

## CALVES NUTRITIONAL MANAGEMENT AND GROWTH IN DAIRY FARMS LOCATED IN PARMA PROVINCE

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### SUMMARY

A good management of dairy farms must include an efficient replacement calves nutritional plan, in order to improve their physiological development and productivity and to enhance herd profitability.

The present survey involved 120 dairy operations located in Parma province where data regarding colostrum phase management, liquid feeding program, health status of calves and heifers reproductive performances have been collected. Moreover, a total of 78 calves from 6 farms (2 small, 2 middle and 2 large) were monitored with the aim of to evaluate growth performances during the first 90 days of life.

A poor colostrum phase management, generally characterized by lack of colostrum quality test and colostrum bank, was observed. This probably led to failure of passive immunity transfer, with high incidence of diseases. Milk replacer seems to be the main liquid feed for calves in small (61%), middle (69%) and large operations (55%). However, its use appears related to high incidence of diarrhea episodes in calves, which affects more than 50% of animals in small (56%), middle (51%) and large (57%) dairy farms. Respiratory diseases are more frequent in large farms calves, than in small ones (21% vs 7%) in analogy with mortality (16% vs 8%).

Weaning age resulted of about 3 months in small and middle farms, while appeared within 2 and 3 months in large farms. Age at first calving about 28 months leading to a reduction in replacement efficiency. Estimated average growth rate was which, resulted 0.570 Kg/d during the first 90 days of life, could potentially support first calving at the age of 24 months, allowing for optimization and strong economization of the replacement process.

### Key words:

calves, weaning, growth rate, milk replacer, starter feedstuff

### RIASSUNTO

Una buona gestione dell'allevamento della bovina da latte deve comprendere un efficiente piano di nutrizione dei vitelli destinati alla rimonta, al fine di migliorare il loro sviluppo fisiologico e la loro capacità produttiva nonché aumentare la resa della mandria.

La presente indagine ha coinvolto 120 aziende situate in provincia di Parma presso le quali sono stati raccolti dati relativi la gestione della fase colostrale, il programma di alimentazione latte e lo stato di salute dei vitelli, nonché le performances

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riproduttive delle manze. Una ulteriore serie di osservazioni è stata inoltre effettuata su un totale di 78 vitelli individuati presso n. 6 aziende di vacche da latte (2 piccole, 2 medie e 2 grandi) con la finalità di valutare le performances di crescita dei vitelli stessi nei primi 90 giorni di vita.

A seguito delle indagini effettuate è emersa una gestione inefficiente della fase colostrale, caratterizzata generalmente da assenza di controlli qualitativi e di una banca del colostro, cui ha fatto riscontro una elevata incidenza di patologie riconducibili a un fallito trasferimento della immunità passiva dalla madre al vitello. I sostitativi del latte sembrano essere i principali alimenti liquidi somministrati ai vitelli sia nelle piccole aziende (61%), sia nelle medie (69%) e grandi (55%). Tuttavia, il loro impiego appare in relazione con una elevata incidenza di episodi diarroici, che colpiscono più del 50% degli animali nelle piccole (56%), medie (51%) e grandi (57%) aziende. Le patologie respiratorie sono risultate più frequenti fra i vitelli allevati nelle grandi aziende rispetto a quelli allevati nelle piccole (21% vs 7%), analogamente a quanto riscontrato per la mortalità (16% vs 8%).

L'età allo svezzamento è risultato di circa 3 mesi nelle aziende piccole e medie, mentre è apparso compreso fra i 2 ed i 3 mesi nelle grandi aziende. L'età al primo parto si attesta intorno ai 28 mesi. Il tasso di crescita medio stimato, risultato pari a 0,570 Kg/d nei primi 90 giorni di vita, è potenzialmente in grado di sostenere il primo parto all'età di 24 mesi consentendo una ottimizzazione ed una notevole economizzazione del processo di rimonta.

**Parole chiave:**

vitelli, svezzamento, tasso di crescita, sostitutivo del latte, mangime starter

**INTRODUCTION**

A proper management of a dairy operation should include an efficient replacement calf/heifer nutritional plan to ensure rapid development and productivity of the animals, improving herd profitability. In fact, as observed by Hutjens (2004), replacement heifers (and calves) provide the basis for profitable milking herds as a source of genetically superior cows, allow for culling of marginal cows, expand the dairy operation and/or provide a source of added revenue by selling surplus animals. The same author identifies two main types of calf weaning/feeding programs: the "Traditional Calf Feeding Program" and the "Accelerated Feeding Approach for Young Calves". The first one is characterised by the administration of colostrum during the first 24-48 hours of life, followed by milk replacer or whole milk at 8 to 10% of the calf body weight (0,45 Kg of milk solids), until calves consume 0.7 Kg of starter (18 % Crude Protein). Average daily gain should range between 0.2 and 0.5 Kg/d and it will increase over 0.7-0.8 Kg/day after three months of age, when calves are offered a 16% crude protein ration. After weaning, calves are fed only starter and forage is offered only when calves consume more than 2 Kg of concentrate. Based on Cornell (Van Amburgh et al., 2001) and Illinois (Davis and Drackley, 1998; Drackley, 2001) studies, the "Accelerated growth" approach induces gains between 0.9 and 1.4 Kg per day, feeding calves higher levels of a higher protein milk replacer. This

improves bone and lean mass growth such as the efficiency of the immune system. Weaning age goes from 40 to 50 days (Van Amburgh et al., 2001; Leismeister and Heinrichs, 2005; Hutjens, 2004) in both Traditional and Accelerated approach. However, as reported by Van Amburgh and Tikofsky (2001), the accelerated approach must be used in the specific replacement heifer management milestone of age at first calving (AFC), which implies management goals such as a target weight and age at which a group of heifers is to be confirmed pregnant. Age at first calving has been indicated as the single most important variable influencing cost associated with raising replacements and heifers (Cady and Smith, 1996), which constitutes 15 to 20% of the total costs of dairy farms. It should be noted that age at first calving is affected by nutrition (Accurate nutrient supply, affecting Weaning weight, Prepuberal growth rate, Breeding weight, Growth rate during pregnancy, Calving weight, Body condition) and other factors such as Birth weight, Disease (through first lactation), Maintenance requirements, Heat detection and Conception rate. Weaning weight is affected by the weaning program and affects in turn prepuberal feeding protocol if growth is targeted. After the publication of Van Amburgh's data, the NRC (2001) indicates the "Target Growth System" as a management tool to raise calves and heifers. According to the Target Growth System, heifers should reach 55% of mature weight at first pregnancy, and first post calving body weight should be about 85% of mature weight to maximize first lactation yield (Van Amburgh et al., 1998). Other authors (Zanton and Heinrichs, 2005) showed that Average Daily Gain should be about 800g between 150 and 320 Kg of Body Weight, in order to obtain best performances.

Colostrum is an excellent source of nutrients and immune proteins that convey protection to the neonatal calf. As colostrum is so important to newborns, producers must often make provision to have a source of colostrum available when the dam doesn't provide enough high quality colostrum for the calf. Therefore, storage of colostrum is necessary. The two most common means of storing colostrum are refrigeration and freezing (Quigley, 2001a).

To manage with colostrums provision, we need to test if colostrum has enough antibodies to protect newborn calf against the pathogens to which it will be exposed. One practical and fast method of estimating colostrum quality is to use a device called a colostrometer. The colostrometer measures the specific gravity of the colostrum and estimates total gamma globulins on the basis of a statistical relationship. The colostrometer has been widely used to estimate IgG concentration in colostrum (Quigley, 2001b).

Calves mortality in the first 3 months of life has been reported to be higher in larger farms (Hartman et al., 1974), varying between 13.3% of smaller dairy farms and 33.4% of larger operations. In a study conducted on 4528 calvings, Johanson and Berger (2003) found a perinatal mortality (first 48 hours of life) of 7.1%. They demonstrated this mortality being related to various factors such as first calf heifer (2.4 times more death), dystocia (2.7 times more death), poor management, season (winter increased death probability by 36%), birth weight (calves weighing more than 42 Kg had higher probability to die) and gestation length (shorter gestation length increased the probability of perinatal mortality). The most recent survey by the United States Department of Agriculture (USDA-2002) places overall preweaning mortality

at 8,7 %, of which approximately two-thirds is due to scours and one-quarter due to respiratory diseases.

During the first few weeks of life, when calves are typically fed whole milk or milk replacer, is also the time when calves experience episodes of diarrhea, often caused by infectious organisms such as Rotavirus, Enterobacteriaceae, *Escherichia coli*, *Cryptosporidium parvum* or *Salmonella* spp. (Quigley, 2007; Ambrosim et al., 2002). As reported by Ambrosim et al. (2002), diarrhea is the major cause of death among calves throughout the world. The causative agent may proliferate in the intestinal tract alone or in combination with another organisms. The published data on the subject are not particularly clear as to whether amount or concentration of liquid feed (milk or milk replacer) might induce or predispose diarrhea. Some very early researches, especially with lower quality calf milk replacer used in the 1950's and 1960's, suggested that increased calf milk replacer feeding often resulted in increased diarrhea. This might be related to the relatively poor technology used at that time to process dry milk ingredients that were used in milk replacer formulations. Quigley (2007) suggests that there have been cases where feeding additional milk or milk replacer have resulted in increased incidence of "loose feces" or, in some cases, in incidence or severity of diarrhea. However, the research indicates that loose feces is not necessarily related to increased milk replacer feeding, but may be related to amount of liquid feed, the composition of the diet, and many other factors, such as the degree of microbial contamination in the environment.

According to Virtala et al. (1996a, 1996b), respiratory diseases in pre-weaning dairy replacement is second only to diarrhea as a cause of morbidity and mortality. As previously reported, respiratory diseases are responsible for approximately 1/4 of calves mortality. They are caused by viral agents such as BRSV, BVDV and PI3, alongside bacterial agents such as *Mannheimia haemolytica*, *Pasteurella multocida*, *Haemophilus somnus*, *Arcanobacterium pyogenes* and *Mycoplasma* spp, sometimes in combined infections.

In Parma province, calf/heifer management is still left to farmer experience and is still substantially unknown. There are not data regarding weaning protocols adopted by farmers, and only a few informations regarding heifers management efficiency. The aim of this study was to observe the nutritional management and growth performances of calves raised in Parma province, in the attempt to verify the potential to improve the efficiency of replacement animals management.

## **MATERIALS AND METHODS**

The study, conducted in summer and fall 2006, was developed through the observation of a total of 120 of small (<50 milking cows), middle (50 to 100 lactating cows) and large (>100 lactating cows) dairy farms located in Parma province. Dairy operations were visited once and farmers were asked to complete a questionnaire (fig. 1) regarding colostrum phase management, liquid feeding program, health status of calves and reproductive performances of farm heifers:

- Colostral phase management: colostrum quality testing, availability of a

colostrum bank;

- Liquid feeding program: administered liquid feed (whole milk, milk replacer or mix), weaning age;
- Health status: respiratory diseases; enteric diseases; mortality;
- Reproductive performances of farm heifers: age at first calving.

During the same period, growth process of a total of 78 calves coming from 2 small, 2 middle and 2 large dairy farms was monitored using an electronic scale (Tassinari Bilance, mod. TE1000L). All the farms were applying the weaning program advised by the feed industry furnishing the milk replacer. Animals were periodically weighted, after 10 hours of fasting, from birth to the age of 90 days. Every animal was weighted a minimum of 3 times and a maximum of 9 times. Growth curve equation was obtained from a total of 319 observations; average weight at birth, average weight at 40, 60 and 90 days of age and growth rate at the same intervals were then estimated to describe growth process of observed animals.

## RESULTS AND DISCUSSION

The results of this study are summarized in table 1. More details are reported in Tables 2, 3 and 4. Colostral phase management seems to be similar in small, middle and large dairy operations and it is characterized by absence of colostrum quality testing and colostrum bank. This could increase the frequency of failure of passive transfer in calves with higher prevalence of diseases and higher neonatal mortality (Quigley, 2001a, 2001b, 2001c). Liquid feed administered during weaning period was mainly milk replacer in small farms (61%), while milk replacer was used as alternative or together with cow milk in 29% of small dairy farms. Whole milk was the only liquid feed administered only in 10% of small operations. Also in middle dairy farms milk replacer was the main liquid feed administered to calves (69%) followed by milk replacer + whole milk (17%) and whole milk alone (14%). A lower percentage of large farms used milk replacer alone to feed calves (55%), with an increased frequency of milk replacer + whole milk use (26%) and whole milk administration (18%). Weaning age was higher than 3 months for both small and middle operations, while was lower, resulting between 2 and 3 months for smaller farms. Health status was determined on the bases of the frequency of respiratory and enteric diseases and mortality reported by the farmers. In all dairy farms, enteric diseases appeared to affect about 40 to 50% of calves, being 49, 44 and 45% respectively for small, middle and large operations. The use of milk replacer appears to be positively related to the prevalence of enteric diseases in all kind of operations. When milk replacer was used, enteric diseases affected more than 50% of the animals in small (56%), middle (51%) and large (57%) dairy farms. This parameter was around 40% in small and middle farms when whole milk alone or whole milk mixed with milk replacer were used. According to Quigley (2007) this high prevalence of enteric diseases could be related to the frequent use of economic milk replacers or improper milk administration practices, to a poor immune response, or high environmental microbial contamination. In large dairy operations the lower and the higher prevalence of enteric diseases were

recorded in correspondence of whole milk and milk replacer respectively. Respiratory diseases appeared increasingly important with the increase of farm dimensions. The prevalence of respiratory diseases was 7% in small, 16% in middle and 21% in large farms.

Age at first calving was over 30 months in the 44% of heifers raised in small farms (only 15% of the animals calves between 24 and 26 months of age), while was lower in middle and large farms (26-28 months). According to the National Animal Health Monitoring System (NAHMS) dairy survey in 2002 (USDA, 2002), 25.4 months is the average age at first calving in the U.S. dairy herds. Of the 44% operations that are calving heifers at less than 25 months of age, about 22% are calving heifers at less than 24 months. Altogether 58% operations calve in heifers younger than 26 months of age, but the 10% that are calving heifers older than 30 months skew the average upward. This 10% represents a major loss of money for the dairy operation. These observations show how in Parma dairy farms there is still a big margin to improve replacement efficiency.

**Table 1:** Summary of the observations

	<i>Small farms</i>	<i>Middle farms</i>	<i>Large farms</i>	<b>General</b>
<b>Colostrum quality testing</b>	No	no	no	no
<b>Colostrum bank availability</b>	No	no	no	no
<b>Main type of milk administrated</b>	Milk replacer (61%)	Milk replacer (69%)	Milk replacer (55%)	Milk replacer (62%)
<b>Enteric disease</b>	49%	44%	45%	46%
<b>Respiratory disease</b>	7%	16%	21%	15%
<b>Mortality</b>	8%	12%	16%	12%
<b>Weaning age</b>	> 3 months	> 3 months	2-3 months	> 3 months
<b>Age at first calving</b>	> 30 months	26-28 months	26-28 months	28 months (26-28 months)

Lower age at first calving is economically advantageous to producers who maintain ownership of their heifers. By modeling discounted income over feed costs at various ages for heifers that calved at different ages, Lormore (2005) showed a cumulative income over feed cost advantage maintained across the first lactation (and herd lifetime) for heifers calving at 22 vs. 24 months of age. Lower calving ages also increase the asset turnover ratio and financial efficiency of the operation since fewer replacements are needed at any given time to meet its internal replacement needs. Reducing age at first calving means heifers are generating cash sooner and fewer replacements are needed to maintain herd size (Lormore, 2005). Based on the data obtained in Parma survey, reducing age at first calving from an average of 28 months to an average of 24 months could reduce the replacement animals needed of about 14%.

**Table 2:** Weaning age and Age at first calving in small, middle and large dairy operations

	<i>Small farms</i>	<i>Middle farms</i>	<i>Large farms</i>
<b>Weaning age</b>			
< 2 months	15 %	7 %	8 %
2 – 3 months	36 %	31 %	55 %
> 3 months	49 %	62 %	37 %
<b>Age at first calving</b>			
24 - 26 months	15 %	21 %	20 %
26 – 28 months	31 %	36 %	42 %
28 – 30 months	10 %	14 %	13 %
> 30 months	44 %	29 %	21 %

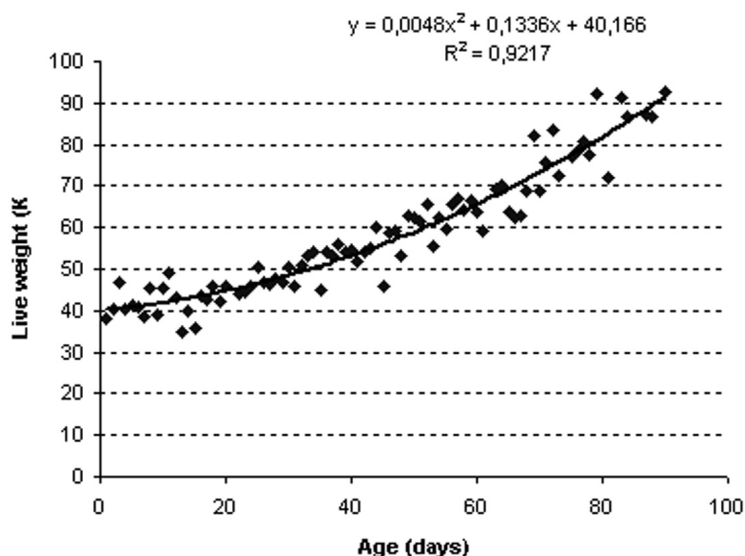
**Table 3:** Enteric and respiratory diseases in small, middle and large dairy operations

	<i>Small farms</i>	<i>Middle farms</i>	<i>Large farms</i>
<b>Enteric disease</b>	49 %	44 %	45 %
<b>Respiratory disease</b>	7 %	16 %	21 %
<b>Mortality</b>	8 %	12 %	16 %

**Table 4:** Use of whole milk or milk replacer in small, middle and large dairy operations

	<i>Small farms</i>	<i>Middle farms</i>	<i>Large farms</i>
<b>Whole milk</b>	10 %	14 %	18 %
<b>W. Milk + M. replacer</b>	29 %	17 %	26 %
<b>Milk replacer</b>	61 %	69 %	56 %

Growth performances of calves are represented in Figure 1 were the growth curve, obtained from a total of 319 observations, is reported. The best fitting function ( $R^2=0.9217$ ) of the data points was a polynomial equation used to calculate the general growth curve such as to estimate the other growth parameters. Estimated average weight at birth was 40.17 Kg, while was 53.19, 65.46 and 91.07 Kg respectively at 40, 60 and 90 days of age. At the same intervals, estimated cumulative ADG were 0.33, 0.42 and 0.57 Kg/d, resulting in ADG of 0,61 Kg between 40 and 60 days and 0.85 Kg/d between 60 and 90 days of age. These growth rates appears to be similar to those indicated as regular adopting a traditional calf feeding program (Hutjens, 2004). However these growth performances are obtained using an higher quantity of milk, being the observed animals weaned at over 3 months of age. This represent a loss of money for dairy operations.

**Figure 1:** Calves growth curve during the first trimester

Assuming a mature weight of 680 Kg, first calving weight should be about 578 Kg. Observed calves appear to weight approximately 91 Kg at 90 days of life. To give first calving at 24 months they should growth 0.773 Kg/d from the age of 3 months to the age of 24 months. Based on data from Zanton and Heinrichs (2005), this average daily gain is very close to optimal for first lactation yield maximization.

**Table 5:** Average Daily Gain (ADG) of observed calves

<i>Age (d)</i>	<i>Estimated BW (Kg)</i>	<i>Estimated ADG cumulative (Kg/d)</i>	<i>Estimated ADG interval (Kg/d)</i>
0	40.17	-	-
40	53.19	0.33	0.33 (0-40)
60	65.46	0.42	0.61 (40-60)
90	91.07	0.57	0.85 (60-90)

## CONCLUSIONS

Calves management and nutritional plan highly affect their development, performances and future productivity, potentially enhancing herd profitability. The lack of colostrum quality tests and colostrum banks in the observed dairy operations could lead to deficient calves immune system, predisposing to enteric and respiratory diseases. The use of milk replacer as the main liquid feed for calves appears to be

related to an increased prevalence of diarrhea, which occurs equally in all kinds of farms; respiratory diseases are indeed more frequent in large farms, than in the others.

In the observed dairy farms there is a margin to improve replacement efficiency by about 14%, being the age at first calving around 28 months. Estimated average growth rate of calves raised in the same area is typical of a traditional weaning program, and could potentially support a first calving age of 24 months, allowing for optimization and economization of replacement process.

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