A Draft Business Case for the establishment of the Animal Breeding and Reproduction Technology Platform
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1) Executive summary

The purpose of this document is to present a situational analysis of animal breeding and reproduction technology in South Africa, and develop a business case to support the establishment of an Animal Breeding and Reproduction Technology Platform (ABRTP) for the country. Animal production is an important industry in the country accounting for 46.4% of the total gross value of agricultural production which at year end 30 June 2013 stood at R180 360 million.

Current breeding methods rely on calculating estimated breeding value (EBVs) based on phenotypic data. The accuracy of this can be improved by augmenting phenotypic data with genotypic data. However, in order to do this, data for reference populations of each breed must be built up. The size of a reference population is scientifically determined. South Africa needs to develop the information infrastructure in order to apply genomic technologies effectively for deploying improved breeding strategies.

The Irish Cattle Breeding Federation (ICBF) embarked on a process to establish interconnected databases to enable improved breeding. It has been an industry led and government supported initiative that has been successful in helping to make more accurate breeding decisions, design better breeding programmes and spotting problem areas where there are declining trends. The Australian Coordinated Research Centre programme also works on the basis of government, industry and academia collaborating to achieve specific technology development goals. The Beef CRC initiative in particular has shown improved genetic gain and increased reproduction rates amongst other factors.

The proposed ABRTP will also function around strong collaboration between government, private sector and academia. A governance model that enables technology development needs of industry to be prioritised and implemented. The structure promotes transparency and regular reporting to stakeholders. A financial plan requiring an investment of R329,525,631 is presented. Guidelines on the type of projects that will be supported are presented.
2) Introduction

Livestock production is the most important agricultural activity in many of the countries in Southern Africa. The estimated total gross value of agricultural production for year ending 30 June 2013 was R180 360 million and animal products contributed 46.4% to that.

The most critical subsectors in descending order of importance to the agricultural economy with specific reference to the livestock sector are poultry and related products, which contribute 45% followed by the beef contributing 23%, then dairy sector contributing 14%. The sheep and goats contribute 6%, pigs 4%, wool 2% and other subsectors jointly contribute 5% to the livestock economy.

About 85% of the country’s meat requirement is produced locally with the balance being imported from Namibia, Botswana, Swaziland, Australia, New Zealand and Europe. From 2000-2010, South Africa was unable to meet its consumption demand for beef, as shown in the figure below. This indicates that the country is not self-sufficient in beef production, as the consumption of beef has been consistently higher than beef production throughout the period.

![Figure 1: Beef Production vs. Beef Consumption in South Africa 2000 - 2010](image)


South Africa has been relying on beef imports to meet its demand. From 2003 to 2010, beef imports were far greater than exports and there was a marked decrease of 59% in beef exports from 2001 to 2010. The figure below compares the beef imports and exports over the 2001 to 2010 period.
Figure 2: Beef Exports and Imports Quantities 2001 - 2010

The graphs above are illustrative of the beef industry but are reflective of other livestock categories as well. South Africa has the potential to grow the livestock industry significantly.

Subsector overview

The dairy industry consists of about 4000 milk producers employing over 100 000 workers across the country. The industry is built on major breeds namely Holstein, Jersey, Guernsey and Ayrshire. Value chain activities consists of production and marketing of raw milk, pasteurised milk and cream, fermented milk, long-life milk and cream, yoghurt, cheese and its by-products, namely whey, milk powder, sweetened and unsweetened concentrated milk, butter and butter oil (ghee). Beef production focuses on the following breeds; The Brahman, indigenous Afrikaner and Nguni, Tuli, Boron, Bonsmara, Drakensberger, Simbra, Beefmaster and Brford. The commercial farmers own 60% of the 14,1 million cattle available in South Africa. The major cattle producing areas in descending order of importance are Mpulamalanga, Free State and Gauteng contributing a total of 66% of the country cattle population.

With regards to small stock (sheep and goats), the country has an estimated 28,8 million sheep in the Eastern Cape, followed by the Northern Cape, Free State, Western Cape and Mpumalanga. Dual purpose breeds found in the country includes; South African Merino, Dohne Merino, the Afrino and Letelle produced for their wool and meat. The mutton breed is
the Dorper. Indigenous fat-tailed and Karakul sheep are still found. The subsector consists of 8000 commercial farmers and 5800 communal farmers. Eastern Cape and Limpopo dominate in terms of number of goats with 37% and 21% respectively. The common goat breeds are Boer goat, Angola goat (mohair).

Game ranching is the fastest growing industry in the country. It generates about R1 073 million annually, which amounts to 2.3% of the South African agricultural sector’s contribution to the economy. Consisting of 15000 farms and 8000 fenced game ranches, the subsector is managed by National Game-Farming Working Group made up of key stakeholders. The subsector has The National Game-Farming Policy whose aim is to: support the effective management of viable game-farming systems ensure the sustainable management of natural resources facilitate the development of norms and standards for sustainable game farming promote and support equitable access to health management, establish a national game-farm and animal, database facilitate promotion and marketing, deal with relevant food-safety issues promote research, training and support and services. Other important sectors include Beekeeping and aquaculture.

The need for improved breeding and reproduction technologies
The following factors on the strategic potential of the livestock sector should be considered:

- It is estimated that almost 80% of the country is considered semi-arid with inadequate or unreliable rainfall to sustain crop production. The South African climate and vast grassland resources are highly suited to livestock production, thus as a country we are not effectively utilising an important competitive advantage.
- About 40% of the national cattle herd is owned by small-scale rural farmers, yet only 10% of this is reflected in the annual commercial off-take. This would suggest that there is huge potential to improve farming and market systems for small-scale livestock farmers and thereby facilitate socio-economic development.
- South African indigenous farm animal breeds have not been adequately conserved and risk extinction in some cases. Certain breeds like the boer goat have been used in breeding improvement schemes internationally but are not sufficiently utilised in SA.
- South African livestock improvement schemes have been running since 1917 and have established an excellent database of phenotypic data. However phenotypic data has not been augmented with genotypic information to update the estimated breeding value system. The livestock industry therefore has not yet benefitted from increased rates of herd improvement that can be achieved from the recent advancements of molecular genetic technologies. In this case we are not adequately leveraging a competitive advantage that the country has strategically invested in over a long period.
- SA has a competitive advantage in Africa having adapted breeds to prevailing African conditions and pests. As countries in Africa invest in the development of their
agricultural sectors, SA can play a strategic role in supplying the African market with appropriate genetic material and technologies.

- South Africa has the potential to grow the livestock industry significantly and could ultimately become a net exporter of high quality genetic resources, meat, animal products and value-added animal products.

South Africa has a number of indigenous breeds; imported breeds that have been adapted to prevailing environmental conditions and composite breeds specially developed for the South African climate and economic needs. Effective breeding programmes have been at the foundation of sustainable livestock industries. Legislation, together with sound science and technology has helped to ensure that the genetic merit of South African livestock has been improving over generations. Pedigree and performance data have historically provided a means of assessing genetic merit. Recent developments in molecular biology, bioinformatics and genomics have provided new tools for assessing genetic, which augmented with traditional methods provide more accurate measures. Breeding and reproduction technologies also provide enablers for speeding up the process of genetic improvement in herds. Some of these technologies are available in SA and some require industry wide initiatives to implement them. This document provides a situational analysis and a proposal for the establishment of an Animal Breeding and Reproduction Technology Platform to enable South Africa to utilise cutting edge technologies to ensure the sustainability of the livestock industry.

3) Perspectives on Technology Platforms

“Technology Platforms” are defined differently across countries and sectors. However, almost all definitions seem to involve a structure (physical or virtual) that provides for government, academic and industry players to combine resources in order to facilitate technology development in areas that would improve national competitiveness.

The TIA Investment Policy defines technology platforms as “…significant capital investments in infrastructure where the targeted outputs are not [the] development of specific technologies into products but instead the provision of a service to the National System of Innovation that lowers the barriers for others to engage in technology innovation.” The platforms must support the development of technologies with market interest either now or envisaged in future.
TIA uses Technology Platforms to realise several objectives:

- Intervene systematically in specific value chains, preferably within TIA sectors of interest where infrastructure gaps are a hurdle to maturation of innovation;
- Create local technological capacity and the critical mass of expertise to undertake further technology development with commercial prospects;
- Promote pre-competitive technology development collaboration among industry partners;
- Promote shared R&D priorities between industry and academic players within the same innovation value chains;
- Exploit economies of scale and lower the risks of failure by clustering related projects around shared facilities;

4) Situational Analysis of Animal Breeding and Reproduction Technology

4.1 Policy Environment

There are a number of policies of the South African government that provide support for innovation, competitiveness and agricultural development in the country. These include the National Development Plan, The Agricultural Policy Action Plan, Industrial Policy Action Plan and the Rural Development Framework. This is by no means an exhaustive list, and the extent of the policy literature that informs current thinking around the Animal Breeding and Reproduction Technology Platform is significant. For the purpose of this discourse we will focus on salient policies of the Department of Science and Technology and The Department of Agriculture Forestry and Fisheries.

The Department of Science and Technology (DST) has championed policies such as the Science and Technology White Paper, The National Research and Development Strategy and the 10 Year Innovation Plan. From these policies various pieces of legislation to enable aspects of the National System of Innovation emerged. The legislation included the Technology Innovation Agency Act, the Intellectual Property Rights from Publicly Financed
Research and Development Act and the R&D tax incentives in the Income Tax Act. The DST has most recently published the Bio-Economy strategy. Agricultural biotechnology is a specific thrust of the strategy, the purpose of which is to ensure food security, enhance nutrition and create jobs through the expansion of sustainable agricultural production and processing. The country's biodiversity, wealth of indigenous knowledge and established biotechnology capacity provides the country with assets that offer a comparative advantage over other countries. The strategy calls for strong industry partnerships to grow the bio-economy and extract the full potential of the country's biodiversity.

There are also a number of policies supportive of agricultural development. The Department of Agriculture, Fisheries and Forestry (DAFF) published the Livestock Development Strategy in 2007. The Strategy noted “Research and Development” as a key factor in creating an enabling environment for the industry. It further noted “Biological efficiency of livestock” as a key element. Strategic interventions for that element would concentrate on:

- Research and Development on sustainable systems for livestock production
- Reproductive efficiency, growth and development
- Genetic improvement and enhanced genetic variation
- Improved efficiency, animal nutrition
- DNA technology and services
- Technologies for diagnostics, services and research
- Integrated livestock and crop systems (especially in communal and resource poor farming areas, e.g. Kwa-Zulu Natal, Limpopo, North West and Eastern Cape), animal health and the management of animal waste

4.2 Legislative Context

The Animal Improvement Act (Act 62 of 98) which is the administered by the Department of Agriculture, Fisheries and Forestry (DAFF) provides the legislative framework for animal breeding programmes in South Africa. The Act provides “for the breeding, identification and utilisation of genetically superior animals in order to improve the production and performance of animals in the interest of the Republic; and to provide for matters connected therewith.”

The Act makes provision for an Integrated Registration and Genetic Information System. This system should provide the information detailing the pedigree and performance data related to individual animals of genetic importance according to their breed. Breeders’
societies are recognized by the Act as custodians of the breed. Such societies are responsible for providing the Registrar of the Act with the defining characteristics of a specific breed i.e “breed standards”. According to the Act “breed standards” mean a written set of phenotypic or genotypic standards of excellence determined and applied in terms of the constitution of an animal breeders' society for a kind of animal.

4.3 The Breeding Process

Information on pedigree and performance provides the basis of calculating estimated breeding values (EBVs) which are an important estimate of genetic value which ultimately correlates to the market value of a breeding animal. The DAFF has assigned the management of the Integrated Registration and Genetic Information System to the Agricultural Research Council (ARC). It is a web-based database called INTERGIS 2000 which provides access to all users in the animal production value chain. This is a national resource that promotes transparency on information related to breeding animals and forms the data source for calculating EBV’s.

Once the breeding goals have been set the best sires and dams are chosen. Selection of breeding lines is based on phenotypic selection and the calculation of EBV’s. These values are based on performance across certain traits. Performance testing is recognised as a very effective tool for increasing economic returns of livestock production. However it is dependent on the time it takes for each generation to go through reproductive and productive cycles and therefore improvements tend to be seen after significant time investment as demonstrated in Figure 4.
Most modern breeding programmes augment phenotypic selection together with genomic selection to calculate Genomic Estimated Breeding Values (GEBV). Schefers and Weigel (2012) state that “GEBVs are calculated by estimating Single Nucleotide Polymorphism (SNP) effects from prediction equations which are derived from a subset of animals in the population (i.e., a reference population) that have SNP genotypes and phenotypes for traits of interest.

The accuracy of the GEBV depends on

- the size of the reference population used to derive the prediction equations
- the heritability of the trait
- the extent of relationships between selection candidates and the reference population.

The GEBV helps to speed up the selection of genetically superior breeding lines. Instead of waiting a minimum of 4 years, artificial insemination companies can use the best DNA tested as sires of sons as soon as they reach sexual maturity (about 1 year). This is a considerable
time saving in herd improvement and benefits of this method have been reported in the
Australian, French and American Dairy Cattle Industries.

4.4 Status of Animal Breeding and Reproduction Technology in South Africa

Animal Breeding

Livestock breeding is highly sophisticated and technology intensive in South Africa. In most
cases genetic material flows as follows:

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elite breeders → multipliers → commercial farmers
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Thus it is the elite breeders that usually set the priorities and pace of genetic change. The
buying decisions made by commercial farmers are based on pedigree and estimated
breeding values as explained above. In SA the INTERGIS database system under the
custodianship of the ARC holds the pedigree and performance data to support the
calculation of estimated breeding values. Most breeding programmes focus on feed
conversion ratios, fertility Data is per breed as recognised by the Animal Improvement Act,
and breeders societies are responsible for recordings of all stud animals. Artificial
Insemination companies and herdbook management companies provide support services
along this value chain.

Reproduction Technology

The sciences of animal physiology and embryology have provided the basis of developing
technologies that control the reproductive function. Such reproduction technologies provide a
means for more rapid improvement of animals of economic importance. Embryo transfer
technology has been successfully implemented by the ARC amongst emerging farmer
communities. It involves the removal of an embryo from a cow of superior genetics and
implantation in a cow within the farmers herd. The donor cow is treated with hormones to
stimulate and multiply ovulation. She is then inseminated 3-4 times and after 7 days the
uterus is flushed. Good quality embryos are then transferred to synchronised recipient
cows. In this way animals of significantly superior genetic merit can be introduced into herds
within a single breeding cycle. Many other reproduction technologies are being developed
internationally and in South Africa. Use of reproduction technologies vary according to the
type of production system, e.g. AI and Embryo Transfer, ovum pick-up for dairy cattle, limited
breeding seasons and oestrus synchronization in beef cattle, laparoscopic insemination in
small stock. Such technologies whilst available in the country have the potential to be
diffused on a much wider scale.
Stakeholder perspectives

In preparation of this business case, we engaged in intensive consultations with many stakeholders involved with animal breeding and reproduction. Their opinions are presented below.

Technology availability and utilisation

- Whilst the use of breeding values is an established practice in scientific communities, it is not always absorbed into production environments. Despite efforts by the ARC to ensure technologies reach end-users, generally, there is inadequate utilization of genetic information in herd improvement and the bulk of breeding stock are still bought without any performance data especially for sheep.
- Breeding is done by stud breeders and commercial farmers make more use of reproduction technologies
- Some stakeholders noted that Genomics is a relatively new technology and therefore its adoption is proceeding at a slow pace owing mainly to the cost of the technology. The expertise within the country is also still limited. In addition, the competition and the fragmentation of the livestock industry currently plagues the implementation of genomics with the industry. It is important that collaboration is forged among the different role players in the industry. The progress that has been made so far regarding the establishment of the SA genomics consortium is a step in the right direction.
- To ensure that there is capacity to support the utilisation of new technologies by end-users, capacity building efforts through short regular courses, graduate and post graduate training, regular contributions to articles in semi-scientific and popular press and rendering professional advisory services to participants. This is currently part and parcel of the research efforts, albeit on a lower scale and is an area for improvement.

Industry dynamics

- Fragmentation in the industry creates challenges in terms of providing animal breeding and reproduction technologies to the end-users in a consistent and coherent manner. This fragmentation should be attended to avoid duplication of efforts, unhealthy competition and wastage of scarce resources.
• There are varying degrees of transparency in the industry. Some commodity organisations are more open to collaboration than others. Breeders are generally transparent with regards to their methodology and the genetic merit of their animals. Breeders’ societies act on behalf of their members and vary in transparency. Most of industry is open to collaborative projects.

• Animal industry players agreed that the country needs a coordinated vehicle or institution to share the risk of research, participate in prioritising research, invest in technology development and participate in technology transfer in order to improve the potential of the SA animal industry.

• The institution must be industry driven not government driven and must be pitched at industry level.

• The structure must promote innovation and financial resources from financiers must not be used to restrict participants to specific research programmes and funding support to be granted on a competitive basis subject to guidelines developed by the structure.

• The structure must only coordinate existing structures and centres able to do research and to prioritise projects and oversee funding (similar to the way the Red Meat Research and Development (RMRD) operates).

4.5 Status of Animal Production Research in South Africa

The public purse funds much of the agricultural research in South Africa with the ARC being the primary agency responsible. The Animal Products Institute (API) and the Onderstepoort Veterinary Institute (OVI) are the two divisions of the ARC that are primarily responsible for animal research. Many of the major Universities have departments which teach and conduct research relevant to animal science. These institutions in the National System of Innovation (NSI) form key participants in any initiative to improve animal breeding and reproduction technology in the country.

The Red Meat Industry Forum is responsible for managing the collection of the levy for cattle, sheep, goats, red meat, red meat products, hides and skins, and livestock agents. Levy collection is done across the animal value chain. The industry collected R16m (2008-2010), R22.7m (2010-2012) and will have collected R25m by 4th of November 2014. The proceeds are utilised to promote industry (advocacy) and some is applied towards research and development. The budget for R&D for the period ending November 2014 is R3.3m which is 13.2% of the total levies collected during the levy period. The pork industry through SAPPA applied to increase statutory levies on pork at the point of sale from 1 November
2013. The proposed levy period will run until 31 October 2016. The association would have collected R65.4m by end of the levy period. However, it is not clear how much of the proceeds will be applied towards research and development. The SA Poultry Association collected R6.4m and R8.2m in levies and bulletin income for 2011 and 2012 respectively. The association applied R1.177m towards research and programmes in 2011, R663k in 2012 and at least R2.1m was budgeted for research in 2013.
5) International Benchmarking

Several countries have established programmes to ensure that animal breeding initiatives are coordinated and bring together government, academic and industrial players. This section will review the initiatives that are currently underway. Some initiatives have started with different goals and technologies, and have recently adopted genomics based technologies as key enablers. The Irish Cattle Breeding Federation and the Australian Beef Cooperative Research Centre provide the most relevant examples for benchmarking and identifying lessons learnt.

5.1 The Irish Cattle Breeding Federation

The ICBF (initially the Irish Cattle Breeding Authority (ICBA)) was established in 1997, with the Irish Government Department of Agriculture Food and Forestry as a key player and was always designed for phased withdrawal of that department. It was envisaged that ownership and control of the ICBF would lie with industry. The ICBF 2012 Annual Report noted that it was established with the objective of achieving the greatest possible genetic improvement in the national cattle herd for the benefit of Irish Farmers, the Dairy and Beef industries and Members.

There are three key studies that informed the formation of the ICBF, namely the Nagle Committee, the Ernst & Young Report and the Interim Planning Board Report. The timeline below maps key events.
Services
Publications on the ICBF website detail operations and governance of the ICBF (Wickham et al.)

The ICBF’s purpose is to:
- operate the cattle breeding database
- provide genetic evaluation services
- provide information useful to cattle breeding decisions

Governance
The ICBF operates as a company and has shareholders in the dairy and beef industries.

<table>
<thead>
<tr>
<th>Institution</th>
<th>Shareholding</th>
<th>Board Representation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Artificial Insemination Organisations</td>
<td>18%</td>
<td>3 members</td>
</tr>
<tr>
<td>Milk Recording Organisations</td>
<td>18%</td>
<td>3 members</td>
</tr>
<tr>
<td>Herd Book Organisations</td>
<td>18%</td>
<td>3 members</td>
</tr>
<tr>
<td>Farmers Associations</td>
<td>46%</td>
<td>6 members</td>
</tr>
<tr>
<td>Department of Agriculture Food and Marine</td>
<td>0%</td>
<td>1 member</td>
</tr>
</tbody>
</table>

Principles of the Data and Information Sharing Agreement Underpinning the ICBF Database
• Contributors of data to the creation of the database retain “ownership” and can obtain a copy of their data at any time.
• All data originating on farm, and known first to the farmer, is captured through ‘Animal Events’ a system controlled by ICBF.
• ICBF operates an industry wide network of systems to facilitate the electronic sharing of relevant data collected for other purposes. Examples include; inseminations, slaughter data, and sale data.
• All data in the database is available for research subject to a minimal set of conditions.
• Genetic evaluations are an integral element of the database.
• Herd owner’s control service provider access to herd and animal data.
• Service providers have access to data and information systems needed by their particular businesses for those herds that have granted access.
• HerdPlus® is a service provided by ICBF to the herd owner that facilitates access to all data and information relevant to the herd in the database.
• Service fees are set on the basis of User Pays and Full Cost Recovery.

Funding

The ICBF in its current form was established in 2000 with initial share capital of €2million. The capital investment was mostly for information technology hardware and software. The Irish initially purchased a Dutch database system. They then developed their own capacity and have customised the system to suit their specific needs.

The current ICBF budget is approximately €5million and the graph below shows the income sources.
Graph XXX: The ICBF funding sources.

Abbreviations: DAFF-Irish Department of Agriculture, Food and Fisheries NDP- Irish National Development Plan

Impact

It is hard to assess specific impact of this programme. It is however safe to say that the availability of high quality data has enabled more accurate breeding decisions to be taken and have helped to design better breeding programmes. It has also helped to spot potential problems in breeding such as declining gains on the maternal index.

The graph below taken from a 2009 grant proposal by the ICBF to the Irish Department of Agriculture, Food and Fisheries suggests the monetary impact achieved up to then and the potential impact going forward.
5.2 The Australian Cooperative Research Centres Programme

The Cooperative Research Centre (CRC) is designed to link public and private sector researchers to end users. The idea is to share the risks and costs of investing in research and development and ensuring effective technology transfer mechanisms. A CRC must comprise of at least one end-user and a publicly funded research organisation or a private one affiliated with a university who collaborate towards specific research outcomes. The CRC can be incorporated or unincorporated. Broadly a CRC can fall into any of the following three models; one that operates as a national benefit centre focusing on public good research, one that operates in industrial research focusing on industry specific outcomes or one that focuses on commercialising the benefits accruing from transfer or sale of intellectual property of new products and services.

**Funding framework**

The CRC programmes issues out an open call for proposals to start and implement CRCs across different sectors of the economy. Since 1991, a total of 14 selection rounds have conducted resulting in $3.4 billion being given to 190 CRCs, while participant organisations have invested a further $10.9 billion in cash and kind. The government has committed $625 to CRC for four years up to 2015/16. The selection process is highly competitive and applicants have to demonstrate competencies in a number of areas and meet minimum requirements in order to qualify for funding. An excel impact tool is used quantify the potential impacts of the proposed CRC by demonstrating the process by which research leads impacts on the end-user or community. The tool is used to inform the contract and becomes the basis for monitoring milestones during implementation.

Currently, there about 11 CRCs, of which 8 are linked to Livestock. These are as follows:

- Australian Seafood CRC
- CRC for Internationally Competitive Pork Industry
- CRC for Sheep Industry Innovation
- Future Farm Industry CRC
- Invasive Animals CRC
- Poultry CRC
Dairy Futures CRC

CRC for Beef Genetic Technologies

A benchmarking study of the CRC programme focused on the Sheep, Beef and Poultry CRCs to gain insights into how the three programmes are currently structured and functioning.

The Sheep CRC

The CRC for Sheep Industry Innovation was established for a term of seven years from July 2007 to June 2014 to undertake research and delivery of innovation to the Australian sheep industry. The Sheep CRC’s role is to facilitate transformation of the sheep industry through developing methods to manage sheep easier, developing the production and processing of meat and wool to meet increasing consumer expectations and to enable the uptake of new technologies by industry.

The Sheep CRC is a collaboration of 21 industry, government and commercial sector organisations. It is co-funded by the Commonwealth and is administered through a Board of Directors that is accountable to various stakeholders such as the Australian Government through the Commonwealth Agreement, participants through the Participants Agreement and Members through the Constitution.

The Sheep CRC impact is tracked by completing a comprehensive analysis to assess the impact expected as a result of achievements to date. An Impact Tracker Model was developed in 2010 to track the delivery of benefits and detail the status of the deliverables in relation to the set schedules. If the delivery of benefits is indicated to fall behind schedule, intervention measures will be set in place to put delivery back on schedule. The inputs to the Impact Tracker model have been regularly reviewed since the model was developed and all indications are that the Sheep CRC is on track to deliver the benefits indicated at the time of the third year review.

The Australian Sheep Breeding Values (ASBVs) is an important and effective tool to measure genetic gain. There have been significant improvements in genetic knowledge as a result of adding data from the Sheep CRC’s Information Nucleus flocks to the data gained over many years from sire evaluation trials, other research flocks and the impressive bank of data contribution in industry flocks in Sheep Genetics. The utilisation of information and data emanating from the Information Nucleus has resulted in improved accuracy of breeding values across many traits. Another success of the sheep CRC is its delivery of an innovative
Lifetime Ewe Management skills training program to over 300 producers (managing two million sheep) to help regrow Australia’s flocks after years of prolonged drought.
# The Sheep CRC

### Key partners
- MLA
- Members and Participants
- Western Australian Sheep Management Council
- Universities offering Graduate certificates in Agricultural Consulting

### Key activities
- Provides research and education to producers of both wool and meat
- Commercialisation of CRC systems, technology and products
- (2012) Preparation of the business case for the post-CRC Information Nucleus
- Management of the genomics pilot project

### Value propositions
- Facilitate the transformation of the Australian sheep industry:
  - Transform sheep for easier management
  - Transform wool to increase demand
  - Transform meat to increase quality
  - Increase rate of innovation adoption
- Developing products such as WormBoss and the e-sheep systems to manage sheep more efficiently and effectively, increasing productivity and profits through more effective use of land and labour resources

### Customers / End Users
- Sheep breeders and producers
- Participants of training programmes and workshops
- Database and research users

### Customer segments
- Industry training institutions
- Sheep Farmers
- Local Retailers
- Abattoirs who package lamb for the export market
- Wool Producers Associations
- Government through departments that focus on primary industries (e.g. Department of Agriculture and Food)

### Key resources
- International resources conducting research projects
- Board members
- Executive and Management Team
- Project leaders
- Training Resources

### Channels
- Database access
- Workshops
- Education programme
- Communication via print media and radio to create awareness of new products
- Through products developed

### Cost structure
- Project salaries, employee expenses and payments to researchers – 37%
- Project operating costs – 60.4%
- Travel and accommodation expenses – 1%
- Professional fees – 0.3%
- Office and admin - 1%          ●  Other – 0.3%

### Revenue streams
**Current Funding**
- Commonwealth grant fund - 61%;
- Participant contributions and Supporting participant contributions - 39%
The Beef CRC

The Beef CRC has undergone three significant stages:

- Beef CRC 1 was established to provide high quality beef for global consumers. CRC 1 was focused on the cattle and beef industry in terms of meat quality, to address issues of guaranteeing beef eating quality from Australia.
- Beef CRC 2 focused on issues of trade-off for guaranteed beef eating quality, implementation of results through new delivery pathways via the Meat Standards Australia (MSA) and Breedplan and the development and commencement of delivery of DNA marker pipeline.
- Beef CRC 3 focuses on the beef genetic technologies. CRC 3 was established to identify the genetic and non-genetic factors affecting beef quality and the other production traits of economic importance. Developing new genetic technologies to deliver high quality beef for global consumers, feed efficiency, maternal productivity and responsible resource use, adaptation and cattle welfare, and female reproductive performance.

Governance

The Beef CRC is run as a business with dedicated management and governance. It is governed by a skills based board. The Management Committee operates the company in accordance with the direction and delegations of the Board. The main task of the Board is to drive the performance of the company to achieve its research and commercialisation outcomes. The CRC is not only governed in line with the CRC Commonwealth Agreement but also in line with its obligations under the CRC Participants’ Agreement.

Participants and supporting Participants give the Centre a national and an international focus. They include state government, industry/private sector, universities, Australian National Government, R&D providers, commercialisation companies and industry organisations that enhance the CRC’s ability to deliver outcomes to a wide range of end-users across Australia and New Zealand. In each state, the outcomes are delivered by participants with expert local knowledge and industry linkages. Seven of the nine Board members are independent of the Participants and six members are from the private sector.
**Impact Measures**

The Beef CRC measures its impact by tracking the status of deliverable products within each stage according to product themes. The Beef CRC 3 program prepares status reports to review each deliverable and status of product delivery according to the following themes: improved genetic gain with genomic technology, improved compliance rates to better meet market specifications, increased reproduction rates and maternal productivity, improved animal welfare standards, improved adaptation and whole herd efficiency and improved beef producer understanding and uptake of technology. One of the key successes of the Beef CRC is that its research underpins Meat Standards Australia (MSA) which is used by thousands of Australian beef and lamb producers to guarantee meat eating quality for domestic and export markets.

The Beef CRC also tracks the increase in the gross revenue of the Australian beef industry due to the platform’s technologies e.g. genetic technologies to measure its impact.
# The Beef CRC

## Key partnerships

**Stakeholders:**
- Partners, governments, politicians, beef industry representatives, scientific groups, etc.

**Partnerships:**
- Other CRCs: Dairy Future CRC, Sheep CRC
- National:
  - Breed Plan, Australia’s beef genetic evaluation scheme, Pfizer animal genetics, Merial, Meat Standards Australia
- International:
  - Beef CFC formally partnered with 2 US commercial companies: Illumina and Affymetrix as part of its gene discovery research;
  - North American genomics consortium, US Department of Agriculture, New Mexico State University, the US National Beef

## Key activities

- On-going beef research
- Education and training
- Communication (to support all research, education, awareness and adoption of projects)
- IP commercialisation and management

## Key resources

- Beef Profit Partnership personnel (New Zealand)
- Board of Directors
- Management
- Program Mangers
- Program Leaders

## Value propositions

- Support research and innovation in Australia:
  - Improve beef cattle efficiency
  - Improved genetic gain with genomic technology
  - Improved compliance rates to better meet market specifications
  - Increased reproduction rates and maternal productivity
  - Improved animal welfare standards
  - Improved adaptation and whole herd efficiency
  - Improved beef producer understanding and uptake of technology

## Customers / End Users

1) Supports projects in research, education, awareness and adoption
2) Education and training support for: postgraduate, undergraduate and vocational training in the sciences underpinning beef genetic improvement
3) Key beef industry organisations:
   - MLA, Cattle Council of Australia, the Australian Lot Feeder’s Association, members of the Northern Pastoral Group of Companies and Pfizer Australia
4) End users:
   - SMEs in the seedstock, breed society, production and feedlot sectors of the beef industry;
   - Participants and Supporting Participants;
   - Sponsors, beef processors, exporters and retailers, beef consumers and the community at large;
   - Students, scientists, other CRC;
   - Red meat industry structures and agribusinesses.

## Cost structure

- Overheads
- Facilities costs
- Employee and supplier expenses

## Customer segments

- Researchers and Scientists in genomics arena
- Exporters and Retailers
- Read Meat Industry
- Institutions of higher learning

## Revenue streams

- CRC Program Funding;
- Core Participants cash contributions;
- Supporting Participants cash contributions;
- Direct cash and in-kind contributions from some of Australia’s largest pastoral companies (most of whom are also SMEs);
- Direct cash and in-kind contributions from hundreds of family-owned seedstock commercial beef producers.
6) **Gap Analysis**

The situational analysis and benchmarking sections above have shown that whilst SA has significant livestock production capacity, breeding and reproduction technologies as applied by other countries; have not been adequately incorporated here. Some of the current challenges in the scientific and production capacities that must be addressed to enable SA to utilise such technologies are as follows:

1a. Inadequate phenotypic data has been recorded on the national database of stud animals to be representative of specific breeds to be considered reference populations.

1b. There is currently no database that records genotypic information that can be related back to the phenotypic information that is available in the public domain.

1c. Any research on the application of genomics in animal breeding in SA is hampered by a lack of relevant data on accessible databases for reference populations of significant size.

1d. Different livestock categories and breeds are at different stages in collating data of the reference population, thus it is necessary to establish baseline data and monitor progress per breed.

1e. Certain breeds have such limited populations in SA that it may be difficult to obtain adequately sized reference populations.

1f. Certain indigenous breeds may not have significant populations to obtain adequately sized reference populations, and may not be able to attract adequate funding due to limited commercial value.

2. There is no transparent mechanism to enable feedback between stakeholders in any specific animal production value chain to set breeding goals and evaluate progress on them.

4. There is inadequate collaboration between government, industry and academic stakeholders to enable a co-ordinated approach to addressing animal breeding and reproduction technology challenges in SA.

5. Funding models for agricultural research that currently exist are not always co-ordinated to ensure the best use of available resources, collaboration
between stakeholders and transfer of technology into the animal production and processing environments.

6. Whilst the infrastructure to enable optimal use of genomics technologies is being set up, relevant biotechnology research is proceeding and it is necessary to ensure that this remains co-ordinated and connected to stakeholder needs.

NOTE:
The challenges presented above suggest that the SA livestock industry is at a pre-competitive stage in the application of genomics technologies in breeding. Industry players would need to collaborate in the short term to enable the establishment of the necessary infrastructure before resuming competitive priorities in the future.

Any initiative to address these challenges must include clear and specific deliverables with structured reporting mechanisms to all stakeholders.
Animal Breeding and Reproduction Technology Platform – Proposed business model

7.1 Objectives
1) To contribute towards long term improvement and sustainability of the SA livestock industry;
2) Prioritize technology innovation in genetics and animal breeding towards industry needs;
3) Provide a financial mechanism for both government and private sector to contribute funding and ensure that funds are used effectively to the benefit of the SA producer and consumer;
4) Ensure capacity development, training and skills development programmes are in place to provide for the needs scientific and technical needs of the industry;
5) Ensure effective transfer of technology from research environments to farmers, processors and retailers;
6) Provide a platform for collecting and sharing information amongst all key stakeholders
7) Have a structured impact analysis capability to ensure that achievements towards the set objectives of the initiative are always monitored and reported to key stakeholders who can then actively direct necessary change.

7.2 Business Model
This business model has borrowed from the international models and various R&D initiatives in SA. The model attempts to promote partnership between government, private sector and academia. It uses existing institutional capacity to manage and administer projects. Central to the governance model are steering committees that act as the liaison and champions of the individual projects. These steering committees are accountable to the funders and members are selected by the funders. These committees thus play an important role in ensuring that funders and project implementers needs and expectations are managed effectively.

It is important to note that the international cases that were reviewed took a much more focussed approach. For instance the Irish ICBF invests specifically in cattle (for beef or milk production) and particularly in the databases and information management around
populations relevant to their breeding initiatives. The Australian CRC initiatives have focussed on separate livestock groupings as well; and have tackled specific research themes with each progressive CRC. The proposed ABRTCP encompasses all livestock categories and relevant applied research needs as long as it is supported and funded in-part by industry. Due to the limited resources available and uncertain demand for this initiative at this time, it is felt that a combined approach will serve the country best. It is also noted that the INTERGIS system serves all livestock categories and it will provide the supporting information for all reference populations, thus allowing us to utilise that resource maximally.

It is also not expected that the ABRTCP will function as a company and accrue any form of profit. It will function as a group of related projects funded by TIA and other co-funders. Projects that wish to develop commercialisable products, would be particularly prioritised and TIA may require a nominal royalty from successful sales. It is not expected however that the ABRTCP would become self-sustaining from such royalties.
7.3 Governance Model

TIA Board

TIA EXCO

TIA ABRTP Secretariat (Agri-BiotechBU)

Steering committee 1
Technology Development Consortium 1

Steering committee 2
Technology Development Consortium 2

Steering committee 3
Technology Development Consortium 3 etc…

Stakeholder/Funder Group 1

Stakeholder/Funder Group 2

Stakeholder/Funder Group 3

Access additional expertise as required
Monitor and advise steering committees
## Roles and Responsibilities

<table>
<thead>
<tr>
<th>Organisation</th>
<th>Role</th>
<th>Responsibility</th>
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<tbody>
<tr>
<td>TIA Board</td>
<td>Providing strategic support</td>
<td>Funding approval, Reporting to state funders</td>
</tr>
<tr>
<td>TIA Exco</td>
<td>Strategic Management</td>
<td>Funding allocation, management and oversight</td>
</tr>
<tr>
<td>TIA Secretariat</td>
<td>Operations management</td>
<td>Budget management, programme management, Communication</td>
</tr>
<tr>
<td>Technology Development</td>
<td>Implementers</td>
<td>Conducting research, development and technology transfer</td>
</tr>
<tr>
<td>Consortia</td>
<td></td>
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</tr>
<tr>
<td>Steering Committees</td>
<td>Liaison, project champions</td>
<td>Ensuring implementers delivery is managed according to funders needs, and</td>
</tr>
<tr>
<td></td>
<td></td>
<td>stakeholders requirements. Managing expectations all around.</td>
</tr>
<tr>
<td>Stakeholder Groups</td>
<td>Funders and end users of</td>
<td>Define research mandate, monitor progress and utilise products of research.</td>
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<tr>
<td></td>
<td>technology development</td>
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### Comment on Technology Development Consortia:

1) Technology Development Consortia must have at least one publicly funded research institution as a member of the consortium.

2) The project should have dedicated project management capacity ideally based at the publicly funded research institution. The level and capacity of project management should be in line with budget and complexity of each project.

3) Funding will be channelled through the research institution.

4) All Technology Development consortia should provide proposals with activity based budgets which reflect accurate costs and indicate the funding sources. TIA will only consider funding a project if industry partners have agreed to co-fund the project.

5) The project proposal should state the industry need, the research that will be conducted, the expected outputs, expected timeframes for such outputs and the proposed technology transfer or commercialisation strategy that will be deployed.

6) Adequately detailed project plans with milestones should be provided.

7) Roles and responsibilities of key research, project management, financial management and technology transfer staff should be included in proposals. Key staff should also submit summarised résumés.
8) Each Technology Development consortium will have a steering committee of up to 7 members. The funders will select up to 3 members of the committee. The committee members will act as liaison between the project and funders, they will also champion the project in relevant forums and networks. The other members of the steering committee will include the Project Manager and the Lead Researchers. Steering committees will meet at least 3 times a year, or more if required.

9) TIA ABRTP secretariat will co-ordinate an annual meeting where all projects that participate in the ABRTP will present to the combined stakeholders of the ABRTP.

7.4 Data and Information Management

To enable the usage of genomics information in breeding programmes two divisions of the Agricultural Research Council will have to be intrinsically involved.

The Animal Products Institute (API) manages the INTERGIS system and implements various programmes around recording of performance data. It is also involved in calculations of EBVs and conducts research to support these activities.

The ARC established a molecular genetics platform at their facility in Onderstepoort. The facility has been fully equipped to enable sophisticated molecular genetics research. The facility is to be used by ARC, academic and industry based researchers. The availability of high throughput sequencing equipment and expertise makes it possible to obtain the necessary genomics data in a relatively short space of time. It plans to hold all genomic data on a Genomics Data Online Storage System (or GDOSS).

Operationally, the INTERGIS and GDOSS systems will exist as separate databases with the functionality for exchange of data the two databases. It would be required that all animals to be genotyped have a National Animal Computer Number assigned by the INTERGIS system and the same computer numbers should be used in the GDOSS database to allow for integration of the two databases. (The issuing of the National Animal Computer numbers is regulated by the Livestock Improvement Act 62 of 1998). In addition, minor modifications of the INTERGIS database will be required to ensure that data on novel traits could be stored in the system. Some of the basic principle of data management would be as follows.
The system would be web-based which would allow access by individuals via the internet. This system would be comprised of two main sections, namely a public section and a restricted section.

The public section would be accessible to all and would include basic functionality such as querying of animals by their National Animal Computer No. Limited data would be returned, such as animal computer number, whether an animal was genotyped or not, technology used for genotyping (SNP, sequencing etc.), and date of genotyping.

The restricted section would be accessible only to authorized administrator(s). They would have additional functionality to that which is found in the public area, such as been able to view full details of Animals, as well as all genotype data for these animals. They would also be able to import the required data into the system, as well as export data when required. Exporting of data would also have various options to select the data that is exported.

Data (genotypic, phenotypic or other) that is contributed to databases in the ABRTP will always be the “property” of the breed society and they can obtain a copy of their data at any time.

All data in the database will be available for research subject to a minimal set of conditions.

Genetic evaluations will be an integral element of the database.

### 7.5 Intellectual Property Management

South Africa is at a stage where the information infrastructure must be developed in order to incorporate genomics into breeding programmes. This requires that various industry players collaborate in order to achieve this first step. This could therefore be considered pre-competitive stage and the intellectual property (IP) management must enable all players to contribute to the collation of relevant data and utilisation of such. Once the data of relevant reference populations has been collected we would then be entering into a stage when companies may gain specific competitive advantages from further research and development, and it would be necessary for information generated at this stage to be handled with appropriate intellectual property protection and management strategies.

Given the diverse nature of the intellectual property that will be developed, the platform will not have a prescriptive intellectual property management strategy. The following guidelines however will be in place.
1) Each Technology Development Consortium will determine the nature of intellectual property that will be generated and will apply an appropriate protection and management strategy. This will be clearly articulated in the proposal.

2) Where the Technology Development Consortium plans to develop a product for commercialisation, the members must agree a commercialisation and licensing strategy upfront and all amendments to this agreement should be reported to funders and TIA.

3) Where there is a specific commercialisable product, funders may be entitled to negotiate royalty based returns.

4) Products developed through the ABRTP should primarily be for the benefit of the SA livestock producer, processor, retailer or consumer. Should any product have secondary international value it will be an added benefit.

5) The ABRTP will be subject to the terms of the Intellectual Property Rights from Publicly Financed Research and Development Act (2008) where applicable.

7.6 Research, Technology Development and Technology Transfer

It is clear from the situational analysis and gap analysis, that the platform cannot immediately begin funding research and development activities in animal breeding. Significant funds will initially have to be expended on the collection of relevant data and on the information technology infrastructure to support this. As time progresses one would expect the budget available for developing the information infrastructure can then be redirected towards specific technology development initiatives in animal breeding. The situation may be significantly different in the arena of reproduction technology where there may be a number of industry needs that may already have specific research, development or technology transfer projects waiting funding.

The ABRTP will be a vehicle to specifically support the livestock industry technology development needs and it is thus envisaged that applied research will be funded as opposed to basic research. Those projects that are expected to have product based outputs that are intended for sale, should have detailed commercialisation plans. It is also acknowledged that certain outputs may not be saleable, but such cases must have effective technology transfer or extension programmes associated with them.
7.7 Financial Plan

The TIA Board will be requested to commit R 329,525,631 over the next 5 years towards this programme. The demand for such funding is untested at this stage and we will gauge the demand with the project proposals that are received and the value that industry is willing to contribute towards specific projects. Should additional funding be required, TIA will approach relevant Government Departments, Development Funding Institutions and International Donors to augment funds and support specific projects. It is expected that over the course of the next 3 years the major commodities that could benefit from this programme would gradually come on board thus explaining the significant increases in the budget year on year. The budget presented below reflects only the proposed TIA contribution for this initiative, it is expected that industry per commodity may match or even exceed this contribution. Funds contributed by industry will thus be commodity and project specific.

Each project should budget at least 10% towards project management. TIA will contribute 30% towards this, with industry and academia absorbing the remaining 70% of the project management cost. A portion of the TIA allocated ABRTIP budget will be set aside for stakeholder communication and an annual conference.

Proposed TIA Budget

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<tr>
<td>Technology development budget to augment industry co-funding – market pull strategy</td>
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<td>R 551,250.00</td>
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<td>R 551,250.00</td>
<td>R 578,812.50</td>
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<td>Total</td>
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<td>R 73,102,500.00</td>
<td>R 86,157,625.00</td>
<td>R 86,215,506.25</td>
</tr>
</tbody>
</table>
7.8 Impact Measures

Steering committees will develop impact measures for each project. Projects will report on both their achievement of project milestones and the impact that they have achieved.

Ideally the ABRTCP will over time measure impact by:

- Percentage of the reference population for which a full dataset has been achieved
- Products developed and transferred to industry
- Impact on improvements at stud level
- Impact of improvement at production level
- Impact of improvement at commodity level

7.9 Guidelines for funding proposals

The purpose of this innovation programme is to engender collaborative technology development programmes, between publicly funded researchers and commodity and/or breed societies, with the primary objective of delivering innovative, high-impact technology solutions for socio-economic benefits to the animal production sub-sector. The goal of the programme/s will be to address clearly defined market challenges or failures affecting end-user sub-sector/industry that can require medium to long-term (5-7 years) collaborative effort that builds critical mass and efficiently leverages the national system.

The following are guidelines for funding proposals:

i. Eligibility:
   o At any one time, a consortium must have at least one industry group as end-users and higher education institutions/science as participants
   o To ensure equitable access and technology transfer to small-scale and emerging farmers, the consortium must present as part of the funding proposal, a strategy to build and improve adoption of technologies by this segment of the industry.
   o The programme activity must include collaborative technology development activities, end-user focused training programme that engages end-users to encourage uptake of outcomes; and technology
transfer activities to ensure impactful deployment and adoption of outcomes.

o The programme will be open to all innovations covering animal breeding and reproduction where economic impact is a goal.

ii. Funding:

o Funding is on a competitive basis determined by proposed area/s of technology innovation, envisaged innovation outcomes and economic impact; and resources (competencies and capabilities) available to achieve the proposed outputs.

o The collaborative team or consortium must provide co-funding in cash or in-kind towards execution of the proposed technology development programme.

o The duration of the programme will be up to 7 years subject to progress in achieving agreed milestones, outcomes of performance reviews and continued financial support from the consortium partner/s.

o Extensions for funding would be considered in instances where applicants have justifiable reasons (need to continued support, evidence of success in delivering socio-economic value or identification of new areas fundamental to industry growth and competitiveness) for additional funding.

o Funds can only be used to cover the following activities: direct cost of technology development, capital items required for technology innovation and HR costs directly linked to technology development.

iii. Governance:

o The consortium must have a governance model that will enable programme execution and effective and efficient management of funds.

o The proposed model must be designed in such a way that the following four principles are achieved:

a) Lay a solid foundation for management and oversight.

b) Promote ethical and responsible decision-making.

c) Safeguard integrity in financial reporting.

d) Recognise and manage risk.

e) Credibility: stakeholders need to trust and believe that the initiative is designed to benefit the scientific community,
industry and ultimately civil society as a collective. This will be achieved by communication, consultation, representation and management of key decision making processes within the cluster.

f) **Independence:** the management of the programme and investment making process should not include institutions and agencies that are going to benefit financially through project or infrastructure funding. The constitution of such bodies should reflect diversity in business, research and governance.

g) **Effective and efficient operation:** this is the most important principle in the model. Only when the programme operates as intended and achieves its strategic goal and objective, will industry find it worthy to invest time and resources to participate in research collaboration and co-funding opportunities.

h) **Leverage local and international funding:** the power of high impact initiatives is their ability to attract co-funding through strategic partnerships. In the early stages of the cluster, leveraging co-funding will be difficult but a performing cluster will find it easy to raise funds to expand programmes and impact.

iv. **Application and Selection Process:**

- TIA may call for applications at any time during a financial year.
- The standard TIA investment process will be used for assessing and evaluating funding proposal
- The following information required for applications to be considered:
  
  a) Technology Innovation objectives that address issues of socio-economic significance to South Africa’s animal production industry.
  b) A clear outline of the path to technology transfer and adoption.
  c) Quality of the project and programme team, with attention of expertise.
  d) A clearly outlined budget justified in relation to expected benefits and return on investment to the sub-sector.
v. Monitoring and Evaluation:
   o TIA will monitor performance against agreed milestones, outputs and technology transfer and adoption:
     a) Annual reporting.
     b) Annual performance review
     c) Independent mid-term performance review
   o At the end of the programme an evaluation of programme performance against projected economic benefits.
   o A close-out report must be submitted to TIA with a wind-up plan for the programme.

8) References

