3rd September, 2024 in Firenze
59th session

Bulk milk quality traits differ according to the ClassyFarm welfare assessment score

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"BRUNO UBERTINI"

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Introduction

Dairy cow welfare

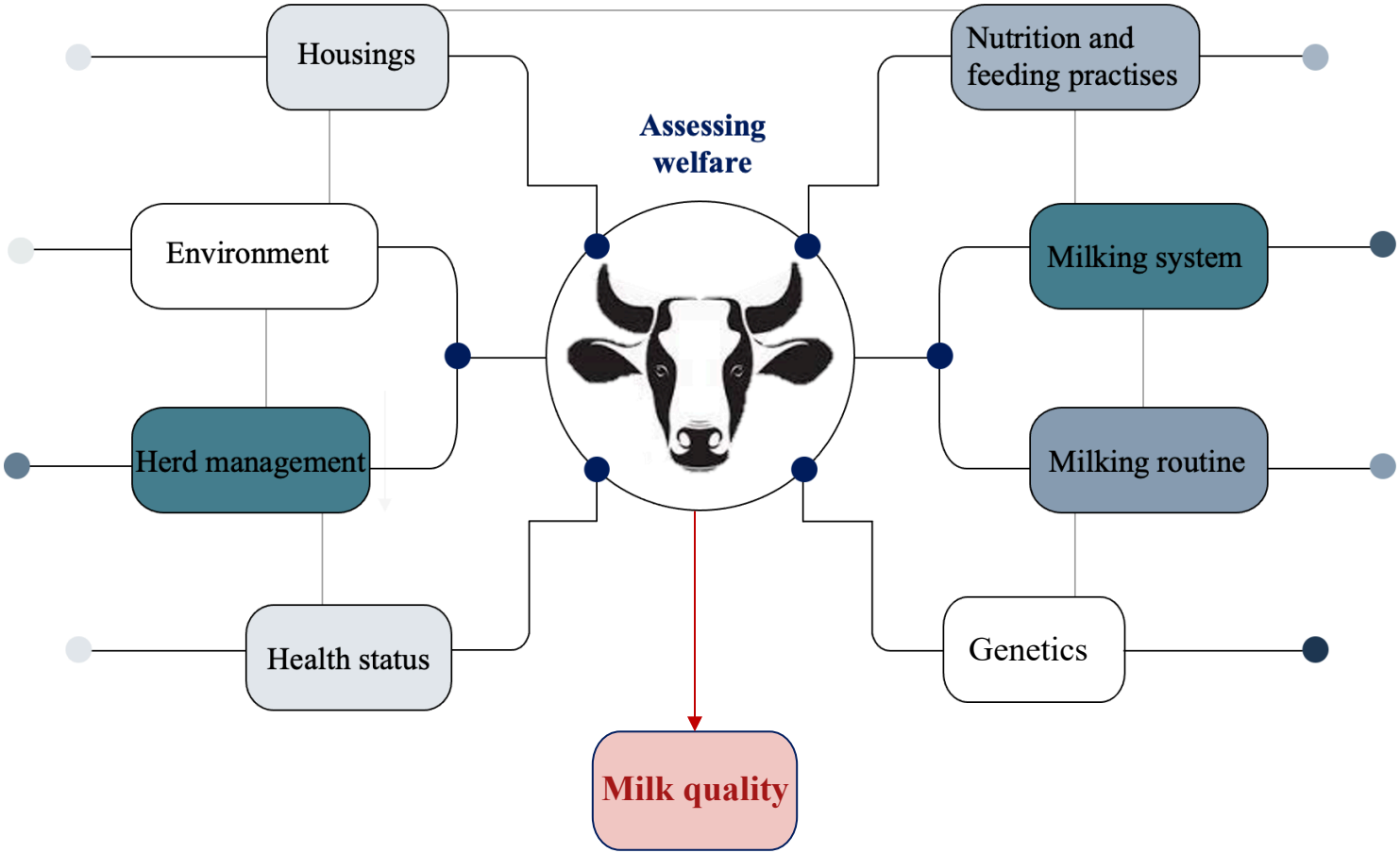
Dairy cow welfare can significantly influence productive performance, behaviour, fertility and milk quality.

Protocols for evaluating welfare standards have been published and some of them are constantly evolving.

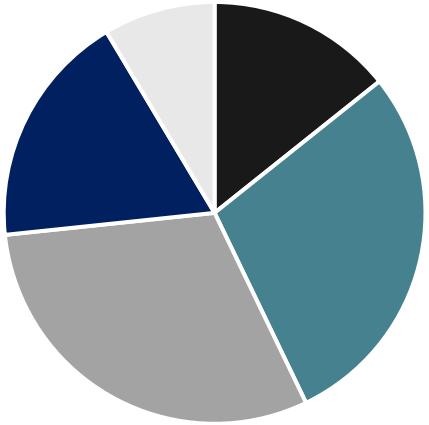
CLASSYFARM DATABASE

https://www.classyfarm.it/index.php/en/what-en

Dairy cow welfare and milk quality



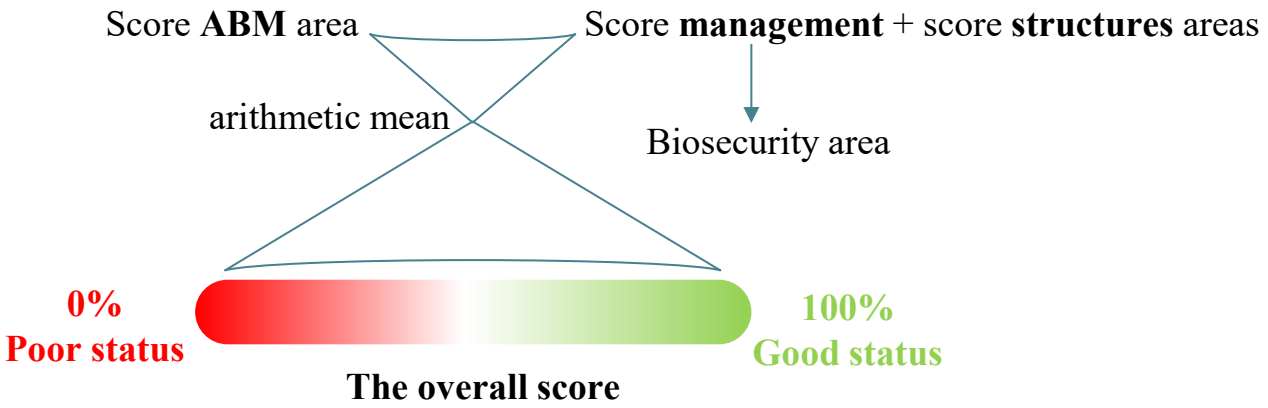
The ClassyFarm protocols



	Tied housing system	Loose housing system
Biosecurity	15 items (1st-15th)	15 items (1st-15th)
Management	25 items (16th- 40th)	30 items (16th- 45th)
Structures	28 items (41st- 68th)	32 items (46th-77th)
Animal-based measures (ABM)	22 items (69th- 90th)	19 items (78th- 96th)
Major Hazards	9 items (91st- 99th)	9 items (97th- 105th)
	99 items	**105 items**

(Bertocchi et al., 2018)

The ClassyFarm protocols



Elemento di verifica	25	ALIMENTAZIONE, ABBEVERAGGIO ED ALTRE SOSTANZE - Tipologia di alimentazione (bovini > 6 mesi d'età)	146/2001 All. Mangimi, acqua e altre sostanze Punto 15

"Tutti gli animali devono avere accesso ai mangimi ad intervalli adeguati alle loro necessità fisiologiche".

L'alimentazione dovrebbe essere somministrata ad libitum per garantire ad ogni animale di alimentarsi secondo esigenza durante le 24 h. Nel caso di alimentazione frazionata gli alimenti dovrebbero essere garantiti quasi costantemente nell'arco di 24 h, comprensivi sia della frazione fibrosa che di quella concentrata (quest'ultima deve essere somministrata in almeno due occasioni). In tal senso è auspicabile l'utilizzo del carro unifeed

Si considera non adeguato: accesso all'alimentazione ad intervalli non corretti perchè non garantita nelle 24 h e frazionata con intervalli non adeguati alle necessità fisiologiche degli animali	☐	Poor
Si considera adeguato: accesso all'alimentazione ad intervalli corretti perché garantita nelle 24 h e frazionata correttamente (concentrati somministrati almeno in 2 volte)	☐	Fair
Si considera ottimale: accesso agli alimenti in modo costante nelle 24 h (es. carro unifeed disponibile per 24h/giorno)	☐	Good

Elemento di verifica	26	Concentrati nella razione (bovine in lattazione) Considerare la % di sostanza secca (s.s.) da concentrati sul totale della s.s. giornaliera	

- In caso di razioni senza silomais: concentrati superiori al 60% della s.s.; **- In caso di razioni con silomais**: concentrati superiori al 50% della s.s.	☐	Poor
- In caso di razioni senza silomais: concentrati inferiori al 60% della s.s.; **- In caso di razioni con silomais**: concentrati inferiori al 50% della s.s.	☐	Fair

AIM OF THE STUDY

Investigation of the effect of the animal welfare level on bulk milk quality traits comparing loose-housing system (LHS) and tied-housing system (THS).

02

Materials and Methods

Animal welfare and milk data

CLASSYFARM DATABASE

194 farms

89 THS

105 LHS

194 welfare assessments

The welfare assessment protocols (year 2022) were applied in all the farms by the same Lattebusche veterinarian expert.

6,971 milk tests

Bulk milk samples were collected on average 2.99 times (SD =0.17) per month.

Milk quality traits

Bulk tank milk sampled in tubes with H_2O_2

- Fat, protein, casein, and **lactose** contents (%);
- urea concentration (mg/dL);
- **somatic cell count** (SCC, cells/mL) →
  SCS = 3 + log2(SCC/100,000) (Ali and Shook, 1980).

CombiFossTM7 (FOSS Electric A/S, Hillerød, Denmark)

- The **total bacterial count** (TBC, CFU/mL), log10-trasformed.

BactoScanTM FC+ (FOSS Electric, Hillerød, Denmark)

Statistical Analysis

The following mixed linear model was used for variance analysis:

$$y_{ijk} = \mu + \boldsymbol{Welfare}_i + Month_j + \boldsymbol{HS}_k + (Welfare\ x\ HS)_{ik} + Herd\text{-}season_l + e_{ijkl}$$

Lactose, SCS, TBC

2 classes (k=2): **LHS** or **THS**

3 classes (i=3):

- insufficient (**INS**, score <65%);
- intermediate (**INT**, score between 65% and 84%);
- excellent (**EXC**, score ≥85%).

month (j = 12, from January to December 2022); using the Bonferroni adjustment with significance set at $P \leq 0.05$.

Statistical Analysis

The following mixed linear model was used for variance analysis:

$$y_{ijk} = \mu + \boldsymbol{Management}_i + Month_j + \boldsymbol{HS}_k + (Welfare\ x\ HS)_{ik} + Herd\text{-}season_l + e_{ijkl}$$

Lactose, SCS, TBC

2 classes (k=2): **LHS** or **THS**

3 classes (i=3):

- insufficient (**INS**, score <65%);
- intermediate (**INT**, score between 65% and 84%);
- excellent (**EXC**, score ≥85%).

month (j = 12, from January to December 2022); using the Bonferroni adjustment with significance set at $P \leq 0.05$.

Statistical Analysis

The following mixed linear model was used for variance analysis:

$$y_{ijk} = \mu + \boldsymbol{Structures}_i + Month_j + \boldsymbol{HS}_k + (Welfare\ x\ HS)_{ik} + Herd\text{-}season_l + e_{ijkl}$$

Lactose, SCS, TBC

2 classes (k=2): **LHS** or **THS**

3 classes (i=3):

- insufficient (**INS**, score <65%);
- intermediate (**INT**, score between 65% and 84%);
- excellent (**EXC**, score ≥85%).

month (j = 12, from January to December 2022); using the Bonferroni adjustment with significance set at $P \leq 0.05$.

Statistical Analysis

The following mixed linear model was used for variance analysis:

$$y_{ijk} = \mu + \boldsymbol{ABM}_i + Month_j + \boldsymbol{HS}_k + (Welfare\ x\ HS)_{ik} + Herd\text{-}season_l + e_{ijkl}$$

Lactose, SCS, TBC

2 classes (k=2): **LHS** or **THS**

3 classes (i=3):

- insufficient (**INS**, score <70%);
- intermediate (**INT**, score between 70% and 84%);
- excellent (**EXC**, score ≥85%).

~~Biosecurity~~

~~Major hazards~~

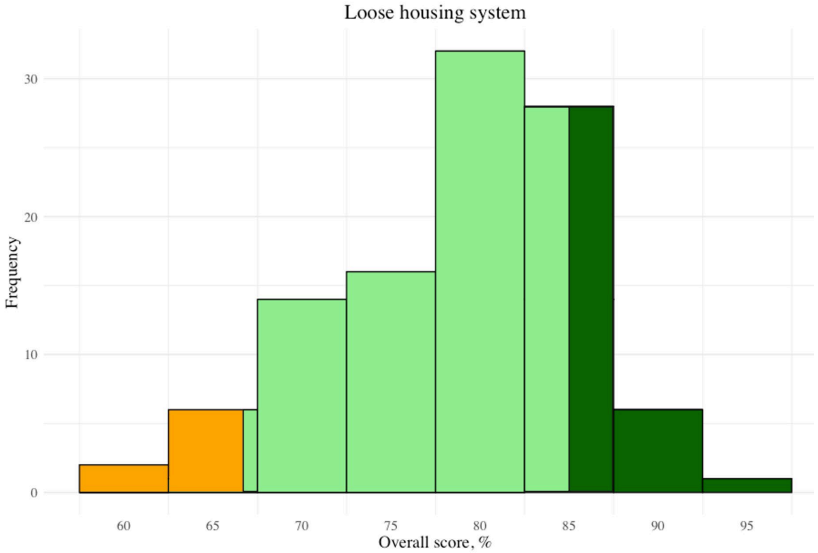
month (j = 12, from January to December 2022); using the Bonferroni adjustment with significance set at $P \leq 0.05$.

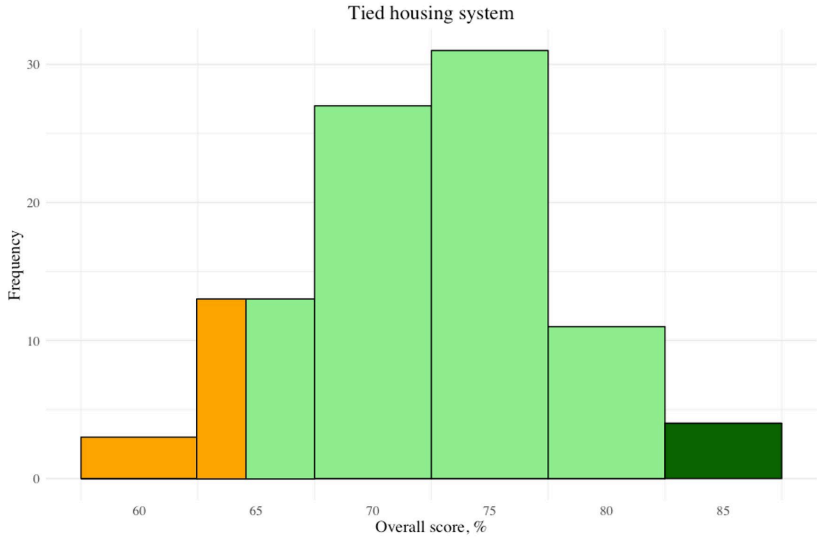
03

Results and Discussion

Frequencies distributions

For THS, 90% of farms were classified as intermediate, 4% as excellent, 6% as insufficient, while for LHS, the corresponding percentages were 75%, 20%, and 5%, respectively.



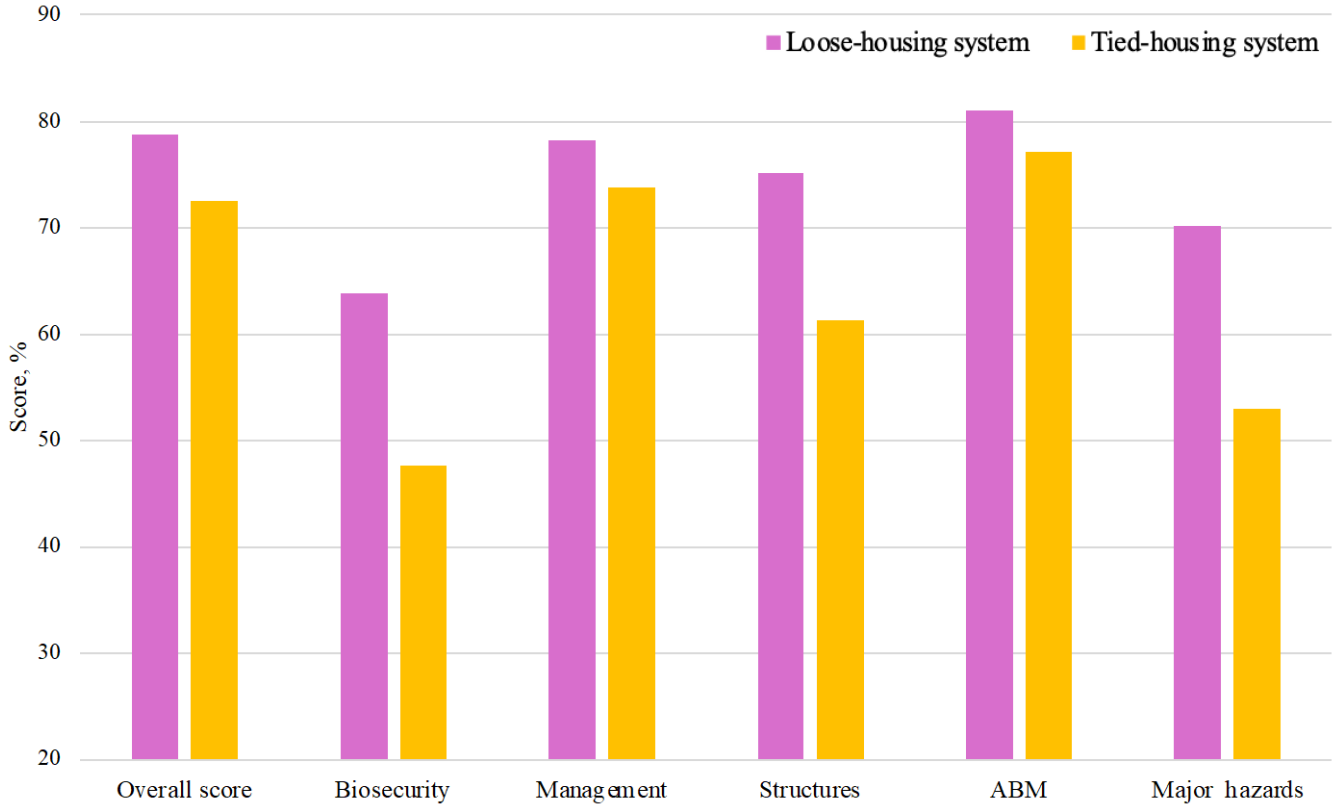


Descriptive statistics

Traits	Loose housing system		Tied housing system	
	Mean (SD)	Range	Mean (SD)	Range
Fat, %	3.96 ±0.24	3.18 -4.83	4.01 ±0.28	3.14 -4.85
Protein, %	3.42±0.16	2.80 -3.99	3.34 ±0.22	2.78 -3.99
Casein, %	2.71 ±0.14	2.16 -2.71	2.65 ±0.19	2.16 -3.20
Lactose, %	4.77 ±0.07	4.45 -4.96	4.73 ±0.10	4.45 -4.95
Urea, mg/dL	25.11 ±4.85	8.40 -42.60	22.91 ±5.99	8.40 -42.60
SCS	3.91 ±0.73	1.16 -6.27	4.05 ±0.98	0.60 -6.97
TBC, CFU/mL	14.24 ±25.77	10.00-722.00	24.24 ±183.74	10.00 -10’000.00
log_{10}TBC	1.07 ±0.19	1.00 -2.86	1.19 ±0.27	1.00 -4.00
Fat-to-protein	1.16 ±0.06	0.92 -1.45	1.21 ±0.07	0.86 -1.54

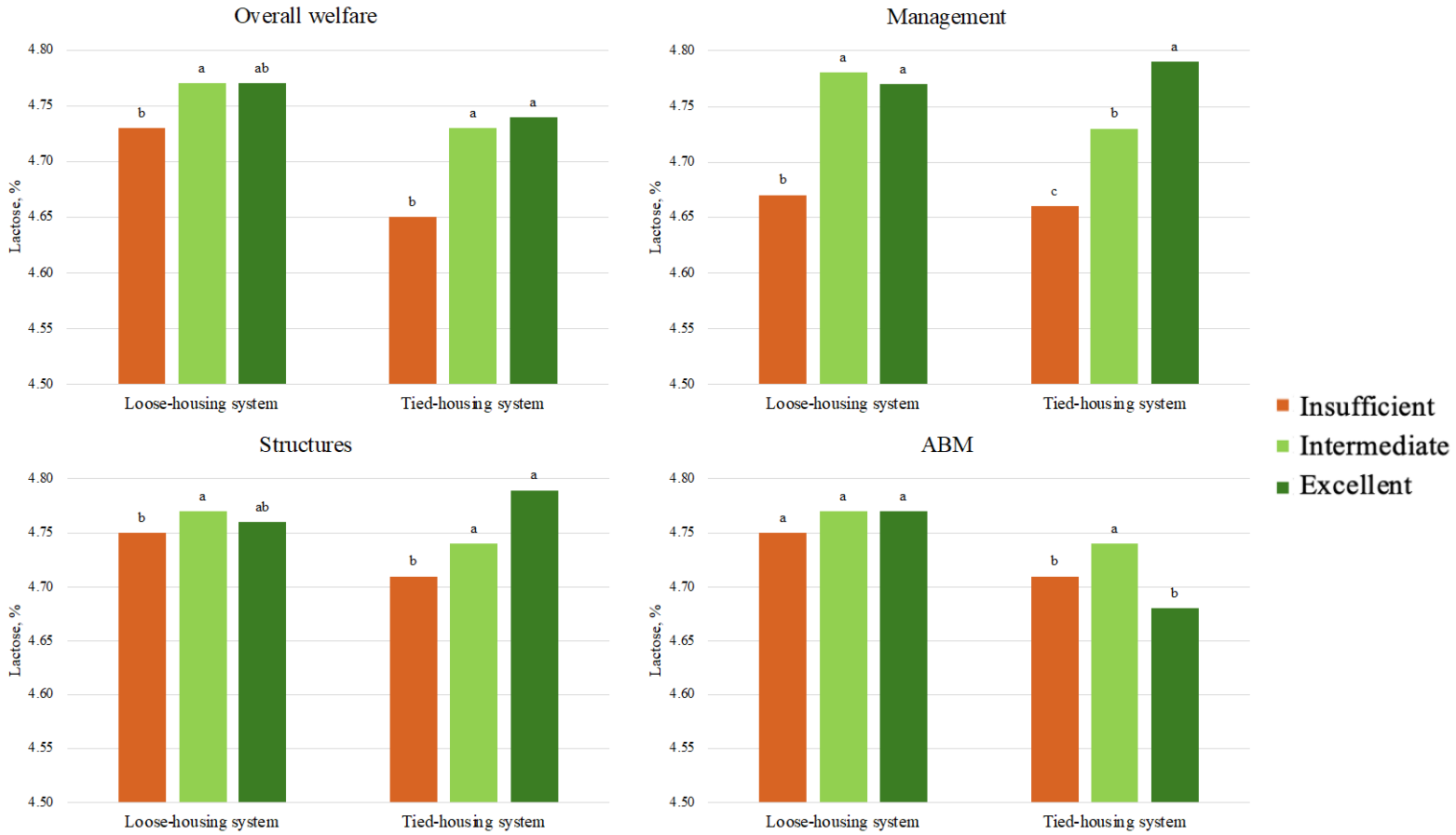
TBC= total bacterial count.
SCS= somatic cells score calculated as SCS=3+log2(SCC/100).

ClassyFarm scores

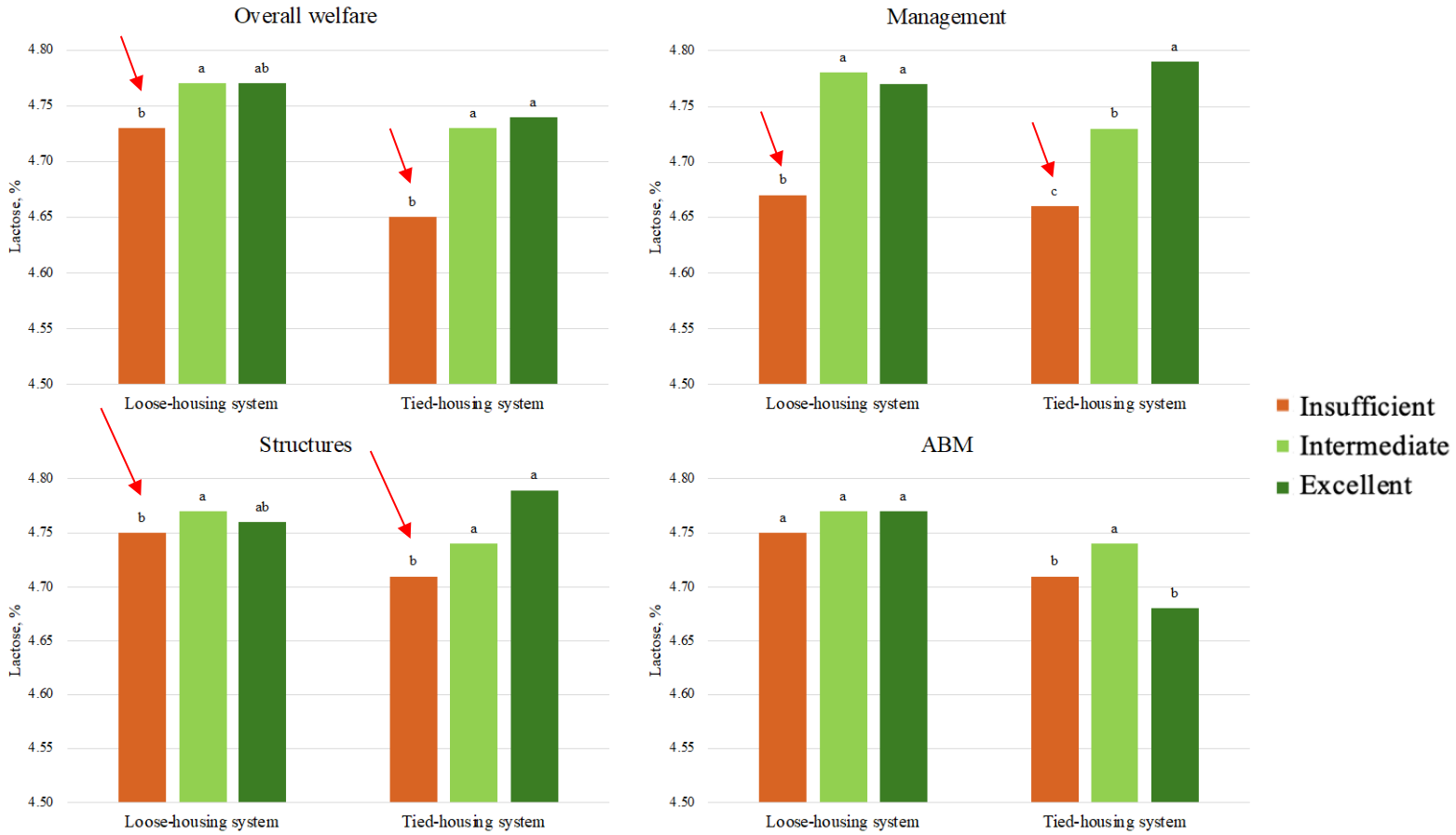


ABM = animal-based measures.

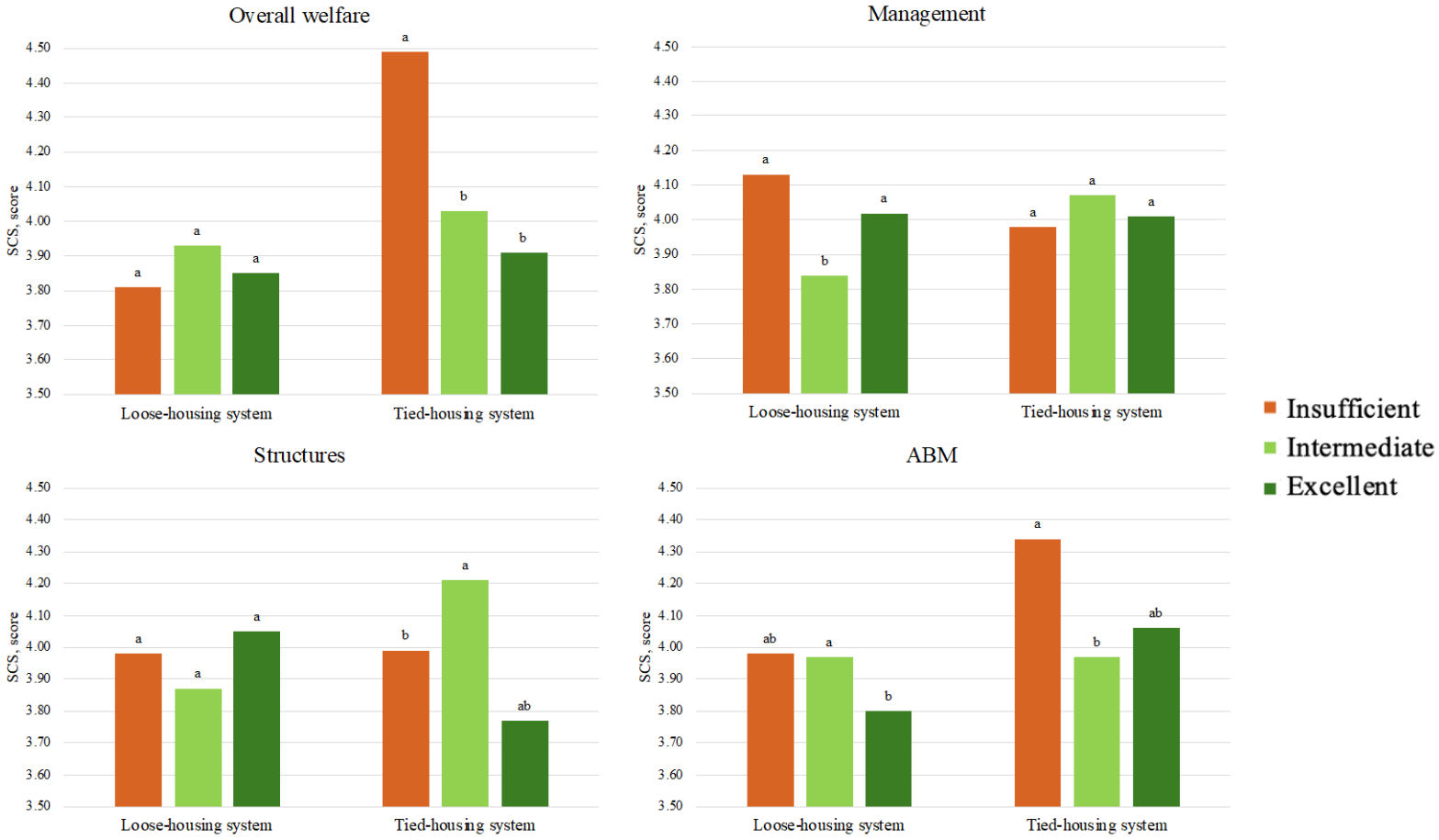
Lactose


Overall welfare
Management
Structures
ABM
Lactose, %
4.80
4.75
4.70
4.65
4.60
4.55
4.50
b
a
ab
c
Loose-housing system
Tied-housing system
Insufficient
Intermediate
Excellent

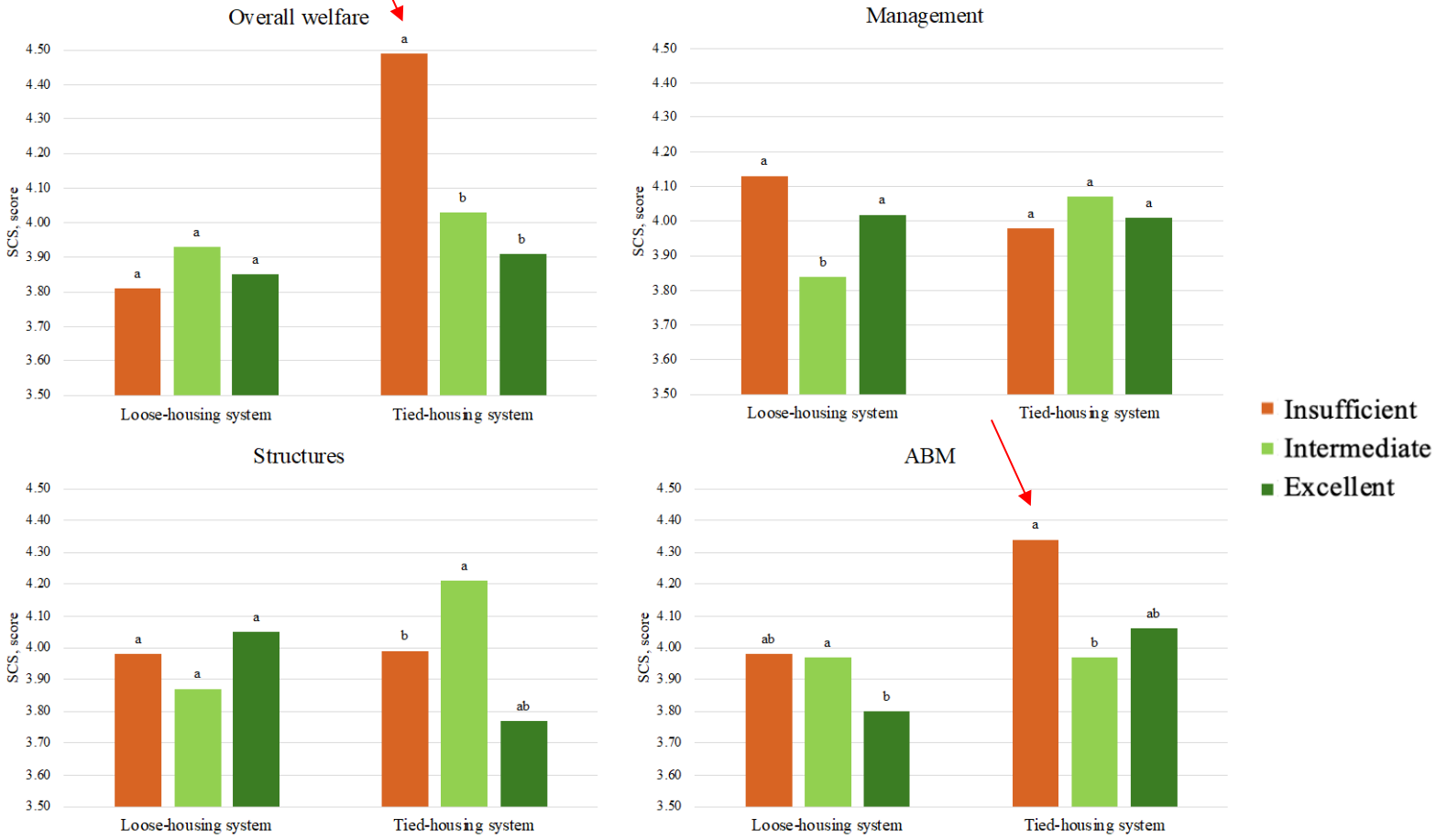
Lactose


Overall welfare
Management
Structures
ABM
Lactose, %
4.80
4.75
4.70
4.65
4.60
4.55
4.50
b
a
ab
b
a
a
b
a
a
b
c
b
a
b
a
ab
b
a
a
a
a
a
b
a
b
Loose-housing system
Tied-housing system
Insufficient
Intermediate
Excellent

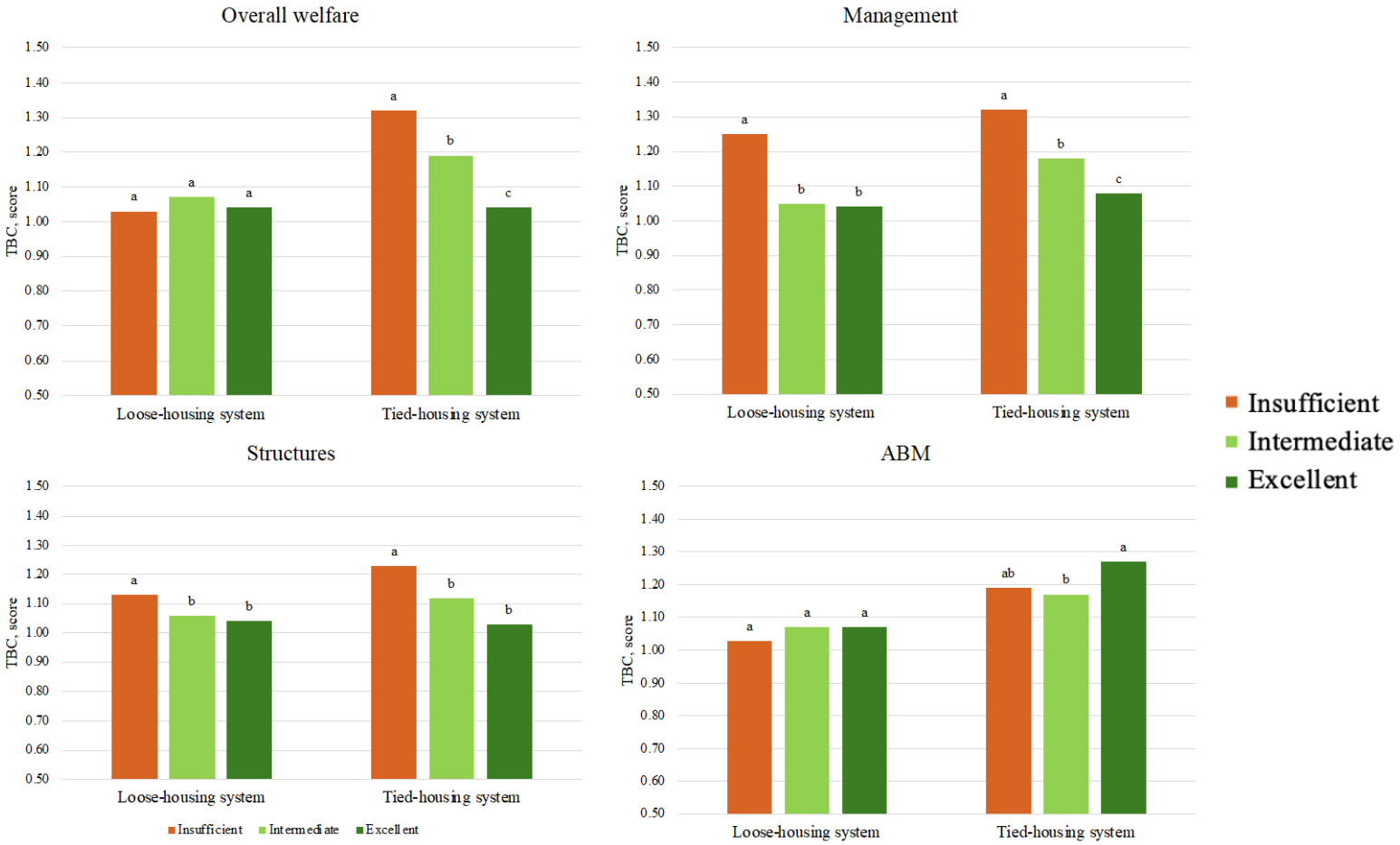
Somatic cell score



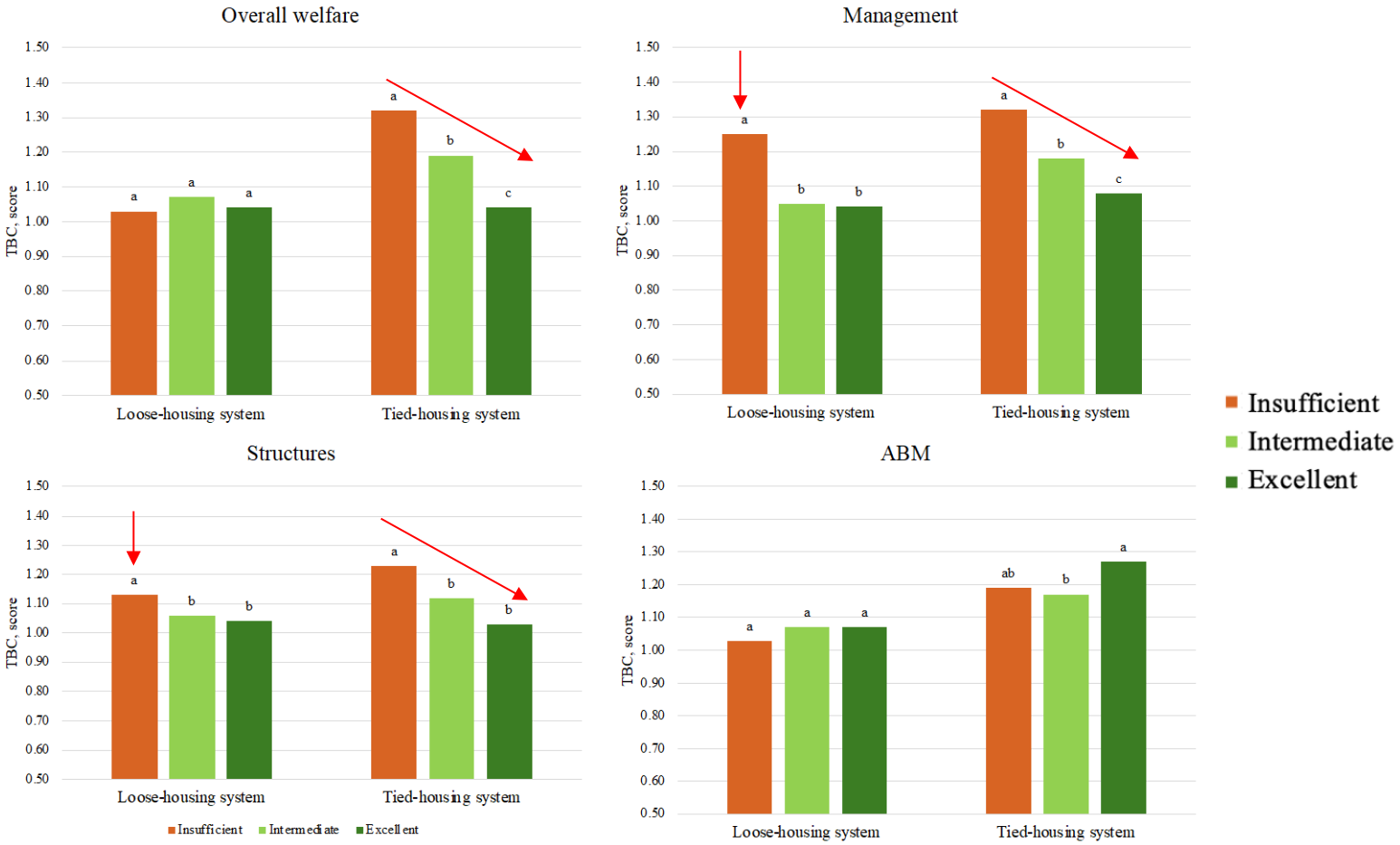
Somatic cell score



Total bacterial count



Total bacterial count



Conclusions

Farms in the worst welfare class exhibited the highest TBC and SCS and the lowest lactose content.

ClassyFarm as a tool to be implemented in the milk quality payment system to stimulate the farmers both to enhance animals welfare conditions and milk quality traits.

To better understand causal relationship of welfare scores and milk traits… more research!

Thanks for the kind attention

Do you have any questions?

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Additional materials

Trait[3]	Eq. [1]		Eq. [2]		Eq. [3]		Eq. [4]	
	Welfare	Welfare * HS	Management	Management * HS	Structures	Structures * HS	ABM	ABM * HS
Fat, %	4.66**	9.76***	8.76 ***	9.23 ***	5.64 **	5.09 **	1.10	5.23 **
Protein, %	2.61 †	4.27 *	1.12	0.30	15.43 ***	1.87	1.40	0.41
Casein, %	2.51 †	5.31 **	1.54	0.64	13.85 ***	2.32 †	1.79	0.95
Lactose, %	11.62 ***	1.26	77.75 ***	12.77 ***	12.39 ***	3.76 *	10.95 ***	10.16 ***
Urea, mg/dL	1.43	2.33 †	0.30	13.75 ***	4.31 *	6.40 **	3.58 *	5.58 **
SCS, score	1.79	3.58 *	1.08	3.87 *	0.89	6.22 **	4.03 *	4.73 **
TBC, score	8.18 ***	7.92 ***	52.90 ***	3.70 *	24.85 ***	1.50	4.86 **	5.89 **
Fat-to-protein	17.07 ***	1.47	20.96 ***	7.86 ***	33.04 ***	1.64	6.36 **	4.93 **
FA, g/100 g								
De novo FA	1.26	12.28 ***	3.08 *	12.29 ***	6.77 **	3.13 *	0.81	1.10
Mixed FA	0.68	7.29 ***	1.28	10.10 ***	1.92	0.34	0.29	0.89
Preformed FA	17.36 ***	0.30	28.54 ***	3.18 *	10.99 ***	11.44 ***	6.09 **	4.62 *
MUFA	13.06 ***	1.63	24.97 ***	3.69 *	6.47 **	11.30 ***	5.34 **	5.49 **
PUFA	9.52 ***	6.43 **	1.64	11.63 ***	13.87 ***	13.55 ***	8.44 ***	7.33***
SFA	0.73	11.52 ***	2.71 †	11.30 ***	3.17 *	1.57	0.04	3.39 *

[1] ***$P < 0.001$; **$P < 0.01$; *$P < 0.05$, † $P < 0.10$.

[2] HS = housing system; ABM = animal-based measures.

[3] TBC = $\log_{10}$ of total bacterial count (CFU/mL); FA = Fatty acids.

Table 6. Least squares means (standard error) of bulk milk traits[1] for the fixed effect of housing system[2]. Means with different superscript letters within row are significantly different ($P \leq 0.05$).

Trait	LHS	THS
Fat, %	4.02[a] (0.01)	4.01[a] (0.02)
Protein, %	3.42[a] (0.01)	3.34[b] (0.02)
Casein, %	2.71[a] (0.01)	2.64[b] (0.02)
Lactose, %	4.76[a] (0.01)	4.71[b] (0.01)
Urea, mg/dL	24.40[a] (0.40)	23.60[a] (0.50)
SCS, score	3.86[b] (0.06)	4.14[a] (0.08)
TBC, score	1.05[b] (0.02)	1.18[a] (0.02)
Fat-to-protein	1.18[b] (0.005)	1.21[a] (0.006)
FA, g/100 g milk		
De novo	0.89[a] (0.01)	0.84[b] (0.01)
Mixed	1.40[a] (0.01)	1.37[b] (0.01)
Preformed	1.19[b] (0.01)	1.27[a] (0.01)
MUFA	1.00[b] (0.01)	1.04[a] (0.01)
PUFA	0.085[a] (0.001)	0.084[a] (0.001)
SFA	2.73[a] (0.01)	2.68[b] (0.01)

[1] TBC = $\log_{10}$ of total bacterial count (CFU/mL); FA = Fatty acids;

[2] LHS = loose housing system; THS = tied housing system.