ELSEVIER

Livestock Science 99 (2006) 185–195

LIVESTOCK SCIENCE

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# Converting to organic dairy farming: Consequences for production, somatic cell scores and calving interval of first parity Holstein cows

W.J. Nauta [a,*], T. Baars [a], H. Bovenhuis [b]

[a] *Louis Bolk Institute, Department of Animal Husbandry, Hoofdstraat 24, NL-3972 LA Driebergen, The Netherlands*
[b] *Animal Breeding and Genetics Group, Wageningen University, P.O. Box 338, NL-6700 AB Wageningen, The Netherlands*

Received 24 November 2004; received in revised form 19 May 2005; accepted 28 June 2005

**Abstract**

This paper aims to describe the changes prompted by conversion to organic farming for milk production and fertility of first parity Holstein cows.

Data was collected for Dutch organic farms, with a distinction made between long-standing-organic farms, converted organic farms and a reference group of conventional farms. The percentage Holstein blood in the herds, milk production (kg milk, % milk fat, % milk protein), somatic cell scores (SCS), calving interval (CI) and age at first calving (AFC) were described over time. An animal model was used to estimate the effects of conversion on different traits based on data from converted organic farms.

Milk production was lower and somatic cell counts were higher on long-standing-organic farms than on conventional and converted organic farms. Interestingly, at pre-organic farms, i.e. before their conversion, the milk production level was already lower than at conventional farms.

The estimates from our statistical analysis showed a highly significant decrease in milk yield and protein percentage due to conversion. Also fat content decreased, SCS increased and AFC increased significantly.

It can be concluded that the conversion to organic farming is a gradual process over years. Dutch farmers who decided during the late 1990s to convert to organic farming, represented a specific group of farmers distinct from conventional farmers, which was reflected by lower milk yields, milk fat percentage and protein percentage before conversion as compared to conventional farms. During conversion, significant changes in milk production, protein and fat contents and somatic cell scores took place. Age of first calving is an important difference between organic and conventional farming.
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*Keywords:* Conversion; Organic farming; Milk production; Calving interval; Somatic cell score; Age at first calving

## 1. Introduction

Converting to organic production necessitates changes in farm management which in turn can be

* Corresponding author. Tel./fax: +31 343 523860/515611.
*E-mail address:* w.nauta@louisbolk.nl (W.J. Nauta).

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doi:10.1016/j.livsci.2005.06.013

expected to have consequences for a farm's characteristics and output. By the end of the 20th century, about 3% of European farmers had converted to organic farming (SÖL, 2003) in response to a growing market for organic products. In order to plan a conversion to organic production, basic information about expected changes is required. Little information is available about milk production, fertility and health of animals that experience a farm's conversion to organic. Information that we do have is based on questionnaires (Nauta et al., 2001; De Jong and Van Soest, 2001) and studies of relatively small groups of organic herds with or without statistical analyses to account for differences in breeds and relationships between animals (Kristensen and Kristensen, 1998; Toledo et al., 2002; Kristensen and Mogensen, 2000; Bennedsgaard et al., 2003; Vaarst et al., 2003; Hovi et al., 2003). For our research we were able to use all the available production and fertility records from calvings from 1990 to 2003 at almost all organic dairy farms in the Netherlands, precluding the risk of selecting a specific group of organic farms and giving us insight into the development of production and fertility over more than a decade.

Differences between organic and conventional dairy farming can be expected due to restrictions on the use of chemical fertilizer and concentrates (EU, 1999). Organic roughage is produced without chemical fertilizer and consequently has lower energy and protein compounds (Padel, 2000). Organic farming regulations also restrict the use of concentrates and set a limit on the content of conventional ingredients in the concentrates (EU, 1999). In practice, the latter restriction will act as a financial restraint on the use of concentrates as well. On top of this, many organic farmers simply opt for a low input of concentrates from an organic point of view. With more organic roughage in the diet and a lower intake of energy and protein from concentrates, milk production is expected to decrease. It is also expected that cattle with high genetic potential for production will have particular difficulty coping with organic environments (Hardarson, 2001; Kristensen and Struck Pedersen, 2001; Nauta et al., 2001). Our interest, therefore, is directed especially at Holstein cattle.

The aim of this paper was to describe the changes prompted by conversion to organic farming, focusing on milk production traits, somatic cell score and calving interval of first parity Holstein cows in those herds.

## 2. Material and methods

### 2.1. Data and edits

The data used were 305-day milk production records and accompanying fertility records, somatic cell count records of first lactations. Data were obtained from the Dutch Herd Book and milk recording organization (NRS). The data on organic farms were identified by using the addresses of all Dutch organic dairy farms in 2002. For the organic farms also their date of conversion was known. This information was obtained from Skal, the Dutch organic certification organization for organic farming. In 2002, 472 organic dairy farms were registered with Skal. The NRS database contained production records of 404 of these farms. Data from conventional farming was collected by a random selection of 966 conventional farms. These farms were situated in the same areas as the organic farms.

The data was edited in such a way that it only contained records that would meet the criteria as described by the NRS (NRS, 2002), e.g. only records of cows with a calving between 17 and 36 months of age and days open between 30 and 250 days. Additionally, in this study we excluded data from animals which moved between farms during their lactation. We could select 46,282 first lactation records from 367 organic farms and 184,993 first lactation records from 966 conventional farms. All cows calved between January 1990 and April 2003.

Three different data sets can be distinguished:

Conventional = data from the 966 conventional farms.

Converted-to-organic = data from 325 farms that converted to organic production somewhere between 1990 and 2003, records were available from the period before and after conversion.

Long-standing-organic = data from 42 organic farms that were already organic before 1990, only records produced under organic conditions were available.

Fig. 1 depicts the distribution of data from converting-to-organic and long-standing-organic farms and shows that most farms converted in the second half of the 1990s.

To describe the changes in breed composition per calving year of conventional, converted-to-organic and long-standing-organic farms between 1990 and 2003 we used 46,282 records for converting-to-organic, 5400 for long-standing-organic and 184,992 records for conventional farming. The breed composition was calculated by adding the breed composition of each animal and dividing this by the total number of animals.

Phenotypic trends based on unadjusted data for milk production, fat and protein percentages, somatic cell scores (SCS), calving interval (CI) and age at first calving (AFC) were estimated using data from the HF breed only. Therefore we selected 1st lactation records of animals with at least 87% HF blood. This resulted in 22,184 records for converting-to-organic, 3066 records for long-standing-organic farms and 132,747 records for conventional farming.

Records for CI between first and second calving and SCS were added to these data. The average SCS per lactation were based on somatic cell counts from test day records. The average somatic cell count per lactation was estimated as the mean of all available test day somatic cell counts records. The somatic cell counts per lactation were transformed to SCS by $SCS = \log_{10}$ (somatic cell count).

Not all cows with milk production records did have records for SCS and/or CI. For SCS 19.107 record from converting-to-organic farms, 2639 records from long-standing-organic farms and 115.398 records from conventional farms were available. For CI we got 92.228 records from converting-to-organic farms, 2048 records from long-standing-organic farms and 115.058 records from conventional farms. The phenotypic trends were calculated as the averages per trait per calving year from 1990 to 2002.

The "effect of conversion" was estimated for milk production, fat and protein percentages, SCS, CI and AFC. This study was based on records from converted-to-organic farms only. In addition, only daughters of sires with at least 4 offspring were selected. This resulted in 17.389 lactation records. For SCS 15.419 records and for CI 11.992 records were available.

### 2.2. Models

We used ASREML (Gilmour et al., 1999) to quantify the "effect of conversion" to organic production. The "effect of conversion" was quantified by the variable BIO which was equivalent to the time span between calving date and conversion date, and was divided into year-classes with a range from 9 years

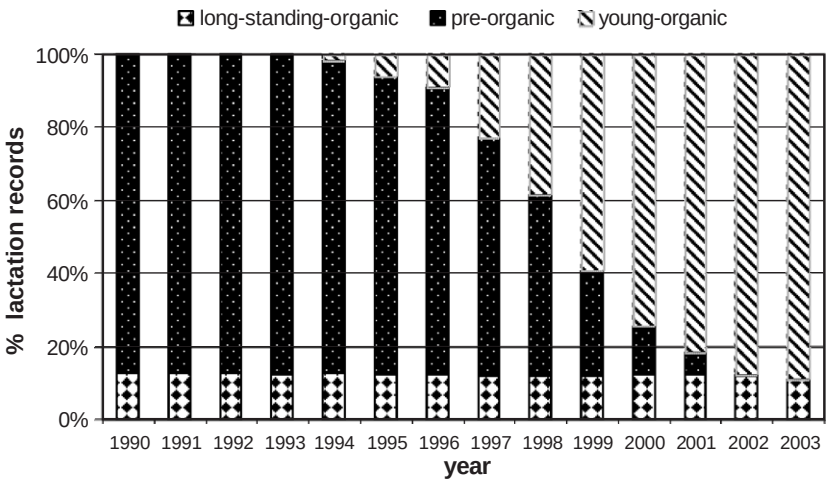


Fig. 1. Distribution of first parity records in percentages of organic farms over calving years 1990–2003 of long-standing-organic, pre-organic (organic farms before conversion) and young-organic (after conversion) farms.

before conversion to 7 years after conversion, or −9 years and +7 years, respectively. Because there was a sharp decline in the number of records per BIO-class smaller than −6 (6 years or more before conversion) and larger than +5 (5 years or more after conversion), we combined all records under −6 into a single ≤6-year class and records over +5 into a single ≥5-year class.

Production traits (kg milk, % milk fat, % milk protein) and SCS were analysed using the following model:

$$Y_{ijkl} = \mathrm{mu} + H_i + \mathrm{YS}_j + \beta_0^* \mathrm{AFC}_{ijkl} + \beta_1^* \left(\mathrm{AFC}_{ijkl}\right)^2 + \beta_3^* \mathrm{DO}_{ijkl} + \beta_4^* \left(\mathrm{DO}_{ijkl}\right)^2 + \mathrm{BIO}_k + \mathrm{Animal}_l + e_{ijkl} \quad (1)$$

$Y_{ijkl}$, trait $x$; mu, overall mean; $H_i$, fixed effect of herd $i$ ($i$=1, 254); $\mathrm{YS}_j$, fixed effect of year-season of calving $j$; the YS effect was based on 4 seasons, January–March, April–June, July–September and October–December. $\beta_0$–$\beta_4$, regression coefficients for linear and quadratic regression on age at calving in months ($\beta_0$ and $\beta_1$) and days open ($\beta_3$ and $\beta_4$); $\mathrm{AFC}_{ijkl}$, fixed effect of age at first calving $ijkl$ (in months) of animal $l$; $\mathrm{DO}_{ijkl}$, covariate days open $ijkl$ (days between calving and conception) of animal $l$; $\mathrm{BIO}_k$, fixed effect of years being organic $k$ (ranging from ≤−6, −5, . . . , 4, ≥5 years); $\mathrm{Animal}_l$, random additive genetic effect of animal $l$; $e_{ijkl}$, residual.

An animal model was used to account for genetic relationships between animals. The covariance structure for this model was:

$$\mathrm{var}\begin{bmatrix} \mathrm{Animal} \\ e \end{bmatrix} = \begin{bmatrix} A\sigma_{\mathrm{a}}^2 & 0 \\ 0 & I\sigma_{\mathrm{e}}^2 \end{bmatrix}$$

where $A$ was the additive genetic relation between animals, $\sigma_{\mathrm{a}}^2$ was the additive genetic variance between animals and $\sigma_{\mathrm{e}}^2$ was the residual variance. Pedigree information was traced back five generations and was included in the analyses.

In the analyses of SCS, phenotypic observations were weighed according to the number of test day records that contributed to the mean.

Age at First Calving (AFC) in months was analysed using the following model:

$$Y_{ijkl} = \mathrm{mu} + H_i + \mathrm{YS}_j + \mathrm{BIO}_k + \mathrm{Animal}_l + e_{ijkl} \quad (2)$$

Calving Interval (CI) between first and second calving was analysed using the following model:

$$Y_{ijkl} = \mathrm{mu} + H_i + \mathrm{YS}_j + \beta_0^* \mathrm{AFC}_{ijkl} + \beta_1^* \left(\mathrm{AFC}_{ijkl}\right)^2 + \mathrm{BIO}_k + \mathrm{Animal}_l + e_{ijkl}. \quad (3)$$

## 3. Results

### 3.1. Changes in breed composition

Holstein Friesian (HF) was the predominant breed in all subsets (see Fig. 2). On organic farms, the average fraction of HF blood in first parity cows increased from about 60% in 1990 to about 82% in 2002. The fraction of HF blood was approximately 12% lower on organic farms compared to conventional farms. The increase of HF blood at organic and conventional farms occurred mainly at the expense of two traditional Dutch breeds, Dutch Friesian (DF) and Maas-Rijn-IJssel (MRY). After 1998, the HF fraction on organic farms stabilized at about 82%. In 2002, the long-standing-organic and converted-to-organic farms still had both about 5.0% MRIJ blood. The long-standing-organic farms did have more DF blood (4.7%) than the converted-to-organic farms (1.9%). Half of the DF cattle on long-standing-organic farms were purebred DF. Between 1996 and 2002, the contribution of other breeds on the recently converted-to-organic farms increased slightly: from 0.5% to 3.5% for Jersey; from 0.2% to 2.0% for Montebéliarde; from 0.6% to 1.1% for Brown Swiss. Most Jersey cows were pure bred.

### 3.2. Phenotypic trends in production, somatic cell count, calving interval and age at first calving of first parity Holstein cows

Fig. 3 depicts the phenotypic trends in milk production of first parity Holsteins on the different types of farms (long-standing-organic, converted-to-organic, conventional) between 1990 and 2003. In the early nineties, when most converted-to-organic farms were still conventional, first parity Holstein cows at these farms produced about 150 kg milk less than on the reference conventional farms. On long-

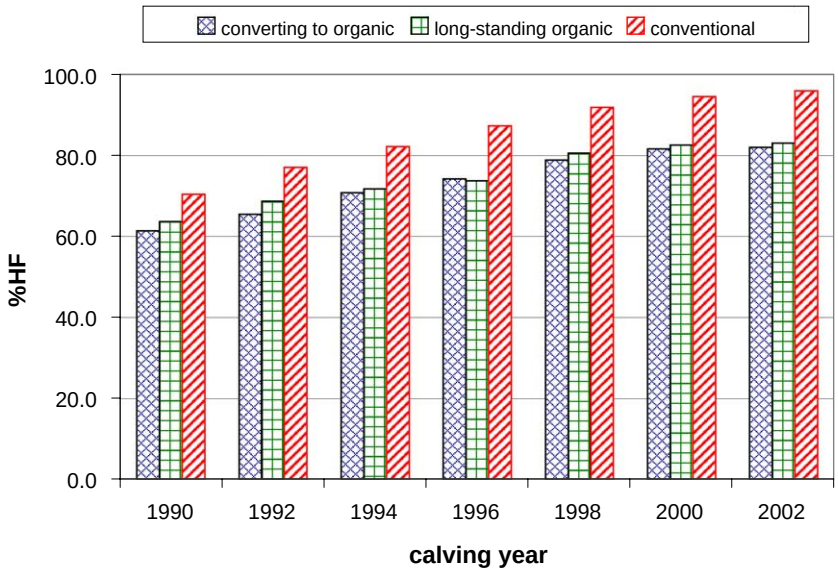


Fig. 2. Percentage of Holstein Friesian (HF) breed on conventional, long-standing-organic and converted-to-organic farms from 1990 to 2003.

standing-organic farms, first parity Holstein cows produced approximately 830 kg less milk than their conventional counterparts. In the heyday of organic conversion (between 1996 and 2001), the first parity milk production of Holstein cows on converted-to-organic farms dropped below the average production of such cows on long-standing-organic farms.

Compared to the conventional farms, long-standing-organic and converted-to-organic farms had a 0.12% and 0.05% lower milk fat percentage respectively over the years. The phenotypic trend of al groups followed a fairly steady pattern, decreasing from 4.5% in 1990 to 4.3% in 2003.

The percentage protein in the milk produced on long-standing-organic and converted-to-organic farms was respectively 0.08% and 0.04% lower than the protein percentage of conventional farms. At converted-to-organic farms, protein percentage in milk declined after conversion and stabilized at the level of long-standing-organic farms.

Based on phenotypic information, long-standing-organic farms had a higher mean somatic cell score (SCS) than conventional farms. Before conversion, the SCS on converted-to-organic farms was similar to that of conventional farms. After 1998, the difference between converted-to-organic farms and conventional farms was 0.04 points.

Between 1990 and 2001, the calving interval (CI) increased by about 23 days for long-standing-organic and 16 days for converted-to-organic farms. For conventional farms the increase in CI was about 12 days.

From 1991 onwards, Holstein cows on long-standing-organic farms had a higher age at first calving (AFC) than on conventional or converted-to-organic farms. Between 1997 and 2002, when most farms converted to organic, AFC at these converted-to-organic farms increased from 26 to 27 months while AFC of conventional farms stayed at 26 months.

### *3.3. Effects of conversion on production, somatic cell score and fertility traits*

Fig. 4 presents the estimated "effect of conversion" (BIO) on milk production, % milk fat and protein, SCS, CI and AFC, obtained from models 1 to 3. The analysis of the data showed that BIO had significant effects on milk production ($P<0.001$), milk fat percentage ($P<0.05$), milk protein percentage ($P<0.001$), SCS ($P<0.01$) and AFC ($P<0.01$). CI was not significantly influenced by conversion.

Conversion decreased milk production in first lactations by about 1000 kg. This decline started some years before conversion. After conversion, it took 5 years before production showed no further decline.

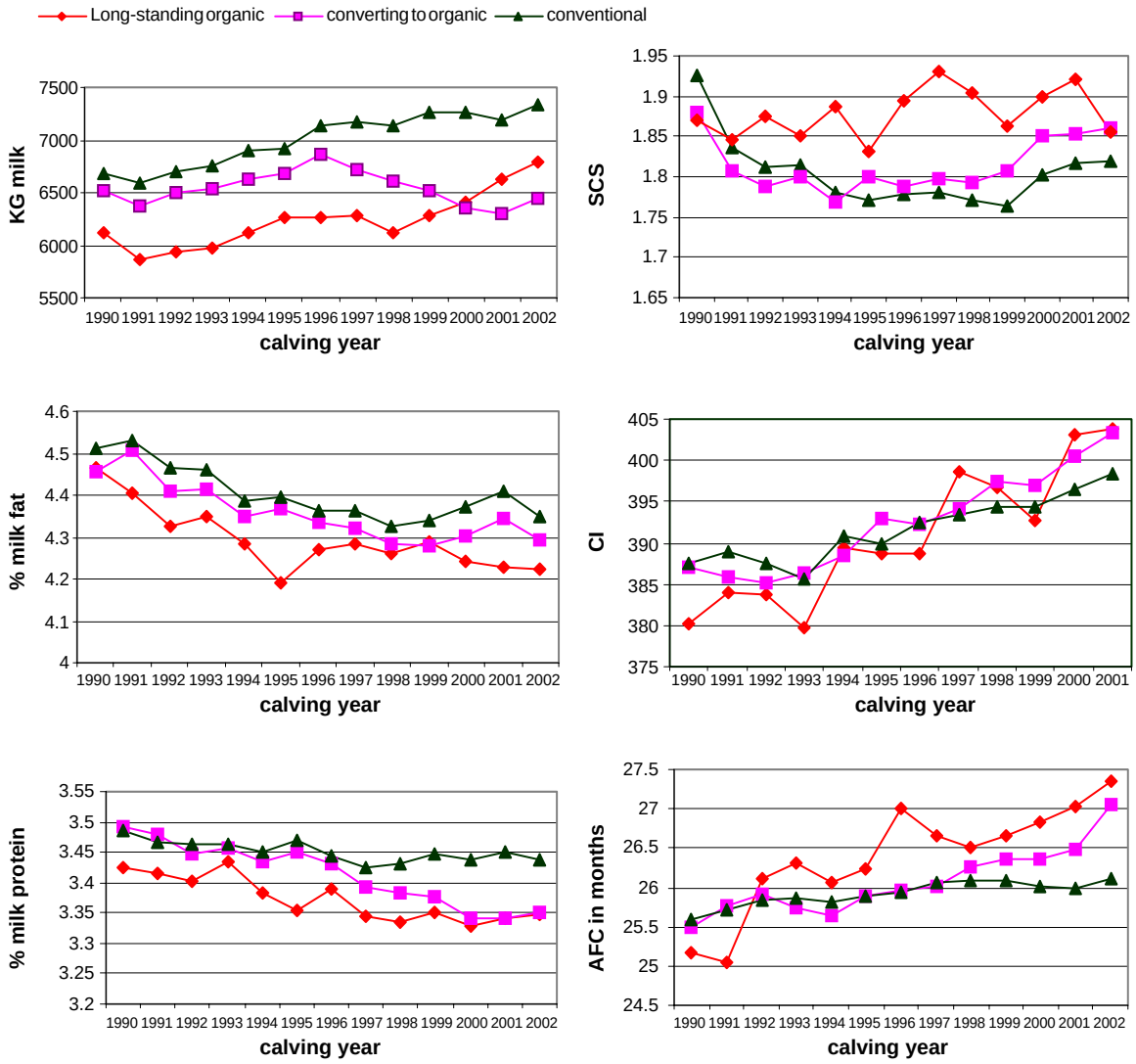


Fig. 3. Trends in kg milk, % milk fat, % milk protein, somatic cell score (SCS), calving interval (CI) and age at first calving (AFC) for first parity 87–100% Holstein cows which calved from January 1990 to 2002 on long-standing-organic, converting-to-organic and conventional farms.

The biggest decline in production occurred in the period from 1 year before to 2 years after conversion, the decline being about 790 kg.

Before conversion to organic, we found that milk fat increased. In the first 2 years after conversion the percentage of milk fat decreased with 0.04%. After 2 years of conversion the percentage fat increased again.

Before conversion, there had been a steady increase in protein level. From 1 year before to 2 years after conversion the protein level decreased 0.075%. Three years after conversion, however, protein level increased again.

SCS started to increase steadily at about 2 years before the conversion date. After conversion, SCS increased by 0.17 units. Assuming a population mean of 150.000 cells/ml, this increase is equivalent to approximately 50,000 cells/ml. Apparently, SCS continued to rise still after 6 years of organic production.

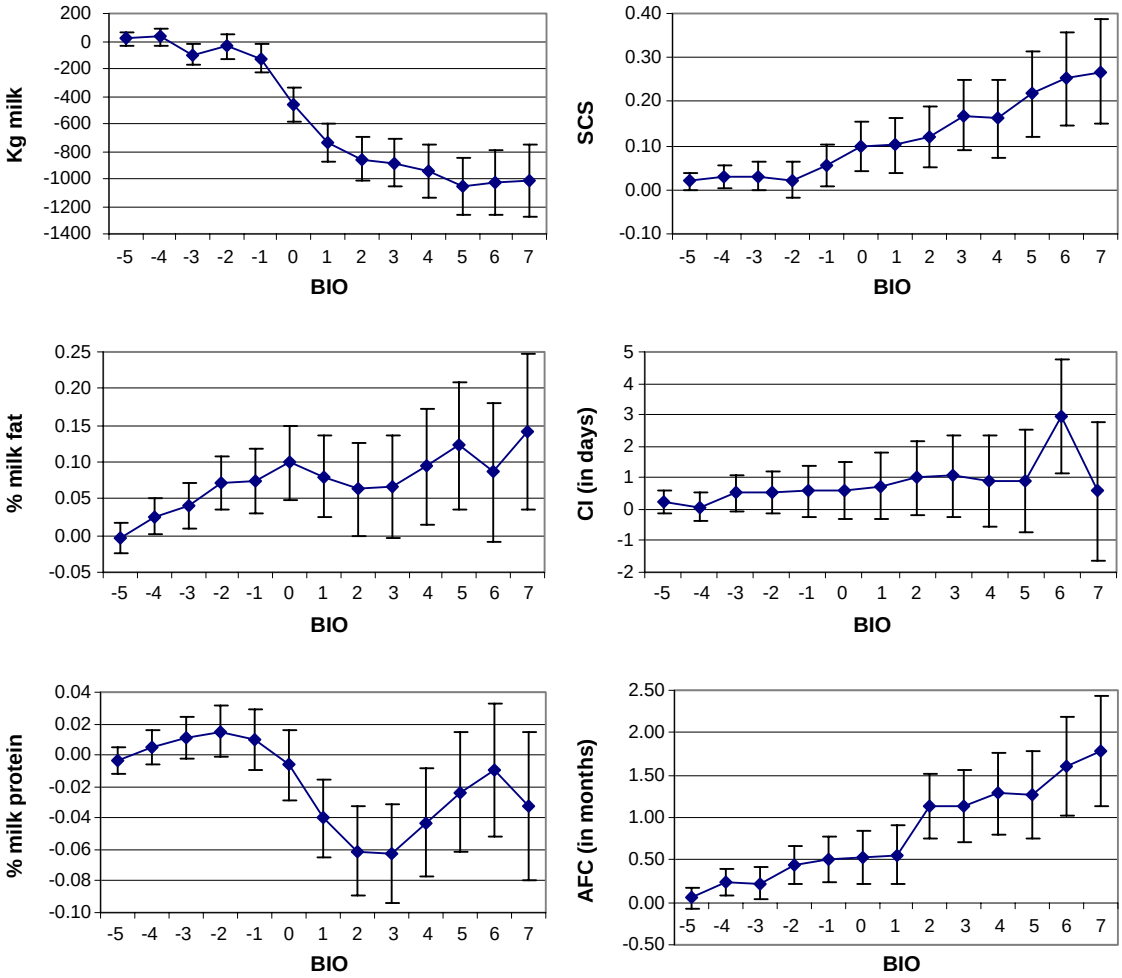


Fig. 4. Effect of conversion to organic farming (BIO) on milk production (kg milk, % milk fat, % milk protein), somatic cell scores (SCS), calving interval (CI) and age at first calving (AFC) of first parity Holstein cows. SE are shown in bars. BIO = 0 at the date of conversion to organic farming.

CI did not change due to conversion. AFC increased by 1.75 months over the total time period, with a rapid increase of about 0.75 months in the second year after conversion. The total increase after conversion was 1.3 months over a period of 7 years.

## 4. Discussion

This paper describes the first longitudinal study on breed composition, milk production, SCS and CI of organic dairy cattle. In this study we looked at the performance of Holstein dairy cattle which have a relatively high genetic potential for milk production as compared to other breeds. This might have resulted in the exclusion of certain specific farming styles, as farming style is connected with the choice of breeds and choice for crossbreeding (Groen et al., 1995). Farms with other breeds and cross-bred cows (more dual-purpose) might, for example, have a more extensive character, with a stronger accent on more robust animals and with meat production playing a role in farm income. The majority of Dutch organic farms, however, stock Holstein cattle, so that this study can be considered as representative for Dutch organic dairy farming in general.

### 4.1. Changes preceding conversion

Farms that convert to organic farming have a lower milk production level before conversion than conventional farms (see Fig. 3, between 1990 and 1996). This indicates that, on the whole, these farms represented a specific stream of Dutch dairy farms and are different from the conventional mainstream. Other researchers have described organic farmers as representing specific styles of farming, such as 'low cost farmers', extensive farmers, 'economy farmers, seeking a better income' or farmers taking care of intrinsic values of animals and production systems (Jonkers, 2000; Midmore et al., 2001, Verhoog et al., 2003).

Conversion to organic farming has mostly been described as a gradual process that takes place after conversion (Østergaard, 1997). We also looked at the years preceding conversion and found that, some years before conversion changes in milk production, SCS and AFC take place towards organic farming, indicating that farmers already seemed to be anticipating, in their management methods, a move in the organic direction (see Fig. 4). Traditionally, problems with conventional farming, especially in the areas of animal health and soil fertility motivated farmers to convert to organic production (Midmore et al., 2001). More recently, many farmers have converted both because of problems in conventional farming (BSE and FMD and dioxins in animal feed) and the economic prospects of organic farming. (Midmore et al., 2001). While considering conversion to organic, farmers might already be making changes in certain aspects of farm management, for example less use of concentrated feed and antibiotics.

### 4.2. Breed composition

Conversion to organic in general did not seem to influence breed preferences. Organic farmers continued using Holstein bulls after conversion and the trends in production were similar to conventional trends. Previously it was found that young organic farmers used the same bulls as their conventional colleagues (Nauta et al., 2001). If a serious genotype-environment interaction (Falconer and Mackay, 1996; Nauta et al., 2002) would exist, one would expect converting farmers to seek other genetics more suited for the new farm environment. But only a small group of farmers consciously chose breeds other than Holstein. The farmers were also not familiar with alternatives, in the sense of organic breeding and were very much used to selecting bulls from the conventional supply and the use of AI which they see as a very easy method (Nauta et al., 2001). Another important point is that issues of breeding are not uppermost in farmers' minds when they are making the conversion to organic. The focus was on other aspects, like grass growth and animal health (Nauta et al., 2001).

### 4.3. Effects of conversion on milk production

We found a decline in milk production in first lactations of about 1000 kg milk or 14% (Fig. 4). It is difficult to compare our results direct with other studies on milk production in organic farming. Firstly, our results were based on first lactations of relative high yielding Holstein cows and high-yielding cows will respond more strongly to conversion than low-yielding cows (Padel, 2000). Secondly we must consider that our results were estimated effects of conversion which were estimated using a model that adjusted the data for several effects. In other studies, phenotypic production levels on organic farms were found to be between 80% and 112% of production levels on conventional farms (Bennedsgaard et al., 2003; Kristensen and Kristensen, 1998; Padel, 2000; Kristensen and Mogensen, 2000; Toledo et al., 2002; Haas and Bapst, 2004; Zastawny et al., 2003; De Jong and Van Soest, 2001). The decrease of approximately 1000 kg (14%) milk production found in our study agrees with reports based on cows with similar production levels (Kristensen and Kristensen, 1998; Kristensen and Mogensen, 2000; De Jong and Van Soest, 2001; Bennedsgaard et al., 2003). Bennedsgaard et al. (2003) looked in their study also at the milk production in first lactations over the conversion period. Based on data from 18 farms which converted in 1999–2000 they found a decrease of 300 kg ECM, but after 2 years the production level at these organic farms was already nearly the same as at the year before conversion. This was not the case in the present study. This might be due to a more farm based feed production including cereals in Denmark while in the Netherlands milk production is more based on

imported conventional concentrates which are restricted by the organic legislation (EU, 1999).

The decline in milk production can be explained by the reduced input of concentrates and a lower roughage quality in terms of energy and protein content. Dutch farmers traditionally feed large quantities of concentrates and they have to drastically cut back their use of concentrates when converting to organic production. In a 4-year study of ten organic Dutch farms, the average annual concentrate consumption was found to be 1200 kg/cow, resulting in an average production of 6860 kg milk in 305 days (Plomp, 2001). Feeding less concentrates stimulates the uptake of roughage which however contains about 10% less energy/kg of dry matter (Padel, 2000). The lower milk yield achieved by organic farmers might also partly be due to a lack of knowledge among newly converted organic farmers about feeding, grazing and housing high-yielding cows under organic conditions.

Using estimates of model 1 we estimated that the 1.3 months increase in AFC in organic farming corresponded to +190 kg milk (not shown). In the "organic system" AFC increased by 1.3 months and this has a relatively strong effect on milk yield in the first lactation. The increase of AFC is probably due to energy and protein shortages in their juvenile period resulting in slower growth (Smolders, 2001). Organic farmers must deal with restrictions on the use of concentrates–which applies to the herd as a whole–and with greater variation in roughage quality (harvested from grassland and nature reserve land). In the interests of milk yield, organic farmers tend to feed the best roughage plus the available supply of concentrates to their milking cows. As a result, young stock grow more slowly and are older when they reach the standard body weight for insemination. Also parasitic infections can slow down the growth of the young animals (Hovi et al., 2003; Svensson et al., 2000) and result in an increase of AFC.

### 4.4. Composition of milk

For the unadjusted data (phenotypic trend) we found that the trend for fat percentage on converting-to-organic farms followed the trend on conventional farms which was in general decreasing (Fig. 3). The estimated effects of conversion based on our model showed a general increase of fat percentage (Fig. 4). This is probably due to the correction in the model for genetic effects (genetic trend). The phenotypic trend of the protein level dropped to the level of long-standing-organic farms.

For both the percentage fat and protein, we saw that the estimated effects of conversion, i.e. after adjusting for HYS, animal, AFC and DO, showed a decline after conversion to organic farming (Fig. 4). This decline was stronger for percentage protein than for fat percentage. Also from other studies it is known that percentage fat and protein in the milk are lower at organic farms as compared to conventional farms (Lund, 1991; Kristensen and Mogensen, 2000; Toledo et al., 2002; De Jong and Van Soest, 2001). However, Toledo et al. (2002) did not find a difference in protein level between organic and conventional farms in Sweden. The fat percentage only decreased in the first 2 years after conversion. This is probably due to the decrease in energy in the roughage and a lower amount of concentrate feeding in the first years of conversion (Padel, 2000). Overall we see an increase of percentage fat which is probably because of more roughage in the diet at organic farms (Padel, 2000). The decrease of the percentage of milk protein under organic conditions is probably a consequence of a lower input of energy at organic farms and a lower supply of proteins in concentrates. Suitable proteins are either expensive or difficult to obtain due to contamination with GMO (soybean, maize) which for that reason are prohibited for organic farming (EU, 1999). After 3–4 years of organic farming the results show an increase of protein percentage in the milk. This might be due to a more balanced forage production and stocking rate after some years of organic farming (Padel, 2000).

### 4.5. SCS on organic farms

The higher phenotypic trend of a high SCS on long-standing-organic farms (Fig. 3) and a significant effect of conversion on SCS agreed with our expectations. Restrictions on the use of antibiotics and the greater prevalence of deep litter stalls on organic farms are expected to increase SCS. Other studies, based on bulk tank scores or herd averages, also showed higher SCS for organic farming (Kristensen and Mogensen, 2000; Vaarst et al., 2003; Smolders and Baars, 2004).

Surprisingly, SCS did not stabilize after some years but increased even 6 years after conversion (Fig. 4). This suggests that, after conversion, the organic environment continues to change over several years. Older cattle which tend to have higher SCS (Smolders and Baars, 2004) might raise the environment's infectiousness, thus making first parity cows more susceptible. But farmers' attitude towards SCS can also change. Jonkers (2000) noticed that organic farmers were not anxious about slightly raised SCS, as they assumed that this was normal in an organic environment and reflected better immune activity. The latter was recently described by Van Groenewege et al. (2004). However, Bennedsgaard et al. (2003) found a significantly lower bulk tank SCS for long-standing-organic farms in Denmark. These farmers were actively trying out alternative methods to control mastitis and SCS, such as frequent milking by hand of clinical cases, drying a gland, or letting cows suckle calves (Vaarst and Bennedsgaard, 2001).

### 4.6. Calving interval

The phenotypic trends for CI on converted organic farms showed a clear increase in time. An extended CI can be the result of a longer interval between calving and first insemination due to different management decisions. CI was however not significantly affected by conversion (Fig. 4). Hovi et al. (2003) also concluded that conversion to organic did not affect the fertility status of the animals at organic farms.

### 4.7. General performance (cooping with organic)

In general, based on this study, the performance of the Holstein Friesian cows during their first lactation seems to be continued at a lower production level and an increased SCS and CI. However, the increased AFC indicates that farmers adjust their management (by inseminating the heifers at a higher age) so that the young animals reach a better body weight at the age of first calving. In this way farmers help their animals to coop with the organic conditions resulting in a higher production.

In this longitudinal study also the developments in organic farming; i.e. development in regulations, might have had an effect on the performance of cattle. Especially during the last 3 calving years used in this research, organic farmers were able to use more concentrates with conventional ingredients due to a change in the EU regulations for organic farming (EU, 1999). These concentrates are cheaper than 100% organic concentrates. However, from January 2005 onwards, organic farmers have to use complete organic feed stuff, including concentrates. This will probably result in a further decrease of the supply of concentrates and good performance of the Holstein cows will get more dependent of farmers skills and possibilities to help the animals to coop with this.

## 5. Conclusions

It can be concluded that the conversion to organic production is a gradual process and that Dutch farmers who decide to convert to organic farming represent a specific group of farmers distinct from mainstream conventional farmers, with different averages for breed composition, milk production levels and somatic cell counts in the milk. Most organic farmers in the Netherlands kept on using Holstein cattle after conversion.

During the conversion process, there were highly significant changes in milk production and protein percentages in the milk. Also fat contents and somatic cell counts in the milk changed significantly over the conversion period. Age at first calving at organic farms clearly differs between organic and conventional farming, indicating that farmers with Holstein cattle adjust their management to organic conditions.

## References

Bennedsgaard, T.W., Thamsborg, S.M., Vaarst, M., Enevoldsen, C., 2003. Eleven years of organic dairy production in Denmark: herd health and production related to time of conversion and compared to conventional production. Livest. Prod. Sci. 80, 121–131.

De Jong, H., Van Soest, Y., 2001. De biologische melkveehouderijsector in kaart gebracht. Productschap Zuivel, Rijswijk.

EU, 1999. Council Regulation No 1804/1999 of July 1999, Supplementing Regulation (EEC) No 2092/91 on Organic Production of Agricultural Products and Indications Referring thereto on Agricultural Products and Foodstuffs to Include Livestock Production.<http://www.europe.eu.int/eur–lex/en>.

Falconer, D.S., Mackay, T.F.C., 1996. Introduction to Quantitative Genetics, 4th Edition. Addison Wesley Longman, Harlow.

Gilmour, A.R., Cullis, B.R., Welham, S.J., Thompson, R., 1999. ASREML reference manual. NSW Agriculture Biometric Bulletin, vol. 3. NSW Agriculture, Orange, NSW 2800, Australia.

Groen, A.F., DeGroot, K., VanderPloeg, J.D., Roep, D., 1995. Stijlvol Fokken. Vakgroep Veefokkerij en Vakgroep Rurale Sociologie. Wageningen University.

Haas, E., Bapst, B., 2004. Swiss organic dairy farmer survey: which path for the organic cow in the future? In: Hovi, M., Sundrum, A., Padel, S. (Eds.), Organic Livestock Farming: Potentials and Limitations of Husbandry Practice to Secure Animal Health and Welfare and Food Quality Proc. Of the 2nd SAFO Workshop, 25–27 March 2004, WitzenhausenUniversity of Reading, Reading, pp. 35–41.

Hardarson, G.H., 2001. Is the modern high potential dairy cow suitable for organic farming conditions? Acta Vet. Scand. 95, 63–67.

Hovi, M., Sundrum, A., Thamsborg, S.M., 2003. Animal health and welfare in organic livestock production in Europe: current state and future challenges. Livest. Prod. Sci. 80, 41–53.

Jonkers, L., 2000. Grenzen verleggen. Tussentijds verslag van twintig verkennende bedrijfsbezoeken bij biologische melkveehouders over het celgetal en de betekenis van dit begrip. Louis Bolk Institute, Driebergen.

Kristensen, T., Kristensen, E.S., 1998. Analysis and simulation modelling of the production in Danish organic and conventional dairy herds. Livest. Prod. Sci. 54, 55–65.

Kristensen, T., Mogensen, L., 2000. Danisch organic dairy cattle production systems – feeding and feed efficiency. In: Hermansen, J.E., Lund, V., Thuen, E. (Eds.) Ecological Animal Husbandry in the Nordic countries. Proceedings from the NJF-seminar No. 303, 16–17 September, 1999. DARCOF report No. 2, Tjele Denmark, 173–178.

Kristensen, T., Struck Pedersen, S., 2001. Organic dairy cow feeding with emphasis on Danish Conditions. In: Hovi, M., Baars, T. (Eds.), Breeding and Feeding for Animal Health and Welfare in Organic Livestock Systems. Proceedings of the 4th NAHWOA Workshop, 24–27 March, WageningenUniversity of Reading, Reading, pp. 134–140.

Lund, P., 1991. Characterization of alternatively produced milk. Milchwissenschaft 46, 166–169.

Midmore, P., Padel, S., McCalman, H., Isherwood, J., Fowler, S., Lampkin, N., 2001. Attitudes towards conversion to organic production systems; A study of farmers in England. Institute of Rural Studies, University of Wales, Aberystwyth, Wales, UK.

Nauta, W.J., Baars, T., Groen, A.F., Veerkamp, R.F., Roep, D., 2001. Animal Breeding in Organic Farming. Discussion paper. Louis Bolk Institute, Driebergen, http://www.louisbolk.nl.

Nauta, W.J., Groen, A.F., en Baars, T., 2002. Breeding strategies for organic dairy cattle; genotype by environment interaction. Proceedings of 14th Organic World Congress IFOAM, Victoria, Canada, p. 95 (abstract).

NRS, 2002. Handboek NRS (Handbook NRS). Chapter E-7. Fokwaardeschatting melkproductiekenmerken. Koninklijk Nederlands Rundvee Syndicaat, Arnhem.

Østergaard, E., 1997. The Role of Learning in Farmers' Conversion to Ecological Agriculture. In Öhlmer, B., Lunneryd, D. (Eds.), Learning in Farmers' Decision Making. Report no. 116, Swedisch University of Agricultural Sciences, Report 116, Uppsala, pp. 1–10.

Padel, S., 2000. Strategies of organic milk production. In: Hovi, M., Bouilhol, M. (Eds.), Human–Animal Relationships: Stockmanship and Housing in Organic Livestock Systems. Proceedings of the 3th NAHWOA Workshop, 21–24 October, Clermont-Ferrand, pp. 121–135.

Plomp, M., 2001. Feeding of dairy cattle on organic farms in the Netherlands. In: Hovi, M., Baars, T. (Eds.), Breeding and Feeding for Animal Health and Welfare in Organic Livestock Systems. Proceedings of the 4th NAHWOA workshop, 24–27 March, Wageningen, pp. 222–224.

Smolders, G., 2001. Growth and development of young stock on organic dairy farms. In: Hovi, M., Baars, T. (Eds.), Breeding and Feeding for Animal Health and Welfare in Organic Livestock Systems. Proceedings of the 4th NAHWOA Workshop, 24–27 March, Wageningen. University of Reading, Reading, pp. 219–223.

Smolders, G., Baars, T., 2004. Udder health, an ounce of prevention is better than a pound of cure. (in Dutch) Praktijkboek 40. Animal Science Group, Wageningen University and Research, Wageningen.

SÖL, 2003. Stiftung Ökologische Landbau. http://www.soel.de/oekolandbau/europa.htm.

Svensson, C., Hessle, A., Hoglund, J., 2000. Parasite control methods in organic and conventional dairy herds in Sweden. Livest. Prod. Sci. 66, 57–69.

Toledo, P., Andren, A., Björck, L., 2002. Composition of raw milk from sustainable production systems. Int. Dairy J. 12, 75–80.

Vaarst, M., Bennedsgaard, T.W., 2001. Reduced medication in organic farming with emphasis on organic dairy production. Acta Vet. Scand., Suppl. 95, 51–57.

Vaarst, M., Thamsborg, S.M., Bennedsgaard, T.W., Houe, H., Enevoldsen, C., Aarestrup, F.M., De De Snoo, A., 2003. Organic dairy farming decision making in the first 2 years after conversion in relation to mastitis treatments. Livest. Prod. Sci. 80, 109–120.

Van Groenewege, F., Mehrzad, J., Dosogne, H., Duchateau, L., Burvenich, C., 2004. Gevoeligheid van melkkoeien met laag celgetal voor intra-mammaire infectie: immunologische betekenis van cellen in de melk. University of Gent, Department of Fysiology, biochemestry and Biometry, Merelbeke.

Verhoog, H., Matze, M., Lammerts van Bueren, E., Baars, T., 2003. The role of the concept of natural (naturalness) in organic farming. J. Agric. Environ. Ethics 16, 29–49.

Zastawny, J., Jankowska-Huflejt, H., Wróbel, B., 2003. Comparison of cattle production on organic and conventional farms in Poland. In: Hovi, M., Sundrum, A., Padel, S. (Eds.), Organic Livestock Farming: Potentials and Limitations of Husbandry Practice to Secure Animal Health and Welfare and Food Quality Proc. Of the 2nd SAFO Workshop, 25–27 March 2004, Witzenhausen, Germany, pp. 207–216.