HOUSING FOR ANIMAL WELFARE IN CATTLE

L. Leso[1], M. Uberti[2], W. Morshed[1], M. Barbari[1]
[1]University of Florence, GESAAF
[2]Freelance veterinarian, Mantua, Italy

FREE STALLS: A WELFARE ISSUE

- Steelworks
- Slippery and hard floors

- Steps
- Liquid manure

- Animal welfare limitation
- Behavioral restrictions
- Lameness and lesions

CPB: AN ALTERNATIVE HOUSING SYSTEM

Housing systems where a deep-bedded pack is aerated to enhance heat production and microbial activity and thus increases the **evaporation** of water (Klaas & Bjerg, 2011).

- The whole surface of the resting area is compost-bedded (loose housing, open pack)
- "Cultivated pack" refers to a mixture of manure and bedding (lignocellulosic, compost)
- Moisture content 40-60%
- Pack depth and space per cow depend on the country and the management style (from 30 cm to > 1 m; from 6 to 15 m^2 bedding/cow)
- Frequently AERATED (stirring and sub-aeration blowing or suckling from the floor)

CPB: WELFARE IMPROVEMEMTS

BEHAVIOR

- No steelwork in the resting area
- High grip surface

- Dry and healthy
- Soft surface and absence of steps

HEALTH

REVIEW OF LITERATURE:WELFARE

		Lameness		Hock lesions		Udder health			Hygiene		
Reference	**Bedding material1**	**Lameness prevalence2 (%)**	**Severe lameness prevalence3 (%)**	**Hock lesion prevalence4 (%)**	**Severe hock lesion prevalence5 (%)**	**Mastitis infection prevalence6 (%)**	**SCC**	**BCS7**	**Hygiene score8**	**Dirty cows prevalence9 (%)**	**Annual herd turnover rate10 (%)**
Balck et al., 2013	SD	11.9	5	NA11	NA	NA	275510	NA	2.2	29.8	NA
Lobeck et al., 2011	SD	4.4	0.8	3.8	0.8	33.4	434000	2.91	3.18	NA	30.1
Ofner-Schröck et al., 2013	SD	25	NA	NA	NA	NA	NA	NA	NA	NA	NA
Barberg et al., 2007b	SD	7.8	NA	25.1	1	27.7	325000	3.04	2.66	NA	20.9
Fulwider et al., 2007	SD	NA	NA	0	0	NA	176700	NA	NA	21.1	20.4
Shane et al., 2010	SD	NA	NA	19.6	0	NA	155000	3.1	2.4	NA	NA
	CC	NA	NA	18.5	0	NA	123000	3.2	2.7	NA	NA
	WC/SD	NA	NA	0	0	NA	175000	3.3	2.5	NA	NA
	SS/SD	NA	NA	19.4	5.4	NA	111000	3	2.9	NA	NA
	WC/SS	NA	NA	37.5	0	NA	282000	3.3	2.6	NA	NA
	SS	NA	NA	46.9	3.1	NA	145000	3	2.8	NA	NA
Klaas et al., 2010	NO	NA	NA	0	NA	NA	192000	NA	NA	51.2	NA
Ouweltjes and Smolders, 2014	WC	NA	NA	NA	NA	NA	NA	3.1	NA	NA	37.8
	GC	NA	NA	NA	NA	NA	NA	2.9	NA	NA	25.1
	GC	NA	NA	NA	NA	NA	NA	3.1	NA	NA	32.1

1SD = sawdust; CC = corn cobs; WC/SD = wood chip fines/sawdust (as mixtures on a 2:1 v/v ratio); SS/SD = soybean straw/sawdust (as mixtures on a 2:1 v/v ratio); WC/SS = wood chip

REVIEW OF LITERATURE:PACK CHEMICAL ANALYSES

Reference	Bedding material[1]	Pack depth cm	Temperature °C	Moisture %	pH	C:N	N % (DM)	P mg/kg	K mg/kg
Balck et al., 2013	SD	0	10.5	56.1	NA[2]	26.7	1.70	4000	13000
		10.2	32.3	NA	NA	NA	NA	NA	NA
		20.3	36.1	NA	NA	NA	NA	NA	NA
Barberg et al., 2007a	SD	15	42.5	52.7	8.4	21.4	2.45	3111	13831
		30		56.7	8.6	17.6	2.69	3442	17202
Shane et al., 2010	SD	15.2	28.0	60.9	8.68	37.1	1.3	1449	4857
		30.5	31.8	57.8	8.69	37.4	1.3		
	CC	15.2	38.1	46.7	7.97	29.1	1.6	1620	8053
		30.5	40.8	41.2	7.38	29.3	1.5		
	WC/SD	15.2	21.4	61.3	8.54	45.7	1.1	1050	3893
		30.5	22.6	59.5	8.67	49.3	1		
	SS/SD	15.2	24.7	60.2	8.58	25.8	1.6	1749	7080
		30.5	28.4	54.9	8.57	25.4	1.5		
	WC/SS	15.2	19.5	60.2	8.48	31.6	1.4	2690	10463
		30.5	19.2	62.3	8.57	30	1.5		
	SS	15.2	13.1	60.3	8.58	22.8	1.6	2104	8196
		30.5	13.1	62.3	NA	NA	NA		
de Boer, 2014[3]	WC	0-40	NA	56.9	8.6	10.5	3.57	6589	44084
	GC	0-40	NA	47.5	8.3	16.6	1.36	3924	12933
	GC	0-40	NA	44.6	8.8	15.1	1.63	3773	23646

[1]SD = sawdust; CC = corn cobs; WC/SD = wood chip fines/sawdust (as mixtures on a 2:1 v/v ratio); SS/SD = soybean straw/sawdust (as mixtures on a 2:1 v/v ratio); WC/SS = wood chip fines/soybean straw (as mixtures on a 2:1 v/v ratio); SS = soybean straw; GC= green waste compost.

REVIEW OF LITERATURE:PACK BACTERIAL ANALYSES

Reference	Bedding material[1]	Total Bacterial Count log10 cfu/g	Klebsiella log10 cfu/g	E. coli log10 cfu/g	Coliforms log10 cfu/g	Streptococci log10 cfu/g	Staphylococci log10 cfu/g	Bacillus spp. log10 cfu/g
Balck et al., 2014	SD	8.2	NA[2]	6.0	6.3[3]	7.2	7.9	7.6
Barberg et al., 2007a[4]	SD	7.0	NA	NA	6.0	6.6	6.2	6.5
Shane et al., 2010[4]	SD	7.4	5.9[5]	NA	6.8	6.9	4.4	6.9
	CC	7.8	5.8[5]	NA	6.6	7.5	6.0	7.4
	WC/SD	7.1	5.7[5]	NA	6.5	6.6	4.6	6.8
	SS/SD	7.1	5.1[5]	NA	6.4	6.7	4.1	6.6
	WC/SS	7.6	5.8[5]	NA	7.0	6.8	ND[6]	7.4
	SS	7.5	4.6[5]	NA	6.5	7.0	ND	7.3
Lobeck et al., 2012[4]	SD	6.5	2.4	NA	4.1	6.5	4.0	4.4
Driehuis et al., 2012	WC	8.4	5.6	2.4	NA	3.0	NA	NA

[1]SD = sawdust; CC = corn cobs; WC/SD = wood chip fines/sawdust (as mixtures on a 2:1 v/v ratio); SS/SD = soybean straw/sawdust (as mixtures on a 2:1 v/v ratio); WC/SS = wood chip fines/soybean straw (as mixtures on a 2:1 v/v ratio); SS = soybean straw.

REVIEW OF LITERATURE:MILK QUALITY

Reference	Bedding material[1]	SCC cells/mL	Milk fat %	Milk protein %	Coliforms cfu/mL	Non-ag strept. cfu/mL	Staph. species cfu/mL	Staph. aureus cfu/mL
Balck et al., 2014	SD	246,500	NA[2]	NA	NA	NA	NA	NA
Barberg et al., 2007a	SD	325,000	3.88	3.21	NA	NA	NA	NA
Shane et al., 2010[3]	SD	155,000	3.36	3.30	50.1	8.6	6.3	0.1
	CC	123,000	3.17	3.16	1,058.1	872.1	5.8	1.9
	WC/SD	175,000	3.32	3.23	102.7	33.4	2.9	0.0
	SS/SD	111,000	3.06	3.09	2.8	6.0	11.1	0.0
	WC/SS	282,000	3.15	3.21	65.4	138.1	26.9	5.7
	SS	145,000	3.08	3.15	85.1	8.0	12.7	0.1
Lobeck et al., 2011 and 2012	SD	434,000	NA	NA	406.8	878.4	52.6	3.6

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REVIEW OF LITERATURE: SUMMARY

ADVANTAGES

Reduced production of liquid manure (CH_4 -> ?)

High agronomic value (+ orgC/+orgN/ -NH_3)

DISADVANTAGES

Gaseous emissions (NH_3/NO_x-> ?)

TAS/XTAS (compost)

Construction + bedding costs

Animal welfare

SPACE PER COW/BEDDING/MANAGEMENT

INTRODUCTION

- The main reasons producers reported for building CPB is improved cow **comfort and longevity**. Despite that little is still known about the effect of this housing system on longevity.

MATERIAL AND METHODS

- 30 dairy farms included
  - 10 free stall + synthetic mattress **(MAT)**,
  - 10 free stall + straw **(STW)**
  - 10 cultivated pack barns **(CO)**
- Cows' performance/longevity
  - Monthly herd records (Associazione Italiana Allevatori)

STATISTICAL ANALISYS:R

- str(DfArt2015)

330 obs. of **32 variables** (housing and perf. parameters):

farm code h_sys date n_tot_cow n_milk_cow m_yie evm m_fat m_pro n_par dim dry calv_int do VWP n_ai HDR CR PR age age_1c culling scc l_sco MIR S_tot S_bed S_conc fence BR Sto_Dens_FS

Univariate linear models (pairwise) to identify variables for the multivariate model. Variables with P<0.2 were included.

Automatic model selection procedure, package "glmulti" (iterative; crit:BIC)

Fitting the **multivariate linear mixed model** (nested rANOVA), package "nlme"

Obtaining the **Last Squared Means and SE**, package "lsmeans"

Post hoc analisys, pairwise comparison, package "multcomp" (Tuckey)

RESULTS: GENERAL (DESCRIPTIVE STATISTICS)

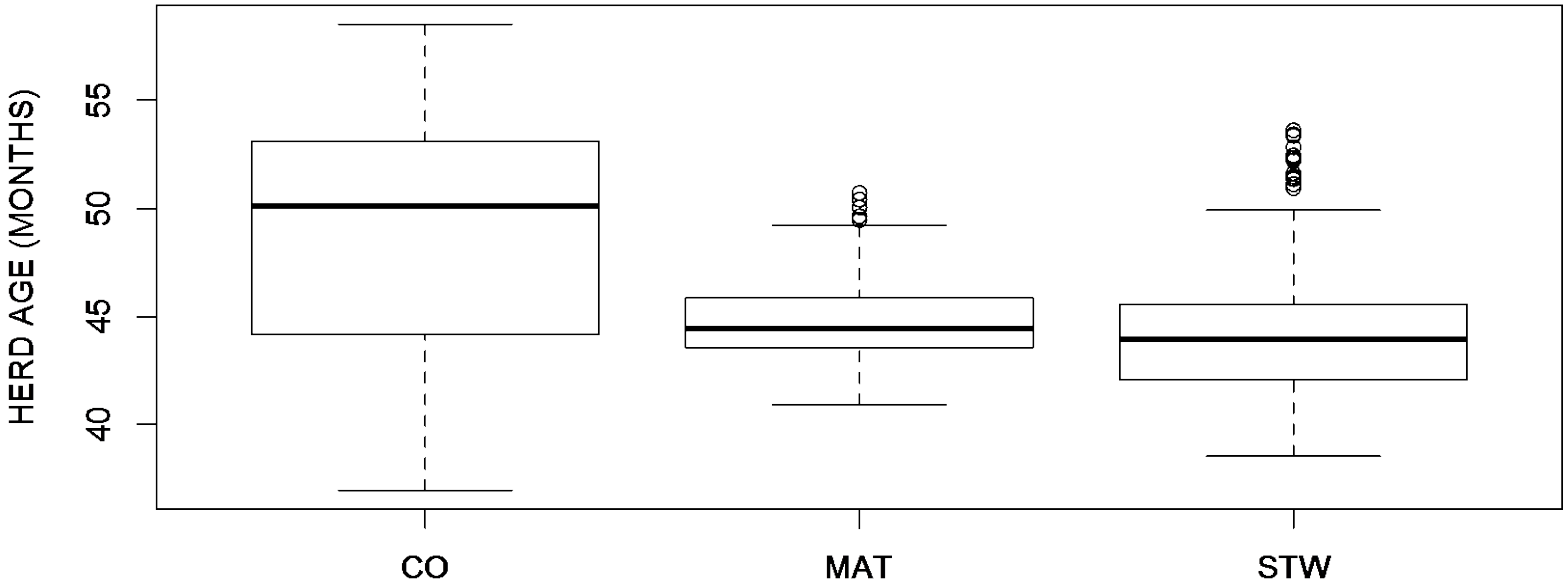
Barns' characteristics

	STW		MAT		CO	
	Mean	SD	Mean	SD	Mean	SD
Total area per cow (m^2/cow)	**9.3**	5.4	**9**	2.3	**11**	4.1
Stocking density (cows/stall)	**1.09**	0.42	**0.92**	0.1		-
Pack density (m^2/cow)	-	-	-	-	**6.8**	2.4
Bedded ratio	**0.37**	0.1	**0.38**	0.06	**0.65**	0.18
Space at feed fence (m/cow)	**0.63**	0.18	**0.66**	0.07	**0.58**	0.2

Cows' performance

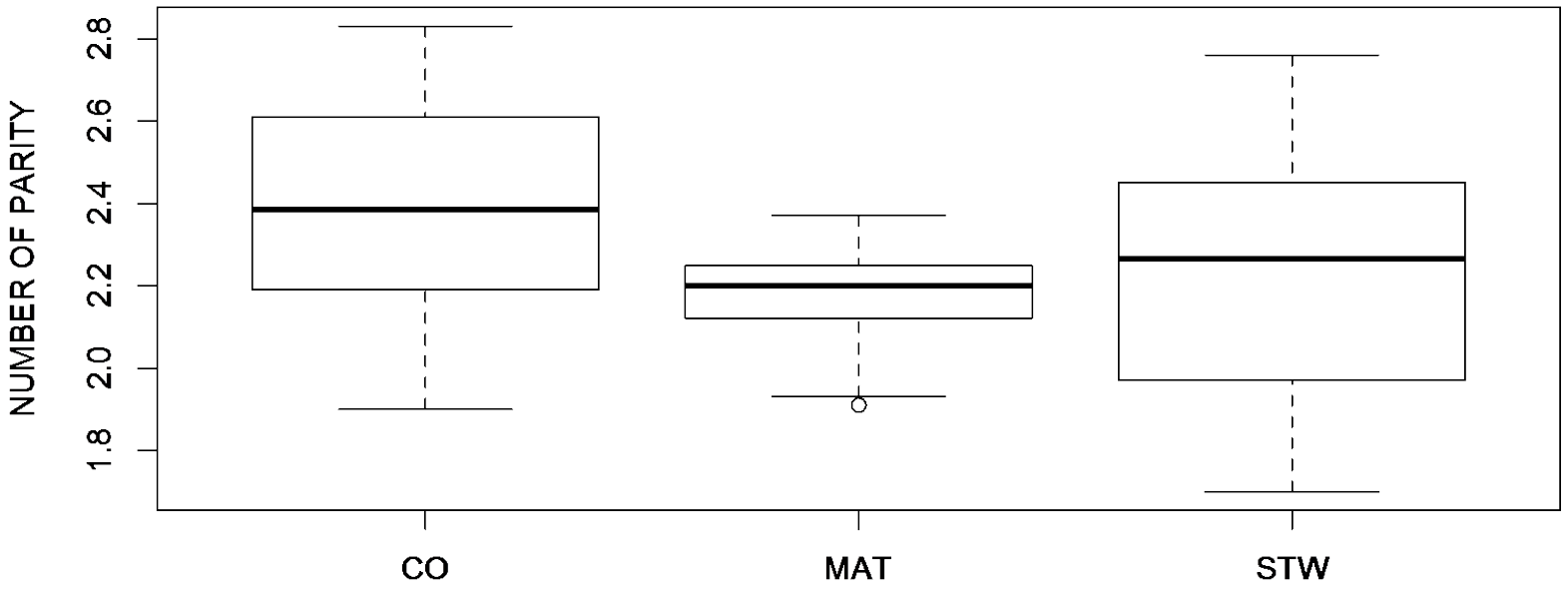
	STW		MAT		CO	
	Mean	SD	Mean	SD	Mean	SD
Cows, no.	**143**	83.9	**147**	102.3	**112**	56.6
Day in milk (days)	**190**	26.3	**204**	35.7	**209**	33.1
Parity	**2.23**	0.27	**2.18**	0.11	**2.39**	0.25
Milk yield (kg/cow*day)	**31.4**	3.91	**29.8**	4.6	**30.8**	3.6
305ME (kg) [1]	**10901**	963	**10450**	1043	**10541**	663
% fat	**3.93**	0.36	**3.75**	0.32	**3.67**	0.28
% protein	**3.43**	0.13	**3.38**	0.15	**3.48**	0.16
SCC (cells*1000/mL)	**310**	128	**259**	115	**354**	171
Calving interval (days)	**420**	19.1	**442**	37.3	**449**	72.9
Services per pregnancy, no.	**2.54**	0.61	**2.59**	0.64	**2.67**	0.5

RESULTS:LONGEVITY:HERD AGE



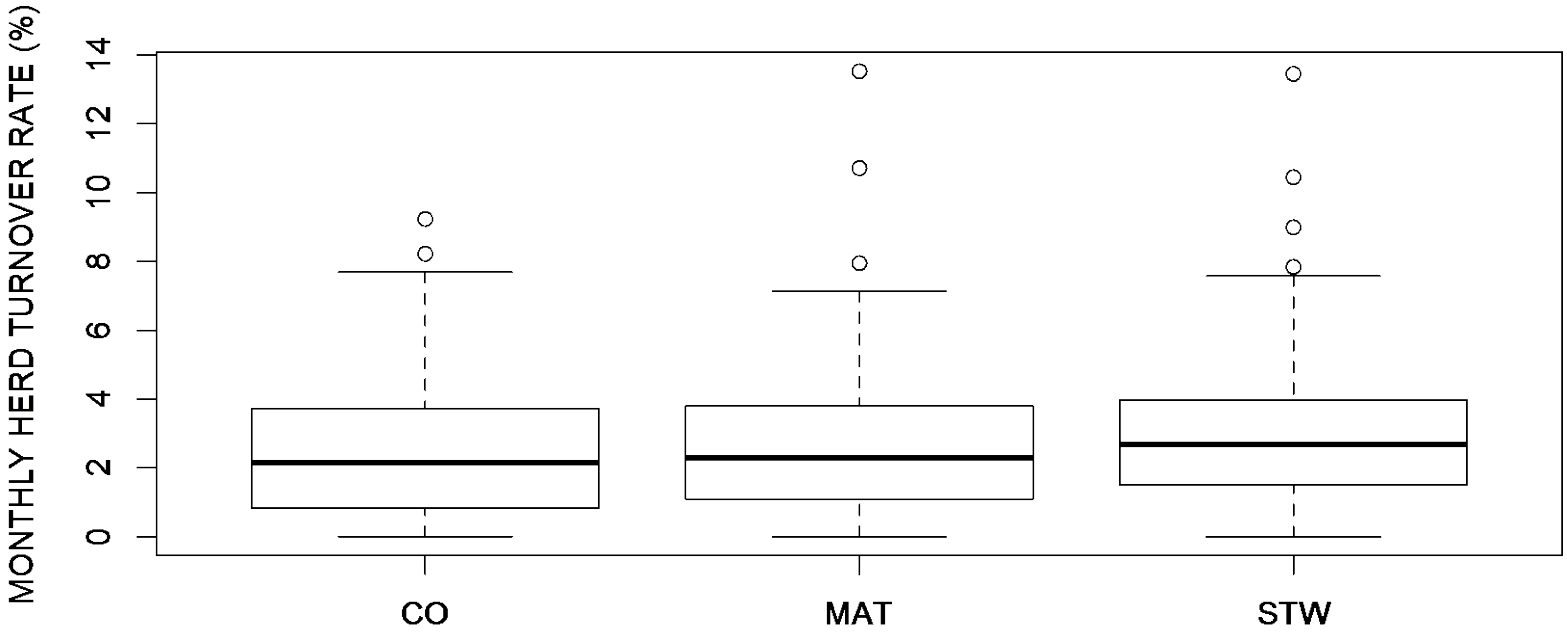
	Herd age		
Item	LSM	SE	P-value
Housing system			<0.001
STW	**44.58**[b]	0.34	
MAT	**44.98**[b]	0.33	
CO	**48.46**[a]	0.33	
	Estimate	SE	
DIM	-0.044	0.007	0.001
Calving interval (days)	0.074	0.007	<0.001
Age at first calving (months)	0.387	0.068	<0.001

RESULTS:LONGEVITY:NUMBER OF PARITY



	Number of parity		
Item	LSM	SE	P-value
Housing system			<0.001
STW	**2.23[b]**	0.21	
MAT	**2.16[b]**	0.19	
CO	**2.41[a]**	0.19	
	Estimate	SE	
Length of the dry period (days)	0.006	0.001	<0.001
Calving interval (days)	-0.003	0.0004	<0.001
Monthly herd turnover rate (%)	-0.014	0.005	0.0045

RESULTS:LONGEVITY:HERD TURNOVER RATE



	Monthly herd turnover rate		
Item	LSM	SE	P-value
Housing system			**0.382**
STW	**2.82**	0.41	
MAT	**2.60**	0.31	
CO	**2.73**	0.26	
	Estimate	SE	
305-d mature eq. yield,(kg)	-0.0004	0.0001	0.006
Number of parity	-1.728	0.5100	<0.001
Days open (days)	-0.011	0.0036	0.001

CONCLUSIONS

- Results confirm that CPB housing can improve longevity of dairy cows.
- Further research is deserved (especially about turnover rates/culling) .
- Reasons for culling should be also evaluated.

THANK YOU, QUESTIONS?

Further info:
Abstract # 21380
lorenzo.leso@unifi.it
+39 3491215931