

Table 1. Definitions of measures used in experimental and observational animal studies in cow-calf contact systems

<b>Production measures</b>	<b>Definition</b>	<b>References</b>	
Milking	Machine milk yield	Milk yield obtained with milking machine	Bramley <i>et al.</i> , 1992
	Suckled milk yield	Measured or estimated milk yield that is being suckled by the calf	Beal <i>et al.</i> , 1990; Rutledge <i>et al.</i> , 1971
	Total milk yield	The sum of machine milk yield and suckled milk yield	Bar-Peled <i>et al.</i> , 1995
	Strip milk	Milk obtained by hand milking or machine stripping after machine milking or suckling	Bramley <i>et al.</i> , 1992
	Residual milk	The milk remaining in the udder after milking/suckling and stripping. Requires exogenous oxytocin for removal	Bramley <i>et al.</i> , 1992
	Milking machine settings	Quarter or udder level milking, automatic stimulation, pulsation ratio and rate, vacuum level, automatic stripping and detachment level	Bramley <i>et al.</i> , 1992

	Milking routine	Duration and type of routines during milking, such as cleaning, pre-milking, pre-stimulation, strip milking	Bramley <i>et al.</i> , 1992
Calf total dry matter intake (DMI)	Calf solid feed intake	Total amount of consumption of concentrate intake and roughage intake	Roth <i>et al.</i> , 2009
	Calf milk intake	Total amount of milk intake; suckled milk intake or artificial milk intake, or both	Johnsen <i>et al.</i> , 2015
Body condition score (BCS)	Cows and calves	A numerical score describing energy reserves in the form of visible/palpable body fat and muscle tissues	Edmondson <i>et al.</i> , 1989
Growth rate	Calves	The individual calves' weight gain per time unit, or its growth in length and height per time unit. An indicator of body development and nutritional status	Roth <i>et al.</i> , 2009
<b>Health status measures</b>			
Calf diarrhoea (scours)	Calves	Enteric disease recognised by loose or watery stool and frequent defecation. Can have infectious or non-infectious	Roth <i>et al.</i> , 2009

		cause. The general condition of the animal is more or less influenced depending on cause, severity and duration	
Mortality rate	Cows and calves	Number of animals that die in a designated period divided by the number of animal-time units at risk during that period	Santman-Berends <i>et al.</i> , 2019
Respiratory disorders	Cows and calves	Pathological changes in the respiratory tract or symptoms thereof (fever, coughing, mucopurulent discharge) in nasal cavity, trachea, bronchiae or lungs	Roth <i>et al.</i> , 2009
Mastitis	Cows	Inflammation of the mammary gland	Andersen <i>et al.</i> , 2010
Somatic cell count in milk (SCC)	Cows	Mastitis indicator	IDF, 2013
<b>Behavioural measures</b>			
Cross-sucking (sucking)	Calves	Sucking of any part of another calf's body, caused by the strong motivation to suck in relation to milk ingestion, and possibly reflecting frustration	Jensen 2003, Roth <i>et al.</i> , 2009

Intersuckling (intersucking)	Cows and calves	Sucking of udder area by other heifers or cows	Lidfors & Isberg 2003, Keil <i>et al.</i> , 2000
Cows and calves	Cows and calves	Suckling of a cow by a non-filial calf	Johnsen <i>et al.</i> , 2015
Affiliative social interactions	Cows and calves	Social interactions related to cohesion of the group or individual; including allogrooming* (or social licking)	Bouissou <i>et al.</i> , 2001
Allogrooming*	Cows and calves	Social licking of mainly the head, neck and shoulder regions between cow-calf, calf-calf or cow-cow (excluding licking between adult animals in a sexual context)	Bouissou <i>et al.</i> , 2001
Agonistic social interactions	Cows and calves	Social interactions related to conflict and competition, including aggression (such as threats pushing, butting, fighting, chasing), avoidance and submission	Bouissou <i>et al.</i> , 2001, Mills <i>et al.</i> , 2010

## References

- Andersen S, Dohoo IR, Olde Riekerink R, Stryhn H 2010. Diagnosing intramammary infections: Evaluating expert opinions on the definition of intramammary infection using conjoint analysis. *Journal of Dairy science* 93: 2966–2975
- Bar-Peled U, Maltz E, Bruckental I, Folman Y, Kali Y, Gacitua H, Lehrer AR, Knight CH, Robinson B, Voet H, Tagari H 1995. Relationship Between Frequent Milking or Suckling in Early Lactation and Milk Production of High Producing Dairy Cows. *Journal of Dairy Science* 78: 2726–2736
- Beal WE, Notter DR, Akers RM 1990. Techniques for estimation of milk yield in beef cows and relationships of milk yield to calf weight gain and postpartum reproduction. *Journal of Animal Science* 68: 937–943
- Bouissou, M F, Boissy, A, Le Neindre, P and Veissier, I 2001. The Social Behaviour of Cattle. In: Keeling, L. J. and Gonyou, H. W. *Social behaviour in Farm animals*. Wallingford, CAB International: 113-145
- Bramley AJ, Dodd FH (Eds) 1992. ‘Machine milking and lactation.’ (Insight Books: Newbury, Engl., Vermont, USA)
- Edmonson AJ, Lean IJ, Weaver LD, Farver T, Webster G 1989. A Body Condition Scoring Chart for Holstein Dairy Cows. *Journal of Dairy Science* 72: 68–78
- International Dairy Federation 2013. Guidelines for the use and interpretation of bovine milk somatic cell counts (SCC) in the dairy industry. IDF Bulletin 466
- Jensen, MB 2003. The effects of feeding method, milk allowance and social factors on milk feeding behaviour and cross-sucking in group housed calves. *Applied Animal Behaviour Science* 80: 191-206
- Johnsen JF, de Passille, AM, Mejdell CM, Bøe KE, Grøndahl AM, Beaver A, Rushen J, and Weary DM 2015. The effect of nursing on the cow–calf bond. *Applied Animal Behaviour Science* 163(0): 50-57

Johnsen JF, Beaver A, Mejdell CM, Rushen J, de Passille AM, and Weary DM. 2015. Providing supplementary milk to suckling dairy calves improves performance at separation and weaning. *Journal of Dairy Sci.* 98:4800-4810.

Keil NM, Audigé L, Langhans W 2000: Factors associated with intersucking in Swiss dairy heifers. *Preventive Veterinary Medicine* 45: 305–323

Lidfors L, Isberg L 2003. Intersucking in dairy cattle- review and questionnaire. *Applied Animal Behaviour Science* 80:207-231

Mills D, Mrachant-Forde JN, McGreevy PD, Morton DB, Nicol CJ, Philips CJC, Sandoe P, Swaisgood RR 2010. The encyclopedia of applied animal behavior and welfare Wallingford CABI.

Roth BA, Barth K, Gyax L, Hillmann, E 2009. Influence of artificial vs. mother-bonded rearing on sucking behaviour, health and weight gain in calves *Applied Animal Behaviour Science* 119 (3-4):143–150.

Rutledge JJ, Robison OW, Ahlschwede WT, Legates JE 1971. Milk yield and its influence on 205-day weight of beef calves. *Journal of Animal Science* 33: 563–567.

Santman-Berends IMG, Schukken YH, and Schaik van G 2019. Quantifying calf mortality on dairy farms: Challenges and solutions. *Journal of Dairy science* 102: 6404-6417.