



BTSF Better Training for Safer Food *Initiative*

Animal welfare in poultry production (chickens kept for meat production) – IV Session

Rome 22-24 November, 2023

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Welfare problems caused by genetic factors and the resistance to stress of commercial broilers

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Content...

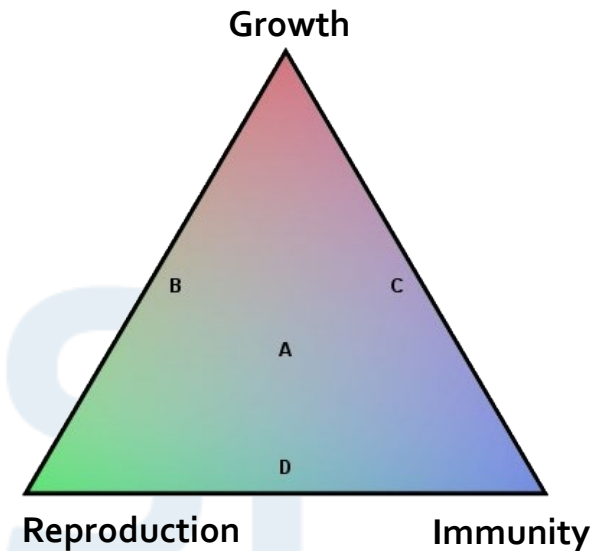
- Background information
 - Genetic selection strategy in broiler production schemes
 - Stressors and stress response
- Main disorders causing welfare problems in relation to genetic selection in broiler chickens
- Conclusion: Take home message

Background...

- Both “natural” selection for adaptation to survive in nature and in commercial genetic selection will result in selection sweeps that increase the frequencies of rare recessive alleles that can have negative or positive effect on fitness.
- Moreover, Trade-Off & Resource allocation notions are based on the hypothesis that nutrient and energy consuming processes cannot be optimal simultaneously for all life parameters (Main life parameters: growth, reproduction, immunity)



(From Bed'Hom & Zerjal, 2017)

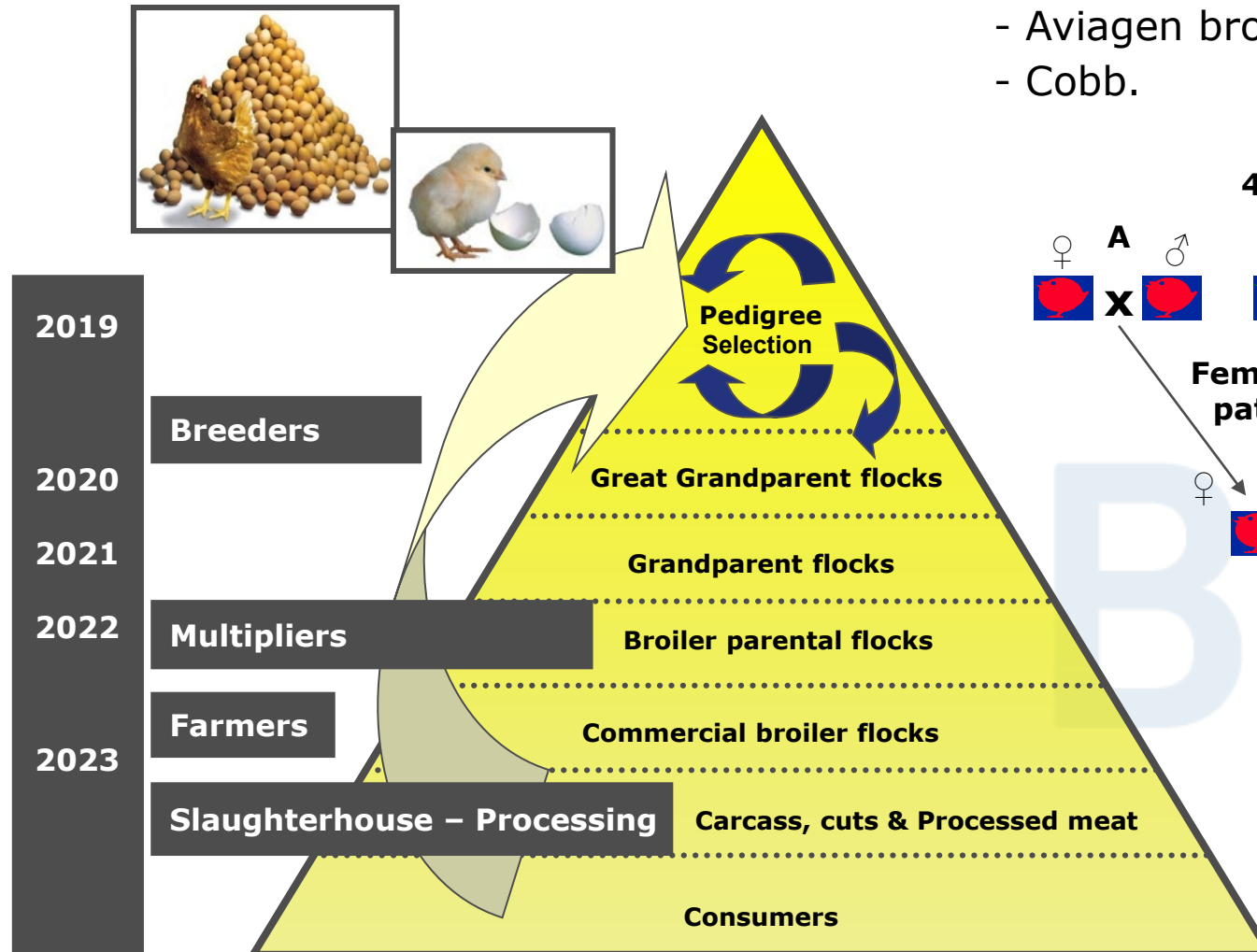


✓ Thus, in brief the genetic theory leads to the expectation that unexpected consequences of genetic selection for production traits will inevitably occur and that some changes are likely to be undesirable and to affect welfare.

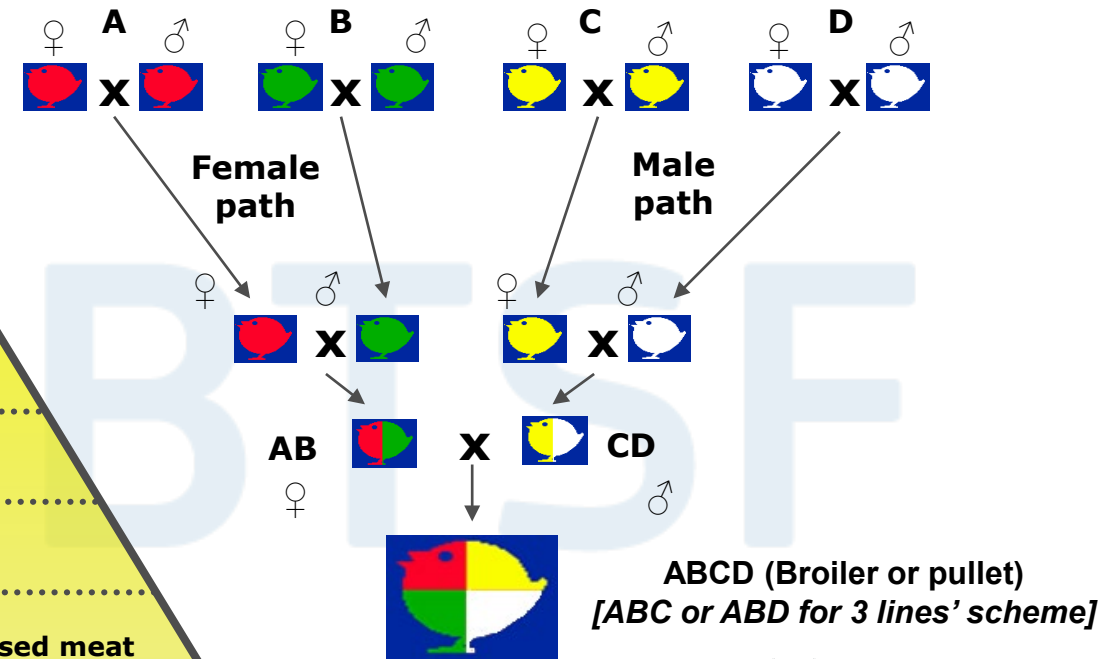
Genetic selection strategy in broiler production schemes A long term process to go...

2 Main breeding companies worldwide:

- Aviagen broiler (Ross, Hubbard),
- Cobb.



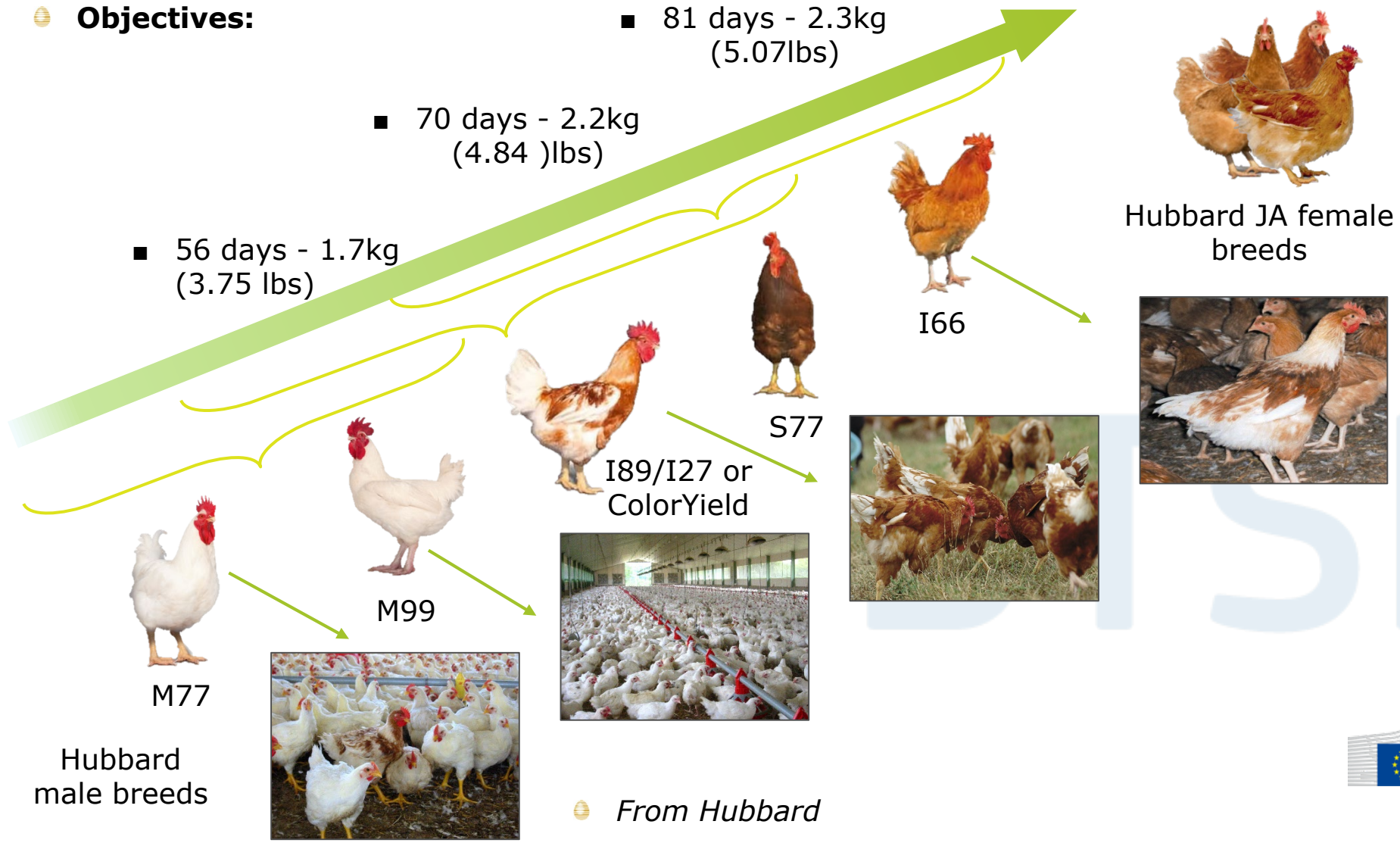
4 lines inter-cross scheme



🥚 Objectives:

- 56 days - 1.7kg (3.75 lbs)
- 70 days - 2.2kg (4.84 lbs)
- 81 days - 2.3kg (5.07lbs)

🥚 Most used crosses:



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There is more than one genotype of commercial broiler produced...



↓

Broiler(Export)
<36d & <1,5kg



↓

Fast growth rate
Conventional broiler
<42d & <2.5kg



↓

Certified & Heavy
broiler
50-70d & 2.5-5kg

↓

Slow growth rate
Organic &
"Label Rouge"
>81d & <2.5kg



↓

Very slow growth rate
Local Breeds
(Poulet de Bresse)
>110 jr



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Welfare problems are taken into consideration by the breeding industry as illustrated by the evolution of the number and nature of selected traits in broilers

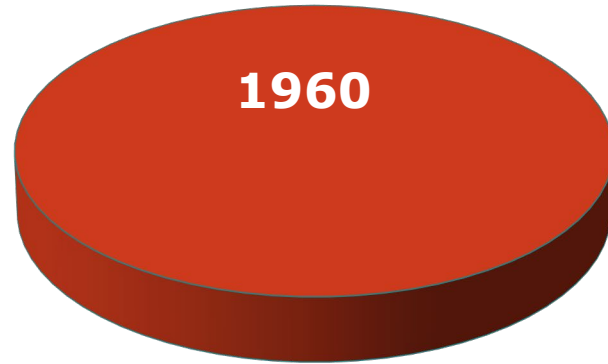


Figure 3: Broiler carcasses from the Ross 308 and the Control (ACRBC) broilers in the 2001 study (Havenstein et al., 2003a,b)

ACRBC Males - 2001 Feed



Ross Males - 2001 Feed



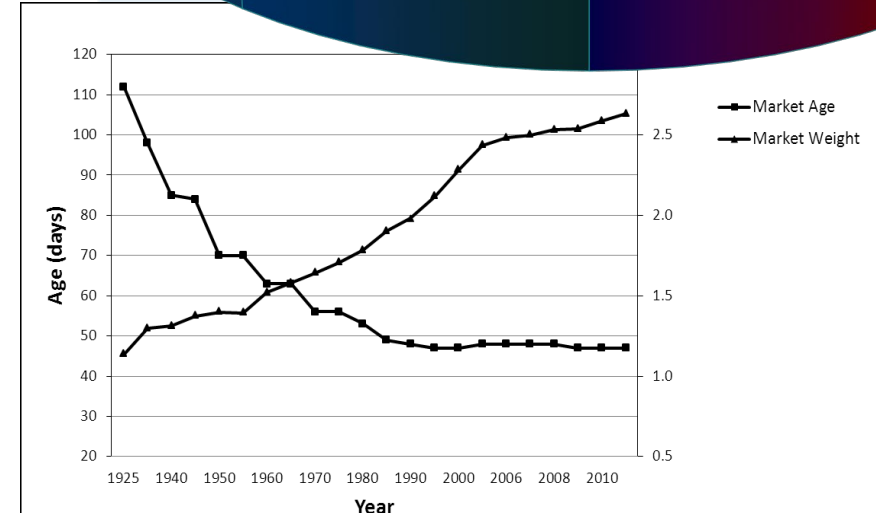
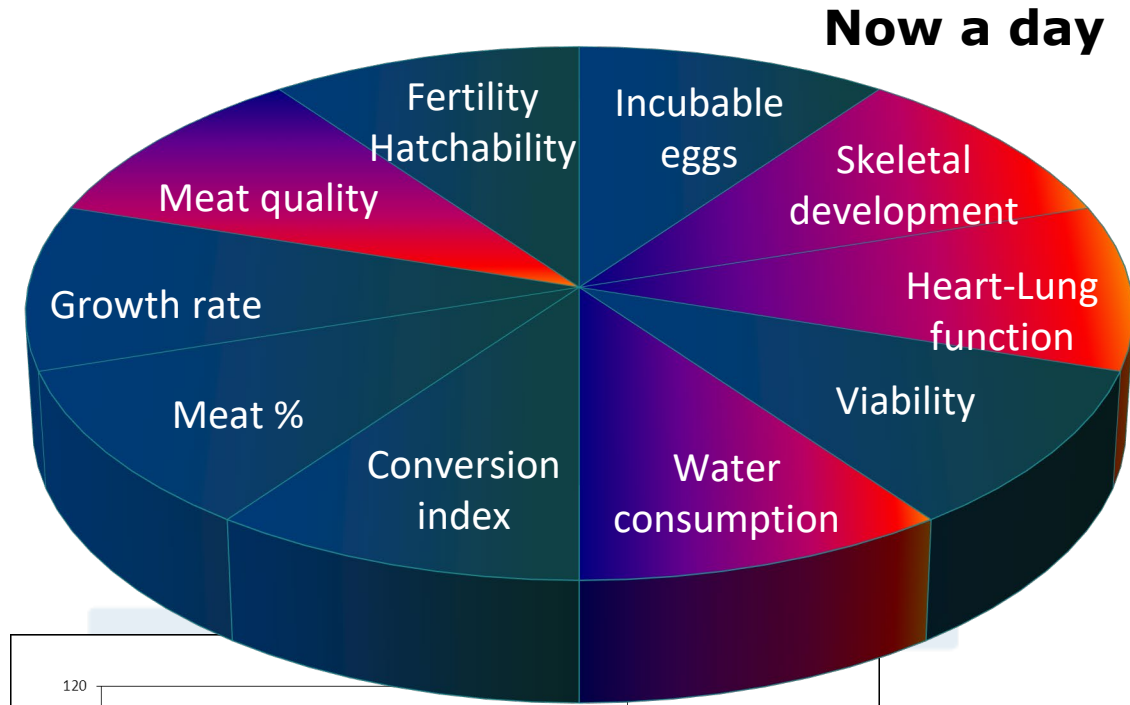
Day 43

Day 57

Day 71

Day 85

Anatomical impact of selecting for "fast growth rate" & "high body weight"

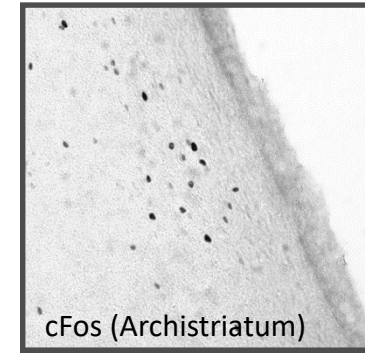
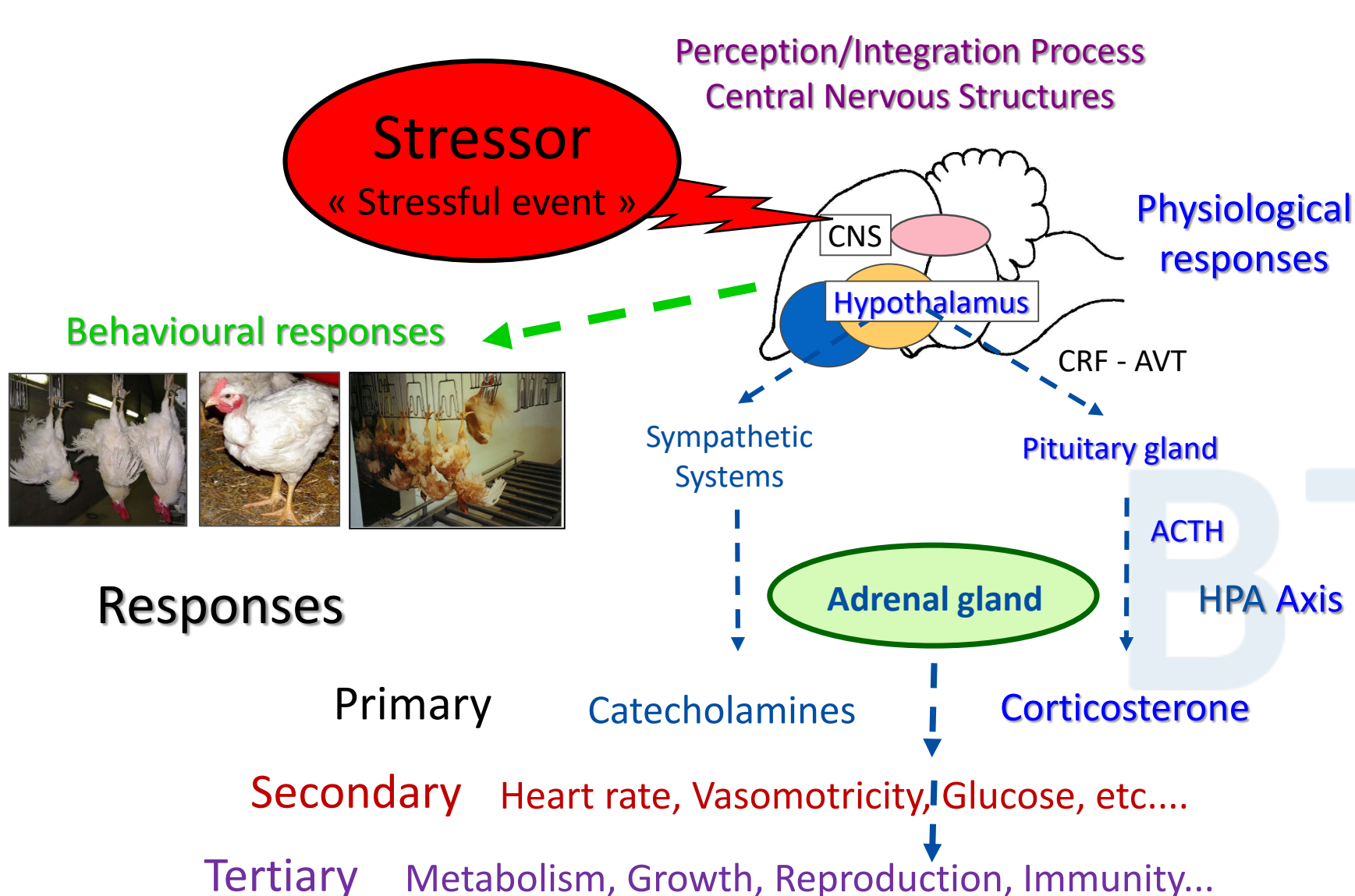


Background...

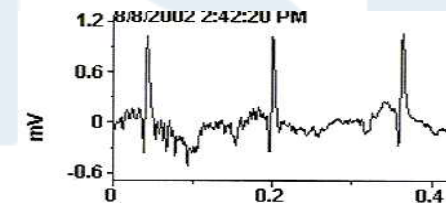
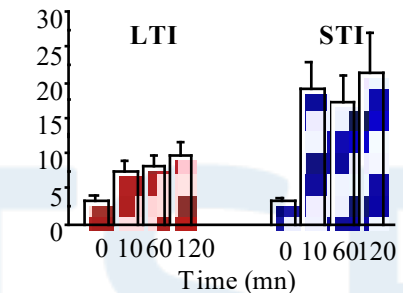
- Stress involves a stimulus (stressor [**Hazard**]) that initiate a stress response.
- Stress can be **Intense** or **Mild**, as well as **Acute** (transient) or **Chronic** (long lasting or repeated acute ones) [**Risk of exposure**].
- Stress response is an adaptive mechanism allowing the re-establishment of a state of homeostasis which is rapidly occurring following an acute stress.
- But a TOO high stress load for a TOO long period, will exhaust the organism resilience and leads to dysfunction resulting in welfare problems.



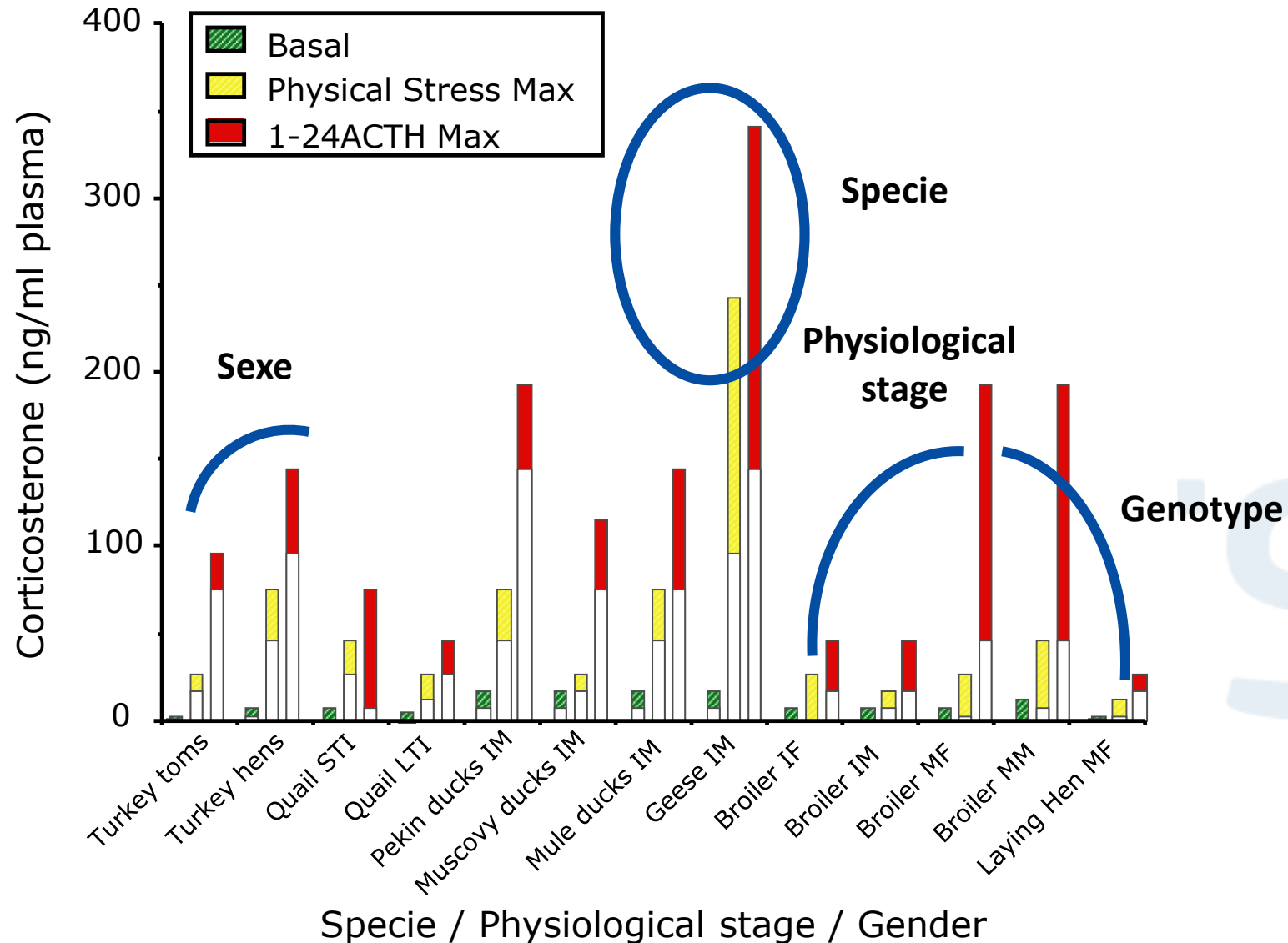
Risk assessments = Hazard (Stressors) x Risk of exposure (Timing, Duration, Intensity)

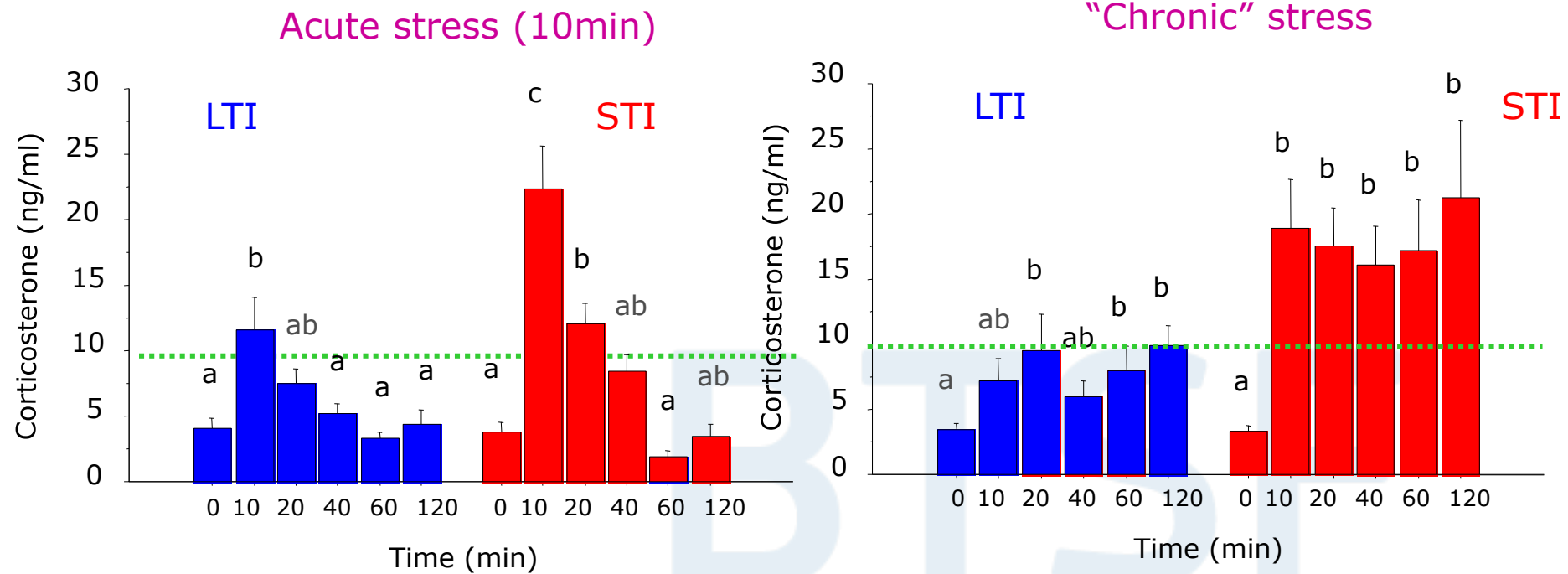


Corticosterone (ng/ml plasma)

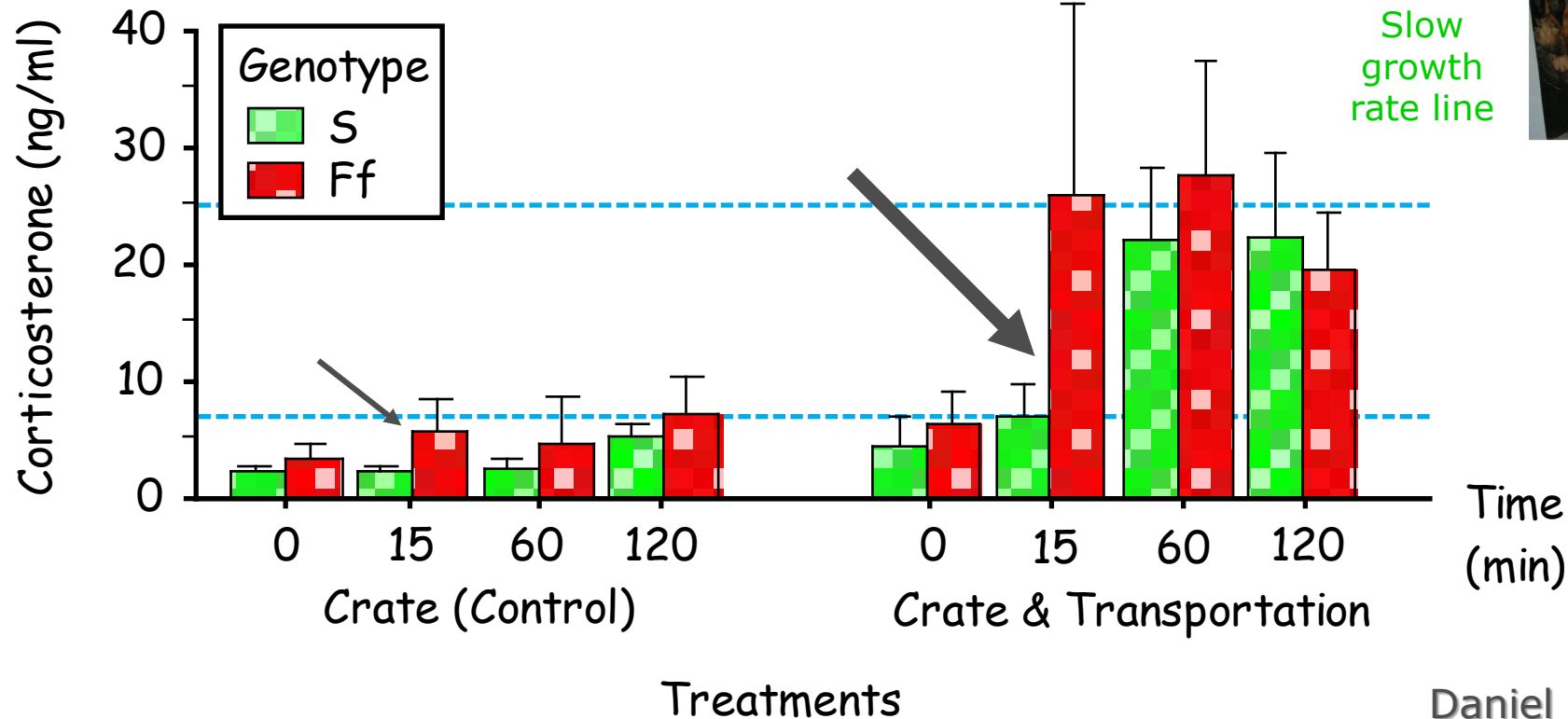


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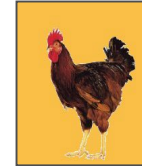
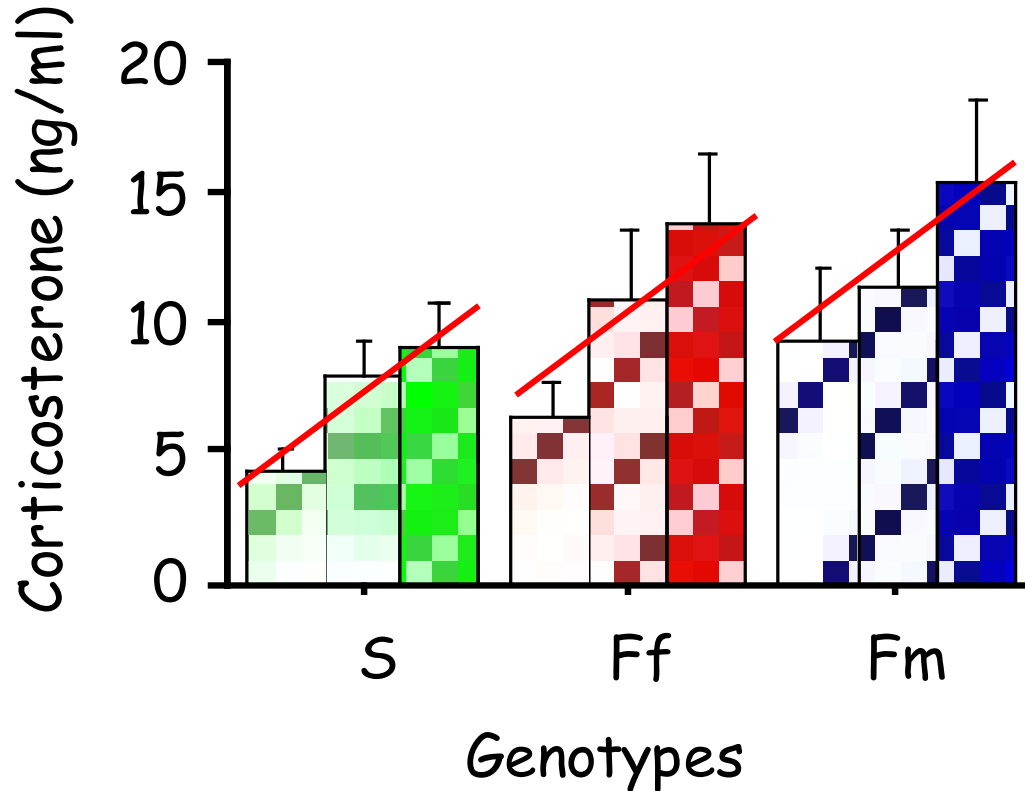


(Hazard et al., 2008)



Fast growth rate line
(Female line)

Phenotype = Genotype + Environment + Genotype x Environment Interaction



Slow
growth
rate line



Fast growth
rate line
(Female line)



Fast growth
rate line
(Male line)

Capture, Transportation (<10mn) &

□ Control (C)

▨ C & Shackle line 2mn (CSI)

▩ CSI & Temperature (210min à 35°C)(CSIT)

ANOVA

Genotype : $P < 0.001$

Treatment : $P < 0.001$

G x T : $P = 0.45$

PLSD ($P < 0.05$)

S < Ff ≤ (0.06) Fm

C < CSI < CSIT



Phenotype = Genotype + Environment
+ *Genotype x Environment Interaction*

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Welfare problems in broilers caused by genetic factors and the resistance to stress of commercial broilers

Phenotype = Genotype + Environment + Genotype x Environment Interaction

Genotype effect : Depend on the heritability (h^2) which is the proportion of the variability of a specific trait transmitted to the next generation due to the genotype... ranging from 0 to 1

Most often heritabilities range from 0.1 to 0.4

Remember: Genetic selection can only be effective if sufficient genetic diversity is present in the selected population (Genetic diversity vs consanguinity)

SCIENTIFIC OPINION

Scientific Opinion on the influence of genetic parameters on the welfare and the resistance to stress of commercial broilers¹

EFSA Panel on Animal Health and Welfare^{2, 3}

European Food Safety Authority (EFSA), Parma, Italy

3.	Overview of the welfare of broilers	9
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*This list remains valid...
with different respective prevalence
depending upon genotype and rearing
environment...
It mainly apply to fast growth rate
broiler genotype!...
Nevertheless, a phenotypic correlation
between traits does not imply the
existence of a genetic one.*

Mortality:

Chicken welfare is influenced more by housing conditions than by stocking density

Marian Stamp Dawkins, Christl A. Donnelly* & Tracey A. Jones

Department of Zoology, University of Oxford, South Parks Road, Oxford OX1 3PS, UK

* Present address: Department of Infectious Disease Epidemiology, Faculty of Medicine, Imperial College London, St. Mary's Campus, Norfolk Place, London W2 1PB, UK

NATURE | VOL 427 | 22 JANUARY 2004 | www.nature.com/nature

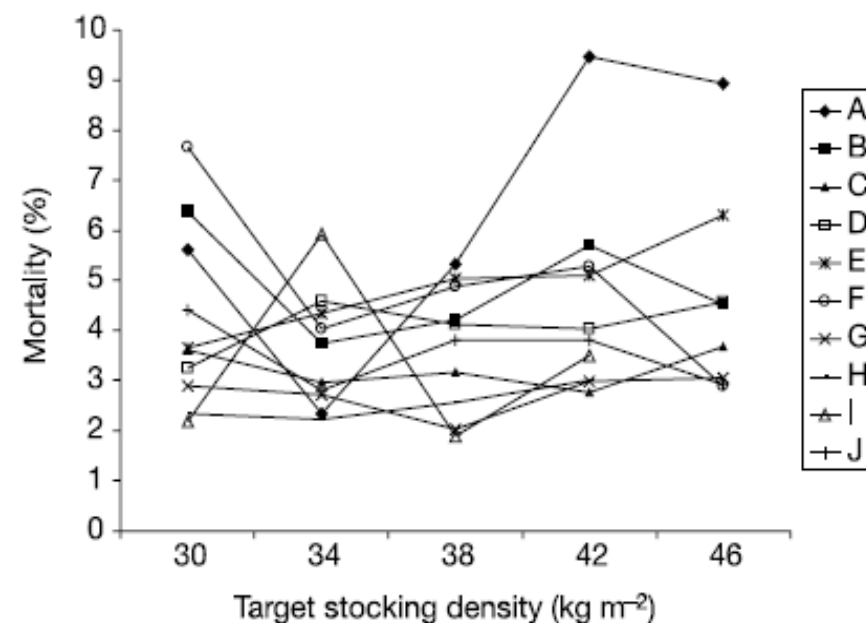
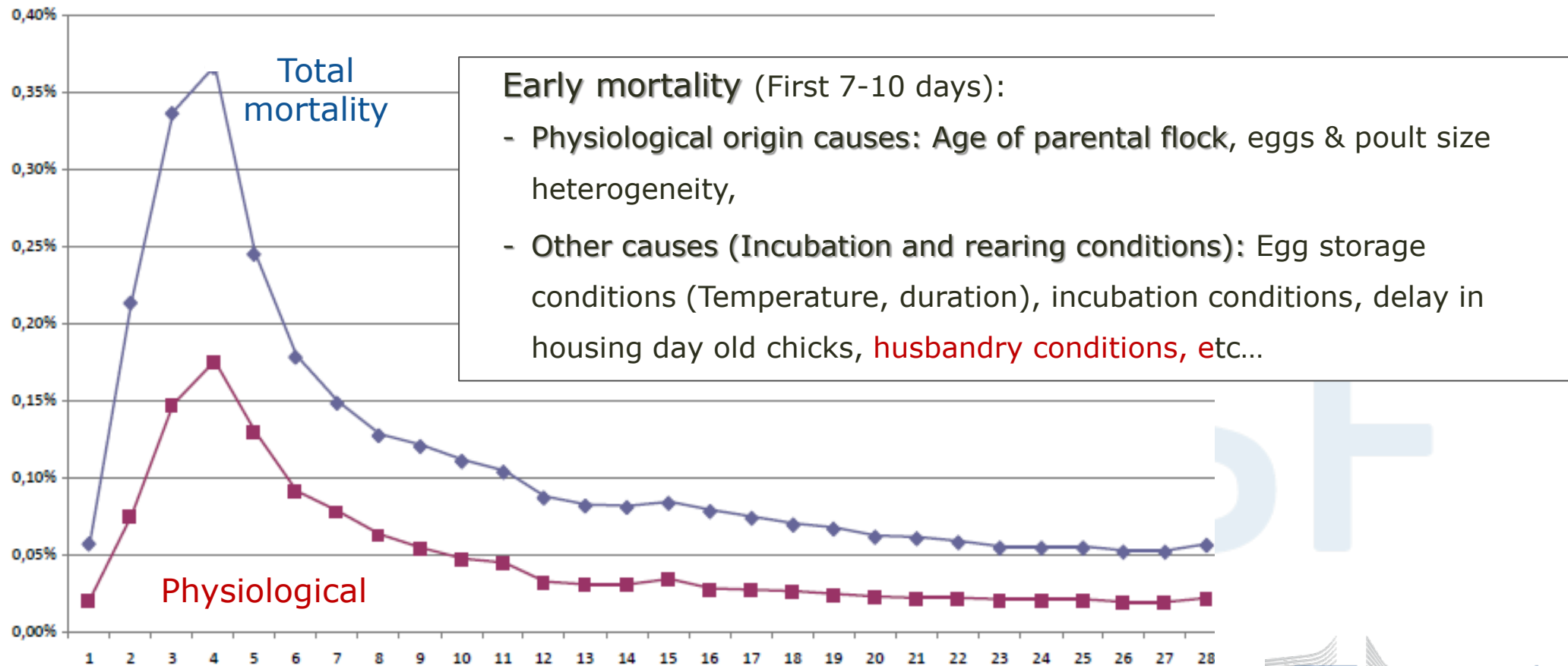


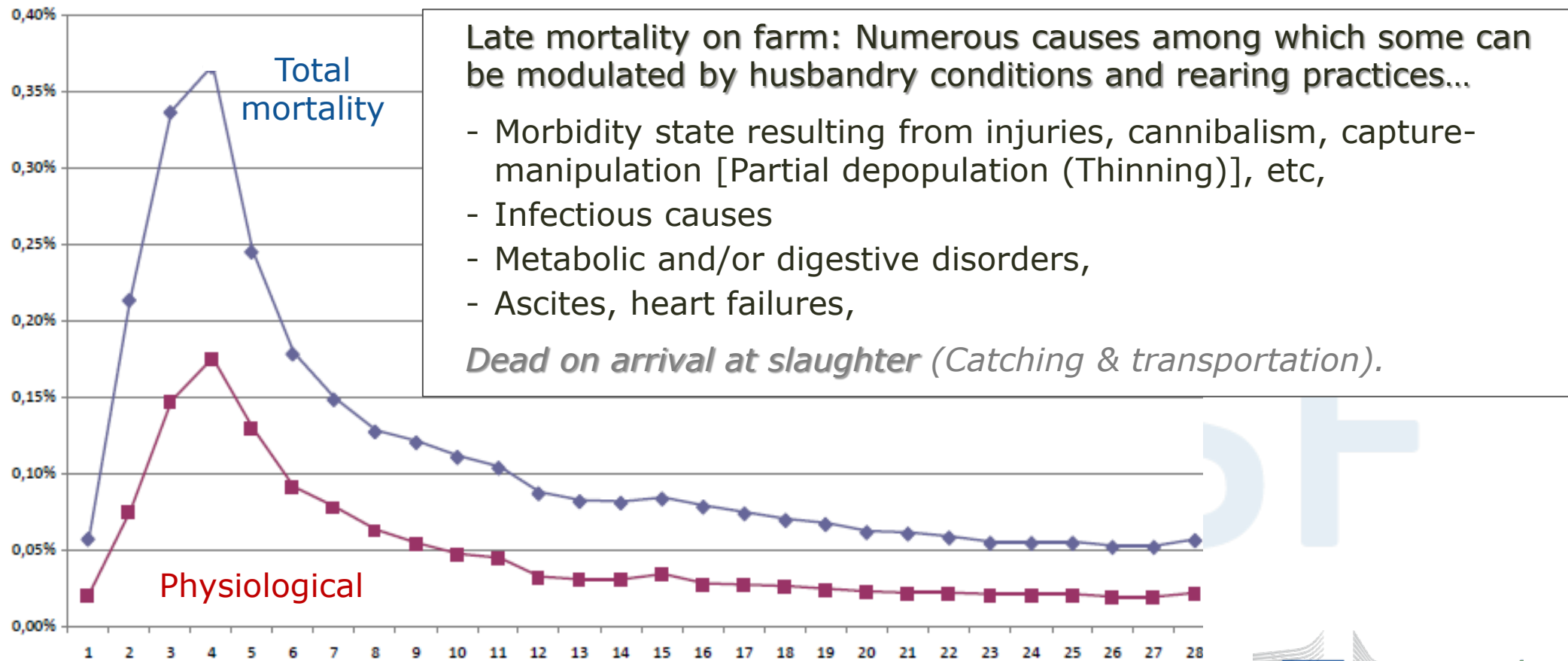
Figure 1 Total mortality in relation to target stocking density. The percentage of total mortality is shown separately for each company (A–J) taking part in the trial.

On farm early (First 7-10 days) and late daily mortality figures.



Cumulative daily mortality rates: Threshold = 1% + 0,06% x slaughter age in days,

On farm early (First 7-10 days) and late daily mortality figures.



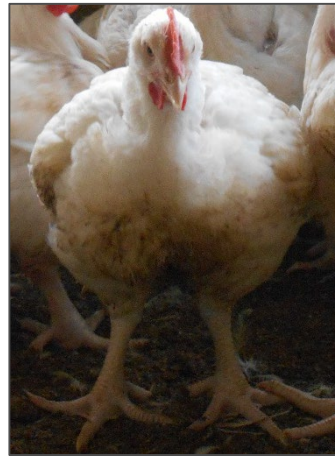
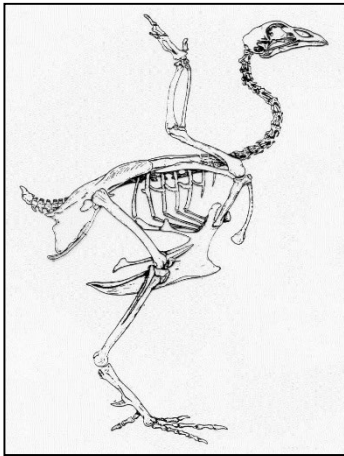
Cumulative daily mortality rates: Threshold = 1% + 0,06% x slaughter age in days,

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Musculoskeletal disorders affect predominantly the locomotor system in fast growth broilers and cause lameness.

➤ Different origins:

- developmental (**valgus-varus**, tibial dyschondroplasia, weak bones),
- infectious (femoral head necrosis, synovitis, infectious stunting).



valgus-varus inwards or outwards deviations of tibia or femur



➤ Genetic origin and selection possibilities: Varus and valgus deformities [Le Bihan-Duval et al. (1997)]

- **High phenotypic correlations with growth parameters, but very low genetic correlation,**
- **Heritable traits** ($h^2 > 0.20$).

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Musculoskeletal disorders affect predominantly the locomotor system in fast growth broilers and cause lameness.

➤ Different origins:

- developmental (valgus-varus, **tibial dyschondroplasia (TD)**, weak bones),
- infectious (femoral head necrosis, synovitis, infectious stunting).

Scoring scale

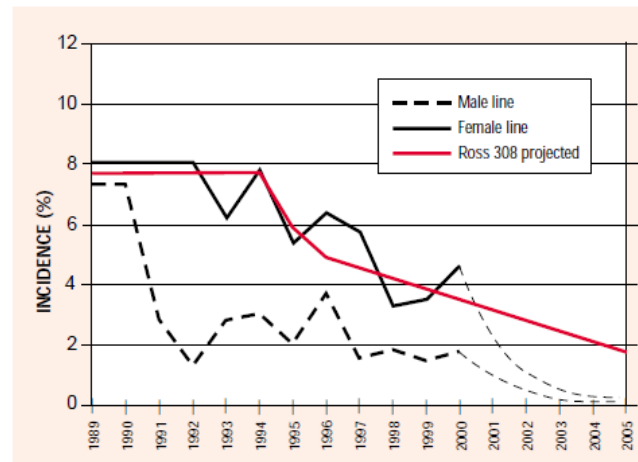
TD 1 = mild

TD 2 = severe

TD 3 = very severe



DIAGRAM 2: Graph of reduction in incidence of Tibial dyschondroplasia through time



➤ Genetic origin and selection possibilities against tibial dyschondroplasia [Kuhlers and McDaniel (1996)]

- **High phenotypic correlations** but **no or very low genetic correlations with growth parameters**
- **High heritability** (0.37 and 0.42 at 4 and 7 weeks respectively).

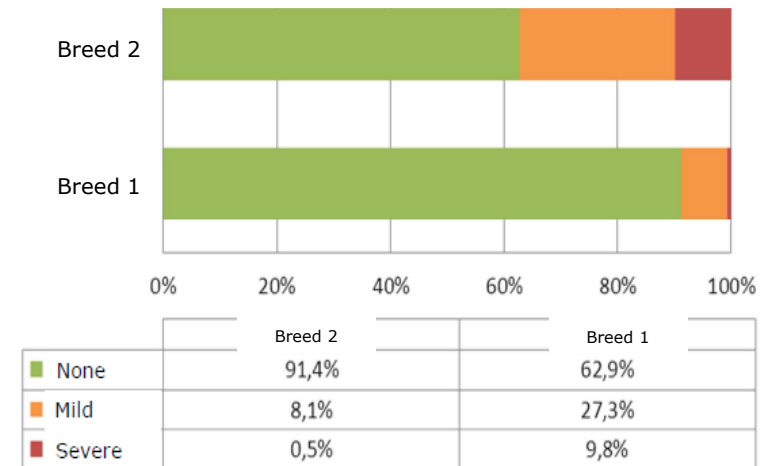
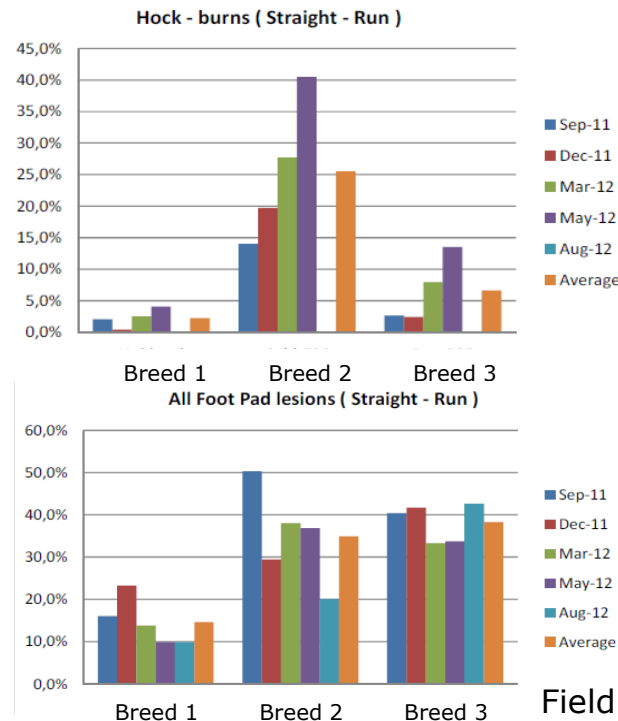
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Skin conditions or lesions of the breast, hock and feet (Contact dermatitis): Genetic predisposition and seasonal effects...

- **Incidence is highly variable and its etiology is multi-factorial** (environmental conditions such as wet litter (Main causes) and genetic predisposition) (Bessei, 2006; Berg, 2004)
- **Relevant management advice can substantially decrease the incidence of foot-pad dermatitis** (Algers and Berg, 2001; Berg & Algers, 2004).
- **Foot-pad dermatitis and hock burn susceptibility are heritable** (Akbas et al. (2009), with very low genetic correlation with body weight



From Hubbard



Foot pad lesions in experimental conditions

Field conditions

- Metabolic, oxydative and structural muscle defaults
 - Myopathies (deep pectoral myopathy, muscular dystrophy, spaghetti meat and wooden breast)... **mainly observed in genotypes of fast growth broiler strains,**
 - **Major consequences on meat quality and economical loss but their impact on welfare is unknown.**
 - **Very high phenotypic correlation but no genetic correlation with body weight in fast growth lines** (Alnahhas et al., 2016)

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Take home message



Genetic selection and welfare problems

Both a cause and a solution...

1. Genetic selection can increase the frequencies of rare recessive alleles that can have a negative effect causing welfare problems,
2. Although welfare problems are often reported to be phenotypically correlated with selected production traits, such as growth rate and body weight, they are most often not genetically correlated...
3. Traits associated to welfare problems are generally heritable leaving room for improvement by genetic selection, but an appropriate rearing environment should also be provided...
4. For these reasons, breeders pay attention to all identified deleterious traits and, although the impact of genetic selection is a long term process as commercial broilers correspond to at least a 4-5 years old genetic background, progressive improvements are observed in pedigree flocks of selected lines.

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Thank you

Thank you for your
attention

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