Technical developments in machine milking and their application in Slovak conditions

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Introduction

No other machine in livestock farming has such a close biological association as the milking machine (1). In this context, the milking machine when in use has specific requirements which can be characterised as follows:

- it must complete its task in a given time without undue delay;
- it can milk the cow only if she actively co-operates, but not before let-down is induced; and
- it is instrumental in extracting and transporting a human foodstuff which can be quickly contaminated by environmental factors.

The above characteristics have always influenced the development of milking machines. Therefore their designs have corresponding features. Their development is endless because the conditions under which milking machines are used are continually changing. The main factors involved are:

- genetic improvement in the biological material;
- increasingly strict requirements with regard to the quality of liquid milk and milk products;
- the desire for a better standard of living for the breeder;
- new technical developments in milking equipment generally, e.g. in materials, hardware, software, etc.

Technical developments

The development of milking machines is, to all intents and purposes, only a little over 100 years old (1). Most of the current technology was developed in the post-war period, although there are elements which were developed in the first half of the 20th century and are still used with certain modifications today, e.g. two-chamber teat cups, and milking parlours. It is said that all dairy cows in larger herds were milked by machine after 1950. The situation was similar in Slovakia, too. After the agricultural co-operatives were established and the former large estates were nationalised, larger herds were gradually created in Slovakia (9). In the

fifties, cow sheds were built for approximately 100 dairy cows. There were usually 2 or more on any one farm. Later, mainly in the seventies, specialized farms were built already incorporating modern milking parlours. Unfortunately, or thankfully, the phases of building dairy cow farms were always undertaken after political events. Enterprising Western suppliers were able to take advantage of this and they not only supplied the latest equipment but took the liberty of performing many “prototype tests on a grand scale”. So one can say that the Slovak herds of dairy cows, especially those which were always among the first to respond to innovation, never fell behind in the application of the latest technology, particularly milking technology.

As with other equipment, developments in milking technology occurred in definite cycles. Always there arose a totally new idea which did not basically change during the next period. It was only technically and materially improved. Some components or their principles which were found out very long ago survive to the present day. Of course, there have always been attempts to bring about change in the afore-mentioned basic principles. For example, the two-chamber teat cup can be used as an illustration. Its beginning dates back to the end of 19th century. Attempts to introduce the pulsationless or hydraulic milking, three-phase pulsation, did not catch on. So today we can still see basically the same two-chamber teat cup. However, it has changed considerably according to the needs of cow milkability and available materials. Similar cycles can also be observed in milking parlour development, but within a shorter time period. It is well known that the first milking parlours had already appeared between the wars. However, their wider use was not apparent before the increase in the capacity of farms. Even now, it is not known whether the invention of milking parlours accelerated the development of loose housing of dairy cows or if the need for natural free movement of animals led the designers to the idea of milking outside the place of housing.

The adoption of milking parlours was very much influenced by the need to decrease the quantity of work involved in milking. The number of cows milked per hour per milker was at one time one of the most important parameters according to which milking machines, mainly milking parlours, were sold. The quality of milking parlours used in Slovakia was also evaluated in a similar way (6). However, there was a difference between the performance claimed by the manufacturers and the real productivity of labour. In addition to this shortcoming, there was the fact that they evaluated the number of cows milked and not the quantity and quality of milk in relation to the cost of the investment. Concentrating on the number of cows milked per hour also deprives the cows of the opportunity of satisfying their physiological needs (11).

The variety of milking parlour types was also influenced by this pursuit of increased number of cows milked per hour. At the beginning of milking parlour use, there were abreast and tandem milking parlours, later on

herring-bone, and then rotary milking parlours. All of these types are, with various modifications, still used today. We, in Slovakia, as well as people elsewhere, yielded to the trends in fashion. We tried everything. In the past, and also at present, the herring-bone milking parlours were the most widespread ones among breeders because of their simplicity and particularly their operational reliability. At the turn of the sixties and seventies, they were already being imported. Later on, the former Czechoslovakia also manufactured rotary milking parlours. Mainly at this time, it was evident that experimentation was taking place at the expense of our farms. The suppliers of the technology used various modes of drive for rotating the milking parlour platform. The aggressive environment, the shortcomings in design, but mainly the poorly-organised service and the impossibility of a substitute milking system, pushed the rotary milking parlours aside for a certain period. The numbers of dairy cows on Slovak farms determine the type of milking system, parlours being the only possible alternative at present. The most common herd size is 300-800 dairy cows in one location (3).

The biggest developments in milking technology were observed following intensification of research into the following spheres:

- hygiene in the milking process;
- physiology of milk let-down; and
- on-line measurements of parameters of the milking equipment (1).

These spheres of interest have influenced the development of milking technology up until now, and the call for new research knowledge in them still persists. First of all, knowledge on the “co-operation” of the dairy cow at milk removal, which we call let-down, is in constant demand. Therefore the organisers of this conference decided to pay great attention to this problem within the sessions.

The research institutes became involved in the development of milking equipment as late as the post-war period. Thanks to the very quick construction of large-scale farms, some original pieces of knowledge were gained which influenced the development of milking technology not only in the former Czechoslovakia but also abroad.

A very important part of the development process for milking equipment in the world was aimed at determining the optimal parameters for pulsation and vaccuum level. At the outset, and for many years thereafter, the rates in general use had been determined empirically. Therefore it was said in scientific circles that they must be checked in relation to the milkability of cows which are being dealt with at a given time (5). Ideas were also applied aimed at regulating the parameters of pulsation and vaccuum in the course of milking according to the speed of milk release. Regulation was introduced at certain critical values, and there were attempts to change the parameters continuously. The milking equipment used at present enables various changes of the pulsation parameters. There

is imported equipment in Slovakia, too, which offers the breeder the possibility of setting various lengths of suction phase. It is not possible to use it in practice because of the variability of milkability parameters in individual cows. The systems of udder stimulation by accelerated pulsation at the beginning of milking partially succeeded, although this technical solution rather extends the time of milking compared with adequate manual massage (11). At first it was believed, and it was also incorporated in milking equipment, that the level of vacuum should be set according to the speed of milking. It was expected that the increased level of vacuum would provide quicker milking. On the other hand, towards the end of milking, when milk flow speed decreased, a decrease in the vacuum level was expected to reduce the amount of stripping out required (8). The so-called „duovac“ was used in our country, too. All the systems mentioned were aimed at changing the nominal value of the vacuum. However, of greatest importance in the search for the optimum method of vacuum control at milking was the large amount of research aimed at the possibilities of greater stabilization of vacuum in the under-teat chamber of the teat cup (7; 12). The principal changes in the design of milking equipment were done on the basis of these results. The parameters of milk pipes (diameters and position), size and shape of collectors and of teat cups, etc., were adjusted. These features also appeared on the Slovak market. Fortunately, simplicity won here again. Two basic constructional adjustments proved to be the most effective for achieving stability of the operating vacuum. The first was the location of milk pipes below the level of the milking stand, and the second was adequate air inlet into the milking cluster. It is necessary also to mention the enlargement of the inner size of milking clusters (short milk tubes and collector) which was conditioned by the increasing amount of milk and milk flow.

Slovak conditions

The parameters of milking equipment should take into account the milkability of the cows which are bred in a given country at a given time. Milkability is closely connected with the genetic make-up of dairy cows. In Slovakia, there are three basic breeds at present: the Slovak Pied (Simmental), Slovak Pinzgau and Holstein and their crosses. Changes in breed structure were influenced by fashion and political changes in Slovakia as well as by the import of milking equipment. To improve efficiency of milk production and milkability, the Danish red, Ayrshire, Lowland Black and black or red Holstein breeds were successivly used in our country. A significant change in the proportion of Holstein cows has occurred over the last 10 years (2). In 1989 there were in Slovakia 121 000 dairy cows of the Slovak Pied breed, 40 000 of the Pinzgau breed and 26 000 Holstein cows. The number of the Slovak Pied breed has decreased to 36 000 cows and of the Pinzgau breed to 9 000 cows at present. There are 118 000 Holstein cows together with crosses with a high proportion of Holstein blood at present. The efficiency and milkability of cows rose in this way. However, the demands for quality of milking technology also rose.

The importance of milkability also becomes evident when using automatic cut-off milking. Automatic indicators together with automatic milking cluster take-off became a common part of the milking equipment on modern farms. However, our measurements show the different responses of the various breeds (5 - see table1). Cows of the Holstein Friesian breed and their crosses with the Slovak Pied (HF more than 50 %) have low machine strippings. There were only small numbers of cows which had greater machine stripping than 0.5 kg, measured at a critical rate of flow of 0.5 $kg.min^{-1}$. Quite high values were measured in the Slovak Pied and Pinzdau dairy cows. After automatic removal of the teat cup at a critical value of 0.2 $kg.min^{-1}$, the control hand stripping was low in the dairy breeds as well as in the Slovak Pied breed. There were problems with automatic end of milking in cows of the Slovak Pinzgau breed.

Table1. Evaluation of automatic end of milking in cows of various breeds.

	Machine stripping		Control hand stripping	
Breed	Average	Percent of herd over 0.5 kg	Average	Percent of herd over 0.2 kg
Holstein	0.17	5.0	0.08	17.5
Crosses over 50 % HF	0.21	6.6	0.07	7.4
Slovak Pied (Simmental)	0.41	23.3	0.13	11.2
Slovak Pinzgau	0.30	16.3	0.28	35.0

The effect of machine milking on eversion of the teat duct was evaluated in the breeds, too. Holstein cows and their crosses had several times greater eversions of the teat duct than the cows of the Slovak Pied breed (Simmental).

The pressure for innovation in milking technology in Slovakia, besides milkability improvement, is caused mainly by demands for milk quality. During the last 15 years the criteria for milk quality evaluation have changed several times. First, the outdated evaluation criteria (Resasurin test) were changed, and then the criteria used in EU countries were gradually made stricter. Somatic cell counts and total bacterial counts are at present the main criteria used for milk quality evaluation (10). The standards are 300 000 SCC and 50 000 BC for Q class, and 400 000 SCC and 100 000 BC for 1st class. In addition, the milk must not contain inhibitory substances. In the year 2000, milk of Q and 1st quality was produced in 92 % of herds. In herds with milking parlours and newer pipeline milking equipment, there are in use devices for automatical control of cleaning and disinfecting which positively influence milk quality.

During the last 10 years, quite a lot of modernisation has occurred on Slovak dairy farms. In 1989, only 12 % of cows were kept in loose housing and milked in milking parlours (3). At present, this figure is approximately 50 % .

After 1989, there were 18 suppliers of various makes and types of milking equipment on the Slovak market. Although their number decreased and the existence of those that remained stabilised, the previous large number of suppliers of the technology still affects the quality of maintenance of the milking equipment and consequently the quality of milk as well. We experienced a similar situation after 1968 (4). However, the market did not stabilise at that time. Equipment was left without service, and the milking technology at that time was not so reliable. A process of unification of the technology followed. On almost all farms, milking technology emanating from the former Czechoslovakia (Agrostroj Pelhrimov) was used until 1989. Servicing was performed by machine and tractor stations which created a common network of repair centres with good measuring equipment to adjust the technical set-up, and they were equipped to renovate parts. Many of the present private service companies arose from them. The only disadvantage of the compact system mentioned was the absence of competition. However, that applied to all facets of life.

At present, the level of service with respect to milking equipment depends not only on the quality of the product itself but also to a large extent on the abilities of the in-country dealer and service companies. Most of them keep to the ISO standards at installation and technical measurements are carried out using accurate equipment.

Near future

The development of milking technology has passed through a not very long but very intensive period. The latest milking technology beside automatic milking systems (AMS) has come into use on our dairy farms. Up until now, AMS have not been adopted either in our country or in the neighbouring countries with similar conditions (the Czech Republic and Hungary). Their use in our countries is limited by a number of factors: the price of milk, the price of labour and the size of farms. However, there is a possibility of research verification of AMS and other technical innovations in milking equipment. The research capacity is still present in all three countries.

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