Automatic milking systems: Characterising the farms equipped with AMS, impact and economic simulations

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Summary

In France, approximately one hundred dairy farms are equipped with automatic milking systems (AMS) and according to the manufacturers of the systems, this market is likely to expand. However, we do not have any information about these farmers and their motivations for buying an AMS. In order to characterise these farmers, nearly half of the total population (44) were surveyed. The farms surveyed are much larger (surface area and herd) than the national average. Their milk production is often in competition with other productions, which leads to labour constraints. The dilapidated state of the milking equipment meant that it almost obligatorily had to be replaced. The choice of the AMS rather than a conventional milking parlour was made in view of lightening the workload. The AMS offers greater flexibility as far as time is concerned but also has an impact on herd management: increased production per cow, zero grazing. Economic simulations show that the annual additional cost of AMS compared to a conventional milking parlour is mainly influenced by four parameters: the cost of labour, the increase in production per cow, the depreciation period and the options of the milking parlour. According to these simulations, the AMS seems more adapted economically to farms of 50 to 75 cows for a quota of 400 000 to 550 000 litres of milk. These considerations must of course be further documented in the future with new references.

Key words: *Automatic milking system (AMS), dairy farms, work, investment.*

Introduction

Dairy farmers have always been subjected to the perpetual constraint of two daily milkings at set times. The milking machine constituted technological progress, continually being improved and adapted to farmers' needs, which has considerably reduced the arduousness of their work. But today, work become a limiting factor on a large number of dairy

farms which have got bigger and more diversified in response to milk quotas (1984) and to the common agricultural policy (1992) in order to maintain their income.

The automatic milking system (AMS) may be a significant innovation as it theoretically takes charge, partly or completely, of milking as well as certain herd management functions.

This technology has benefited from more than ten years of research. Its real expansion in farming began two years ago and about 150 farms in France are now (mid 2001) equipped. But this expansion could be slowed down, among other reasons, because of insufficient information (in particular in France) concerning farmers who have invested, the reasons which pushed them to invest and the role played by the socio-economic aspects. Farmers wanting to invest in this technology therefore have trouble obtaining information and advice. It is urgent to establish some initial guidelines to help future buyers and this is the aim of our study.

Description of farms equipped with AMS

The 44 farms surveyed are situated in zones of mixed cropping and animal farming: Lorraine (9), Pays de Loire (19), Normandy (9), Burgundy (3), Brittany (4) and are distributed in the same way as all the farms equipped with AMS.

Large structures with diversified production

Overall, they are large farms, with greater surface areas and milk production than the national average (Table 1) and than their respective regional averages (RICA 1998).

However, these farms are relatively diversified since non fodder crops represent 42% of the total surface area. Before the arrival of the AMS, a little more than half the farms (55% of the sample) include at least a second animal production unit (fattening of baby beef from the dairy herd or housed rearing unit).

The fodder system is based essentially on maize silage and the systems use little grass.

Work productivity is also higher than the national average (47.7 ha of usable farm area and 177 400 litres of milk per male worker unit against respectively 34 ha and 126 000 in the RICA sample). But almost half the sample is or will be concerned by voluntary or involuntary reductions in manpower.

A desire to change equipment

The age and condition of the equipment (18 years on average) as well as standardising farm buildings as part of the Pollution from Agriculture Management Plan encouraged farmers to invest. Two thirds of the farmers would have wanted to change their equipment even if the AMS had not existed.

Table 1. Structures of the 44 farms surveyed before investing in the AMS.

	AMS 44 Farms	RICA* France 1998
Labour (male worker unit)	3.10	1.56
Including employees	*0.50*	*0.05*
Usable farm area (ha)	148	53
Main fodder area (ha)	86	44
% of usable farm area	*58*	*83*
Maize silage (% main fodder area)	38	20
Number of dairy cows	77	36
Production of milk per cow and per year (kg)	7 950	5 540
Volume of milk produced per year (l)	550 000	197 000

*Réseau d'Information Comptable Agricole OTEX 41.

The quantity of work

The dairy unit requires on average 7.4 hours of work per day, that is 2700 hours per year. Milking represents two thirds of the dairy unit's work, that is 4.8 hours per day or 1750 hours per year.

91% of farmers became equipped with an AMS because of labour difficulties and particularly to reduce the workload and have more flexibility as far as time is concerned. Few farmers (fewer than 10%) express the desire to have free time for another activity.

The purchase of an AMS therefore does not correspond to a desire for intensification, but rather to the desire to maintain the system in place without extra labour, or even fewer workers. In 16% of cases (7 farmers), the AMS "saved" the dairy unit which was in an unfavourable equilibrium with other units.

Consequences of the AMS

On average, the AMS have been set up on the farms in our sample for only 14 months.

Impact on grazing

Before the AMS, fewer than a half of farmers put their herds to graze, without any extra fodder distribution in the barns. One third practised zero grazing and 27% used a simple outdoor grazing run distributing all their ration in the barn.

After installing the AMS, zero grazing increased to half the farms. Grazing is maintained on 34% of farms, but in all cases, fodder is distributed every day at the trough.

The practice of grazing is therefore not easily compatible with AMS since the cows frequent the system less (Ketelaar-de Lauwere and Ipema, 2000).

Impact on the dairy herd

The average milk production before installing the AMS reached 7 950 kg per cow. After installing the AMS, according to the farmers, the milk production per cow and per year increased by an average of 3%. However, 55% of farmers had no variation in the production level of their herd. The installation date of the AMS may explain this point. The productivity per cow increases more for the AMS installed for longer: +3% for farms equipped for less than two years and +9% for the farms equipped for more than two years. The increase in the production per cow, for a given production quota, results in a reduction in the size of the herd. This increase in production per cow can be linked to the AMS (Hillerton and Winter, 1992) but also to a greater comfort for the animals due to adjusting or reconstructing the building.

When the AMS is put into operation, certain cows (between 5 and 10% of the herd) have to be culled due to the unsuitable conformation of their udder or also to their stance.

Attention must also be paid to grouping of calving: the AMS may be running on overload over a period, which could lead to a drop in its performances (number of milkings per cow and per day).

Impact on milk quality

An increase in the number of leucocytes was observed on some farms when the AMS was installed. This increase seems to be temporary. However, the farmer must take daily care of the cleanliness of the animals and take preventive measures and especially minimise risks of contamination by butyric spores (Pomies and Bony, 2000).

Impact on work

86% of the farmers surveyed consider that their workload has decreased (arduousness, constraints) and also, in particular, they have obtained more flexibility as far as time is concerned. On the other hand, the fact that the farmer must be able to be contacted at any hour of the day, ready to respond to an alarm if the AMS breaks down, is not considered a major constraint.

On the INRA experimental domain of Le Roc in Orcival, the AMS was timed and the results showed that the AMS reduced the duration of work by 2.5 hours per day, which amounts to 900 hours a year. These 900 hours in relation to the 1750 hours of milking per year represent a 50% time saving.

The physical arduousness of the work also decreases. The proportion of manual labour decreases considerably and is replaced largely by the task of observing the animals, by office work (consulting the listings and the data recorded by the AMS) and by technical maintenance work.

According to all accounts, the farmers must prepare themselves for a difficult period of adaptation and possibly to cope with the economic and / or human consequences.

Economic advantages of AMS

Presentation of the method.

The method which we used involves calculating partial budgets of the dairy unit. The method is similar to that used by Dijkhuisen *et al.* (1997), Favre *et al.* (1998), Arendzen and Van Scheppingen (2000). We attempt to determine the additional cost of the AMS:

$$\mathbf{S = R_{SdT} - R_R}$$

Where S = extra cost of the AMS

R_{SdT} = profit made by the dairy unit with a milking machine

R_R = profit made by the dairy unit with an AMS

With : $\mathbf{R = (MB_{al} + MB_{sl}) – (A + MO)}$

Where R = profit made by the dairy unit

MB_{al} = dairy unit gross margin

MB_{sl} = vacated area gross margin

A = annual repayments on the investment in milking machinery

MO = labour cost

We carried out simulations on three farm types (“60 DC”, “80 DC” and “100DC”) defined from our sample by selecting according to the volume of milk produced. The flock of 60 dairy cows of the “60 DC” farm type corresponds to the optimum announced by the manufacturers for a single stall robot. The 100 dairy cows of the farm type “100 DC” requires two robots of the Lely concept and three milking stalls of the Prolion concept. As far as the “80 DC” farm type is concerned, it constitutes an intermediate case which requires two stalls for the Prolion concept and two robots for the Lely concept.

Hypotheses

We placed ourselves in a situation where the farm operated at cruising speed rather than in the first year of installation which is rather disrupted. These disruptions are very difficult to calculate since they are mainly linked to individual factors.

- **Price of the AMS and price of the equipment of the new milking parlour: catalogue price**
  From 730 000 F to 960 000 F for a single stall AMS, 1 250 000 F for a two stall AMS and 1 500 000 for a three stall AMS of the Prolion concept, 1 350 000 for two AMS of the Lely concept.

  250 000 F for a milking parlour 2 x 6 (herds with fewer than 80 cows) and 350 000 F for a 2 x 10 (herds with more than 80 cows). Each time we envisaged a milking parlour without options and a milking parlour with all options in order to obtain, as far as possible, the same information as with the AMS.

- **Work on the building**
  The only difference calculated was the size of the milking block.

- **Depreciation (linear) and reimbursement of loan**
  It is difficult today to predict how long an AMS will last (rapidity of technological progress, second-hand market?). Two cases will be studied: the depreciation period and reimbursement over 7 years, and a long period of 10 years.

  The interest rate on the loans is 6% for an investment financed 100% by the loan.

- **Milk production level of the cows**
  In the case of a milking parlour, no modification in milk production is envisaged. We will study three hypotheses in the case of the AMS: no increase in milk production, a 5% increase and a 10% increase. The land areas used for fodder production which will be left free will be used for cash crops.

- **Costs linked to milk production and the selling price of milk and animals**
  The costs of milk production depending on the level of production of the cows, the prices of milk and animals are the average prices in 1999 of milk producers' groups monitored in ECOLAIT by the BTPL (766 farmers throughout France). The selling price of milk produced by the AMS is penalised by two centimes to take into account the risk linked to butyric spores.

- **Operating costs, hygiene costs and maintenance costs**
  The cost of maintenance retained is the cost announced by the manufacturers. However, as there was no reference concerning operating and hygiene costs of the AMS, we retained almost double that of a milking parlour since it would seem that the AMS consumes more energy (Artmann and Bohlsen, 2000) and cleaning products.

- **Cost of salaried labour**
  We took into account the labour costs linked to the presence of an employee who milks the cows in a milking parlour. In the case of an AMS there is no employee, it is the farmer who carries out the necessary work (various verifications, maintenance), which amounts to 1.5 hours a day (timed at the INRA farm at Orcival). The work of the farmer was not counted, it has to be remunerated by the farm's profits.

  From the milking times announced by the farmers in milking parlours, we deducted the 1.5 hours each day necessary for the AMS. It is this difference in hours worked which must be carried out in part or completely by an employee.

  We considered three cases: milking is carried out by an employee during the week and weekend (A), by an employee during the week and by the farmer the weekend (B), by the farmer during the week and an employee during the weekend and during two weeks of holidays (C).

  The hourly cost of labour corresponds to that of a herdsman paid 8500 francs net per month, which is 88.76 francs an hour, all social security costs included.

Results of the 3 types of farms

The extra cost of the AMS is minimal for the "60 DC" farm since the single stall AMS is used to its full capacity. The extra cost is maximum for the "80 DC" farm since the purchase of a second stall or a second robot, which do not operate to full capacity, leads to increased costs that the volume of milk produced does not manage to compensate for (Table 2). The volume of milk produced by the "100 DC" farm makes it possible to limit the extra cost of the AMS compared to the "80 DC" farm.

For all the types of farms, the extra cost of the AMS can be explained in large part by the difference in the levels of investment but also by the gross margin of the dairy unit which drops by about 10 centimes per litre of milk produced (selling price of milk lower because of a penalty due to butyric spores, cost of maintaining the equipment and higher costs linked to hygiene).

Five parameters have a greater influence

- **The price of the AMS, the increase in productivity per cow and the cost of labour.**
  In all cases, the AMS is only valid if an employee does the milking every day of the week. The AMS is not a good alternative for farmers looking for a lighter workload during the weekend. In this case, it would be better to employ someone to replace himself. Otherwise the extra cost represents the farmer's consent to pay for the lightening of his workload and access to this technology.

Table 2. Extra cost of the AMS (in Francs) paid back over 7 years compared to a milking parlour with all options, depending on its price, the increase in production per cow and labour.

Farm type price of the AMS	Increase in the production per cow	Type of labour replaced by the AMS (hours per year of an employee in milking parlour) Excluding labour	A	B	C
			(876)	*(618)*	*(279)*
	0	71 484	- 5 164	16 668	46 714
730 000 F	5 %	55 996	- 20 652	1 180	31 226
	10 %	41 915	- 34 733	- 12 901	17 145
60 DC					
	0	112 686	36 038	57 870	87 916
960 000 F	5 %	97 197	20 549	42 381	72 437
	10 %	83 116	6 468	28 300	58 346
			(1 194)	*(854)*	*(385)*
	0	182 121	76 166	106 351	147 872
1 250 000 F	5 %	162 782	56 827	87 012	128 533
	10 %	145 202	39 247	69 432	110 953
80 DC					
	0	206 215	100 260	130 445	171 966
1 350 000 F	5 %	186 876	80 921	111 106	152 627
	10 %	169 296	63 341	93 526	135 047
			(1 495)	*(1 069)*	*(483)*
	0	176 703	44 017	81 819	133 813
1 350 000 F	5 %	147 120	14 434	52 236	104 230
	10 %	120 226	- 12 460	25 342	77 336
100 DC					
	0	203 573	70 887	108 689	160 683
1 500 000 F	5 %	173 990	41 304	79 106	131 100
	10 %	147 097	14 411	52 213	104 207

For herds of more than 60 cows requiring a second stall or a second AMS, the extra cost brought about by this overequipping is not compensated for by the labour cost. The AMS does not seem adapted for these farms and the farmers would be better advised to invest in conventional equipment and to take on a competent and well paid herdsman. For large herds of 100 cows, the AMS may be economically interesting on condition that the milk production increases by more than 5% per cow.

Concerning the purchasing price of an AMS, our simulations show that for all types of farms, a reduction of 100 000 F reduces the extra cost by 17 900 F per year for an investment paid back over 7 years.

- **Options of the milking parlour**
  Equipping the milking parlour with all the options leads to an increase in annual repayments compared to a simple milking parlour. The extra cost of the AMS compared to a simple milking parlour is from 30 000 to 40 000 F higher than a milking parlour with all the options.

- **The depreciation period of the investments**
  Increasing the depreciation period from 7 to 10 years makes it possible to lower the annual repayments. Since investing in an AMS is more onerous, it thus benefits from a greater reduction in annual repayments in absolute value than that of the milking parlours, hence an extra cost reduced by 10 000 to 40 000 F depending on the price of the equipment.

Conclusion

Acquiring references on the motivations behind the purchase of AMS and especially on the conditions of the technical, economic and human success of its installation is essential to help future potential buyers in making a decision before investing.

The structures which have become equipped with an AMS are large structures where milk production is often in competition with other animal or plant production units. This diversity of production leads to choices in how to use labour. Labour therefore plays a major role in deciding on the investment and the issue of labour must not be considered solely from the point of view of milking but as part of an overall assessment (Dedieu *et al*. 1993).

Despite the fact that they have a higher production volume than the national average, the most suitable farms for making the AMS profitable are family structures of fewer than 65 dairy cows.

The milking parlour certainly remains adequate for a large majority of dairy farms (farms which are too small for such a large investment, grazing-based systems, farmers who are reluctant about computers…).

Some hypotheses have been put forward and time is needed to see whether they can be validated: technological innovations on the next generation of AMS and milking parlours, life expectancy of an AMS, maintenance and operating costs, second-hand market, evolution in the prices of different types of milking machinery. The more references which are available, the more potential buyers will be informed objectively and we will have a true idea of the AMS market.

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