Memòria justificativa de recerca de les convocatòries BCC, BE, BP, CTP-AIRE, INEFC i PIV

La memòria justificativa consta de les dues parts que venen a continuació:
1.- Dades bàsiques i resums
2.- Memòria del treball (informe científic)

Tots els camps són obligatoris

1.- Dades bàsiques i resums

Nom de la convocatòria

BP

Llegenda per a les convocatòries:

BCC	Convocatòria de beques per a joves membres de comunitats catalanes a l'exterior
BE	Beques per a estades per a la recerca fora de Catalunya
BP	Convocatòria d'ajuts postdoctorals dins del programa Beatriu de Pinós
CTP-AIRE	Ajuts per accions de cooperació en el marc de la comunitat de treball dels Pirineus. Ajuts de mobilitat de personal investigador.
INEFC	Beques predoctorals i de col·laboració, dins de l'àmbit de l'educació física i l'esport i les ciències aplicades a l'esport
PIV	Beques de recerca per a professors i investigadors visitants a Catalunya

Títol del projecte: ha de sintetitzar la temàtica científica del vostre document.

ON-FARM ANIMAL WELFARE ASSESSMENT IN DAIRY CATTLE: IMPROVED LAMENESS DETECTION

Dades de l'investigador o beneficiari

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Número d'expedient
2009 BP_A 00186

Paraules clau: cal que esmenteu cinc conceptes que defineixin el contingut de la vostra memòria.
DAIRY CATTLE, WELFARE, HEALTH, LAMENESS, RISK FACTORS

Data de presentació de la justificació
01/09/2012

Nom i cognoms i signatura
del/de la investigador/a

Vist i plau del/de la responsable de la
sol·licitud

Resum del projecte: cal adjuntar dos resums del document, l'un en anglès i l'altre en la llengua del document, on s'esmenti la durada de l'acció

Resum en la llengua del projecte (màxim 300 paraules)
El projecte es va dur a terme de l'1 de Septembre de 2010 al 31 d'Agost del 2012. Primeratment es va desenvolupar una escala per mesurar coixeses (amb valors de l'1 al 5). Aquesta escala es va utilitzar per estudiar l'associacio entre factors de risc a nivell de granja (disseny de le instal.lacions i maneig) i la prevalencia de coixeses a Nord America. Les dades es van recollir en un total de 40 granges al Nord Est dels E.E.U.U (NE) i 39 a California (CA) . Totes les vaques del group mes productiu es van categoritzar segons la severitat de les coixeses: sanes, coixes i severament coixes. La prevalencia de coixeses en general fou del 55 % a NE i del 31% a CA. La prevalencia de coixeses severes fou del 8% a NE i del 4% a Ca. A NE, les coixeses en general increntaren amb la presencia de serradura als llits i disminuiren en granjes grans, amb major quantitat de llit i acces a pastura. Les coixeses mes severes incrementaren amb la falta d'higiene als llit i amb la presencia de serradura als llits, i disminuiren amb la quantitat de llit proveit, l'us de sorra als llits i amb la mida de la granja. A CA, les coixeses en general incrementaren amb la falta d'higiene al llit, i disminuiren amb la mida de la granja, la presencia de terres de goma, l'increment d'espai als cubicles , l'espai a l'abeuredor i la desinfeccio de les peulles. Les coixeses severes incrementaren amb la falta d'higiene al llit i disminuiren amb la frequencia de neteja del corral. En conclusio, canvis en el maneig i el disseny de les instal.lacions poden ajudar a disminuir la prevalencia de coixeses, tot i que les estrategies a seguir variaran segons la regio.

Resum en anglès (màxim 300 paraules)

The project took place from September the 1st, 2010 to Agust the 31st, 2012. A simplified locomotion scoring system in a 1-to-5 scale was developed for the detection of lameness on farm. This scoring system was used to investigate the association between herd-level management and facility design factors and the prevalence of lameness in high producing dairy cows in freestall herds in North America. Data was collected in 40 farms in the Northeast of US (NE) and 39 in California (CA). All cows in the pen were gait scored and classified as sound, clinically lame and severely lame. In NE, lameness increased on farms using sawdust bedding, and decreased with herd size, use of deep bedding, and access to pasture. Severe lameness increased with the percentage of stalls with fecal contamination and with use of sawdust bedding), and decreased with use of deep bedding, sand bedding, larger herd size, and when rearing replacement heifers on site. In CA, clinical lameness increased with the percentage of stalls containing fecal contamination, and decreased with larger herd size, presence of rubber in the alley to the milking parlor, the neck rail further from the rear curb, more water linear space per cow, and increased frequency of footbaths per wk. Severe lameness increased with the percentage of stalls containing fecal contamination, and decreased with frequency of manure removal in the pen per day. In conclusion, changes in housing and management factors may help decrease the prevalence of lameness on dairy farms, but key risk factors vary across regions.

2.- Memòria del treball (informe científic sense limitació de paraules). Pot incloure altres fitxers de qualsevol mena, no més grans de 10 MB cadascun d'ells.

The objective of this project was the improvement of lameness detection as part of on-farm animal welfare assessment in dairy cattle. The project was extended to assess the herd-level risk factors of lameness. In order to learn statistical skills to analyze large datasets collected on farm, a collaboration with the Department of Population Medicine, University of Guelph, Canada was established. During this collaboration, I had the opportunity to collaborate in other projects that studied other diseases that also jeopardize the welfare of dairy cattle, such as metabolic diseases and mastitis. In this report, I will focus on the results regarding the lameness projects, which have recently been submitted to the Journal of Dairy Science, and it is accepted pending minor revisions. Another manuscript is being currently written investigating the association between herd-level risk factors and the prevalence of hock lesions, using the same dataset.

Herd-level risk factors for lameness in freestall farms in North Eastern US and California

Lameness is one of the most important welfare and production problems in modern dairy herds. The current trend in the dairy industry is to house cows in free stalls, but research suggests that free stall housing increases the risk for lameness relative to other housing systems including tie stalls and straw yards. However, few studies have investigated the complex interaction of herd-level risk factors on modern freestall herds. The objective of current study was to investigate the association between herd-level management and facility design factors and the prevalence of lameness in high producing dairy cows in freestall herds in these two regions of the US with different environmental conditions and different traditions of barn design and management.

Farm selection and data collection

A total of 40 farms in NE (New York n = 28, Pennsylvania n = 8, and Vermont n = 4), and 39 farms in CA were selected for this cross-sectional study. Each farm was visited twice, with approximately 3 to 5 d between visits. The same 2 trained observers performed all animal and facility based measures (Table 1) on all farms in each of the 2 regions. One group of high producing and primarily multiparous cows was assessed on each farm; this 'high' group was identified by the producer. All cows housed in the assessment group were gait scored as they exited the parlor using a 5-point scale, where 1 = sound and 5 = severely lame Cows with score ≥ 3 were considered clinically lame, and cows with score ≥ 4 were considered severely lame. The proportion of clinically and severely lame cows was calculated for each farm.

Data analysis

Statistical analyses were performed with SAS (version 9.2, SAS Institute Inc. 2003, Cary, NC) considering the herd as the experimental unit. The 2 regions were analyzed separately due to large differences in management and facility design. The outcomes of interest were proportion of high-producing cows with clinical lameness and with severe lameness. A logit transformation with a bias correction factor of 0.25 was applied to meet the assumptions of normality and homogeneity of variance and to ensure that estimates and CI were correctly calculated. If a linear model is applied directly to proportions, the estimate of the means and CI could fall outside the range of values between 0 and 1. For instance, it is likely for the lower CI limit to be negative when the response rate is low. Univariable analyses were first performed to assess the association between the outcome variables and each of the predictors (PROC GLM). Only categorical predictors with at least 6 farms per category were considered. Linearity between continuous predictors and the outcome variables was assessed graphically and by testing the quadratic term in the model. Predictors with a univariable association of $P \leq 0.05$ were submitted to a multivariable model (PROC GLM), controlling for the proportion of primiparous cows in the assessment pen. Correlations between the predictors were calculated to avoid submitting highly correlated variables ($|r| > 0.70$) to the same model. When 2 predictors were highly correlated, the predictor with the strongest univariable association (largest R^2) was selected. Moreover, variance inflation factors were calculated after each model to confirm lack of multicolinearity. Models were built by manual stepwise selection. First, predictors were removed from the final model if $P > 0.05$ through manual backwards elimination. If the removal of a variable changed the parameter estimate of any of the remaining predictors by > 30 % on the logit scale, the eliminated variable was retained as a confounder regardless of its *P*-value. On a second step, eliminated predictors were reentered in the model one by one and retained if $P \leq 0.05$. Two-way interactions between the predictors that remained in the final model were tested and retained if $P \leq 0.05$. Residuals were examined after each model to verify normality and homogeneity of variance. Outliers, high leverage points and observations with an undue influence in the model were examined using residuals, leverage values and Cook's distances. Parameter estimates were back transformed and results are presented as OR and 95% CI. The OR expresses how a herd level predictor affects the odds of experiencing clinical or severe lameness in a particular herd.

Results

The prevalence of clinical lameness averaged 55% in NE, and 31% in CA, with a large variability within region. When only severely lame cows were considered, the estimated prevalence was 8% and 4%, for NE and CA, respectively.

North Eastern United States

At the univariable level (Table 2), clinical lameness increased with sawdust bedding, and decreased with herd size, deep bedding and access to pasture. Use of deep bedding was correlated with access to pasture (r = 0.47; *P* = 0.003) and acted as a confounder for pasture in the final model (when deep bedding was removed from the model, the absolute value of the parameter estimate for pasture increased by 65 %). Use of sawdust bedding was correlated with both deep bedding (r = -0.41; *P* = 0.01) and herd size (r = - 0.35; *P* = 0.03), and was not retained in the final model containing herd size. After controlling for the confounding effect of deep bedding, the model containing herd size and access to pasture explained 50 % of the variation in clinical lameness (R^2 = 0.50; Table 3).

One farm was discarded from the severe lameness analyses because it was an outlier and was an influential observation for most of the univariable models as well as the multivariable model (large negative residuals and Cook's distances). At the univariable level, severe lameness increased with the percentage of stalls with fecal contamination and with use of sawdust bedding, and decreased with deep bedding, sand bedding, herd size, and rearing of replacement heifers on site. Deep bedding and sand bedding were highly correlated (r = 0.96; *P* < 0.001) since all the farms that using deep bedding also used sand (except for one that had dry manure), and none of the farms without deep bedding used sand. Only deep bedding was used in the multivariable model, since it had larger R^2 at the univariable level. The percentage of stalls with fecal contamination was correlated to deep bedding (r = -0.65; *P* < 0.001) and this variable was not retained in the final model containing deep bedding. The final model for severe lameness included deep bedding and herd size, and explained 59 % of the variation (R^2 = 0.59).

California

At the univariable level (Table 4), clinical lameness increased with the percentage of stalls with fecal contamination, and decreased with herd size, presence of rubber in the alley to the milking parlor, neck rail distance to the rear curb, water linear space per cow, and frequency of footbaths per wk. The frequency of footbaths per wk was correlated with the percentage of stalls with fecal contamination (r = -0.44; *P* = 0.01), and was not retained in the model when the percentage of stalls with fecal contamination was accounted for. Herd size was correlated to the water linear space per cow (r = 0.43; *P* = 0.01) and the neck rail distance to the rear curb (r = 0.49; *P* = 0.002). When herd size was accounted for in the model, neither water linear space per cow nor neck rail distance to the rear curb was retained. The final model for clinical lameness included herd size, percentage of stalls with fecal contamination, and presence of rubber in the alley to the milking parlor, and explained 44 % of the variation (R^2 = 0.44; Table 5).

At the univariable level, severe lameness increased with the percentage of stalls with fecal contamination, and decreased with frequency of manure removal in the pen per day. The final model for severe lameness included both the percentage of stalls with fecal contamination and frequency of manure removal in the pen, and explained 28% of the variation (R^2 = 0.28).

Conclusions

Management and facility design differed between NE and CA, but some risk factors for lameness were common, including fecal contamination of the bedding and smaller herd size. Several aspects of the bedding were associated with lameness in NE, particularly the presence of deep bedding, which was associated with both decreased clinical and severe lameness. Access to pasture during the dry period and rearing heifers on site was associated with decreased clinical and severe lameness, respectively. In CA, presence of rubber in the alley to the milking parlor, less restrictive neck rail placements, more water space per cow, and frequent footbaths were associated with decreased clinical lameness, and frequent removal of manure in the pen was associated with decreased severe lameness. Most of the herd-level risks factors associated with lameness in the current study can be modified to prevent lameness. These results provide a basis for formulating science-based, region specific recommendations for reducing lameness on commercial farms.

Table 1. Herd-level predictors of interest considered in the univariable analysis for each region. Units and categories are shown for continuous and categorical variables, respectively.

Predictors	Units/ Categories	Region
General management		
Herd size	no.	NE, CA
Barn age	yr	NE, CA
Rearing heifers on site	yes/no	NE, CA
Pasture access (dry period)	yes/no	NE
Exercise corral access	yes/no	CA
Pen (high-producing assessment group)		
Space	m^2/cow	NE, CA
Rubber surface in part of the pen	yes/no	NE, CA
Dirty alley	yes/no	NE, CA
Automatic scraper	yes/no	NE
Frequency of manure removal	times/d	CA
Stall		
Stocking density	%	NE, CA
Brisket locator	yes/no	NE
Width[1]	cm	NE, CA
Neck rail height [1]	cm	NE, CA
Neck rail distance to the rear curb [1]	cm	NE, CA
Adjustable neck rail	yes/no	CA
Bedding		
Deep bedding	yes/no	NE
Sand bedding	yes/no	NE
Sawdust bedding	yes/no	NE
Bedding dry matter [2]	%	NE, CA
Percentage of stalls with fecal contamination (before milking)[2]	%	NE, CA
Feeder/water trough		
Feed bunk space	cm/cow	NE, CA
Feeding frequency	1 or more times/d	NE, CA
Feed push-up frequency	times/d	NE, CA
Water line space	cm/cow	NE, CA
Milking		
Frequency of milking	2 or 3 times/d	NE, CA
Distance walked for milking	m/d	NE, CA
Time away from the pen for milking	min/d	NE, CA
Rubber surface in part of the parlor or holding area	yes/no	NE, CA
Rubber in the alley to the parlor	yes/no	NE, CA
Lameness management		
Footbath frequency	times/wk	NE, CA
Hoof trimming frequency	times/yr	NE, CA

[1] n = 3 to 7 stalls/pen
[2] n = 10 stalls/pen

Table 2. Univariable associations of the logit-transformed proportion of clinical and severe lameness with herd-level factors in the North Eastern US (n = 40 and 39 farms for clinical and severe lameness, respectively). Herd-level factors are sorted separately for clinical and severe lameness by descending R^2. Parameter estimates were back-transformed and results are presented as OR and 95% CI.

Variables	OR	95% CI	R^2	*P*
Clinical lameness				
Herd size (100-cow increase)	0.94	0.90 - 0.97	0.23	0.002
Deep bedding	0.48	0.29 - 0.79	0.19	0.01
Access to pasture	0.52	0.32 - 0.85	0.16	0.01
Sawdust bedding	1.71	1.06 - 2.76	0.12	0.03
Severe lameness				
Deep bedding	0.31	0.19 - 0.50	0.40	< 0.001
Sand bedding	0.32	0.19 - 0.53	0.35	< 0.001
Percentage of stalls with fecal contamination[1] (10% increase)	1.15	1.06 – 1.25	0.27	0.001
Herd size (100-cow increase)	0.93	0.89 - 0.97	0.24	0.002
Sawdust bedding	2.13	1.31 - 3.47	0.21	0.003
Rearing of replacement heifers on site	0.57	0.32 - 0.99	0.10	0.05

[1] 10 stalls/pen assessed before milking

Table 3. Multivariable associations of the logit-transformed proportion of clinical and severe lameness with herd-level factors in the North Eastern US (n = 40 and 39 farms for clinical and severe lameness, respectively). Parameter estimates were back-transformed and results are presented as OR and 95% CI.

Variable	Parameter estimate	SE	OR	95% CI	*P*
Clinical lameness					
Intercept	1.01	0.17	-	-	< 0.001
Herd size (100-cow increase)	-0.07	0.02	0.93	0.90 - 0.96	< 0.001
Deep bedding[1]	-0.41	0.23	0.66	0.41 - 1.07	0.09
Access to pasture	-0.44	0.22	0.64	0.41 – 1.00	0.05
Severe lameness					
Intercept	-1.78	0.16	-	-	0.001
Deep bedding	-1.09	0.20	0.34	0.22 - 0.50	<0.001
Herd size (100-cow increase)	-0.06	0.02	0.94	0.91 - 0.97	<0.001

[1] Retained in the model as a confounder for access to pasture

Table 4. Univariable associations of the logit-transformed proportion of clinical lameness with herd-level factors in California (n = 39 farms). Herd-level factors are sorted separately for clinical and severe lameness by descending R^2. Parameter estimates were back-transformed and results are presented as OR and 95% CI.

Variables	OR	95% CI	R^2	*P*
Clinical lameness				
Herd size (100-cow increase)	0.96	0.94 - 0.99	0.23	0.002
Percentage of stalls with fecal contamination[1] (10% increase)	1.15	1.05 – 1.26	0.22	0.003
Rubber in the alley to the parlor	0.46	0.28 - 0.76	0.21	0.003
Neck rail distance to the rear curb [2] (1-cm increase)	0.97	0.95 - 0.99	0.18	0.01
Water linear space per cow (1-cm increase)	0.92	0.85 - 0.99	0.13	0.03
Frequency of footbath per week (1-unit increase)	0.90	0.81 - 0.99	0.12	0.04
Severe lameness				
Percentage of stalls with fecal contamination[1] (10% increase)	1.23	1.06 - 1.42	0.18	0.01
Frequency of manure removal in the pen per day (1-unit increase)	0.72	0.53 - 0.97	0.12	0.03

[1] 10 stalls assessed before milking
[2] 3 to 7 stalls/pen

Table 5. Multivariable associations of the logit-transformed proportion of clinical lameness with herd-level factors in California (n = 39 farms). Parameter estimates were back-transformed and results are presented as OR and 95% CI.

Variable	Parameter estimate	SE	OR	95% CI	*P*
Clinical lameness					
Intercept	-0.69	0.30	-	-	0.03
Herd size (100-cow increase)	-0.02	0.01	0.98	0.96 - 1.00	0.03
Percentage of stalls with fecal contamination[1] (10% increase)	0.09	0.04	1.10	1.01 - 1.19	0.03
Rubber in the alley to the parlor	-0.55	0.23	0.58	0.36 - 0.92	0.02
Severe lameness					
Intercept	-3.58	0.63	-	-	<.001
Percentage of stalls with fecal contamination[1] (10% increase)	0.19	0.07	1.21	1.05 - 1.39	0.01
Frequency of manure removal in the pen per day (1-unit increase)	-0.30	0.14	0.74	0.56 - 0.98	0.04

[1] 10 stalls/pen assessed before milking

Publications

During the last 2 years, I have been able to collaborate with other projects with the objective to expand my knowledge in dairy cattle welfare assessment as well as to enhance my skills in data analysis and scientific writing. As a result, I have submitted and published the manuscripts listed below. The scholarship Beatriu de Pinos has been mentioned in the acknowledgements in all cases.

1. **Chapinal, N.**, A. K. Barrientos, M. A. G. von Keyserlingk, E. Galo, and D. M. Weary. 2012. Herd-level risk factors for lameness in US freestall herds. Journal of Dairy Science (accepted pending minor revisions)

2. **Chapinal, N.,** M. Carson, S. J. LeBlanc, K. E. Leslie, S. Godden, M. Capel, J. E. P. Santos, M. W. Overton, and T. F. Duffield. Herd-level association of serum metabolites in the transition period with disease, milk production and early lactation reproductive performance. Journal of Dairy Science (in press)

3. Roberts, T., **N. Chapinal**, S. J. LeBlanc, D. F. Kelton, J. Dubuc, and T.F. Duffield. 2012. Metabolic parameters as indicators for increased early lactation culling risk in transition dairy cows. Journal of Dairy Science 95:3057–3063

4. Cyples, J. A, C. E. Fitzpatrick, K. E. Leslie, T. J. DeVries, D. B. Haley, and **N. Chapinal**. 2012. The effects of experimentally-induced E. coli clinical mastitis on lying behavior of dairy cows. Journal of Dairy Science 95:2571–2575

5. **Chapinal, N.,** M. Carson, S.J. LeBlanc, K.E. Leslie, S. Godden, M. Capel, J.E.P. Santos, M.W. Overton, and T.F. Duffield. 2012. The association of serum metabolites in the transition period with milk production and early lactation reproductive performance. Journal of Dairy Science 95:1301–1309

6. **Chapinal, N.**, M. Carson, T.F. Duffield, M. Capel, S. Godden, M. Overton, J.E.P. Santos, and S.J. LeBlanc. 2011. The association of serum metabolites with clinical disease during the transition period. Journal of Dairy Science 94:4897–4903

7. **Chapinal, N.**, A. Koeck, S. Mason, A. Sewalem, D. Kelton, and F. Miglior. Estimation of genetic parameters for hoof lesions in Canadian Holstein cows. Journal of Dairy Science (submitted)

8. **Chapinal, N**., G. Zobel, K. Painter, K. E. Leslie. Changes in lying behavior following abrupt dry-off in a free-stall dairy herd. Journal of Dairy Science (submitted)

9. **Chapinal, N.** A. Sewalem, F. Miglior. Estimation of genetic parameters for gait in Canadian Holstein cows. Journal of Dairy Science (under review)

10. Fitzpatrick, C. E., **N. Chapinal**, C. S. Petersson-Wolfe, T. J. DeVries, D. F. Kelton, T. F. Duffield, K. E. Leslie. The effect of meloxicam on pain sensitivity and rumination time in dairy cows with experimentally-induced clinical mastitis. Journal of Dairy Science (under review)

Refereed conference abstracts

1. **Chapinal, N.**, A. K. Barrientos, M. A. G. von Keyserlingk, E. Galo, and D. M. Weary. 2012. Herd-level risk factors for lameness in US freestall herds. J. Dairy Sci. 95 (E-Suppl. 2):724

2. Barrientos, A. K., **N. Chapinal**, D. M. Weary, E. Galo, and M. A. G. von Keyserlingk. 2012. Herd-level risk factors for hock injuries in US freestall herds. J. Dairy Sci. 95 (E-Suppl. 2):724

3. **Chapinal, N.**, A. Koeck, S. Mason, A. Sewalem, D. Kelton, and F. Miglior. 2012. Estimation of genetic parameters for hoof lesions in Canadian Holstein cows. J. Dairy Sci. 95 (E-Suppl. 2):442

4. Bond, G. B., M. A. G. von Keyserlingk, **N. Chapinal**, E. A. Pajor, and D. M. Weary. 2012. Assessing among-farm variability in heifer body weights. J. Dairy Sci. 95 (E-Suppl. 2):84

5. **Chapinal, N.,** F. Miglior, A. Sewalem, A. M. de Passille, J. Rushen, M. A. G. von Keyserlingk, and D. M. Weary. 2011. Estimation of genetic parameters for gait in Canadian Holstein cows. J. Dairy Sci. 94 (E-Suppl. 1):465

6. **Chapinal, N.,** M. E. Carson, S. L. Leblanc, K. E. Leslie, S. Godden, M. Capel, J. E. P. Santos, M. W. Overton, and T. F. Duffield. 2011. Association between serum metabolite concentrations in the transition period and milk production in dairy cows. J. Dairy Sci. 94 (E-Suppl. 1):747