A.D. 1308 unipg

DIPARTIMENTO
DI SCIENZE AGRARIE,
ALIMENTARI E AMBIENTALI

INRAE

PPILOW

Day 2 - Session: Co-adapted systems, genotypes and animals

# Principal characteristics of suitable broiler genotypes adapted to outdoor system

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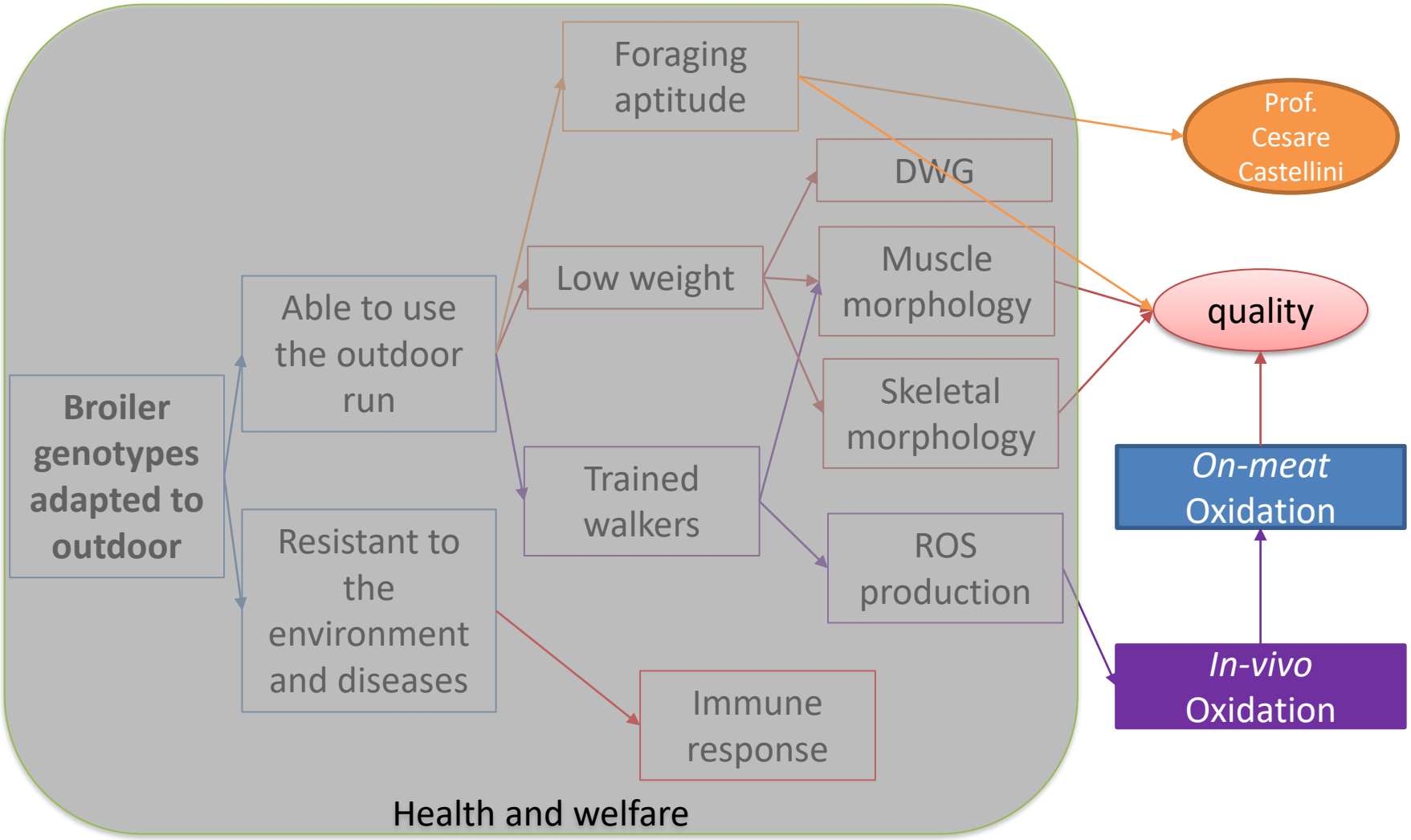

Foraging aptitude
Prof. Cesare Castellini
DWG
Low weight
Muscle morphology
quality
Able to use the outdoor run
Broiler genotypes adapted to outdoor
Skeletal morphology
Trained walkers
On-meat Oxidation
ROS production
Resistant to the environment and diseases
In-vivo Oxidation
Immune response
Health and welfare

Able to use the outdoor run

# Outdoor system mandatory conditions

- the chickens need to **go out**


too much sun, rain, wind


Environmental enrichments

- presence of **pasture**


vs

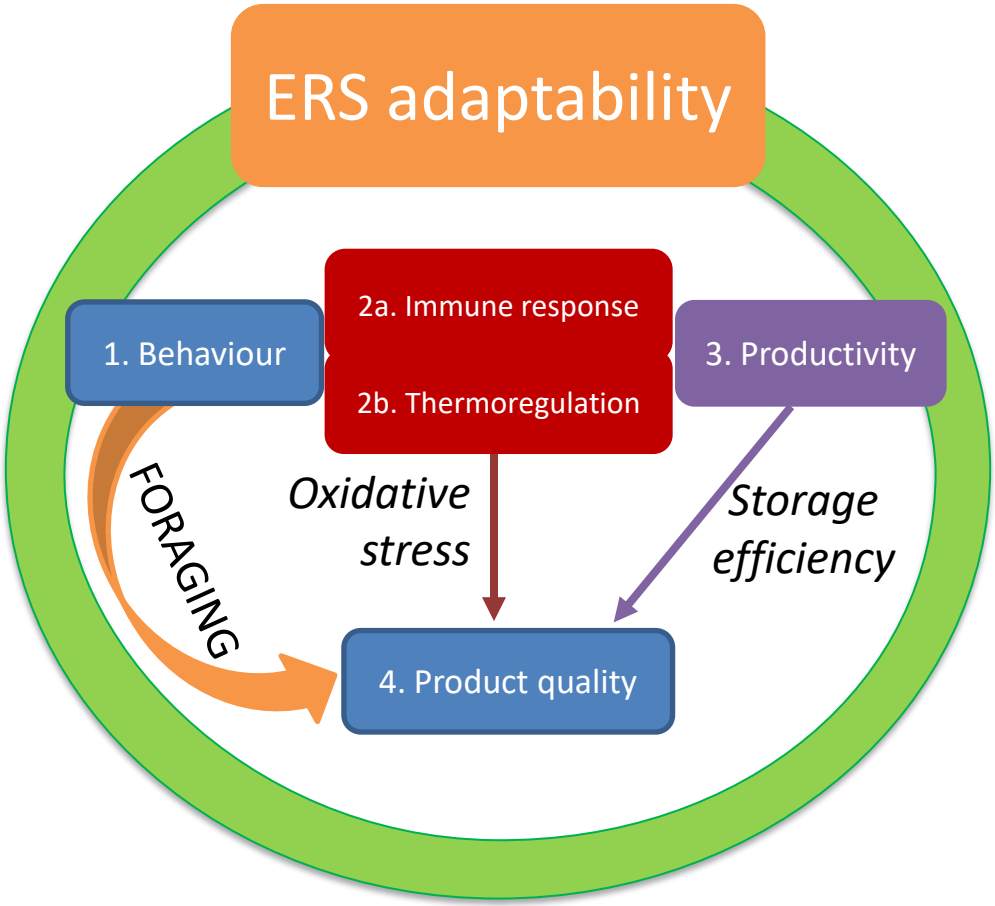
**Broiler genotypes adapted to outdoor**

Able to use the outdoor run

Resistant to the environment and diseases

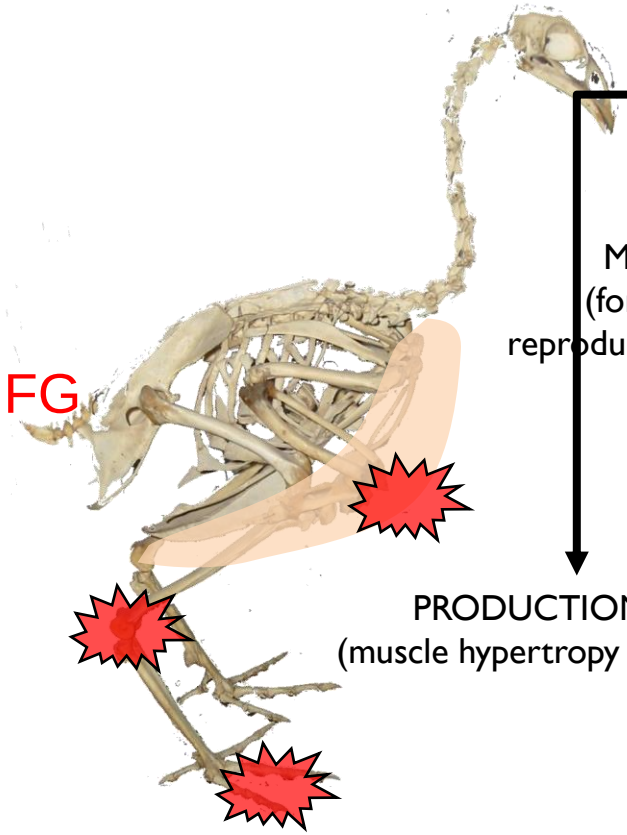
# Outdoor adaptability criteria

Extensive Rearing System (ERS) must **optimize a production system that promotes biodiversity, environmental sustainability and food safety** (*National Organic Standards Board, 1995)*



# RESOURCE ALLOCATION

| |
|---|
| Low weight |
| DWG |
| Muscle morphology |
| Skeletal morphology |



FG

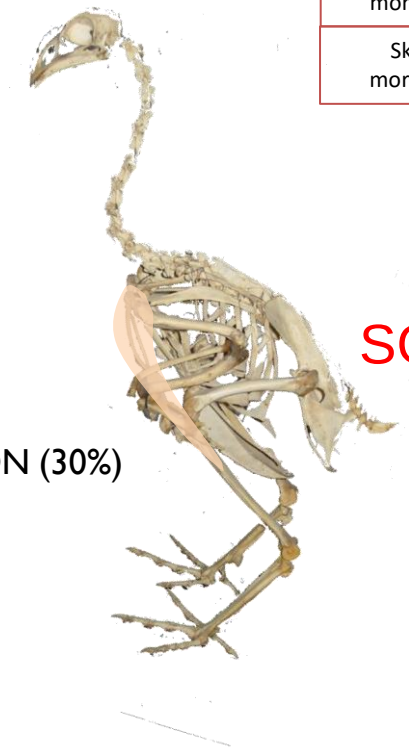
intake

MANTEINANCE
(foraging behaviour, reproduction, immune system)

MANTEINANCE
(70%)

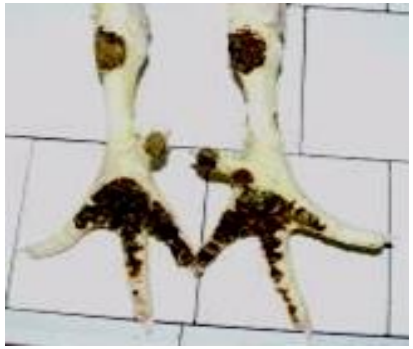
PRODUCTION (50%)
(muscle hypertropy & hyperlasia)

PRODUCTION (30%)



SG

sternal lesions



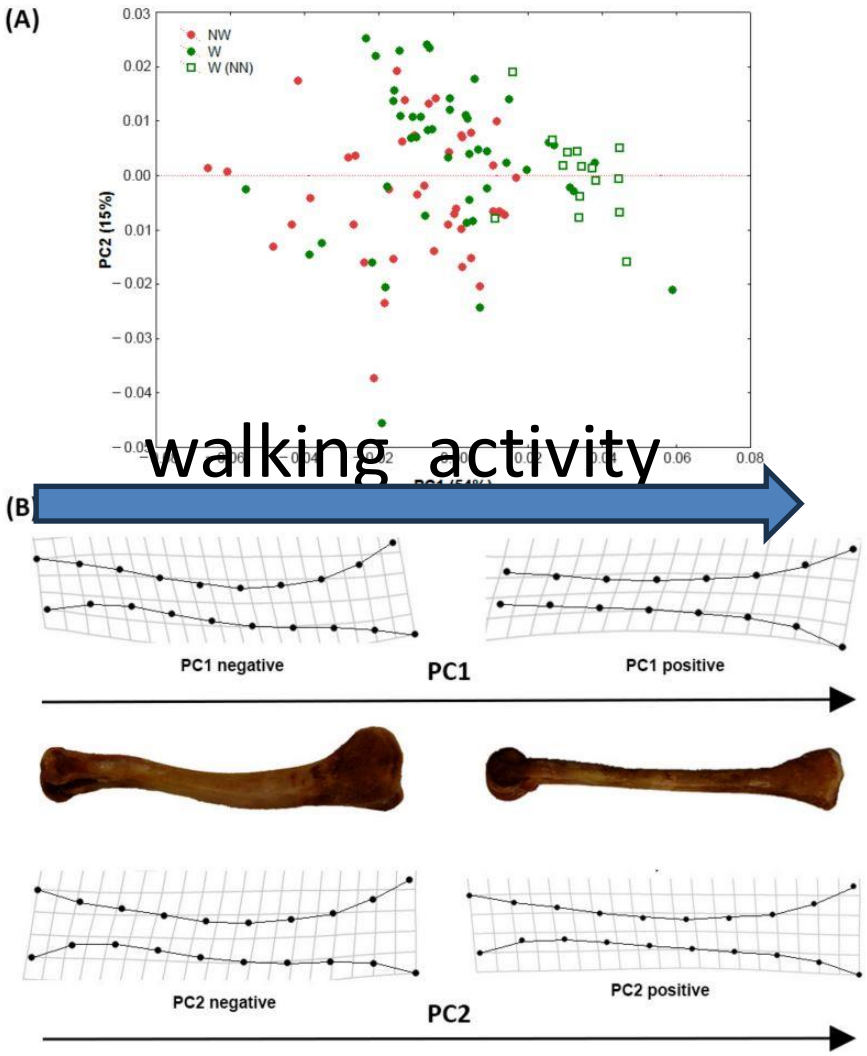
plantar lesions

VSG <30g/d

SG 30-45 g/d

FG >45 g/d

Tibia length and shape

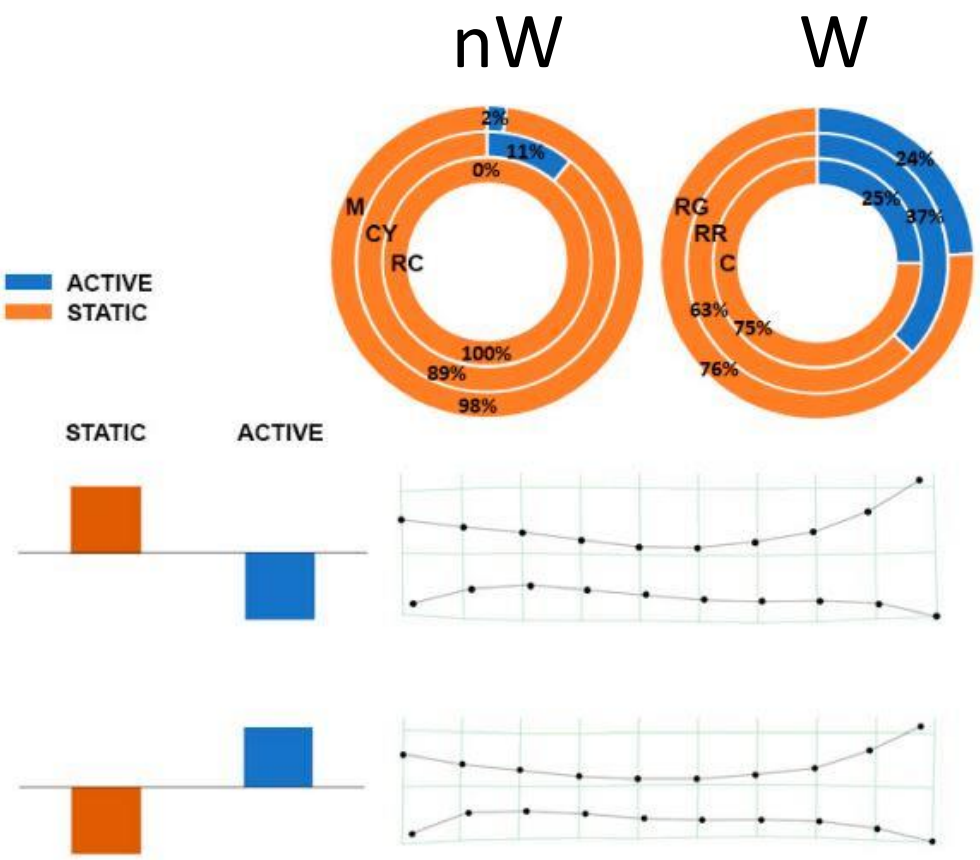



(A) Principal component analysis plot of chicken classified on the basis of walking activity.

- walking (W)
- not-walking (NW)
- walking naked neck (W-NN)

(B) Shape variation along PC1 and PC2 was represented by splines relative to positive and negative extremes of the axes.
For shape variation along PC1, tibiae of two extreme individuals were reported.

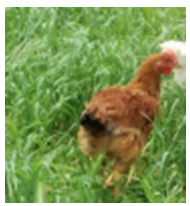
Pulcini et al., 2022 - *Animals*

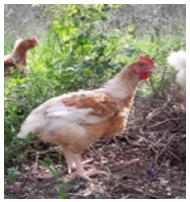



Partial least squares (PLS) showing the **morphological relationship between the tibia and the walking/resting behavior** described as a percentage of time spent in two main activities (Walking W and Not Walking—NW).

Percentages for each genotype are represented in pie charts. The splines depict tibia shape configuration corresponding to opposite patterns of behavior.

Pulcini et al., 2022 - *Animals*



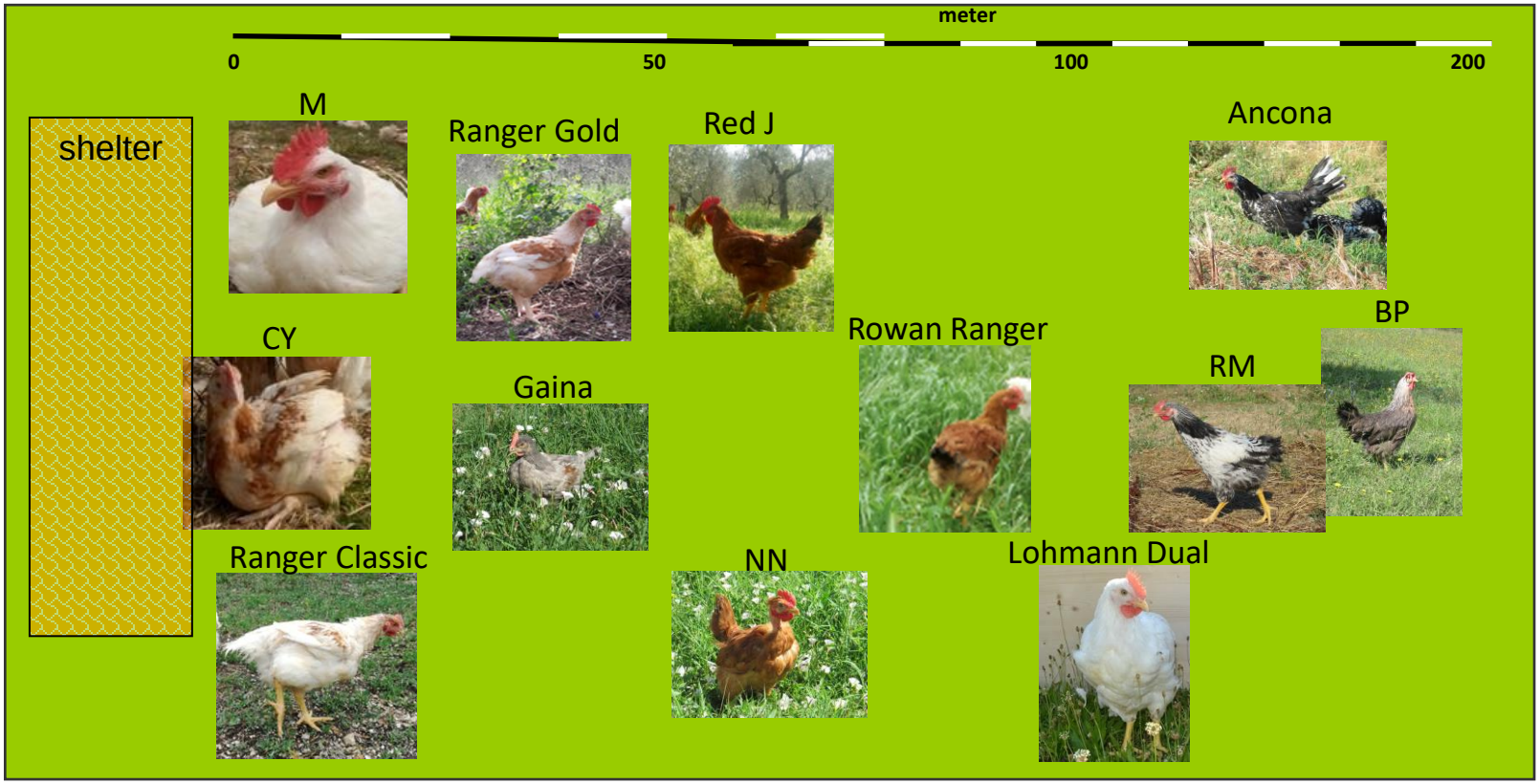

| DWG (g/d/bird) | 32.11 | 32.50 | 34.91 | 38.60 | 42.36 | 44.83 | 48.87 |
|---|---|---|---|---|---|---|---|

Walking (W) chickens

Not-Walking (NW) chickens

Cartoni Mancinelli et al. (2021)
Pulcini et al. (2021)

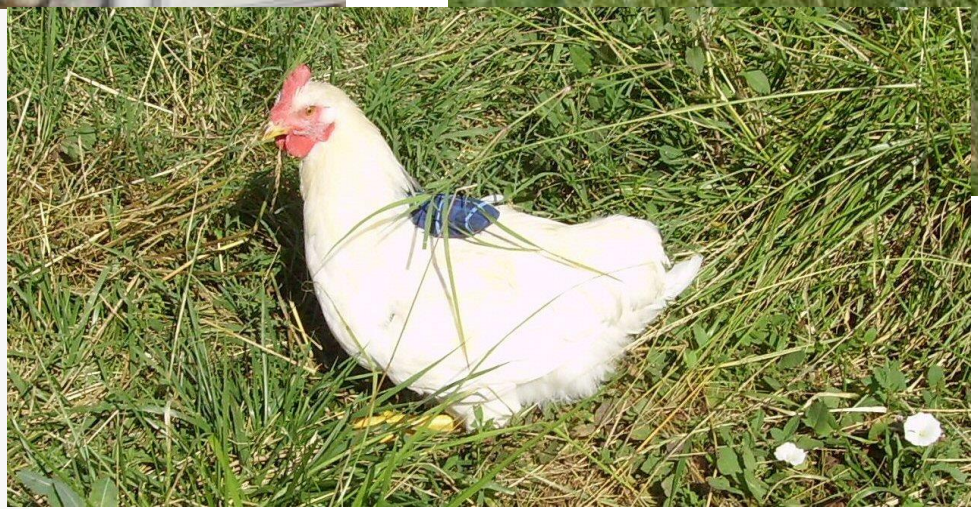
# Use of outdoor run*




* Schematic representation of the exploitation of the outdoor run by the different genotypes on the basis of behavioral observations or GPS movement detection in different experimentations

# Behavior of different strains



(link:www,trackstick,lu,htm)

trackstick

Device Name: Trackstick
Device Type: Super Trackstick (v 4.05)
Created By: Trackstick Manager 3.0.0

## Covered distance (mt)

### Slow growing Organic-plus

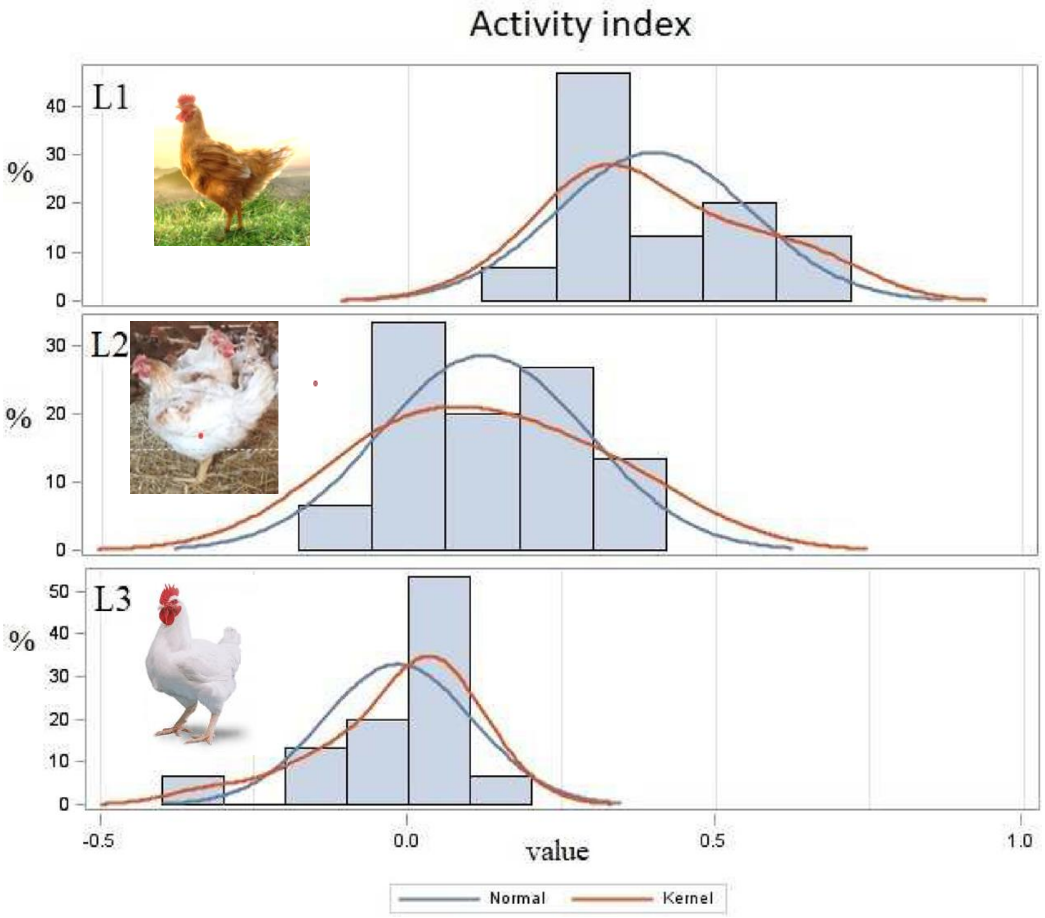
Records: 2361 - 2481
Dates: 06/27/2008 08:00 AM - 06/27/2008 20:00 AM
Duration: 12 hr 00 min
Distance: 1.13 kilometers
Latitude: 43 00 0972N Longitude: 12 17 5125E
Course: S Altitude: 238.1 m
GPS Fix: Y Signal: 3
Av. Temp: 27.1°C
Map Link: http://maps.google.com/maps?q=43.000972+12.175125&h=en&t=h


### Fast growing organic

Records: 4145 - 4265
Dates: 06/28/2008 08:00 AM - 06/28/2008 20:00 AM
Duration: 12 hr 00 min
Distance: 0.22 kilometers
Latitude: 43 00 0837N Longitude: 12 17 4834E
Course: S Altitude: 229.9 m
GPS Fix: Y Signal: 3
Av. Temp: 26.9 °C
Map Link:
http://maps.google.com/maps?q=43.000837+12.174834
&h=en&t=h

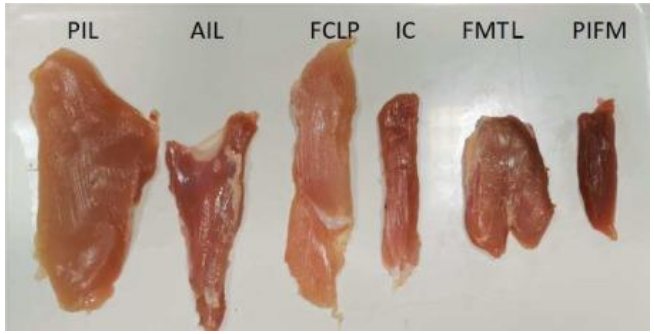

Google

# KINETIC ACTIVITY




Probability distribution expressed as percentage, normal and density curves of Activity index in three commercial lines.
Commercial lines:
L1 = active commercial line;
L2 = sedentary commercial line;
L3 = Fast Growing Ross 308.

The blu lines indicate normal distribution;
The red lines indicate kernel density estimation.




Failla et al., 2021 – *Poultry Science*

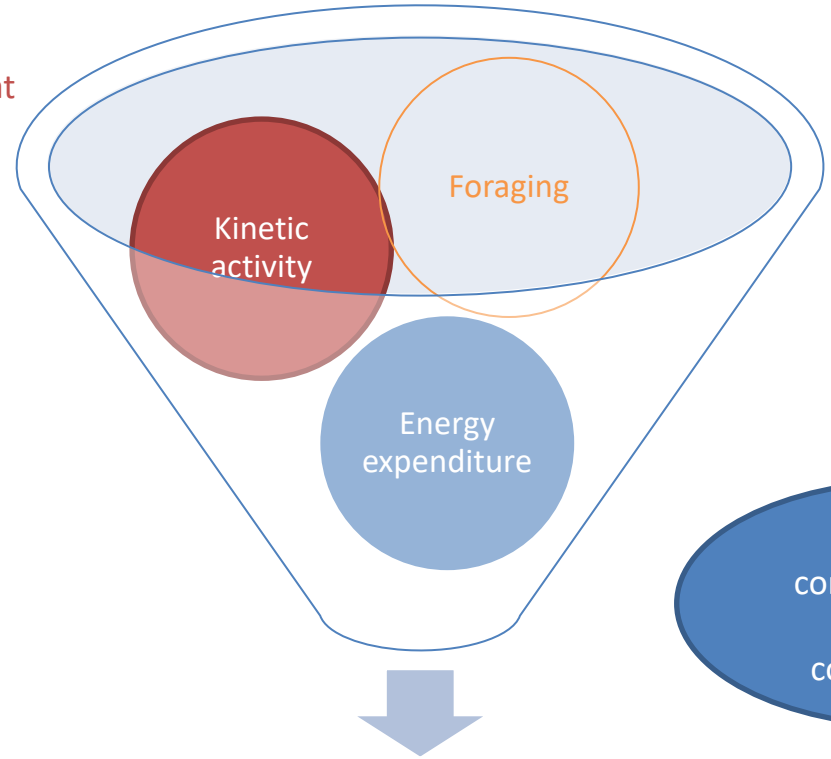
$$\text{Activity index} = \text{White m (n} - 3\,\text{HUFA)/ALA} - \text{Red m (n} - 3\,\text{HUFA)/ALA}$$

*In vivo*
Oxidation

↑lipid/protein oxidation of meat
↓Shelf-life of meat
↓technological quality

Antioxidants
PUFA n-3

↑ animal welfare (desease)
↑ meat antioxidants
↓ meat oxidation
↓ technological quality




LC-PUFA consumption for energy compensation

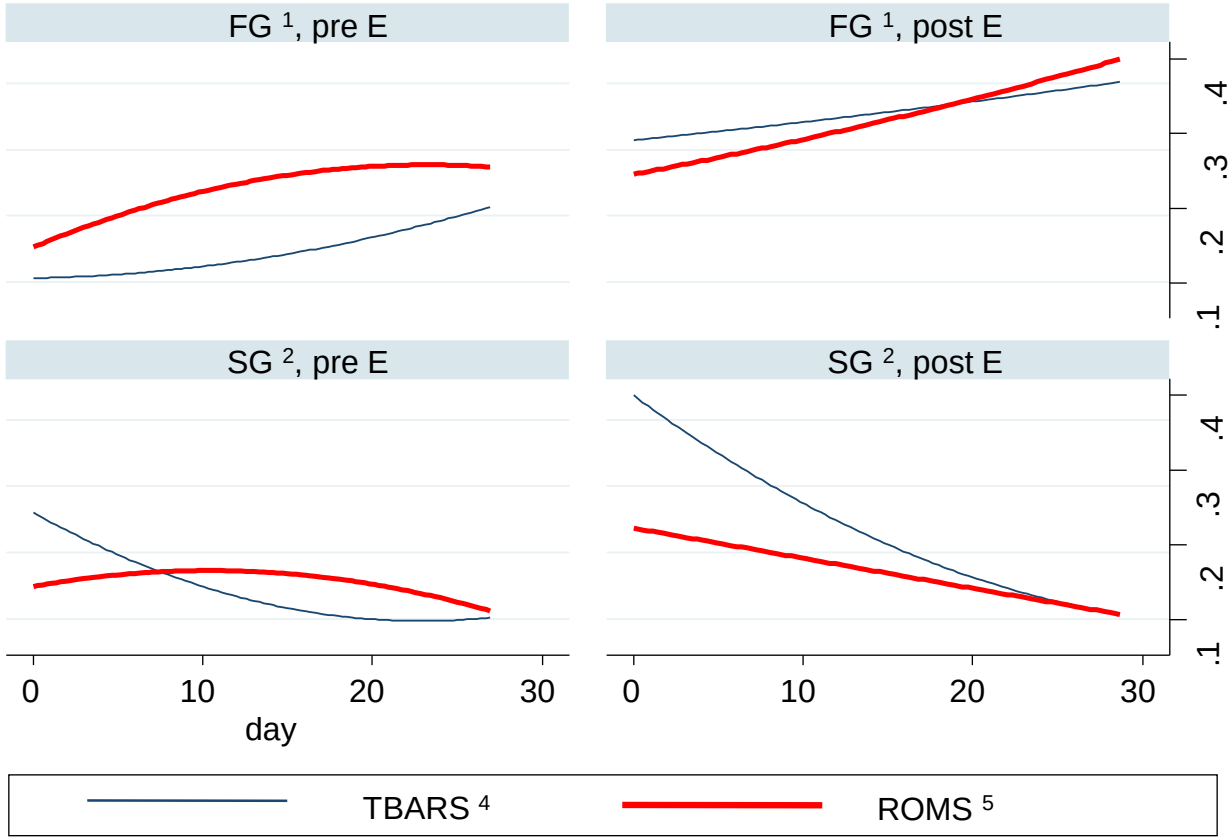
↓ fat deposit
↓ lipid % in meat
↓ healthy PUFA

# Activity index

Failla et al., 2021 – *Poultry Science*

# **TREINED Walking**: EXERCISE IN FAST vs SLOW-GROWING

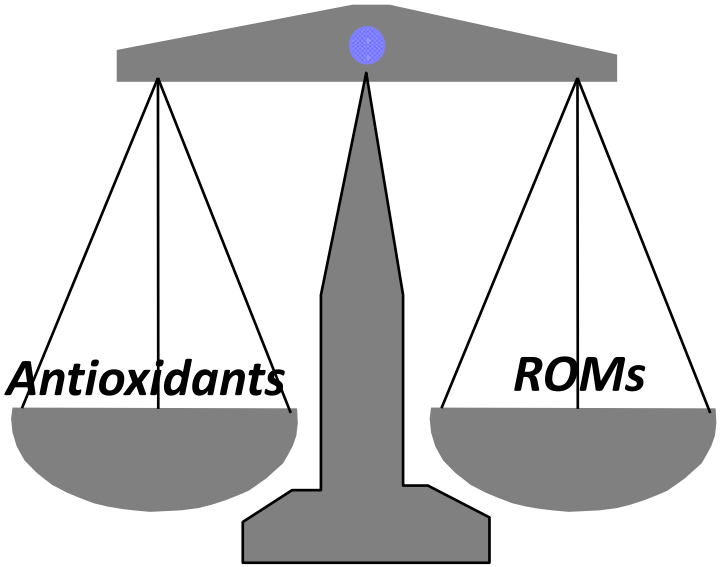
Kinetic activity

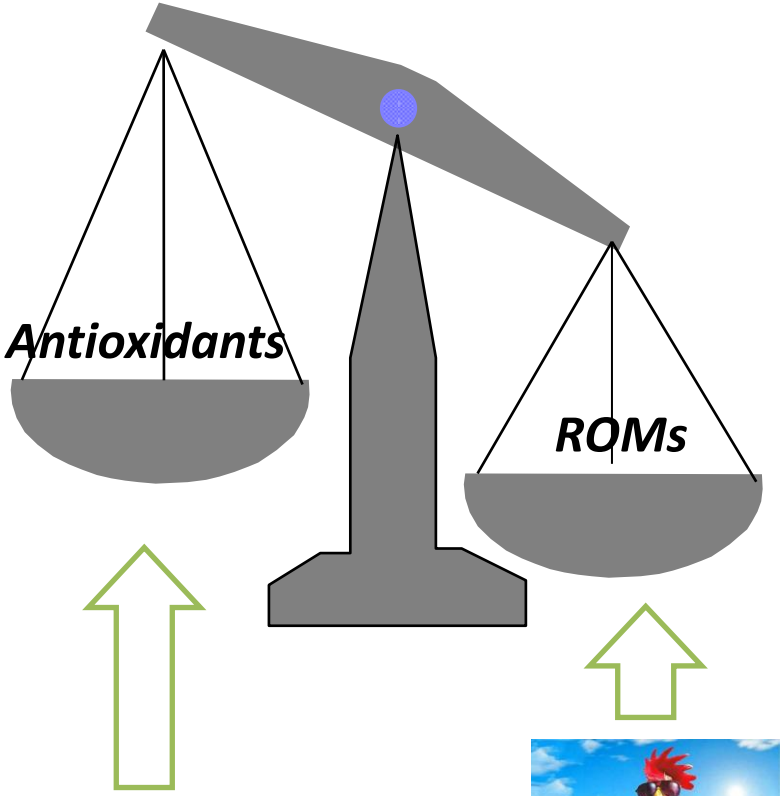



Mattioli et al., 2014 –Poultry Science

# *IN VIVO*

What means
*Trained and not trained animals?*




***Health status***
***Antioxidants intake***



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Energy expenditure

ALA

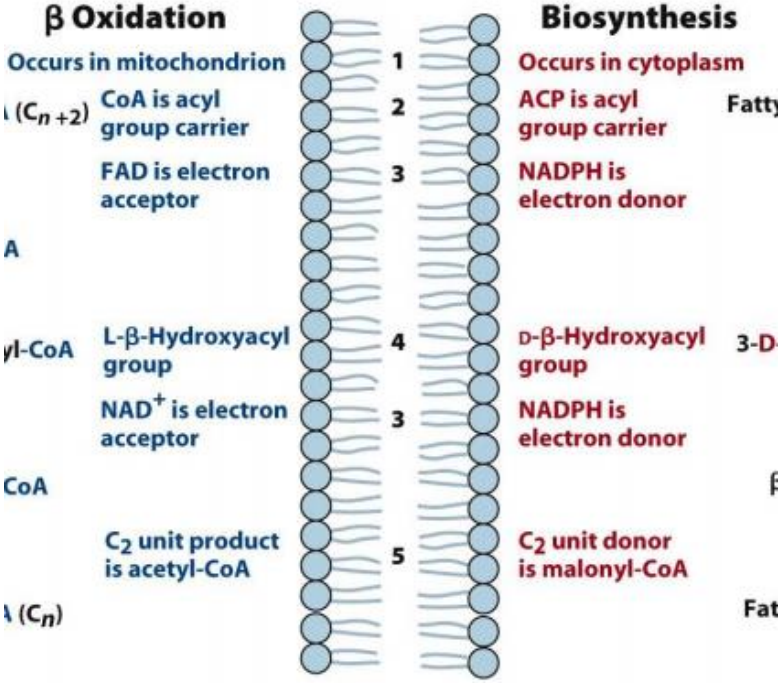
anabolica

HUFA

Catabolica

acetyl-CoA

n-3




diet

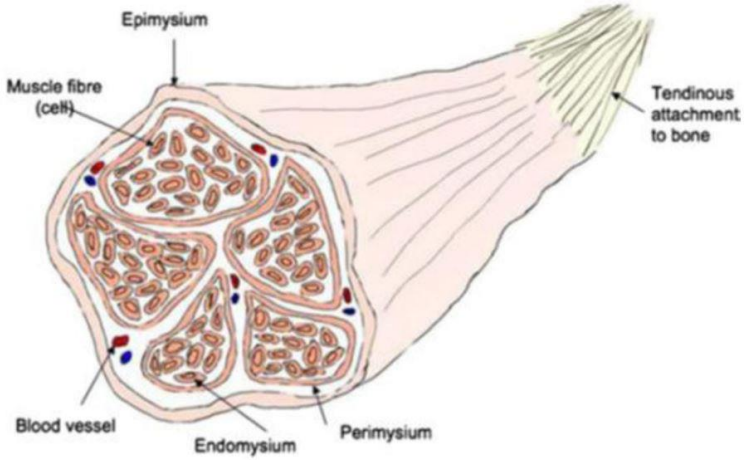
ALA

anabolica (Δ6)

HUFA

# Muscle chickens' changes in the last 70 years






Chang et al., 2016 – *Animal Production Science*
Smith et al., 2010 – *Meat science*

# News

More than 200 leading food companies across Europe are embracing the European Chicken Commitment (ECC), which defines standards for improving **broiler welfare**, **production sustainability**, and **food safety** in the poultry meat chain.

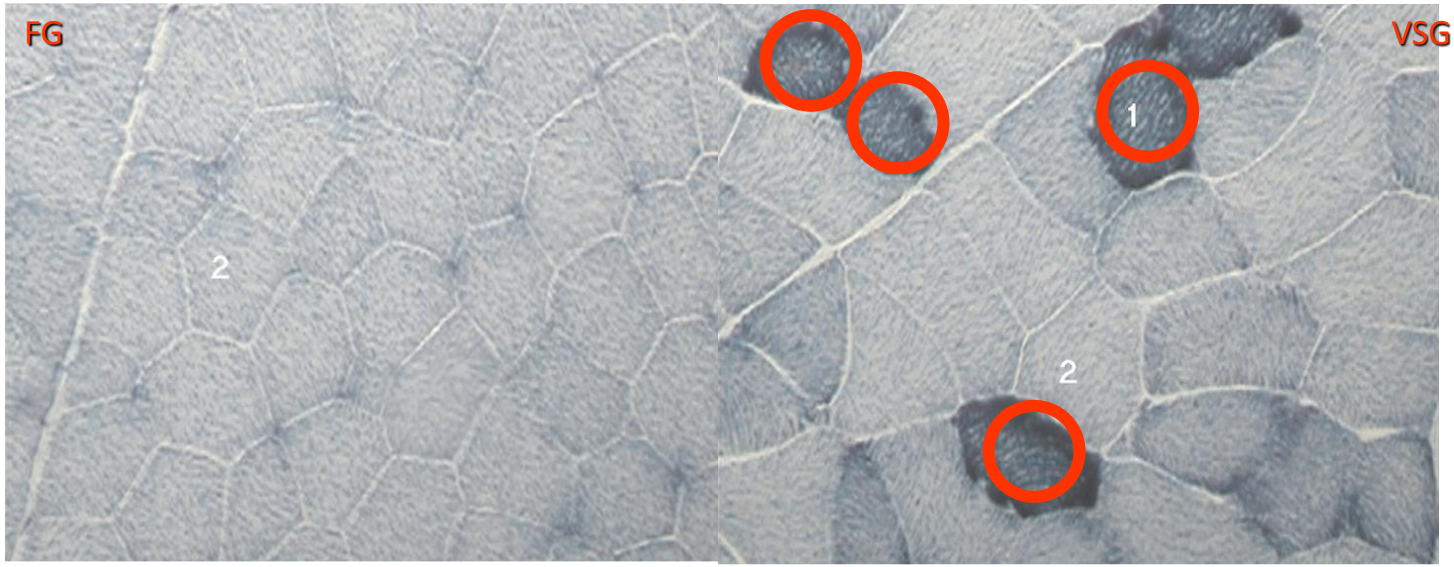
Poultry producers providing meat to **ECC-adopting retailers** must ensure that, by 2026, all supplied meat is obtained according to the ECC requirements.

Hubbard Redbro (only indoor)
Hubbard Norfol Black/JA757/JACY57/787/957/987
Rambler Ranger,
Ranger Classic,
Ranger Gold
….others that satisfy the criteria of the Protocol “RSPCA Broiler Breed Welfare Assessment”

# Meat Cuts morphology

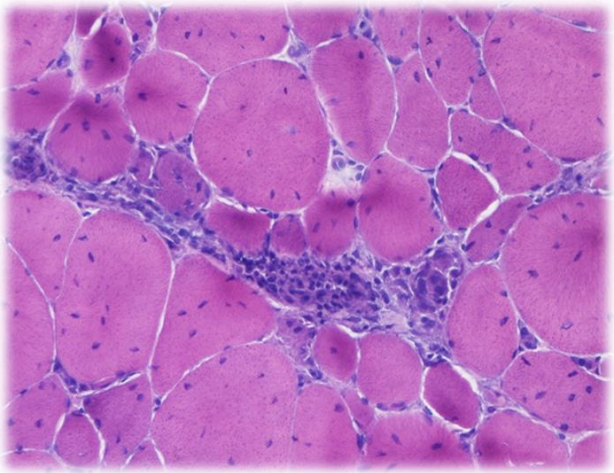
# Muscle fiber and genetic strain

| | Fiber | Slow-growing | Fast-growing |
|---|---|---|---|
| ***Pectoralis major*** | αR (1) | **4** | **0** |
| | αw (2) | 96 | 100 |
| ***Biceps femoris*** | αR | 56 | 37 |
| | αw | 44 | 63 |

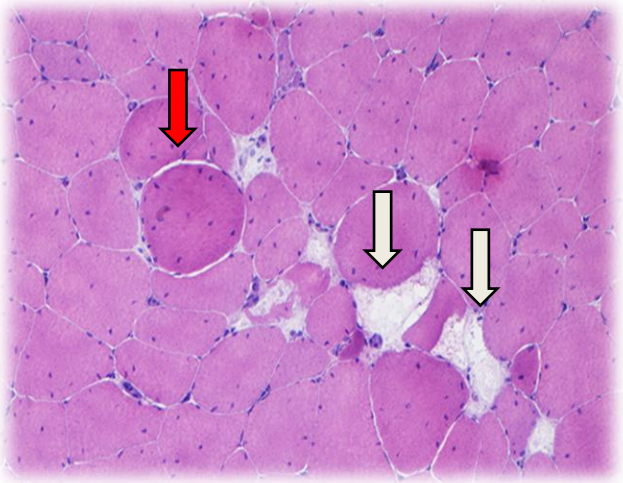



Branciari et al., 2009 – *Journal of Animal Science*

# Muscle anomalies in broilers



Ross; *PM*. Inflammatory infiltrates composed mainly by lymphocytes, plasma cells and macrophages.

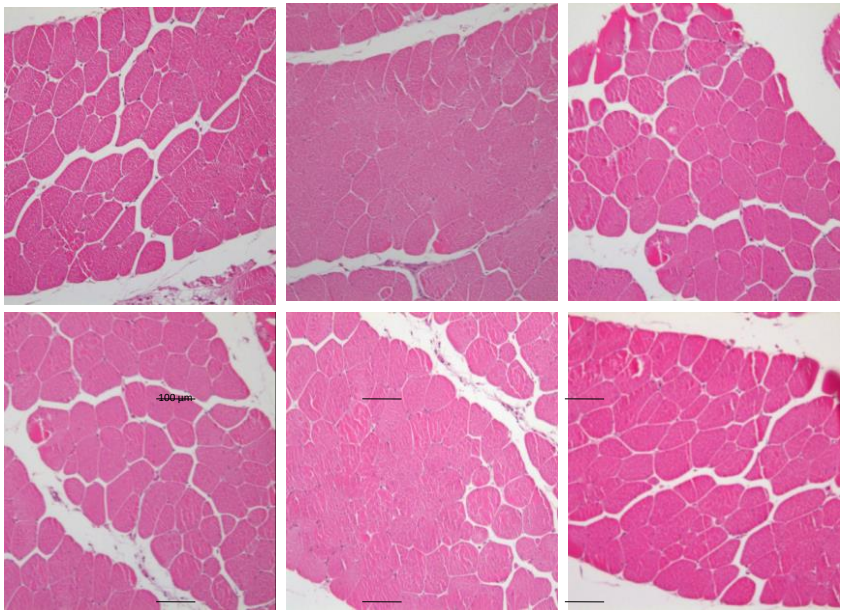


Ross; *PM.* with muscle fibers necrosis (black arrows) and giant fiber (red arrow)

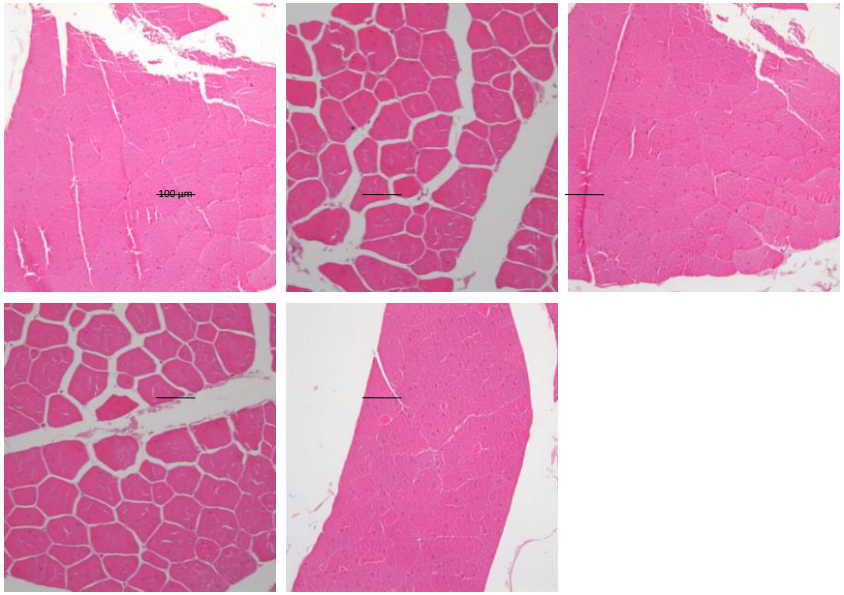
| | Broiler | Leghorn |
|---|---|---|
| **Fibers** (n/microscopic field) | 49.99 $_{a}$ | 140.15 $_{b}$ |
| **Capillaries** (n/microscopic field) | 24.56 $_{b}$ | 22.35$_{a}$ |

Sforna et al., 2017 – *Italian Journal of Animal Science*

**FG**



**SG**



Many more nuclei within the myofibers in SG than FG

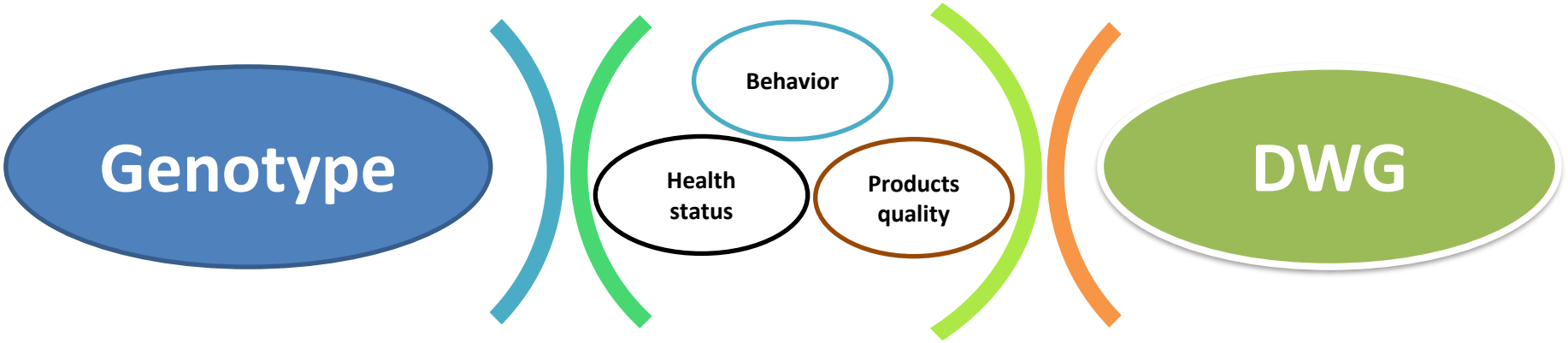
**Number of fibers**

**dir ion**

Research In progress

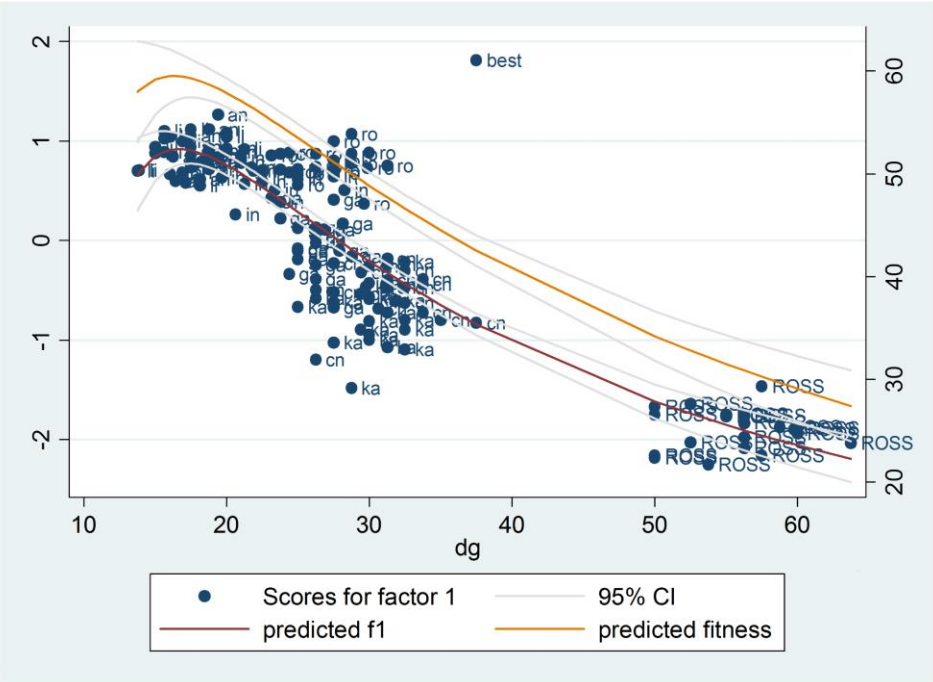
**What means** suitable broiler genotypes adapted to outdoor system?

# ADAPTABILITY




| | Leghorn | Ancona | Crossbreed | Gaina | Robusta Maculata | Kabir | Naked Neck | Ross 308 | Pooled SE |
|---|---|---|---|---|---|---|---|---|---|
| Adaptability index | 0.49 | 0.50 | 0.58 | 0.41 | 0.94 | 0.56 | 0.18 | -1.77 | 0.50 |
| | VSG | | | SG | | | | FG | |
| Mean±SD | 0.53±0.41 | | | 0.52±0.90 | | | | -1,77±0.48 | |

Behavior
Welfare
(lesions, feather condition, TI)
Health status
(physiological parameters)




Castellini et al., 2016 – *Italian Journal of animal science*

Ranger Classic (R1)

Ranger Gold (R2)

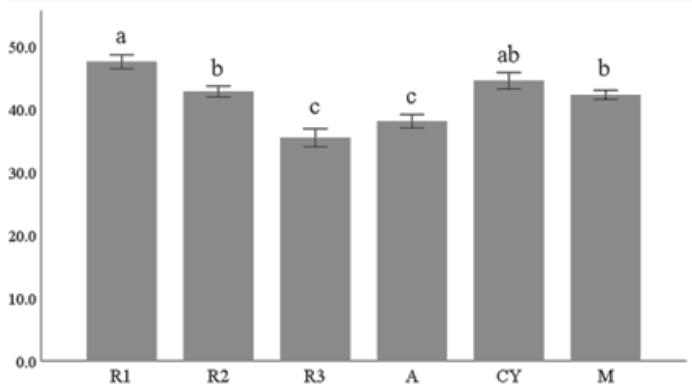
Rowan Ranger (R3)

Campese (A)

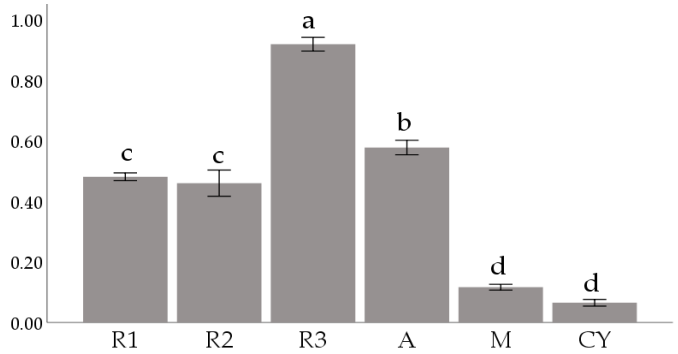
CY Gen 5 x JA87 (CY)

M22 x JA87 (M)

**Daily weight gain (g/d) of six poultry genotypes on the entire rearing cycle (p<0.05)**




**Adaptability Index (AI) of six poultry genotypes (p<0.05)**




Behaviour
Welfare
(lesions, feather condition, TI)
Performances

Cartoni Mancinelli et al., 2020 – *Animals*

Ranger Classic (R1)

Ranger Gold (R2)

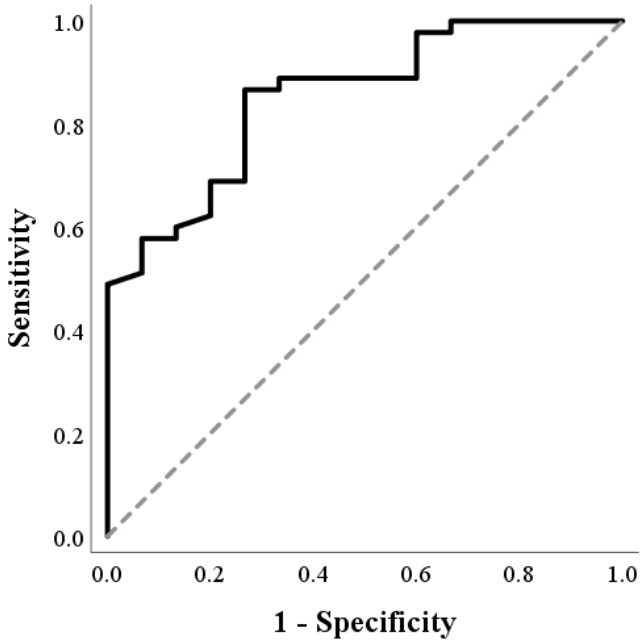
Rowan Ranger (R3)

Campese (A)

CY Gen 5 x JA87 (CY)

M22 x JA87 (M)

ROC curve, indicated that the DWG was a moderately accurate predictor of adaptability and that, when DWG was ≥ 38.6 g/d, it predicted a low adaptability with a sensitivity of 87% and a specificity of 73%. Moreover, for each 1 g/d increase in DWG, the odds of having a low adaptability increased by 42%.




Behavior
Welfare
(lesions, feather condition, TI)
Performances

Cartoni Mancinelli et al., 2020 – *Animals*

# Take home message

What do we know to date about chicken genotypes adapted to ERS?

- The differences between FG and SG are well defined, and FG is not adapted to ERS
- Not all SG genotypes have the same adaptability to ERS, but we are sure that the DWG ~38.6 g/d
- To define the adaptability of SG to ERS we have to take into consideration all criteria (not some): behaviors, welfare, physiology, health status, performance, quality

What do we know more thanks to PILLOW?

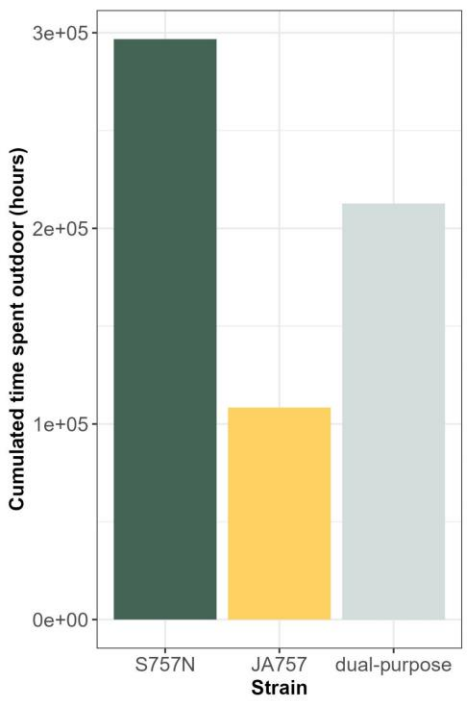
***PPILOW results are coming see you after break***

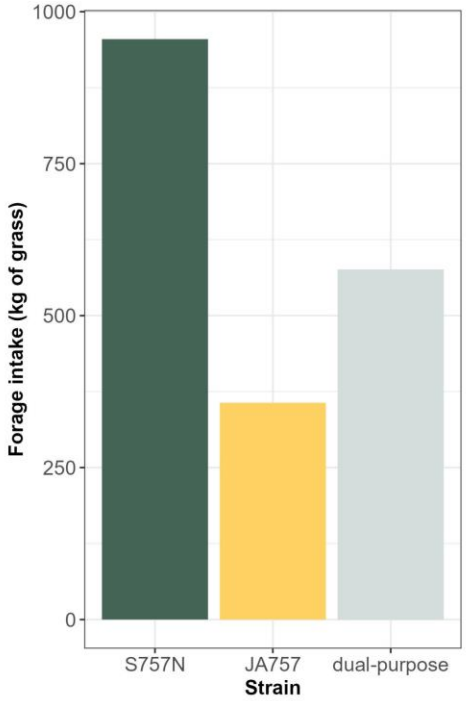
# Experiment conducted in spring 2021 to better understand range use

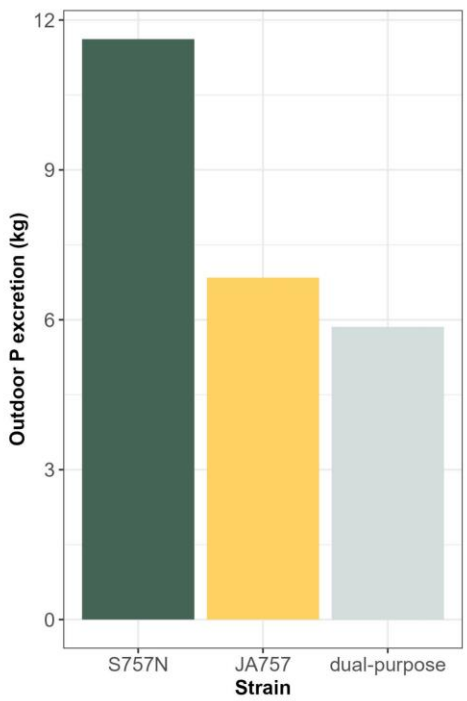
| Dual-purpose | JA757 | S757N | White Bresse |
|---|---|---|---|
| **16g/d** | **36g/d** | **26g/d** | **23g/d** |
| Reared for 14 weeks | Reared for 10 weeks | Reared for 12 weeks | Reared for 15 weeks |

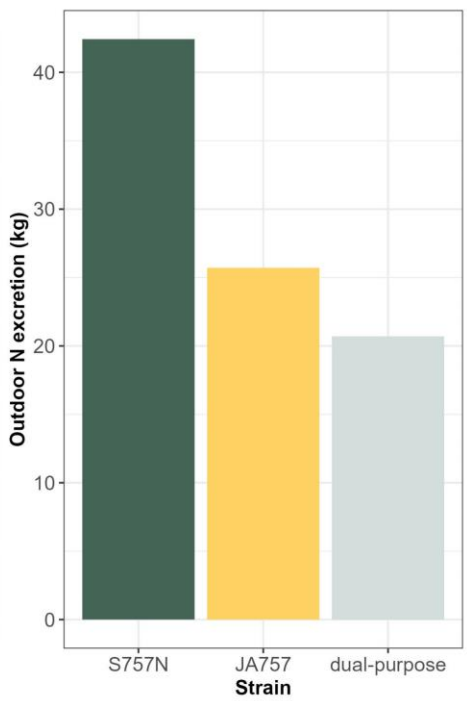
750 mixed sex chickens

# Environment and range use ?




The S757N strain spent twice more time outdoors than the two other strains

The S757N strain consumed about twice as much grass per day as the two other strains

The S757N chicken outdoor excretions of N and P per day of outdoor access were about 200% and 30% greater than those of dual-purpose and JA757 chickens, respectively

# At the level of the individual ?

Is range use a personality trait ?

- Time-consistent?
- Consistent across season?

Ferreira et al

S757N strain

Meadow

Behavioural observations

Bonnefous et al

JA757, S757N, White Bresse and a dual purpose strain

Tree covered grassy outdoor

Behavioural observations

Collet et al

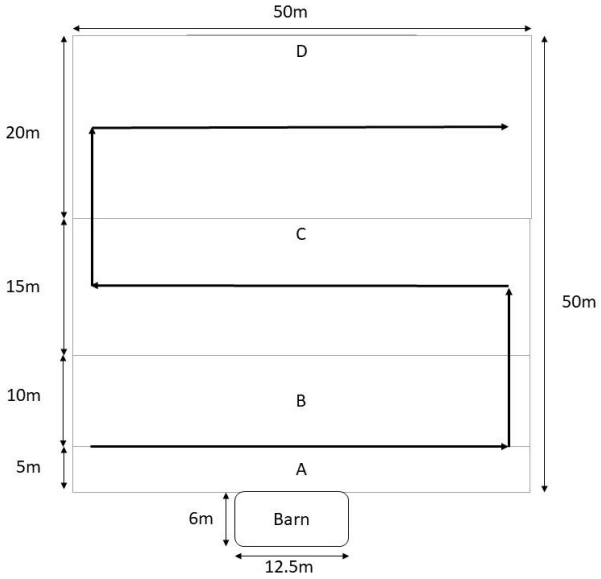
JA757, S757N, and a dual purpose strain

Tree covered grassy outdoor

Radio Frequency Identification

# Behaviour: methods

## Behavioural observations

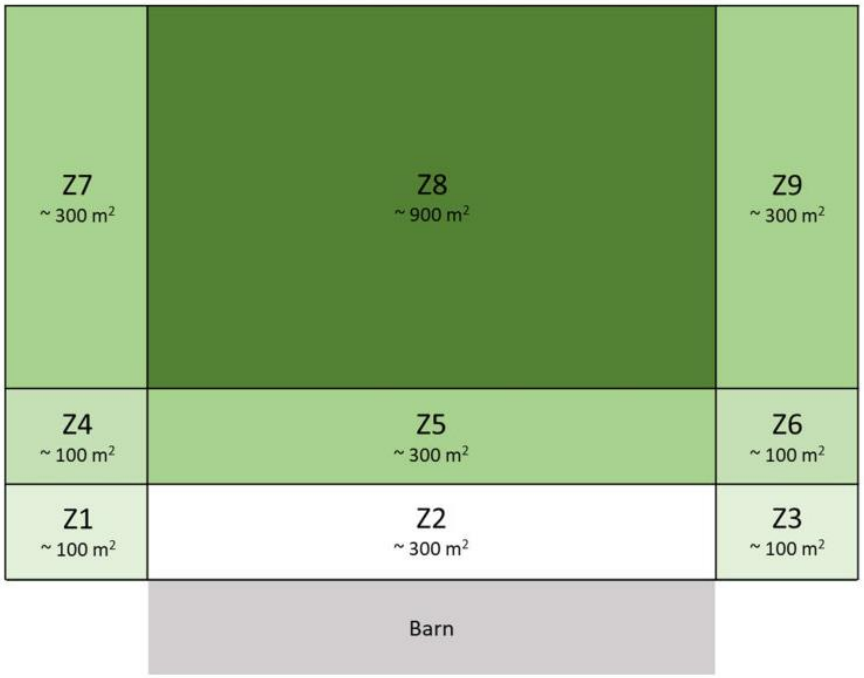



7 scans per day of observations 11 to 15 days of observation

$$\text{Distance index} = NTa \times 2.5 + NTb \times 10 + NTc \times 22.5 + NTd \times 40$$

Discontinuous
Accurate indicator of range use
4 strains

## Radio Frequency Identification




Continuous
Error rate of 15% for JA757 and only around 2 % for dual-purpose and S757N
3 strains

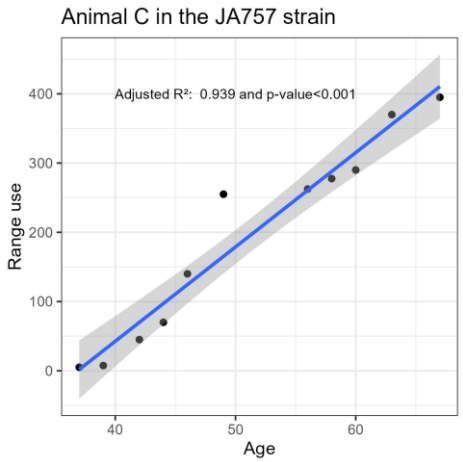
PPILOW

# Behaviour: time-consistency of range use

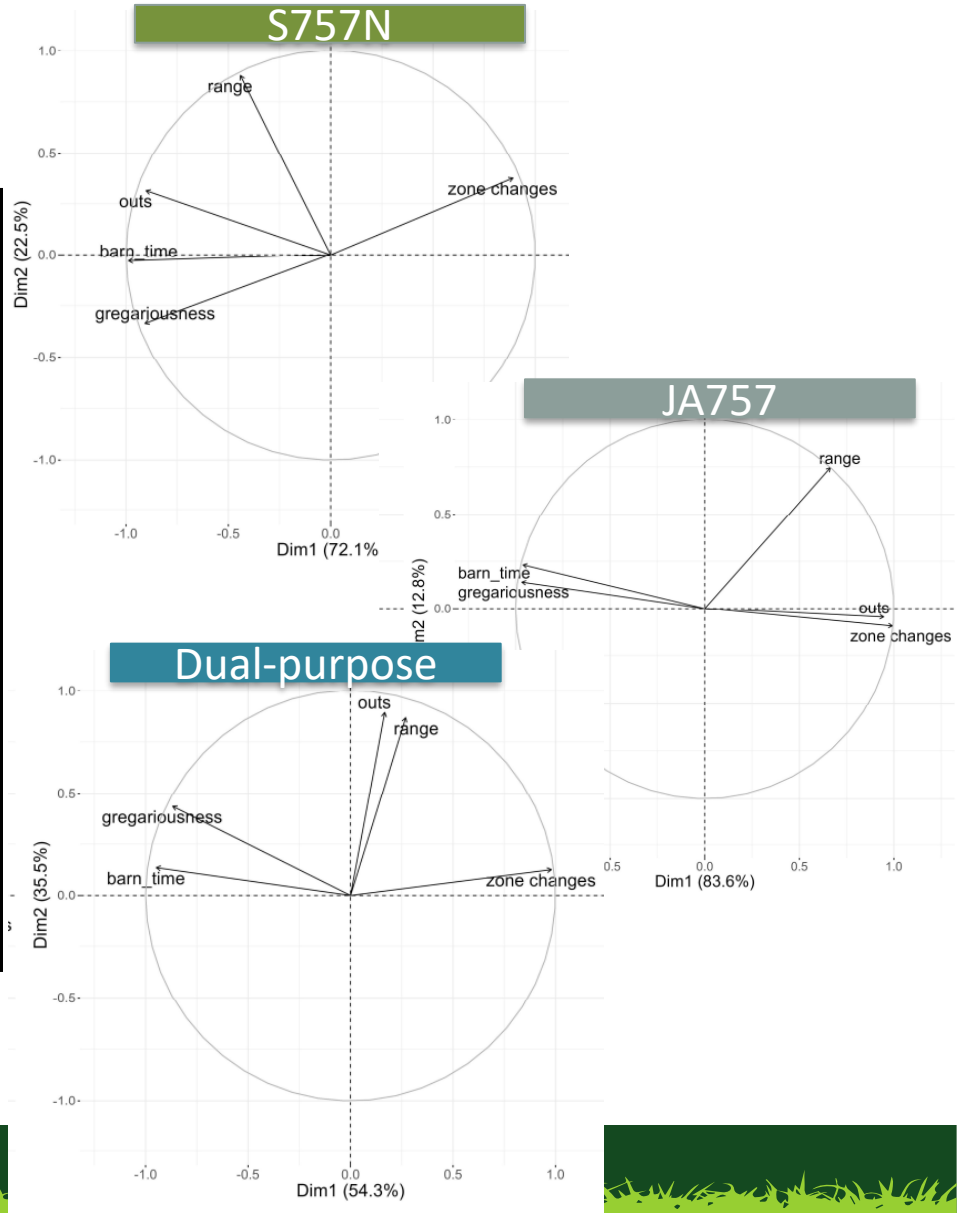
## Behavioural observations

S757N: sum of the five first days of scans and the five last days of scans

| | 0.8 < x | 0.5 <x< 0.8 | 0.3 <x< 0,5 | 0.1 <x< 0.3 | x < 0.1 |
|---|---|---|---|---|---|
| JA757 | 86 | 8 | 3 | 1 | 0 |
| S757N | 89 | 10 | 1 | 0 | 0 |
| White Bresse | 99 | 1 | 0 | 0 | 0 |
| Dual-purpose | 82 | 12 | 3 | 0 | 1 |

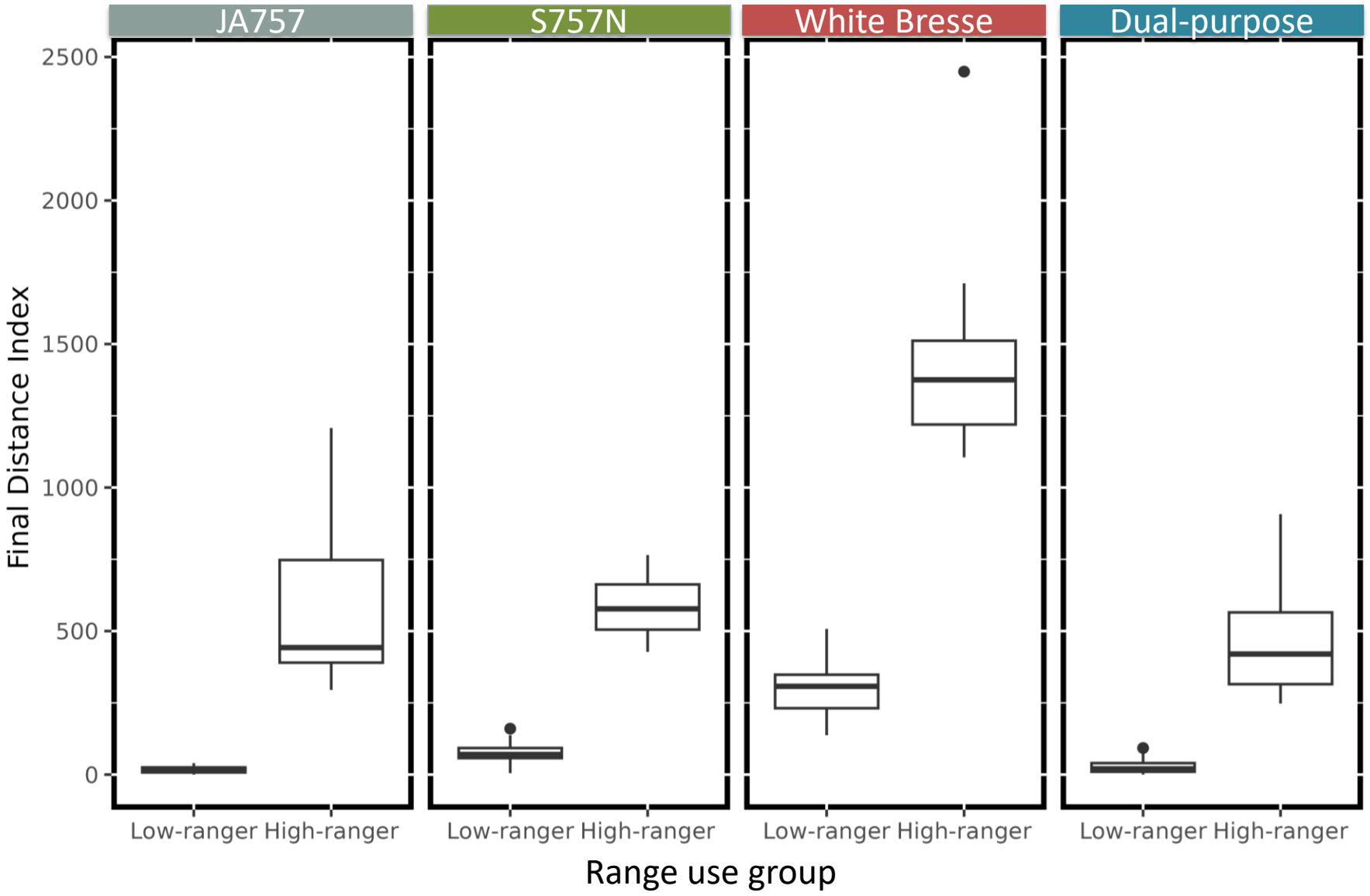



## Radio Frequency Identification

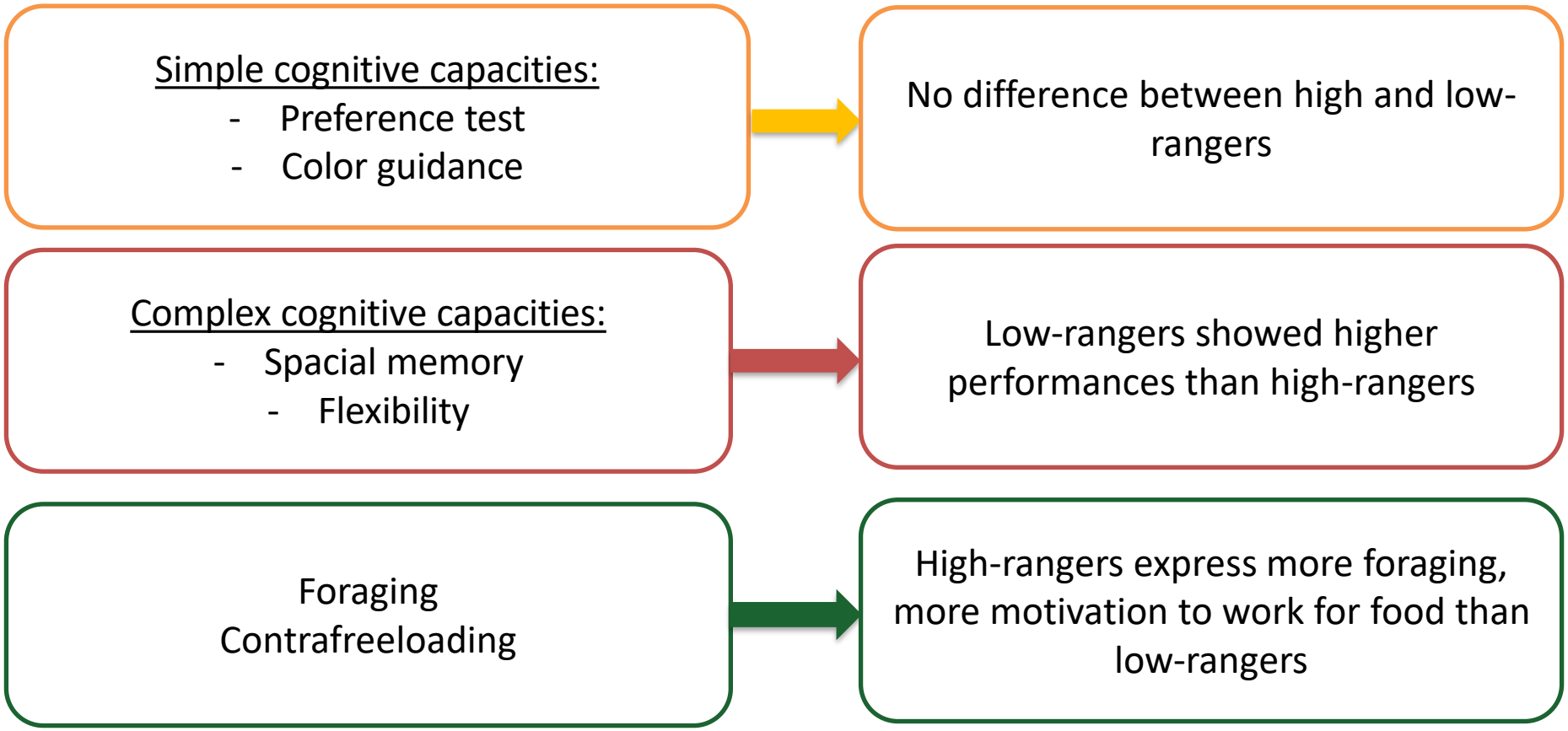



Consistency between strains and in time

# Behaviour: selecting chickens on their range use

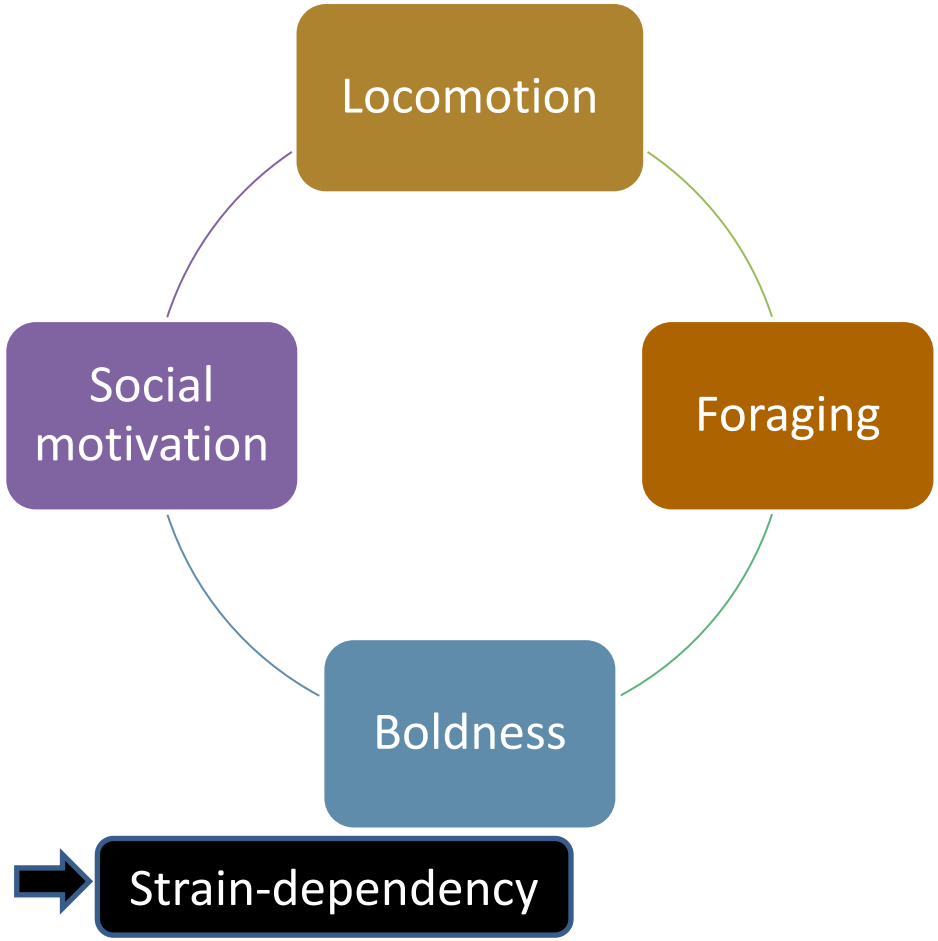


# Behaviour: variables related to range use
# Ferreira et al., first work : cognition, foraging and motivation to work for food



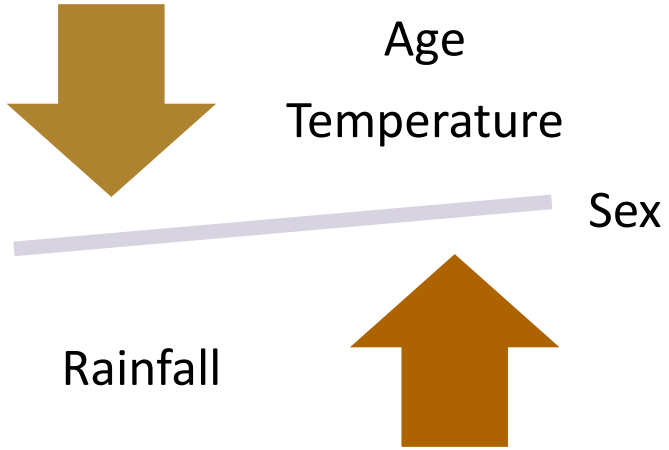
# Behaviour: variables related to range use

## Behavioural observations




Strain-dependency

## Radio Frequency Identification




Valid for the three studied strains

# Variables related to range use at slaughter

JA757
S757N
White Bresse
Dual-purpose

In the blood

n6/n3 fatty acids ↘ ↗

Yellowness ↗

Welfare indicators at slaughter

No difference by range group :
Pododermatitis
Hock burns
Duration of wing flapping
Struggling on the slaughter line

Muscle growth

Creatine kinase activity ↘ ↘

Range use ↗

Immunity / Anti-inflammatory systems

↘ ↘ Lysozyme activity

↘ Haptoglobin-like activity

Performances

Carcass weight ↘ ↘ ↘

Carcass yield ↘ ↘

Breast weight ↘ ↘

Thigh weight ↘ ↘

Thigh yield ↘ ↘

Redox status

Oxidants : $[H_2O_2]$

Antioxidants :

∑ [Tocols] ↘

[Uric acid] ↘

Total Antioxidant Status ↗ ↗

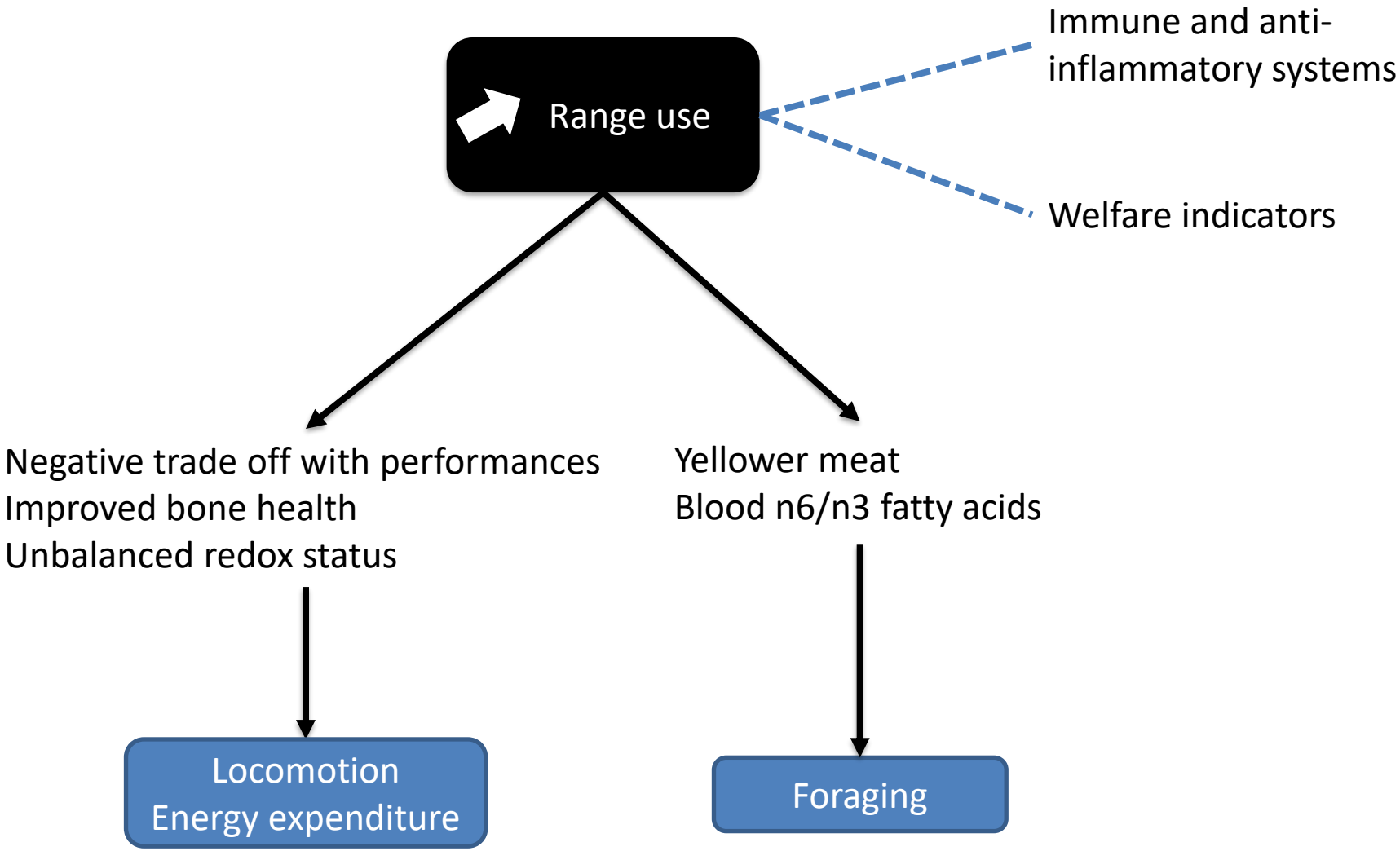
Bone Health

Tibial bone-breaking strength ↗

Tibial length ↘

Tibial diameter ↘

# Range use relationship with indicators at slaughter



# Indicators of later range use : behavioural indicators. Ferreira et al, 2021

Only foraging was significantly correlated to range visits in all periods, even before range access!!

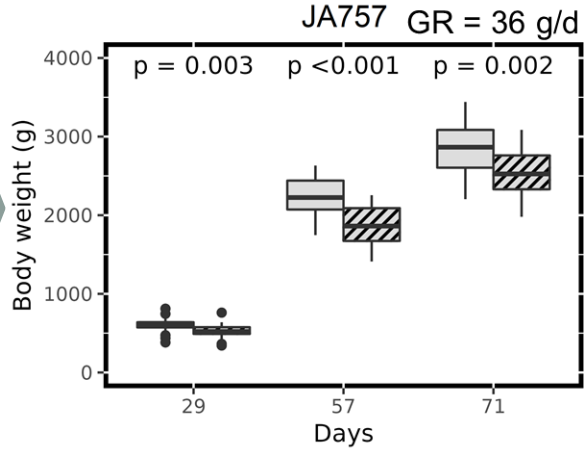
| | Period | Period 2 + Period 3 |
|---|---|---|
| | | Range visits |
| Period 1 | Standing | −0.01 |
| | Resting | −0.12 |
| | Locomotion | −0.07 |
| | Foraging | **0.31** |
| | Feeding/drinking | −0.14 |
| | Comfort behaviors | −0.16 |
| | Environment pecking | 0.01 |
| | Positive social pecking | −0.02 |
| | Time spent near conspecifics (SM) | 0.23 |
| | Number of zones crossed (ET) | −0.01 |
| | Foraging (ET) | −0.03 |

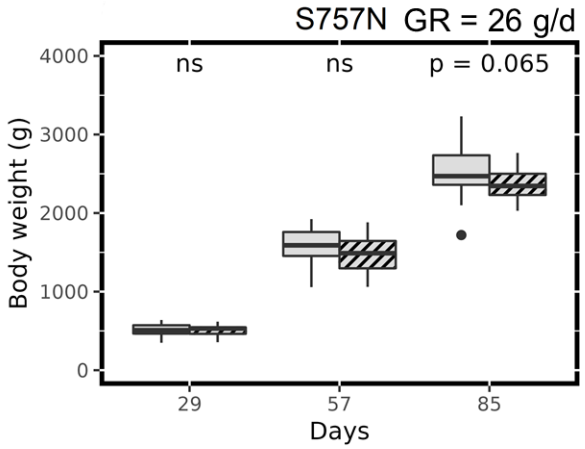
# Indicators of later range use : behavioural indicators

| | JA757 | S757N | White Bresse | Dual-purpose |
|---|---|---|---|---|
| State behaviour recorded during focal sampling | | | | |
| Standing | 0.01 | -0.01 | -0.02 | -0.15 |
| Resting | -0.17 | 0.06 | -0.08 | 0.00 |
| Sleeping | -0.24 | 0.06 | 0.02 | 0.11 |
| Locomotion | 0.26 | 0.09 | -0.01 | 0.06 |
| Foraging | 0.29 | -0.02 | 0.17 | 0.04 |
| Drinking & Eating | -0.17 | -0.12 | -0.02 | 0.06 |
| Variables of the social motivation test | | | | |
| Latency to exit | -0.09 | -0.04 | -0.08 | -0.02 |
| Latency to arrive to the zone close to conspecifics | -0.13 | 0.05 | -0.10 | 0.09 |
| Number of pecks | 0.03 | -0.14 | -0.06 | -0.09 |
| Variables of the multivariate test | | | | |
| Latency to make a first step | -0.09 | 0.05 | 0.07 | 0.00 |
| Foraging | 0.17 | 0.04 | 0.00 | 0.22 |
| Number of times the chicken walked behind a wooden panel | 0.05 | -0.03 | -0.04 | -0.05 |
| Time in the outer circle | 0.02 | 0.20 | 0.00 | -0.01 |

# Indicators of later range use : body weight

Differential body weight may be partly a cause of differential range use?



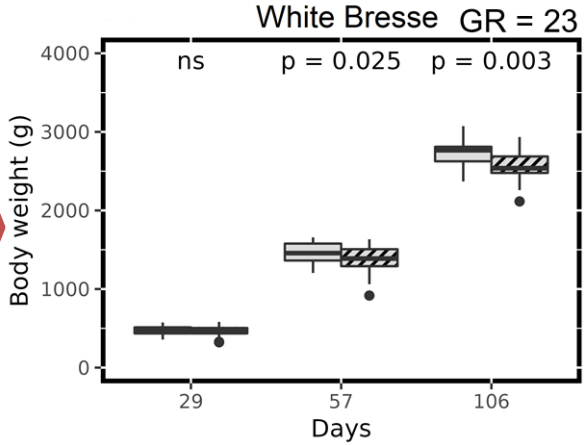



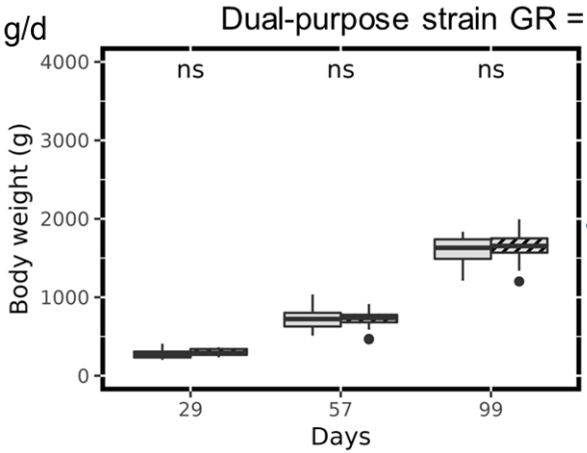

Low-rangers

High-rangers

Differential body weight may be a consequence of differential range use?

Differential body weight may be a consequence of differential range use




No relationship between range use and body weight

# PPILOW **PARTNERS**

*Thank you for your attention and involvement!*

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