Reduced calf mortality when the calf’s needs are leading

Pledge for a renewed view on calf rearing

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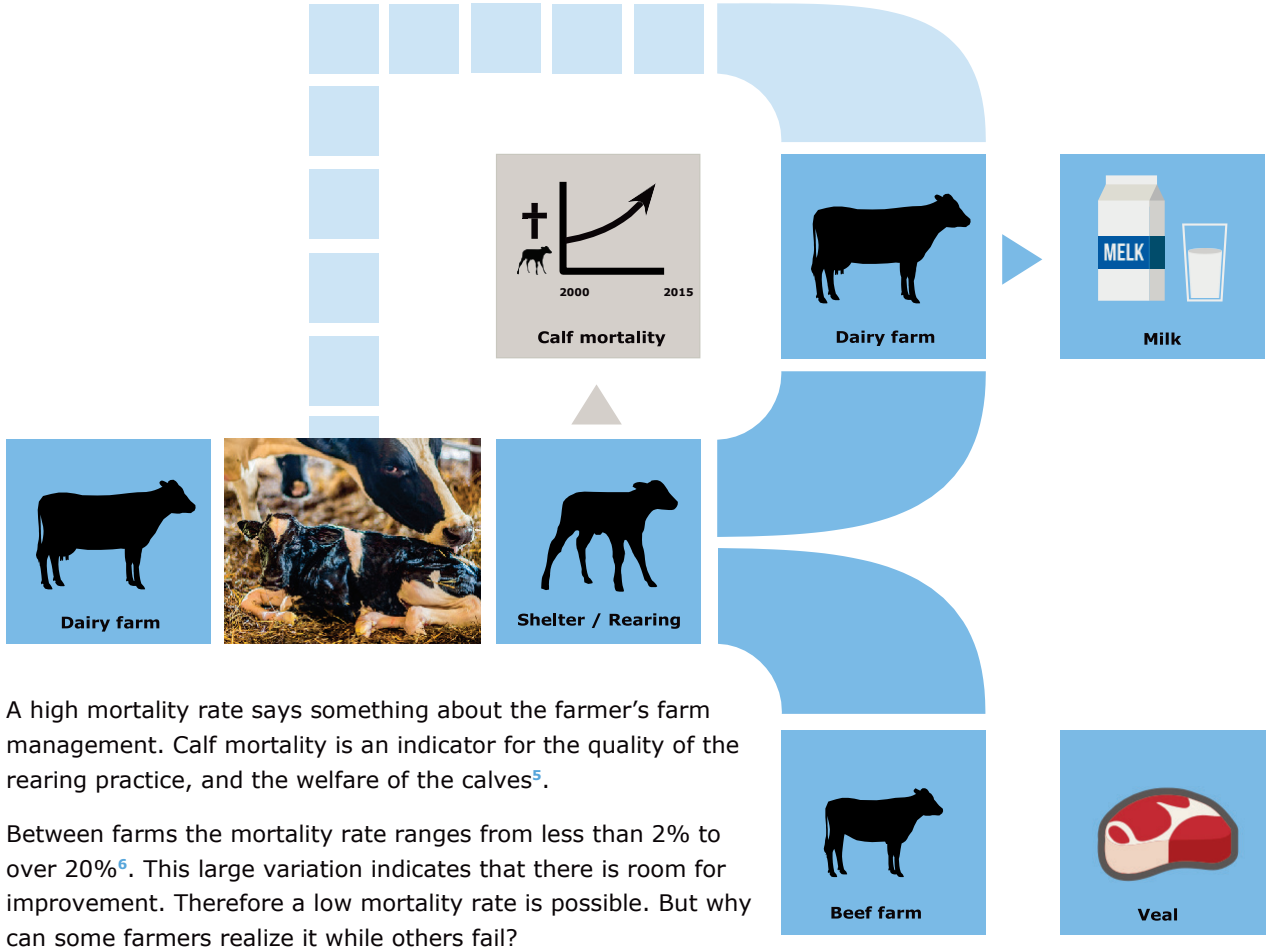
Pledge for a renewed view on calf rearing

Over the past years calf mortality is gradually increasing in The Netherlands. This is not good for the calves in the first place, but secondly a problem for the dairy farmer as well as the whole sector (dairy and veal/beef). Most significant measures are well known but seemingly hard to implement. Due to the often high workload on dairy farms, other farm activities easily get priority over calf rearing. Lack of time and attention prevent a structural improvement of the rearing results[1]. A renewed view on management and housing systems, and nutrition of young calves can be a stimulant in the quest for solving pathways meeting the care needs of the young calf and the optimal care offer of the dairy farmer. And let's be honest, no farmer likes to see his calves die!



The facts

In 2015 the average calf mortality on Dutch dairy farms is 13.3% for calves from three days to one year[2]. This is excluding the calves dying around the moment of birth. For years the mortality rate exceeds 10% and even seems to increase slowly[3]. The majority dies within 21 days. Dehydration, caused by a combination of moisture loss due to diarrhoea and a shortage of moisture administering, is death cause number 1 (56%). Respiratory diseases are second (23%). In wintertime more calves die than in summertime[4].

A high mortality rate says something about the farmer's farm management. Calf mortality is an indicator for the quality of the rearing practice, and the welfare of the calves[5].

Between farms the mortality rate ranges from less than 2% to over 20%[6]. This large variation indicates that there is room for improvement. Therefore a low mortality rate is possible. But why can some farmers realize it while others fail?

Attention for calves suffers by increased workload

Livestock farmers have every reason to aim for low calf mortality. Nevertheless, the average mortality rate has been above 10% for years and this is accepted by the sector despite the fact that 2% is feasible. It appears that awareness, time and mentality of the farmer are important factors that play a role in the results of calf rearing[7]. With young calves -beside the right knowledge- time, attention and discipline are crucial factors[8] for a successful rearing result. This is difficult for many dairy farms; after all, a dairy farmer has many different tasks and responsibilities. Caring for the calves has been added to that because nowadays the farmer's partners often hold off-farm jobs. Farms keep expanding and with this the workload also increases. Especially expanding one-man farms are meeting the limits of their labour capacity. Moreover, it is difficult to plan calving and care for the new-born calf.

Forty percent of the dairy farmers believe that the increasing intensification and farm size result in less time and priority for calving and rearing. According to them, that is the main reason for the rising calf mortality rate[9].

Bad start has long term effects

Having been sick during their first few weeks effects the future performance of adult cows (and veal calves)[10]. The farm management during the rearing period eventually effects the longevity and economics of all on-farm livestock[11]. As research has shown, a calf suffering from diarrhoea has a 17 times higher risk to develop respiratory diseases[12]. Also chances for cows to be culled already after their first lactation increase by 2.5 when they have suffered from diarrhoea as a calf[13]. Bull calves that have had diarrhoea are experiencing growth retardation and are more often ill, requiring more veterinary medicines[14].The health and resilience of (bull) calves is of great importance for the results in veal calf husbandry. There seems to be less and less room for weak, light weighted calves[15].

Damage for multiple aspects

To the farmer calf mortality does not only lead to less job satisfaction, it also represents economic loss. For instance the direct loss of breeding material, the extra labour, and the disposal costs of dead calves. And the consequential damage due to reduced possibilities for expansion and genetic improvements[16]. Moreover, there is a risk of image loss when high mortality rates become part of a societal debate. For example, calf rearing has recently been questioned in connection with calf mortality rates[17], the immediate separation of cow and calf[18], and the so-called pet-food calves –new-born calves which, even after 14 to 35 days, are still too light weighted to be transferred to veal farms.

Early separation calf-cow enlarges duty of care

With the early separation from the dam all care totally becomes the responsibility of the dairy farmer. In practice this is not a simple task. In addition, the conditions on several dairy farms are not ideal for problem-free shelter and rearing of calves into a healthy, resilient dairy cow or veal/beef calf. In both the housing and the feeding of the young calves, the hygiene according to research is insufficient on many farms[19]. For example, in out-dated barns it is often difficult to ensure an optimal climate and hygiene. Moreover, the necessary investments for improvement are sometimes financially not feasible.

From defenceless to resilient

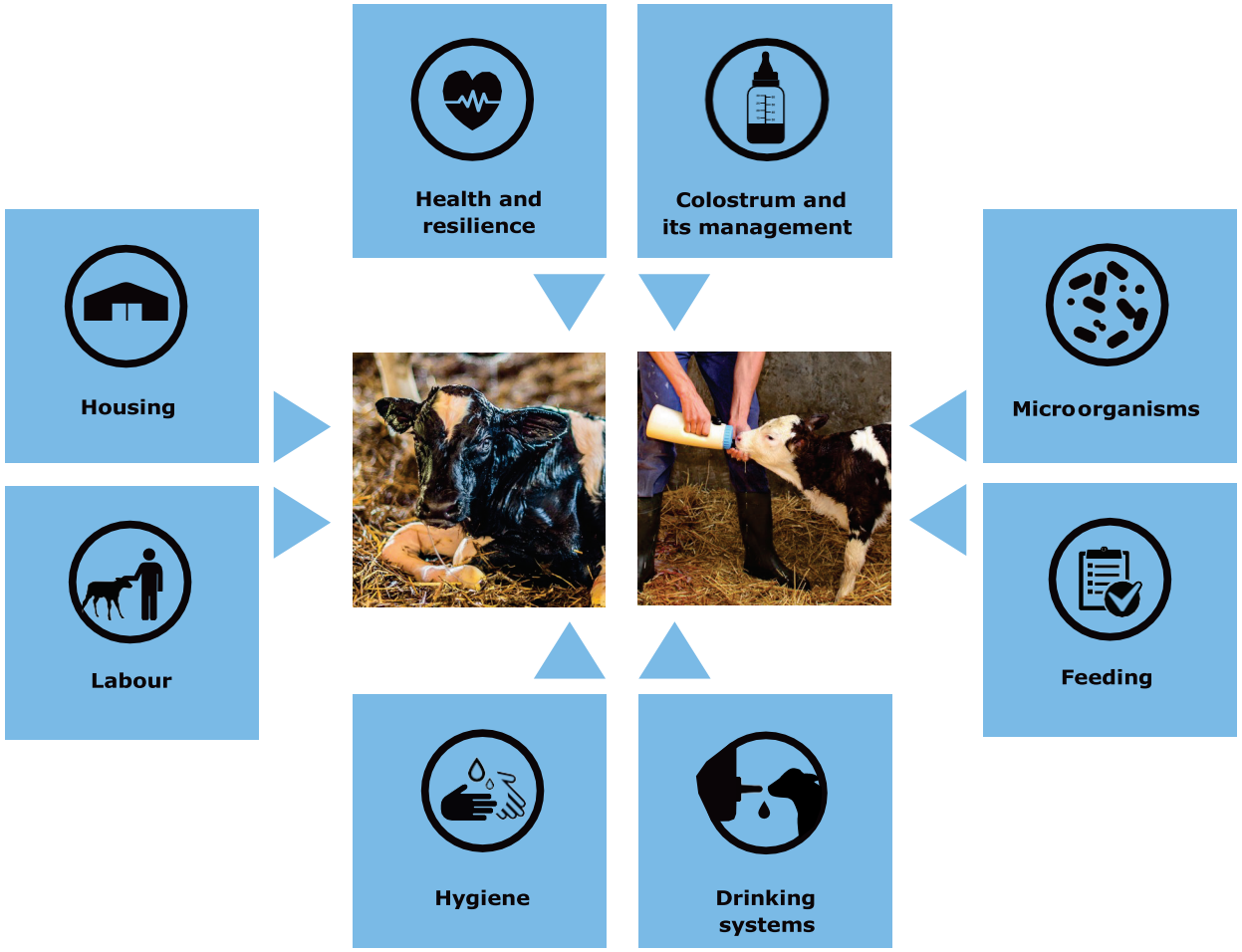
After a fairly carefree period in the womb, protected against potential pathogens and provided with all primary life needs (including food, heat and security), the calf is born after a gestation period of about 285 days. From that moment on it must grow and develop itself.

The calf immediately starts its respiratory system to provide all other vital systems with oxygen. Normally the dam will help the calf for a while, for example by revitalizing the calf by (dry)

licking, and by supplying the milk providing energy, nutrients, antibodies, and the microorganisms to colonize the gastrointestinal tract. Until birth the gastrointestinal tract is more or less a sterile pipe without a real function. However, immediately after birth it has to be able to start absorbing carbohydrates, fats, proteins and antibodies. In this starting up process many things can go wrong which may lead to a great variety of clinical problems[20]. This is also the moment in which the farmer can make a difference. Good management and appropriate nutrition can prevent many problems. An optimal nutritional strategy, the prerequisite for the good start-up of the immune system, leads to better resistance and a better regenerative capacity, with as indicators a lower mortality rate and fewer cases of gastrointestinal and respiratory infections[21].

Colostrum essential for building resistance

To the calf colostrum is an essential source of nutrients and antibodies[22]. For the development of the young calf into a healthy animal with a good resistance and performance, colostrum - as every dairy farmer knows by now - is of crucial importance. Colostrum stimulates the development of the gastrointestinal tract[23] and contributes to the establishment and composition of the types of microorganisms in the intestines (microbiota)[24]. The latter plays a crucial role in programming the immune system and developing the calf into a robust animal with good resistance[25]. A calf does not receive any antibodies from the mother at birth and is largely dependent on the absorption of antibodies from colostrum for the protection against potential pathogens during the first weeks of its life (passive immunity)[26]. These antibodies must be offered and taken up as soon as possible after birth[27]. The possibility of absorbing antibodies is the greatest in the first 2 hours after birth and decreases rapidly thereafter[28]. Already from 12 hours after birth, the intestines of a calf only absorb a limited amount of immunoglobulins[29]. Calves which are first fed only after 12 hours have a greater chance of a reduced resistance, because



they probably have less passively obtained antibodies and therefore are more susceptible to infections. This is also the basis of the earliest 3Q advice to provide colostrum: 'Quantity, Quality and Quickly'[30]. If the calf's level of immunoglobulins is too low on the first day, this also leads to lower milk production and higher mortality during the first lactation[31].

Insufficient priority in the care for the new-born calf means that in many dairy farms calves do not get the right amount and quality of colostrum on time. Passive passage of antibodies obtained via the mother cow, energy intake and the regulation of the body temperature are therefore not optimal[32]. Moreover, the development of the gastrointestinal tract is not stimulated properly and is insufficiently and incorrectly colonized with microorganisms.

Good colostrum improves the immune system

The quality of colostrum is determined firstly by the concentration of antibodies. Colostrum with insufficient antibodies increase the risk of disease and mortality of the calf[33]. The more colostrum the cow produces and the longer it takes for the cow to be milked for the first time, the lower the concentration of antibodies in the first milk, and the fewer antibodies the calf can take in[34]. A production of less than 8.5 litres of colostrum in the first milking is regarded as optimal[35]. By mixing colostrum from different cows, the quality is probably less and certainly not optimally attuned to the calf[36]. Moreover, the chance of transmitting pathogens, such as the bacterium which causes para-tuberculosis, increases[37]. However, if the quality of the mother's own colostrum is inadequate, it is necessary to provide good quality colostrum from another cow or a mixture.

Hygiene in the feeding of colostrum also seems to play a role in the development of immunity: the new-born calf absorbs immunoglobulins better when the colostrum contains the right amount and types of microorganisms[38]. However, udder and teats of the cow are often cleaned when milking the colostrum, as a result of which the calf probably does not get the right amount and composition of microorganisms necessary for an optimal intake of immunoglobulins. Colostrum that is not fed within the hour after milking must be stored correctly, i.e. covering, quick cooling or freezing[39]. Pasteurization has the disadvantage that in addition to the pathogens it also kills the desired microorganisms.
In addition, an important health risk of the calf is to provide colostrum with material (such as artificial teats, buckets and tubes) that has not been sufficiently cleaned. Material with milk residue is a breeding place for bacteria, including potentially pathogenic bacteria. Even so, some bacteria have a mechanism that allows them to survive the cleaning. In addition to cleaning, therefore, disinfection of materials used in milk feeding is also of great importance. Incorrectly milked or stored colostrum and milk may contain too many potential pathogenic microorganisms[40], increasing the risk of disease and death[41].

Sucking has many functions

Colostrum and milk (replacers) are provided via the cow, teat bottle, (teat) buckets, or drink machine. In practice, the (teat) bucket is usually used[42]. As an emergency measure sometimes the first colostrum is fed with a tube (probe).

Sucking is a reflex and, in addition to food intake, has surprisingly many functions[43]. The sucking reflex together with the temperature of the milk and milk proteins, stimulates the oreflex closure of the esophageal groove. Sucking and swallowing activates and quiets down the intestines, and has a stimulating effect on the removal of the first stool (meconium) from the intestines[44]. In addition, sucking lowers blood pressure and heart rate, improves sleep, and stimulates the jaw muscles. When calves drink from buckets or suck from teat buckets, the suction reflex does not work or does not work optimally, the drinking speed is higher, and the drinking position, quality and temperature of the milk are different than sucking from the cows udder.

Sucking with the dam calms and relaxes the calf, helps it learn to trust and strengthens the mother-calf bond[45]. And it induces an increase in the release of the hormone oxytocin (in cow and calf), and promotes the milk production of the cow and the growth of the calf[46]. Moreover, there are indications that immunoglobulins from colostrum are better absorbed when the calf sucks with its mother[47].

In most dairy farms the calves do not drink with the cow for practical reasons. A frequently heard argument is that many calves do not take in enough colostrum quickly enough, and there is insufficient control on the colostrum intake[48]. It is not clear whether this is a consequence of the current husbandry system, in which cows that have been motherlessly reared and have never learned what maternal care is, receive calves, and where breeds and crossbreds are used in which maternal care consciously or unconsciously has been banned as a selecting criteria. Another argument is that many years of selection for optimal udder shape, teat length and teat placement for high milk production and milking, resulting in large udders and short, upright teats, makes colostrum intake by the calf difficult.

Manual milk feeding is often not optimal

For at least the first three weeks calves are completely dependent on milk (or milk replacers)[49]. In practice, calves often get too little milk[50]. Although a calf drinks an average of 10-12 litres of milk a day with ad libitum feeding or suckling[51], most dairy farmers only provide 5-6 litres of milk per day, spread over two feedings[52]. By nature, however, calves drink on average seven times a day[53]. When these farmers take over the care duties of the cow, the calf often gets less milk, and, in addition, regularly drink relatively large quantities at a time. The consequence of this limited feeding is that the calf ultimately does not reach its optimal natural growth[54]. By the way, for a number of years farmers can substitute manual milk feeding by drinking machines. Research shows that stunted growth also affects future milk production[55], and malnutrition leads to deficiencies in the immune response[56].

Cold disastrous for resistance and growth

The lower critical ambient temperature for new-born calves is 15°C. Originally, the calving season coincided with the start of the crop growing season and automatically followed the rising temperature. Too low a temperature was almost never a problem. Now cows also calve in and around the winter. In the Netherlands, more calves die during winter than during summer. When the environment is too cold, the calf needs extra energy to maintain its body temperature. The calf cannot use that energy for growth and body development. Because of the increased energy requirement[57] the Dutch Animal Health Service advises to provide more milk during cold periods. Also, the absorption capacity of immunoglobulins is reduced in a cold environment, which in turn increases the number of calves without passive immunity and therefore the possibility of disease and death[58].

The challenge

In short: good hygiene, sufficient milk and, above all, proper colostrum supply are crucial for the health and development of the calf. Nevertheless, this often proves difficult in practice due to lack of given priority and attention, but also due to lack of time. Especially in the case of growing one-man farms, labour is under pressure. In addition, on many farms the housing of the young stock seems to be sub-optimal.

The challenge is not only to bring about a change of consciousness, and attitude and behaviour among dairy farmers, but at the same time to tackle the 'time' issue. Calf care, and in particular the care for the new-born calf, must be given a proper place in the daily farm management. We have to think about how we can unburden the dairy farmer. That requires different solutions. These can be integrated into another and better design[59] of the housing and management systems for calf rearing. A design in which care and attention are natural and feasible, especially for the youngest calves.

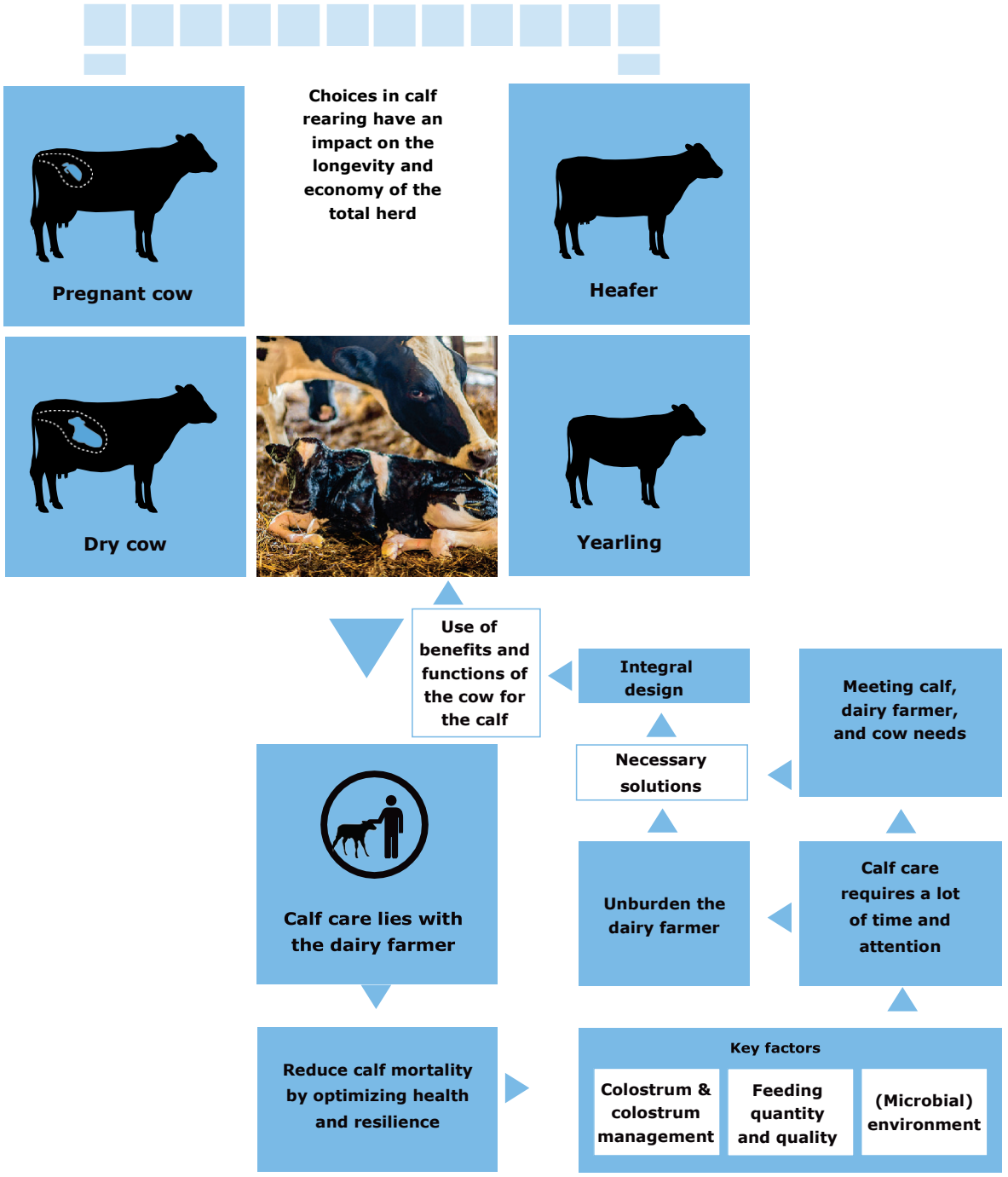
An integral design that meets the desires and needs of both farmer and calf, and that provides insight into the resilience and health of the calves. No such design yet exists, neither will it ever be just one standard design. Several possible solutions can be envisaged and developed to which such a design must comply.

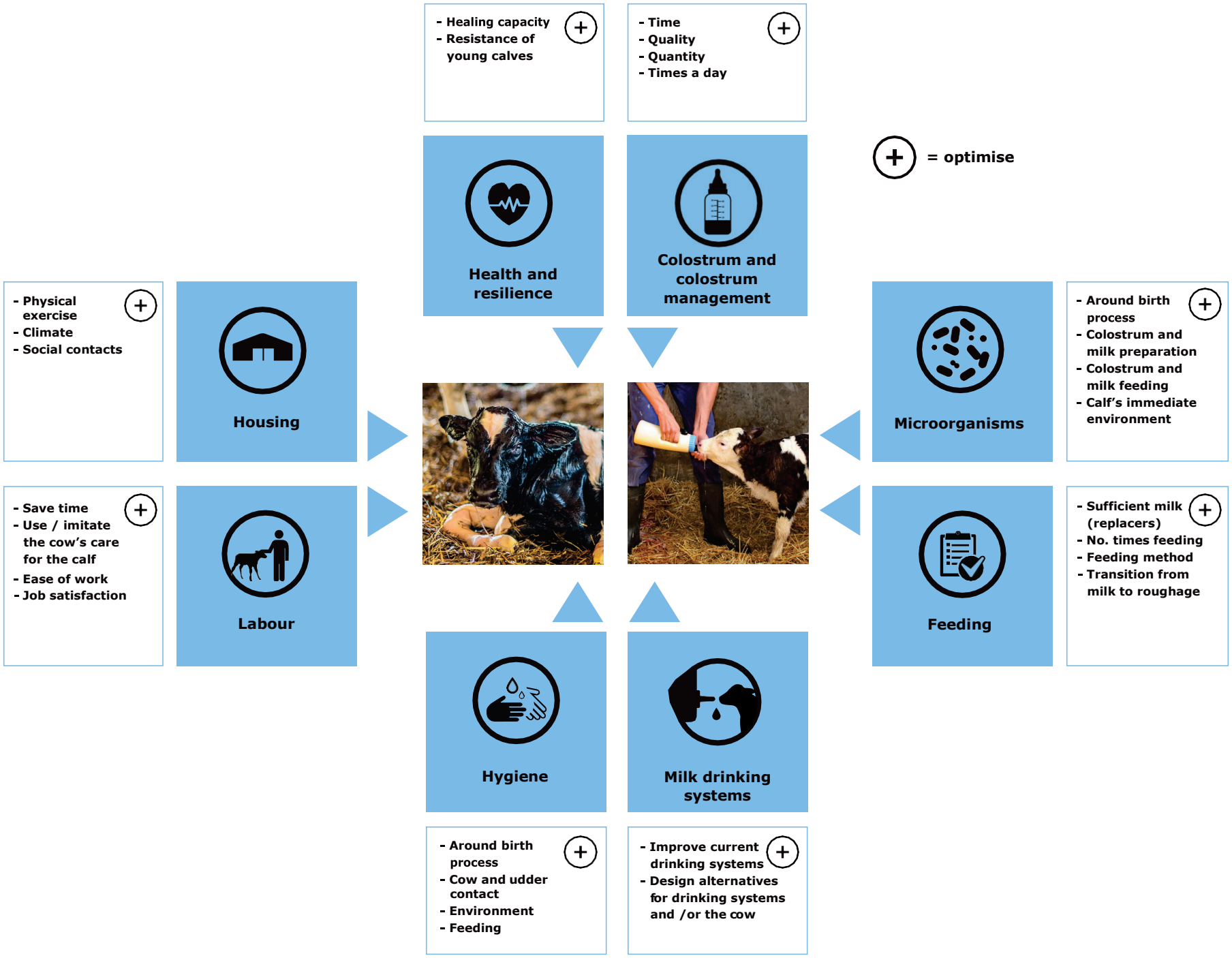
Optimizing the microbial environment, colostrum management and the amount of liquid food, and the quality of the colostrum, milk or milk replacing products are key factors in this design process. In addition, more attention is needed for factors in the development of calf into a resilient dairy cow, which are still underexposed. For example, diet and stress during the dry period of the mother cow, social contact and exercise, play and learning opportunities in the rearing period, and the influence of early experiences on the development of the brain. These factors may well have an (assumed) impact on longevity[60].

The most important innovation tracks should pay attention to:

- the pregnant milk-producing cow,
- the pregnant dry cow,
- the calf's birth,
- the reception of the new-born calf, including the colostrum and milk feeding,
- the contact between cow and calf,
- the contact between calf and congeners, and its environment.

How do we set up the farming system so that the needs of cow, calf and dairy farmer are optimally provided for? Over the past decades, much attention has been paid to the needs of the cow and the dairy farmer, to a much lesser extent to the needs of the new-born calf and the mutual relationships.




- Healing capacity
- Resistance of young calves
- Time
- Quality
- Quantity
- Times a day
= optimise
Health and resilience
Colostrum and colostrum management
- Physical exercise
- Climate
- Social contacts
Housing
Microorganisms
- Around birth process
- Colostrum and milk preparation
- Colostrum and milk feeding
- Calf's immediate environment
- Save time
- Use / imitate the cow's care for the calf
- Ease of work
- Job satisfaction
Labour
Feeding
- Sufficient milk (replacers)
- No. times feeding
- Feeding method
- Transition from milk to roughage
Hygiene
Milk drinking systems
- Around birth process
- Cow and udder contact
- Environment
- Feeding
- Improve current drinking systems
- Design alternatives for drinking systems and /or the cow

In a follow-up process, we need to think about a number of basic questions:

- How do we give new-born calves proper care, without conflicting with other duties of the dairy farmer and with his night's rest? Is it possible to partly automate this care, or to make it much more a natural part of the daily routine?
- How do we ensure that every calf gets sufficient and at the right times high-quality colostrum from its own mother?[61] More concretely: can we also achieve the certainty and controllability of tube feeding - an emergency measure - in a way that better matches the physiology of the calf?
- Improvement is also needed around liquid feeding. How do we ensure that calves receive adequate and sufficiently often liquid food? And how do we combine this with sufficient roughage so that the rumen development is also stimulated?
- How can we better meet the sucking needs of the calf, and better take advantage of the co-benefits of sucking on the calf and cow; and which position do we give the on-farm and cow-specific microorganisms in the new system, without exposing the calf to possible health risks?

Good care should be part of daily routine

Newly designed housing and management systems should be focused on the ease and job satisfaction of the farmer, with the care for young stock being more integrated in the daily routine. Such a design also offers the benefits and functions of caring for the calf by the cow (suckling, relaxation, quietness) or imitates them as well as possible. And by combining the advantages of individual housing with the benefits of group housing, the calf's needs in terms of movement, climate and environment (social contacts) are met. In a new design, naturally, the optimisation of hygiene in both housing and in colostrum and milk preparation and feeding is anticipated. It is a challenge to develop clean and comfortable systems that require little labour; for example solutions for better hygiene of drinking systems or for better, faster and easier cleaning of buckets.

Last but not least, it is important for dairy farmers to gain more insight into the health and resilience of their calves, also in relation to their later performances as dairy cow or veal/beef calf. Knowing your position is a prerequisite for improvement and an incentive to take action.

Summary

Meeting the calf’s care needs

By taking over the mother care for the calf the dairy farmer becomes responsible to do it better, or at least as well as the dam would have done. However, the average farmer does not seem to be able to meet the calf's needs in the current system. The current mortality rates of calves indicate that a fresh look at current shelter and rearing systems is desirable. Alternative designs are needed that better meet the needs of calf and dairy farmer. Designs in which better control of microorganisms is given a place; sufficient attention is paid to the quality and quantity of the colostrum, milk and milk replacers (liquid feeding phase); and in which functions that the cow normally performs, such as suckling, are filled in or simulated as well possible in order to preserve the positive effects of sucking. Designs that do not take extra time; where work can be planned as far as possible; and which give insight into the health and resilience of the animals. Only in this way can a calf, born without any resistance, develop into a healthy, balanced and resilient animal; and eventually develop into a robust, problem-free dairy cow or an animal that finds a place elsewhere in the chain in a more responsible way.

Footnotes

1 Santman-Berends I.M.G.A., Buddiger M., Smolenaars A.J.G., Steuten C.D.M., Roos C.A.J., Van Erp A.J.M., Van Schaik G. (2014) A multidisciplinary approach to determine factors associated with calf rearing practices and calf mortality in dairy herds. Preventive Veterinary Medicine, PREVET, http://dx.doi.org/10.1016/j.prevetmed.2014.07.011
Also our research shows that, in addition to the right knowledge, time, attention and discipline are crucial factors for the successful rearing of especially young calves.

2 The cattle monitor of the Dutch Animal Health Service (AHS) shows that in 2013 the average calf mortality was 12.5% for calves from 3 days - 1 yr on dairy farms and in 2015 the average calf mortality was 13.3% for calves from 3 days - 1 yr.

3 The rising trend in calf mortality is apparent in both the cattle monitor of AHS (see previous footnote) and in the article by Smolenaars, A. (2014). Data-analyse brengt kalversterfte in kaart. GD ruminant, p.20-21. In an accompanying graph, the course of the calf mortality percentage (3 days – 1 yr) on dairy farms for the last five years is shown quarterly. This figure shows that there is still a small increase in calf mortality.

4 Smolenaars A. (2014) Data-analyse brengt kalversterfte in kaart. GD-herkauwer, p.20-21.
In the accompanying figure an annual seasonal influence can be seen; less calf mortality occurs in the summer months than in the winter months.

5 Ortiz-Pelaez A., Pritchard D.G.., Pfeiffer D.U., Jones E., Honeyman P., Mawdsley J.J, (2008) Calf mortality as a welfare indicator on British cattle farms. Veterinary Journal Vol. 176 (2): 177-181.

6 Pelikaan F. (2009) Voorkom kalversterfte. Deel van kalveren met diarree sterft hongerdood. Veeteelt, maart 2, p. 37. http://edepot.wur.nl/152622
According to Snoep (AHS), only 1.6% of the calves die on the 25% best farms and more than 20% die of the 10% worst farms.

And: Achten J. (2011) Kalversterfte ongrijpbaar. Geen aantoonbaar verband tussen kalversterfte en omzet en aanwas. Veeteelt, februari 1, p. 39, http://edepot.wur.nl/162346

7 Santman-Berends I.M.G.A., Buddiger M., Smolenaars A.J.G., Steuten C.D.M., Roos C.A.J., Van Erp A.J.M., Van Schaik G. (2014) A multidisciplinary approach to determine factors associated with calf rearing practices and calf mortality in dairy herds. Preventive Veterinary Medicine, PREVET, http://dx.doi.org/10.1016/j.prevetmed.2014.07.011

8 Our research also shows that, in addition to the right knowledge; time, attention and discipline are crucial factors for a successful rearing especially for young calves.

9 Santman-Berends I.M.G.A., Buddiger M., Smolenaars A.J.G., Steuten C.D.M., Roos C.A.J., Van Erp A.J.M., Van Schaik G. (2014) A multidisciplinary approach to determine factors associated with calf rearing practices and calf mortality in dairy herds. Preventive Veterinary Medicine, PREVET, http://dx.doi.org/10.1016/j.prevetmed.2014.07.011
Most dairy farmers (40%) indicated that the evolution of Dutch dairy farming towards more intensive cattle farming systems with more cows resulted in less time and priority for the calves and that this was the main reason for the increasing calf mortality on Dutch dairy farms (see table 2) .

10 Oikonomou G., Teixeira A.G.V., Foditsch C., Bihalco M.L., Machado V.S., Bihalco R.C. (2013) Fecal Microbial diversity in pre-weaned dairy calves as described by pyrosequencing of metagenomic 16S rDNA. Associations of Faecalibacterium Species with health and growth. Plos One, vol. 8 (4), e63157, p. 1-11.

And: Windeyer M.C., Leslie K.E., Godden S.M., Hodgins D.C., Lissemore K.D., LeBlanc S.J. (2014) Factors associated with morbidity, mortality, and growth of dairy heifer calves up to 3 months of age. Preventive Veterinary Medicine 113, p. 231-240.

And: Hötzel M.J., Longo C., Balcão L.F., Cardoso C.S., Costa J.H.C. (2014) A survey of management practices that influence performance and welfare of dairy calves reared in Southern Brazil. PLoS ONE 9(12): e114995. Doi:10.1371/journal.pone. 0114995.

11 Drew B. (1998) Targets for rearing dairy heifers - weaning to calving. In Pract. 20: 35-39. The management during the rearing period effects the longevity and economy of the total herd.

And: Pettersson K., Svensson C., Liberg P. (2001) Housing, feeding, and management of calves and replacement heifers in Swedish dairy herds. Acta vet. scand. vol. 42 no. 4.

And: Williams D.R, Pithua P., Garcia A., Champagne J., Haines D.M. and Sharif S.A. (2014). Effect of three colostrum diets on passive transfer of immunity and preweaning health in calves on a California dairy following colostrum management training. Veterinary Medicine International, vol. 2014, article ID 698741, 9 pages, http://dx.doi.org/10.1155/2014/698741.
Adequate passive immunity is associated with lower vet costs in the period before weaning, improved growth and increased milk production and longevity of the dairy herd.

And: Quigley, J. 2002. Passive immunity in newborn calves. Advances in Dairy Technology, vol. 14, p. 273-291.
The management level has a strong effect on illness and mortality. Good calf rearing, especially during the neonatal period, can greatly reduce illness and mortality. Improper management leads to economic losses due to increased animal costs, dead calves, reduced growth and suboptimal fertility results. Poor young stock management can reduce the life production per cow and the herd.

12 Preventing gastrointestinal disorders is the first step to reduce calf mortality. Diarrhoea has, both directly and indirectly, the greatest impact on the mortality rate and on the development of the calf. Nutrition plays an important role in this. A calf that has had diarrhoea is 17 times more likely to develop respiratory problems (BRD).

13 Nijhoving, I., Henselmans T. (2015) Alstubiest: gezonde start, gezonde kalveren. MSD Kalvermagazine.

14 Lorenz I., Fagan J., More S.J. (2011) Calf health from birth to weaning. II. Management of diarrhoea in pre-weaned calves. Irish Veterinary Journal, 64:9, http://www.irishvetjournal.org/content/64/1/9.

15 Artikel http://veeteelt.nl/gezondheid/nieuws/definitieve-oplossing-voor-moeizame-afzet-kalveren-nabij-0

16 Mee J.F., Berry D.P., Cromie A.R. (2008) Prevalence of, and risk factors associated with, perinatal calf mortality in pasture-based Holstein–Friesian cows. Animal 2: 613–620.

And: Torsein M., Lindberg A., Sandgren C.H., Waller K.P., Tornquist M. and Svensson
C. (2011) Risk factors for calf mortality in large Swedish dairy herds. Prev. Vet. Med. 99:136–147.

And: Klein-Jöbstl D., Iwersen M., and Drillich M. (2014) Farm characteristics and calf management practices on dairy farms with and without diarrhea: A case-control study to investigate risk factors for calf diarrhea. J. Dairy Sci. 97:5110–5119, http://dx.doi.org/10.3168/jds.2013-7695

And: Santman-Berends I.M.G.A., Buddiger M., Smolenaars A.J.G., Steuten C.D.M., Roos C.A.J., Van Erp A.J.M., Van Schaik G. (2014) A multidisciplinary approach to determine factors associated with calf rearing practices and calf mortality in dairy herds. Preventive Veterinary Medicine, PREVET, http://dx.doi.org/10.1016/j.prevetmed.2014.07.011

17 http://nos.nl/artikel/2158007-1-op-7-kalveren-binnen-jaar-dood-door-gebrek-aan-aandacht.html

And: http://www.boerderij.nl/Rundveehouderij/Nieuws/2017/2/Kalversterfte-onder-de-loep-94001E/?cmpid=NLC|boerderij_vandaag|2017-02-13|Kalversterfte_onder_de_loep

18 http://eostrace.be/artikelen/over-koetjes-en-kalfjes

19 Patel S., Gibbons J., Wathes D.C., 2014. Ensuring optimal colostrum transfer to newborn dairy calves. Cattle Practice, 22, p. 95-104.

And: Quigley J. (2002). Passive immunity in newborn calves. Advances in Dairy Technology, vol. 14, p. 273-291.

And: Williams D.R, Pithua P., Garcia A., Champagne J., Haines D.M. and Sharif S.A. (2014). Effect of three colostrum diets on passive transfer of immunity and preweaning health in calves on a California dairy following colostrum management training. Veterinary Medicine International, vol. 2014, article ID 698741, 9 pages, http://dx.doi.org/10.1155/2014/698741.

20 Nijhoving, I., Henselmans T. (2015) Alstubiest: gezonde start, gezonde kalveren. MSD Kalvermagazine.)

21 Borderas, T.F., De Passillé A.M.B., Rushen J. (2009 I). Temperature preferences and feed level of the newborn dairy calf. Applied Animal Behaviour Science, D. 08-291.

And: Lorenz I., Mee J.F., Earley B., More S.J. (2011) Calf health from birth to weaning. I. General aspects of disease prevention. Irish Veterinary Journal, 64:10, http://www.irishvetjournal.org/content/64/1/10.

22 Parrish D.B., Bartley E.E., Burris D.U., McIntyre R.T. (1953) Properties of the colostrum of the dairy cow. VIII. Digestibility of colostrum and milk by calves during the early postnatal days of life. Journal of Dairy Science 36: 489-494.
Colostrum from the first milking contains not only immunoglobulins but also a considerable amount of nutrients.

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And: Hammon H.M., Steinhoff-Wagner J., Schönhusen U., Metges C.C., Blum J.W. (2012). Energy metabolism in the newborn farm animal with emphasis on the calf: endocrine changes and responses to milk-born and systematic hormones. Domestic Animal Endocrinology, 43: 171-185.

And: Patel S., Gibbons J., Wathes D.C., 2014. Ensuring optimal colostrum transfer to newborn dairy calves. Cattle Practice, 22, p. 95-104.

24 Taschuk R. and Griebel P.J. (2012) Commensal microbiome effects on mucosal immune system development in the ruminant gastrointestinal tract. (Review) Animal health research reviews / Conference of Research Workers in Animal Diseases, Vol. 13 (1): 129-141.

And: Rogier E.W., Frantz A.L., Bruno M.E.C., Wedlund L., Cohen D. A., Stromberg A.J., Kaetzel C.S. (2014) Secretory antibodies in breast milk promote long-term intestinal homeostasis by regulating the gut microbiota and host gene expression. PNAS 111 (8) p. 3074-3079.

And: Smits M.A., Jansman A.J., Savelkoul H.F.J., Rebel A.J.M. (2014) De rol van microbiota voor een evenwichtig afweersysteem. Tijdschrift voor Diergeneeskunde, nr. 6, p. 22-26.

And: Liang G., Malmuthuge N., Guan L.L., Griebel, P (2015) Model systems to analyze the role of miRNAs and commensal microflora in bovine mucosal immune system development (Review). Molecular Immunology, Vol. 66 (1): 57-67.

25 Smits M.A., Jansman A.J., Savelkoul H.F.J., Rebel A.J.M. (2014) De rol van microbiota voor een evenwichtig afweersysteem. Tijdschrift voor Diergeneeskunde, nr. 6, p. 22-26.

And: Oikonomou G., Teixeira A.G.V., Foditsch C., Bihalco M.L., Machado V.S., Bihalco R.C. (2013) Fecal Microbial diversity in pre-weaned dairy calves as described by pyrosequencing of metagenomic 16S rDNA. Associations of Faecalibacterium Species with health and growth. Plos One, vol. 8 (4), e63157, p. 1-11
Microbiota in the intestines of calves promote growth and help prevent diarrhoea by protecting against pathogens. Good health, growth and development of calves

result in better-performing heifers and cows, and less work and costs for the dairy farmer.

26 Godden S. (2008) Colostrum Management for Dairy Calves (Review) Veterinary Clinics of North America - Food Animal Practice, Vol. 24 (1): 19-39.
Due to the structure of the placenta, the blood supply of both mother and foetus is separated, so that a calf is born without immunoglobulins, and is completely dependent on the absorption of colostrum to obtain adequate immunity and protection against pathogenic organisms until its own immunity is sufficiently developed. This is the case when the calf is about 3-4 weeks old.

27 Yang M., Zou Y., Wu Z.H., Li S.L., Cao Z.J. (2015) Colostrum quality affects immune system establishment and intestinal development of neonatal calves. Journal of Dairy Science 98: 7153-7163. http://dx.doi.org/10.3168/jds.2014-9238.
Good quality colostrum helps the calf to start up both the immune and antioxidant system immediately after birth. AHS cattle veterinarian A. Smolenaars advises 'a lot, quickly and often' (The 3 Q's – Quantity, Quality, Quickly). At least 3 litres in the first 4 hours after birth. Again 2 litres within 12 hours. Within 24 hours a total of 6 litres of first-time colostrum.

And: Patel S., Gibbons J., Wathes D.C., 2014. Ensuring optimal colostrum transfer to newborn dairy calves. Cattle Practice, 22, p. 95-104.
A calf must receive 3-4 litres of colostrum within 1-2 hours after birth with at least 50 mg / ml of IgG.

28 Chigerwe M., Tyler J.W., Schultz L.G., Middleton J.R., Steevens B.J. and Spain J.N. (2008) Effect of colostrum administration by use of oroesophageal intubation on serum IgG concentrations in Holstein bull calves. Am. J. Vet. Res. 69: 1158–1163.
The ability of the neonatal intestine to absorb immunoglobulins progressively decreases from 2 hours after birth.

And: Conneely M., Berry D.P. ,Murphy J.P., Lorenz I., Doherty M.L. and Kennedy E. (2014) Effect of feeding colostrum at different volumes and subsequent number of transition milk feeds on the serum immunoglobulin G concentration and health status of dairy calves. Journal of Dairy Science 97 : 6991–7000, http://dx.doi.org/10.3168/jds.2013-7494.
Substantially more IgG must be consumed by calves during colostrum feeding from 2 hours after birth to achieve adequate passive transfer (ADP).

29 Bush L.J. and Staley T.E. (1980) Absorption of colostral immunoglobulins in newborn calves. Journal of dairy science, Vol. 63 (4): 672-680.

And: Weaver D.M., Tyler J.W., VanMetre D.C., Hostetler D.E., Barrington G.M. (2000) Passive transfer of colostral immunoglobulines in calves. Journal of Veterinary Internal Medicine, 14: 569-577.

And: Patel S., Gibbons J., Wathes D.C., 2014. Ensuring optimal colostrum transfer to newborn dairy calves. Cattle Practice, 22, p. 95-104.

30 Osinga A. (1987). Gezondheidszorg voor het rund. Deel 3 Bedrijfsgezondheidszorg. Culemborg, Educaboek, p. 126.

31 DeNise S.K., Robison J.D., Stott G.H., Armstrong D.V. (1989) Effects of passive immunity on subsequent production in dairy heifers. Journal of Dairy Science 72: 552-554.

32 Murray C.F., Leslie K.E., 2013. Newborn calf vitality: Risk factors, characteristics, assessment, resulting outcomes and strategies for improvement. Veterinary Journal, 198 (2), p. 322-328.
Quick colostrum intake improves the passive passage of immunoglobulins, energy intake and thermoregulation.

33 Patel S., Gibbons J., Wathes D.C., 2014. Ensuring optimal colostrum transfer to newborn dairy calves. Cattle Practice, 22, p. 95-104.

34 Quigley J. (2002). Passive immunity in newborn calves. Advances in Dairy Technology, vol. 14, p. 273-291.

And: Weaver D.M., Tyler J.W., VanMetre D.C., Hostetler D.E., Barrington G.M. (2000) Passive transfer of colostral immunoglobulines in calves. Journal of Veterinary Internal Medicine, 14: 569-577.

And: Lorenz I. (2013) An update on research into factors affecting calf health. Cattle Practice 21: 237-239.

35 Pritchett L.C., Gay C.C., Besser T.E., Hancock D.D (1991) Management and production factors influencing immunoglobulin G1 concentration in colostrum from Holstein cows. Journal of dairy science, Vol. 74 (7): 2336-2341.

And: Weaver D.M., Tyler J.W., VanMetre D.C., Hostetler D.E., Barrington G.M. (2000) Passive transfer of colostral immunoglobulines in calves. Journal of Veterinary Internal Medicine, 14: 569-577.

36 Weaver D.M., Tyler J.W., VanMetre D.C., Hostetler D.E., Barrington G.M. (2000) Passive transfer of colostral immunoglobulines in calves. Journal of Veterinary Internal Medicine, 14: 569-577.

And: Patel S., Gibbons J., Wathes D.C., 2014. Ensuring optimal colostrum transfer to newborn dairy calves. Cattle Practice, 22, p. 95-104.

37 McGuirk S.M. and Collins M. (2004) Managing the production, storage, and delivery of colostrum (Review). Veterinary Clinics of North America - Food Animal Practice, Vol. 20 (3): 593-603.

And: Godden S. (2008) Colostrum Management for Dairy Calves (Review) Veterinary Clinics of North America - Food Animal Practice, Vol. 24 (1): 19-39.

And: Lorenz I., Mee J.F., Earley B., More S.J. (2011) Calf health from birth to weaning. I. General aspects of disease prevention. Irish Veterinary Journal, 64:10, http://www.irishvetjournal.org/content/64/1/10.

And: Cummins C., Berry D.P., Sayers R., Lorenz I., Kennedy E. (2016) Questionnaire identifying management practices surrounding calving on spring-calving farms and their associations with herd size and herd expansion. Animal, 10:5, pp. 868-877.
Several articles, including those of Lorenz et al. (2011 I) and Cummins et al. (2016), mention the importance of colostrum of the own mother i.e. to prevent the chance of transmission of diseases (including para-TB).

38 McGuirk S.M. and Collins M. (2004) Managing the production, storage, and delivery of colostrum (Review). Veterinary Clinics of North America - Food Animal Practice, Vol. 20 (3): 593-603.
The total number of microorganisms should not exceed 100,000 colony forming units (cfu) / ml and should contain less than 10,000 cfu / ml faecal coliform bacteria.

And: Lorenz I., Mee J.F., Earley B., More S.J. (2011) Calf health from birth to weaning.
I. General aspects of disease prevention. Irish Veterinary Journal, 64:10, http://www.irishvetjournal.org/content/64/1/10.

And: Patel S., Gibbons J., Wathes D.C., 2014. Ensuring optimal colostrum transfer to newborn dairy calves. Cattle Practice, 22, p. 95-104.

And: Williams, D.R, P. Pithua, A. Garcia, J. Champagne, D.M. Haines and S.A. Sharif. 2014. Effect of three colostrum diets on passive transfer of immunity and preweaning health in calves on a California dairy following colostrum management training. Veterinary Medicine International, vol. 2014, article ID 698741, 9 pages, http://dx.doi.org/10.1155/2014/698741. Uit Williams et al., 2014:
Studies show that immunoglobulins from colostrum with <100,000 cfu / ml bacteria are better absorbed than colostrum with more bacteria.

And: Khan M.A., Bach A., Weary D.M., von Keyserlingk M.A.G. (2016) Invited review: Transitioning from milk tot solid feed in dairy heifers. Journal of Dairy Science 99: 885-902.
Under natural feeding conditions, when calves are fed by their mothers, calves acquire anaerobes from their mother, older calves, and their environment (e.g. infected meadows); in artificially raised calves, the acquisition and establishment of the anaerobic ecosystem in the rumen depends on the type of feed that is provided, the housing system and the handling situations.

39 McGuirk S.M. and Collins M. (2004) Managing the production, storage, and delivery of colostrum (Review). Veterinary Clinics of North America - Food Animal Practice, Vol. 20 (3): 593-603.

And: Lorenz I., Mee J.F., Earley B., More S.J. (2011) Calf health from birth to weaning. I. General aspects of disease prevention. Irish Veterinary Journal, 64:10, http://www.irishvetjournal.org/content/64/1/10.

40 McGuirk S.M. and Collins M. (2004) Managing the production, storage, and delivery of colostrum (Review). Veterinary Clinics of North America - Food Animal Practice, Vol. 20 (3): 593-603.
The total bacterial count should not exceed 100,000 colony forming units (cfu) / ml and should contain less than 10,000 cfu / ml faecal coliform bacteria.

And: Lorenz I., Mee J.F., Earley B., More S.J. (2011) Calf health from birth to weaning.
I. General aspects of disease prevention. Irish Veterinary Journal, 64:10, http://www.irishvetjournal.org/content/64/1/10.

41 Patel S., Gibbons J., Wathes D.C., 2014. Ensuring optimal colostrum transfer to newborn dairy calves. Cattle Practice, 22, p. 95-104.

And: Quigley J. (2002). Passive immunity in newborn calves. Advances in Dairy Technology, vol. 14, p. 273-291.

And: Williams D.R, Pithua P., Garcia A., Champagne J., Haines D.M. and Sharif S.A. (2014). Effect of three colostrum diets on passive transfer of immunity and preweaning health in calves on a California dairy following colostrum management training. Veterinary Medicine International, vol. 2014, article ID 698741, 9 pages, http://dx.doi.org/10.1155/2014/698741.

42 Pettersson K., Svensson C., Liberg P. (2001) Housing, feeding, and management of calves and replacement heifers in Swedish dairy herds. Acta vet. scand. vol. 42 no. 4.
A survey conducted in Sweden shows that calves are fed with the bucket at 77% of farms. The remainder uses automated drinking systems (13%), teat buckets (4%), suckler cows (1%) or other methods (5%).

43 Blass E.M., Teicher M.H. (1980) Suckling. Science, New Series, Vol. 210, No. 4465, Oct. 3, p. 15-22.

44 Yamauchi Y., Yamanouchi I. (1990) Breast-feeding frequency during the first 24 hours after birth in full-term neonates. Pediatrics, vol. 86 (2) p. 171-175.
Frequent feeding in the neonatal phase presumably stimulates bowel movements, reducing the reabsorption of bilirubin in the small intestine and reducing serum bilirubin.

45 E.g. Pluháček J. et al. (2013) Time spent suckling is affected by different social organization in three zebra species, Journal of Zoology, DOI: 10.1111/jzo.12077
The psychological effects include providing comfort, calming, reassuring, relaxing, helping to learn to trust and interact. In the event of more unrest in the herd, the mother suckles longer. In the mother, the oxytocin level increases, resulting in an increase in milk production and the let down of milk. Failure to meet the sucking requirement leads to stereotypical, compulsive behaviour. Calves start to suckle and lick other calves and objects. Read e.g. Fröberg S., Gratte E., Svennersten-Sjaunja K., Olsson I, Berg C., Orihuela A, Galina C.S., García B., Lidfors L. (2008) Effect of suckling ('restricted suckling') on dairy cows' udder health and milk let-down and their calves' weight gain, feed intake and behaviour. Applied Animal Behaviour Science 09; 113 (s 1-3): 1-14.
No more drinking milk with the mother, or weaning, happens in nature at an age of 7-14 months. After weaning, mother and calf spend a lot of time in close proximity (Reinhardt and Reinhardt, 1982b). According to the EFSA report (2006, pp. 37, 38), natural weaning occurs at an age of 8-9 months. The weaning age is less important than the rumen development. Calves can only be weaned when their rumen is well developed. In nature, bull calves suck up to an age of 11 months and female calves up to 8.5 months (Reinhardt en Reinhardt, 1981).
Weaning occurs naturally in nature, because the calf drinks less often with the mother. Five-days old calves drink 5-14 times 8 minutes a day (Reinhardt and Reinhardt, 1981). After 10 months a calf drinks 3 times a day and after 400 days 1.5 times a day (Vessier en le Neindre, 1989).
Reinhardt, V. and Reinhardt, A. 1981. Cohesive relationships in a Zebu cattle herd (Bos indicus). Behaviour 77: 121-151.

And: Reinhardt, V. and Reinhardt, A. 1982. Social behaviour and social bonds between juvenile and sub-adult Bos indicus calves. Applied Animal Ethology 9, 92-93 (abstract).

46 Acevedo N., Hernández A., Orihuela L., Lidfors M., Berg C., (2005) Effect of restricted suckling or temporal weaning on some physiological and behavioural stress parameters in Zebu cattle (Bos indicus) Asian-Australian Journal of Animal Sciences, vol. 18 (8), p.1176-1181.

47 Studies suggest that sucked colostrum leads to better passive transfer in the calf.
F. B. Garry, R. Adams, M. B. Cattell, and R. P. Dinsmore (1996) Comparison of passive immunoglobulin transfer to dairy calves fed colostrum or commercially available colostral-supplement products, Journal of the American Veterinary Medical Association, vol. 208, no. 1, pp. 107–110.

48 Patel S., Gibbons J., Wathes D.C. (2014). Ensuring optimal colostrum transfer to newborn dairy calves. Cattle Practice, 22, p. 95-104.
Patel et al. (2014) describes that sucking with the dam leads to insufficient intake, so feeding with a teat bottle is recommended. Feeding with a teat bottle stimulates the closing of the esophageal groove, allowing the colostrum to enter the abomasum. Although feeding with a teat bottle is preferable, according to Patel et al. it is also possible to use tube feeding when feeding with the teat bottle fails. Using tube feeding must be done properly to prevent damage to the calf. Also read the articles by Williams et al. (2014) and Quigley (2002) on passive transfer of colostrum. Calves which do not receive sufficient IgG (<10g / litre or IgG or <50g / litre total protein measured in the blood) have a reduced resistance against diseases.

And: Beam A.L., Lombard J.E., Kopral C.A., Garber L.P., Winter A.L., Hicks J.A., Schlater J.L. (2009) Prevalence of failure of passive transfer of immunity in newborn heifer calves and associated management practices on US dairy operations. Journal of Dairy Science 92: 3973-3980.

49 Borderas, T.F., De Passillé A.M.B., Rushen J. (2009 I). Temperature preferences and feed level of the newborn dairy calf. Applied Animal Behaviour Science, D. 08-291.

And: Lorenz I., Mee J.F., Earley B., More S.J. (2011) Calf health from birth to weaning. I. General aspects of disease prevention. Irish Veterinary Journal, 64:10, http://www.irishvetjournal.org/content/64/1/10.

50 Jasper J. and Weary D.M. (2002) Effects of ad libitum milk intake on dairy calves. Journal of Dairy Science, Vol. 85 (11): 3054-3058.

And: Lorenz I., Mee J.F., Earley B., More S.J. (2011) Calf health from birth to weaning. I. General aspects of disease prevention. Irish Veterinary Journal, 64:10, http:// www.irishvetjournal.org/content/64/1/10.
Lorenz et al. (2011 I) mentions that calves sucking with the dam or drink ad libitum can take up about 20% of their body weight per day and can grow up to 1 kg per day.

51 Interviews with experts and research show that calves drink 10-15 litres a day when fed ad libitum.
Borderas T.F., de Passillé A.M.B, Rushen J. (2009 II) Feeding behavior of calves fed small or large amounts of milk. Journal of Dairy Science, Vol. 92 (6) p. 2843-2852.

And: De Passillé A.M.B., Marnet P.G., Lapierre H., Rushen J. (2008) Effects of twice-daily nursing on milk ejection and mild yield during nursing and milking in dairy cows. Journal of Dairy Science, Vol. 91, p. 1416-1422.

And: Appleby M.C., Weary D.M., Chua B. (2001) Performance and feeding behaviour of calves on ad libitum milk from artificial teats. Applied Animal Behaviour Science, Vol. 74, p 191-201.

And: Lorenz I., Mee J.F., Earley B., More S.J. (2011) Calf health from birth to weaning. I. General aspects of disease prevention. Irish Veterinary Journal, 64:10, http://www.irishvetjournal.org/content/64/1/10.

52 Most calves are only fed twice daily and receive 5-6 litres per day. In fact they get too little milk to drink. This and the fact that this is not only the practice in the Netherlands is also apparent from the literature: Lorenz I., Mee J.F., Earley B., More S.J. (2011) Calf health from birth to weaning. I. General aspects of disease prevention. Irish Veterinary Journal, 64:10, http://www.irishvetjournal.org/content/64/1/10.

53 Borderas, T.F., De Passillé A.M.B., Rushen J. (2009 I). Temperature preferences and feed level of the newborn dairy calf. Applied Animal Behaviour Science, D. 08-291.
In addition: Five-days old calves drink 5-14 times 8 minutes a day (Reinhardt and Reinhardt, 1981). After 10 months a calf drinks 3 times a day and after 400 days 1.5 times a day (Vessier en le Neindre, 1989).
And: Jensen (2003) states that the cow suckles the calf during the first weeks 5-9 times a day and 3-5 times a day in the months thereafter. A reference is made to various sources. See also De Passille (2001). It mentions 4-10 times a day and refers to various sources.
Reinhardt V. and Reinhardt A. (1981) Natural sucking performance and age of weaning in zebu cattle (Bos indicus). The Journal of Agricultural Science, Vol. 96 (2): 309-312.

And: Veissier I. and Le Neindre P. (1989) Weaning in calves: Its effects on social organization. Applied Animal Behaviour Science, Vol. 24 (1): 43-54.

And: De Passillé A.M. (2001) Sucking motivation and related problems in calves (Review). Applied Animal Behaviour Science, Vol. 72 (3): 175-187.

And: Jensen M.B. (2003) The effects of feeding method, milk allowance and social factors on milk feeding behaviour and cross-sucking in group housed dairy calves (Review). Applied Animal Behaviour Science, Vol. 80 (3): 191-206.

54 Borderas, T.F., De Passillé A.M.B., Rushen J. (2009 I). Temperature preferences and feed level of the newborn dairy calf. Applied Animal Behaviour Science, D. 08-291.

And: Lorenz I., Mee J.F., Earley B., More S.J. (2011) Calf health from birth to weaning. I. General aspects of disease prevention. Irish Veterinary Journal, 64:10, http://www.irishvetjournal.org/content/64/1/10.

And: Appleby M.C., Weary D.M., Chua B. (2001) Performance and feeding behaviour of calves on ad libitum milk from artificial teats. Applied Animal Behaviour Science, Vol. 74, p 191-201.

Appleby et al. (2001) describes that calves receiving ad lib milk during the first 2 weeks of life grew 2.4 times faster than calves that were fed limited.
Lorenz et al. (2011 I) mentions that calves that receive suckling from the dam or ad lib can take up about 20% of their body weight per day and can grow up to 1 kg per day.

55 Bach, A. & Ahedo, J. (2008) Record keeping and economics of dairy heifers. Veterinary Clinics of North America: Food Animal Practice 24: 117–138.
Bach and Ahedo have established the relationship between growth rate at a young age and an increase in milk production during the first lactation.

56 Borderas, T.F., De Passillé A.M.B., Rushen J. (2009 I). Temperature preferences and feed level of the newborn dairy calf. Applied Animal Behaviour Science, D. 08-291.

And: Lorenz I., Mee J.F., Earley B., More S.J. (2011) Calf health from birth to weaning. I. General aspects of disease prevention. Irish Veterinary Journal, 64:10, http://www.irishvetjournal.org/content/64/1/10.

And: Stratton R.J., Green C.J., Elia M. (2003) Disease-Related Malnutrition: an Evidence Based Approach to Treatment. Wallingford, Oxon: CAB International
The official definition of malnutrition is: Malnutrition can be defined as a state of nutrition in which a deficiency or excess (or imbalance) of energy, protein and other nutrients causes measurable adverse effects on tissue/body form (body shape, size, composition), body function and clinical outcome (Stratton, 2003). When too few nutrients and protein are digested, body tissue is broken down. Fat breakage does not have to be a problem in itself (apart from the possible risk of released toxins from the broken down fat tissue), but muscle breakdown is harmful because it leads to reduced vitality and thus to less mobility and less health. Muscle breakdown implies a protein deficiency and thus too few nutrients for optimal immune system. Weight loss is a sign of energy shortage. Energy is needed for resistance, well-being, temperature, etc. In the case of protein and energy deficiency, the chance of lack of other essential elements such as vitamins, minerals and omega-3 fatty acids is high.

57 Smolenaars, A., 2014. Data-analyse brengt kalversterfte in kaart. GD-herkauwer, p.20-21.

58 Patel S., Gibbons J., Wathes D.C., 2014. Ensuring optimal colostrum transfer to newborn dairy calves. Cattle Practice, 22, p. 95-104.
Calves that do not get enough IgG (<10g / litre or IgG or <50g / litre total protein measured in the blood) have a reduced resistance against diseases.

And: Beam A.L., Lombard J.E., Kopral C.A., Garber L.P., Winter A.L., Hicks J.A., Schlater J.L. (2009) Prevalence of failure of passive transfer of immunity in newborn heifer calves and associated management practices on US dairy operations. Journal of Dairy Science 92: 3973-3980.

And: Olson D.P., Papasian C.J., Ritter R.C. (1980) The effects of cold stress on neonatal calves. II. Absorption of colostral immunoglobulins. Canadian Journal of Comparative Medicine 44: 19-23.

59 Jansen J., Wessels R., Lam T.J.G.M. (2015) How to R.E.S.E.T. farmer mindset? Experiences
https://www.researchgate.net/ publication/264340019_How_to_RESET_farmer_mindset_Experiences_from_The_Netherlands
Behavioral change among dairy farmers is achieved by combining strategies. The R.E.S.E.T. model is an adaptation of the model of Van Woerkum et al. (1999) and Leeuwis (2004). The strategies are Regulations (R), Education (E), Social pressure (S), Economic incentives (E) and Tools (T).

60 Of the most underexposed factors, it is still unclear what the effect on longevity exactly is. And sometimes we only know from other animal species or the adult cows what the impact of a factor on longevity is. For example, with the mobility factor. Lameness is one of the three main reasons for removal of dairy cows. For proper development of bones and muscles, sufficient movement and free movement at a young age are necessary (Barneveld and Van Weeren, 1999; Arnemann, 2003). Insufficient movement also has consequences for the functioning of the brain and overall health (Scherder, 2014). This requires a critical look at current (individual) housing systems, in which there is often little space for free movement. At the moment there is on-going research into the effect of movement on health and physiology in adult dairy cows (Ouweltjes, 2015).

And: Barneveld and Van Weeren (1999) and Arnemann (2003): Barneveld and Van Weeren (1999) found in their research in 43 foals that lack of exercise in general led to a delayed development of the muscles and skeleton.
Arnemann (2003) found a significantly higher heart rate and lactate values in boxed horses compared to free running horses. This supports the hypothesis that more freedom of movement leads to better endurance.
https://books.google.nl/. https://books.google.nl/

And: Scherder E. (2014) Laat je hersenen niet zitten. Singel uitgeverijen. Amsterdam, p.232.

And: Ouweltjes W., 2015. Gezond bewegen voor een lang leven. Lopend onderzoek. https://www.wageningenur.nl/nl/project/Gezond-bewegen-voor-een-lang-leven-2.htm

61 Lorenz I., Mee J.F., Earley B., More S.J. (2011) Calf health from birth to weaning. I. General aspects of disease prevention. Irish Veterinary Journal, 64:10, http://www.irishvetjournal.org/content/64/1/10.

And: Cummins C., Berry D.P., Sayers R., Lorenz I., Kennedy E. (2016) Questionnaire identifying management practices surrounding calving on spring-calving farms and their associations with herd size and herd expansion. Animal, 10:5, pp. 868-877.

Colophon

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Liability

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