Is automatic milking acceptable in organic dairy farming? Quantification of sustainability indicators.

Oudshoorn, F.W.[1], de Boer, I.J.M.[2]

Key words: organic dairy, automatic milking system, sustainability indicator, milk quality

Abstract

The objective of this research, was to quantify sustainability indicators of organic dairy farms using Automatic Milking Systems (AMS), and a comparative group of organic dairy farms using conventional milking systems (CMS). Milk yield per cow was higher for AMS farms but did not result in higher net return to management. Nitrogen surplus per ha of available land was higher for AMS farms, Animal health was unaffected by AMS use, as also most milk quality aspects; somatic cell count, clostridium spores and urea. Acid degree value (ADV), measured as free fatty acids (FFA) in the milk, was higher in milk from AMS users. Labour time was decreased by almost 50% for AMS users, to 2.3 min/cow/day. It could be concluded from quantification of selected indicators on economy, environment, cow health, milk quality, and labour time, that the organic dairy farms using AMS, in spite of the substantial decrease in grazing time, show potential for a sustainable development.

Introduction

The use of Automatic Milking Systems (AMS) has been increasing vastly the last few years in organic dairy production in Denmark. At the end of 2005, 9% of the 480 organic herds were using AMS. This is not surprising as organic farmers have been known to be innovative, both in system approach and technology. New technology can however provoke skepticism (Meskens and Mathijs. 2002) not at least when organic markets are based on trust and integrity for product quality and production process (Torjusen et al.2004.). A rising concern was registered among stakeholders involved in the production, addressing some sustainability issues of automatic milking (Oudshoorn et al. 2007). A survey was made of literature on AMS use (Oudshoorn & de Boer, 2005), considering possible conflicts with the organic view on sustainability and these were analyzed using focus groups with stakeholders. However no data was available for only organic AMS use so theoretical extrapolation was conducted. The issues of concern comprised economic profitability, increasing eutrophication potentials, caused by too high stocking density close to the barn, milk quality and the problems of pasturing (grazing and eating fresh herbage) the herd sufficiently (Oudshoorn et al. 2007). An accepted method for validation of these issues of concern comprises (Mollenhorst and de Boer, 2006) identification and quantification of indicators. The objective of the work was to acknowledge if the identified theoretical concerns were correct, by quantifying indicators for these issues and validating them using CMS farmers and legislative thresholds as reference.

[1] University of Århus, Faculty of Agricultural Science, Institute of Agricultural Engineering, Schüttesvej 17, 8700 Horsens, DK. FrankW.Oudshoorn[a]agrsci.dk

[2] Wageningen University, Animal production Systems, Marijkeweg 40, 6709 PG Wageningem, NL.

Materials and methods

To validate selected sustainability indicators we chose to compare values of 9 organic AMS farms with 9 farms using conventional milking systems (CMS) for the year 2005. To make comparison possible, interdependent factors were avoided, like farms size and race. The issues of concern addressing sustainability were economic performance or profitability of the farm, on-farm eutrophication and biodiversity, labor, animal welfare including health, and milk quality aspects. For each of these issues we selected a set of sustainability indicators (SI's). We followed the definition of Bell and Morse (2003) who stated that an indicator should be an operational representation of a property, quality or characteristic of a system.Economic profitability was measured by quantifying financial result (i.e., gross income minus fixed and variable costs) and specifying some selected account items. Eutrophication was measured by quantifying N & P balances at farm gate and in specific fields used for grazing and mowing. Biodiversity was quantified by registering the amount of species in the selected fields. In addition the average field size was registered as field borders often give space to more diversity. Labor was registered as the average time used on tasks concerning dairy cows. Animal welfare and health were registered by selecting health indicators especially related to grazing, such as claw problems, mastitis, and reproduction, as well as the total amount of treatments (treatments per cow per year). Milk quality aspects concerning use of AMS were in the survey identified to the amount of free fatty acids (FFA), hygiene indicators and somatic cell count (SCC). Grazing itself was registered as well as direct influence on fat % and Urea content.

All results were tested for normal distribution and for variance and significant differences for the factor investigated (ANOVA).

Results and discussion

Tab. 1: Quantification of some general characteristic parameters, as average of 9 farms in each of the two groups: farmers with automatic milking systems (AMS) and farmers with conventional milking systems (CMS). Standard deviation in brackets.

Parameter	*Dimension*	AMS		CMS		
Dairy cows	*amount*	114	(34)	118	(38)	ns
Total area	*ha*	149	(63)	116	(57)	ns
Stocking rate	*LU* ha^{-1}	1.28	(0.32)	1.65	(0.68)	ns
Area available for grazing	*ha* cow^{-1}	0.29	(0.14)	0.25	(0.11)	ns

As a result of the partly structured selection of farms, the average herd size of AMS and CMS farms was the same (Table 1.). Stocking rate for CMS farms seems a bit higher, but due to large internal variation no statistically significant differences were found. Clearly the farms using AMS had higher milk yields than their organic colleagues using conventional systems (Table 2) but their profitability, shown as financial result, was not better. Surprisingly, as most economic assessment of AMS based on non organic farming systems show inferior economic performance for AMS compared to CMS farms (Meijering et al. 2004).

Tab. 2: Sustainability indicators for economic performance, eutrophication, milk quality and animal welfare and health. Average of 9 farms in each of the two groups: farmers with automatic Milking systems (AMS) and farmers with conventional milking systems (CMS). Standard deviation in brackets.

Indicator	*Dimension*	AMS		CMS		
Milk yield, delivered	*ECM cow⁻¹*	8539	(557)	7302	(880)	**
Financial result	*€ x 1000*	161	(54)	123	(69)	ns
Surplus N at farm level	*kg N ha^{-1}*	110	(29)	66	(40)	*
Surplus P at farm level	*kg P ha^{-1}*	8.8	(6.6)	3.4	(8.7)	ns
Surplus N grazing pasture	*kg N ha^{-1}*	92	(82)	166	(60)	*
Surplus N mowing pasture	*kg N ha^{-1}*	148	(79)	53	(80)	*
Average field size	*Ha*	5	(1.1)	5.3	(3.8)	ns
Plant species[1)] "graze"	*amount*	5.4	(1.3)	5.6	(2.1)	ns
Plant species "mow"	*amount*	3.4	(2)	2.4	(1.1)	ns
Labor used	*min cow^{-1}*	3	(1.2)	5.3	(1.2)	**
Sum vet. treatm. Summ.[2)]	*pr. cow*	0.48	(0.24)	0.33	(0.23)	ns
Sum vet. treatm. Wint.	*pr. cow*	0.40	(0.09)	0.32	(0.21)	ns
Culling rate	%	37	(6)	32	(5)	*
Grass uptake pasture	*kg dm d^{-1}*	5.1	(1.6)	6.9	(2.2)	ns
Grazing time	*hr y^{-1}*	968	(198)	2083	(788)	**
Somatic Cell Count	*10^3 ml^{-1}*	219	(67)	226	(65)	ns
Clostridium spores summer	*10^3 l^{-1}*	411	(661)	244	(108)	ns
Free Fatty Acids	*meq l^{-1}*	0.78	(0.16)	0.49	(0.11)	**
Applied concentrates	*Kg LU^{-1}*	7.28	(1.6)	6.25	(1.7)	ns
N balance import-export	*kg N ha-1*	8.00	(21)	-48.00	(66)	*
Available N for fertilizing	*kg N ha-1*	135.00	(26)	117.00	(48)	ns

*P value < 0.05 ** P-value < 0.001 [1)]Plant species: grass species counted as one. [2)]Sum vet treatm. summ.: the number of veterinary treatments per cow during the selected summer months (summer= Apr.-Sept.)

Surplus Nitrogen at farm level was higher on AMS farms, but in debt analysis showed that this was mainly due to larger export of farm manure by the CMS farms. The amount of concentrates used to accomplish the higher yield on AMS farms was not significant. The surplus N for grazing pastures on AMS farms was lower than for CMS farms. Explainable because the area available for grazing was the same for both groups, but the cows were outside grazing much longer for the CMS farms (Table 1 & 2). The increased time cows on AMS farms were inside resulted in higher amounts of manure collected, which could be applied on mowing fields and cash crops. No difference of biodiversity indicators was found between AMS users and CMS users. Labor time used for AMS users was dramatically lower, giving the farmer more time for other tasks, like observing the herd for possible sickness. In addition the flexibility of the labour day is larger (Meskens and Mathijs, 2002). Concerning animal health parameters, no significant differences could be registered between the two groups. It was however found that the culling rate for AMS users had a tendency to be higher. It has been reported in literature that the use of AMS provokes the culling, as some cows simply are not suitable for automatic milking (Østergaard et al. 2002). Milk quality is of major concern. Corresponding to other literature, no differences were found in SCC or Clostridium spores. However, the Free Fatty Acid (FFA) concentration in AMS milk was higher, a notorious disadvantage of AMS milking, mainly due to the higher frequency of milking (2.3 – 2.7 times per 24 hours). The absolute value of the FFA concentration is still low, in comparison to FFA values for non organic systems with AMS (Rasmussen et al. 2006).

Conclusions

Few of the selected sustainability indicators proved to be different for organic dairy farms using AMS, compared with farms using CMS. There was large variance between the farms of each group, however the production level was higher for the AMS farms. Higher feeding levels were registered for AMS farms. Animal health was unaffected by AMS use, as also milk quality aspects; somatic cell count, clostridium spores. Total grazing time per cow per year was less for AMS farms, and the free fatty acid value for AMS milk higher. However, these values were not alarming and thus organic dairy farms using AMS, show potential for a sustainable development.

References

Bell S., Morse S. (2003). Measuring Sustainability: Learning from Doing. Earthscan Publications, London.

Meijering A., Hogeveen, H., de Koning C.J.A.M. (Eds.) (2004). *Automatic milking: a better understanding*. Wageningen: Wageningen Academic Publishers.

Meskens L., Mathijs, E., 2002. *Socio-economical aspects of automatic milking*. Deliverable D2 EU Report QLK5-2000-31006. Retrieved April 2006 from http://www.automaticmilking.nl/

Mollenhorst H., Berentsen P.B.M., de Boer I.J.M., 2006. On-farm quantification of sustainability indicators: an application to egg production systems. Br.Poult.Sci. 47: 405- 417

Oudshoorn F.W., de Boer I.H.M. (2005). Survey of the sustainability aspects of Automatic Milking Systems (AMS) in organic dairy production. In: S. Cox (Eds.), Precision Livestock Farming '05, (pp. 193-199). Wageningen: Wageningen Academic Publishers.

Oudshoorn F.W., Renes R.J., de Boer I.J.M., 2008. **S**ystems in organic dairy production. J. agric environ. ethics. DOI 10.1007/s10806-007-9082-5

Torjusen H., Sangstad L., O'Doherty Jensen K., Kjærness K. (2004). European Conceptions off organic food. A review of available research. National Institute for Consumer Research, Oslo.

Rasmussen M.D., Viking L., Bjerring M., Larsen H.C., 2006. Influence of air intake on the concentration of free fatty acids and vacuum fluctuations during automatic milking. J. Dairy Sci., 89: 4596- 4605

Østergaard S., Sørensen J.T., Hindhede J. 2002. Culling strategies in herds with AMS, analyzed by stochastic models. Pages 12-23 Proc.from the first North American conference on robotic milking, Ontario, Canada. 2002.