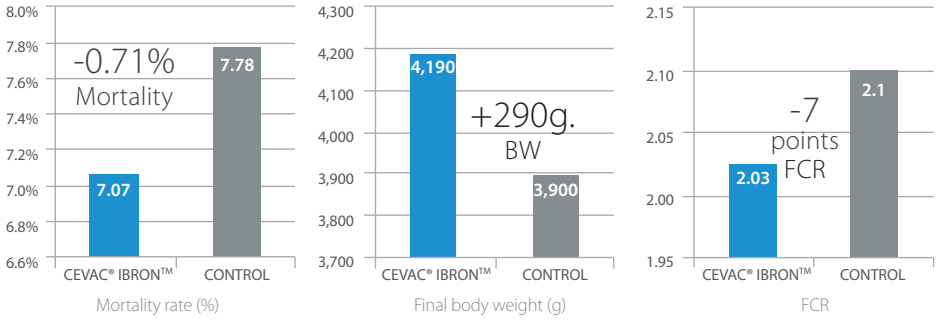
GROUP 2: 7,835,800 BIRDS,
ROUTINE PROGRAM

SLAUGHTER AT 61.07
DAYS OF AGE (GROUP 1)
AND 62.07 DAYS OF AGE (GROUP 2)

VACCINATION PROGRAMS

	GROUP 1 - CEVA PROGRAM	GROUP 2 - CONTROL
D1 (Hatchery)	Live IB **+ Cevac® IBron™ (spray)**	Live IB (Spray)

RESULTS & CONCLUSIONS



ECONOMIC EVALUATION

Based on cost-benefits calculation (mortality, body weight and FCR)

the extra revenues per 1,000 birds would be +143.70€

Source: Linares J.A. et al., 2017. Biology Scientific Forum.

United States of America (2)

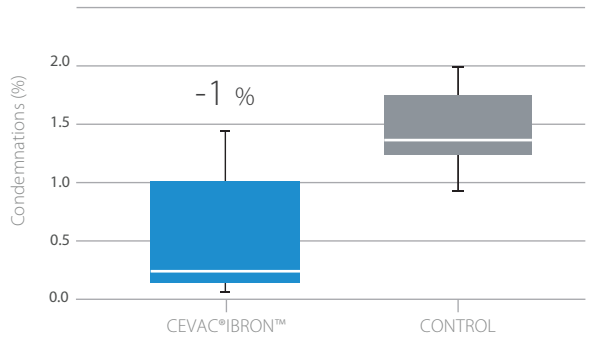
5,340,000 DAY-OLD CHICKS
2 GROUPS CONTEMPORANEOUS

GROUP 1: (CEVA) 2,670,000 BIRDS
89 FLOCKS - CEVAC® IBRON™ + MASS

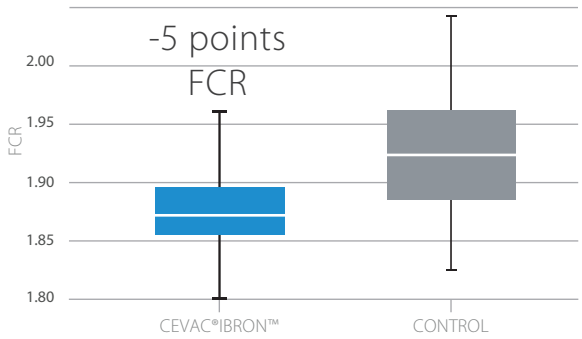
GROUP 2: 2,670,000 BIRDS
MASS VACCINATION

RESULTS & CONCLUSIONS

	GROUP 1 Cevac® IBron™+ Mass	GROUP 2 Control	P. VALUE
Slaughter age (d)	53.3	52.9	>0.05
ADG (g/d)	59.67	59.92	>0.05
Slaughter weight	3.18	3.17	>0.05
ADJ slaughter weight (32.95 d)	3.17	3.18	
FCR	1.88	1.93	<0.05
Adj FCR (32.95 d)	1.88	1.93	
Condemnation (%)	0.45	1.45	<0.05



The group vaccinated with Cevac® IBron™ demonstrated a better condemnation rate, 0.45% against 1.45% in the control group, with statistical difference



Cevac® IBron™ improved the feed conversion rate in 5 points, from 1.93 to 1.88

ECONOMIC EVALUATION

Based on cost-benefits calculation (mortality, body weight and FCR)

the extra revenues per 1,000 birds would be +46 €

United States of America (3)

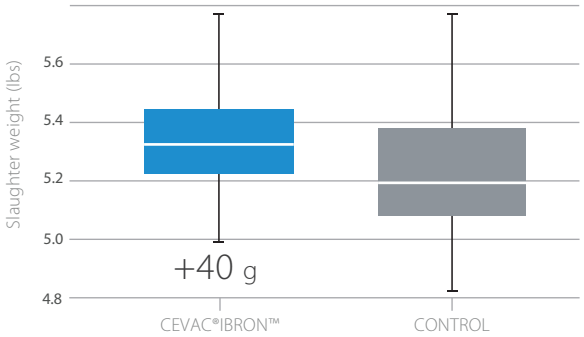
5,580,000 DAY-OLD CHICKS, 2 GROUPS CONTEMPORANEOUS

GROUP 1: (CEVA) 2,520,000 BIRDS, CEVAC® IBRON™ + MASS AT DAY 1

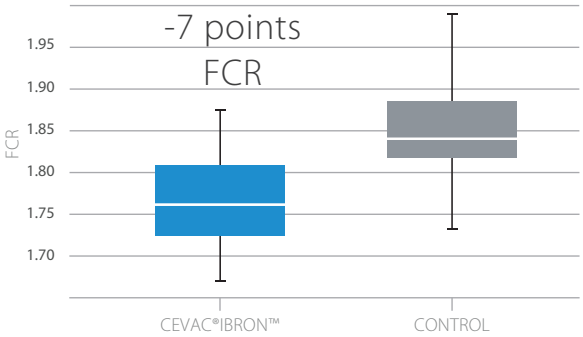
GROUP 2: 3,060,000 BIRDS, MASS VACCINATION

RESULTS & CONCLUSIONS

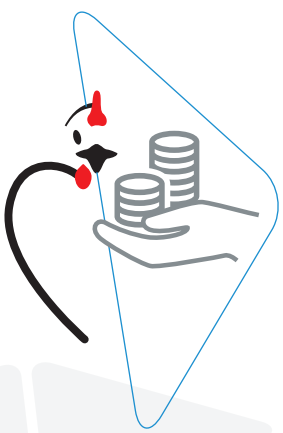
	GROUP 1 Cevac® IBron™+ Mass	GROUP 2 Control	P. VALUE
Number of flocks	84	102	
Slaughter age (d)	41.1	42.7	<0.05
ADG (g/d)	58.64	55.5	
Slaughter weight	2.41	2.37	<0.05
ADJ slaughter weight (32.95 d)	2.48	2.31	
FCR	1.77	1.84	<0.05
Adj FCR (32.95 d)	1.78	1.83	



The group vaccinated with Cevac® IBron™ demonstrated a better slaughter weight in 40g, with statistical difference



Cevac® IBron™ improved the feed conversion rate in 5 points, from 1.84 to 1.77



ECONOMIC EVALUATION

Based on cost-benefits calculation (mortality, body weight and FCR)

the extra revenues per 1,000 birds would be +46 €

United States of America (4)

CUSTOMER WITH GA08 AND GA13 CHALLENGE INTRODUCED CEVAC® IBRON™ DURING THE YEAR 2016

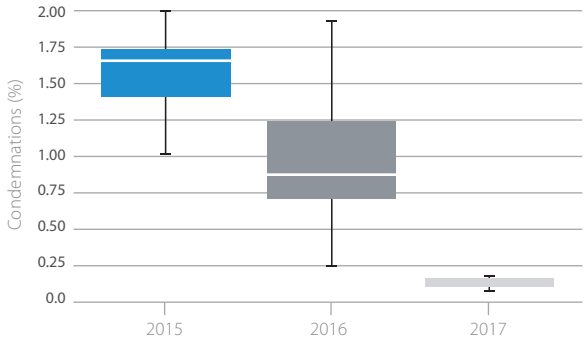
2015: MASS VACCINATION

2016 : PARTIAL CEVAC® IBRON™, YEAR OF VACCINE INTRODUCTION IN THE BROILER PRODUCTION

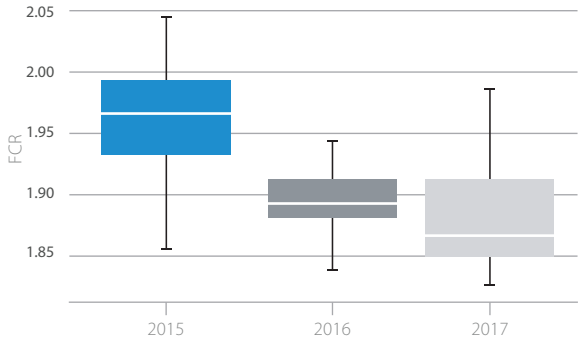
2017: CEVAC® IBRON™

RESULTS & CONCLUSIONS

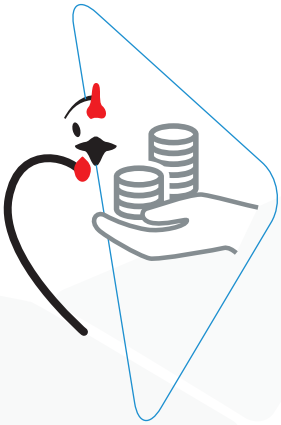
	2015	2016 Partial Cevac® IBron™	2017 Cevac® IBron™	P. VALUE
Slaughter age (d)	54.6	53.9	52.91	-
ADG (lb/d)	0.13	0.13	0.13	<0.05
Slaughter weight (lb)	7.24	7.02	6.96	-
FCR	1.96	1.89	1.88	-
Adj FCR (32.95 d)	1.94	1.89	1.88	
Condemnation (%)	1.55	0.94	0.09	-



The dramatic decrease in condemnations was due to Cevac® IBron™ as most of the condemnations were due to airsacculitis with GA08 and GA13 challenge.



Cevac® IBron™ improved the feed conversion rate in 8 points, from 1.96 in 2015 to 1.88 in 2017



ECONOMIC EVALUATION

Based on cost-benefits calculation (mortality, body weight and FCR)

the extra revenues per 1,000 birds would be +106 €

6 Summary of profitability

Cevac IBird®
Cevac IBras®
Cevac IBron™

Country	Mortality (%)	BW (extra g./bird)	FCR	Results (€/1,000 birds)
MALAYSIA (1)	-1.21	+30	-0.04	+67.20
MALAYSIA (2)	-3.08	+10	-0.12	+105.00
SRI LANKA	na	na	na	+146.86
INDONESIA	-1,04	+140	-1	+72,00
PHILIPPINES	na	na	na	+21.68
ITALY	-2.00	+52	-0.18	+146.65
SPAIN	-0.72	+100	0	+38.60
RUSSIA	-0.10	na	-0.02	+12.00
SOUTH AFRICA	na	+80	-0.04	+83.62
ARGENTINA	na	na	na	+116.60
BRAZIL*	na	+160	-0.08	+185.70
USA (1)**	-0.71	+290	-0.07	+143.70
USA (2)**	na	+10	-5	+46.00
USA (3)**	na	+40	-7	+46.00
USA (4)**	na	+10	-5	+106.00

*Table 2. Values used to evaluate the economic return of the field cases previously described: BW: 2Kg. ; F.C.R.: 1,6 ; Feed price: 0,3€/Kg. Live Bird Price: 0,8€/Kg. na: non applicable * Cevac® IBras **Cevac® IBron™*

Cevac
IBird®

HEALTHY CHICKENS

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Cevac® IBird: infectious bronchitis under control from the hatchery.

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