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Heifer management characterization in dairy herds from the west of Buenos Aires, Argentina

Caracterização da gestão de novilhas em rebanhos leiteiros do oeste de Buenos Aires, Argentina

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ABSTRACT

The replacement program in a dairy farm represents the second or third largest cost in a dairy operation. This study aimed to characterize and typify the practices related to the dairy heifer replacement program and describe the growth, development, and health parameters during this period in commercial dairy herds in Trenque Lauquen. A cross-sectional observational study was carried out, including 54 randomly selected dairy farms that were visited once to collect data about facilities and management through a semi-structured survey. Cluster and principal coordinates analysis were applied to classify the farms based on all variables collected, grouped in four main areas: pre-fresh cows, colostrum management, pre-weaning calf's management, and personnel. Additionally, growth, development, and health status were also recorded and described for calves and breeding heifers. Two similar-sized farm clusters were identified with differences in management and facilities in different areas of calves rearing. In one cluster there was a greater proportion of farms having a pre-fresh group, implementing appropriate health (colostrum, vaccination) and feeding management. Also, differences in personnel and technical support were relevant. The estimated body gain was 452 and 774 g/d for calves younger or older than 60 d of age, respectively. The age and weight farm averages in breeding heifers were 21.0 mo (range: 16.7-27.5) and 416.3 kg (range: 336.7-519.3), respectively. Diarrhea and respiratory affections were the major problems in pre-weaning calves and heifer rearing, respectively. The median mortality was 7.3, 7.6, and 2.9% at the calving, pre-weaning, and heifer rearing period, respectively. The results showed an improvement opportunity for producers, the design of precise and high impact programs that could lead to an improved replacement program.

Keywords: Calf rearing. Herd typification. Age at first service.

RESUMO

Nos rebanhos leiteiros, o programa de reposição representa o segundo ou o terceiro maior custo da atividade de produção de leite. O objetivo do presente trabalho foi caracterizar e tipificar as práticas relacionadas ao programa de reposição de novilhas leiteiras e descrever o crescimento, desenvolvimento e parâmetros de saúde durante este período em rebanhos leiteiros comerciais localizados em Trenque Lauquen, oeste de Buenos Aires, Argentina. Foi realizado um estudo observacional transversal incluindo 54 fazendas de produção de leite selecionadas ao acaso e visitadas uma única vez para a colheita de dados relacionados a instalações e manejo empregando-se um questionário semi-estruturado. Foi efetuada a análise dos agrupamentos e das coordenadas principais para classificar as fazendas com base em todas as variáveis colhidas e agrupadas em quatro principais áreas: vacas pré-parto, manejo de colostro, manejo pré-desmame de bezerros e recursos humanos. Os dados referentes ao crescimento, desenvolvimento e estado de saúde dos animais também foram registrados e descritos para bezerros e novilhas. Dois grupos de fazendas de tamanho semelhante foram identificados com diferenças no manejo e instalações em distintas áreas de recria de bezerros. Em um grupo houve uma maior proporção de fazendas que tinham um grupo de vacas pré-parto, com implementação de adequado manejo de saúde (colostro, vacinações) e manejo alimentar. Também foram relevantes as diferenças em termos de pessoal e suporte técnico. O ganho de peso estimado foi de 452 e 774 gramas por dia, respectivamente, para os bezerros jovens e os com idade superior a 60 dias. As médias das fazendas da idade e do peso das novilhas de reprodução foram,

respectivamente, 21,0 meses (variação de 16,7 a 27,5) e 416,3 kg (variação de 336,7 a 519,3). A diarreia e as afecções respiratórias foram os maiores problemas de saúde, respectivamente, nos bezerros em pré-desmama e novilhas em recria. A média de mortalidade foi de 7,3; 7,6 e 2,9%, respectivamente, ao parto, na pré-desmama e durante a recria de novilhas. Os resultados obtidos demonstraram a existência de oportunidades de melhoria para os produtores, com o delineamento de programas precisos e de alto impacto que poderão propiciar um programa de reposição aprimorado.
Palavras-chave: Recria de bezerros. Tipificação de rebanhos. Idade do primeiro serviço.

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Introduction

The replacement program in a dairy farm impacts the lactating group size and its genetic improvement (Cabrera, 2012; Groenendaal et al., 2004; Mellado et al., 2014). This program represents the second or third largest cost in the dairy operation after considering lactating cow costs and labor (Larriestra 1993; Mellado et al. 2014).

The management of the replacement heifers to improve health and growth is a well-known topic (Vasseur et al. 2010a). Different studies about pre-fresh management (Brandão et al., 2016; Drackley, 2008; Garry et al., 2007), colostrum administration (Godden, 2008; McGuirk, 2008; Raboisson et al., 2016), nutrition during the preweaning phase (Davis & Drackley, 2001; Jasper & Weary, 2002; Khan et al., 2007; Lagger, 2010), personnel training (Garry et al., 2007; Hussain & Priya, 2016; Jenny et al., 1981; Ullah & Zheng, 2011), heifer growth and development monitoring (Heinrichs et al., 2005; Losinger and Heinrichs, 1997), among others, have been published showing their productive and economic benefits.

The knowledge about replacement heifer management allowed the development of tools to check, register, and monitor the on-farm practices (Vasseur et al., 2010b). However, the application of that knowledge is still an issue in Argentina and other places around the world (Dematteis Llera, 2015; Hötzel et al., 2014; Schild et al., 2020; Vasseur et al., 2010b). Typification methodologies allow the identification of practice adoption profiles among producers (Castel et al., 2010; Escobar & Berdegué, 1990; Gaspar et al., 2008). This methodology has been applied in different dairy areas (Rampone et al., 2015; Vissio et al., 2013) and could lead to the design of high-impact extension programs for replacement dairy heifers.

This study aimed to characterize and typify the practices related to the dairy heifer replacement program and describe growth, development, and health parameters during this period in commercial dairy herds.

Materials and Methods

Study population

A cross-sectional observational study was carried out during April and March 2016 in Trenque Lauquen County, one of the largest counties in terms of milk production in Buenos Aires province (SENASA, 2015). The data set of dairy farms enrolled in the National Organization for the Vaccination of Foot and Mouth includes 160 total farms, and 66% of them had a size of 60 to 400 cows. Within that stratum, 54 farms were blocked by size (size 1: 60-120, size 2: 120-200, size 3: 200-300, and size 4: 300-400 total cows) and randomly selected (Thrusfield and Christley, 2018).

Data collection

Farms were visited once to collect information about facilities and management, and growth, development, and health. Facilities and management were assessed with a semi-structured questionnaire conducted to the farm owner to collect information about 4 main areas: pre-fresh cows (4 variables), colostrum management (9 variables), pre-weaning calves management (18 variables), and personnel (5 variables), all based on published research studies (Pereyra et al., 2015; Tiranti et al., 2011; Vasseur et al., 2010a). In addition, heart girth and withers height of pre-weaned calves and breeding heifers were measured to assess growth parameters (Heinrichs et al., 2007). Also in the same visit, diarrhea and respiratory affections were recorded following the guidelines of McGuirk (2008).

Morbidity was estimated as the number of calves with diarrhea or respiratory symptoms divided by the total number of animals on the same day. Data of born and dead calves from 2015 were also collected from the registration provided by the farm owner. Mortality was determined as the total number of dead calves divided by the number of born calves during the calendar year 2015.

Data analysis

The data collected through the questionnaire was described using relative and absolute frequencies. Afterward, within each of the 4 areas, a multiple correspondence analysis was applied (Greenacre, 1984) to select the variables with the highest inertia on axis 1. Finally, to classify the farms, all the selected variables were evaluated both using cluster analysis and principal coordinates analysis (Hair et al., 1998).

Weight, height, and age distributions were described at the herd level using median and quartiles. The growth rate for pre-weaning calves was estimated fitting a linear regression model, considering age as a predictor of live weight, and adjusting that by the herd (Thrusfield and Christley, 2018). Morbidity was estimated as the number of calves with diarrhea or respiratory affections divided by the total number of animals on the same day. Mortality was determined as the total number of dead calves divided by the number of born calves during the calendar year 2015. Morbidity and mortality data were then described overall and at the herd level.

Results and Discussion

From a total of 54 farms, 8 refused to participate resulting in 46 farms being evaluated. Response rates were 81.3, 90.9, 81.8, and 70.0% for size blocks 1, 2, 3, and 4, respectively. This overall response rate is considered appropriate for interview-based studies (Singleton and Straits, 2010). Results from this study could be generalized for similar-sized diaries in the region, as farms were selected by random stratified sampling, assuring representativeness (Thrusfield and Christley, 2018). Because of the response rate and the sampling design we assumed there was little response bias (Dunn et al., 2004).

According to the survey results, deficiencies in surveillance and facilities for calving were registered (Table 1). The lack of a pre-fresh cow group could mean less control over the last period of gestation, with negative consequences for the calf (Tao et al., 2012) and no specific diet formulation for the cow (Quigley and Drewry, 1998). Incorrect pre-fresh cow management could also increase the incidence of dystocia (Mee, 2008) and limit calf welfare (Vasseur et al. 2010a).

The colostrum administration was only accomplished systematically by 28% of the farms visited (Table 2), similar to the percentage reported in the Trenque Lauquen region before (Demateis Llera, 2015). It has been proved that this practice is cost-effective (Raboisson et al., 2016), as low serum immunoglobulin concentration is related to high morbidity and mortality rates (Godden, 2008; Kehoe et al., 2007; Tiranti et al., 2015). Some deficiencies were found within farms implementing this practice, like colostrum feeding after 12 h of life and less than the recommended volumes of colostrum. Those errors contributed to the lack of efficacy of this broadly validated practice (Godden, 2008; Rocha et al., 1998; Tiranti et al., 2015). In addition, the lack of quality and quantity colostrum evaluation, as registered in some farms, would also increase uncertainty (Buczinski et al., 2018).

Most of the farms fed their calves with restricted amounts of milk (4 L/d; Table 3) with the purpose of early stimulation of feed starter consumption. This could explain the low growth rates achieved as mentioned above (Rosenberger et al., 2017). One of the goals of the pre-weaning period is the duplication of weight from birth to weaning (Hammon et al., 2002; Jasper and Weary, 2002). But under a conventional feeding program (4 L of milk per day), such requirements are not met (Davis & Drackley, 2001;

Table 1 – Herd descriptors about pre-fresh cow area for the random sample of dairy farms from Trenque Lauquen, Argentina (2016)

Variables	Classes	Number of farms	Frequency (%)	CI 95%
Prefresh pen (n = 46)	No	16	35	20 – 50
	Yes, permanent place	12	26	12 – 40
	Yes, alternating place	18	39	24 – 54
Calving assistance facilities (n = 44)	No	18	41	25 – 57
	Yes	26	59	43 – 75
Personnel house distance to prefresh pen (n = 46)	50 to100 m	15	33	18 – 47
	< 50 m	8	17	5 – 29
	> 100 m	23	50	34 – 66
Prefresh cow vaccination (n = 46)	No	28	61	46 – 76
	Yes	18	39	24 – 54

Table 2 – Herd descriptors about colostrum management for the random sample of dairy farms from Trenque Lauquen, Argentina (2016)

Variables	Classes	Number of farms	Frequency (%)	CI 95%
Systematic colostrum feeding (n = 46)	No	33	72	58 – 86
	Yes	13	28	14 – 42
Stock of colostrum (n = 46)	No	27	59	43 – 74
	Yes	19	41	26 – 57
Time of the 1st colostrum meal (n = 46)	Natural suckling	33	72	58 – 86
	Within 1st 12 h of life	9	2	7 – 32
	After 1st 12 h of life	4	09	2 – 21
Colostrum quantity fed (n = 46)	< 10% BW	6	13	2 – 24
	> 10% BW	7	15	4 – 27
	Natural suckling	33	72	58 – 86
Colostrum feeding method (n = 46)	Natural suckling	33	72	58 – 86
	Esophageal tube	1	2	0 - 12
	Bottle	12	26	12 – 40
Colostrum meals (n = 46)	Natural suckling	33	72	58 – 86
	1 meal	7	15	4 – 27
	2 o more meals	6	13	2 – 24
Colostrum quality assessment (n = 46)	None	43	93	82 – 99
	Colostrometer	2	4	1 – 15
	Refractometer	0	0	0 – 8
	Visual	1	2	0 – 12
Colostrum heat treatment (n = 46)	Yes	0	0	0 – 8
	No	46	1	92 – 100
Evaluation of passive transfer (n = 46)	Yes	1	2	0 – 12
	No	45	98	88 – 100

Kiezebrink et al., 2015), while intensified or accelerated feeding programs have succeeded (Jasper and Weary, 2002; Kertz et al., 2017). More than half the farms offered water to the calves just once a day (Table 3), even though water is an essential nutrient making up 65 to 75% of the calf´s body (Drackley, 2008). Limiting water intake could decrease starter intake and lead to lower growth rates (Davis & Drackley, 2001). The starter was provided from the 1st month of life in 25% of the farms (Table 3). This could delay rumen development (Khan et al., 2007; Roth et al., 2009) and extend the period of liquid feed feeding, as shown in 33% of the calves evaluated.

Personnel involved in the pre-weaning area were affected by other activities on the farm and showed a relatively low level of formal and informal education (Table 4). Both aspects are relevant to get positive results in the rearing period (Hussain and Priya, 2016). Trained personnel provided with appropriate working protocols contribute to complying with standardized procedures and enhance the results in calf health and survival (Garry et al., 2007; Hussain & Priya, 2016). Although previous studies showed that proper human resources management leads to lower staff turnover rates and better economic results (Ullah and Zheng, 2011), half the farms visited had employees with less than 2 years in service (Table 4). Only 34% of the farms had continuous technical support (Table 4), even though uninterrupted technical support is one of the ways to promote good management practices implementation (Vissio et al., 2013).

Two similar-sized clusters were identified, although predominant herd sizes included in cluster 1 were smaller than in cluster 2 (Table 5). The difference in herd size between clusters could explain some but not all the differences in good management practices implementation (Gargiulo et al., 2018), as 33% of the farms in cluster 2 had less than 200 cows. In general, this cluster showed a greater proportion of farms having a pre-fresh group, implementing appropriate health (colostrum administraion, vaccination), and feeding management. Also, differences in personnel and technical support between clusters were relevant. Deficiencies detected in cluster 1 are important for calf health and could affect herd efficiency. Clustering analysis has previously been applied to classify small and medium-size dairy herds in Argentina considering management mastitis control schemes (Vissio et al., 2013), identifying two clusters where farms differed in having or

Table 3 – Herd descriptors about pre-weaning calves management for the random sample of dairy farms from Trenque Lauquen, Argentina (2016)

Variables	Classes	Number of farms	Frequency (%)	CI 95%
System (n = 46)	Collective	11	24	11 – 37
	Individual	35	76	63 – 90
Pre-weaning program initiation (n = 46)	Within the 1st 24 hs	18	39	24 – 54
	After the 1st 24 hs	28	61	46 – 76
Navel disinfection (n = 46)	Yes	24	52	37 – 68
	No	22	48	32 – 63
Calf identification (n = 46)	Yes	37	8	68 – 93
	No	9	2	7 – 32
Shelter (n = 46)	Correct	6	13	2 – 34
	Scarce	39	85	73 – 96
	None	1	02	0 – 12
Calf place rotation (n = 46)	Yes	39	85	73 – 96
	No	7	15	4 – 27
Bucket hygiene (n = 43)	Every day	6	14	2 – 34
	Once a week or less frequently	37	86	68 – 93
Milk temperature measurement (n = 46)	Yes	16	35	20 – 50
	No	30	65	50 – 80
Water provision (n = 46)	All day long	10	22	9 – 35
	Twice a day	6	13	2 – 34
	Once a day	25	54	39 – 70
	Not provided	5	11	4 – 24
Weaning criteria (n = 46)	Age	7	15	4 – 27
	Visual appreciation	17	37	22 – 52
	Age and visual appreciation	22	48	32 – 63
	Starter intake	0	0	0 – 8
Weaning method (n = 46)	Abrupt	9	2	7 – 32
	Gradual	37	8	68 – 93
Transition pen for weaned calves (n = 46)	Yes	30	65	50 – 80
	No	16	35	20 – 50
Liquid feed type (n = 46)	Waste milk	25	54	39 – 70
	Saleable milk	16	35	20 – 50
	Milk replacer	5	11	4 – 24
Liquid feed quantity (n = 46)	> than 4 L/d	3	07	1 – 18
	4 L/d	34	74	60 – 88
	Stepped program	9	2	7 – 32
Liquid feed meals (n = 46)	1	1	02	0 – 12
	2	45	98	88 – 100
Starter provision (n = 46)	From the 1st wk of life	35	76	63 – 90
	From the 1st mo of life	11	24	11 – 37
Starter feed (n = 46)	Formulated specially for pre-weaning calves	33	72	58 – 86
	Other formulas	13	28	14 – 42
Hay provision during pre-weaning period (n = 46)	Yes	12	26	12 – 40
	No	34	74	60 – 88

not a comprehensive udder health program. Similarly, in this study a gap related to calf health management was identified, representing different levels of intensification. Cluster analysis might be useful in understanding patterns of management that are not evident when analyzing the sampled population as a whole (Escobar and Berdegué, 1990). This information could be used for the design and implementation of specific advisory programs to improve herd management.

Only 63% of the visited farms registered birthdates of calves and from them, 296 calves and 467 heifers were evaluated. Figures 1 and 2 show the relationship of weight and height with age respectively. Estimated body gain during the pre-weaning period was 452 g/d ($R^2 = 0.56$), and 774 g/d

(R^2 = 0.43) for calves younger or older than 60 d of age, respectively (Figure 1). These results are similar to those of a previous report in Trenque Lauquen (Dematteis Llera & Maekawa, 2015). The restricted amounts of milk fed to calves in the evaluated farms could explain the low growth rates achieved. Khan et al. (2007) reported similar growth

Table 4 – Herd descriptors about personnel area for the random sample of dairy farms from Trenque Lauquen, Argentina (2016)

Variables	Classes	Number of farms	Frequency (%)	CI 95%
Technical support (n = 44)	No	7	15	4 – 28
	Continuously	15	34	19 – 49
	Sporadically	22	50	34 – 66
Exclusive personnel in pre-weaning area (n = 44)	No	30	68	53 – 83
	Yes	14	32	17 – 47
Years in service (n = 44)	< 0.5	12	27	13 – 42
	0.5 to 2	10	23	9 – 36
	> 2	22	50	34 – 66
Formal education of person in charge of calves and heifers (n = 43)	None	6	14	2 – 25
	Primary school	29	67	52 – 83
	Secondary school	8	19	6 – 31
Informal training (n = 41)	Never	21	51	35 – 68
	Once	9	22	8 – 36
	> once	11	27	12 – 42

Table 5 – Characteristics of the farm clusters for the random sample of dairy farms (n = 46) from Trenque Lauquen, Argentina (2016)

Variables	Classes	Frequency (%)	
		Cluster 1 (n = 24)	Cluster 2 (n = 22)
Systematic artificial colostrum feeding	Yes	8	52
Prefresh cow vaccination	Yes	16	67
Prefresh pen	Yes, permanent pen	28	24
	Yes, alternating pens	24	57
Navel disinfection	Yes	36	71
Calf identification	Yes	68	95
Water provision	All day long	24	19
	Twice a day	8	19
	Once a day	56	52
	None	12	10
Weaning method	Abrupt	4	38
	Gradual	96	62
Transition pen for weaned calves	Yes	56	76
Liquid feed type	Waste milk	76	29
	Saleable milk	16	57
	Milk replacer	8	14
Liquid feed quantity	> 4 L/d	84	61
	4 L/d	4	10
	Stepped program	12	29
Starter provision	From the 1st wk of life	76	76
	From the 1st mo of life	24	24
Technical support	Sporadically	52	48
	Continuously	24	48
Years in service	< 0.5	40	10
	0.5 to 2	24	19
	> 2	36	71
Formal education	Primary school	76	48
	Secondary school	8	38
Farm size (total cows)	60 to 120	48	19
	121 to 200	24	14
	201 to 300	24	24
	301 to 400	4	34

rates when calves were fed only 10% of their body weight (BW). Calves' height at 2 mo of age was on average 80.2 cm. This height was among the lower quartile in the standards published by Heinrichs et al. (2007).

Age, weight, and height distribution among total breeding heifers and farm averages are described in Table 6. In this study, the reported age at breeding was 5 to 7 mo older than recommended to achieve first calving at 22 to 24 mo of age (Heinrichs, 1993; Losinger & Heinrichs, 1997), although they had already reached more than 55% of mature BW (assuming mature BW of 650-700 kg), as recommended by the Subcomitee on Dairy Cattle Nutrition (2001). Besides the growth of the heifers, age at first breeding depends on the farmers' criteria to initiate breeding (Schuenemann et al.,2016), as demonstrated by our results with older and overweight heifers at breeding. Differences in breeding age and weight were observed between and within the herds, as reported by Brickell et al. (2009). Both within-herd variability and heifer overweight could be explained by inconsistencies in feeding, health, and general management during the rearing period (Heinrichs et al., 2005).

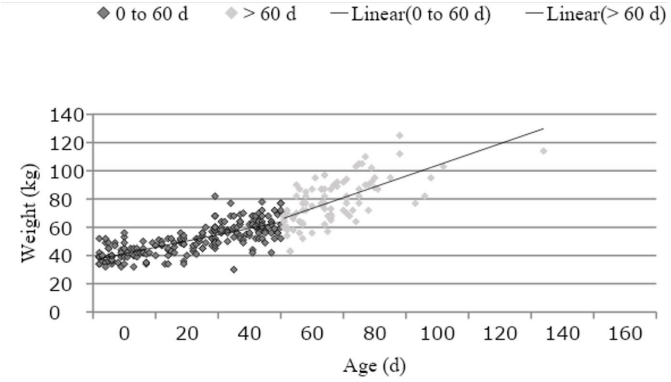

Figure 1 – Weight of different age calves during the pre-weaning period for the random sample of dairy farms (n=40) from Trenque Lauquen, Argentina (2016).

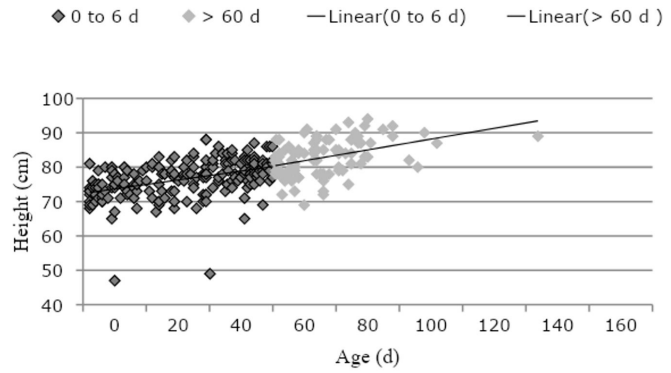

Figure 2 – Withers height of different age calves during the pre-weaning period for the random sample of dairy farms (n=40) from Trenque Lauquen, Argentina (2016).

Diarrhea and respiratory affections in pre-weaning calves were evaluated in 40 farms. Although we found a farm average of 9.1% (IQ range = 0-12.5%) in diarrhea prevalence, 5% of the farms showed values over 21%. As expected, respiratory affections were a minor problem at the farm level, with only 5% of the farms with averages of 2.9% or higher. Of the 29 farms checked for disease prevalence in breeding heifers, only 10% showed high values of diarrhea (20% or higher). Regarding respiratory infections, the average prevalence was 5.8% (IQ range = 0-6.7%), with 3 farms over 20%. Diarrhea was the main health issue in the pre-weaning period, as reported in other countries (McGuirk, 2008; García and Ruiz, 2013; Svensson et al., 2003), while respiratory problems were the most important in the rearing period (Callan and Garry, 2002).

Only 48, 41, and 35% of the farm owners could provide data about the number of dead animals at the calving, pre-weaning, and heifer rearing periods, respectively. Among those herds, median mortality was 7.3% at calving (Q1: 5.2 - Q3: 9.8), 7.6% during the pre-weaning period (Q1: 5.0 - Q3: 10.5), and 2.9% during the heifer rearing period (Q1: 1.4 - Q3: 4.0). In our country, lower mortality rates of 4.1 and 4% were reported in pre-weaning calves in Buenos Aires and Córdoba provinces, respectively (Larriestra, 1993; García and Ruiz, 2013). High mortality rates could affect heifer selection and culling rates, and both these factors negatively affect farm economics (Cabrera, 2012). Mortality rates obtained in this study could be underestimated. In general, farm owners who were able to provide health records may have been more prone to

Table 6 – Age, weight, and height distributions among total breeding heifers and farm averages (n = 30) from Trenque Lauquen, Argentina (2016)

	Age (mo)		Weight (kg)		Height (cm)	
	average (range)	interquartile range	average (range)	interquartile range	average (range)	interquartile range
Total heifers (n=464)	20.8 (7.4-38.7)	17-23.9	410.7 (172-800)	345-470	129.2 (102.0-148.0)	123.0-136.0
Farm averages (n=15.5 heifers/ farm)	21.0 (16.7-27.5)	19.0-22.5	416.3 (336.7-519.3)	378.8-443.5	129.7 (121.6-137.8)	126.6-132.5

have better management. This underestimation could be explained by the selection bias (Dargatz and Hill, 1996)

Conclusion

These results provide information about the most common practices in dairy farms about pre-fresh cows, colostrum management, pre-weaning calves' management, and personnel. It was possible to identify two farm profiles according to the degree to their good management practices adoption. A high mortality rate, as well as low growth rates and high BW among older heifers at breeding, were found. The findings highlight an opportunity for producers in terms of the identified practices to improve heifer replacement programs. It would be important to assess them through the development and implementation of precise, high-impact extension programs to improve the dairy farm replacement program.

Conflict of interest

The authors have no competing interests to declare.

Ethics Statement

At the time of this study, the animal care and use committee of the National Institute of Agricultural Technology (INTA) and the University of Buenos Aires reviewed animal experiments only when they interfered with health or welfare and this study was not the case.

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