Advanced technologies in swine reproduction

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Over the last 20 years the use of artificial insemination has become the method of choice for swine reproduction.

Through new technologies, advancements in genetics, management, buildings, and all other areas involved in raising pigs, have greatly improved our ability to feed the world.

Today, farrowing rate can average over 90% and litter size over 12.5 pigs year round, pushing sow productivity to over 30 pigs weaned per year. With these levels of performance, it becomes more and more difficult to increase productivity without careful selection of the best technologies.

EasyCyte: new generation flow cytometers specifically designed for production cen-

In addition, as industry major players spread their activity internationally, we see an increasing necessity to move genetics economically and safely (that is, without risk of spreading diseases).

Automated collection

Introduced several years ago, automated boar collection technology is now widely accepted. Today, almost 100 facilities in more than 10 countries are equipped using different systems.

The main reason for adopting these technologies is labour cost reduction, by increasing the number of boars collected per hour by a single technician (see Table 1).

However, automated collection also increases employee safety and semen quality by reducing the bacteria contamination of the semen collected.

Several experiments showed that the use of automated collection systems significantly reduces the semen bacterial count (see Fig. 1).

Low level of bacterial contamination is key to final semen quality: bacterial pollution was pointed as a cause of rapid loss of semen viability and motility in insemination doses.

Semen contaminated with high concentration was also found to be the cause of decreased sperm longevity of extended semen, and increased regular returns to oestrus and/or vaginal discharges across parity.

Semen evaluation

Over the last five years, CASA (computer assisted semen analysis) systems have gained popularity. These systems give accurate and consistent information about semen concentration, motility and morphology.

This additional information has helped the industry in improving the evaluation of the semen, therefore the quality of semen used.

Today, the use of flow cytometry to assess semen quality is making its debut in semen production centres. This technology goes one step further in semen evaluation, by actually looking into the sperm cell physiological profile.

The newest generation of those flow cytometers is user friendly and uses a very small amount of semen. These systems are compact in size and work fast. They also generate a very small amount of waste compared to the previous generation of flow cytometers.

The equipment is available along with sets of tests specifically developed for semen analysis in specific species.

Available tests automatically measure the viability of the sperm cells, the potential of the mitochondria to generate energy, the level of calcium inside the cell (one early event related to capacitation), the level of DNA fragmentation, and the level of bacterial contamination of a semen sample.

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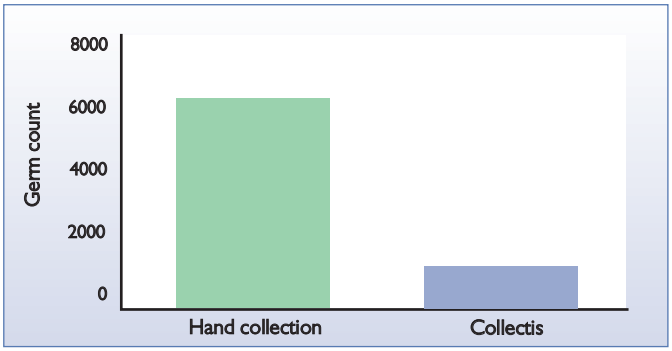
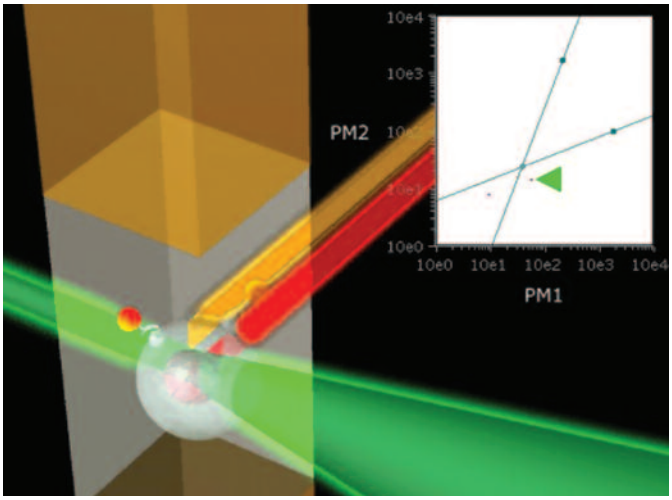


Fig. 1. Average germ count in raw boar semen when using Collectis compared to manual technique.

Table 1. Automated collection. Number of collections per hour when using Collectis compared to manual technique (Collectis automated boar collection technology, S. Barrabes Aneas, B. G. Gary, B. P. Bouvier. Journal of Theriogenology Vol 70, 8, 1368-1373, 2008).

	Manual		Collectis		Difference	
Employee ID	Number of collects	Collection/ hour	Number of collects	Collection/ hour	Collections/ hour	%
A	1,467	4.49	929	7.66	3.35	75
B	1,733	3.90	995	6.65	5.12	131
C	1,663	4.80	938	8.35	2.39	50
D	1,176	3.72	30	7.20	4.61	124
E	1,234	3.60	1,808	7.12	4.82	134
F	1,264	3.97	543	6.69	2.72	68
G	2,030	4.32	1,427	6.94	4.33	100
H	1,428	3.79	1,412	8.26	3.47	92
I	1,361	4.47	2,448	9.28	2.00	45
J	1,907	4.44	1,764	8.21	2.87	65
K	1,731	4.05	1,500	7.78	3.66	90
L	1,685	4.41	760	8.53	2.63	60
M	612	3.54	2,205	7.51	4.46	126
N	1,732	4.42	1,860	8.89	2.33	53
O	692	3.94	300	7.98	3.57	91
P	1,697	3.93	1,828	7.72	3.84	98
Total	**23,412**	**4.14**	**20,747**	**7.87**	**3.74**	**90**

Inside the EasyCyte – sperm cells travel automatically through a microcapillary system to be analysed.



Each sperm cell is analysed by several fluorescence detectors providing very accurate information.

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This type of equipment will allow the boar stud to have a lot better information on the quality of the semen, therefore providing the industry with an extra tool to:

- Improve the quality and the value of the semen produced by centres and supplied to producers.
- Screen and select the boars on their semen quality merits.

Frozen semen

Frozen semen is one technology that has been used for decades. This technology allows for preservation of valuable boars, and allows genetics from breeds not in common use today to be saved for future genetic diversity.

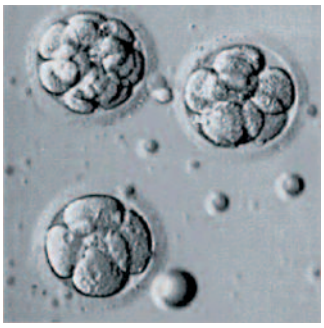
It also gives producers better access to valuable genetic material at minimised costs, and simplifies semen transportation. Because of reduced reproduction performances and higher production cost, this technology is almost exclusively used today to transfer high value genetics across borders, or for gene banking.

Several studies have shown variation between genetic lines and between boars. It is also common knowledge that boar selection prior to freezing (based on semen quality and post-thawing evaluation) has a significant impact on the reproductive performances when using frozen semen. Use of new semen analysis equipment, such as flow cytometry, could give researchers additional tools to better select boars for freezing, thus increasing results.

As pig production becomes a more global industry, a need to safely and cost effectively transfer genetics has become a challenge.

Embryo transfer

Gene transfer can be done in several ways: by live animals, fresh or frozen semen, and fresh or frozen embryos. The safest way is the use of frozen embryos as they can be washed after harvest. This technology provides the highest disease free guarantee available at this moment.



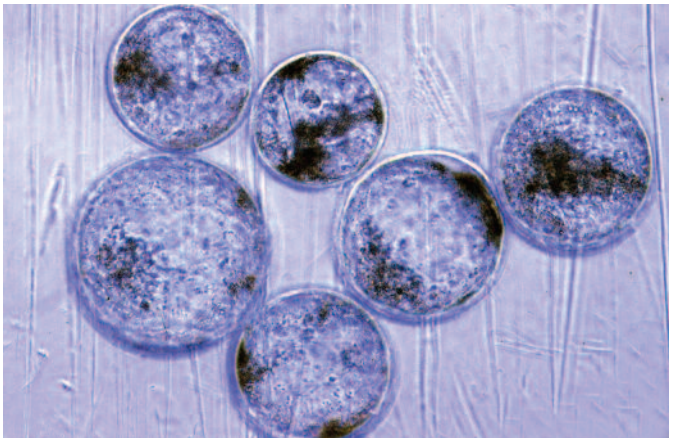
The current technologies are using preservative media containing animal protein. These proteins are themselves potential source of infectious agents, and therefore impossible to use for export. In addition, the containers used to preserve the frozen embryos are not sealed, potentially causing cross contamination during storage in liquid nitrogen.

Late developments in swine embryo transfer include media free of animal products and the use of high security vitrification straws (guaranteeing a perfect seal in liquid nitrogen and consequently cross contamination is impossible). The combination of both advancements provides a completely secure system to freeze, preserve and ship swine embryos.

Even if several catheters are already available, the development of non surgical embryo transfer catheters, easier to use, could also make embryo transfer a more widely used technique.

As these safer and easier to used technologies become more reliable, it is conceivable that instead of purchasing semen to breed pigs, frozen litters will be purchased for embryo transfer into female recipients.

Swine embryos. Courtesy of F. Berthelot, INRA, PRC, Nouzilly, France.



Gender selection

One new technology that has gained a considerable amount of attention has been the recent reports of improved methods for sex sorting semen.

Depending on the needs of the producer, gender selection using sex sorting technology allows the choice of either male of female offspring.

The reference method remains the sorting of sperm cells using specifically designed flow cytometers (different from those used to assess semen quality as mentioned earlier in this article).

This method can now sort about three million sperm cells per hour, and produces litter composed of more than 90% of the pre-selected gender.

The technology is today used regularly in the dairy industry and a large choice of frozen sexed semen is available from several AI companies. However, the efficiency of the technology is not sufficient to make it commercially available for swine breeders.

Genomics

In the past decade, several genes and many genomic regions affecting economic traits have been identified. Several of these have been incorporated in selection programmes.

The impact of molecular genetics on pig breeding programmes and pig production is, however, expected to dramatically accelerate in the future through complete sequencing of the pig genome and availability of large numbers of markers.

Sequencing efforts have started and are moving along with accelerated pace. Results of these efforts are already being used to help select markers for improved growth and meat quality.

Undoubtedly, breakthrough technologies such as gender selection and genomics will finally be widely available for swine breeding as they start to be in other species.

Meanwhile, available new technologies such as the introduction of clean and automatic boar collection, the adaptation of flow cytometry for semen evaluation and boar performance analysis, or even soon the transfer of vitrified embryos, offer current and practical ways to further boost reproduction performances in pigs. ■

References are available from the author upon request.