An index for adaptability evaluation of slow-growing chicken genotypes reared in free-range system

S. Mattioli, L. Menchetti, E. Angelucci, A. Cartoni Mancinelli, A. Dal Bosco, L. Madeo, D. Chiattelli, F. Di Federico, C. Castellini

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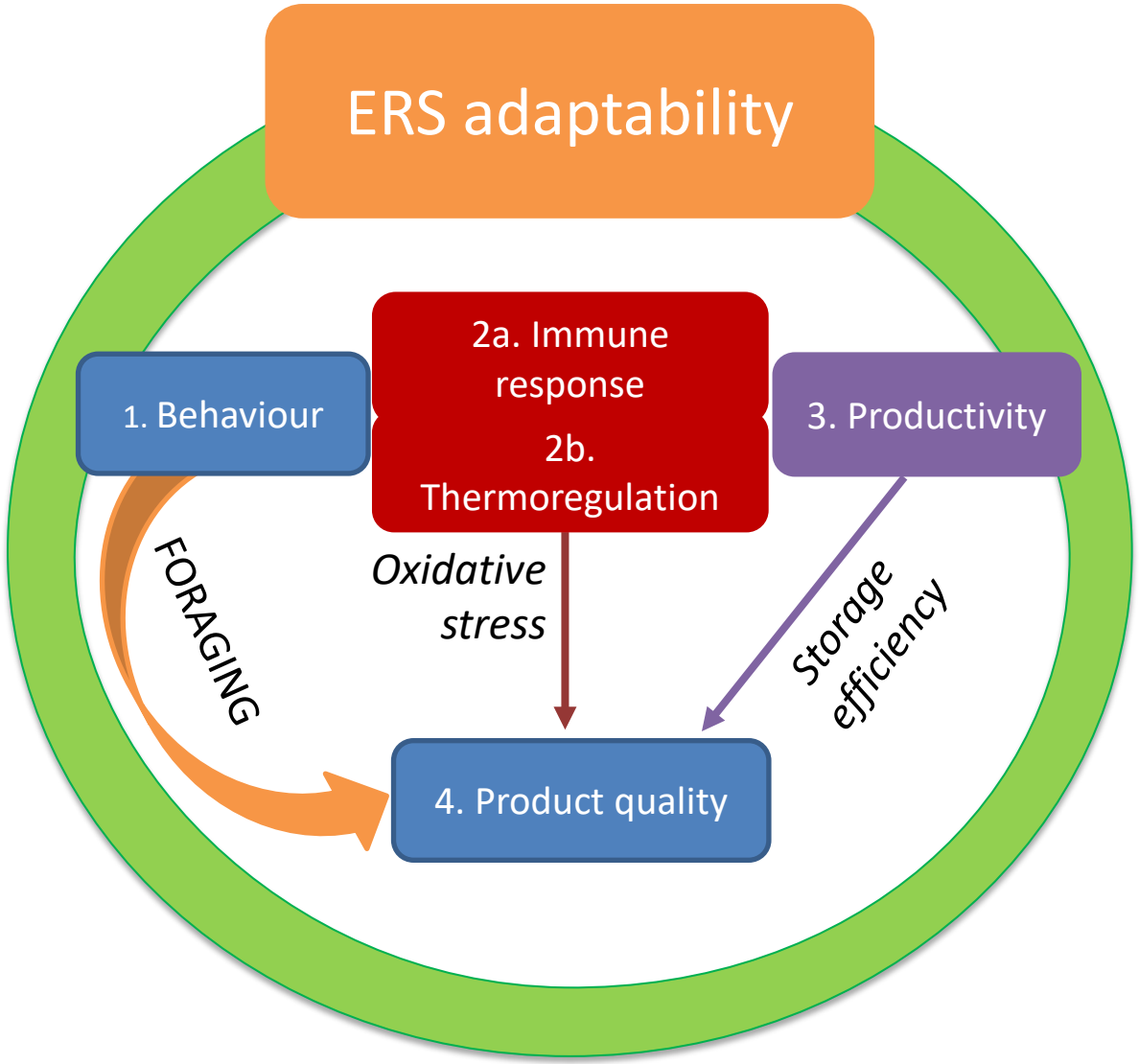
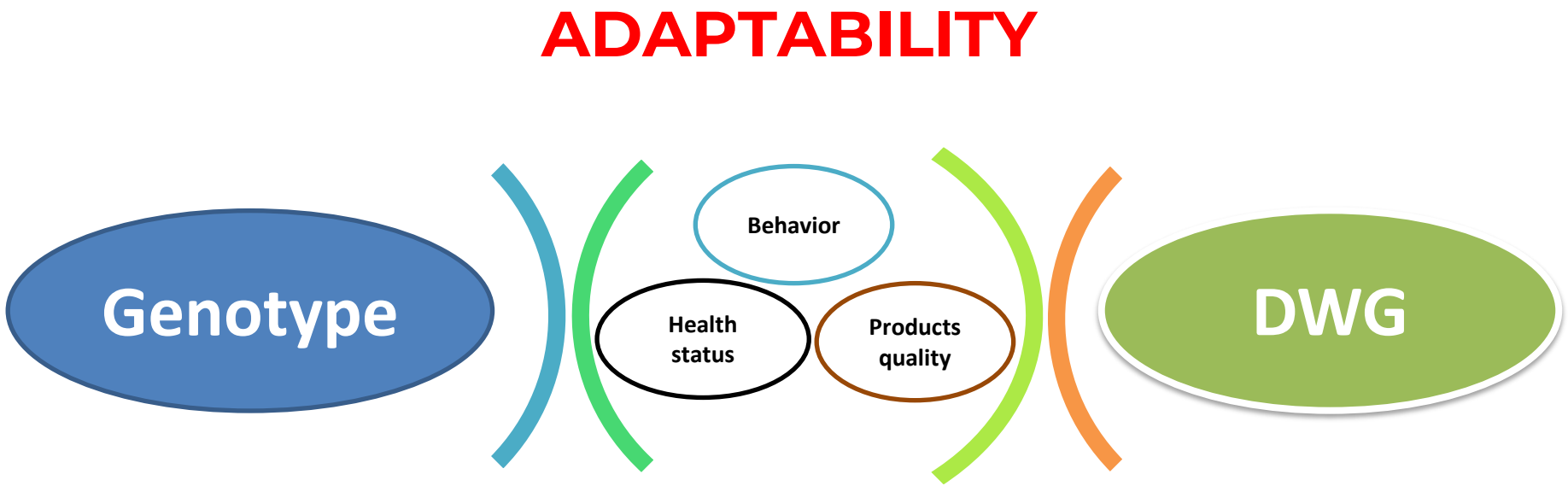
Outdoor adaptability criteria

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

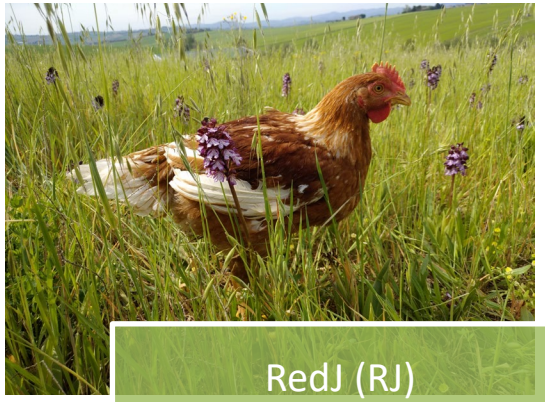


What does it mean to choose suitable genotypes adapted to outdoor system?

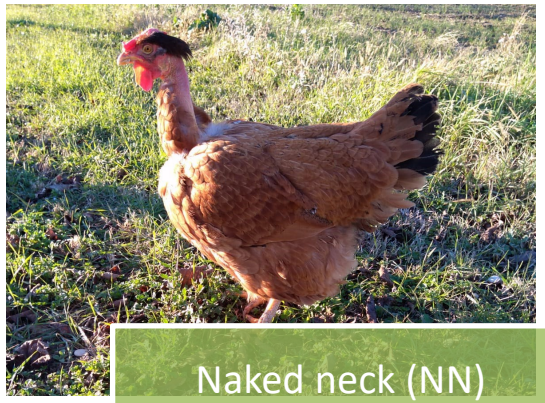


- Guarino Amato, et al. (2022). Adaptability challenges for organic broiler chickens: a commentary. Animals, 12(11), 1354.
- Cartoni Mancinelli, et al. (2021). The assessment of a multifactorial score for the adaptability evaluation of six poultry genotypes to the organic system. Animals, 11(10), 2992.
- Castellini, et al. (2016). Adaptation to organic rearing system of eight different chicken genotypes: behaviour, welfare and performance. Italian journal of animal science, 15(1), 37-46.
- Cartoni Mancinelli, et al. (2020). Performance, behavior, and welfare status of six different organically reared poultry genotypes. Animals, 10(4), 550.
- Mattioli, et al. (2021). How the kinetic behavior of organic chickens affects productive performance and blood and meat oxidative status: A study of six poultry genotypes. Poultry Science, 100(9)..

MATERIAL & METHODS



RedJ (RJ)



Naked neck (NN)

Lohmann Dual (LD)

Robusta Maculata x Sassò (CB)

- 100 hundred chicks/strain of both sexes were used.
- Chickens were reared in pens (2 pens/strain) with an indoor (0.10 m^2/bird) and outdoor (4 m^2/bird) area.
- The animals fed *ad libitum* the same starter and grower diets.
- At 81 days of age, 15 chickens/pen were selected and slaughtered.
- Many variables have been evaluated:
  - *On-farm* (productive performances, behaviors, lesions and feather conditions)
  - *In vivo* parameters (blood)
  - Carcasses and Meat cuts (breast and drumstick)

MATERIAL & METHODS: pillars

Behaviour	Performance	Health status	Physical -chemical traits	Meat oxidative status	Meat fatty acids profile and indexes	Blood fatty acids profle	Blood traits
Running Attack Swell Rest Allo-grooming Grooming Escape Grass Pecking Walking Stretching Hide Other_peck. Sand Scratch	Carcass Weight Drumstick (no bone) Breast Weight Bust Yield Breast Yield Bone Weight Live Weight Tibia Length Breast Thickness Sternum Length	Plantar Lesions Sternal Lesions Neck score Breast score Wings score Beck score	Drip loss (drumstick) b* colour (breast) Drip loss (breast) WHC (breast) b* colour (drumstick) White Striping (WS) a* colour (drumstick) L* (drumstick) a* colour (breast	Lipids (drumstick) MDA (breast) Retinol (breast) Retinol (drumstick) Tocols (drumstick) Tocols (breast) Total lipids (breast) Carbonyls (drumst.) Carbonyls (breast)	PUFA (breast) C18:2n-6, LA (breast) C18 (breast) C18:1n-9 (breast) MUFA (breast) C20:2 (breast) n-3 (breast) C20:5n-3, EPA (breast) C22:2 (breast) C22:5n-3, DPA (breast) C22:4 (breast) C20:4n-6, AA (breast) C14 (breast) C18:3n-3, α-ALA (breast) C16:1 (breast) C17:1 (breast) C14 (drumstick) C22:6n-3, DHA (breast) C14:1 (drumstick) C16 (drumstick) C16:1 (drumstick) C20:5n-3, EPA (drumstick) C18 (drumstick) C22:2 (drumstick) n-3 (drumstick) PUFA (drumstick) C22:6n-3, DHA (drumstick) C18:1cis9 n-9 (drumstick) C22:4 (drumstick) C22:5n-3, DPA (drumstick) C20:4n-6, AA (drumstick)	PUFA blood SFA blood C18 blood n-6 blood C18:2cis n-6, LA blood C16 blood C20:4n-6, AA blood C20:5n-3, EPA blood C18:3 n-3, α-ALA blood n-3 blood C18:1n-9 blood MUFA MDA blood	HCT (%) Lysozyme ROMS PAO Heterophiles/lymphocytes

STATISTICAL ANALYSIS OF DATA

Discriminant Analysis

- Selection of the variables characterizing the genotype for 4 pillars

Principal Component and Reliability Analyses

- Creation of a composite Index and its validation and refinement

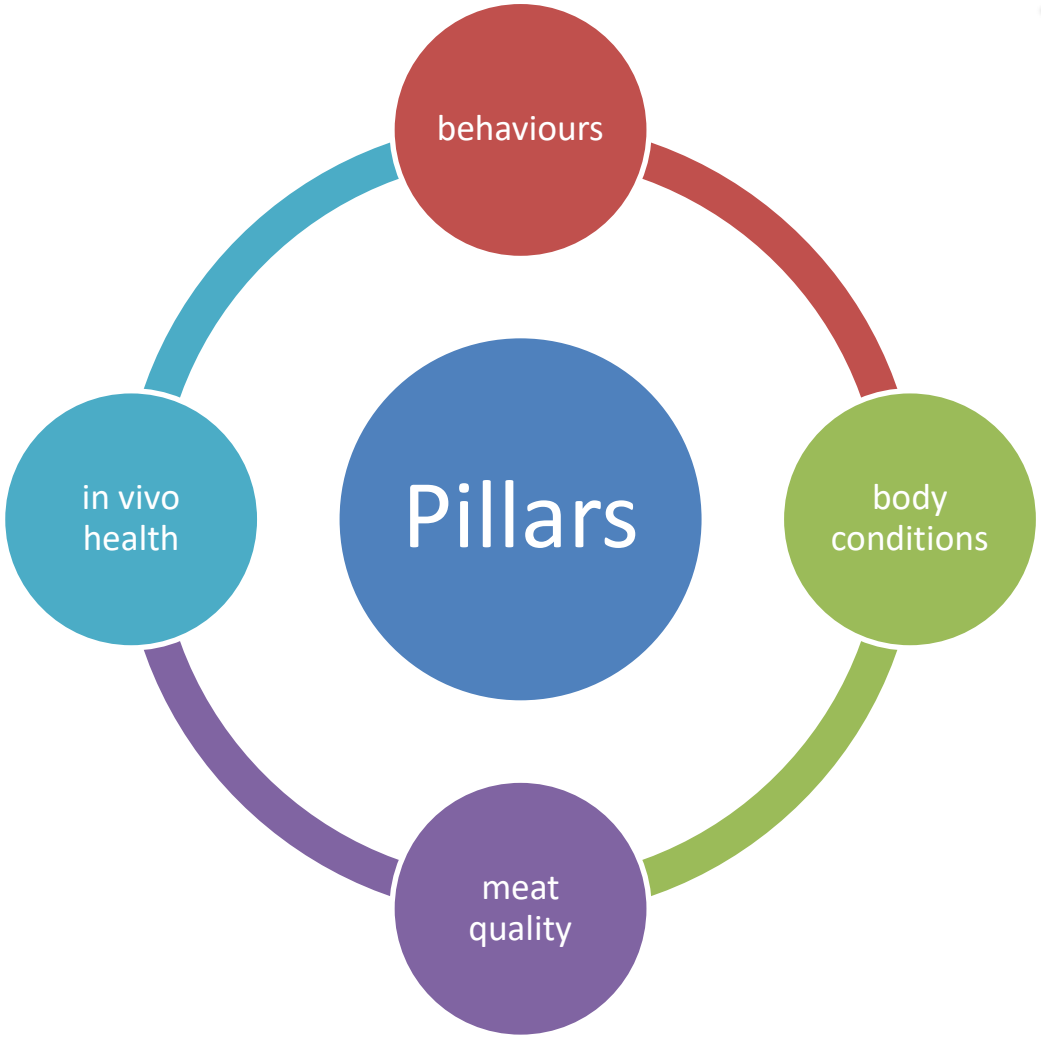
Graph

- Index scores of genotypes

Cronbach alpha

- Refine the Index and assess its internal consistency reliability

1. DA: selection of the variables characterizing the genotype for each pillar



- ✓ *stepwise method* (F value = 0.02)
- ✓ To avoid multicollinearity, the variables were first selected using correlation and pooled within-groups correlation matrices by eliminating those with a coefficient ≥ |0.8|
- ✓ In the "behavior" pillar, variables with a mean occurrence < 1 were not included (i.e., rare behaviors).

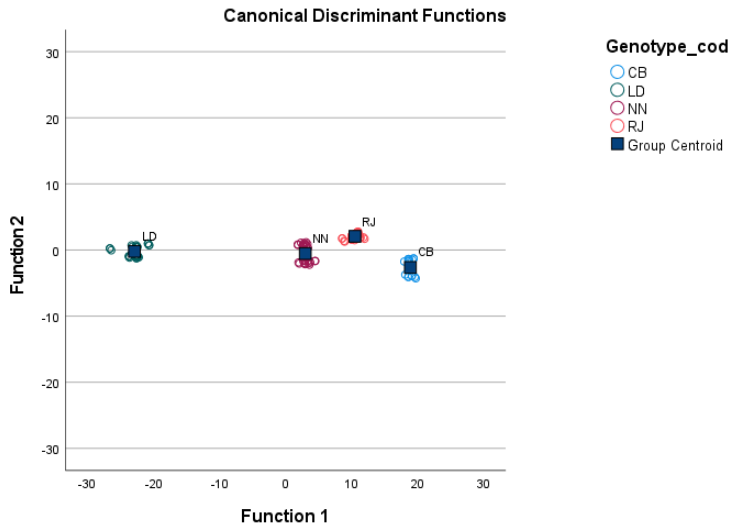
- The DA produced the discriminant function -*most parsimonious linear combinations of indicators describing between-genotype differences for each pillar*

- For each pillar, the variables to be included in subsequent analyzes were selected based on their contribution to discrimination (Dfs explaining at least 80% of the variance between genotypes).

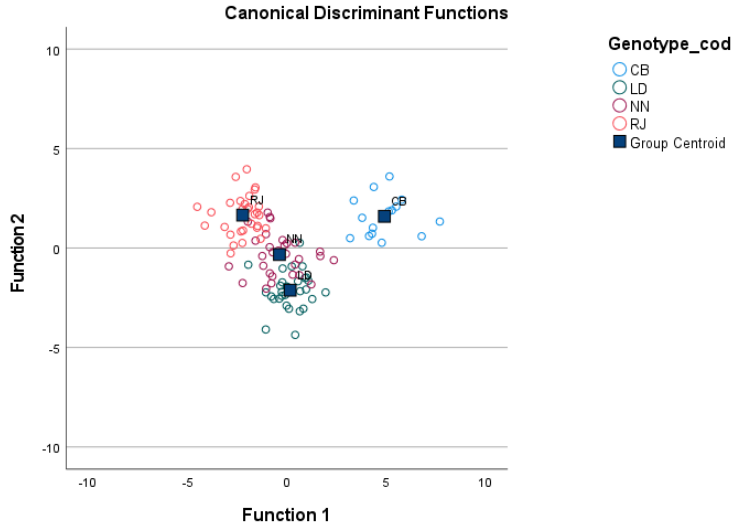
2. Principal Component and Reliability Analyses: creation of a composite Index and its validation and refinement

$DA_{behaviour}$		$DA_{body\ condition}$		$DA_{meat\ quality}$			$DA_{In\ vivo\ health}$		
Variable	**Df1 (98.8%)**	**Variable**	**Df1 (84.0%)**	**Variable**	**Df1 (55.5%)**	**Df2 (27.8%)**	**Variable**	**Df1 (65.6%)**	**Df2 (28.1%)**
Resting	5.699	**Live weight**	0.724	**HFI2_breast**	0.479	0.523	**HCT (%)**	1.101	-0.981
Scratching	4.066	**DFI**	0.457	**Carbonyls_drumstick**	0.460	0.225	**tocols**	0.603	0.053
Roosting	0.698	**Breast yield**	0.303	**DRIP loss %_drumstick**	0.319	-0.493	**Retinol**	0.488	0.156
Grass peking	0.114	Back Score	0.203	Carbonyls_breast	0.299	0.246	**H/L**	-0.057	0.547
Attacking	-3.712	Plantar Score	0.044	MUFA_breast	0.295	0.237	**Carbonyls**	-0.124	0.526
Grooming	-4.450	**Breast Score**	-0.470	pH_breast	0.268	-0.261	**Lisozima**	-0.129	-0.447
				n-3_drumistick	0.167	0.384	**HGB**	-1.266	0.351
				SFA_drumistick	-0.045	-0.614			
				n-6_drumistick	-0.083	-0.703			
				SFA_breast	-0.237	0.434			
				DRIP loss%_breast	-0.257	0.043			
				Retinol_breast	-0.352	-0.415			
				lipids_breast	-0.594	0.578			

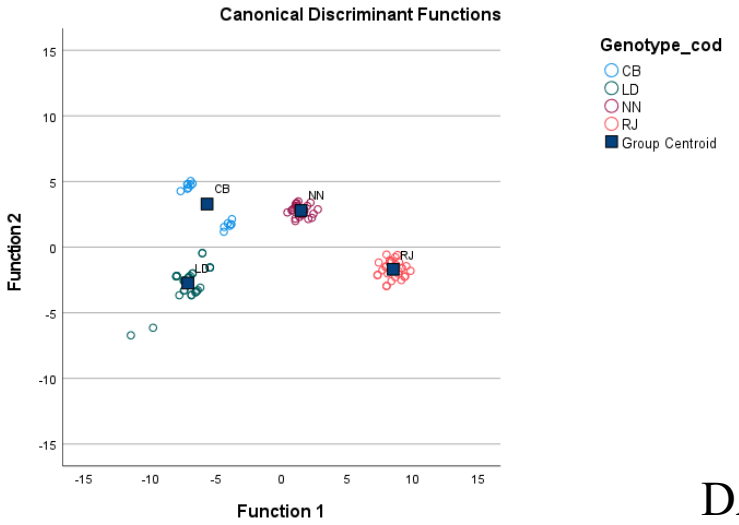
RESULTS



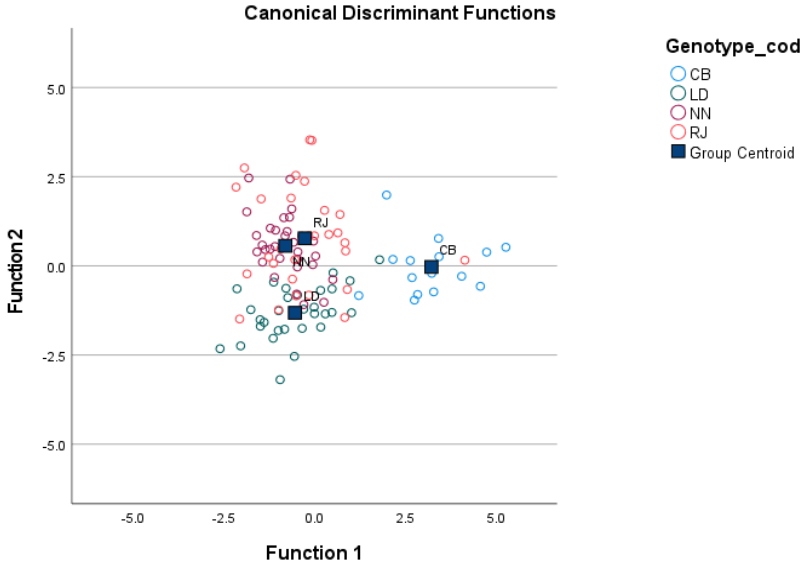
$DA_{behaviour}$



$DA_{meat\ quality}$



$DA_{body\ condition}$



$DA_{In\ vivo\ health}$

3. Principal Component and Reliability Analyses: creation of a composite Index and its validation and refinement

REFINE

- One variable was excluded because it did not present any correlation coefficient >0.3 (SFA_drumstick).
- Other variables were removed because had a loading <0.32 (HGB, Scratching, Attack, Tocols_blood, n-6 and n-3 drumstick, retinol_breast, tocols_blood, lysozyme)

Component Matrix

	Component 1
Zscore (live weight)	.919
Zscore (DFI)	.876
Zscore (BREAST feather condition)	-.862
Zscore (lipids_breast)	.746
Zscore (breast yield)	.662
Zscore (DRIP loss %_drumstick)	-.655
Zscore (HFI2_breast)	-.535
Zscore (SFA_breast)	.521
Zscore (Confort)	-.499

FINAL SELECTION:

- 9 variables were thus selected for the creation of the Index.
- The Cronbach's Alpha value for this composite index was 0.869.
- A final PCA was conducted including the nine variables listed in Table (**PCA explained 38.6% of the variance**)

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4. Index scores and differences among genotypes

Index score equation:

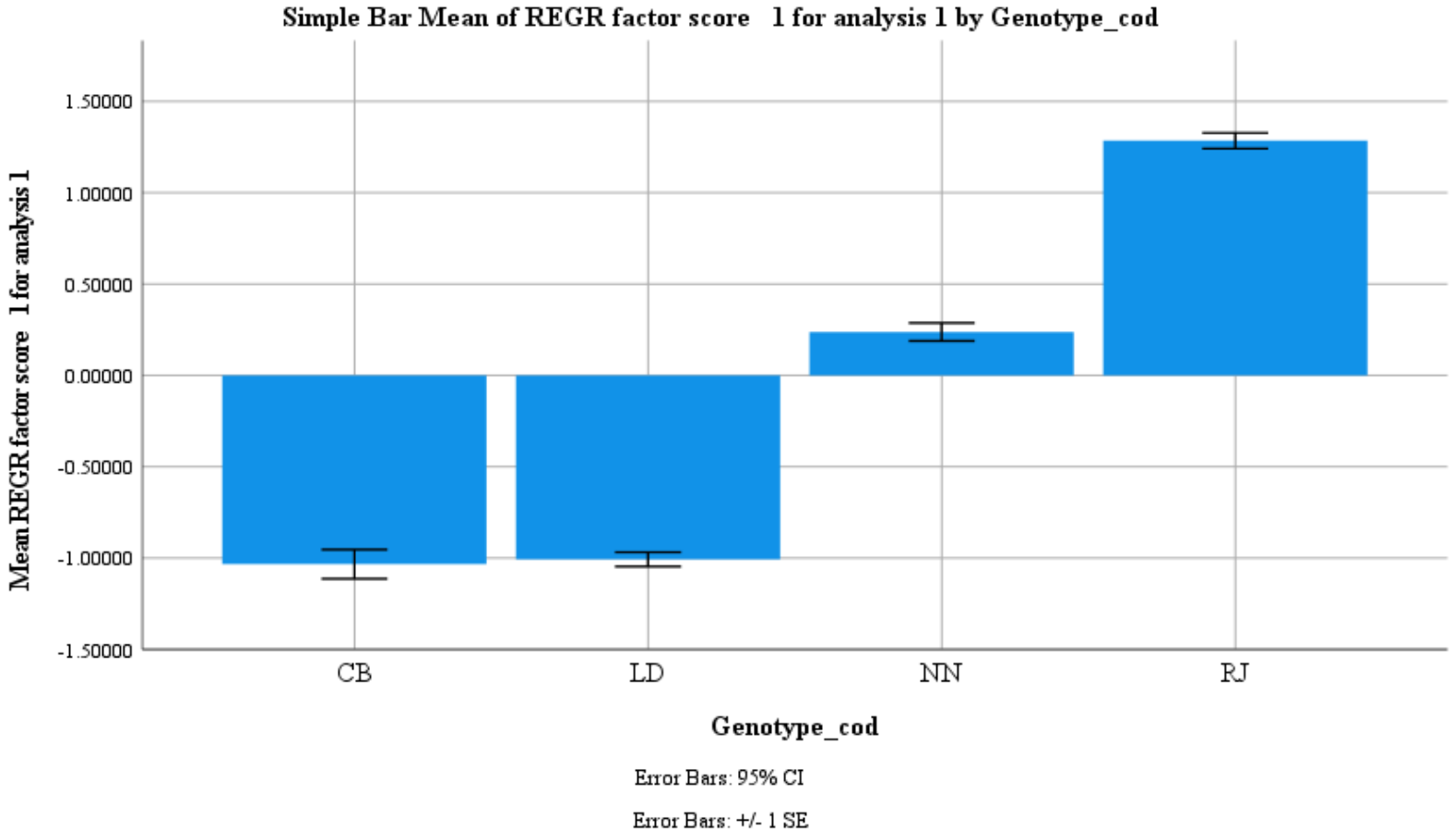
$$I = \sum x_i W_i$$

Where,

I=score of the index

X_i = value of the i^{th} variable

W_i =weight (i.e., loading) of the i^{th} variable



CONCLUSIONS - Take home message

- A simple index for describing the chickens adaptability to ERS is needed
- The choice of the criteria for the index building is very important, more criteria produce more robust index. It is need
  1. Consistency: Pillars representability
  2. Reliability: number of variables to include
  3. Simplicity: few, simple and «cheap» variables to assess, with the aim to use them also in large-scale/on-farm application
- To reduce the criteria number is needed to refine the index by including more data (chicken genotypes) in the analysis

The tested genotypes are SG, therefore very similar in characteristics, consequently the variance explained by the criteria is limited.
Probably applying the index to extreme lines would be more explanatory.

PPILOW **PARTNERS**

Thank you for your attention

simona.mattioli@unipg.it

www.ppilow.eu

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