2012 STATISTICS OF EMBRYO COLLECTION AND TRANSFER IN DOMESTIC FARM ANIMALS

Collated by George Perry, Chair – IETS Data Retrieval Committee (gperry47@gmail.com)

SUMMARY

This is the 22nd annual report of the International Embryo Transfer Society (IETS) Data Retrieval Committee on the data collected during 2013 by the IETS on embryo collection and transfer activities in domestic farm animals in 2012 globally. The year saw the development of a secure web based data collection system by the IETS internet service providers (the Federation of Animal Science Societies - FASS) which became available for collection of data from July 2012. Previously embryo transfer data was collected, stored and processed electronically or manually by the chair on the chair's personal computer. This development enabled the IETS to have responsibility for the storage of embryo transfer data collected and submitted by group heads and individual submitters.

Historically, the quality of the submissions varied greatly between regions and countries. Best quality and quantity of data were from countries or regions with embryo transfer industry for livestock that is supported by a regulatory or industry code structure that required accountability of embryos collected and transferred. Data submitted represented only a portion of the embryo transfer activity globally. It is hoped that the structure and accessibility of the new IETS database will encourage more embryo transfer practitioners and more countries to contribute their data to the new IETS database.

1.1 BOVINE ANIMALS

Globally, data collectors reported a total of 1,143,119 in-vivo derived (IVD) and in-vitro fertilised (IVF) embryos collected/produced, available for transfer to other cattle. Of this total, 699,586 were IVD embryos and 443,533 were IVF embryos. This is the first time since 2004 that the report on the number of transferrable IVD embryos be below 700,000 for the year and is believed to be in part due to the lower level of data submission with several countries which have reported in the past not submitting data or fewer practitioners than before submitting data to the data collectors.

Globally 890,875 fresh and frozen IVD and IVF embryos were transferred of which 505,876 were IVD embryos and 384,999 were IVF embryos. Given that only a proportion of countries provide data and not all practitioners in submitting countries provide data, it is most likely embryos were transferred to over one million cattle. Of the IVD embryos transferred, 209,071 were fresh and 296,805 were frozen. Of the IVF embryos transferred, 348,238 were fresh and 36,761 were frozen embryos. While the number IVF embryos produced and transferred continue to rise in South America, data indicates it has fallen markedly in Asia.

Of particular interest is the transfer of 303,168 fresh IVF embryos in Brazil. To overcome issues associated with freezing of IVF embryos, it appears they have developed transportable incubators for the safe transportation of embryos undergoing in-vitro culture from the IVF embryo laboratory to the recipient farms, which can be as much as 2000 kilometres away (*Pontes et al (2010) Theriogenology 74: 1349-1355*).

Only five countries provided any reports on exports of embryos. These countries reported exporting a total of 34,999 bovine embryos of which 300 were IVF embryos.

1.2 OTHER LIVESTOCK SPECIES

Embryo transfer data were collected for buffalo, sheep, goats, deer, pigs and horses.

Canada was the only country that report in-vivo embryo work in buffalo (bison), Italy reported IVF embryo collection in buffalo (Riverine buffalo) but no transfers. The definition of buffalo may need to be clarified as to

whether it refers to *Bubalus bubalis* (Water buffalo) only or includes *Bison bison* (American buffalo) and/or African/Cape buffalo (*Cencerus caffer*).

Twelve countries reported embryo transfer in sheep with Australia leading the way strongly with over 1000 flushes and over 7000 embryos collected. South Africa, Mexico and Argentina all reported over 100 flushes each. Globally, 13,633 IVD embryos were collected and 12,458 transferred. Only six countries reported embryo transfer in goats with 1805 IVD embryos collected and 1013 embryos transferred.

New Zealand was the only country reporting collecting (292) and transferring (337) cervine IVD embryos.

Canada, France and Ireland were the only countries to report collecting (2478) and transferring (2478) swine IVD embryos.

Ten countries reported embryo transfer activity in horses. Brazil and Argentina each reported collecting and transferring over 15,000 equine IVD embryos, while the remaining eight each reported less than 100 embryos collected and transferred.

1 INTRODUCTION

This is the 22nd annual report of the IETS Data Retrieval Committee. In the early 1990's, the International Embryo Transfer Society (IETS) established the Data Retrieval Committee to collect and present global data on activities related to embryo transfer technologies in domestic farm animals. To fulfil the mission statement of the committee, that is, to show the main activities and trends in the area of commercial embryo transfer, the data is collected yearly by data collectors who were appointed by affiliate societies or who were simply volunteers where affiliate societies are not active, and collated, analysed and presented as an annual report for publication in the IETS December Newsletter.

The annual reports present data from previous year, e.g., data collected during 2013 reflects embryo transfer activities in domestic animals globally for 2012. The year 2013 marked a significant step in how the data was collected and stored. The IETS Board of Governors agreed to the development of a secure web based data collection system by the IETS internet service providers (the Federation of Animal Science Societies - FASS) which became available for collection of data from July 2012. Previously embryo transfer data was collected, stored and processed electronically or manually on the chair's personal computer. This development enables the IETS to assume responsibility for the storage of embryo transfer data collected and submitted by the data collectors.

Historically, the quality of the submissions varied greatly between regions and countries. Best quality and quantity of data were from countries with embryo transfer industry for livestock that is supported by a regulatory or industry code structure that required accountability of embryos collected and transferred. Data submitted represented only a portion of the embryo transfer activity. This still occurs; however, it is hoped that the structure and accessibility of the new IETS database will encourage more embryo transfer practitioners and more countries to contribute their data to the new secure IETS database, especially in countries with a fragmented embryo transfer industry, that is, countries with no well-structured industry organisation recognised by the veterinary authority of that country.

2 METHODOLOGY

2.1 IETS DATA COLLECTORS

Table 1 lists the data collectors who volunteered to collect embryo transfer data from their region/country. Embryo transfer associations in several countries, in particular, Canada (Canadian Embryo Transfer Association CETA), United States (American Embryo Transfer Association AETA), Mexico (Mexican Embryo Transfer Society META), Brazil (Sociedade Brasileira de Tecnologia de Embriões SBTE), Argentina (Sociedad Argentina de Tecnologias Embrionairias SATE) and Member States of the European Union and other European countries

(European Embryo Transfer Association EETA or Association Europeenne de Transfert Embryonnaire AETE), collected data from their members, collated and pooled the data and provided, via designated data collectors, the IETS Data Retrieval Committee with a country by country summary for inclusion in this report.

Data collectors from remaining countries rely largely on the goodwill of individual embryo transfer practices to volunteer their data. Those involved in international trade are more likely to submit data as they realise potential importers may refer to these annual reports for information on the livestock embryo transfer industry in the exporting country.

Individual Australia, New Zealand and Panama embryo transfer practitioners submitted data on a practice by practice basis. The data collector for South Africa submitted data practice by practice, while other countries provided pooled data. Collection of data from Australia and New Zealand and other Asian, African and South American countries remained problematic with many practitioners reluctant to provide data. It hoped the new report format with greater details about each country will encourage practitioners to provide data to demonstrate the scale of the embryo transfer industry within their own country, thus reducing under-reporting.

Table 1 – List of Data Collectors by region/country

REGION/COUNTRY	Collector	REGION/COUNTRY	Collector
AFRICA		**EUROPE**	
Kenya	Morne de la Rey	**AETE**	Hiemke Knijn
Namibia	Morne de la Rey		
Rep South Africa	Morne de la Rey	Austria	Gabi Wetchy
ASIA		Belgium	Peter Vercauteren
India	Aditya Misra	Bosnia & Herzegovina	Teodor Markovic
Israel	Amir Shiffman	Croatia	Mario Matkovic
Japan	Osamu Dochi	Czech Republic	Pavel Bucek
Kazakstan	Victor Madison	Denmark	Henrik Callesen
Korea	Sun Ho Choi	Estonia	Jevgeni Kurykin
Taiwan	S N Lee	Finland	Marja Mikkola
Thailand	Rangsun Parnpai	France	Clair Ponsart
NORTH AMERICA		Germany	Hubert Cramer
Canada	Reuben Mapletoft	Greece	Samartzi Foteini
Mexico	Salvador Romo	Hungary	F Flink
United States	Michael Wehrman	Ireland	Pat Lonergan
SOUTH AMERICA		Italy	Giovanna Lazzari
Argentina (bovine)	Gabriel Bo	Luxembourg	J Westphal
Argentina (equine)	Luis Losinno	Netherlands	Jan Derksen
Brazil (equine)	M Alvarenga	Norway	Eiliv Kummen
Brazil (bovine)	Joao Henrique Moreira Viana	Poland	Jedrzej Jaskowski
Dominican Rep	Michael Wehrman	Portugal	Joao Nestor das Chagas e Silva
Ecuador	Michael Wehrman	Russia	Victor Madison
Panama	Luis Nasser	Spain	Julio de la Fuente
Peru	R Mancheno	Sweden	A Tidstrom
Uruguay	Pedro Bañales	Switzerland	Rainer Saner
St Martinique	Michael Wehrman	Turkey	Ebru Emsen
OCEANIA		United Kingdom	Ian Kippax
Australia	Rob Pashen; George Perry	Ukraine	Victor Madison
New Zealand	Grant Clarke		

While less work is involved in submitting pooled data onto the IETS database, more work is required by country/regional data collectors to pool the data. It may become possible for affiliate societies to use the IETS database for storage of individually submitted data along with individual practices from other countries to submit yearly data directly to the database, ready for compilation and analyses by individual countries, regions and the IETS. This would significantly reduce duplication in collecting, processing, storing and analysing data and further enhance the analytical capabilities of the IETS database.

The data collectors were from a small percentage of countries with embryo transfer activity globally (Table 2). More data collectors and more effective communications are required to enable collection of data from other countries in future years. Some data collectors have provided reports of nil activity in some countries. For example, the South African data collector, Dr de la Rey, advised zero activity in Botswana, Zimbabwe, Malawi, Mozambique, Democratic Republic of Congo, Tanzania, Burundi, Angola and activity in Zambia (data unavailable). He also advised that Brazil had been active in South Africa producing IVF embryos for which no data was provided.

Table 2 Number and proportion of Data Collectors by region

Region	No of countries in region	No countries submitting data	% countries submitting data
Africa	57	2	3.51%
Asia	53	5	9.43%
Central America	31	1	3.23%
Europe	45	26	57.78%
North America	3	3	100.00%
Oceania	23	2	8.70%
South America	13	2	15.38%
Globally	**225**	**41**	**18.22%**

2.2 SUBMISSION OF DATA

2.2.1 IETS DATABASE

http://www.iets.org/data-retrieval/ is the home page for new IETS database system. That page serves as the common login page for the chair, the group heads, and the data submitters. On this page is:

Login: *Submitter's email address*

Password: *Unique password created by FASS and sent to the submitter by email.*

After development and testing of the new database, the Chair prepared the system for data collection by granting access to the group heads (data collectors). The Chair (first tier) had responsibility for creating new regional/country data collectors (second tier), using the email address provided by them for login. An email with login details were then automatically sent by FASS to the new group heads. The Chair downloaded all or filtered data in csv format for auditing and analyses using Microsoft Excel®.

Second tier data collectors collecting data from one or several countries in their region were given the responsibility for providing secure access to third tier data submitters for their region/country. The second tier data collectors could submit/view/edit data they and their delegated (third tier) submitters provided. They could also download data in csv format for their region/country for auditing and further analysis.

When submitting data, submitters had to ensure they selected the correct "Year" and "Region/Country". All data collectors could submit data more than once and could correct their data. Some data collectors submitted data team by team, others country by country.

There were two links ("Start New Submission" and "Return to Home Page") in the yellow message box that appeared at the top of the page after data was submitted or saved. The "Start New Submission" link cleared out the previous data on the page so new data could be entered, otherwise any new data overwrote the previous unsaved data. Also, the link in the breadcrumb bar (Data Retrieval …. Home > Submission) above the page title was available to return the user to the home page. Logging out was via a logout link at the upper right corner of the home page.

Data could be "saved" without filling in every field, but it could not be "submitted" unless all unused fields were filled with "0". After clicking the "SUBMIT" button, it was necessary to wait until the page reloaded and check if there were any error messages or if submission was accepted. If there was a message in a red box, then an error has occurred and data was ***not*** saved. After correcting the problem, the "SUBMIT" button was clicked again. If the user saw a yellow box, then submission was saved/accepted, and the "Start a new Submission" link was clicked to clear the data and start a new submission, or the user could return to the home page via the "Return to Home Page" link.

Data submitters were advised to enter data according to the year they related to, not the year they were submitted. Those having data going back to 2003 could add whatever historical data they had.

It is expected 2014 will see the development of an analysis program being added to the database to simplify analysis – and present data as tables, graphs and charts for viewing by others.

2.2.2 DATABASE ISSUES

Submission of data was not entirely without problems with some issues or details lacking that may need to be addressed. This is to be expected when using a new system for the first time. These will be discussed and hopefully decided upon at the 2014 IETS Data Retrieval Committee Annual meeting.

Some embryo transfer practitioners worked not only in their country but also in other countries. They had provided embryo transfer data for all countries they had worked in to their local embryo transfer association and were entered onto the IETS database accordingly by their home country data collector. When data collectors of other countries were informed of extra data for their region/country, they were advised not to add that data to the database to avoid duplication. From next year, all group heads are being requested to forward all foreign data to the data collector of other country for their data entry. All data collectors will need to maintain contact details with each other.

Europe collected embryo transfer activity data for cattle as a whole, not separately into dairy and beef cattle. They have been asked to consider separating cattle data into dairy and beef breeds in the future. All EU bovine in-vivo data were entered under dairy given it was likely to be mostly dairy breeds. Europe also collected data from Italy for buffalo IVF embryo production. The IETS database collects data only for buffalo IVD embryos. The definition of buffalo may need to be reviewed given that *Bison bison* is commonly known as American buffalo, *Bubalus bubalis* and its subspecies as water/riverine buffalo and/or *Cencerus caffer* as African/Cape buffalo.

Europe does not collect data relating to export of embryos.

Japan in 2013 collected data for 2011. Although stored in the database as 2011, it was included in the 2012 data analysis report as 2012.

Some countries collect embryo data segregated into sexed and unsexed semen. The IETS database currently has no provision for separate data for sexed semen but it can be modified to do so. The committee may consider whether this should be done in the future.

3 RESULTS

3.1 GENERAL COMMENTS ON TABLES AND CHARTS

1. All cattle (that is, unseparated dairy and beef) data for Europe are listed under dairy.
2. The results do not give an accurate picture of the scale of embryo collection and transfers within each country as the database relies entirely on the data voluntarily provided by practitioners directly to the database or via the data collectors. There are exceptions, for example, in Canada, all CETA certified practitioners must submit data and 90% of non-certified practitioners volunteer their data. This resulted in 99% of all embryo transfer data was collected (Mapletoft R, *pers comm*).
3. Trendlines (mainly exponential) were added to some Figures to show the overall trend, given the yearly fluctuation in data.

Country details regarding the embryo transfer industry for 2012 are tabulated below while regional trends in embryo collection and transfers since 1997 are tabulated and graphed in the Results section.

3.2 BOVINE IN-VIVO DERIVED (IVD) EMBRYO COLLECTION

Table 3 summarises the global activity for in-vivo embryo collection and transfer according to the data submitted to the IETS database, and includes the average number of embryos per flush for each region.

Table 3 Collection and transfer of embryos by region

Region	Embryo collection				Embryo transfer			
	Flushes	Transferrable	No embryos	% global	Fresh	Frozen	Total	% global
Africa	1107	7609	6.87	1.09%	3272	3075	6347	1.25%
Asia	9494	100558	10.59	14.37%	20436	44334	64770	12.80%
Central America	0	0	0.00	0.00%	0	0	0	0.00%
Europe	23653	135217	5.72	19.33%	40174	66289	106463	21.05%
North America	52701	355866	6.75	50.87%	100354	134990	235344	46.52%
Oceania	2654	15538	5.85	2.22%	6959	8091	15050	2.98%
South America	15274	84798	5.55	12.12%	37876	40026	77902	15.40%
Grand Total	**104883**	**699586**	**6.67**	**100.00%**	**209071**	**296805**	**505876**	**100.00%**

Table 4 shows details of the data received concerning IVD embryo collection from all the countries that submitted data for 2012. As stated earlier, European countries do not report data for dairy and beef cattle, only cattle as a whole. Tables 5, 6 and 7 and Figures 1, 2 and 3 report on the changes in IVD embryo collection by region since 1997.

3.3 BOVINE IN-VIVO DERIVED (IVD) EMBRYO TRANSFERS

Table 8 shows details of the data received concerning IVD embryo transfers and exports from all the countries that submitted data for 2012. As stated earlier, European countries do not report data for dairy and beef cattle, only cattle as a whole nor do they report exports.

Tables 9, 10 and 11 and Figure 3, 4 and 6 report on the changes in IVD embryo transfers reported by countries grouped by regions since 1997. According to the submissions, North America is the largest user of embryo transfer biotechnology in cattle globally, followed by South America and Europe.

3.4 BOVINE IN-VITRO FERTILISED (IVF) EMBRYO PRODUCTION AND TRANSFERS

The section relate to bovine in-vitro fertilised embryos collected either by the ovum pick-up (OPU) method or by collecting ovaries from freshly slaughtered cows at abattoirs (Abattoir). Table 12 details IVF embryo activities in countries that provided data. Several countries that reported zero activity in this field were excluded from the table. The results for Italy includes IVF embryo collection in buffalo, the only country that reported IVF activity in livestock apart from cattle. Table 13 analyses some production aspects of IVF embryo production and transfers.

3.5 IN-VIVO (IVD) EMBRYO TRANSFERS IN OTHER ANIMAL SPECIES

Table 18 details the data provided by those countries reporting on activities in other animal species. Italy reported IVF embryo activities in buffalo, as detailed in Table 12.

Table 4 In-vivo embryo production by country

Region / Country	In-vivo flushes		In-vivo embryos		Total flushes	Total embryos
	Dairy	Beef	Dairy	Beef	Bovines	Bovines
AFRICA						
Namibia	0	6	0	51	6	51
South Africa	46	1055	388	7170	1101	7558
ASIA						
Israel	77	0	325	0	77	325
Japan	1776	6469	11587	87234	8245	98821
Kazakhstan	75	0	309	0	75	309
Korea (South)	260	724	30	462	984	492
Thailand	92	21	478	133	113	611
CENTRAL AMERICA						
Panama	0	0	0	0	0	0
EUROPE	**NOTE: Data not separated for dairy and beef breeds**					
Austria	45	0	207	0	45	207
Belgium	1025	0	4985	0	1025	4985
Bosnia and Herzegovina	0	0	0	0	0	0
Croatia (Hrvatska)	5	0	50	0	5	50
Czech Republic	34	0	206	0	34	206
Denmark	508	0	3565	0	508	3565
Estonia	3	0	5	0	3	5
Finland	390	0	2626	0	390	2626
France	6414	0	32985	0	6414	32985
Germany	2436	0	16498	0	2436	16498
Greece	3	0	19	0	3	19
Hungary	99	0	875	0	99	875
Ireland	495	0	2682	0	495	2682
Italy	2240	0	13893	0	2240	13893
Luxembourg	143	0	1120	0	143	1120
Netherlands	5688	0	31874	0	5688	31874
Norway	0	0	0	0	0	0
Poland	168	0	914	0	168	914
Portugal	155	0	965	0	155	965
Russian Federation	98	0	247	0	98	247
Spain	584	0	3147	0	584	3147
Sweden	36	0	114	0	36	114
Switzerland	459	0	3536	0	459	3536
Turkey	0	0	0	0	0	0
Ukraine	98	0	247	0	98	247
United Kingdom	2527	0	14457	0	2527	14457
NORTH AMERICA						
Canada	10826	2029	75765	16062	12855	91827
Mexico	73	988	384	6711	1061	7095
United States	15443	23342	96515	160429	38785	256944
OCEANIA						
Australia	176	2058	743	12635	2234	13378
New Zealand	400	20	2000	160	420	2160
SOUTH AMERICA						
Argentina	722	5765	3329	30546	6487	33875
Brazil	3461	5326	20029	30894	8787	50923
GRAND TOTAL	**57080**	**47803**	**347099**	**352487**	**104883**	**699586**

Table 5 Number of In-vivo embryo collection by region and year.

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
AFRICA	3031	1672	1765	1205	929	1968	1565	1953	1893	1607	1916	2389	1446	1515	1438	1107
ASIA	14435	11324	11519	12225	10440	17557	18717	21608	19811	18919	17563	9205	10924	12986	15444	9494
EUROPE	28706	25744	26429	22734	19594	18294	17503	17458	16995	15859	18332	14894	16856	17694	23480	23653
N AMERICA	27681	46593	51224	50527	55981	42238	47638	52855	65520	64711	68633	67684	52921	51735	54837	52701
OCEANIA	3074	2432	15508	17040	3340	7419	1531	500	590	2816	1689	2324	10070	8458	10755	2654
S AMERICA	5380	8412	12719	9327	11007	14189	21212	22619	26052	18000	14505	15313	12065	12263	12174	15274
Grand Total	**82307**	**96177**	**119164**	**113058**	**101291**	**101665**	**108166**	**116993**	**130861**	**121912**	**122638**	**111809**	**104282**	**104651**	**118128**	**104883**

Table 6 Number of transferrable in-vivo embryos collected per year

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
AFRICA	17452	945	10005	7049	5218	12641	10064	12751	12612	13660	13459	13537	10128	9738	9401	7609
ASIA	72466	67780	74811	89063	80521	120951	162640	119157	135633	139534	135016	92343	112783	131718	124362	100558
EUROPE	150428	141742	145305	125035	109698	102996	104726	101989	96581	94090	106284	115344	106495	117813	108712	135217
N AMERICA	178818	245925	299180	287460	315628	265175	280432	320908	392232	415596	424053	419846	347531	338540	362781	355866
OCEANIA	12669	11410	92655	99068	15402	37352	9540	2650	2480	15240	10764	12934	60200	56775	59419	15538
S AMERICA	24425	60886	92400	56645	53610	90572	126385	134090	150434	99627	73891	92246	67093	77643	68187	84798
Grand Total	**456258**	**528688**	**714356**	**664320**	**580077**	**629687**	**693787**	**691545**	**789972**	**777747**	**763467**	**746250**	**704230**	**732227**	**732862**	**699586**

Table 7 Average number of transferrable in-vivo embryos collected per collection

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
AFRICA	5.76	0.57	5.67	5.85	5.62	6.42	6.43	6.53	6.66	8.50	7.02	5.67	7.00	6.43	6.54	6.87
ASIA	5.02	5.99	6.49	7.29	7.71	6.89	8.69	5.51	6.85	7.38	7.69	10.03	10.32	10.14	8.05	10.59
EUROPE	5.24	5.51	5.50	5.50	5.60	5.63	5.98	5.84	5.68	5.93	5.80	7.74	6.32	6.66	4.63	5.72
N AMERICA	6.46	5.28	5.84	5.69	5.64	6.28	5.89	6.07	5.99	6.42	6.18	6.20	6.57	6.54	6.62	6.75
OCEANIA	4.12	4.69	5.97	5.81	4.61	5.03	6.23	5.30	4.20	5.41	6.37	5.57	5.98	6.71	5.52	5.85
S AMERICA	4.54	7.24	7.26	6.07	4.87	6.38	5.96	5.93	5.77	5.53	5.09	6.02	5.56	6.33	5.60	5.55
Global Average	**5.54**	**5.50**	**5.99**	**5.88**	**5.73**	**6.19**	**6.41**	**5.91**	**6.04**	**6.38**	**6.23**	**6.67**	**6.75**	**7.00**	**6.20**	**6.67**

Figure 1 **Graph of In-vivo embryo collection by region and year.**

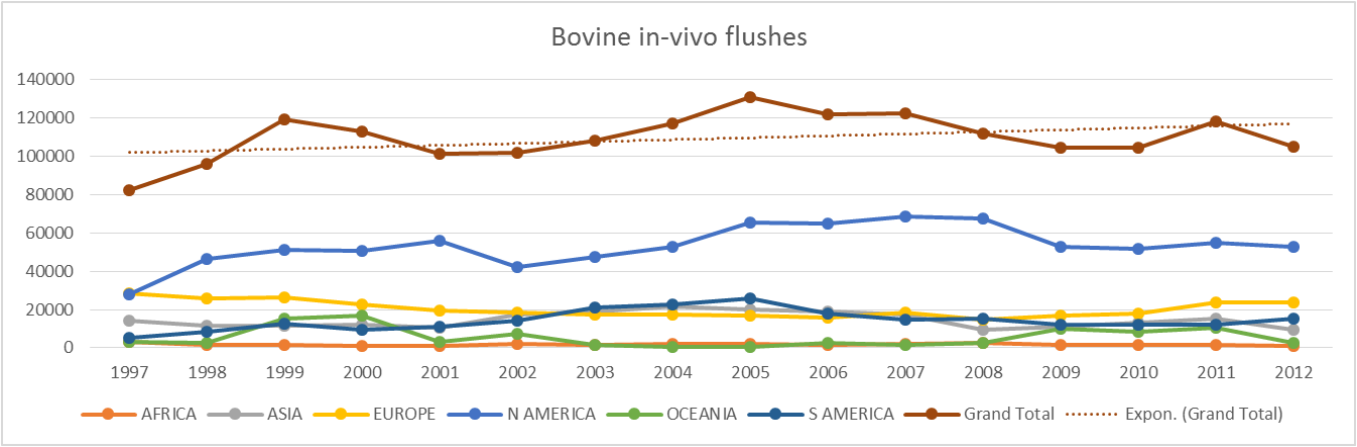

Figure 2 **Graph of transferrable in-vivo embryos collected per year.**

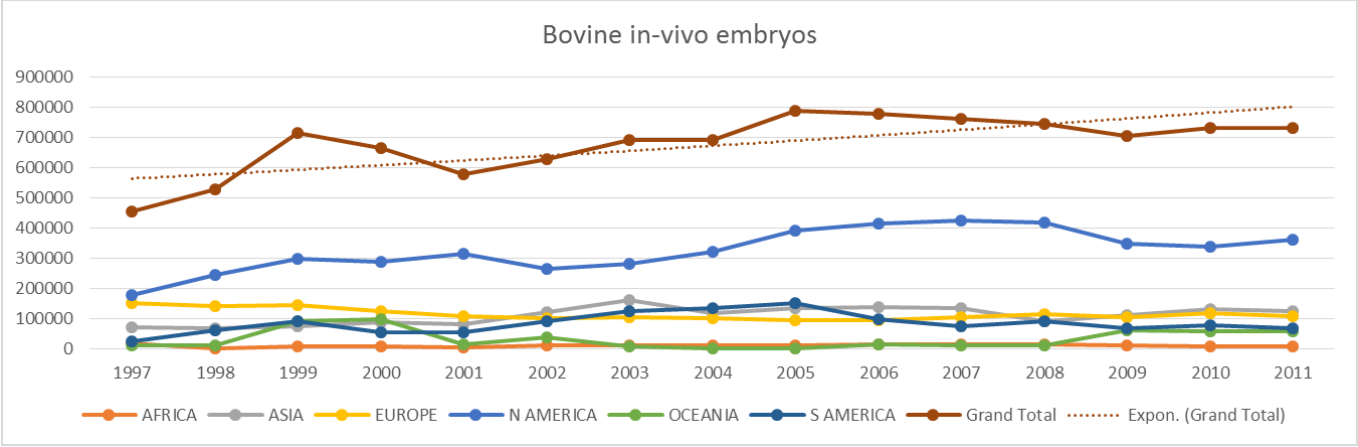

Figure 3 **Average number of transferrable in-vivo embryos collected per collection**

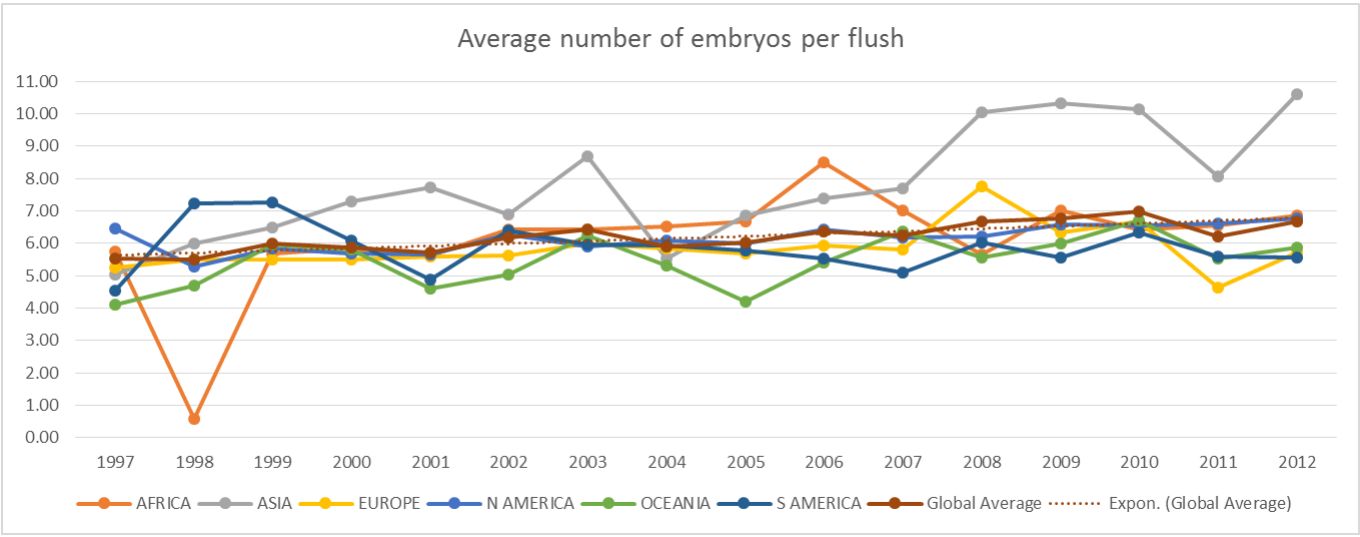

Table 8 In-vivo embryo transfers and exports by country

REGION / Country	EMBRYO TRANSFERS									EXPORTED		
	FRESH			FROZEN DOMESTIC			FROZEN IMPORTED					
	DAIRY	BEEF	TOTAL	DAIRY	BEEF	TOTAL	DAIRY	BEEF	TOTAL	DAIRY	BEEF	TOTAL
AFRICA												
Namibia	0	25	25	0	17	17	0	0	0	0	0	0
South Africa	216	3031	3247	119	2370	2489	53	516	569	20	961	981
Grand Total	**216**	**3056**	**3272**	**119**	**2387**	**2506**	**53**	**516**	**569**	**20**	**961**	**981**
ASIA												
Israel	238	0	238	45	0	45	0	0	0	0	0	0
Japan	2427	16956	19383	5410	37011	42421	1116	0	1116	0	0	0
Kazakhstan	213	0	213	447	0	447	0	0	0	0	0	0
Korea (South)	7	122	129	16	161	177	0	0	0	0	0	0
Thailand	368	105	473	0	105	105	0	23	23	0	0	0
Grand Total	**3253**	**17183**	**20436**	**5918**	**37277**	**43195**	**1116**	**23**	**1139**	**0**	**0**	**0**
EUROPE												
Austria	46	0	46	97	0	97	0	0	0	0	0	0
Belgium	1122	0	1122	3576	0	3576	0	0	0	0	0	0
Bosnia and Herzegovina	0	0	0	0	0	0	0	0	0	0	0	0
Croatia (Hrvatska)	7	0	7	22	0	22	0	0	0	0	0	0
Czech Republic	129	0	129	32	0	32	0	0	0	0	0	0
Denmark	2011	0	2011	928	0	928	0	0	0	0	0	0
Estonia	5	0	5	5	0	5	0	0	0	0	0	0
Finland	844	0	844	2810	0	2810	0	0	0	0	0	0
France	14778	0	14778	15416	0	15416	0	0	0	0	0	0
Germany	5834	0	5834	11169	0	11169	0	0	0	0	0	0
Greece	6	0	6	6	0	6	0	0	0	0	0	0
Hungary	167	0	167	417	0	417	0	0	0	0	0	0
Ireland	973	0	973	1053	0	1053	0	0	0	0	0	0
Italy	0	0	0	0	0	0	0	0	0	0	0	0
Luxembourg	0	0	0	0	0	0	0	0	0	0	0	0
Netherlands	4847	0	4847	17043	0	17043	0	0	0	0	0	0
Norway	0	0	0	45	0	45	0	0	0	0	0	0
Poland	437	0	437	346	0	346	0	0	0	0	0	0
Portugal	227	0	227	639	0	639	0	0	0	0	0	0
Russian Federation	177	0	177	479	0	479	0	250	250	0	0	0
Spain	1047	0	1047	875	0	875	0	0	0	0	0	0
Sweden	15	0	15	95	0	95	0	0	0	0	0	0
Switzerland	727	0	727	2146	0	2146	0	0	0	0	0	0
Turkey	0	0	0	0	0	0	0	0	0	0	0	0
Ukraine	177	0	177	479	0	479	0	0	0	0	0	0
United Kingdom	6598	0	6598	8361	0	8361	0	0	0	0	0	0
Grand Total	**40174**	**0**	**40174**	**66039**	**0**	**66039**	**0**	**250**	**250**	**0**	**0**	**0**
NORTH AMERICA												
Canada	25282	2295	27577	25263	5580	30843	237	123	360	7956	3611	11567
Mexico	139	811	950	85	461	546	93	476	569	0	0	0
United States	37729	34098	71827	29539	73133	102672	0	0	0	13409	5111	18520
Grand Total	**63150**	**37204**	**100354**	**54887**	**79174**	**134061**	**330**	**599**	**929**	**21365**	**8722**	**30087**
CENTRAL AND SOUTH AMERICA												
Argentina	810	9726	10536	2186	13563	15749	229	242	471	0	1957	1957
Brazil	9962	17378	27340	10067	13739	23806	0	0	0	0	0	0
Panama	0	0	0	0	0	0	0	0	0	0	0	0
Grand Total	**10772**	**27104**	**37876**	**12253**	**27302**	**39555**	**229**	**242**	**471**	**0**	**1957**	**1957**
OCEANIA												
Australia	398	5241	5639	513	5376	5889	184	1068	1252	50	1624	1674
New Zealand	1200	120	1320	800	40	840	30	80	110	0	0	0
Grand Total	**1598**	**5361**	**6959**	**1313**	**5416**	**6729**	**214**	**1148**	**1362**	**50**	**1624**	**1674**

Table 9 Number of bovine in-vivo fresh embryos transferred

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
AFRICA	5238	1992	3766	3566	2284	5557	3658	4430	3453	2063	3235	5749	4424	4685	4056	3272
ASIA	11416	12294	11684	15046	14703	39375	50975	56886	49814	60730	38601	18057	22958	34148	24026	20436
EUROPE	59997	59086	54286	47270	44890	41753	41289	39302	36500	36033	49973	39102	43999	48555	41040	40174
N AMERICA	65570	101532	98391	102285	110619	89472	101237	117949	130523	131510	136481	131934	111106	106400	109197	100354
OCEANIA	7610	5929	29182	32410	7927	17631	5531	1700	1300	7849	4177	5658	18522	21895	31921	6959
S AMERICA	18542	39390	58423	45679	47655	73952	87877	106711	110817	76521	49273	41506	42486	47353	36953	37876
Grand Total	**168373**	**220223**	**255732**	**246256**	**228078**	**267740**	**290567**	**326978**	**332407**	**314706**	**281740**	**242006**	**243495**	**263036**	**247193**	**209071**

Table 10 Number of bovine in-vivo frozen embryos transferred

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
AFRICA	3528	1019	1949	3197	2142	8785	2796	2602	3223	3118	4181	3298	4641	3730	2469	3075
ASIA	38308	34948	38487	43925	39574	53037	67778	61651	65745	123195	57132	44814	53172	53590	51697	44334
EUROPE	67525	61274	75494	58698	49713	48618	53328	48249	48787	51808	47994	50798	51074	60859	69381	66289
N AMERICA	59383	95301	99495	122166	111082	99652	112674	98670	146223	161095	165501	152009	137599	147271	139418	134990
OCEANIA	6827	3873	14626	15456	8523	15314	2762	1900	1360	5049	3694	7130	27573	37870	35130	8091
S AMERICA	16712	24657	34929	38842	10034	45166	10890	9229	14433	11740	17635	39628	16546	24205	26054	40026
Grand Total	**192283**	**221072**	**264980**	**282284**	**221068**	**270572**	**250228**	**222301**	**279771**	**356005**	**296137**	**297677**	**290605**	**327525**	**324149**	**296805**

Table 11 Total number of bovine in-vivo embryos transferred

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
AFRICA	8766	3011	5715	6763	4426	14342	6454	7032	6676	5181	7416	9047	9065	8415	6525	6347
ASIA	49724	47242	50171	58971	54277	92412	118753	118537	115559	183925	95733	62871	76130	87738	75723	64770
EUROPE	127522	120360	129780	105968	94603	90371	94617	87551	85287	87841	97967	89900	95073	109414	110421	106463
N AMERICA	124953	196833	197886	224451	221701	189124	213911	216619	276746	292605	301982	283943	248705	253671	248615	235344
OCEANIA	14437	9802	43808	47866	16450	32945	8293	3600	2660	12898	7871	12788	46095	59765	67051	15050
S AMERICA	35254	64047	93352	84521	57689	119118	98767	115940	125250	88261	66908	81134	59032	71558	63007	77902
Grand Total	**360656**	**441295**	**520712**	**528540**	**449146**	**538312**	**540795**	**549279**	**612178**	**670711**	**577877**	**539683**	**534100**	**590561**	**571342**	**505876**

Figure 4 **Number of bovine in-vivo fresh embryos transferred**

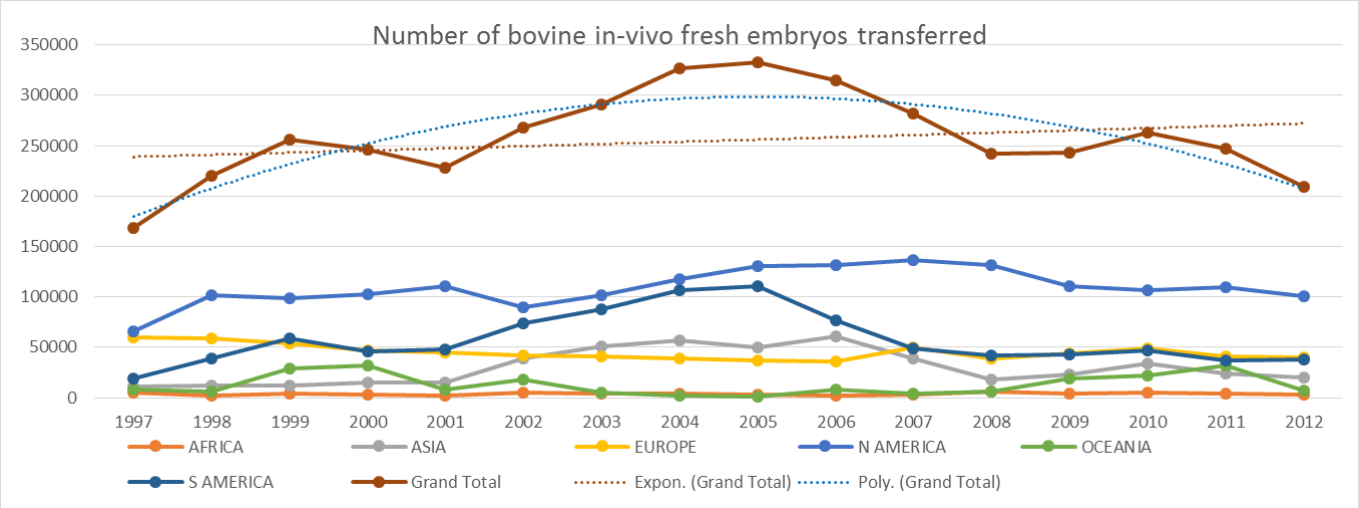

Figure 5 **Number of bovine in-vivo frozen embryos transferred**

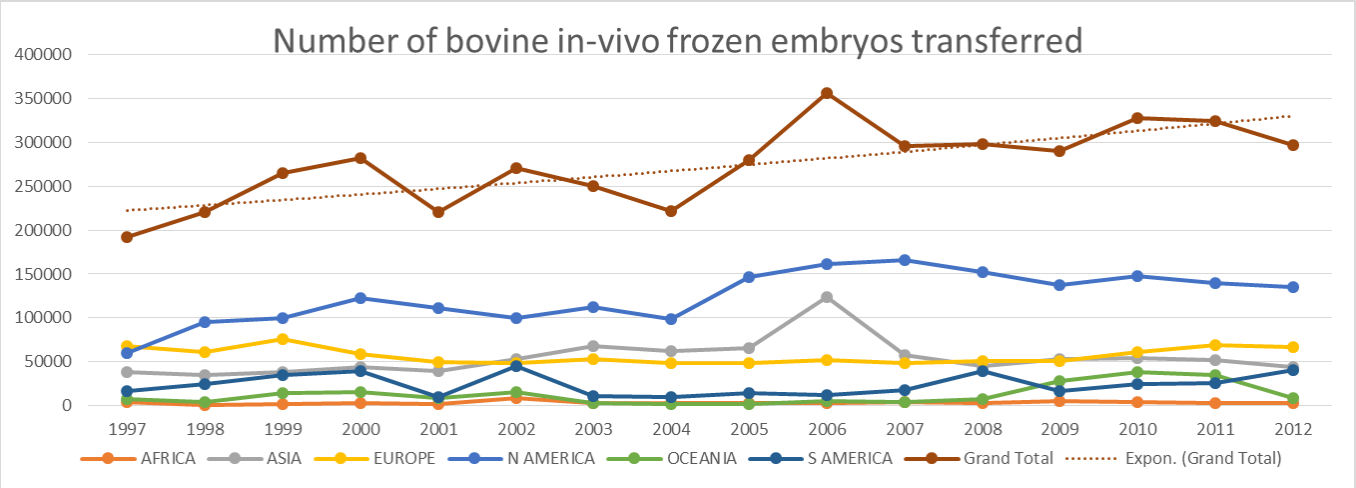

Figure 6 **Total number of bovine in-vivo embryos transferred**

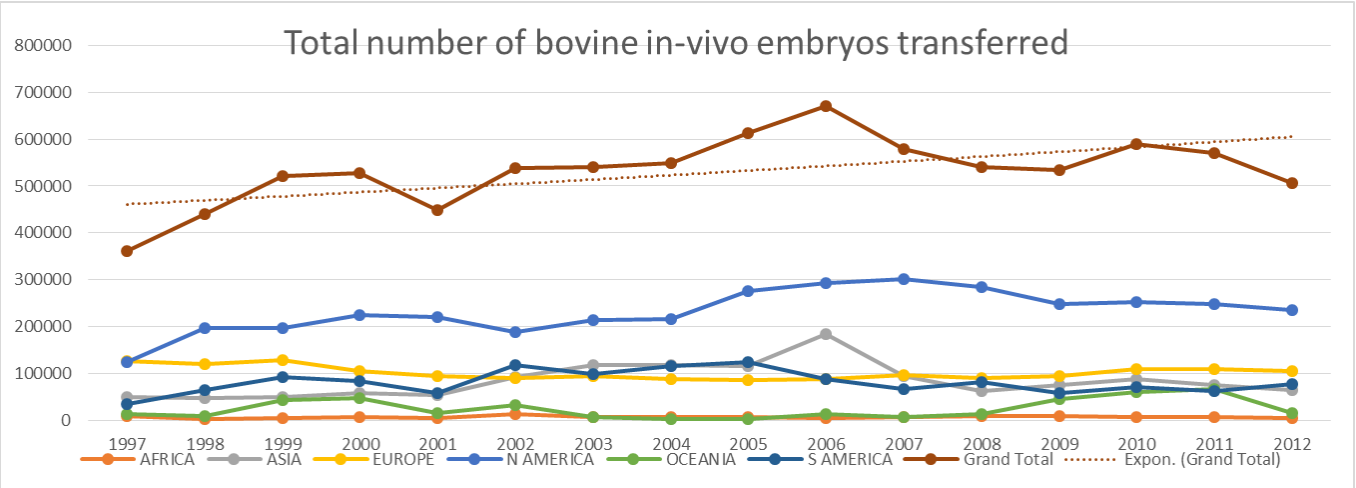

Table 12 Bovine in-vitro embryo production

REGION / Country	Ovum pick up							Abattoir						
	Collection			Transfers			Exports	Collection			Transfers			Exports
	Donors	Oocytes	Embryos	Fresh embryo	Frozen domestic	Frozen foreign		Donors	Oocytes	Embryos	Fresh embryo	Frozen domestic	Frozen foreign	
AFRICA														
Grand Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
ASIA														
Japan	1791	29317	3333	0	0	0	0	29830	596765	10685	4547	5827	0	0
Korea (South)	22	5827	1961	465	200	0	0	283	4382	1899	1350	85	0	0
Grand Total	**1813**	**35144**	**5294**	**465**	**200**	**0**	**0**	**30113**	**601147**	**12584**	**5897**	**5912**	**0**	**0**
EUROPE														
Czech Republic	1	12	2	0	0	0	0	0	0	0	0	0	0	0
Estonia	37	627	51	2	0	0	0	37	627	51	0	0	0	0
France	338	2414	639	337	299	0	0	1	20	0	0	0	0	0
Germany	1268	5562	3900	2021	891	0	0	0	0	0	0	0	0	0
Ireland	0	0	550	550	0	0	0	0	0	0	0	0	0	0
Italy	61	1340	234	0	479	0	0	134	1354	271	0	0	0	0
Italy (Buffalo)	*113*	*1195*	*177*	*0*	*0*	*0*	*0*	*212*	*1586*	*75*	*0*	*0*	*0*	*0*
Netherlands	3543	28587	3239	3011	652	0	0	0	0	0	0	0	0	0
Portugal	0	0	0	0	0	0	0	1125	10841	741	28	10	0	0
Switzerland	0	0	0	0	24	0	0	0	0	0	0	0	0	0
Grand Total	**5361**	**39737**	**8792**	**5921**	**2345**	**0**	**0**	**1509**	**14428**	**1138**	**28**	**10**	**0**	**0**
NORTH AMERICA														
Canada	1018	9549	4453	2653	339	0	49	0	0	0	0	0	0	0
Mexico	569	13681	2888	3180	52	0	0	150	1645	200	386	14	1516	0
United States	13950	266869	66901	29448	4874	0	0	0	0	0	0	0	0	0
Grand Total	**15537**	**290099**	**74242**	**35281**	**5265**	**0**	**49**	**150**	**1645**	**200**	**386**	**14**	**1516**	**0**
SOUTH AMERICA														
Argentina	461	7940	2308	1613	27	0	0	0	0	0	0	0	0	0
Brazil	72743	872927	349171	303168	28314	0	0	0	0	0	0	0	0	0
Panama	757	14333	3726	2420	452	0	251	0	0	0	0	0	0	0
Grand Total	**73961**	**895200**	**355205**	**307201**	**28793**	**0**	**251**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
OCEANIA														
Australia	0	0	0	0	125	0	0	0	0	0	0	0	0	0
Grand Total	**0**	**0**	**0**	**0**	**125**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Table 13 Bovine in-vitro embryo analyses

Country	Ovum pick up						Abattoir					
	No. of donors	Oocytes collected per donor	Oocytes per donor	Embryos for transfer	Embryos per donor	Oocytes to produce an embryo	No. of donors	Oocytes collected	Oocytes per donor	Embryos for transfer	Embryos per donor	Oocytes to produce an embryo
Argentina	461	7940	17.2	2308	5.0	3.4	0	0	-	0	-	-
Brazil	72743	872927	12.0	349171	4.8	2.5	0	0	-	0	-	-
Canada	1018	9549	9.4	4453	4.4	2.1	0	0	-	0	-	-
Czech Republic	1	12	12.0	2	2.0	6.0	0	0	-	0	-	-
Estonia	37	627	16.9	51	1.4	12.3	37	627	16.9	51	1.4	12.3
France	338	2414	7.1	639	1.9	3.8	1	20	20.0	0	0.0	-
Germany	1268	5562	4.4	3900	3.1	1.4	0	0	-	0	-	-
Ireland	0	0	-	550	-	-	0	0	-	0	-	-
Italy	174	2535	14.6	411	2.4	6.2	346	2940	8.5	346	1.0	8.5
Japan	1791	29317	16.4	3333	1.9	8.8	29830	596765	20.0	10685	-	55.9
Korea (South)	22	5827	264.9	1961	89.1	3.0	283	4382	15.5	1899	6.7	2.3
Mexico	569	13681	24.0	2888	5.1	4.7	150	1645	11.0	200	1.3	8.2
Netherlands	3543	28587	8.1	3239	0.9	8.8	0	0	-	0	-	-
Panama	757	14333	18.9	3726	4.9	3.8	0	0	-	0	-	-
Portugal	0	0	-	0	-	-	1125	10841	-	741	-	-
United States	13950	266869	19.1	66901	4.8	4.0	0	0	-	0	-	-
Grand Total	**96672**	**1260180**	**13.0**	**443533**	**4.6**	**2.8**	**31772**	**617220**	**19.4**	**13922**	**0.4**	**44.3**

Table 14 Bovine OPU in-vitro embryo collected

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
AFRICA	0	50	421	975	800	450	4832	2598	383	0	0	0	400	0	0	0
ASIA	28622	59680	136751	97011	92706	77199	228623	122142	136553	86945	77020	80817	80775	116614	62418	5294
EUROPE	11674	19180	24146	26520	13031	11084	12171	111128	18545	13942	5832	7832	7653	7155	8034	8792
N AMERICA	0	4690	1384	1741	0	20378	27413	2385	29243	134162	137958	17747	20390	43058	48474	74242
OCEANIA	1336	1300	0	1358	2000	521	5350	0	2007	1846	2275	4092	11325	15012	9196	0
S AMERICA	0	126	92	12667	668	51063	63341	80833	143916	204469	211496	220465	256033	268310	325349	355205
Grand Total	**41632**	**85026**	**162794**	**140272**	**109205**	**160695**	**341730**	**319086**	**330647**	**441364**	**434581**	**330953**	**376576**	**450149**	**453471**	**443533**

Table 15 Bovine OPU in-vitro embryo transferred fresh

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
AFRICA	0	200	31	1	10	4	4	74	0	0	0	0	100	0	0	0
ASIA	3151	4686	4089	6680	9216	13859	22297	42547	49099	20859	13767	6666	5923	15993	4086	465
EUROPE	7166	7347	6074	6377	4482	5952	3635	3437	2689	2763	2404	2314	2389	3412	8034	5291
N AMERICA	0	3980	2182	1382	498	464	1798	2070	1451	4306	9223	13142	17850	25778	17850	35281
OCEANIA	1701	0	895	930	974	42	474	0	898	1390	1392	1649	10666	13644	6679	0
S AMERICA	0	56	27	12527	199	46630	63164	80333	129340	196759	188726	204029	246260	256888	307278	307201
Grand Total	**12018**	**16269**	**13298**	**27897**	**15379**	**66951**	**91372**	**128461**	**183477**	**226077**	**215512**	**227800**	**283188**	**315715**	**343927**	**348238**

Table 16 Bovine OPU in-vitro embryo transferred frozen

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
AFRICA	0	100	17	21	156	97	139	47	8	0	0	0	0	0	0	0
ASIA	7409	7372	6114	5684	9465	8968	9262	107570	78396	61448	18695	5989	7764	6510	6699	200
EUROPE	11142	6766	7314	7426	4830	5191	4775	3196	3217	4082	3428	3287	3419	2249	3419	2345
N AMERICA	0	820	117	533	78	30	355	49	18	3	29	0	807	2322	2930	5265
OCEANIA	0	0	50	130	154	52	317	0	897	203	399	1226	683	654	1015	158
S AMERICA	0	0	42	0	202	2040	0	0	68	32	7194	16412	10088	12235	15879	28793
Grand Total	**18551**	**15058**	**13654**	**13794**	**14885**	**16378**	**14848**	**110862**	**82604**	**65768**	**29745**	**26914**	**22761**	**23970**	**29942**	**36761**

Figure 7 **Bovine OPU in-vitro embryo collected**

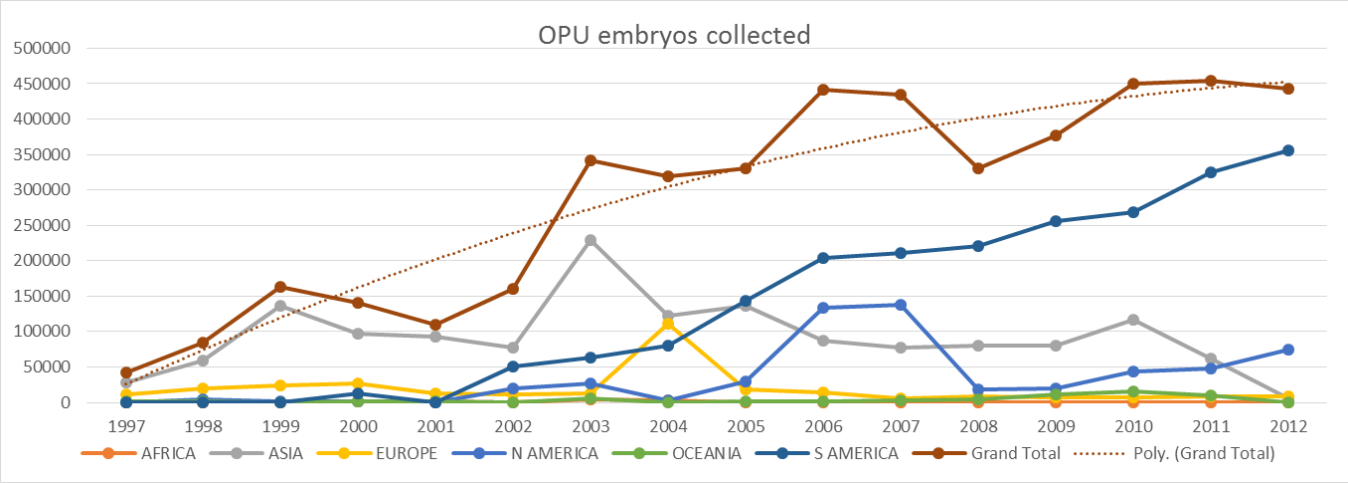

Figure 8 **Bovine OPU in-vitro embryo transferred fresh**

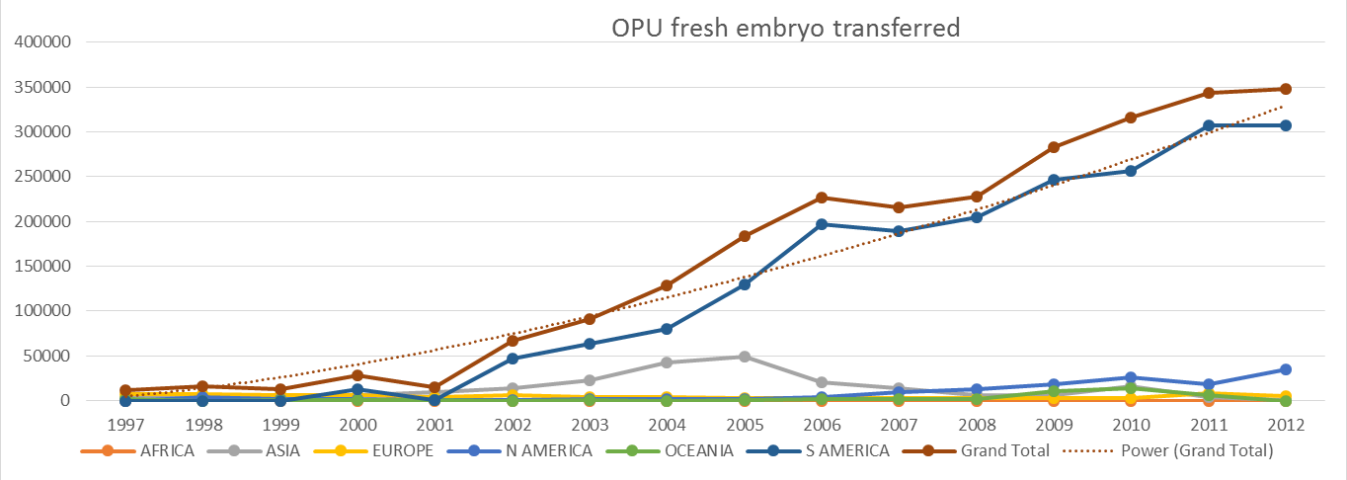

Figure 9 **Bovine OPU in-vitro embryo transferred frozen**

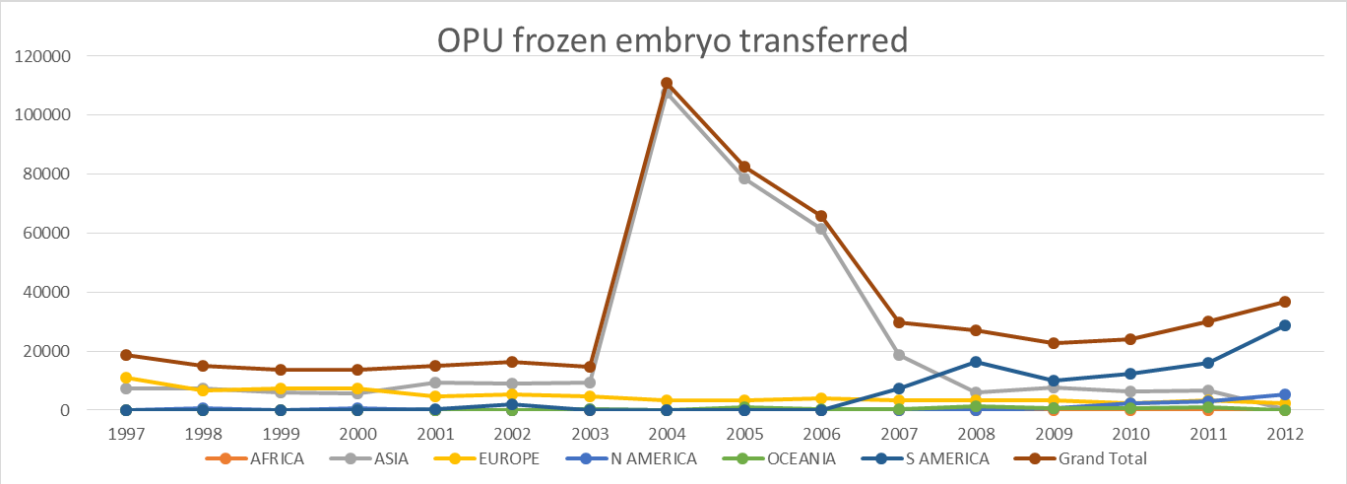

Table 17 Total number of bovine OPU in-vitro embryo transferred

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
AFRICA	0	300	48	22	166	101	143	121	8	0	0	0	100	0	0	0
ASIA	10560	12058	10203	12364	18681	22827	31559	150117	127495	82307	32462	12655	13687	22503	10785	665
EUROPE	18308	14113	13388	13803	9312	11143	8410	6633	5906	6845	5832	5601	5808	5661	11453	7636
N AMERICA	0	4800	2299	1915	576	494	2153	2119	1469	4309	9252	13142	18657	28100	20780	40546
OCEANIA	1701	0	945	1060	1128	94	791	0	1795	1593	1791	2875	11349	14298	7694	158
S AMERICA	0	56	69	12527	401	48670	63164	80333	129408	196791	195920	220441	256348	269123	323157	335994
Grand Total	**30569**	**31327**	**26952**	**41691**	**30264**	**83329**	**106220**	**239323**	**266081**	**291845**	**245257**	**254714**	**305949**	**339685**	**373869**	**384999**

Table 18 Total number of bovine IVD and IVF embryo collected

YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
AFRICA	17452	995	10426	8024	6018	13091	14896	15349	12995	13660	13459	13537	10528	9738	9401	7609
ASIA	101088	127460	211562	186074	173227	198150	391263	241299	272186	226479	212036	173160	193558	248332	186780	105852
EUROPE	162102	160922	169451	151555	122729	114080	116897	213117	115126	108032	112116	123176	114148	124968	116746	144009
N AMERICA	178818	250615	300564	289201	315628	285553	307845	323293	421475	549758	562011	437593	367921	381598	411255	430108
OCEANIA	14005	12710	92655	100426	17402	37873	14890	2650	4487	17086	13039	17026	71525	71787	68615	15538
S AMERICA	24425	61012	92492	69312	54278	141635	189726	214923	294350	304096	285387	312711	323126	345953	393536	440003
Grand Total	**497890**	**613714**	**877150**	**804592**	**689282**	**790382**	**1035517**	**1010631**	**1120619**	**1219111**	**1198048**	**1077203**	**1080806**	**1182376**	**1186333**	**1143119**

Table 19 Total number of bovine IVD and IVF embryo transferred

YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
AFRICA	8766	3311	5763	6785	4592	14443	6597	7153	6684	5181	7416	9047	9165	8415	6525	6347
ASIA	60284	59300	60374	71335	72958	115239	150312	268654	243054	266232	128195	75526	89817	110241	86508	65435
EUROPE	145830	134473	143168	119771	103915	101514	103027	94184	91193	94686	103799	95501	100881	115075	121874	114099
N AMERICA	124953	201633	200185	226366	222277	189618	216064	218738	278215	296914	311234	297085	267362	281771	269395	275890
OCEANIA	16138	9802	44753	48926	17578	33039	9084	3600	4455	14491	9662	15663	57444	74063	74745	15208
S AMERICA	35254	64103	93421	97048	58090	167788	161931	196273	254658	285052	262828	301575	315380	340681	386164	413896
Grand Total	**391225**	**472622**	**547664**	**570231**	**479410**	**621641**	**647015**	**788602**	**878259**	**962556**	**823134**	**794397**	**840049**	**930246**	**945211**	**890875**

Figure 10 **Total number of bovine OPU in-vitro embryos transferred**

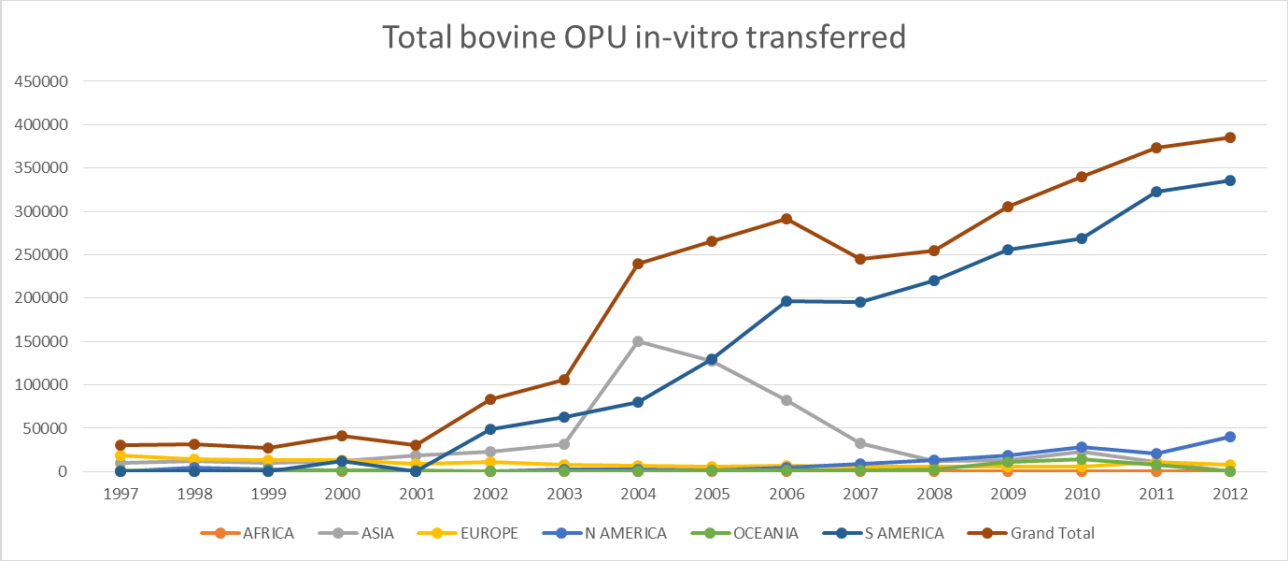

Figure 11 **Total number of bovine IVD and IVF embryos collected**

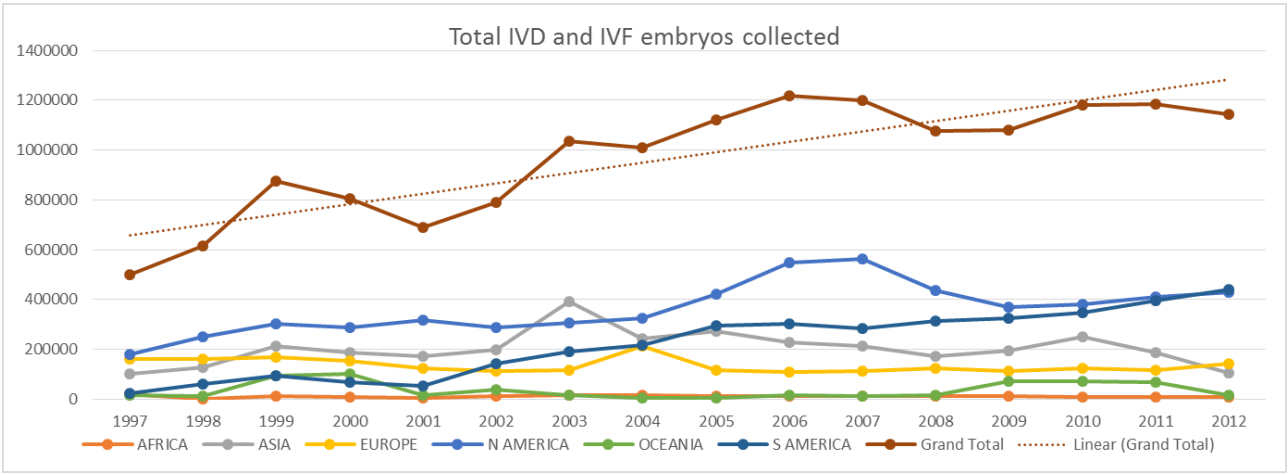

Figure 12 **Total number of bovine IVD and IVF embryos transferred**

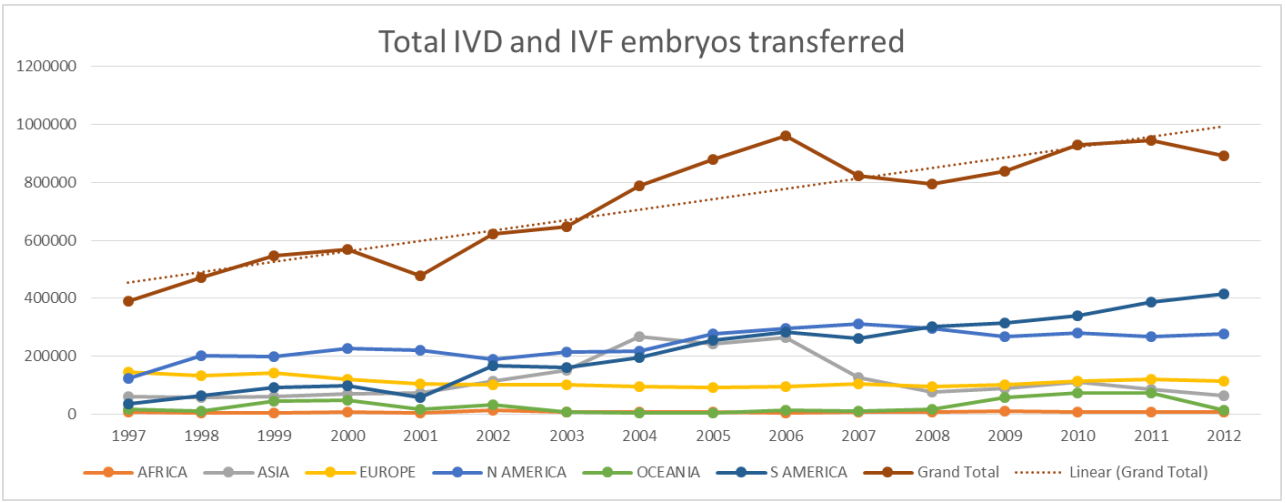

Table 20 Embryo transfer activity in other animal species

COUNTRY	COLLECTION		TRANSFERS			EXPORTS
	FLUSHES	IN-VIVO EMBRYOS	FRESH EMBRYOS	FROZEN DOMESTIC	FROZEN FOREIGN	
BUFFALO						
Canada	4	1	1	0	0	0
Grand Total	**4**	**1**	**1**	**0**	**0**	**0**
SHEEP						
Argentina	132	694	452	233	84	0
Australia	1037	7135	3888	3000	0	168
Bosnia and Herzegovina	1	2	2	0	0	0
Canada	22	104	79	0	0	550
Czech Republic	0	0	13	0	0	0
Denmark	0	0	13	0	0	0
Greece	0	116	0	0	0	0
Mexico	161	1241	1191	115	130	0
South Africa	637	4116	2047	666	0	505
Sweden	12	63	63	106	0	0
Turkey	0	0	250	0	0	0
United States	35	162	126	0	0	0
Grand Total	**2037**	**13633**	**8124**	**4120**	**214**	**1223**
GOATS						
Canada	34	77	0	0	0	0
France	0	406	406	0	0	0
Mexico	25	156	156	34	0	0
South Africa	183	789	66	0	0	621
United States	55	377	351	0	0	0
Grand Total	**297**	**1805**	**979**	**34**	**0**	**621**
CERVIDS						
New Zealand	81	292	292	45	0	0
Grand Total	**81**	**292**	**292**	**45**	**0**	**0**
HORSES						
Argentina	22173	14335	14335	7	0	0
Brazil	22100	16800	16800	0	0	0
Canada	65	32	30	0	0	0
Finland	1	5	1	0	0	0
Italy	0	91	74	0	0	0
Mexico	22	17	28	8	0	0
Poland	1	1	1	0	0	0
Switzerland	0	7	7	0	0	0
Thailand	0	0	0	0	0	0
United States	64	43	47	0	0	0
Grand Total	**44426**	**31331**	**31323**	**15**	**0**	**0**
SWINE						
Canada	24	525	485	0	0	525
France	29	485	525	0	0	0
Ireland	61	1468	1468	0	0	0
Grand Total	**114**	**2478**	**2478**	**0**	**0**	**525**

4 DISCUSSION AND CONCLUSION

The results of global embryo transfer activity (both IVD and IVF embryos) in cattle in 2012 indicate a drop in collection and transfers from 2011. Some of the fall is due to drop in reporting from several countries, especially those in Asia and Oceania. Although there is embryo transfer activity in other domestic farm animal species, especially sheep, it remains insignificant when compared with bovine embryo transfer activity.

The quality of the data submissions has varied greatly between regions and countries. Of the 225 countries on the database, 41 submitted data of embryo activity, with North America (3/3) and Europe (26/45) providing most data. Best quality and quantity of data were from countries with embryo transfer industry for livestock that is supported by a regulatory or industry code structure that required accountability of embryos collected and transferred. Data submitted represents only a portion of the embryo transfer activity globally. It is hoped that the structure and accessibility of the new IETS database will encourage more embryo transfer practitioners and more countries to contribute their data to the new IETS database. Even information on zero activity in countries where it is known that there is no embryo collection/production and transfers are of value. As stated earlier, the South African data collector, Dr de la Rey, reported zero activity in Botswana, Zimbabwe, Malawi, Mozambique, Democratic Republic of Congo, Tanzania, Burundi and Angola.

Of concern is the difficulty in collecting and processing data from practitioners working in other countries. Dr de la Rey advised that Brazil has been active in South Africa producing IVF embryos for which no data was provided. Professor Mapletoft provided data on Canadian practitioners working in several other countries. However, data collectors in those countries were unaware of such data until informed by the Chair when asked to confirm data. While steps were taken to remedy this, it may be necessary for the IETS Data Retrieval Committee to formalise future arrangements.

However, poor data submissions cannot entirely account for the situation in North America where bovine embryo transfer activity has fallen from a peak of 562,011 bovine embryos collected/produced and 311,234 embryos transferred in 2007 to 430,108 and 275,890 respectively in 2012 (Tables 18 and 19). North America usually provided good data year after year. For a long time the global leader in embryo transfer technology, North America has passed the crown to South America which reported 440,003 bovine embryos collected/produced and 413,896 embryos transferred in 2012 (Tables 18 and 19).

Similarly bovine embryo transfer activity has generally been stronger in Asia than in Europe. Submitted data indicate for the first time since 1998, Europe collected/produced more bovine embryos than Asia in 2012. Bovine embryo transfer activity in Asia appear to have become increasingly under-reported since the reports of a collection/production of 272,186 embryos in 2005 and peak transfers of 266,732 embryos in 2006. In 2012 Europe reported 144,009 bovine embryos collected/produced and 114,099 bovine embryos transferred while Asia reported 105,852 bovine embryos collected/produced and 65,435 bovine embryos transferred. As regards the decline in data submission from Asia, in 2012, no data was received from the People's Republic of China, Taiwan and Vietnam, where some practitioners had provided some data before 2010. Of particular note was the dramatic decrease in IVF technology reported, unlike the situation elsewhere, especially in South America (Brazil). Historical data show that Asia in the early years embraced the IVF technology and was for a time global leader in the use of IVF technology - to quote from the 2004 Annual Report:

> *In Asia, Japan has produced 34,000 transferable embryos and close to 10,000 were transferred, half of them as frozen-thawed. But it is in the People's Republic of China that this technology has been the most actively put into the field with more than 130,000 embryos imported and transferred. Further, some hundreds of embryos have been produced after ovum pick-up operations inside the country. In addition to those two countries, increased activity has been seen in Taiwan, in Thailand and in Korea. More than 60,000 transferable embryos were produced, mostly collected from abattoirs, and greater than 20,000 embryos were transferred,*

a quarter being transferred after freezing and thawing. Vietnam produced also close to 2,000 transferable embryos from which half were transferred, mainly as fresh embryos.

The Canadian data collector (Prof R Mapletoft) (*pers comm*) advised that most of the 130,000 IVF embryos imported into China and transferred and also most IVF embryo activity in the same year in Korea were from one Canadian company that is no longer in business.

In 2012, Thailand provided data on IVD embryos but not IVF embryos. Thus it is possible the size of the IVF embryo industry in Asia is very under-reported.

In 2012, globally, 104,883 flushes in cattle were reported, the lowest level since 2002 and is much lower than the peak of 130,861 reported in 2005 (Table 5 and Figure 1). Fortunately, progress in IVD embryo collection technology has resulted in improved recovery of transferrable embryos per flush, from 5.5 embryos per flush in the 1990's to around 6.5 in the 2010's (Table 7 and Figure 3). Thus drop in number of transferrable embryos collected has not been as marked as the drop in number of flushes (Table 6 and Figure 2). Even so, 699,586 transferrable embryos collected globally in 2012 is the lowest since 2004, lower than the peak in 2005 when 789,972 transferrable embryos was collected. The main reason for the global decline has been the drop in embryo transfer data from Africa and Oceania. In Africa, embryo transfer activity was once high because of exports but the foot-and-mouth disease outbreak there in 2011 has resulted in significant loss of export markets. In the Oceania, embryo transfer activity is grossly under-reported. Europe on the other hand went against the global trend in 2012, reporting 23,653 flushes and 135,217 transferrable embryos recovered, the highest since 1999. In South America, the use IVD embryos had been declining due to the rapid acceptance of IVF technology, falling from a high of 150,434 transferrable IVD embryos in 2005 to 67,093 in 2009. Surprisingly, despite the continuing utilisation of IVF technology, the number of transferrable IVD embryos increased from the low in 2009 to 84,798 in 2012. This is probably due to the increasing utilisation of sexed semen as support by recent research into improved biotechnology procedures resulting in better outcomes.

Of interest is the data from Japan, reporting 98,821 transferrable embryos from 8,245 flushes for an average of almost 12 embryos per flush. The database refers to "number of collections", meaning number of flushes. The author cannot as yet confirm whether the data actually referred to 8,245 donors rather than flushes.

Perhaps an important reason for the decline in IVD embryo technology was due to the fall in transfer of fresh IVD bovine embryos (Tables 8 and 9). Two trendlines are shown in Figure 4, showing changes in transfer of IVD fresh embryos. The polynomial trendline more accurately reflects the trend than the exponential trendline and indicates transfers of fresh IVD embryos to be decreasing from a high of around 300,000 average during 2004-2006 to around 200,000 and is likely to continue to decline in the future. The exponential trendline on the other hand indicates a steady increase over the past 16 years.

Unlike the transfer of fresh bovine IVD embryos, the transfer of frozen IVD embryos seem to be increasing steadily (Figure 5), with the exponential trendline on the indicating a global steeper increase over the past 16 years averaging around 6,000-7,000 frozen embryos transferred per year, despite the drop to 296,805 in 2012. The peak was 356,005 in 2006.

However, when data for transfers of fresh and frozen bovine IVD embryos are combined, Figure 6 show the fall in IVD embryos to be steadily decreasing to 505,876 embryos from the peak in 2006 of 670,711 embryos. In fact the 2012 data show the lowest level of embryo transfer transfers since 2002. This is probably due to the increased utilisation of IVF embryo transfers replacing IVD embryo.

Data was first collected for IVF embryos in 1997 when the technology was in its early days. Tables 12 to 16 and Figures 7 to 10 gives an insight into how far this technology has progressed and how well established it has become. What is rather surprising is the apparent lack of international trade in IVF embryos. There are several reasons for this, including:

- Trade does occur, especially between European countries. However, Europe AETE does not currently collect export data.
- There has been inadequate research into disease transmission risks associated with IVF embryos. Many countries limit international trade in IVF embryos for this reason.
- Most IVF embryos are transferred fresh. Brazil is currently by far the world's biggest producer and user of the IVF embryo technology, being more economical and successful than IVD in the *Bos indicus* breeds. Furthermore, Brazil is using transportable embryo incubators that enable them to send IVF embryos from the laboratory in the in-vitro culture (IVC) stage up to 2,000 kilometres by air around the countryside (*Pontes et al (2010) Theriogenology 74: 1349-1355*). The author is not aware of studies to determine the viability for international trade in fresh IVF embryos though studies in transportation of fresh IVF embryos continue (*Itoi et al. (2012) PLoS ONE 7(10): e47512. doi:10.1371/journal.pone.0047512*).

Generally, transfer of frozen IVF embryos result in lower reproduction rates than with fresh IVF embryos. IVF bovine embryos, especially those of *Bos indicus* breed, are more sensitive to cryopreservation than IVD embryos due to their higher lipid concentrations and research in improving the outcome of IVF frozen embryos is continuing. Perhaps Asia, in particular tropical regions of Asia, need to consider adapting the fresh IVF embryo technology to replace frozen IVF embryo technology (*Stewart et al (2011) Journal of Dairy Science 94: 3437–3445*).

The use of ovum pick-up (OPU) technology in live animals with IVF embryos is much more widespread than the abattoir method, where ovaries are collected from slaughtered cattle in abattoirs, in all regions except Asia where Japan reported collecting ovaries from nearly 30,000 abattoir slaughtered cattle, mainly the full blood Japanese Black cattle breed, for culturing IVF embryos. The low number of OPU donors (22) and high oocyte recovery (5827 oocytes) reported by Korea is of interest. The author has not yet received confirmation but considers this may be due to OPU's being repeated at regular intervals on individual donors.

The collection and transfer of IVD embryos in other animal species, namely buffalo, sheep, goats, cervids, horses and swine, are detailed in Table 18. Because it is most likely there was gross under-reporting of data from these species, little comment can be made about the results. The author has not yet attempted to determine if it possible to retrieve historical data to the extent that trends can be analysed.

However, of the 12 countries reporting sheep embryo transfer activity, Australia continues to dominate although the actual data is likely much higher given that only a proportion of Australian sheep embryo transfer practitioners provided data. South Africa is normally a significant producer of sheep embryos but loss of export markets due to the foot-and-mouth disease outbreak in 2011 has affected the livestock embryo transfer industry. Despite this, South Africa led the world with embryo transfer activity in goats in 2012. Embryo transfer activity in goats was reported by only six countries.

New Zealand was the only country reporting embryo transfer activity in deer (cervids) while Canada, France and Ireland were the only country reporting embryo transfer activity in swine.

Both Argentina and Brazil reported significant embryo transfer activity in horses despite what may be considered poor results with a combined total of 31,135 fresh embryos collected and transferred from 44,273 flushes, that is, 0.7 embryo per flush. This is in marked contrast to the global average of 6.68 bovine embryos per flush in 2012, so recovery of transferrable embryos in horses remain a challenge. Many countries under-reported embryo transfer activity in horses because of difficulties in obtaining such data. Not all owners declared foals as an embryo transfer foal when registering with their respective breed societies and not all breeding farms or their embryo transfer practitioners will provide information about embryo transfer activities in horses. It is suspected that there may be as many as 15,000 and 3,000 embryo transfers in horses in USA and in Europe respectively.

So in conclusion, despite under-reporting and an apparent decrease in IVD embryos for the many reasons discussed above in 2012, the future for embryo transfer technology in domestic animals remain strong and should in the main continue to increase. Efforts will be made to improve the level of reporting of embryo transfer data.

5 ACKNOWLEDGMENTS

Firstly I thank the Board of Governors for their support in the development of the new web-based secure database for the receipt, storage and download of all data received from collectors and individual embryo transfer practitioners around the world. This has given a renewed impetus to the collection, storage, processing and analyses of data and enabled improvements to the annual reporting of the results.

I thank all the regional and country collectors for their persistent and tireless efforts in collection, collating and forwarding data to the IETS. This is a voluntary task. In addition, the Committee as a whole acknowledges the excellent work of the past Chairs (Professor Michel Thibier and Dr Brad Stroud) with the legacy they left in encouraging the ongoing success of the Committee. I also thank Professors Reuben Mapletoft and Michel Thibier for their editorial input to this report.