# SIGNIFICANT INCREASES IN TRANSFERS OF BOTH *IN VIVO* DERIVED AND IN VITRO PRODUCED EMBRYOS IN CATTLE AND CONTRASTED TRENDS IN OTHER SPECIES IN 2004.

By Professor Michel THIBIER – Chairperson.

**Summary**

The committee met in early 2005 at the IETS venue at Copenhagen (DK). The results from the survey of the previous year were discussed and emphasis was addressed on the effort that was to be made for those countries where there is difficulty finding a national collector able to report the data. Posting of this yearly report on the IETS web site in such a manner that it is accessible to all including non-members was strongly suggested to the Board and action has been taken during the 2005 year.

The total number of bovine *in vivo* derived embryos transferred has largely increased in 2004, with almost 550,000 embryos transferred, which is close to breaking the current record. This is mainly related to the increased activity in Asia and South America where new and prospective markets reside. A similar trend of increased transfers holds true for *in vitro*- produced embryos. Here the record was broken this year and for the first time 239,813 IVF embryos were transferred. Hence, a total of about 789,000 bovine embryo transfers were performed, 30% derive from *in vitro* production.

In small ruminants, the activity in sheep has significantly increased as opposed to that in caprine or cervids, which have declined slightly although there is some underestimation in our retrieval data due to the lack of response from teams in Australia and New Zealand. The equine ET industry is doing well in its traditional regions and some frozen embryos have been transferred this year. Finally in swine, although it seems difficult to receive data from some private companies, more than 15,000 embryos have been transferred including close to 2,000 frozen embryos.

The year 2004 was a very good year for the ET industry on the whole with obvious variations according to regions. The numbers of embryos transferred has never been so high, illustrating the benefits of this technology to the whole farming industry.

**Introduction**

For the 14th year in a row, this committee is reporting to the IETS members and the world, where the Embryo Transfer industry stands in terms of numbers and of activity. The Committee met at the onset of the year 2005 at the IETS annual conference venue in Copenhagen (Dk). Fifteen members from all continents attended and apologizes were received from 11 members. Among the points arising from the previous meeting, two were of particular note, one refers with the recurrent lack of data from some countries that must be approached in a more efficient manner (from Asia, South America and Oceania) and the other referred to the need of an increased effort of communication. This relates in particular to the posting of some of this information on the IETS website and Gabriel Bo agreed to take care of this as soon as possible. There were also comments on the trends seen in 2003 as compared to 2002, on both *in vivo* and *in vitro* collected and produced embryos in the bovine. The decrease in the *in vivo* embryos observed in 2003, were estimated mainly due to lack of reports from some significant countries (such as in Oceania) rather than to a real decline in the activity. It was also noted that the figures we get for small ruminants, equine and swine must be collected in a more appropriate manner. It was also decided that it was better to report the figures the chairperson received rather than nothing, giving at least an indication of the activity to the world, provided that it was so stated in the report. Each member expressed their willingness to improve our retrieval system where appropriate and in particular would mention this committee to the audiences of all conferences in which they were participating. It was finally agreed that the forms in their present format were satisfactory but emphasis was made that they be followed by everyone to prevent difficulties in getting data as it does not always match from one given country to another. New contact persons and collectors were listed and will be posted to collect their national data.

**1. A significant increase in the numbers of *in vivo* collected and transferred embryos.**

The total number of flushes reported this year has never been so high and is shown in Table 1, to be over 115,000. These flushes result in a high number of transferable embryos, close to 700,000 embryos. Not all of them were transferred, of course, but almost 550,000 embryos were transferred in the year 2004. It is of note that this number is certainly underestimated although it is difficult to measure the magnitude of such an underestimation. Clearly some countries have not reported (like India) or partially reported (like in Oceania in particular) where some activity is known to be happening. However, some new countries have reported and this may partially explain the increase in numbers seen in 2004.

**Table 1. Overall Activity of *In Vivo*-Derived Bovine Embryos in 2004.**

| CONTINENTS | FLUSHES | TRANSFER - RABLE EMBRYOS | NUMBER OF TRANSFERRED EMBRYOS | | |
|---|---|---|---|---|---|
| | | | FRESH | FROZEN | TOTAL |
| AFRICA | 1,953 | 12,751 | 4,430 | 2,602 | 7,032 (1.3%) |
| N. AMERICA | 52,855 | 320,908 | 117,949 | 98,670 | 216,619 (39.5%) |
| S. AMERICA | 22,619 | 134,090 | 106,711 | 9,229 | 115,940(21.1%) |
| ASIA | 21608 | 119,157 | 56,886 | 61,651 | 118,537 (21.6%) |
| EUROPE (*) | 17,458 | 101,989 | 39,302 | 48,249(**) | 87,551 (15.9%) |
| OCEANIA (***) | 500 | 2,650 | 1,700 | 1,900 | 3,600 (0.6%) |
| TOTAL | 116,993 | 691,545 | 326,978 | 222,301 | 549,279 |

*(*) Those European data are derived from the statistics of AETE, 2005.*
*(**) One country did not split the figures between fresh and frozen (Total 5,000). By convention, they were all included in the frozen column so as to take them into account in the gross total.*
*(***) Due to lack of responses from many ET teams from this continent, this line is highly underestimated.*

Percentage wise from the various continents (Table 1), it can be seen that North America counts for close to 40% of the total, South America and Asia make up around 21% of the total and Europe ranks next with approximately 16% of the total. This illustrates the fact that the embryo transfer industry continues to develop well in North America and even more interestingly develops even better in Asia and South America. Africa and Oceania only take into account, respectively, a little more than 1% and less than 1%. However, neither Australia nor New Zealand has reported activity by more than a few teams so their figures are therefore very much underrepresented.

Regarding the fresh and frozen embryos, again the situation this year is in contrast but inline with the previous reports. On the whole, more fresh embryos were transferred than frozen embryos but this derives from the great differential seen in South America, in particular in Brazil where most of the embryos from Zebu cows were transferred as fresh. In Asia and Europe slightly more frozen embryos were transferred than fresh. The reverse is true in North America. On average, 5.9 transferable embryos were collected from the flushed cows. This is slightly less than the figure observed the previous year but again there are so many differences according to report that this number is only indicative.

Several features from the country reports are interesting to share. Data from Africa indicate that some transfers have taken place in various countries in addition to South Africa such as in Kenya, Namibia and Sudan. In Asia, some figures were again reported from Indonesia and the Japanese report states that more than 17,000 calves were registered from *in vivo* collected embryos. The US collector, states that at least 80% of the teams (total 103 teams) have given their figures to the AETA Statistics Committee. More than 125,000 frozen embryos from beef breeds are in storage along with approximately 16,000 from dairy cows. The number of frozen embryos in 2004 (150,000 embryos) exceeds by 80 % about the number of transferred embryos. These frozen embryos represent significant storage for the future. A

rough number of ~10,500 embryos have been exported (mainly from beef breeds). The Canadian report based on 61 clinics, not only is very exhaustive but also includes interesting features, thanks to the collectors. In Canada, more than 2,400 embryos have been sexed and either transferred as fresh or frozen, most of them being collected from dairy breeds. Of these 957 split embryos were subsequently transferred. A total of 53,784 embryos are in storage. Exports from Canada have been very active as evidenced by transfers in foreign countries (North America, Asia and Europe) by Canadian practitioners. Canada has also shipped large exceeding 10,000 with only 257 imported embryos reported.

From Europe, 23 countries have reported their numbers. It can be seen from Table 2, that France and the Netherlands remain the main countries both in terms of flushed cows and transferred embryos. France has declined its number by close to 10% but the Netherlands has remained at about the same level as last year. By contrast, Germany has increased by ~1,000 its number of transferred embryos. Belgium, the Czech Republic, Italy and the United Kingdom in that order have transferred between 5,000 and 10,000 embryos with a significant increase for the first two as compared with the previous year. Behind those five countries, stands Ireland that has transferred 1,244 embryos. These results have been possible thanks to the European association collector who also retrieved data from Russia with more than 200 embryos reported transferred either fresh or frozen.

**Table 2. The Top Twelve European Countries Ranked According to Numbers of *In Vivo*-Derived Embryos Transferred in 2004 (AETE, 2005).**

| COUNTRIES | NUMBER OF FLUSHES | NUMBER OF EMBRYOS TRANSFERRED | |
|---|---|---|---|
| FRANCE | 5 520 | 29,414 | ↘ |
| NETHERLANDS | 3 223 | 14,778 | ≅ |
| GERMANY | 2 806 | 10,522 | ↗ |
| BELGIUM | 1 095 | 6,800 | ↗ |
| CZECH Republic | 1 184 | 6,339 | ↗ |
| ITALY | 1 021 | 5,978 | ≅ |
| UNITED KINGDOM (*) | n.d. | 5,000 | ≅ |
| DENMARK | 579 | 3,538 | ↘ |
| FINLAND | 550 | 2,962 | ≅ |
| SWITZERLAND | 254 | 1,663 | ↘ |
| SPAIN | 335 | 1,321 | ≅ |
| SWEDEN | 328 | 1,300 | ≅ |

(*)This is the only data available for this country this year.
↗↘≅ evolution as compared to the previous year

Table 3 reports the data from the top 5 countries outside North America and Europe. One can see that Brazil has the lead among those countries with more than 100,000 embryos transferred that are essentially from the so-called beef cows including zebu females. Most of them are transferred as fresh. Japan and China have similar numbers reported although in Japan; some extrapolation of the data from the previous year has been made. The variations noticed here are small for both countries. The same holds true for some teams in Argentina but the total number close to 14,000 of embryos transferred has increased according to the collector. Finally, the Republic of South Africa has seen its activity only slightly decreased by 100 as compared to last year and with still more than 6,000 embryos transferred in that country. It is to note that the proportion of fresh vs. frozen embryos varies according to countries and in Japan for instance, many more embryos are frozen whereas it is the reverse in China. This is probably due to the types of breeds that are collected (beef vs. dairy).

**Table 3. The Top Five Countries Outside Europe and North America in 2004.**

| | | NUMBER OF EMBRYOS TRANSFERRED | | |
|---|---|---|---|---|
| COUNTRIES | NO. FLUSHES | FRESH | FROZEN | TOTAL |
| BRAZIL | 19,501 | 101,233 | 867 | 102,100 ↗ |
| JAPAN | 10,433 | 16,931 | 41,027 | 57,958 ↗ |
| P R CHINA | 10,430 | 38,478 | 20,122 | 58,600 ↘ |
| ARGENTINA | 3,018 | 5,478 | 8,632 | 13,840 ↗ |
| SOUTH AFRICA | 1,698 | 4,387 | 1,682 | 6,069 ↘ |

**2. The number of *in vitro* produced embryos in cattle has more than doubled in 2004.**

The year 2004 again saw the production of *in vitro*-produced embryos in cattle increase its performance with more than 200,000 of such embryos transferred achieved for the first time (see Table 4). The trends are similar to those described last year. The activity in Africa, North America and Europe is small, but it has increased dramatically both in South America and in Asia. It is a shame that no data were obtained from either Australia or New Zealand in this regard, as then the reality would even have been better reflected. Regardless, this total figure **breaks the record** for the number of IVF embryos transferred in a single year.

**Table 4. The Number of Bovine *In Vitro*-Produced Embryos Transferred in 2004.**

| | TRANSFERABLE EMBRYOS | TRANSFERRED EMBRYOS | | |
|---|---|---|---|---|
| | COLLECTED | FRESH | FROZEN | TOTAL |
| AFRICA | 2,598 | 74 | 47 | 121 ≅ |
| ASIA | 122,142 | 42,547 | 107,570 | 150,097 ↗ |
| N.AMERICA (*) | 2,385 | 2,070 | 49 | 2,119 ≅ |
| S.AMERICA | 80,833 | 80,833 | | 80,833 ↗ |
| EUROPE | 111,128 | 3,437 | 3,196 | 6,643 ↘ |
| OCEANIA | N.D. | | | N.D. |
| TOTAL | 319,086 | 128,951 | 110,862 | 239,813 ↗ |

In the Republic of South Africa, most of the ~2,600 *in vitro*-produced embryos were from abattoir oocytes but only 98 of them were further transferred (75% frozen), some frozen IVF embryos were also imported and transferred.

European statistics show that there were 9,139 IVF produced embryos[1] , of which two thirds were produced from Ovum Pick Up collection. In this regard, it is reported that 4,534 sessions of OPU were performed by the European teams with a mean number of 1.41 embryo produced per session. The remaining third of such embryos were derived from abattoir collection of ovaries. The total number of IVF embryos transferred in this continent was only 6.4 % of the total embryos transferred. It is of note also that their number is split with approximately half fresh and half frozen. This results from the fact that most ET teams transfer as fresh with a notable exception the Italian laboratory, which has transferred ~2,000 embryos as frozen-thawed in 2004 and the Netherlands which transferred 784 fresh *in vitro*-produced embryos and 904 embryos that frozen-thawed.

[1] These data for IVF embryos were issued from the AETE statistics modified with additional data collected after its annual conference.

The number of collections in the USA is 2,665 resulting in more than 2,000 embryos assessed as transferable and almost all were further transferred. Only a few (>50) were frozen, the vast majority being transferred as fresh. By contrast, in Canada, and Europe for example most (98%) of these IVF embryos were produced by OPU, all from dairy breeds. Only a few hundreds of them were reported transferred in Canada and those were fresh. Thousands were exported primarily to the Republic of China and transferred by Canadian teams.

As mentioned above, the South Americans and quasi exclusively the Brazilians have increased dramatically their activity in producing IVF embryos. More than 300,000 collections essentially from Zebu females were performed and 80,833 transferable embryos were recorded. Those were all transferred as fresh. The situation is more diverse in Asia. In Japan, 8,865 IVF embryos were transferred but the collector did not indicate, which proportion of them were frozen or fresh, they were each around 50% the previous year. It was however, reported that 19,575 calves were recorded and registered as conceived by IVF. Thailand transferred less than 100 IVF embryos and has some in storage. Korea continues to develop an intense activity in producing such embryos. Close to 400,000 oocytes were collected either from OPU or from abattoir and resulted in 69,936 transferable embryos. More than 40,000 of such embryos were transferred, 35,134 as fresh and 5,493 as frozen-thawed, 4,664 are reported as stored. Taiwan, in 2004, obtained 127 transferable embryos and 65 were transferred as frozen.

The Republic of China has also had an intense activity in terms of IVF production and transfer. There were 16,375 transferable embryos produced and 1,248 transfers of fresh embryos and 93,627 of frozen were reported. The latter originated either from local production or from foreign embryos in storage dating from the previous years. As a matter of fact, this trade has been impaired to some extent due to the ESB status of the two North American countries, which had set quite an active exchange of IVF embryos.

**3. Contrasted results from embryo transfer in other species.**

The small ruminants are also parts of the embryo transfer industry with some dramatic contrasts according to regions in the world. For sheep and on the whole, the numbers collected this year are much higher than last year. This situation is not due to such a high increase in the activity but reflects mostly the great help some of our colleagues have given the committee in sending their data on time. As shown in Table 5, close to 100,000 transferable embryos have been collected this year and 68,000 about were transferred essentially as fresh with only 10% being frozen and transferred. Three main countries have contributed to this number, South Africa, Australia and New Zealand. In the republic of South Africa, from 2,317 collections, 19,048 total embryos were collected with two thirds being assessed as transferable, 913 were transferred as fresh, 155 as frozen and a stock of 6,665 is currently banked. In Australia, some data have been collected, thanks to individual practitioners who reported directly to the Committee and following a discussion the practitioners involved in the sheep ET industry had at their last AETS conference. Hence from both real figures and estimates, the total number of sheep flushes comes to 9,600 and resulted in 70,000 transferable embryos with 59,800 embryos transferred and ~10 % frozen. Very few practitioners reported from New Zealand but this country too is actively involved with thousands of embryos transferred. However, the Committee has recorded only 920. Besides those major countries, Canada reported 598 embryos collected and 549 transferred but some Canadian practitioners were involved in some transfer overseas such as in China, Turkey and also in the US. This activity represented a total of 760 embryos collected and transferred fresh. Some frozen embryos were also exported to Turkey (n= 53) and the People Republic of China (n = 26). Europe has a marginal activity with sheep embryos producing approximately 100 embryos collected from France, Rumania and Greece.

By contrast, the activity in goats has not reached its peak of early 2000 and in fact has declined. This year, less than 2,000 embryos were collected (Table 5) and less than a thousand have been transferred. Behind the Republic of South Africa, still the leader in this area, Korea and Taiwan got involved and contributed 153 fresh transfers in Korea and 216 fresh and 312 frozen transferred embryos for Taiwan. In Europe, Romania has transferred a few tens of fresh embryos and Canada in North America also indicated that 206 embryos were collected and only 15 transferred domestically.

The deer activity has also declined lately and the Canadians and the new Zealanders are the only members that reported having transferred such embryos. Some exports of deer embryos from Canada to Spain with 112 fresh and 6 frozen ones, were of note.

**Table 5. Small Ruminants ET Activity in 2004.**

| SPECIES | TRANSFERABLE EMBRYOS | TRANSFERRED EMBRYOS | |
|---|---|---|---|
| | | FRESH | FROZEN |
| ***SHEEP*** | | | |
| TOTAL | 84,943 | 62,088 | 6,006 |
| ***GOAT*** | | | |
| TOTAL | 1,755 | 422 | 315 |
| ***CERVIDS*** | | | |
| TOTAL | 322 | 220 | 62 |

For horses, only a few countries were involved and remain the same from one year to another of course in close link with the equine business. In some countries, the numbers result from a strict inventory, for a number of others, it is an estimate due to the difficulty for some practitioners involved in equine ET to report. It is of satisfaction nevertheless to see not only an improvement in retrieving such data but also to see that the figures also increased by close to 50% (see Table 6) as compared to last year. North America, mainly the US and South America (both Argentina and Brazil) contribute to more than 90 % on the whole. Europe has only a marginal activity in this area and so has the Republic of South Africa. It is not known if any activity of this kind in this species takes place in any country of Asia such as India for example.

**Table 6 Equine ET Activities in 2004.**

| COUNTRIES | FLUSHES | TRANSFERABLE EMBRYOS | EMBRYOS TRANFERRED | |
|---|---|---|---|---|
| | | | FRESH | FROZEN |
| ARGENTINA | 10,000 | | | |
| BRAZIL | 8,500 | 5,500 | 5,500 | |
| CANADA | 50 | 28 | 26 | |
| EUROPE | 750 | 446 | 387 | |
| SOUTH AFRICA | 15 | 9 | 9 | |
| USA | 12,000 | 5,750 | 5,500 | 250 |
| TOTAL | 31,315 | 11,733 | 11,422 | 250 |

This year is the fifth year this committee has attempted to collect data for the swine industry. Obviously the committee does not get such a good response than for other species mainly because of private interests that the managers think communication of the numbers might impair their business. This is of course totally false.

**Table 7 Swine ET Activity in 2004.**

| COUNTRIES | FLUSHES | TRANSFERABLE EMBRYOS | TRANSFERRED EMBRYOS FRESH | FROZEN | RECIPIENT FEMALES |
|---|---|---|---|---|---|
| CANADA | 154 | 1,367 | 2,448 | | 212 |
| KOREA (1) | 105 | 2,608 | 34 | | 63 |
| | | 13,604 | 9,780 | | |
| EUROPE (2) | | 389 | 387 | | |
| (3) | 178 | 6,584 | 548 | 1,934 | |
| TAÏWAN | 51 | 885 | 885 | | 26 |
| USA | N d | | | | |
| TOTAL | 488 | 25,437 | 14,082 | 1,934 | - |

*(1)* In vitro *produced and clones*
*(2) From AETE statistics*
*(3) In addition to the AETE data.*

This committee appreciates those that do agree to give their figures anonymously so that the world knows where this technology is in terms of further development, having no doubt that in this species too, this technology may benefit very substantially the pig industry. From the records the committee received, there is not much change this year in the numbers as compared to those of last year. The total number of flushes has increased by 25% but the number of transferable embryos has remained similar and the number of fresh transferred embryos is slightly less. Interestingly, close to 2,000 embryos collected were frozen and transferred as such in 71 females. Taiwan indicates that from its 885 transfers as fresh onto 26 recipient females, the pregnancy rate recorded was 50% and the number of piglets born 88.

**Conclusion**

The year 2004 was certainly a landmark in the embryo transfer industry in terms of activity. For the first time, more than 789,000 bovine embryos have been transferred. If the *in vivo*-derived embryos in this species have reached one of its larger numbers like a few years ago, the *in vitro* produced had never reached such a high activity with more than 200,000 IVF embryos transferred. This also shows that the two continents, namely Asia and South America, which are those where those numbers have increased the most dramatically, are the area where this ET industry may benefit the most farmers in introducing the desired genotypes in an efficient and convenient manner.

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