Automatic milking: lessons from an EU project

K. de Koning

Animal Sciences Group, Wageningen University and Research Centre, P.O.Box 65,
NL-8200 AB Lelystad, The Netherlands
E-mail: kees.dekoning@wur.nl

Abstract

Since the first commercial systems appeared in 1992, automatic milking systems (AM-systems) have been installed increasingly. No other new technology since the introduction of the milking machine, has aroused so much interest and expectations among dairy farmers and the periphery. Reduced labour, a better social life for dairy farm families and increased milk yields due to more frequent milking are among the important benefits of automatic milking.

Automatic milking changes many aspects of farm management since both the nature and organisation of labour is altered. Manual labour is partly replaced by management and control, and the presence of the operator at regular milking times is no longer required. Visual control on cow and udder health at milking is, at least partly, automated. Facilities for teat cleaning and separation of abnormal milk are incorporated into the automatic system and adaptation of conventional cleaning schemes and cooling systems is needed to accommodate continuous milking. Cow management including routing within the barn and opportunities to apply grazing is altered. A high quality of management together with realistic expectations are essential for a successful implementation of automatic milking. Automatic milking systems require a higher investment than conventional milking systems. However increased milk yield and labour reduction may lead to a decrease in the fixed costs per kg milk. Automatic milking is gaining widespread acceptance and is now estimated to be in use on more than 2500 farms in over 20 countries worldwide.

Key words: *Automatic milking, AM-systems, management, milk quality, animal health, labour*

Introduction

Interest in fully automated milking began in the mid-seventies. It was initially driven by a sound technological curiosity with the growing costs of labour in Europe in mind. Since automatic cluster detachment and teat spraying had become common practise in machine milking, automatic cluster attachment became the challenge of European research and development work. Although various prototypes demonstrated its feasibility in the initial state of development, it took a decade before fully integrated and reliable automatic milking became a reality and another five years before adoption by farmers had reached a level worth mentioning. After the first introduction of AM-systems on commercial farms in The Netherlands, adoption went slowly, until 1998 (figure 1).

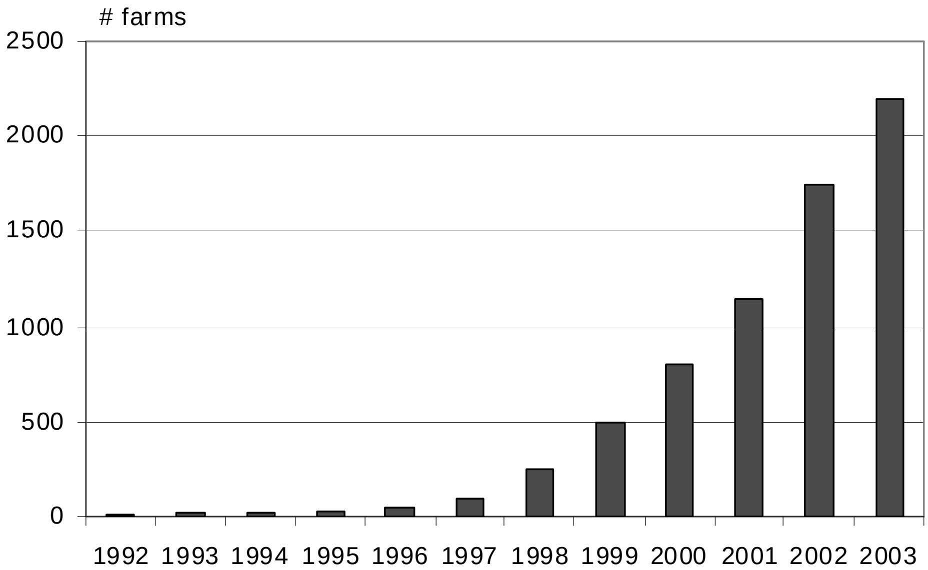

Figure 1. Number of farms using an automatic milking system upto the end of 2003 (De Koning & Rodenburg (2004).

From that year on automatic milking gradually became an accepted technology in the Netherlands and a number of other countries in the North-west of Europe. Later, farmers in central and south Europe followed, as well as in North America and Japan. Recently a few automatic milking systems have been installed in Australia and New-Zealand. By the end of 2003, worldwide some 2200 commercial farms used one or more AM-systems to milk their cows (figure 1). Over 85 % of the world's automatic milking farms are located in north-western Europe. The largest group of present adopters in Europe are middle-sized enterprises with a relatively high numbers of cows (50-100), high herd yields per hand (>700.000 kg) and consequently labour under stress (Mathijs, 2004).

Management Aspects

Switching from a milking parlour to automatic milking results in big changes for both the herdsman and the cows and can cause stress to both. Although with AM-systems immediate supervision of milking is eliminated, new labour tasks include control and cleaning of the AM-system, twice or three times a day checking of attention lists including visual control of the cows and fetching cows that exceeded maximum milking intervals. Field data on labour savings is limited. On average a 10% reduction in total labour compared with the conventional twice daily milking is assumed, but large variations between farms can be found. In the study on 107 AM-farms in Belgium, Denmark, Germany and The Netherlands (Mathijs, 2004),labour savings recorded were around 20% on average. Averages per country varied between around 11% in Denmark and almost 30% in Belgium.

However, the biggest change is the nature of labour. The physical work of machine milking, is replaced with management tasks such as frequent checking of attention lists from the computer and appropriate follow up. This work is less time bound than parlour milking, the input of labour is more flexible, which is particularly attractive on family farms. But because milking is continuous, and system failures can occur anytime there must be a person "on call" at all times. System failures and associated alarms typically occur about once in two weeks although this varies with the level of maintenance and management. For the sake of a better management support, the industry is challenged to realize improvements in the integration between milking system and heard management software, in the presentation of attentions and in the control functions of the milking system (Ouweltjes, 2004). A further improvement and development of sensor techniques for an accurate detection of abnormalities or for in-line measurements of milk composition is on the wish-list as well.

In terms of the impact on cows, the AM-system is not suitable for all cows. Poor udder shape and teat position may make attachment difficult and some cows may not be trainable to attend for milking voluntarily. In new installations, the number of cows found to be unsuitable is generally reported to be less than 5-10% at maximum. In the transition from conventional to automatic milking, cows must learn to visit the AM-system at other than traditional milking times. Training and assistance in the first weeks should involve quiet and consistent handling, so they adapt to the new surroundings and milking system.

Attitude and expectations

One important factor in successful implementation of an AM-system is the attitude and expectation of the dairy farmer (Hogeveen et al, 2001, De Koning et al, 2002, Ouweltjes, 2004). While there is considerable variation in level of satisfaction with different types of systems, an estimated 5-10% of owners have switched back to conventional technology. In some cases expectations were not realistic, in others farmers were unable to adapt to the different management style, and in some cases a high rate of failures of the AMS discouraged the farmer to continue.

During the start up period, automatic milking requires a high input of labour and management. Key factors of a successful implementation of AM-systems are:

- Realistic expectations
- Good support by skilled consultants before, during and after implementation
- Flexibility and discipline to control the system and the cows
- Ability to work with computers
- A well-adapted barn layout supporting a smooth cow traffic
- Good technical functioning of the AM-system and regular maintenance
- Healthy cows with good feet and an eager eating behaviour

Milk quality

Milk quality is a critical concern on modern dairy farms because milk payment systems are based on milk quality and consumers expect a high level of quality and safety from the milk products they buy. Although automatic milking uses the same milking principles as conventional milking, there are major differences. Results from commercial farms in Europe (Klungel et al, 2000, Van der Vorst & Hogeveen, 2000. Pomies et Bony, 2001, Van der Vorst et al, 2002, De Koning et al, 2004) and North America (Rodenburg and Kelton 2001) indicate, that milk quality is somewhat negatively effected after introduction of automatic milking. In general data show an increase in bacteria counts, although the levels are still relatively low and well within the penalty limits. A recent study (Helgren and Reinemann, 2003) determined that SCC and bacteria counts in the US were similar to conventional milked herds. Both the cleaning of the milking equipment and milk cooling are critical factors in controlling bacteria counts. Also cell counts are not reduced after the change to automatic milking, despite the increased milking frequency. With increasing milking frequency a small decrease in fat and protein percentage and an increase in the free fatty acids levels has been reported (Ipema and Schuiling, 1992, Jellema, 1986, Klei et al, 1997 and De Koning et al, 2004).

De Koning et al (2004) conclude that, although milk quality requires attention during the transition period from conventional to automatic milking, in general no serious problems are encountered afterwards (Figure 2). The observed increase in level of free fatty acids demands more research however. An increased milking frequency is not the only explanation of increased free fatty acid levels as can be seen from table 1.

The general conditions of hygiene in milk production in the EU are currently defined by the Commission Directive 89/362/EEC (1989) but not all elements apply to automatic milking (Rasmussen, 2004). The following text is proposed to be included in the coming EU Hygiene Directive: “Milking must be carried out hygienically ensuring in particular, that milk from an animal is checked for abnormalities by the milker or by a method achieving similar results and that only normal milk is used for human consumption and that abnormal, contaminated, and undesirable milk is excluded".

AM-systems have accurate cow identification and this also means less chance of human errors than in conventional milking, which might have a positive effect on lowering the presence of inhibitors in milk, as reported from North America. In this way automatic milking also potentially enhances food safety and quality.

Table 1. Initial FFA level (meq/100 g fat) and increase after passing through a conventional or an AM system (De Koning et al, 2004).

Milking system	mean initial FFA (mmol/100 g fat)	increase FFA (mmol/100 g fat)
Test 1		
Conventional	0.36	+0.04[a]
AM brand 1		+0.07[a]
Test 2		
Conventional	0.52	+0.07[a]
AM brand 2		+0.21[b]

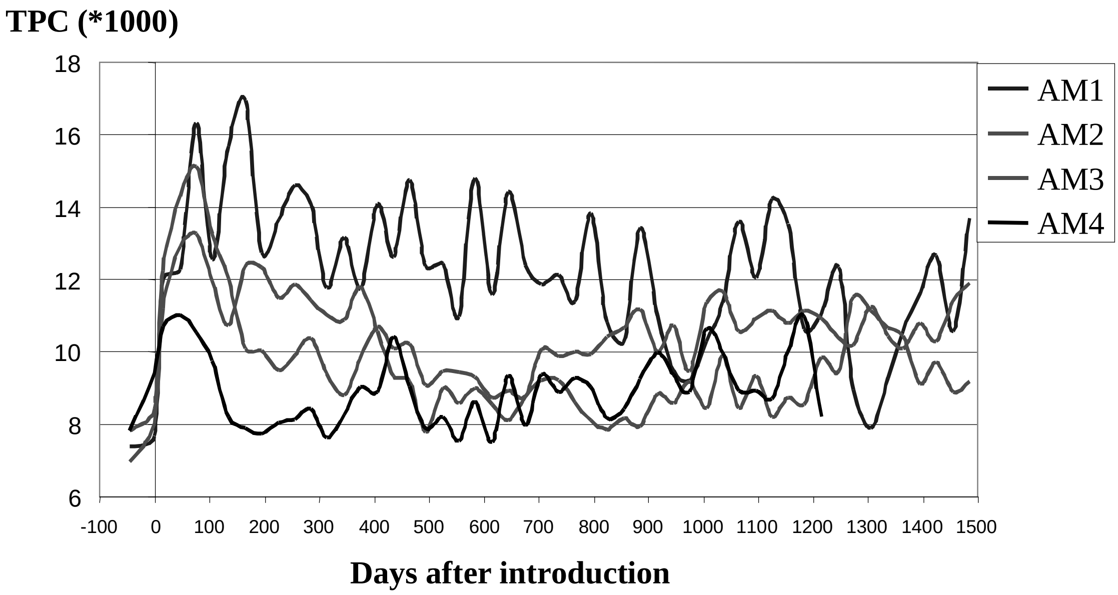

Figure 2. Course of TPC after introduction of the AM-system on Dutch farms (De Koning et al, 2004).

Animal Health

Within the EU project Automatic Milking, special attention was paid to animal health. In Denmark, The Netherlands, and the UK, 15 herds each were recruited for monitoring the impact of transition to automated milking on animal health. The herds recruited represented the types of AMS marketed in each country. Each farm was visited at least twice before installation of the AMS and a minimum of twice, but often up to six times, after installation. On these visits assessments were made of at least half of the cows or fifty animals on body condition and locomotion, and forty cows for teat condition (on some farms in the Netherlands and UK only). Farm data including milk production, milk quality, animal records on individual cow cell count, fertility, animal treatments, animal movements, veterinary purchases were collected.

The body conditions varied more between countries than in response to the introduction of AM (Hillerton et al, 2004). In Denmark and the UK there was no change in body condition between 3-6 months prior to AM installation and 6 months post installation. A slight but not significant drop occurred with the Dutch cows (Dearing et al, 2004). On the Dutch farms the range of body condition narrowed significantly from 1.35 to 0.98 points score suggesting that the farms are managing body condition better.

No change in locomotion was seen one month after AM installation. The scores in Denmark and UK increased slightly by 3 months after installation, but not significant. In the UK the average score increased on seven farms whilst unchanged on 6 farms. Scoring was continued on 12 of the UK farms. Twelve months after installation of AMS the lameness has increased significantly. Prior to installation eleven of fourteen UK herds were grazed but only six after installation. The poorer locomotion may reflect the increase in constant housing (Hillerton et al, 2004).

The overall impact of conversion to AM was assessed by comparing how each individual farm handled the main indicators of animal health during and after the transition to automatic milking. Comparing 12 Dutch farms only one farm improved in locomotion, body condition as well as cell counts. Overall, little change was apparent. Locomotion improved in five herds and deteriorated in five herds. Body condition score decreased in eight herds but only by a small amount. It increased in two herds but not making the cows any fatter, just more typical (Hillerton et al, 2004). The only major deterioration was in average milk cell count and the proportion of cows with a cell count above a threshold, where only two of the herds produced better quality milk. Average milk yield in the Dutch herds decreased in continuation of a trend starting up to 12-months prior to installation of the AMS and the cows became thinner with only a small reduction in DIM. Overall there is little evidence of major changes occurring in the common measures of fertility. None of the changes were statistically significant but all suggestive of poorer fertility, at least in the transition period from conventional milking to AM.

Hillerton et al (2004) conclude that no major problems in converting from conventional milking to AM have been identified but equally none of the 44 farms has been found to achieve a substantial improvement in any aspect of cow health. The transition period to AMS comprises a period of higher risk to health that extends from weeks before installation when resources start to be diverted from cow management.

Grazing

In most European countries, grazing during summer time is routine (Van Dooren et al, 2002); in some Scandinavian countries even compulsory. Moreover, from an ethological point of view, many consumers in North Western Europe believe grazing is essential for cows and one Dutch dairy pays a premium for milk from grazed herds. In the Netherlands grazing is common practice (>80%). However, only about 52% of the farms with an AM-system apply grazing, showing on one hand that grazing in combination with AM is less common, but on the other that it is still possible (Van der Vorst & Ouweltjes, 2003; Mathijs, 2004). In respect of capacity use of the milking system and percentage of cows to be fetched, restricted grazing systems perform better than unrestricted (Van Dooren et al., 2004). Walking distances of up to 500 meters seem to be of little influence on the frequency of robot visits.

Economical aspects

Investment required for AM-systems are much higher than for conventional milking systems and thus the fixed costs of milking are higher. However more milk with less labour means that the costs of milking per kg of milk will decrease. Theoretically, with an AM-system more cows can be kept with the same labour force than with conventional milking, but this may involve additional investments in buildings, land or feed and perhaps in milk quota. On a farm with more than one full time worker the possibility exists to reduce labour input and thus costs. Quite often that does not happen and the time saved as a result of lower labour requirement is used for personal activities. Meskens and Mathijs (2002) found that two third of AM-farmers state social reasons for investing in automatic milking, such as increased labour flexibility, improved social life and health concerns. In parts of North America, with large-size herds and numerous milkers, it may turn out that savings on labour costs may become a decisive motive to implement automatic milking.

Several simulation models have been developed to calculate the pure economic effect of investment in automated milking. The “Room for Investment” model computes the amount of money that can be invested in an AMS, without a decrease in net return compared with conventional milking (Arendzen & van Scheppingen, 2000). The RFI-value calculates the annual accumulated return from increased milk yield, savings in labour, and savings in not investing in a milking parlour and divides this by the annual costs of the AM-system. The model can use farm specific factors and circumstances to calculate the RFI-value. Figure 3 shows the results of a combined sensitivity analysis illustrating that increased milk yield and labour savings are essential factors regarding the economy of automatic milking. The RFI-value for the basic farm (700.000 kg milk, 8500 kg milk per cow per lactation, 82 cows, 75 hrs of labour per week) with 500 kg per cow yield increase, 0,75 hour net labour saving per day (~10% labour saving), compared with a automated milking parlour and 25% annual costs of the AM-system amounts 137.000 Euro. Both labour saving and yield increase have a large effect on the RFI value. Since capital costs tend to decrease while labour costs tend to increase, more widespread adoption of automatic milking in nearly all areas of the developed world would appear to be only a matter of time.

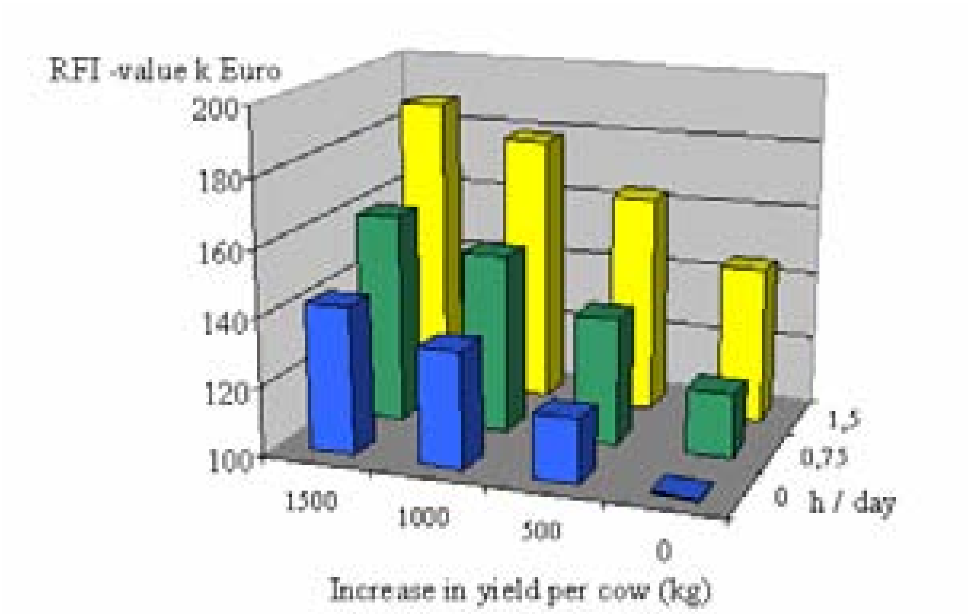

Figure 3. Room for Investment (RFI) due to labour saving and milk yield increase with annual costs for AM-system of 25% of investment. Comparison made with an highly automated milking parlour (De Koning & Rodenburg, 2004).

Conclusion

The number of farms milking with automatic milking has increased significantly since 1998. In areas where labour is expensive or in short supply, automatic milking is a promising alternative for traditional parlour milking. However if (cheap) labour is available, and particularly where herd sizes are large conventional milking, often with rotary or rapid exit parlours equipped with features to increase throughput per man- hour will be competitive.

The introduction of automatic milking has a large impact on the farm and affects all aspects of dairy farming. Because milking is voluntarily there is large variation in milking intervals. Both farm management and the lifestyle of the farmer is altered by automatic milking. AM-systems require a higher investment than conventional milking systems but increased milk yields and reduced labour may lead to lower fixed costs per kg milk. Successful adoption of automatic milking depends on the management skills of the farmer and the barn layout and farming conditions. Both conventional and automatic milking will be used on dairy farms in modern dairy countries in the foreseeable future.

Acknowledgements

The EU research project QLK5-2000-31006 ‚Implications of the introduction of automatic milking on dairy farms' was funded by the EU-program ‚Quality of Life and Management of Living resources'. The content of this publication is the sole responsibility of its publisher, and does not necessarily represent the views of the European Commission. Neither the European Commission nor any person acting on behalf of the Commission is responsible for the use, which might be made of this information. More information about this project and the project outcomes can be found at the web-site www.automaticmilking.nl.

References

Arendzen I. and van Scheppingen, A.T.J., 2000: Economical sensitivity of four main parameters defining the room for investement of AM-systems on dairy farms. In: Robotic Milking, Proceedings of the international symposium held in Lelystad, pp 201-211.

De Koning C.J.A.M., van der Vorst, Y. and Meijering, A., 2002: Automatic milking experience and development in Europe. In: Proceedings of the first North American Conference on Robotic Milking, Toronto, Canada, pp I1 – I11.

De Koning C.J.A.M., Slaghuis, B., and van der Vorst, Y., 2004, Automatic milking and milk quality. In: A. Meijering, H. Hogeveen and C.J.A.M. de Koning (eds), Automatic Milking, a better understanding, pp 311-320, Wageningen Academic Publishers, Wageningen, The Netherlands.

De Koning C.J.A.M. and Rodenburg, J., 2004: Automatic milking: State of the art in Europe and North America. In: A. Meijering, H. Hogeveen and C.J.A.M. de Koning (eds), Automatic Milking, a better understanding, pp 27-37, Wageningen Academic Publishers, Wageningen, The Netherlands.

Helgren, J.M. and Reinemann, D.J., 2003: Survey of Milk Quality on US Dairy Farms Utilizing Automatic Milking Systems, ASAE paper # 033016, St. Joseph's, Michigan USA

Hillerton, J.E., Dearing, J., Dale, J., Poelarends, J.J.,Neijenhuis, F., Sampimon, O. C., Miltenburg, J. D. H. M. and Fossing, C., 2004: Impact of automatic milking on animal health. In: A. Meijering, H. Hogeveen and C.J.A.M. de Koning (eds), Automatic Milking, a better understanding, pp125-134, Wageningen Academic Publishers, Wageningen, The Netherlands.

Hogeveen H., van der Vorst, Y., de Koning, C., and Slaghuis, B., 2001: Concepts et implications de la traite automatisée. In: Symposium sure les bovines laitiers, pp 104-120, CRAAQ, Canada.

Ipema, A.H.and Schuiling, E., 1992: Free fatty acids; influence of milking frequency. In: Proceedings of the Symposium Prospects for Automatic Milking, November 23-25, 1992, EAAP Publ. 65, Wageningen, The Netherlands, pp 491-496.

Jellema, A., 1986: Some factors affecting the susceptibility of raw cow milk to lipolysis. Milchwissenschaft. 41:553-558.

Klei, L. R., Lynch, J. M., Barbano, D. M., Oltenacu, P.A., Lednor, A. J., and Bandler, D. K., 1997: Influence of milking three times a day on milk quality, J. Dairy Sci. 80: 427-436.

Klungel, G.H., Slaghuis, B.A., Hogeveen, H., 2000: The effect of the introduction of automatic milking on milk quality. Journal of Dairy Science, 83:1998-2003.

Mathijs, E, 2004: Socio-economic aspects of automatic milking. In: A. Meijering, H. Hogeveen and C.J.A.M. de Koning (eds) Automatic Milking, a better understanding, pp46-55, Wageningen Academic Publishers, Wageningen, The Netherlands.

Meskens, L. and Mathijs, E., 2002: Socio-economic aspects of automatic milking; Motivation and characteristics of farmers investing in automatic milking systems. Deliverable D2 from EU project Implications of the introduction of automatic milking on dairy farms (QLK5 2000-31006), www.automaticmilking.nl.

Pomies D. and Bony, J., 2001: Comparison of hygienic quality of milk collected with a milking robot vs. with a conventional milking parlour. In: H. Hogeveen and A. Meijering (editors) Robotic Milking, pp. 122-123, Wageningen Pers, Wageningen, The Netherlands.

Rodenburg, J. and Kelton, D.F., 2001: Automatic milking systems in North America: Issues and challenges unique to Ontario. In: National Mastitis Council Annual Meeting Proceedings, pp 163-169, NMC, Madison, WI, USA.

Van Dooren, H.J., Sporndly, E. and Wiktorsson, H., 2002: Automatic milking and grazing, Applied grazing strategies in Europe, Deliverable D25 from EU project Implications of the introduction of automatic milking on dairy farms (QLK5 2000-31006), www.automaticmilking.nl.

Van Dooren, H. J. C., Heutinck,L. F. M., Biewenga, G. and Zonderland, J. L., 2004: The influence of three grazing systems on AMS performance. In : A. Meijering, H. Hogeveen and C.J.A.M. de Koning (eds) Automatic Milking, a better understanding, pp 292-297, Wageningen Academic Publishers, Wageningen, The Netherlands.

Van der Vorst, Y., and Hogeveen, H., 2000: Automatic milking systems and milk quality in the Netherlands. In: Robotic Milking, Proceedings of the international symposium held in Lelystad, pp 73-82.

Van der Vorst, Y., Knappstein, K. and Rasmussen, M.D., 2002: Effects of Automatic Milking on the Quality of Produced Milk, Deliverable D8 from EU project Implications of the introduction of automatic milking on dairy farms (QLK5 2000-31006), www.automaticmilking.nl.

Van der Vorst, Y., Bos, K., Ouweltjes, W., Poelarends, J., 2003: Milk quality on farms with an automatic milking system; Farm and management factors affecting milk quality. Report D9 of the EU Project Implications of the introduction of automatic milking on dairy farms (QLK5-2000-31006), www.automaticmilking.nl.

Ouweltjes W., 2004: Demands and opportunities for operational management support. Deliverable D28 from EU project Implications of the introduction of automatic milking on dairy farms (QLK5 2000-31006), www.automaticmilking.nl.