NATIONAL BIOTECHNOLOGY ADVISORY COMMITTEE (NBAC)

PROCEEDINGS OF THE NATIONAL WORKSHOP ON FEEDING THE BIOTECHNOLOGY PIPELINE

30 SEPTEMBER 2010

IRENE COUNTRY LODGE, IRENE, PRETORIA

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SESSION 1: WELCOME AND INTRODUCTION (CHAIR: MS KHUNGEKA NJOBE)

Ms Njobe welcomed delegates to the workshop and acknowledged the NBAC members who were present. She commended the committee members for their leadership in issues that were critical for biotechnology in South Africa. The Minister of Science and Technology had sent her apologies and had assured NBAC of her continued support of the committee's work and of the biotechnology agenda in this country.

Biotechnology is prioritised by government in terms of addressing many of the developmental challenges experienced in this country. The National Biotechnology Strategy of 2001 guided much of the investment made by government in biotechnology, in particular the Biotechnology Regional Innovation Centres (BRICS), the National Bio-informatics Network and a programme to communicate biotechnology to the public. Much still needs to take place in the biotechnology sector in South Africa in order for the benefits to accrue. The Ministers and all the decision makers need the expertise present at this workshop to advise them on the role of government in the future of biotechnology in the country. Initiatives are already underway to consider a new path for biotechnology. At the beginning of her term of office, Minister Naledi Pandor stressed the need for advice from NACI that would enable her to make the necessary changes in the sector that would support and promote the interests of the biotechnology sector.

The themes of the workshop address key success factors that are necessary to achieve the objectives of the National Biotechnology Strategy and future trends in this regard. There is common awareness of the incoherent, and at times contradictory overall legislative environment that frustrates some of the efforts of the players in the biotechnology sector. It is important that through this workshop, key insights and advice are provided that would assist the decision makers' efforts in the support of constructive changes in the biotechnology sector.

There appears to be some dissatisfaction in terms of the return on investment of the BRICS, now part of the Technology Innovation Agency (TIA), while some have lamented that investment did not occur across the research, development and innovation value chain. It is important for this workshop to discuss not only the need for more funding, but also the quality of the investments that should be made in the biotechnology sector.

Human capital is a critical issue globally, although it is more acute in South Africa. A 'business unusual' approach is necessary in order for our biotechnology programmes to be competitive. Although there are men and women of formidable expertise in the sector, many of the research groups do not have access to sufficient competent human capital, jeopardising South Africa's competitiveness in comparison to that of other developing countries. The future of human capital is compromised by the feeder system from schools and universities. Entrepreneurs, needed to commercialise knowledge that is developed from the research process, are scarce yet a crucial part of building the bridge across the innovation chasm. A committed approach to the issue of human capital is needed over the long-term in order to achieve the benefits that will grow the sector.

It is anticipated that the discussions at this workshop will be open, honest and productive and contribute to the Minister's effective endorsement of changes in the system that will allow the biotechnology sector in South Africa to flourish.

SESSION 2: GOVERNANCE AND REGULATORY ISSUES

REGULATORY ISSUES (FACILITATOR: PROF. HENK HUISMANS)

The Regulatory Environment and the New Bio-Economy in South Africa (Prof. Michael Pepper)

The objective of the presentation is not to be critical of those who are currently writing the regulations, but to highlight some of the areas of the regulatory environment that are either enabling or inhibitory with regard to the development of biotechnology in South Africa.

The National Biotechnology Strategy published in 2001 is now outdated. The Department of Science and Technology (DST) has embarked on the development of a new strategy called the Bio-economy Strategy which relates to the contribution of biotechnology to a significant share of the economic output. The application of biotechnology covers the areas of primary production, health and industry. Business contributes to 85% of the total R&D expenditure on health, whereas only 6% is spent on agriculture even though agriculture has the potential to contribute 75% of the revenue that could be generated by the bio-economy. It is therefore necessary to invest more in the development of the agricultural sector without reducing the expenditure on the health sector. Gross inequality exists between the potential market share and the amount invested in R&D in the health and agricultural sectors. Almost all the new drugs, 50% of the global production of the world's major crops and an increased number of everyday products will be products of biotechnology within five to ten years, illustrating the importance of a strategy for bio-economy.

Data from the Global Competitiveness Index (2010/2011) of the World Economic Forum indicates that South Africa is ranked 54 out of 139 countries. In terms of the impact of the current infectious diseases on our economy, South Africa is ranked 138th and in terms of the availability of scientists and engineers, it is ranked 116th. While the country is ranked 27th in terms of public institutions, intellectual property protection, the burden of government regulation and government inefficiency places the country 94th. Accumulated regulation is perceived as having a negative effect on the economy of the country. The strength of accountability structures of private institutions contributes to a considerable higher placing in the ranking structure.

The new strategy cannot be developed without the participation of government, the private sector and civil society who are all consumers of the bio-economy.

The purpose of a regulatory environment is to:

- provide guidelines for people working in a specific area. It is necessary to consider whether legislation or self-regulation is preferable. King III is not regulatory or dictatorial and is an example of self-regulation, promoting governance and focussing on the triple bottom line of revenue, community and environment.
- protect the consumer
- facilitate the emergence of new products, services and companies, in particular the creation of small, medium enterprises (SME's).

The National Health Act

The Act was published in 2003 and Chapter 8 titled, "Control of use of blood, blood products, tissue and gametes in humans", has to date not been promulgated. A dedicated group of people has completely revised Chapter 8 of the National Health Act and although some draft regulations have been published in the government gazette, legislation does not currently cover the following areas:

- Blood transfusion service(s)
- Cell-based therapy (including stem cells)
- Assisted reproductive technology (including in vitro fertilisation)
- Transplantation
- Genetic services
- Tissue banks
- Examination, allocation and disposal of human bodies and tissues

There are serious consequences to the absence of a regulatory environment in these areas.

The Consumer Protection Act

The Act was published by the Department of Trade and Industry and was recently deferred until 31 March 2011. The purpose of the Act is to promote broad-based public good, to protect the public from exploitation and harm (including GMO products). Part D section 24 (6) of Chapter 2 of the Act refers to labelling requirements of GMO products. This section was included in the Act prior to publication without consultation of all the stakeholders who were involved. Various problems arise from the inclusion of this section of the Act, namely:

The cost of labelling:

- The development of an identity preservation system involves set-up and maintenance costs of between 5 and 20% of the product price, borne by the consumer
- As it is well known that GMO's do not carry any additional health risks, the labelling of GMO products will inform consumer preference, a subjective rather than a rational issue.
- Higher costs and infrastructure hurdles will jeopardise attempts to integrate small-scale farmers with the more formal, commercial economy.

Accuracy of labelling:

- There is currently a one percent adventitious presence threshold and thus far the accuracy of voluntary labelling of GMO's has been shown to be unreliable. Some products derived from GMO's cannot be differentiated on a molecular level from conventional counterparts and a law that is not respected, or cannot practically be complied with, will negatively impact public perception of government efficiency.
- Industry self-regulation may be a better approach. It should be considered and may result in fewer unintended consequences.
- A simple GMO label does not provide useful information and more detail would be needed.

Compliance:

- It would be difficult to enforce compliance, particularly because 50% of fresh produce is sold at informal markets in South Africa.
- It is unclear how the labelling requirement of the Act could be practically enforced.

Trade relations:

- Detection facilities would need to be developed.
- Labelling requirements may affect trade relations for seed, food and feed imports.
- Labelling of all products containing GMO or GMO derived products would require extensive accredited capabilities throughout the country which are not currently available.

Impact on public perception:

- GMO's currently available have traits of advantage to the farmer and not the consumer
- GMO's are being developed and tested that will benefit the consumer (nutritional enhancements, allergen removal, etc.).
- Labelling requirements introduced at this stage may, in the minds of consumers, become associated solely with health risks as opposed to consumer benefits or information.
- This may have negative impacts on South Africa's implementation of the new Bio-economy Strategy.

The recommendations from NBAC that were presented to the Minister of Science and Technology in relation to the specific section of the Consumer Protection Act that refers to the labelling of "*prescribed goods*" or GMOs, are:

- *"Prescribed goods*" should include only products that will have a real and informative benefit, such as GMO-derived vaccines.
- The inclusion of GMO products as "*prescribed goods"* could be phased in as a gradual process to ensure labelling provides real benefits to the consumer.
- The premium charged on such products could offset the requirement for labelling.
- The South African public will have a more balanced perception of GMO's when there are products which carry consumer benefits and not just perceived risks.

Intellectual Property Rights (IPR) Act

The National Intellectual Property Management Office (NIPMO) has recently been established with the aim of ensuring that research undertaken at universities remains relevant and responds to the countries needs. The legislation limits walk-in rights to those situations in which there is

failure to disclose the Intellectual Property (IP). The IPR Act favours a more market-driven approach in which research is done in a context where IP is generated and protected. It has been asked why public funding is used for research that has no commercial endpoint, how a balance can be achieved between basic ("Blue Skies") research and applied (market-driven) research and whether the balance should be different in developing versus developed countries.

The Act stipulates certain management obligations and disclosure duties that are expected of researchers as well as research and academic institutions. However, it is unclear whether institutions are adequately equipped to respond to these obligations, posing a problem with regard to the fundamental principles of the institutions.

Biodiversity Act

The Biodiversity Act was published in 2004. It regulates the export of indigenous biological resources for the purpose of bio-prospecting or any other kind of research and wishes to ensure the fair and equitable sharing of benefits arising from bio-prospecting involving indigenous biological resources. Apart from the fact that the country does not have the necessary skills and manpower to deal efficiently with the implications of the Act, material of human origin is excluded from the Act which only applies to plants and animals. The Act is silent on the issue of genomic sovereignty which is the capacity of a people, a country or nation to own, to control both access to and use of, samples, data and knowledge concerning genomic material. There is no control of genetic material which continues to leave the country, stunting the opportunity of benefit sharing and capacity building in South Africa.

The generic problems and unintended consequences of the current regulatory environment include:

- Administrative delays: Although the legislation is necessary, it has been put into place without foresight to developing the capacity to deal with enforcement thereof.
- Disincentives for foreign investment
- The exclusion from funding agencies such as the Bill and Melinda Gates Foundation, that preclude the generation of IP in projects which they fund.
- Skills and manpower shortages
- Legislation versus self-regulation.

NBAC advised the Minister that:

- DST should drive the establishment of an inter-departmental government forum to develop a cross-department policy position on, and vision for, the South African biotechnology sector.
- DST should establish a system for monitoring and evaluating the biotechnology sector against set objectives, not only for inputs to and outputs from biotechnology, but also with regard to the regulatory environment.

A study done by the US Department of Labour produced a graph titled 'Education Pays' which shows that the higher the degree of education, the lower the chance of being unemployed and the higher the median earning. DST's perspective of driving a knowledge economy has been promoted in South Africa for the last ten years or more and more emphasis has been placed on education during this period. Unemployment rates in South Africa as a percentage of unemployment by educational level from 1995 to 2005, shows that there was no change in the percentage of people who were unemployed. However, the observation concerning a 50% increase in unemployment among those who have received tertiary education is disturbing. It is therefore pertinent to question whether the environment provides those with a tertiary education the opportunity to be employed or create their own employment. It is crucial to avoid the creation of an onerous regulatory environment that does not provide employment opportunities.

Recent legislation has put several institutions into place (such as TIA and NIPMO) to address the innovation chasm, or the inability to translate knowledge production into commercial production. The objective of much of the legislation that covers the value chain is to ensure that the

environment is properly controlled. However, it should be asked whether the legislation serves to regulate the real problem which relates to the country's ability to feed the pipeline and create knowledge that is translated into commercial production.

In conclusion, it is perhaps necessary to focus on creating knowledge that can be productively commercialised, instead of putting substantial efforts into creating a regulated environment for what may not exist.

PANEL DISCUSSION

A brief overview of the Consumer Protection Act (Prof Tanya Woker)

The Consumer Protection Act has implications for the biotechnology industry. It is an overarching piece of legislation that gives consumers an extensive range of rights and exists to protect the interests of consumers. One of these rights concerns the informative and correct labelling of products used by consumers.

Part D section 24 (6) of Chapter 2 of the Act says that consumers must be informed of the presence of GMOs in the products they consume. The section refers to regulated products and regulation. The biotechnology sector was possibly unaware of the pressure placed on government and the extensive deliberations that resulted in the inclusion of this section in the legislation. The Act has been postponed until March 2011 because the regulations are not finalised and a consumer commissioner has not yet been appointed. The Act cannot be enforced until the regulations are complete. The regulations attempted to govern all aspects and have been discussed in a variety of workshops attended by a large number of people but have not yet been published.

The National Consumer Tribunal has powers to impose penalties on those who contravene the legislation and it will therefore be very important for business to be able to comply with the regulations. The severe consequences to non-compliance could have a negative effect on the GMO market. Currently the regulations stipulate disclosure to consumers if the GMO content of a product is 5% or more. The labels must meet requirements of Section 22 of the Act which deals with plain and easily understandable language, and states that the product is produced using genetic modification or contains at least 5% GMOs. Numerous products that fall within this category are listed in an annexure to the regulations, namely maize, soya beans, cotton, all animal products, as well as prepared or cooked foods that are sold. Products that are commitment to the regulations are approved by an organ of state in terms of the legislation applying to GMOs. Biotechnologists are in a better position than lawyers to interpret the implications of these regulations.

It is in the interest of whoever is concerned about the regulations pertaining to GMOs to make their views heard. The National Consumer Tribunal is concerned about its ability to make the correct decisions with regard to the correct labelling of products containing GMOs and will possibly seek independent advice from specialists in the biotechnology sector in this regard.

Effects of legislation on competitiveness (Prof. Jocelyn Webster)

South Africa is becoming less and less competitive in all areas. It needs to be understood that non-renewable resources are depleting and renewable resources that produce new products are not increasing. The only way in which more can be produced from renewable resources is to invest considerable amounts of money and protect the ability to develop biotechnology. It is only through renewable processes that products will be able to be developed for future needs.

Every prominent global entity is looking at how to develop a global bio-economy. Whilst the government's development of a new Bio-economy Strategy is reassuring, it requires a serious approach in order for the strategy to result in increased competitveness. The matter was raised

twenty years ago and to date there has been very little response from government. This raises the question as to who should be held liable for all legislation and all policy development when legislators and policy makers have neglected to act on the advice of the experts and the input from stakeholders over the years.

Those who have offered up many hours to contribute constructively to the development of regulations should be applauded. The GMO Act no.15 of 1997 was an excellent Act in the context of that period in time. The only criticism would be that the Act should have been implemented by the Department of Science and Technology and not by the Department of Agriculture, Forestry and Fisheries. However, the Act was put in place with good intentions based on good information yet the general biotechnology stakeholders were not fully satisfied with the regulations. Over the last ten years, the interpretation of that Act has become a political, socio-economic issue. Without proper assessment and permits to produce and commercialise, GMO products are denied. This has resulted in lessened international interest and investment in this country and is turning research away. An example of this is the Super Sorghum project, where an application to conduct glasshouse trials was turned down and it took nearly two years to overturn what was a poor decision. In the meantime the research left South Africa for Kenya where it is able to continue because the legislative processes and decisions are more efficient even though the capacity, expertise and the facilities are available in South Africa. This raises the question about who is liable for the loss of income to our researchers and institutes, the loss of job opportunities and the loss of potential for food production that is a result of the legislative and decision process around GMO products.

The IPR Act places financial liability on scientists who neglect to declare potential IP emanating from research. This is detrimental to the future of research in this country as scientists are not willing to expose themselves to such personal liability.

The Biodiversity Act provides for scientists to have many opportunities to do research supported by international funding. Research consortiums are formed and most of the funding is spent on research that is done abroad using South African plant material which the international partners obtain by legitimate means, allowing them to benefit from the IP.

Workshop participants are invited to attend a meeting on 1 October 2010 to deliberate the Consumer Protection Act and its regulations. NBAC has done much work with regard to the analysis of the Act, as well as the issues pertaining to the labelling of GMO products on consumer goods. It is encouraging to note that industry is becoming involved in this discussion. NBAC opposed the Consumer Protection Act and communicated its concerns, together with information to support these concerns, to all the relevant government departments, the Ministers, Chairpersons of all the Parliament Portfolio Committees, Provincial Governments and political parties. Although the organisation agrees that consumers need to be informed of the contents of products they purchase and consume, there is disagreement in terms of the penalty consumers would be required to pay for the costly implementation of the legislation and regulations demanded by an extremely small group of consumers. This raises the question about who is liable for non-scientific decisions, based on demands of a small section of the population and penalising the rest of the population of this country.

Practical implications of policies and regulations (Dr Hennie Groenewald)

Biosafety South Africa deals with the biosafety of biotechnology products, focussing on the following:

- Investment in research to get data that informs decisions in terms of biotechnology products
- Support for developers of technology to ensure the safety of products.

In the context of the work done by Biosafety South Africa, a preferable term would be 'sustainability'. The GMO Act refers to the underlying socio-economic issues related to the safety as well as the sustainability of biotechnology products. The development pipeline involves

relevance, accessibility and deployment in addition to safety. Regulations are in place to contribute to the management of risk, accepting that some degree of risk is associated with all biotechnology.

One of the most important implications of practical implementation of the GMO Act is that the decision makers represent individual government departments, each with a specific mandate that does not share the same vision of the application of biotechnology products. The decision making process is impacted negatively by the lack of a common vision of the government departments. Although NBAC's recommendations are based on the scientific data, the decision makers are influenced by political choices and hesitate to clearly define the policy parameters, making it difficult for those who need to implement and comply with the regulations.

In practice, the difference between technology and products is very important in the exposure of biotechnology. Enforcing application and product development emanating from the investment of public funding in research that is done at academic institutions does not contribute to the promotion of biotechnology. Policies, funding and infrastructure alone will not bridge the innovation chasm. A coordinated approach that focuses on the necessary capacity and specific skills is needed to develop biotechnology products. The variety of specific skills that are needed to develop a product differs greatly from the skills needed for the academic research process. The current environment is not conducive to the successful development of products that are outcomes of research. Care needs to be taken to balance the various rights of consumers and minority opinion should not deny the majority from deriving benefits from GMO products, substantiated by scientific data.

OPEN DISCUSSION

Prof. Rybicki: The IPR Act has one unintended consequence for inventors who are required by the Act to patent inventions that are part of research. Who will pay for the patent application that is extremely costly? It will be necessary to build patent costs into every research grant or many patents will be abandoned because they are in the public domain and cannot be protected.

Prof. Pepper: Who will not only file the initial patents, but maintain them? If they cannot be maintained, there will be a wasteland of IP.

Prof. Kinderlerer: Prof. Pepper referred to legislation that is internal to South Africa but we cannot ignore that we are members of a number of international treaties that require us to take certain actions. We have to export our products and therefore need to patent them outside of South Africa. Although the US regulations accept the South African limit of 5% GMO content of products, the EU has limited the GMO content of products to less than 1%. It is necessary to consider the competitiveness of South African innovation, not only in South Africa but also in other countries.

Prof. Woker: Prof Pepper's suggestions of self-regulation should apply in this instance because the regulations do specify that the product does not have to be labelled if the GMO content of a product is less than 5%. However, if the product contains more than 5% GMOs, then it has to be labelled accordingly. Knowledge about the rule that applies in other countries is essential if a product is to be exported. The Act applies only to products that are sold in South Africa.

Prof. Webster: Our maize contains over 60% GM, cotton over 90% GM and soya 80% GM. Although it is helpful to talk about these issues in various forums, we tend not to listen to the people who are trading with the technology, using it every day and managing the biosafety protocol and the existing legislation. In addition, we need to look at what is working currently. Identity preservation of our normal growing of maize from the farm through to the silos and processing, will not work. In the future there will be many identity preservation issues because there will be Corn Flakes that are made specifically for diabetics and those with heart conditions. These high value products will have an identity preservation process all the way through the

prodcution chain. If this is necessary for the general use of maize it will cost up to 20% more and the additional costs will be bourne by the consumer. This issue needs to be carefully considered. South Africa is already exporting considerable amounts of food to numerous countries throughout the world. The issue needs to be discussed with the stakeholders who work with it everyday.

Mr Durham (DST): To support what is being said, this is a political and social issue that cannot be solved scientifically. It is very complex. We have a history that says there is a disconnect between established industry and government. How do we address these problems as opposed to identifying them? In the US, the consumer is seen as the industry whereas this does not apply in South Africa. The divide needs to be bridged by a clarification of the process, avoiding a purely scientific approach and focussing on the impacts and the positive features of biotechnology.
Prof. Pepper mentioned the development pipeline and the need to develop capacity and new ideas. We need to talk about why it is necessary for innovation to have a social impact and the persistent innovation chasm. The fact is that innovation in South Africa is a relatively new concept from a government perspective. Traditionally, the NRF has supported academic research, much of which is well respected globally. Although an innovation focus has been placed on many areas of science through the BRICS and TIA, many products are not reaching the market and having a socio-economic impact on the country. It is agreed that we need more fundamental research and more people, but we also have to look at the entire value chain and discard what is not working in the system. We cannot continue with the previous system that developed people and ideas, and need to ensure that research and innovation impacts on the socio-economic aspects of our society.

Prof. Pepper: After a substantial financial investment by DST into the BRICS, we have a few additional services, platforms or products. The creation of TIA has resulted from this. Five years after the establishment of the BRICS there is little to show for the investment. The reasons for this are:

- Five years is a very short time for what is regarded as a long-term investment.
- It is necessary to look at the nature and quality of the potential products and services that went into the system, many of which have not materialised.
- There is a natural attrition rate in the system that sometimes reaches up to 90%. In order to ensure that successes are derived from the system, it is necessary to look at the long-term and to select suitable products.

One of the positive points about the IPR Act is that it will force people to become 'IP aware'. We need to be aware that there is a potential product or service in the research that is being conducted. We cannot continue to merely satisfy our own intellectual curiosity.

Prof. Thomson: We are grateful for the window of opportunity offered in terms of the Consumer Protection Act. This opportunity needs to be well used. During NBAC's discussion with Minister Pandor, she was very concerned about the ability to enforce the regulations pertaining to labelling of GM products.

Prof. Woker: We need to bear in mind that the Consumer Protection Act empowers consumers to make informed choices. People who are fixated on GMOs want to be informed of the GM content of food products. The regulations need to clarify what GM content is reasonable and what can be enforced. A similar process is followed for additives. However, consumer awareness and education to empower consumers to make choices is essential in order to overcome the negative view attached to GMOs.

Prof. Huismans: To what extent should an Act be changed to accommodate the opinions of a very small group of consumers who can be regarded as 'elitist'? Has a survey been made of consumers' views on the 20% additional cost of products due to labelling that is required by the regulations?

Prof. Woker: This is not government's role. Most consumers are unaware of the real issue concerning GMOs.

Unknown person: If government wants to promote social justice for all the people of this country, it has a responsibility to educate everyone. Perhaps government needs to educate people before putting legislation in place. Government's role is to make informed decisions based on an informed public because it represents its constituency. Government has assumed that consumers know what a GMO is.

Prof. Woker: Government cannot assume that only a few thousand people are interested in the GM content of products. Part of government's function is to legislate by informing people about the GM content products and allow consumers to make their own choices. Prior to the Act, consumers did not have a choice because they did not know of the existence of GMOs in the products they consume.

Dr Van Harmelen: It is unlcear what is meant by researcher liability in terms of the IPR Act. The Act does not provide for a fine or another form of punishment for non-disclosure of potential IP emanting from research. The only punitive provision in the Act concerns no disclosure (the responsibility of the recipient of public funding i.e. the university) when NIPMO can take the IP. This will require constant monitoring by NIPMO. In terms of the IP transactions, various requirements need to be in place and if not, the Act states that the transactions will be 'nul and void' from the start. A further matter concerns TIA's function to fund research and development which is of socio-economic benefit to the country which is aligned with the IPR Act in that grant proposals submitted to TIA will be required to show a socio-economic benefit form the research. Research institutes will need to make strategic decisions about what is worth protecting in terms of IP and whether the product is able to be commercialised.

Prof. Mundree: A public education programme was undertaken before legislation aorund GMOs was put in place in Australia. The tone of the debate changed when consumers were educated about the benefits of the GMO processes used in the products they buy and consume, including medical products. Consumers were able to make evidence based decisions, rather than emotional decisions. Surveys were conducted and the Office of the Gene Technology Regulator was established which distanced government from the suggestions and recommendations that came out of the surveys. GM products need to carry labels that not only inform consumers of the GM content, but also other health benefits of the products.

IP AWARENESS (FACILITATOR: PROF. AMES DHAI)

IP Awareness: A Tool to feed the Biotechnology Pipeline (Dr Antonel Olckers, DNAbiotec)

DNAbiotec exists because the company gerenates, protects and 'productises' IP. IP is managed in order to generate maximum return on the investment made. The government has taken similar responsibility through the development of the IPR Act which is expected to evolve over time.

It is thought that only business people discuss IP awareness and that it was not the domain of the academia. I founded DNAbiotec when I left academia nine years ago and for six years I managed the company as well as a full academic department at a university. The company translates intellectual capital to market capital. I agree with Sir Winston Churchill that, "the empires of the future are the empires of the mind" but I also believe that the economies of the future are the economies of the mind.

Singapore has transformed from a labour Intensive economy to a knowledge-intensive economy over a period of approximately forty years. The labour- and skills-intensive economies were not lost during transformation. Each economy was built upon the previous one. The reality is that South Africa is transforming to a knowledge economy. The meaning of knowledge economy is unpacked by beginning with knowledge (which is valuable) that requires skills to understand, to have insight, to deconstruct and to synthesise. It is then possible to produce something new, or make something with a new use which is innovation, that in turn creates intellectual capital,

translated to market capital which turns the economy. IP is the currency of the knowledge economy. There is a distinction between creativity (when smart ideas are thought about) and innovation (when smart things are done).

The IPR Act is a reality in South Africa and as a law, it requires execution and not futile discussion. Currently, teething problems are being experienced in the implementation of the relevant legislation. The public and private sectors have a responsibility to highlight and to minimise the unintended consequences of the Act. As in South Africa, other countries are also experiencing difficulty in persuading scientists to adapt their ways and embrace another outcome. In previous years, scientists were expected to publish or perish and all academic activities were geared towards achieving the single goal: to publish. Scientists were not trained to be 'IP aware' and at the time, IP awareness was not a national priority. It is important to learn the lesson of that era, but it is more important to set goals for the future: the knowledge economy.

In order to understand the currency of the knowledge economy, we need to be IP aware. IP awareness allows one to recognise IP, to know how to protect it, to choose the appropriate form of protection and put IP to work through commercialisation. The IP has a long path to travel from the time it is generated in the laboratory to the time it becomes necessary to take the IP to an IP attorney.

It is essential to generate maximum return on investment for the country. Research now has two outcomes: publishing and patenting, which are not mutually exclusive goals. This requires a change in mindset of scientists, change was done in the past and change academic culture from 'publish or perish' to 'patent and publish' even though the latter is not the comfort zone of many scientists. These changes can be achieved by using the tools available to us, namely:

- IP awareness
- Truly enabling structures and environment
- Offering incentives and rewards, by updating schemes in science and clarifying the priorities
- Make IP awareness a national priority by integrating it into existing structures (at school level)
- IP awareness should become part of the science process.

In order to fast-track IP awareness for scientists, it is essential to use all the tools available and accelerate the IP awareness learning curve by ensuring that research generates two outcomes: the introduction of IP awareness as part of the first year science curriculum at HEIs, and IP awareness of scientists who graduate. Multiple generations of scientists should be trained in IP awareness and institutions need to be IP aware. Discussions about the unintended consequences of the IPR Act and working together to minimise these will serve to fast track the process and allow the country to move towards a knowledge economy. Scientists need to familiarise themselves with the Act and be able to learn from others' experiences. The country needs to learn the lessons of other countries in terms of IPR. The following entities in particular, require IP awareness:

- National and regional decision makers: A national IP awareness culture must be created and national strategies need to be aligned with IP awareness**.**
- Funding agencies: Managers should facilitate a culture of IP awareness. Funding agencies should offer grants with the potential to generate IP, fund IP awareness training, reward IP awareness and make IP protection part of the grant critieria.
- Academia: Managers and supervisors should facilitate a culture and actively advocate IP awareness which should be inlcuded in the formal curricula so that IP can be produced, protected and put to work to maximise the return on investment of IP for the institution. Students should be empowered to use and to recognise IP and know that it must be protected. Academics also needs to be aware of IP's in terms of branding and marketing.
- Private sector: It is clear from the South African Science and Technology Indicators of 2008 that the private sector is not IP aware as under 10% of companies register their trademarks, have planned copyrights or have been granted IPR from innovation. IP awareness offers a strategic advantage to companies who generate IP.

Know-how is transferred through discussions between scientists and has often led to trade secrets leaving the country in the past, resulting in many missed opportunities.

A change of mindset is clearly necessary. Without IP awareness the knowledge economy cannot become a reality in South Africa. A workforce that is IP aware will maximise the IPR in science and feed the biotechnology pipeline. IP awareness is a multiplyer on many levels of the economy and global IP awareness is a reality. We cannot afford to stay where we are and we cannot afford not to take advantage of the opportunities available in this country. The three important Ps of IP are:

- Produce
- Protect
- Productise.

PANEL DISCUSSION

Mr MacLean Sibanda

IP has become relevant in society today and IP awareness is essential in all areas. We have a collective responsibility to ensure that each person becomes aware of the importance of IP, not only for business purposes but also for the benefit of the economy of the country.

We need to understand what makes up biotechnology today. An analysis of the trading of biotechnology companies shows that the value is in terms of IP. Most of these companies trade without a single product. The value is attached to the patent portfolio or other IP that is not patented. It is important for the biotechnology industry to emphasise IP. Another school of thought suggests that open access to IP needs to be created. IP is a currency and should therefore be used to trade to make more money, to get access to other IP or to get access to particular parties. In essence, IP is not a barrier for collaboration. Some people try to utilise IP to try to make money through infringements, patent controls, but this is not what the IPR Act stands for.

Patent data is probably the most recent, useful information available. The difference between patent data and publications is that the patent requirements require an enabling disclosure. The principle behind patents is to be able to teach the invention whereas publications are not directed to teach the invention. Therefore, the patent data become very important for cutting edge technology, to develop technology and to assess whether the technology is current or past. Many scientists in South Africa do incredible work. It is important for lecturers and supervisors to teach students to not only do literature searches, but also to work on an ongoing basis with patent data. Recipients of public funds are responsible to ensure that patent data searches are done. Scientists are obliged to inform the funding agency if their research is already being done elsewhere, by other scientists.

The integration of IP into the existing structures is important. The DST has made progress in this regard, through the establishemnt of two IP Research Chairs (at UCT and UNISA), which are responsible to develop appropriate curricula to be utilised by those who work with IP but are not lawyers. The culture of ‘publish or perish’ has evolved to become ‘patent or perish’ and more recently, ‘protect or perish’. The IPR Act does not promote patenting and deliberately refers to ‘intellectual property’ and not ‘patent’ to ensure an emphasis on protection. The IPR Act has not been perfected, but has to be applied in its current form and an appropriate attempt has been made by government to deal with the problems. The regulations provide an enabling environment in which to apply the Act. It is important for those who operate in the South African context to take ownership of the Act, understanding its limitations and learning to work within those limitations. It has been recommended that NIPMO issues practice notes on a number of subjects namely, international collaborations, open source and the full costing model.

Concerns about the Act have come from funders, venture capital (VC) and international funding agencies. Some of the concerns are unfounded because they are based on previous versions of the Act. It is the responsibility of scientists and policy makers to promote a proudly South African environment, by asking why a VC should be concerned about international organisations not buying into it.

The various initiatives of government (such as the IPR Act, the TIA Act, Bio-economy Strategy) need to be viewed within the context of the package that is directed at creating the appropriate environment to become a knowledge based economy. It is anticiapted that NIPMO's engagement with stakeholders to improve the understanding of the IPR Act will result in more IP awareness in terms of IP protection as well as commercialisation of IP. Patents are commercial tools and must be linked to the market. If patents do not link to the market, they will remain dormant and have no commercial value.

Prof. Julian Kinderlerer

The US Patent Office issues approximately 160 000 patents per year. Last year, 85 of those patents originated in South Africa and a similar trend has been followed since 1980. There has been virtually no change in this trend. Most of the patents that are issued are in the fields of electronics and engineering. Approximately 30% of all patent applications to the US, EU or Japanese patent offices, are in the chemistry areas and one in eight of these is from biotechnology. It is important to note that currently 70% of all applications for biotechnology patents are turned down by the US or EU patent offices. If a patent is registered at the Companies and Intellectual Property Registration Office (CIPRO) first, there would be no problem. A patent search process would not be followed and it would be a straightforward process. However, this is not the case in Europe or the US. South African patents are therefore worthless, unless a search procedure has been followed. It is unaffordable to have patents in countries all over the world. Many European companies would want to have technology patented in each of the 27 European member states. It would cost millions of Rands to get the patents, including the patent search. In relation to the number of patents being granted around the world, it would be necessary to patent in the US, Japan and probably South Korea and Israel. Very few patents are being generated in South Africa.

Whether there is a link between innovation and patents is a tenuous issue. For example, a pharmaceutical firm doing combinatorial chemistry would take out numerous patents that result in a drive on the market. Less than 1% of the patents held in pharmaceutics produce products that make money. Although patents are a form of currency and a way of protecting knowledge, they do not necessarily generate money.

It is important to increase innovation in South Africa and look at the network of scientists that produces advances in research. The collaborative networks tend to be very large. It is often found that scientists use the ideas of other scientists in their research. Sometimes these ideas are already patented in another country. As scientists work in networks, it is important to recognise that IP is related to working with others who are in other countries and address the network. The network can be produced through collaborative research projects or through discussing research with other scientists and then using their ideas. It will be difficult for South African scientists to participate in any EU FP7 project until NIPMO produces case law in this regard, as these projects are not compatable with the IPR Act. Although IP generated from the Bill and Melinda Gates Foundation funding can be owned, the work cannot be commercialised. The IPR Act must therefore not prevent South African scientists from accessing funding from the Foundation and other major funders in the biotechnology field. International collaboration is more important than getting patents.

In Africa, many biotechnology and pharmaceutical patents have never been taken out by the companies that hold the patents in Europe and the US. South African scientists have every right to use the published information in the patent directories to put the infrastructure into place which

allow innovation to take place. It is wise to use the fact that companies have not patented in South Africa and ensure that there are the incubators which allow people to use equipment and infrastructure so as to develop biotechnology and use it to innovate rather than talking about patents. This is the role of the TIA.

Dr Joanne van Harmelen

Capacity needs to be developed to make the IPR Act work. The Act requires that if public funding is used for R&D, it is necessary to identify the outcomes of the R&D that is worth protecting. The identification process requires capacity from the university Technology Transfer Offices. Different offices within universities will be required to collaborate in order to identify the outcomes of R&D. The Grants and Contracts Office needs to communicate with the Technology Transfer Office that needs to communicate with the research groups. Some universities already have these systems in place while those that have not yet developed these systems will require a culture change.

The second area of capacity needs relates to the assessment of IP that is an outcome of R&D from public funding. Government's focus of research that benefits socio-economic development is the most important factor that needs to be taken into account in the assessment of IP. The Act does not necessarily apply to research that does not have a socio-economic benefit. The potential for commercialisation also needs to be assessed. Universities will need to put in place capacity that is across the whole field of disciplines, as well as people who understand and can give advice on issues related to commercialisation, market research, legal issues and process engineering. It is suggested that ad hoc committees are established within universities to offer advice on the various aspects of IP assessment. It is not necessarily appropriate to take out numerous patents for each research project because not everything is worth patenting, in the broad sense of the word. It may be preferable for the recipients to seriously consider whether the research outcomes should be patented, be registered as a trade secret or whether it should be placed in the public domain, in which case NIPMO would need an efficient process to be able to make specific determinations. It would be irresponsible and costly to patent every part of the R&D and is preferable to identify the business focus which would provide for an IP portfolio that supports that focus. Although it may be difficult for universities to identify the business focus of R&D, it is an essential process that would involve education of researchers and interaction between the various university departments and the Technology Transfer Office.

It will be necessary for NIPMO to deal efficiently with the aspect of the IPR Act that deals with assigning and exclusive licensing of IP because there are various requirements that have to be met. The common notion that the Act is onerous and limiting in terms of IP will be dispelled if NIPMO is able to deal efficiently and effectively in generating the necessary approval of IP licenses.

Capacity needs to be developed between private and public sectors. Researchers are not necessarily entrepreneurs and do not necessarily have the ability to source the right partners in industry to ensure that the outcomes of R&D are commercially viable. More local organisations such as Techtique, are required. Techtique is an organisation that liaises with academia, the private sector and entrepreneurs to facilitate collaboration between them. Science parks have been successful in countries such as India and should be revisited in South Africa as a way to facilitate collaboration between the various sectors and areas of specific skills.

One of the requirements in terms of the Act is to report on the outcomes of R&D to NIPMO. A standardised set of metrics would be useful to assist recipients of public funding to assess these R&D outcomes and their socio-economic benefit.

OPEN DISCUSSION

Dr Duneas: Having been involved for many year in the commercialisation of biotechnology, I believe that the innovation chasm is mainly due to the lack of capacity of multiple resources

across disciplines to take innovation to commercialisation. China and India are examples of highly entrepreneurial societies that copy IP with impunity. They have managed to build their own capacity over time. If we are able to stimulate this opportunity in South Africa, we could benefit greatly and contribute positively to bridging the innovation chasm.

Prof. Woker: We have discussed IP awareness from the point of view of researchers being aware of their own IP. However, people also need to be educated to become aware of what they are allowed to do within the IP system because there is a danger of South Africans being intimidated by the more developed communities in terms of innovation. It is necessary to educate multiple layers of our society about the IPR Act.

Prof. Pouris: Is it dangerous for a South African to apply to CIPRO for a patent because the idea would have to be disclosed and cannot be protected internationally. As South Africa uses a registration system that is non-examining, the patent is worthless. We do not protect the national interests by making it difficult for inventors from other countries to protect their idea in South Africa.

Prof. Kinderlerer: Once a patent is registered with CIPRO, one has a year in which to register the patent elsewhere through the Patent Cooperation Treaty (PCT) system, or directly at any of the patent offices in other countries. A patent is therefore protected for that year. It is difficult to patent something that is being published elsewhere because of the requirements for originality. It can be used but it cannot be patented. A decision needs to be taken whether money is to be spent on research or on patents.

Mr Sibanda: It is important to understand that within that one year, the disclosure remains confidential. If one does not proceed to patent, the registration will fall away. There are currently discussions taking place between the United States Patent and Trademark Office (USPTO) and CIPRO to try to assist South Africa to move towards an examining status. However, there are issues of capacity to do this. Various models are being proposed by the USPTO as well as the Brazil patent office. Within the current system, if it is worth patenting, proceed with registration of the patent in South Africa because there is case law and a court of the commissioner of patents and the decisions have been very sound. In addition, there is a requirement of the IPR Act that the complete patent application is filed by patent attorneys. The screening of patent applications is done by patent attorneys who are world class. The World Intellectual Property Organisation (WIPO) provides access to a free novelty search for universities on the submission of the provisional specifications. This search is as good as the search is provided by the PCT system.
Researchers are encouraged to take advantage of this opportunity because when the search report is received, a decision can be taken as to how to amend the claims in terms of the South African Patent Office so that if there is litigation, case law will apply and protection will be received.

Mr van Zyl: It is not problematic to obtain patents but it is difficult to protect the patents and there is a huge cost involved in protecting patents abroad. Mr Sibanda mentioned that it is not only necessary to obtain patents to protect IP. What are the alternative options for the protection of patents?

Mr Sibanda: In some cases filing a patent may not be helpful because it is not possible to control how it is used. In such cases, it is preferable to register a trade secret. It is necessary to get advice from patent attorneys to put in place the appropriate mechanisms to prevent others from obtaining unlawful access to the trade secret. It is important to understand IP as a package and ensure that the appropriate form of protection is obtained.
In response to Dr Duneas's comment, inbound technology transfer is an important component of whether society will grow. TIA is fully aware of this and we are trying to encourage inbound technology transfer where we can bring in technology from elsewhere on the understanding that local knowledge is being developed. Patents are territorial and therefore researchers need to negotiate the whole patent with parties abroad. The negotiations for inbound technology transfer

differ from negotiation related to technology that is patented in South Africa. There is no obligation to pay royalties on something that is not protected in South Africa unless know-how or products are being imported.

Dr van Harmelen: A product such as Panado can be used to illustrate the other forms of IP that can be used to protect patents. The tablets will have a patent and possibly a trade secret, the bottle will have a design that is patented, the name and logo form the trademark protection, and there is copyright protection on the package insert.

Prof. Dhai: I believe that ethics rises above the law and one ought to regard law as the minimum standard. While the law has failed on a number of aspects, well functioning, competent research ethic committees have managed to ensure that researchers conduct themselves ethically. There are a number of national and international codes and guidelines for ethics in research. The latest of these is the Singapore Declaration of Commonwealth Principles. These codes and guidelines are silent on researcher responsibilities in terms of IP protection. Should a principle not be proposed within these codes and declarations for the propagation of researcher responsibilities towards IP protection? DST is looking at developing a research integrity code based on the Singapore Declaration of Commonwealth Principles and NBAC should consider giving input into this process.

Prof. Kinderlerer: I was involved in drafting a document for the UNESCO **Inter-Agency Bioethics** Committee. Codes of practice are being developed throughout the world for scientists in particular areas. DST has produced a code of practice for workers in nanotechnology. The European Patent Convention states that inventions whose commercial application would be contrary to morality are not able to be patented. The question remains that if some very nasty experiments were done that produced results that could save lives, *could* the results be used and be patented. It is debatable whether or not the product *should* be used or patented.

SESSION 3: BIOTECHNOLOGY RESOURCES

FUNDING GAP (FACILITATOR: PROF. ANASTASSIOS POURIS)

Prof. Jennifer Thomson

Three case studies illustrate the funding gap in biotechnology in South Africa. Trait discovery, product development and commercialisation require different types of funding. The first two case studies have a concept, gene discovery (which is not a single event), transformation (which could be single or multiple crops with different types of transformation), glasshouse trials and confined field trials.

Example 1: Maize Resistant to Maize Streak Virus (MSV)
Maize streak virus is endemic in Africa causing huge economic losses to commercial farmers and to small-scale farmers. A concept was developed and a process of gene discovery followed. The Claude Harris Leon Foundation funded R1 million for the project from approximately 1992 to 1998. Low level funding was also received from the NRF. The first PhD was in tissue culture, testing genes in black Mexican sweetcorn, followed by transformation of a type of grass called *Digitaria sanguinalis, a* model system wether learnt transformation of maize. Pannar Seed South Africa agreed to fund the project from this stage, the ongoing gene constructs being improved and transformed into maize, to develop the first transgenic MSV resistant plants. The glasshouse trials proved to be expensive at which point the Claude Leon Foundation terminated their funding of the project. However, Pannar continued their support in terms of finances and in kind. The product was patented in African countries as MSV is only found in Africa. UCT contributed a substantial portion of the patenting costs, together with Pannar. Dr. Dionne Shepherd presented a paper based on the research, with the title, "*Maize streak virus-resistant transgenic maize: a first for Africa"* at a conference in Chicago in 2007.

The next problem concerns funding that is required for the confined field trials. Pannar is committed to the project and MSV has been researched and the product has been developed in South Africa.As the research team felt it was important to continue the final stage of the project in South Africa. However, the Executive Committee that administers the GMO Act has to grant permission for the confined field trials to go ahead in South Africa and as the committee's decisions are not scientifically based it remains uncertain whether the trials will be able to go ahead. The problems related to the GMO Act have been raised with the Minister of Science and Technology.

Example 2: Maize Tolerant to Drought

Genes were taken from a resurrection plant for introduction into maize to generate drought tolerance. A plant physiologist, part of the research team was particularly helpful during the gene discovery phase of the project. Significant funding was received from the Rockefeller Foundation for a period of 5 years. However, once then concept was proved, the leadership of the Rockefeller Foundation changed and the new leadership was not interested in funding the project. The South African Maize Trust provided funding during the transformation phase of the research.. The NRF provided low level funding in the early days of the project.

The promoter aspect of the product was patented in South Africa, US and China and the costs of the patenting were borne by UCT and the South African Maize Trust. As the facilities at UCT for maize transformation were fully taken up with the MSV resistant research, it became necessary to find facilities in Africa, leading to a successful partnership with the Kenyatta University.

Example 3: Probiotics for Ostrich Chicks

Ostrich chicks are grown in incubators and are born sterile. When they are put out into pens, there are no bacteria in their gut, making them susceptible to disease. In addition they do not have the bacteria that they would normally get from the faeces of the adults. This has resulted in a 50 to 100% mortality rate in ostrich chicks. The concept was to feed probiotics to ostrich chicks in order to stem the mortality rate.

Five bacterial species were discovered during a process of organism discovery. The NRF funded a probiotic cocktail to the value of R750 000. The NRF and ARC funded the feeding trials that were done at the ARC premises. The initial trials showed that the probiotics led to increased weight. Currently, neither the ARC nor the NRF is prepared to fund a third feeding trial that is necessary and it is not possible to get a commercial partner until it can be proved that the probiotics work.

Conclusion

It was invaluable to have had a commercial partner almost from the onset of the MSV project. The importance of the funding and assistance that was received in kind cannot be over-emphasised. It was also extremely helpful to have received funding from the Claude Leon Foundation in the early days of the project. In the maize tolerant to drought project it was invaluable to have an interested party (South African Maize Trust) involved who wanted all the products to be available to South African farmers and who realised the importance of the patent. Funding from the Rockefeller Foundation in the early days of this project was also invaluable. In terms if the probiotics for ostrich chicks, the NRF only funds basic research and no commercial funding will become available without confirmatory feeding trials, presenting a huge problem in the innovation pipeline.

PANEL DISCUSSION

Mr Ben Durham

There is no funding gap in South Africa. Everything from fundamental science through to commercialisation is being funded and there is no specific gap, although there are problems

related to the emphasis and the quantum of funding. The innovation chasm is a real phenomenon across the world but it is being addressed in South Africa.

The fact that insufficient funding is given towards bridging the innovation chasm creates a set of problems related to the unintended consequences of limited funding. The problems include:

- The focus on supporting smaller projects because more projects can be funded.
- While the 'Rolls Royce' projects that have enormous political and social consequences are funded, the funding of the basic building blocks that develop a biotechnology sector or industry sector are neglected.
- Bureaucracy is increased through small amounts of funding being administered by many people, resulting in difficulties in accessing funding and slow turnaround processes that lead to missed opportunities for innovation.

Although a substantial increase in funding will ease the problems, it is not the fundamental problem. Other problems include:

- Government priorities and government alignment, particularly in terms of the National Biotechnology Strategy that is only being driven by DST. The enormous purchasing power of the Department of Health with respect to therapeutics in South Africa is driven from a cost efficiency process rather than from a point of view of developing the industry. In terms of the GMO Act, each sector is protecting their own interests instead of considering the need to develop the ability to exploit biotechnology for the good of the country.
- Collaboration and networking in South Africa is not encouraged. Many South African academics reference overseas collaborators, possibly because more resources are available from those partners. This must change because we are competing on quality and not on price. Although international linkages are necessary, we need to enhance our local collaboration to produce a better product.
- Increased IP awareness is essential in order to compete internationally. Biotechnology is currently a government strategy and is not receiving private funding, particularly from the VC sector.
- The lack of a biotechnology vision that is required in order to unify South African institutions and government departments.
- DST funding has been focussed on biotechnology, creating a separate innovation system that is isolated from the rest of the innovation system. Networking needs to be developed beyond the traditional biotechnology sector into the broader sphere of innovation in South Africa.
- South African scientists are highly critical of themselves and do not promote their successes. We neglect to celebrate success while we focus on complaints. We need to make a concerted effort to promote ourselves in a more effective manner. South Africa needs to be aware that although there is always room for improvement, the systems are working.

Dr Dusty Gardiner

The funding system, particularly in the biotechnology sector, is under severe pressure. This is not unique to South Africa. While South Africa is using infrastructure spend to secure the way through the economic recession, the US is investing in R&D as a mechanism to get through the economic recession. Two key issues that were identified in an article that looked at the South African R&D in science landscape were:

- Difficulty of access to funding
- Lack of skills.

A top South African scientist has worked for a number of years on a multinational project where the bulk of the funding comes from the US. In the US, the project has gone through the demonstration phase, demonstration plants have been built and the project is about to proceed to large-scale commercialisation. A license has been secured to commercialise the product in South Africa but the process is currently in the innovation chasm. Funding needs to be secured for a pilot plant so the product can be tested and validated in South Africa but the R&D funding agency

does not fund infrastructure. The commercial buyers want guaranteed, bankable projects, where pilot studies are complete.

Another example is of an entrepreneur who led the creation of a start-up company that is currently negotiating international contracts for their products with big international companies. He discovered that funding that he thought he had secured from the public sector funding system, has been put on hold. He needs to continue with production to fulfil contractual obligations. It has become necessary for him to take personal loans to maintain the company.

These are examples of expert technology. In the one case the product is about to be commercialised internationally and in the other case, international technology was brought into South Africa, yet funding cannot be secured. This may be an indication of a funding system that is under severe pressure. There are many consequences of this funding gap. The R&D intensity in biotechnology may decrease and the creation of a biotechnology industry will remain sluggish to non-existent. People and technology will tend to follow the money that is offshore. Another issue that is prevalent in South Africa at the moment is the intense competition between research and development organisations. Competition is not necessarily unhealthy as it promotes excellence but competing organisations that have complementary skills, should be collaborating, especially when funding opportunities are scarce. Most researchers collaborate with offshore partners, possibly due to the intense competition for limited funding. Another consequence of the funding gap is that many organisations move out of their areas of core competence in order to survive, resulting in non-delivery. Collaboration is a mechanism to overcome this problem.

It is not difficult to identify the problem, but it is difficult to identify the solutions and to implement these. Some possible solutions are:

- DST is expected to continue to strive to increase the R&D budget and there have been recent signs of inter-government departmental collaboration and joint strategy development. These are good mechanisms to grow the biotechnology sector and to grow the R&D spend.
- Prof. Thomson gave an excellent example of how to diversify funding sources, with a combination of public and private sector funding as well as international funding. Scientists need to leverage the limited public money and have to access private and international funding. The top scientists in South Africa are successful in dong this and the lessons learnt need to be disseminated in order to assist the younger scientists. It is unreasonable to rely on DST alone to fund all the research in the country.
- Strategic leadership is needed in biotechnology in South Africa where resources are limited. The current situation is that a multitude of small projects receive public funding. The country does not have sufficient funding, skills and expertise to succeed in all these small projects. A small number of national programmes should be identified that are critically important to the country, and public money should be used to fund these programmes. DST should be leading the other government departments as well as the research institutions in the country in this regard.

Prof. Bala Pillay

The challenge that is faced in the creation of a knowledge economy is to train enough students, starting at school level. The number of matriculants that enter university science faculties is decreasing year on year and the quality of students entering university is not what one would expect. This places a strain on universities that are obliged to use the little money they receive to offer access programmes to bring first year students up to speed with the level of university education. This places many constraints on the training aspect of universities.

Another challenge is the severe shortage of skills in science and technology, with very few skilled students entering and exiting the higher education system. There will be very few academics to replace the current group of academics when they reach retirement age.

There is awareness that South Africa spends a very small proportion of the GDP on R&D in biotechnology in comparison to many other countries.

It is often mentioned that academics and scientists should learn, understand and teach IP and commercialisation. However, the demands that are placed on academics today are on the increase. They are expected to teach, do research, administer and get involved in community outreach. This is very difficult, particularly as universities continuously cut down on staff and resources and increase bureaucracy. Although it could be accepted that some academics and scientists have an interest in biotechnology, it should be understood that the majority of academics would not necessarily become involved in biotechnology.

Several projects have been undertaken at the University of KwaZulu Natal and commercial potential of the outcomes has been assessed. Some of the research is at a very early stage and there are often problems in taking the research to the next phase. Recent developments with the BRICS and TIA have certainly exacerbated the problem of limited funding available for R&D. The delay in the establishment of TIA as a functional organisation has created problems for the research projects. This is an important issue and needs to be addressed urgently.

There are representatives from a few universities at this workshop. The universities that are not represented ought to be brought on board because they are involved in training students that will become involved in biotechnology. Spreading resources, as suggested by Mr Durham, is not a solution given the small community of researchers in South Africa. It would be preferable to focus our efforts and limit the amount of projects. The lack of coordination between the funding agencies in the country implies that researchers have to apply to each agency individually, through a complex and inefficient application process. The delays associated with applications for funding are unacceptable. Compressed timelines should be considered to avoid this problem. Students at various postgraduate levels tend to lose interest because of the indecisiveness about funding of their research projects, adding to the high attrition rate experienced by universities. It is necessary to align R&D and commercialisation expectations to the quality and quantity of the resources that are invested in those areas. This will bring about reasonable expectations and prevent disappointments and criticism related to non-delivery. Even though it is often difficult to measure the many intangible outputs that are achieved through the limited investment, these should be acknowledged to encourage the way forward.

OPEN DISCUSSION

Dr Chikwamba: We talk about building a bio-economy. We live in a global environment where the intensity and pace of innovation is very fast. We need to take this into consideration when we consider the funding that we have to drive this work. The NRF funds basic research but how much open funding is available and how quickly can one develop an idea from a concept to a product when working with students? When we look at other systems of innovation we find that five or ten postdoctoral students work intensively on one project, in line with an intensive level of funding. I would say that there is a funding gap if we want to build a bio-economy and the only source of funding currently available is from the Innovation Fund of the NRF. It is important that TIA needs to become fully functional as soon as possible. It takes a very long time to recruit, train and bring people up to speed with the work being done at the CSIR. This is interrupted by the inclusion of TIA in the innovation system. Suddenly there are no funds available. The critical mass that has taken years to build dissipates because of the lack of funding. This is a serious set back and has done much damage. TIA has been proactive in engaging with all the players in the innovation system but the focus is on bringing products to the market. We need to continually support basic science to ensure that the pipeline will not dry out.
Scientists are confident to state that their idea is worth patenting, but they are not able to translate the patent into a successful business. This takes time and costs money. How do we translate that potential to innovation that is a business? This is a gap.
The additive effect of both the issues referred to, as well as the GMO Act and how this has been interpreted, challenges scientists to such a degree that there is no incentive to make innovations

in cutting edge GM technology. What does this say about the vision and the attempt to build a bio-economy? The institutionalisation of regulations sector by sector is counterproductive to what we are trying to achieve.

Mr Mulder: The three projects mentioned by Prof. Thomson have considerable impact in terms of financial savings, poverty alleviation and job creation, yet they received minimal funding. There is substantial funding in economic development and social development agencies that is waiting to be unlocked and should be used for projects that are justified and have the appropriate socio-economic impact. Researchers need to justify their projects and tap into government economic development and social development institutions for funding.
In terms of the regulations pertaining to the IPR and GMO Acts, the role of advocacy on the impact of the Acts is critical. Advocacy is important to break down the barriers if the Acts are creating barriers to performance or to the growth of the industry.

Prof. Mugabe: How wide is the funding gap? Do we have a sense of how much money South Africa needs to invest in biotechnology R&D? Much funding is available for projects. What needs to be done to move from project funding to programme funding that will encourage collaboration between universities?

Mr Durham: The easiest way to assess our competitiveness compared to other countries in terms of funding for R&D is to look at the R&D spend as a proportion of GDP. Currently South Africa spends less than 1% of GDP on R&D, and is competing with countries with significantly greater economies that have an investment of 2 to 3,5% of GDP in R&D.
With respect to programmes, we need to significantly increase funding in order to identify specific programmes. DST has initiated Centres of Competence which to some extent are programmes for funding of science towards commercialisation. Programme funding for fundamental research does not yet exist.

Prof. Thomson: The Minister of Science and Technology has encouraged NBAC to indicate the priorities. One of the examples is ARC**-**Onderstepoort Veterinary Institute. South Africa used to be a world leader in animal vaccines. It is up to us to inform the minister and it is important to have an inter-ministerial forum that deals with these issues.

Prof. Wingfield: I would suggest that the gap is the funding. The figures indicated by Prof. Thomson related to the running costs of the projects. I suggest that every PhD student that is trained in this country is costing somebody R1 million. This is a real cost that does not take into account the salaries of the academics. This matter requires serious consideration.

Prof. Kinderlerer: Universities in the US have done work on drought tolerant strains of maize. Pioneer has indicated that they wanted to trial their drought tolerant maize in South Africa because this would be strategic philanthropy. Why are we doing the same project?
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Prof. Thomson: The leader in Africa for drought tolerant maize is Monsanto. Many discussions have been held in this regard. We do not know what is going to work and we have totally different approaches to the problem and are working with totally different genes.

Prof. Rees: The government is about to invest R280 million in building a new factory for specific vaccines at Onderstepoort.
The Technology and Human Resources for Industry Programme (THRIP) has not been mentioned at this forum. The Ministers of Science and Technology and Trade and Industry need to be requested to prioritise THRIP for biotechnology in order to leverage biotechnology as a strategic priority in THRIP.
National Treasury announced tax breaks of 150% for companies spending money in research but this is not implemented. Exploitation of this strategy could lead to free research and can leverage additional capital for R&D.

Prof. Pouris: If funds are derived from tax breaks, no other government support is allowed. The direction of priorities within DTI means that there is a greater investment in SMME's and not in larger companies.

Unknown person: Why are more public private partnerships (PPP) not promoted in South Africa? These should be elevated in biotechnology, particularly as we are struggling to commercialise our products.

Prof. Sue Harrison: Prof. Thomson's set of projects made us think across the different forms of funding that are available. One of the unintended consequences of the IP Act is that companies do not want to have THRIP funding on their projects because there is a potential risk. This has caused problems with regard to leverage of extra student training and support, of which THRIP has been a good example.
In terms of the quantum of funding, people are putting their projects into the incorrect funding streams, often pushing the commercialising phase far too early, resulting in the need to apply for funding in the next round.
The biotechnology sector is privileged because of the BRICS. However, there is a huge disjuncture since the BRICS have moved to TIA. We need to work hard to get ahead of this issue that should be seen as a priority.

Prof. Rybicki: The BioVac Institute is an example of a PPP. The government involvement in the establishment of this institute includes the donation of the land as well as an outdated facility which has largely been demolished and replaced. BioVac has had to use their own money to develop the institute. What began as a state vaccine research institute (making ten vaccines at one point) has become a facility that makes one experimental vaccine and packages others that are imported. We have therefore lost an asset to biotechnology in which this country used to be a world leader.

HUMAN CAPACITY (FACILITATOR: PROF. JASPER REES)

Dr Sagadevan Mundree

It is important to understand capacity building in the context of the broader objectives that we want to achieve both nationally and globally.

A definition of capacity building is, "the strengthening of economies, institutions and individuals through education, training, mentoring, and the infusion of resources. Capacity building aims at developing secure, stable, and sustainable structures, systems and organisations, with a particular emphasis on using motivation and inspiration for people to improve their lives."

Capacity building cannot be viewed as a way of producing a certain number of masters and doctoral graduates and expect that by placing the individual into the value chain, a ripple effect will result. A more strategic approach to capacity building is necessary. The infusion of resources requires both 'brains and bricks', involving not only postgraduates but also the infrastructure that will allow the individuals to take up appointments and find opportunities that will encourage them to stay in this country. South Africa is not the only country that is experiencing a situation where young graduates are migrating to greener pastures. A broader systems approach is needed in terms of capacity development. The seeds must be planted from school level, ensuring that our children are sufficiently informed to make the appropriate career choices.

Some examples of successful capacity building in S&T are found in India, China and South Korea's experiences. For the past decade these groups have experienced the loss of key skilled labour to the West and to Europe. The former CEO of the CSIR in India indicated that India responded to the capacity building challenges by continuing to train and skill people rather than focus on the loss of the skills. They also set up institutes such as the Indian Institute of Technology which has become almost comparative to similar situations in US or Europe. A point

was reached where nationals were keen to return to India because they could identify with the quality of the science, technology and engineering that was undertaken. China and South Korea have responded to the brain drain by doing the same as India. They have begun to contact their ex-patriots who are spread around the world to attract them back through what is called the 'reverse brain drain' or 'brain circulation'.

In order to achieve the desired social economic outcomes from investing in capacity building it is necessary to:

- Continue to find strategies to create a solid base of skilled people, being mindful that some the skilled individuals will come from other parts of Africa and the world. It is almost inherent genetically for the 'generation Y' and the 'bubble wrap generation' to follow opportunities that take them anywhere in the world. It is necessary to cater for the needs of those individuals in order to attract them to South Africa. People are no longer satisfied to remain in one place of employment for many years.
- Create a policy and regulatory environment that is conducive to exploring the opportunities from the intellectual capital and innovations. The policy environment needs to ensure an authorising environment which creates the opportunities for investment and collaboration.
- Provide a basis for business development by local entrepreneurs. Although there has been criticism of the BRICS, much has been achieved in their five-year existence. The culture of entrepreneurships is starting to emerge and markets are being opened.
- Attract investment by multinational companies. South Africa offers the right economic climate, geographic environment as well as local hospitality to attract foreign investment.

The economic outcomes from these investments are critical and it is necessary to have economists to look for opportunities for such investments. It is not feasible to spread investments too thin as the required impact will not be achieved. It is necessary to ensure that there are sufficient opportunities to develop the SMME sector through entrepreneurship, in the context of international trade, sustainable economic development and job creation that will alleviate poverty. The Queensland Department of Employment, Economic Development and Innovation tracks the economic outcomes of investments in capacity development as part of its accountability to the public.

Innovation in products and services, through the support of research and development aimed at economic development, is needed. Although the culture of developing incubators and technology parks has not taken root in South Africa, many other countries have embarked aggressively in this area and in Australia it already exists. Through geographical location close to universities and research institutions, technology parks encourage cross-pollination and the seeding of companies. Although VC appears to be well endowed in South Africa, the reality is that it is not. The major venture capitalists have not been attracted to the opportunities presented by this country.

Increased employment opportunities are necessary in order to stem the brain drain. The brain drain is a very important contributing factor in terms of the capacity problems in this country. Statistics from 2004 reveal that close to 180 000 skilled people have exited South Africa. This is a significant loss, particularly considering that the country has a total population of approximately 45 million. According to the World Health Organisation (WHO), twenty-seven countries in Africa have approximately two physicians per 10 000 people, while the world average is thirteen. Many of the physicians in the developed world come from Africa and the rest of the developing world. In order to address the gap that has been created by the brain drain, a way must be found to build capacity in an appropriate manner. The brain drain needs to be looked at in the context of globalisation. Globalisation in the broad sense refers to the diffusion of manufacturing, services, markets, culture, lifestyle, capital, technology and ideas across national boundaries and around the world. Through globalisation, increased migration is taking place, leading to a multicultural society, a spread and absorption of other cultures and decreased control of population growth or composition. Issues associated with this globalisation include barriers to immigration instituted by some governments, awareness of national cultures and religions and the emergence of

xenophobia and increased protection of nationals. The efforts to build capacity should embrace and accept people from other parts of the world.

The high number of individuals that departed permanently from Australia during the period 1993 to 2008 is of great concern and has necessitated considerable deliberation to find ways to fill the resultant skills gap and to attract the individuals back to the country. In response, the Queensland Government committed to grow the S&T sector to AUD 4 billion in revenue, employing over 16,000 people in an industry that will be worth $20 billion by 2025. Investment decisions were made within the full context of the economic view of the expected outcomes of the investments, overseen by a team of economists. The key drivers of the capacity building strategies in S&T used by the Queensland Government are the environmental, economic and social benefits. The key stages of investment in S&T began with a 'smart state strategy' which served to accelerate economic growth in Queensland and involved a large investment in infrastructure, working with the universities to build institutes that complemented the existing state and federal infrastructure. The investment in 'brains', eventually translated to investment in 'business'. The strategic international partners and the most lucrative markets were sought and the most outstanding researchers were supported through setting up fellowships at different institutes around the world. Inadvertently, the individuals who experience life in another country acquire knowledge and return to their home institutes. This is an extremely effective way to build capacity. The capacity building strategies in S&T also aimed to attract investment from international companies.

The Queensland Government's strengths in S&T include:

- Strong leadership, by intensifying efforts to position Queensland as an international hub for industrial biotechnology
- Science that is world class
- A competitive research infrastructure and supporting infrastructure that allows further industry development
- Clear and supportive regulatory and legislative frameworks
- Exploitation of the unique environment and tropical climate to develop excellence and allow access to Asian markets.

The following are examples of how capacity can be built by creating a supportive and enabling policy environment:

Renewable Fuels Industry policy

Queensland produces 95% of all the sugar cane that is grown in Australia, presenting opportunities for biogas to be used to produce ethanol (to supplement other fuels) as well as a variety of high valued products. The state funded a range of big projects in order to take advantage of these opportunities and attract international investment and industrial partners.

Gene technology policy

A co-existence framework was put into place to manage the issues of GMOs.

National R&D framework for Primary Industries

Queensland grows 62% of all the beef cattle in Australia and decided to invest in R&D so that the other states would benefit from the IP by way of license agreements and Queensland would use the IP generated from the wheat industry. In doing so, it was found that a 'team Australia approach' was created. The wise use of limited budgets created more critical mass in specific areas as well as interaction between the different states.

The Queensland Government has shown commitment to the development of capacity in S&T by significant investment in major research infrastructure over the past ten years. More recently, a $200 million 'Ecosciences Precinct and Health' was constructed with the aim of bringing together the biological sciences, engineering and environmental sciences to deal with climate change issues. Another example of infrastructure funded by the Queensland Government is a glasshouse facility called the Queensland Crop Development Facility that can be leased to the universities that do to have the facilities to grow GM crops.

The Queensland Government has made numerous commitments in terms of forward planning towards the realisation of further building of capacity in S&T. The government is fully aware of their obligation to fulfil the commitments that have been made in order to realise the goal to create 16 000 jobs.

The Queensland government's $3.6 billion funding investment in R&D and innovation over 10 years has resulted in more than:

- 36 new research institutes
- 300 research-related projects, research scholarships and fellowships
- 60,000 new jobs including 10,000 in science and research.

Knowledge intensive exports have increased by more than 100% and business R&D investment increased by more than 160%.

The vision for industry is to employ over 16 000 people, to generate AUD 4 billion in revenue and to create a AUD 20 billion industry by 2020. Any impediments to achieving these goals will require policy adjustments.

In conclusion, it is necessary to:

- understand the components of a world-class education and training system by:
  - identifying teaching practices and learning environments that improve student performance according to international best practice, particularly for disadvantaged groups and gifted students
  - identifying drivers of and obstacles to student engagement, uptake of further education and transitions to employment
  - forecasting South Africa's skills needs.
- optimise teaching and resources for a world class education and training system through:
  - assessing the impact of curriculum, teaching methods and other factors on learning outcomes, with a focus on improving literacy, numeracy and science education
  - trial and evaluating of new approaches to workforce attraction and retention, teacher development, teaching methods, further education and employment.
- transform education and training to meet the diverse needs, regardless of academic ability, geographical location or socio-economic status by using new technologies and best practices to address diverse needs.

PANEL DISCUSSION

Prof. Ed Rybicki

Africa is the poorest continent in the world, with the weakest S&T institutions and needs new and innovative approaches to capacity building. Some of the problems with capacity building involve the definition of excellence, research focus and performance.

Some of the solutions to the challenges presented by capacity building mentioned by Prof. Mundree include:

- Judging science on relevance to the needs of users. Agriculture has been one of the areas that is under-funded in this country in terms of biotechnology funds. For six years, a group of researchers has not been able to get funding from PlantBio for a transformation and plant improvement facility that included bio-farming. Presently, TIA is not funding the bio-farming research. This is a reflection of the priorities of funding agencies.
- Developing innovation systems and knowledge networks
- Facilitating R&D and commercialisation
- Exploiting local advantages
- Investing in life science.

Some personal opinions include:

- Capacity development is narrowly defined as the training of students as well as technical people.
- In South Africa, funding is insufficient for biotechnology research.
- The funding body situation is dysfunctional and chaotic. This is obvious rather than controversial. There was an innovation fund that initially offered partial funded for the type of work done by start-ups and changed its priorities (as well as personnel) resulting in disjuncture between the priorities of the research project at the onset and those at the end of the project. The BRICS came into existence in the following era of funding that intended to fund a wider range of projects, when suddenly the BRICS no longer exist. There is no smooth path into TIA and there is no funding from TIA because they do not exist as a funding agency. The knock-on effects are that, for example, an academic research team is retrenched due to the lack of funding. Researchers have been forced into accepting funding that is going to be 'full cost' so that the company involved can take the IP. This practice could result in a net loss to South Africa.
- There is very little support for early pipeline, long-term projects. Innovation Fund projects ran for three years and funding was not renewed thereafter. There is uncertainty about long the TIA projects will run for.
- There is no recognition that biotechnology product-oriented projects are not really suitable for students. Placing a student on a completely product-driven project amounts to a violation of the supervisor's contract with the student. A product-oriented project does not provide for this 'apprenticeship' as funding could be withdrawn if there is a breech of contract between the university and the student.
- There is too much emphasis on quick turnaround because it is believed that these projects can be profitable within three years. However, this is untrue. An example of this is vaccines, which take fifteen years from concept to the end of phase 3 trials.

In terms of the funding gap, the NRF funds several people but they do not fund them very well. The result is that research is conducted and student training takes place. However, when the project reaches the development phase, business training is offered and the scientists' task is complete. If insufficient funds are put into research, the result is the NINO principle of 'nothing in, nothing out' because a few people have been trained and very few outcomes of research can be commercialised. If the goal is to increase the number of postgraduate students in order to improve the skills training in South Africa, sufficient and substantial funding is required, and to a certain extent, in the R&D sector of biotechnology.

It costs a university approximately R150 000 per year to offer support and research support to one masters or doctoral student. If more money were made available to academics to train students, more students would receive postgraduate training. Technical training requires funding to indulge in teaching technicians. Skills migration is a reality in academia today. Many people come to South African universities for postgraduate training. It is therefore reasonable to allow South African academics to leave for other countries, particular in terms of the global knowledge economy.

The MSV project (also presented by Prof Thomson) produced only two PhDs, one postdoctoral fellow and four scientific officers. A biotechnology funding agency in South Africa is not likely to fund the project throughout the total timeline of about twenty years. A further example involves a vaccine development project that started in 2000 under the South African Aids Vaccine Initiative (SAAVI) run by the MRC and funded by DST to the effect of about R10 million per year. In the third funding cycle, DST withdrew funding from SAAVI because of governance issues and as part of a policy decision. A consortium of forty-five people at UCT alone worked on the project. The products of the project at the time the funds were withdrawn were two vaccines in human trial. Four vaccines and vectors were in mid-stage pipeline and had to be completely stopped. One of the four projects is being funded by the NIH and it is anticipated that the other three will also be funded by the NIH. As a result of a policy decision, the biggest molecular biotechnology project in Africa and one of the biggest ever in the Southern hemisphere, was terminated and the capacity

that was developed has been lost. No students were affected because the end of their projects had been planned to coincide with the end of the third cycle of funding. This is cautionary if researchers rely too heavily on one funding agency in a climate where circumstances can change without warning.

The involvement of schools in biotechnology is essential. Funding agencies and academics need to become involved in open content in order to educate the public about biotechnology.

Dr Mapitso Molefe

The Minister has made it clear that the DST should be driving human capital development, developing infrastructure and funding strategic projects that are aligned to government priorities. Unlike the previous Biotechnology Strategy that looked at harnessing the product at the end of the pipeline, the new Bio-economy Strategy attempts to start investing in the beginning of the pipeline, ensuring that the basic building blocks are in place that would enable good ideas to be taken to commercialisation.

It has been understood that innovation in life sciences is a long-term investment and DST is looking at such long-term investments in R&D in biotechnology.

Human capital forms an important part of DST's investments in biotechnology. DST stipulates that 30% of all the funding for programmes is allocated to human capital development, in addition to other DST initiatives such as the South Africa Research Chairs Initiative (SARChI) and the Centres of Excellence programme.

Prof. Pepper mentioned that the percentage of unemployment of graduates in South Africa had increased by 50%. The system is not able to absorb the human capital that is being trained. Investment is therefore needed to prepare the system to absorb the trained human capital.

Different government departments are beginning to work together to address the twelve priorities of government, one of which is skills and human capital development. Government departments are co-signing agreements to ensure that they collectively address the issues related to human capacity and align their strategies towards human capital development for the S&T sector. The various government instruments that are used to develop human capital also need to be aligned.
South Africa is one of the few African countries that do not have a comprehensive programme to train students abroad. Such a programme that builds capacity abroad to later return to South Africa and contribute to the bioeconomy has become essential, particularly in the context of global knowledge economy. The human capital required by this country will not necessarily come from South Africa.

Prof. Brenda Wingfield

It is a South African phenomenon to train students from a variety of countries all over the globe. In terms of training and biotechnology, it should be emphasised that the biotechnology industry is very close to its science roots, making it very different to other industries such as the computer industry. PhDs are necessary in order for biotechnology to thrive. Training PhDs is not a trivial matter. It is very expensive to train a PhD student. It should also be emphasised that a student that is training towards a PhD in science does not get trained by producing a product that they want to sell, develop or implement, but only by doing good science and publishing in internationally recognised journals. A PhD does not have a curriculum. It is the premier degree in science and it takes approximately ten thousand hours of very hard work to get a PhD.

In terms of capacity development, it is necessary to train not only the students and the scientists, but also to train industry and explain to them about training of a PhD student. Academia needs industries that have the capacity to take the ideas of scientists and develop them by working together. Industry takes the ideas of scientists without patenting them, and develops them.

Industry does not appear to be interested in patenting scientific ideas from the university environment but they have strong R&D sectors where they take the work that is done at universities to the next level.

OPEN DISCUSSION

Prof. Rees: We currently train 1200 PhDs per year and the DST wants us to train 3000 per year, representing a five-fold increase. The whole science system will have to be extended in order to increase the number of PhDs we train each year or we will have to think differently about the way we do things.

Prof. Pillay: The money spent on NRF road shows should be better spent on bursaries.

Prof. Baruth-Ram: Before we can talk of increasing the PhDs, we need to focus on students passing their first degrees and honour's degrees. Do we need an honours programme?

Prof. Wingfield: We do need an honour's programme. The 4 x 4 model (a four year BSc degree onto a four year PhD degree) has been discussed. The statistic of 10 000 hours for a four year PhD helps us understand that very few people are ever going to be able to do a PhD. In terms of the four year BSc degree, we do not have the physical capacity in most of our universities to train that number of students to that level. In an ideal world, we could do as the UK has done which is to adopt a kind of 4x4 model. The major difference is that the PhDs that they train are not able to run research programmes, while South Africa needs PhDs that can run research programmes. We cannot allow PhDs to qualify without having gained sufficient experience to run a research programme.

Prof. Rybicki: In our faculty we looked at where the bottlenecks were and found that there are only bottlenecks that relate to funding. Money is needed to do a technical honours degree. The researchers, and not the university, pay for the honours students. More honours and masters students can be catered for if there were more funds.

Prof. Huismans: How much are we reinventing the wheel in dealing with the problems in South Africa? We often seem to start form scratch. There are many excellent examples of the whole biotechnology chain. We are missing out on the scientific principle by ignoring the scientific studies that have been done, instead of using them to shortcut our processes.

Prof. Mundree: We are constantly changing the playing field, resulting in us going backwards instead of forwards. Time is valuable. Once the pipeline is broken, it takes substantial energy to get back on track. The strategies change while they should remain consistent. Political leadership is needed to persist with strategies.

Prof. Harrison: This is a major problem. There have been some very good ideas, such as THRIP funding. This was a good way to generate human capacity. Once the programme was going well, extra criteria were introduced, such as SMEs. This changed the face of THRIP funding. The NRF's focus themes worked well and were then withdrawn. The BRICS started and have done wonderful work, but have recently been moved to TIA. There is a disconnect between biotechnology and other sectors and the disconnect of funding flowing into TIA is creating frustrations. We need to create a system where we can keep traction on what we are doing and move it through to allow the programmes to show their value before they are scrapped or changed.

Mr Durham: The NRF's goal to reach 3000 PhDs was based on other successful economies and the ratio of PhDs in those economies. The number of PhDs produced annually is associated to the budget and the growth of the whole science system. This remains a problem.

Prof. Rees: Does DST know if there has been any progression towards the target number of PhDs? We have not seen any change in the environment that would help us achieve the goal. The number must be tracked annually and we need to see what is being done to increase the number of PhDs.

Mr Durham: The BRIC experience showed that South Africa is not short of ideas relative to the money that is spent and the number of entrepreneurs who could take ideas and transform them. In biotechnology this process requires higher skilled individuals. It was the entrepreneurial drive and not the biotechnology skills available in this country that was the limiting factor in the BRICS.

Prof. Mundree: This strategy needs to stand the test of time and we need to see the process through. There are some long-haul examples of such strategies that have borne fruit after many years. We need to set targets and track them, without expecting unrealistic outcomes.

Prof. Wingfield: We cannot teach innovation but I would suggest that we require a critical number of people that have PhDs before the innovators will come out of the system. Therein is the problem. We are training too few PhDs and lot of them are leaving the country.

Prof. Dhai: Are we doing enough advocacy in parallel with regard to sustainable capacity building. We need to ensure that there is an enabling environment in which to train PhDs. We can produce the PhDs but without the correct environment we cannot keep them. Parallel structures are necessary to ensure sustainability.

Prof. Rybicki: We have a dearth of biotechnology companies and we need parallel industry that is successful to feed through our PhD graduates. This is not happening. Perhaps we lack entrepreneurs and people with the vision to mine local advantage space. There are examples of vaccines that are not patented in South Africa and we therefore have complete freedom to operate. However, the mandate given to the Innovation Fund and the BRICS was that they needed a well-patented idea in order to commercialise. Rather, we need to exploit local advantage and exploit the short-term advantages by subsidising them in order to create the environment where PhD graduates can work.

Prof. Wingfield: PhD students from UP get jobs before they complete their PhDs and this is a problem. When we talk of unemployed graduates we are speaking of those with bachelor degrees.

SESSION 4: WAY FORWARD AND CLOSING REMARKS

Prof. Michael Pepper

Several similar comments have made during this workshop by different speakers. Many have felt that for the first time, the views expressed have been open and unbiased. The speakers, the panel members and those who contributed to the discussion were thanked for their contribution. NBAC colleagues who had put together the programme, the administrative staff and conference organisers were also thanked.

On numerous occasions, the Minister has asked NBAC to provide her with appropriate advice in the form of specific details of what should be done to feed the biotechnology pipeline. Many of the details discussed at this workshop are very relevant, the most urgent of which is the need to resurrect the funding instruments that have gone dormant as a result of the incorporation of many entities into TIA. Education and human capacity development have already been recognised by DST as important. It has become evident that emphasis would have to be placed on prioritisation, courage will be needed to make the decisions and there will be an element of risk management in drawing up the new Bio-economy Strategy. Currently, a problem of ‘change fatigue’ is being experienced due to constant cycles of change. The strategy cannot keep changing. It will be necessary to stay focussed on the Bio-economy Strategy once it is developed in order to see

whether or not it is viable. There is a real danger that the creation of more structures and more policies could result in the entrenchment of mediocrity. The structure must be kept simple, light and mobile so that the objectives can be achieved as efficiently and cost-effectively as possible.

Prof. Krish Baruth-Ram

Many interesting problems that require much consideration have been highlighted at this workshop. In particular, the question of IP needs careful consideration, particularly as the final output of research is unknown at the onset of the project.

The laser was used to point out elements contained in the presentations at this workshop, but the laser was discovered as result of an experiment in optics and the theory was developed by Albert Einstein. This raises the questions of ownership of the IP. The Annual Conference of the South African Institute of Physics is taking place this week. The opening speaker at the conference said that the laser was a discovery waiting for an application. There are several instances of this in science. Allan McLeod Cormack published a paper that formed the basis of the Computed Axial Tomography scan known as the CAT scan but this was not realised in South Africa at the time. However, he was enticed by the US who realised the potential of his discovery for which he received the Nobel Prize in Medicine in 1979. Much IP has been lost from South Africa in this way.

The workshop also stressed the lack of public funding and the lack of business savvy in terms of innovation. The situation has been recognised by the NACI Council and a meeting has been convened with business leaders of this country to try to set up an innovation fund that would attract investors who would buy into this the project and set up a national fund that would support innovation. The author of the book entitled, '*The Other Side of Innovation'* argues that innovation is like climbing a mountain where attention is focussed on reaching the top, but the more difficult task is climbing down from the peak. The challenge that is faced is how to translate the high quality research that is being done at the universities into commercialisable projects. It is anticipated that by setting up this fund, some space will be provided for thought to be given to the second half of the problem.

It is encouraging to see the different sectors represented at this workshop and to see that most of the participants stayed until the end of the day. We all need to work together in achieving a common goal.

The participants were thanked for their contribution, the NBAC committee for putting together the workshop and the NACI Secretariat for their organisation of the event.

APPENDIX A: ATTENDANCE LIST

NAME			ORGANISATION
Bailey	Andrew	Dr	University of Cape Town
Beharee	Vihitha	Mrs	Private
Bharuth-Ram	Krish	Dr	NACI
Buthelezi	Nozipho		NACI
Chikwamba	Rachel	Dr	CSIR
Clelland	Sandra	Ms	Spoor & Fisher Attorneys
Dhai	Ames	Prof	Wits University
Duneas	Nicolaas	Dr	Altis Biologics
Durham	Ben	Mr	Dept of Science and Technology
Erasmus	Heather	Ms	Write Connection (Scribe)
Evans	Sandy	Dr	Spoonful of Science
Friedenthal	Jacquelene	Ms	Swiss Embassy
Galada	Ncebakazi	Ms	NACI
Gardiner	Dusty	Dr	CSIR
Gopaul	Melissa	Ms	SAASTA/PUB
Groenewald	Hennie	Dr	Biosafety South Africa / TIA
Harrison	Sue	Prof	University of Cape Town
Heyman	Heino	Mr	University of Pretoria
Huismans	Henk	Prof	University of Pretoria
Jones	Gareth	Mr	African Centre for Biosafety
Kinderlerer	Julian	Prof	University of Cape Town
Komane	Organs	Mr	Tshwane university of technology
Kubayi	Donald	Mr	Xitokofela Group Investments Club
Malefetse	Tshepo	Dr	Mintek
Masia	Mavis	Ms	NACI
Mngadi	Phakamile	Ms	Academy of Science of South Africa
Mohlokoane	Tshepo	Mr	Tshwane University of Technology
Molefe	Mapitso	Dr	Department of Science and Technology
Mosenthal	Thabo	Mr	NACI
Mpele	Simon	Mr	NACI
Mugabe	John	Prof	University of Pretoria
Mulder	Robert	Mr	IsambuloAMI
Mundree	Sagadevan	Prof	Queensland University of Technology

Naidoo	Suresh	Mr	CANEGROWERS
Nedambale	Tshimangadzo	Dr	Agricultural Research Council
Netshiluvhi	Thiambi		NACI
Njobe	Khungeka	Ms	CSIR - Environmentek
Nkosi	Sandile	Mr	PPS
Olckers	Antonel	Dr	DNAbiotec
Pepper	Michael	Prof	University of Pretoria
Pillay	Bala	Prof	University of KwaZulu Natal
Pires	Nuno	Mr	Altis Biologics
Pouris	Anastassios	Prof	University of Pretoria
Ramafi	Grace	Dr	USA Embassy
Rees	Jasper	Prof	Agricultural Research Council
Rybicki	Ed	Prof	University of Cape Town
Segooa	Louisa	Ms	Dept of Science and Technology
Sibanda	MacLean	Mr	Technology Innovation Agency
Snyman	Sandy	Dr	South Africa Sugarcane Research Institute
Soomaroo	Swasthi	Ms	Department of Science and Technology
Sunil	Manjusha	Dr	SAASTA/NRF
Taylor	Sue	Dr	University of the Free State
Thomson	Jennifer	Prof	University of Cape Town
Tsatsi	Nyakallo	Mr	NACI
Van Harmelen	Joanne	Dr	Spoor & Fisher Attorneys
Van Zyl	Nick	Mr	Bansha Investments (Pty) Ltd
Webster	Jocelyn	Prof	AfricaBio
Wingfield	Brenda	Prof	University of Pretoria
Woker	Tanya	Prof	UKZN