

The 1998 Statistical Figures for the Worldwide Embryo Transfer Industry: A Data Retrieval Committee Report

A Boom for Bovine Embryo Transfer in the Two Americas?

M. Thibier, Chairman of the IETS Data Retrieval Committee

SUMMARY

The IETS Data Retrieval Committee here reports for the 8th consecutive time the numbers of embryos that were collected and transferred throughout the world. Following the Quebec City meeting of the Committee, some adjustments were made in the forms in order to be more convenient for most local or regional collectors.

The data retrieval network has again improved its performance particularly in South America where new countries have entered the network, including Bolivia and Uruguay. Similarly, the USA has dramatically improved its retrieval system thanks to the collector and his colleagues.

The total number of bovine *in vivo*-derived embryos that were transferred in 1998 was 441,295 of which 45% are of North American origin. Europe covers close to a third of the total number and South America and Asia respectively 14.5 and 10.7 %. The most striking feature this year is the considerable increase in the number of embryos transferred in North America (+ 50%) and in South America (+ 85%). Obviously the more efficient system of retrieving the data has had a role in this observed increase but this also reflects the good health of the bovine embryo transfer industry in the two Americas. More than 30,000 *in vitro*-produced bovine embryos were recorded as transferred this year, this is a small increase as compared to last year (+ 3%), although the countries from Oceania reported little on this activity, this year. The Committee has had more success this year with retrieval of embryos transferred for other species than bovine. However, there is still a long way to go before these numbers accurately reflect the real impact of this segment of our industry. Close to 20,000 sheep embryos have been transferred. Several thousand horse, goat and cervid embryo transfers were also reported as well as some from elk, llamas and even rabbits. For the first time, porcine embryos have been recorded with 2,300 being transferred either experimentally or commercially.

INTRODUCTION

Following the previous years reports and after its stimulating meeting in Quebec City, the IETS Data Retrieval Committee is again in a position to report to the IETS members and indirectly to the world, where does our industry stands. It should be reiterated, to all practitioners involved in the embryo transfer business and to all farmers who get the benefits of those technologies, that it is very important to keep collecting these data. Numerous letters, calls or e-mails from around the world come to the Committee asking questions or commenting about the statistical data that IETS releases through the Committee. Not only is the magnitude of activity of interest to the solicitors but also the yearly trends over time. It is very good and shows a high degree of professionalism, as one of our correspondents told us, that we now have consistent data from 8 consecutive years. There are not many branches in the farming industry that can follow worldwide the long-range evolution of our industry. Again all that participated to these collections should be acknowledged. It should also be clear to the few reluctant colleagues who fail to participate in providing their data, that in doing so they not only harm their own business but also contribute to mitigate the real impact of our industry. This is particularly detrimental at a period of time where it should be possible to show the maximum impact of our industry through the most accurate compilation of our data. The period of time in question is indeed labeled as that of an economic globalization like it has never occurred in world history.

OBJECTIVES AND METHODS OF THE COMMITTEE

The objective and methods of the Committee were discussed in our yearly meeting and remain very much like they were the previous years. What was clearly discussed and emphasized in our meeting at Quebec City last January, was two aspects:

1. The need to **extend our data retrieval to other species** as much as possible and

not concentrate exclusively to the bovine. As seen below, a considerable progress has been made this year. There is still a long way to go before the committee is satisfied with the degree of accuracy. It is yet far from describing the real situation and the figures we feel are well underestimated. This is true particularly in some countries in Europe and Oceania where we know there is a strong activity, for example in sheep, but has been unable to get the collectors to obtain those figures. The competence and dedication of the collectors are not in question at all. The reason for this lack of data is that there still is some reservation about providing the data from practitioners even though the anonymity has been intact since we started this system early in the present decade. There also has never been any misuse of data considered as privileged information. The system works, it is consistent from one year to another so that the figures can be loaded directly filling the tables from the business computer. These tables were re-discussed and approved by our committee at our Boston meeting in 1998.

and

2. The need to **strengthen the networks in some areas** of the world where "centralization" is difficult. The Committee had identified two regions where such a problem was acute, one in South America and one in Asia, as well as a specific problem in the USA. It is noticeable that at the end of this survey from the 1998 data, the Committee has been very successful in South and North Americas. The system has worked beautifully well in South America where countries and ET teams that had never reported before were able to join in the network. This is due to the extreme dedication of our Committee member from Argentina who put in a lot of effort and very successfully provided the data. He indeed should be commended for his efforts. Similarly from the US, the US collector helped by Committee members both from the bovine and horse fields, has succeeded in increasing dramatically the number of teams reporting. Of course this

Table 1. Overall Activity of *In Vivo*-Derived Bovine Embryos in 1998.

CONTINENTS	FLUSHES	TRANSFER- ABLE EMBRYOS	NUMBER OF TRANSFERRED EMBRYOS		
			FRESH	FROZEN	TOTAL
AFRICA	1,672	945	1,992	1,019	3,011 (0.7%)
N. AMERICA	46,593	245,925	101,532	95,301	196,833 (44.5%)
S. AMERICA	8,412	60,886	39,390	24,657	64,047 (14.5%)
ASIA	11,324	67,780	12,294	34,948	47,242 (10.7%)
EUROPE (*)	25,744	141,742	59,086	61,274	120,360 (27.4%)
OCEANIA(**)	2,432	11,410	5,929	3,873	9,802 (2.2%)
TOTAL	96,177	528,688	220,223	221,072	441,295

(*) Those European data are derived from the statistics of AETE, 1999, the data of Finland, not available from the AETE have been here added.

(**) Due to the low number of teams that responded in Australia, in accord with the AETA, we have increased the 1997 figures from this country by 10% so as to give sense to the 1998 results.

Table 2. The Top Twelve European Countries Ranked According to Numbers of *In Vivo*-Derived Embryos Transferred In 1998 (AETE, 1999).

COUNTRIES	NUMBER OF FLUSHES	NUMBER OF EMBRYOS TRANSFERRED
FRANCE	6,775	34,212 ↗
NETHERLANDS	4,864	25,146 ↗
GERMANY	4,139	20,663 ↗
BELGIUM	1,904	7,477 ↗
ITALY	1,309	8,368 ≡
IRELAND	668	3,350 ≡
CZECH Republic	935	4,544 ≡
UNITED KINGDOM(*)	934	4,311 ↘
DENMARK	735	NA
SPAIN	528	1,963 ↗
SWITZERLAND	448	2,681 ↗
SWEDEN	358	1,772 ≡

↗↘ Evolution as compared to the previous year

(*) Unfortunately, only 9 out of the 27 officially approved ET teams have responded, explaining the spectacular drop in the numbers here recorded

Note: While the number of flushes does not increase on the mean, the number of transferred embryos does increase, indicating a trend in an increase of the mean number of embryos transferred per collection.

NA=not available

will explain a somewhat artificial increase in the numbers. They however, reflect more accurately the impact of the ET industry in the USA. The Committee still has problems with some countries of Asia for example Pakistan, which some time reports and other times have some difficulty in putting the figures together. We should be able to solve these difficulties possibly by identifying several collectors in one of these huge countries, which can sum up the figures for the Committee but also divide the large amount of work and effort. This will be one point on the agenda of the Maastricht meeting. Any ideas from the membership from these countries or area will be most welcome. China also has the same kind of difficulty gathering data from various regions but some data has been obtained from this country.

The tables used to collect the numbers were revised the previous year and seem to be very satisfactory. It is noticeable once more, that it is difficult to summarize within distinct breeds even with the only three categories identified. This is either because some data are missing, the data is mixed together, or some countries give more emphasis to the dual-purpose breeds as opposed to others that classify dual-purpose breeds as beef breeds. We might at the next meeting try to define which breeds will go into which category!

THE STATISTICS: MAJOR INCREASES OF THE *IN VIVO*- DERIVED EMBRYO TRANSFER IN THE TWO AMERICAS

Bovine *In Vivo* Derived Embryo Transfers

The embryo transfer industry **has set a new record** this year (Table 1). The number of bovine *in vivo*-derived embryos transferred has never been as high as the figure, 441,295, reported this year! Moreover, one can see that the number of fresh embryos transferred is almost identical to the number of frozen-thawed embryos. This balance reflects one of the advantages of this technology. It is now so flexible and able to adapt to meet such a wide variety of different types of demands worldwide. Now either fresh or frozen-thawed embryo transfer may be an answer. This total number of embryos transferred results from close to 100,000 flushes with more than 500,000 transferable embryos collected and stored. On average, this increase of the number of flushes and transferable embryos is 20%. This is consider-

able even though the figures of the previous year were slightly lower than in 1997. However, that year the number of *in vivo* produced bovine embryos transferred was only 413,000. When compared to that year where a record had already been broken, it is an observed increase of 6%. The main origins of such an increase are the activities from both South and North America. The data reported from South America are about 85% higher than those reported last year. This region now represents almost 15% of the world ET activity. Teams identified and reporting originated from Argentina, Brazil, Bolivia, Paraguay and Uruguay. The numbers reported from North America were also significantly higher than those of last year (+ 50%) due to a considerable higher number reported from the USA. This region represents almost 45% of the total activity throughout the world this year. The European countries have had some stable activities and the numbers reported were likely underestimated due to some problems encountered in the United Kingdom. In the U.K. only 33 % of the teams performing embryo transfer have channeled their data to the British collector. Similarly, Denmark for the first time this year was not in a position to deliver an accurate figure of the number of embryos transferred in the field. Some countries however, reported in the AETE proceedings (Lyon, September 1999) and summarized in Table 2, have had a significant increase in the number of bovine *in vivo*-derived embryos transferred. The three leading countries in this region were France, the Netherlands and Germany. Each of these three have transferred more than 20,000 embryos in 1998. The total activity in Europe represents, on the whole, a little less than a third of the activity worldwide. Asia has also had quite a stable year in 1998 as compared to 1997. There were however, slightly fewer flushes. As a percentage, their activity represents just above 10% of the total this year. However, the committee did not receive any data from India or from Pakistan. The main activity in this region derives from Japan and Korea. South Africa has quite an active ET industry as does the two countries from Oceania. There too as for their British cousins, it has been a little difficult to retrieve the data this year. To that extent, in accord with the Australian Embryo Transfer Association, we have decided to take the 1997 data plus 10%. This number seems to be a reasonable figure showing that ET is also alive and well down under. Table 3 shows the activity in the top

five countries outside North America and Europe. One first sees a dramatic increase of the number of flushes and transfers in Brazil (close to 100%!) and in Argentina (+ 25%). Brazil now ranks third in the world after the USA and Canada. Japan has also increased significantly its number of *in vivo*-derived embryos transferred (+ 10%). Interestingly enough, the percentage of embryos transferred as fresh is almost opposite when comparing Brazil and Japan. The former has its two-thirds of its embryos transferred as fresh. Almost all the dairy embryos (a fifth of the Brazilian total) and the majority of beef breeds are transferred as fresh embryos. In Japan, the opposite is the case with most of the embryos transferred as frozen-thawed. A fifth of these are from dairy breeds and only 20% of them are transferred fresh. Similarly the vast majority of the beef breeds embryos (80% of the total) are also transferred as frozen-thawed. In Argentina, the percentage of fresh and frozen is almost equal both in the dairy breeds (a third of the total) and in the beef breeds. In South Africa and New Zealand, two-thirds of the embryos are transferred as fresh and in the two countries just over 50% of the embryos transferred are from dairy breeds. It seems that the strategy used for selecting the mode of transfer (fresh or frozen) varies greatly according to each country's unique situation. This report does not aim to give technical results per se, however the Canadians do always report very extensively on their very dynamic industry and some pregnancy results have been given on rather large numbers. For example, the pregnancy rates from fresh and frozen-thawed embryos were respectively 61 and 60 % (out of more than 10,000 transfers in each case). For direct transfer, which is being used for ~80 % of the embryos transferred, a pregnancy rate of 60 % was reported.

In terms of international exchanges, it is always a challenge to retrieve these figures with the notable exception of Canada and the USA who through their national (or Federal) administration keeps a good record of their export/import activities. The committee has then learned that the USA has exported 18,370 embryos to 34 countries in 1998. Most of these were exported to Australia, Brazil and the UK. At the same time they only imported about 600 *in vivo*-derived bovine embryos mainly from Canada and Australia. The Canadians have exported 8,559 and imported 456 embryos and the Mexicans have exported and imported a few dozen *in vivo*-derived bovine embryos.

Table 3. The Top Five Countries Outside Europe and North America in 1998.

COUNTRIES	NO. FLUSHES	NUMBER OF EMBRYOS TRANSFERRED		
		FRESH	FROZEN	TOTAL
BRAZIL	5,301	30,939	16,389	47,328
JAPAN	10,475	9,780	33,332	43,112
ARGENTINA	2,516	6,401	6,331	12,732
SOUTH AFRICA	1,672	1,992	1,019	3,011
N ZEALAND	782	5,020	1,879	6,899

Table 4. The Number of Bovine *In Vitro*-Produced Embryos Transferred in 1998.

	TRANSFERABLE EMBRYOS	TRANSFERRED EMBRYOS		
	COLLECTED	FRESH	FROZEN	TOTAL
AFRICA	50*	200	100	300
ASIA	59,680	4,686	7,372	12,058
N.AMERICA	4,690	3,980	820	4,800
S.AMERICA	126	56		56
EUROPE	19,180	7,347	6,766	14,113
OCEANIA	1,300	N A	N A	N A
TOTAL	85,026	16,269	15,058	31,327

*Number of embryo collections

New Zealand has released its export/import numbers and 1,930 embryos were exported mainly to the people Republic of China. They have imported 2,961 embryos mainly from North America and Australia. Finally, both Argentina and Brazil have reported exporting 100-200 embryos from beef breeds. As far as the total number of bovine embryos banked in liquid nitrogen, it is difficult to have accurate data because of the irregular response from the collectors. However, Europe reports that 54,000 embryos are stored frozen (AETE, 1999). Asia has at least 1,000 (PR China and Taiwan), Argentina and Brazil 8,000 and 18,000, respectively, Paraguay and Uruguay 300 and 200, respectively, and Canada more than 43,000. This results in approximately 125,000 embryos stored and eventually available for transfer. This figure does not include those banked in the USA for which figures were not reported. This is in any case a considerable amount of embryos stored. These numbers are approximately equivalent to half a year of business.

Bovine InVitro Produced (IVP) Embryo Transfers

For the third consecutive year, these statistics are separated from the bovine *in vivo* produce embryo data. The number of IVP embryos transferred has increased as compared with last year, but only moderately (+ 2%). However, data were not available from Australia and New Zealand who could only provide figures for the number of transferable embryos but not the number of transferred. Therefore, the figures presented are underestimated. The fact however, that more than 30,000 *in vitro*-produced embryos have been transferred is interesting because of the larger range of countries involved. We so learned that IVP embryos are produced and transferred in all parts of the world. This was not the case only two years ago. Bovine *in vitro* embryo production is a technique that is in hand all around the world. It is not known however, at this point what the situation is in the countries of the former Soviet Union. It has not been possible to retrieve any information from these countries this year. Europe has lead with over 14,000 embryos transferred and Asia, mainly Japan with over 12,000. The most striking feature from this set of data however, is the relative importance of frozen embryos. Almost 48% of such embryos were transferred after freezing and thawing. In Europe, most of these frozen

embryos derive from the Italian team who relies on *in vivo* (in sheep) transfer of young cleaved embryos. This does not seem to be the case in Japan. In Europe, the Netherlands, Ireland, France and Belgium (in this decreasing order in terms of numbers) mainly transfer fresh *in vitro*-produced embryos (see AETE 1999). No activity has been recorded from Germany! But the UK, Czech Republic, Spain and Portugal have all reported transfers of fresh *in vitro*-produced embryos. North America has released their data and the three countries are all involved in *in vitro*-production of embryos. The vast majority of these are transferred as embryos fresh. Finally two-thirds of the *in vitro* produced embryos in South Africa were also transferred as fresh.

Embryo Transfers in Other Species

As stated above, the Committee has registered a significant amount of information on ET in other species. However, much is yet to be done to retrieve data that reflect the actual activity in these species.

In sheep, data from Oceania, the People Republic of China, South Africa, North America and Europe (4 countries) have been obtained. The figures are reported in Table 5. More than 15,000 embryos were transferred with two-thirds as fresh. There is a considerable number of embryos exported in this species and ~90% of the frozen embryos are in fact exported. The data for goat and cervid embryos are also collated in Table 5. Quite a significant number of embryos have been collected from various areas of the world. The countries range Taiwan to Uruguay and from Romania to South Africa. The latter also has an important export activity. We had no report from Australia about the cervid ET this year. There was information provided by the Canadians and New Zealanders showing us that there is again this year quite an active ET business with more than 1,000 cervid embryos transferred. The Canadians report pregnancy rates from fresh and frozen cervid embryos of 72% and 55%, respectively. Further, Canada has 166 cervid embryos in storage and has imported 240 cervid embryos.

This year for the first time, the Committee has received some relevant information about equine embryo transfer from almost all parts of the world. These data are summarized in Table 6. One can see the predominance of the US and Argentina in terms of numbers but some practitioners from Europe (Czech, France and UK), South

Africa, Canada and Mexico also participate in this technology. Although, not reported, we know that some horse embryo transfer is also taking place in Australia and probably in some Arabic countries. The Committee hopes that those involved in equine ET will cooperate and report their data to the Committee. Embryos from llamas and rabbits, particularly from Taiwan, have been reported transferred. The numbers are still small, but it is important to hear that these activities are on going. Finally, again for the first time this year, the Committee has recorded some embryo transfer activities in swine. Thanks in particular to the efforts of some members of the Committee who tried to individually identify those involved with swine all throughout the world. Table 7 collates the data obtained, they do not cover 100% of the activity but likely reflects, quite well, the state-of-the-art in terms of transfers in this species which is recognized as one of the most difficult, especially for cryopreservation. Again, there is quite a variety of countries involved, North America (Canada particularly), Europe (the Czech Republic, the Netherlands and France) and most of all Asia (Korea and Taiwan). It would be interesting to get data from the USA and the People Republic of China as well. Unfortunately, the Committee has failed to do so this year because of the lack of a collector for such data in these countries.

In conclusion, 1998, according to the present report, has been a very active year in terms of embryos that were collected and transferred. A record number of bovine *in vivo*-derived embryo transfers was performed with more than 440,000 transfers. Bovine *in vitro*-production of embryos also seemed to continue its development with greater numbers being frozen being transferred. In the other species, although with numbers of 2 to 3 logs less, embryo transfer seems also to be developing quite strongly. This allows, in particular, some international movements, indirectly reflecting the fact that world globalization also touches our industry to the benefits of the farmers worldwide.

Table 5. Small Ruminants E T Activity in 1998.

CONTINENTS	FLUSHES	TRANSFERABLE EMBRYOS	NUMBER OF EMBRYOS TRANSFERRED			
			FRESH	FROZEN	STORAGE	EXPORT
SHEEP						
ARGENTINA	30	270	180			
AUSTRALIA	1,241	5,578	5,517	4,664	261	
CANADA	22	106	99	7		
CHINA (PRC)			1,000(*)			
EUROPE		5,636	4,399	757		
MEXICO	31	170	170	50		
NEW ZEALAND	18	108				
SOUTH AFRICA	892	4,890				4,890
USA	54	333				
TOTAL	2,288	17,091	11,365	5,478	261	4,890
GOAT						
SOUTH AFRICA	58	311				311
AUSTRALIA	65	1,085	1,035	363	40	
ARGENTINA						
EUROPE		1,378	167	384		
MEXICO	23	117	117	75		
NEW ZEALAND	602	5,408	282		330	
TAIWAN	32	254	123		27	
URUGUAY	9	28	5		28	
USA	745	7,782				
TOTAL	1,534	16,363	1,729	822	425	311
CERVIDS						
NEW ZEALAND	94	520	443	56	77	
CANADA	142	761	108	517		
TOTAL	236	1,281	551	573	77	

(*) No indication if fresh or frozen

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Table 6. Equine E T Activity in 1998.

CONTINENTS	FLUSHES	TRANSFERABLE EMBRYOS	NUMBER OF EMBRYOS TRANSFERRED			
			FRESH	FROZEN	STORAGE	EXPORT
ARGENTINA	1,354	1,110	1,025	23		
CANADA	16	11	6	5		
EUROPE(*)		421	283	144		
MEXICO	12	14	14			
SOUTH AFRICA	1	1				
USA	3,000	1,100	1,100			
TOTAL	4,383	2,657	2,428	172		

(*) Includes the Czech Republic, France and United Kingdom

Table 7. Swine E T Activity in 1998.

CONTINENTS	FLUSHES	TRANSFERABLE EMBRYOS	NUMBER OF EMBRYOS TRANSFERRED			
			FRESH	FROZEN	STORAGE	EXPORT
CANADA	405	7,387	106			
EUROPE(*)	170	1,699	1,531	107		
KOREA	98	1,994	86			
TAIWAN	28	184	388	107		
TOTAL	701	11,264	2,111	214		

(*) Includes the Czech Republic, France, the Netherlands and Romania