COFISA
Cooperation Framework on Innovation Systems between Finland & South Africa

science & technology
Department:
Science and Technology
REPUBLIC OF SOUTH AFRICA

COFISA Biotechnology Foresight: 2nd Gauteng Workshop Report

1 April 2009

Non-Zero-Sum Development
Knowledge Ecology • Innovation • Foresight • Information Society

SMART innovation

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1 Introduction

Biotechnology is one of the "grand challenge" areas that has been identified in the ten-year innovation plan published by the Department of Science and Technology (DST), and supported by Cabinet. Following on from previous successful provincial Foresight exercises in 2008, and in support of DST's biotechnology "grand challenge", the Cooperation Framework on Innovation Systems between Finland and South Africa (COFISA) decided to hold a biotechnology Foresight exercise for Gauteng (and also in COFISA's two other target provinces, W Cape and E Cape) during late 2008 and early 2009. The objectives of this exercise were:

- To anticipate emerging areas of opportunity related to biotechnology, with a particular focus on Gauteng;
- To support existing and encourage new biotechnology SMMEs in Gauteng.

The Foresight exercise included two two-day residential workshops. The first of these took place on 29th & 30th October 2008 at St George Hotel, Tshwane, while the second workshop took place on 4th & 5th March 2009, at the Centurion Lake Hotel, Tshwane. The details of the second workshop are covered in this report. See Annex 2 for the programme followed by the workshop.

2 Background

2.1 Brief overview of COFISA

The introductory session began with Mr Thembinkosi Semwayo, the COFISA Foresight Coordinator for the Western Cape, providing an overview of the aims and objectives of the COFISA programme. COFISA is a programme that has been developed jointly by the Governments of South Africa, through DST, and Finland, through the Embassy of Finland in Pretoria. Its objective is to contribute to the enhanced effectiveness of the national, and particularly the provincial, systems of innovation contributing to economic growth and poverty alleviation. COFISA's three pilot provinces are Gauteng, Eastern Cape and Western Cape.

Why is Foresight Important to COFISA?

- Foresight is a good tool in helping to create commitment, enhance collaboration and build common ground;
- Foresight promotes creative, proactive policies and strategies that respond in time, learn in time and are able to adapt and evolve;
- The long time horizon used in the Foresight process neutralises contentious issues thus facilitating cooperation between diverse actors as well as consensus building; and
- There are insufficient Foresight capabilities at national and provincial level.

Through the Foresight processes, COFISA thus aims to achieve the following:

- Grow the understanding and awareness of Foresight;
- Facilitate the establishment of networks;
- Transfer knowledge and skills;
- Facilitate the initiation of relevant projects related to the Foresight exercises that may be collaboratively implemented or driven by specific role-players e.g. SMMEs; and
- Feed into strategic processes at the national and provincial government levels.

2.2 Process to date

Invitations to the first workshop

Although numbers were limited, a wide range of participants was invited to the first workshop. They were identified through relevant organisations, and through peer nomination.

First workshop proceedings[1]

The first workshop included the following main items:

- A slide presentation by Dr Sibongile Gumbi, based on the previously circulated "*Biotechnology Trends Analysis*" document;

- Participants were then asked to join one of three working groups based on the following sub-components of biotechnology:
  - Food & Agriculture;
  - Animal & Human Health; and
  - Industrial Biotechnology, Environment and Natural Resources.

  Each working group then used the rest of the first morning to add relevant knowledge within their sub-component to the *Biotechnology Trends Analysis*, particularly related to current or emerging biotechnology activities in Gauteng.

- Then followed a slide presentation by Bob Day of three proto-scenarios for Gauteng. This was based on a document that had been previously circulated: "*Three Scenarios for Gauteng - 2030*";

- Participants used the remaining 1½ days to participate in Foresight activities intended to convert these proto-scenarios into full Biotechnology Scenarios that were specific to Gauteng.

- Participants were then asked to join one of three different groups, this time each based on one of the proto-scenarios. Each group then produced two levels of biotechnology Futures Wheels for their proto-scenario.

- Finally, based on the most important issues identified in their Futures Wheels, the groups each wrote fairly detailed biotechnology proto-scenario fragments.

Post first workshop

Modifications were made to the *Biotechnology Trends Analysis* document, based on the inputs received during the workshop, and the revised document was distributed electronically amongst workshop participants for further feedback. A final COFISA *Biotechnology Trends Analysis* document will be produced for general distribution once this feedback has been received and relevant material added to the document.

The biotechnology proto-scenario fragments were worked into the original proto-scenarios to produce preliminary drafts of three *Gauteng Biotechnology Scenarios*. These draft scenarios were circulated electronically amongst the workshop participants and feedback was solicited. The inputs are being incorporated into each draft scenario to produce three *Gauteng Biotechnology Scenarios*.

[1] A full report of the 1st workshop is available online at www.cofisa.org.za

The second workshop
The second workshop built on the outputs of the first workshop. Most of the participants from the first workshop were invited to the second workshop. However, given the strong emphasis on technology road-mapping in the second workshop, additional participants from Gauteng that had research and technology expertise were invited, and particularly those with expertise in the biotechnology opportunity areas identified during the first workshop. The full list of participants in the second workshop is provided in Annex 1.

During the second workshop three technology roadmaps were produced, opportunities for SMMEs were identified, and action plans were drawn up. This process and its background are set out in more detail in the next section.

3 Technology Road-Mapping

3.1 Background

This section provides a brief overview of the main aspects of Technology Road-Maps (TRMs). For more in depth material on several aspects of TRM, the following references are recommended:

- *"Technology Roadmapping: a Strategy for Success":* Industry Canada, 2000. Available online at: http://strategis.ic.gc.ca/trm
- *"Technology Roadmapping: a Guide for Government Employees":* Industry Canada, 2002. Available online at: http://strategis.ic.gc.ca/trm
- *"Scenario-based Roadmapping – a Conceptual View":* F Lizaso & G Reger, EU-US Seminar: New Technology Foresight, Forecasting & Assessment Methods; Seville 13-14 May, 2004. Available online at: http://forera.jrc.ec.europa.eu/fta/fta2004.html
- *"Technology roadmapping in review: A tool for making sustainable new product development decisions":* I J Petrick & A E Echols, Technological Forecasting & Social Change, 71, 81–100, 2004. Available online at: http://www.sciencedirect.com

What is Technology Road-Mapping?
TRM, which dates from the late 1980s, brings stakeholders together in a far-reaching planning process, opening the door to collaborative R&D:

- It can play a key role in enhancing innovation.
- It does NOT predict future breakthroughs in science.
- Rather, it DOES forecast and articulate the elements required to address future technological needs.
- It describes a given future, based on the shared vision of the people developing it, and provides a technology-oriented framework for making that future happen.
- It offers only a high level strategy for developing the technologies. A more detailed plan is then needed to specify the actual projects and activities required.

TRM can help organisations at any level (government, corporate, industry/discipline, cross-industry/national or international) to collaboratively identify future needs, to then map them into process/product/service technology alternatives, and then to develop plans to ensure that the required technologies, skills and resources will be available when needed.

TRM facilitates better decision making by identifying science and technology (S&T) areas of high potential or strategic value, and also technology gaps, when these are not clear. It can aid in deciding:

- which technology alternative to pursue;
- how and when a technology will be available;
- when it will be necessary to coordinate the development or acquisition of multiple technologies.

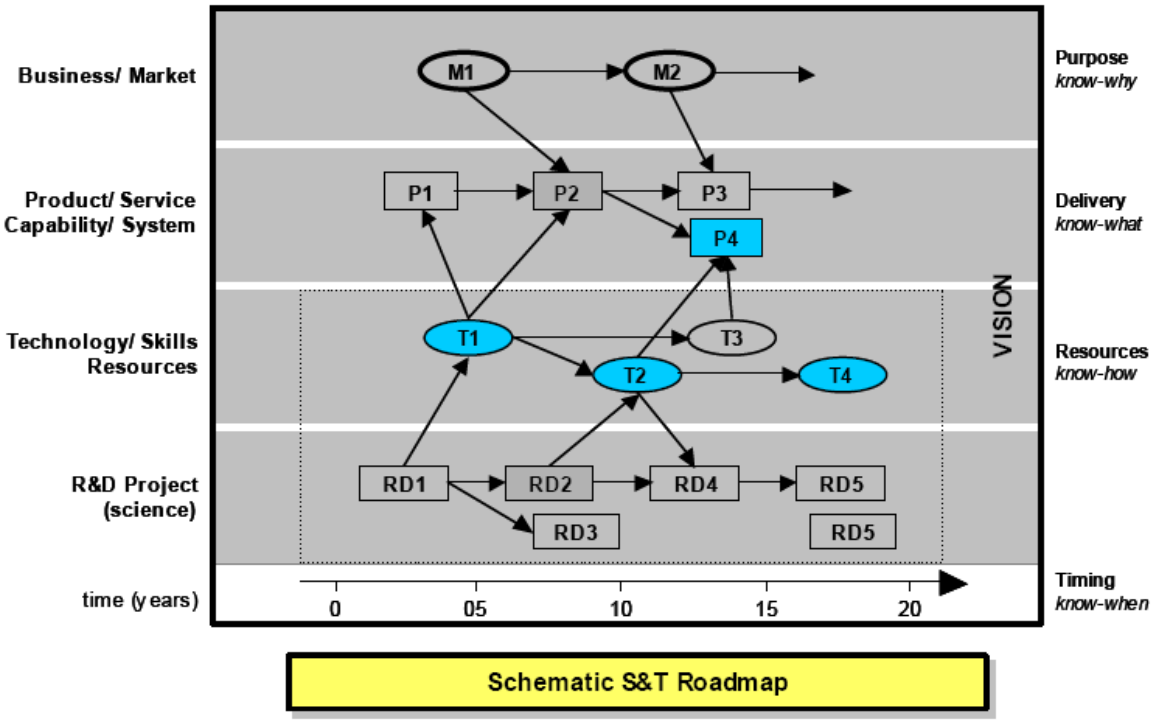


Figure 1. Schematic representation of a generic S&T roadmap nodes and links, showing how all perspectives involved can be aligned. Source: adapted from Kostoff, Ronald N., et al., 2001.

Multi-layer TRMs are the most common (see Figure 1 above):

- The top layer refers to the purpose that is driving the roadmap ('know-why').
- The bottom two layers relate to the resources, the science and technology (i.e. the "know-how") that will be deployed to address the objectives.
- The middle layer provides a bridging/delivery mechanism between the purpose and the resources layers ('know-what'). It ordinarily focuses on product development, but services, capabilities, risks or opportunities are also appropriate for the middle layer, to understand how technology can be delivered to provide benefits to stakeholders.

What types of technology are important for this process?

Disruptive Technology (DT):

- This is significantly superior and different from current technologies (also termed "revolutionary" by some). A DT both changes the market and how a problem is solved. The technology's new capabilities alter customers' expectations and requirements. E.g.: telephone, motor car, Internet.

- *Alternative definition:* A DT falls short of satisfying one or more current customer requirements, BUT it has such a rapid trajectory of improvement that it will soon overcome this drawback. In most cases, the DT eventually replaces the existing technology. E.g.: flash memory.

Emerging Technology (ET):

- A new technology in early development and with promising broad application, but its uses and benefits are not yet fully understood.
- Investments in ETs tend to be undertaken to obtain good early positioning in a technology that could quickly gain dominance, rather than for short-term return on investment.
- The development of an ET is too premature for the creation of specific products. Instead, ET development creates core capabilities for the sponsors.
- Examples of ETs are lasers and nanotechnology.

Types of TRM

There are several types of TRM, each of which share several common elements but also *differ significantly*. The types of roadmaps most commonly in use today are:

- ***Product TRMs:*** used by companies to identify the technical processes for development of a specific product or service;
- ***Corporate TRMs:*** developed internally by a single company/university/laboratory as part of their technology planning;
- ***Industry TRMs:*** used to assess and extrapolate the direction of needs within *an area of technology*, and then identify R&D strategies to meet those needs;
- ***Emerging TRMs:*** specifying the timeline and expected performance for a technology currently in early development, and *not driven by specific product requirements.*

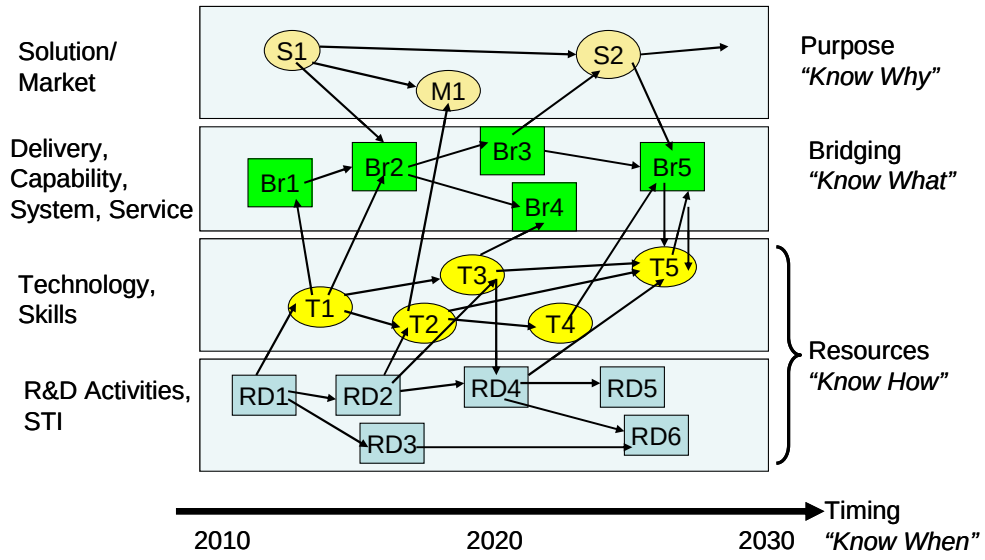
Following general guidelines, it is recommended that a company, industry, organisation, or government should create its own type of roadmap ***by adapting (one or more of) the above types*** to meet their particular needs or challenges.

What type of TRM best suits the needs of the COFISA biotechnology Foresight process?

The Product TRM and Corporate TRM models focus typically on incremental technologies, which has proven a useful approach for the majority of applications in the developed world. However, given our focus on 2030 for a very broad technology area with comparatively little established capacity and capability, particularly in the private sector, we need to identify and emphasise all possibilities for:

- *Emerging Technologies*, and
- *Disruptive Technologies*

The Industry TRM and Emerging TRM models are therefore more suited to our purpose. Rather than trying to choose between these two, a *combined* model was used: *"Emerging Industry TRM"*, as depicted in the following diagram.



3.2 Stages of the TRM process

The primary aims of the second provincial biotechnology Foresight workshop were to create biotechnology roadmaps for several areas of particular promise in Gauteng, and then to use those roadmaps to identify related opportunities for SMMEs, and to develop preliminary action plans. The details of the programme used in the workshop are provided in Annex 2.

The first main activity of the workshop participants was to prioritise biotechnology areas of particular long term promise for Gauteng. This was achieved in a plenary session, based on the eleven biotechnology opportunities that emerged from the biotechnology 2030 proto-scenario material created during the 1st workshop and the post workshop electronic interactions. The participants selected their three top priority opportunities from the full list (see section 4.1). The participants were then divided into three working groups, each tasked with developing a TRM for one of the top priority opportunities during the remainder of the workshop.

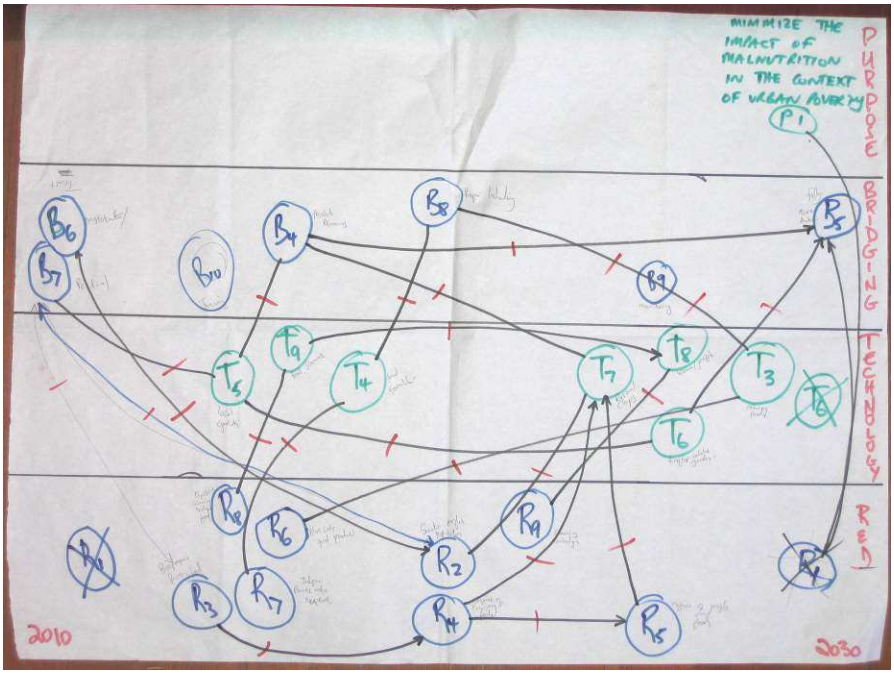
Developing the TRMs

As described in section 3.1, TRMs are fairly complex tools, and hence their development needs hard work and careful management. The following five processes were carried out by each working group in the construction of their TRM:

- ***Futures Wheel:*** The working group's chosen biotechnology opportunity was used as the basis for a 2030 Futures Wheel, where each participant was encouraged to "dump" their ideas, no matter how "off the wall" (see sections 4.2.1, 4.3.1, and 4.4.1).
- ***Categorisation and prioritisation:*** Next, the working group members were asked to categorise each "bubble" in their 2030 Futures Wheel by inserting them into a *Categorisation and Prioritisation Table* under the four main headers that matched the TRM rows, i.e.: Purpose, Bridging, Technology, and R&D (see the relevant *Categorisation and Prioritisation Table* in sections 4.2.1, 4.3.1, and 4.4.1). Then they were asked to use their judgement to prioritise these issues and select a subset that would form the basis for the TRM. The first draft of the TRM could now be started, where each issue from the subset was inserted as a node in the matching row of the TRM, but at the 2030 time marker. Each node was marked with a simple identifier label (e.g. T1, Br3), with a matching full description captured in supplementary text.

- ***Identifying nodes:*** The next phase of the development of the TRM was for each group to work backwards in time (from 2030) along each TRM row, identifying the missing nodes needed to ensure that each of the 2030 nodes could be realised. Some of these new nodes might be in the same row, but (several) others were likely to be in one of the other three rows. Since TRMs are tools intended to handle uncertainty and complexity, it was particularly important at this stage to include a node wherever complexity/uncertainty was high. In other words, do not avoid difficult issues, but rather confront them!
- ***Identifying links:*** When the first attempt at filling in the nodes for all four rows was complete (although this was an iterative process, so that new nodes and links could be added at any stage), each group next worked backwards from 2030 along each TRM row, identifying all important links between each node and any of the other nodes, whether in this or other rows. Each link was marked with a simple identifier label (e.g. P1 – Br6), with a matching full description listed in supplementary text.
- ***Criteria and attributes:*** Finally, additional criteria and attributes related to each and any of the nodes and links in the TRM were then added under the appropriate lists in the supplementary text. This additional information is most valuable and important for the nodes and links with the highest levels of uncertainty or complexity.

Although the above five steps have been presented as a linear processes, in reality they are best performed as iterative cycles, where the group improves on its earlier material with each iteration. Hence, before they are comfortable with the output, groups normally produce more than one draft of a TRM. The following diagram shows a typical example of an early draft of a Gauteng TRM.



In effect, TRMs are dynamic tools – they are always a work in progress, rather than a finished product. The final versions of the TRMs produced by the three groups from Gauteng can be seen in sections 4.2.1, 4.3.1, and 4.4.1.

Developing the other outputs

Once each group had developed their TRM for their chosen biotechnology opportunity, they used it to perform three further tasks:

- ***Identifying opportunities for SMMEs:*** The group revisited each node and link (and even attribute) across the 20 year time span of their TRM to identify areas where either current SMMEs could be encouraged to play a significant role, or new SMMEs would need to be established to fulfil or enhance the aims of the TRM (see sections 4.2.2, 4.3.2, and 4.4.2).
- ***Action plans to "kick-start" their TRM:*** The group next focused on the first 2½ years of the TRM, and identified the essential actions that were needed to kick-start the TRM. In particular, all funding issues were considered, but then the group was encouraged to move on to other essential activities based on the assumption that the funding had indeed been secured (see sections 4.2.3, 4.3.3, and 4.4.3).
- ***Action plans to "kick-start" the related SMMEs:*** Finally, the group investigated the early actions needed to implement all aspects of the TRM in the first 2½ years, as well as a complementary action plan to identify as many opportunities as possible for new and established SMMEs (see sections 4.2.3, 4.3.3, and 4.4.3).

In practice, there were small variations in the processes followed by each group, with corresponding small variations in their outputs.

4 Outputs of the Gauteng Workshop

Based on the processes described in section 3.2 above, the workshop resulted in the following outputs.

4.1 Prioritisation of Biotechnology Opportunities

In a plenary session, the participants voted to choose their top three priorities from the eleven biotechnology opportunities that emerged from the biotechnology proto-scenario material created during the 1st workshop and the post workshop electronic interactions. The opportunities and the votes they each received are shown in the following list:

- **Water management cluster** **2**
- **Waste recycling, remediation & pollution control** **2**
- **Biotechnology adoption/adaptation cluster** **9**
- **Advanced and smart bio-manufacturing** **2**
- **Wellness and prevention** **5**
- **Diagnostics and therapeutics** **7**
- **Renewable and sustainable energy** **1**
- **Bioprospecting & bioprocessing** **1**
- **Alternative food production** **2**
- **Bio-based security systems** **0**
- **Bio-informatics** **0**

The Gauteng participants chose to focus on:

- Biotechnology adoption/adaptation cluster
- Wellness and prevention
- Diagnostics and therapeutics

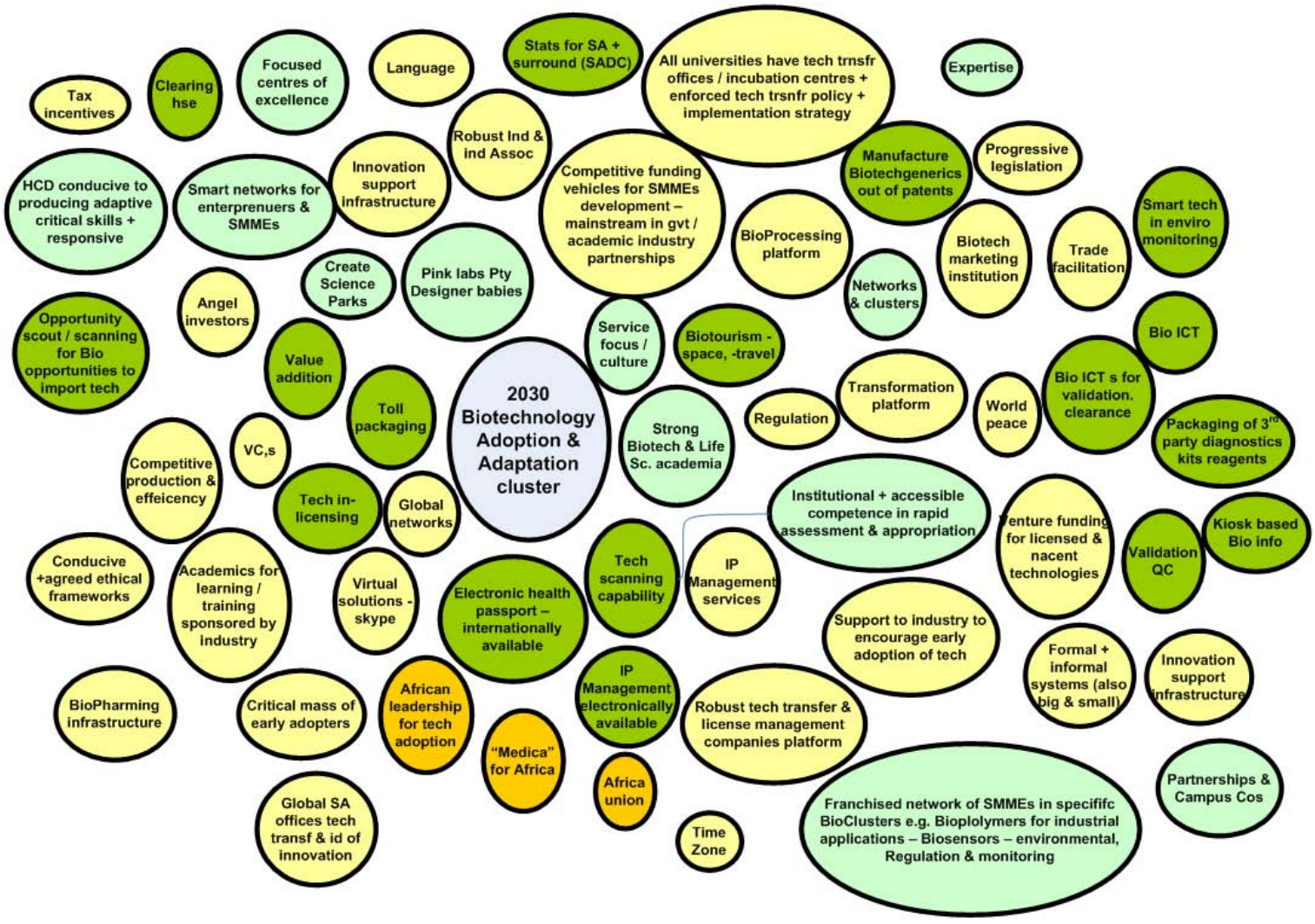
Three break-away working groups were established via a process where each participant chose which of the above opportunity areas most closely matched their expertise and interest. Each of these working groups was then tasked for the remainder of the workshop with developing and building a TRM for their chosen biotechnology opportunity area, and putting together the associated action plans.

The outputs from the three working groups are presented in the sections below.

4.2 Group 1: Biotechnology Adoption/Adaptation Cluster

4.2.1 Building the Adoption/Adaptation TRM

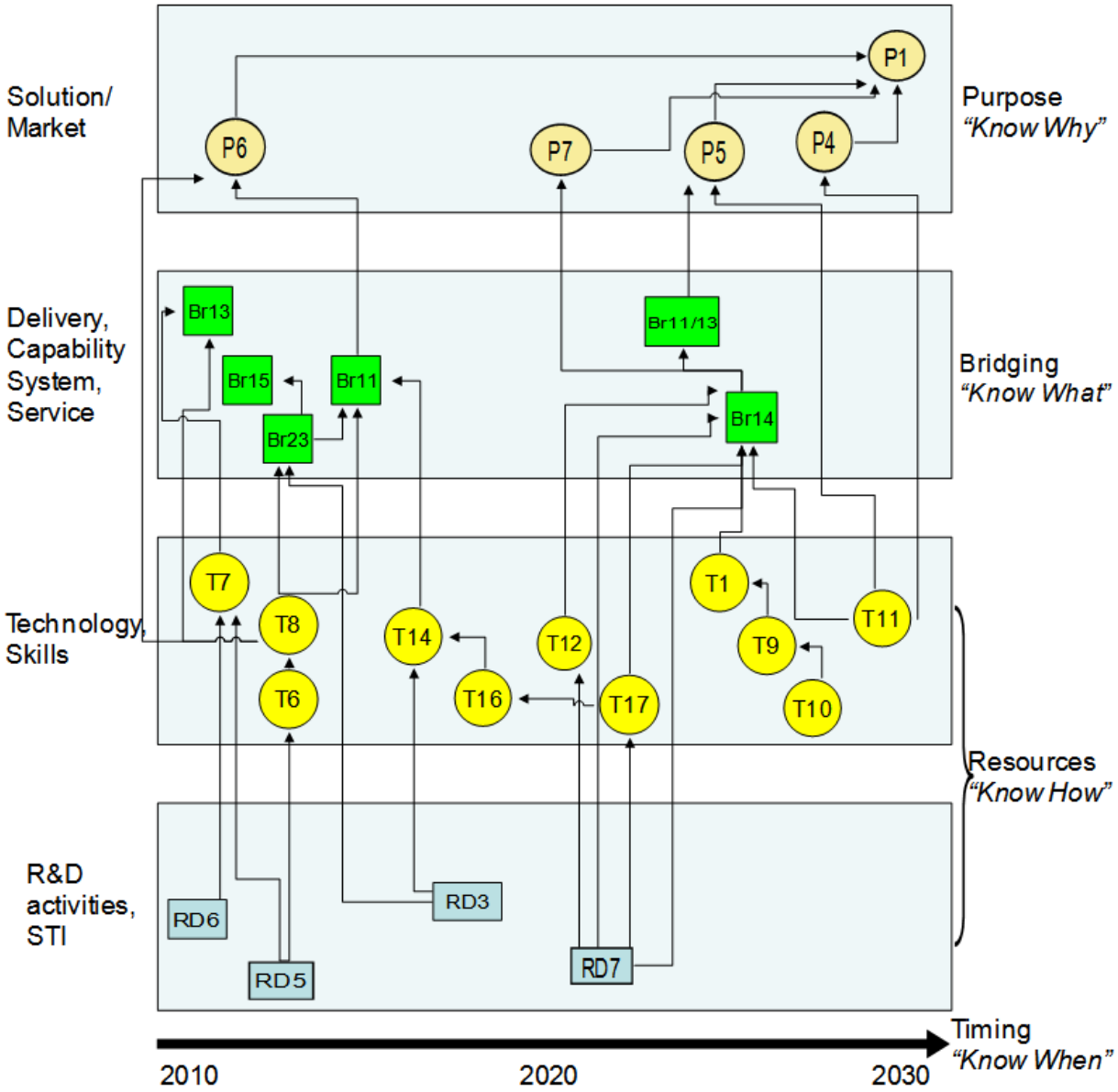
Futures wheel for *Adoption/Adaptation Cluster*



Categorisation and Prioritisation Table for *Adaptation/Adoption Cluster*

Purpose	Bridging	Technology / skills	R & D
Out of patent	Media	Electronic health profile	Expertise knowledge generation
Toll manufacturing	Global networks	Academics / expertise	Appropriate responsive skills development
Create science parks develop pilot and transfer platform for Africa	Venture Capital	Stats for SA	Social cultural engineering
SMME cluster development	Economic climate, Smart ICT	Smart ICT	Legislative environment
Life labs & treatment centre	IP and licensing management	Transformation skills	Adaptation R&D
Create Campus Companies	Packaging 3rd party solutions	IP & License expertise & market	Organogenesis
Early adopters	Transformation platform	Tech scan capability	Adoption
Smart Biotech Manufacturing (Bio-fermentation) **P1**	Biopharming	Due diligence services	
	Global offices	Biotourism logistics	
	Tax incentives	Service orientation	
	Funding vehicles	Certification & validation	
	Franchising mechanisms	Value addition skills	
	Technology & market scan offices	Bio-processing technology transfer offices	
	Regulatory compliance	Issue engineering capability	
	Ethical framework	Tissue Eng Infrastructure	
	Innovation promotion & advocacy	Clinical facilities /skills	
	Enabling trade environment	Clinical trials	
	Formal associations		
	24/7 time zone management		
	African union		
	Bioprocessing platform		
	Certification & validation		
	Bio-informatics		
	Legislative development in formal & informal sectors		
	SA Leadership for Africa		

Final TRM for *Adoption/Adaptation Cluster*



TRM KEY

Purpose Layer

P1	Smart Biotech Manufacturing
P4	Create science parks, develop, pilot and transfer platform for Africa
P5	Create Campus companies
P6	SMME cluster development
P7	Life labs & treatment centre

Bridging Layer

Br11	Funding vehicles
Br12	Franchising mechanisms
Br13	Technology and market scan offices
Br14	Regulatory compliance,
Br15	Ethical framework
Br23	Bio-informatics
Br11/13	Combined office for technology scanning & funding

Technology/skills Layer

T1	Electronic health profile
T6	IP & License expertise & market
T7	Technology scan capability
T8	Due diligence services
T9	Biotourism logistics
T10	Service orientation
T11	Certification & validation
T12	Value addition skills
T14	Tissue engineering capability
T16	Clinical facilities /skills
T17	Clinical trials

Research and Development Layer

RD3	Social cultural engineering
RD5	Adaptation R&D
RD6	Organogenesis
RD7	Adoption

4.2.2 Opportunities for Adoption/Adaptation SMMEs

It was agreed that the following areas could stimulate existing SMMEs and contribute to their further development:

- Mobile Bio–Lab Franchise
- Mini-clinics (in body organs growth possibility)
- PPP Biotech scanning and weak signal scanning
- Recuperation hotel
- Due diligence consulting company
- SMMEs commercialisation management consulting companies
- Nascent level Venture Capitalists
- Tissue engineering companies
- Clinical Research Organisations & Associations (CSOs & CRAs)
- Spin-offs based on the identified technology for new product lines
- Regulatory consultants for biotech products (not large-scale)
- Life lab spin-off manufacturing companies e.g. body organs
- Bio-tourism companies
- Insurance
- Pet-related health companies
- After-sales support
- Lifestyle
- Medical travel agency
- Marketing companies
- Life extension industry (Extendlife), Executive extend heart plan

4.2.3 Action plans for the Adoption/Adaptation TRM and SMMEs

To kick-start the Adoption/adaptation TRM the following actions are required during the first 2½ years:

- *Workshop* – call interested stakeholders to present the proposal
- *Exploratory stage:* group of committed people to drive this process – group of people with a vested interest – plug into a think tank which is funded by DST.
- *Scanning Office* (SO) to conduct :
    - Technology scanning
    - Trends analysis
    - Patent scanning
    - SO to produce reports which can assist private sector
- Set up a partnership with partners from private sector and public sector to take this forward. Need:
    - Entrepreneurial champion
    - Industrial champion
    - An association

    - Science council
- Refine TRM and market to Blue IQ, GEDA
- Important to identify the impediments:
    - Trade
    - Infrastructure
    - Legislative
- DST: BRICs can interrogate this and develop a business plan:
    - Create a centre of competence to roll this out
    - This is not aligned well enough with Government priorities – DST

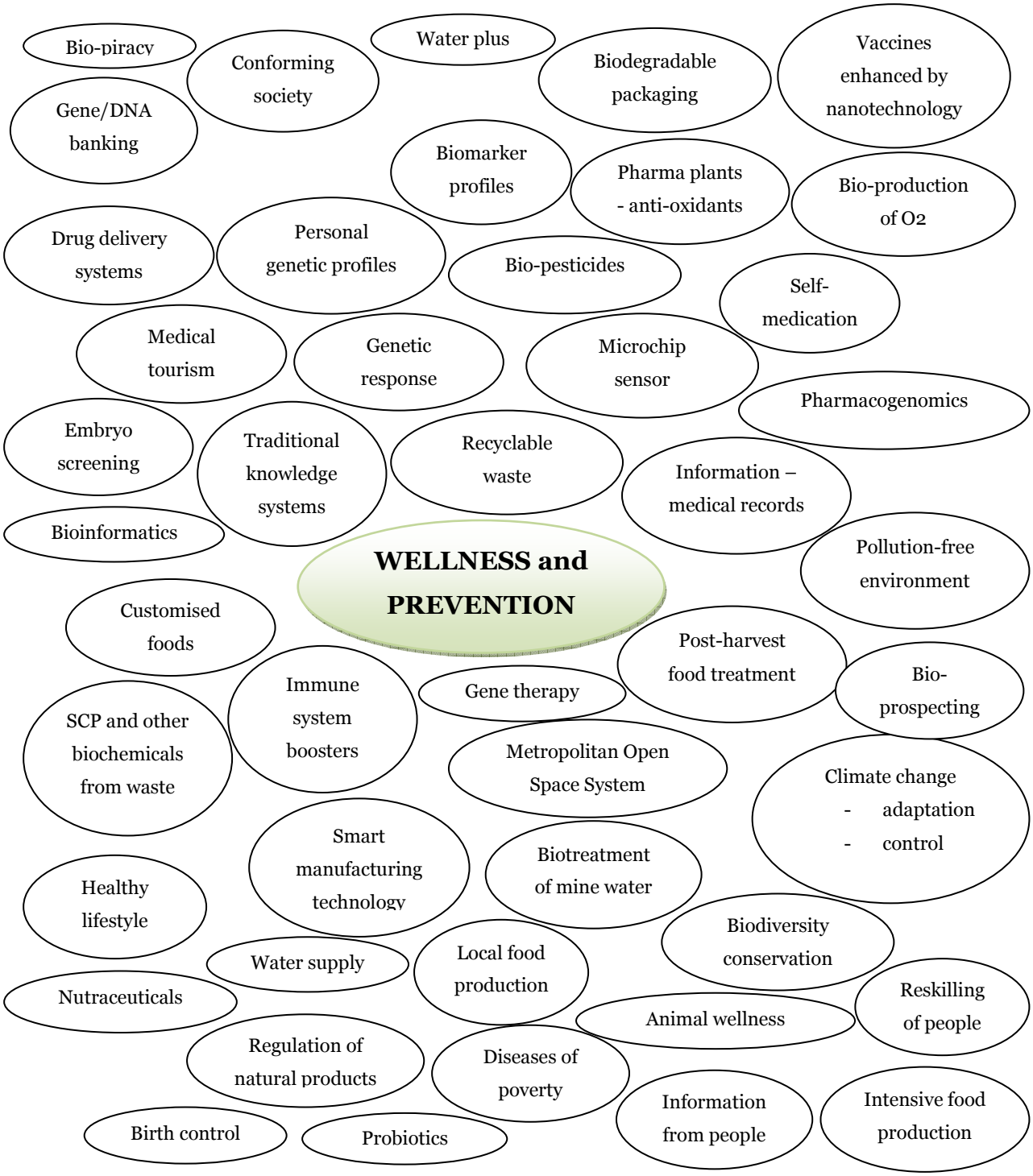
Action Plan for SMME establishment in the first 2½ years:

- Due diligence and value addition
- Deliberate approach to ensure that SMMEs want the technology scan as a service
- Focused strategy for SMME pull
- Create a centralised "bridging capacity hub" with all of the following:
    - Technology and market scanning
    - IP and licence management
    - Linking to VC and funding vehicles
    - Regulatory – ethics and advisory services

4.3 Group 2: Wellness and Prevention

4.3.1 Building the Wellness and Prevention TRM

Futures wheel for *Wellness and Prevention*

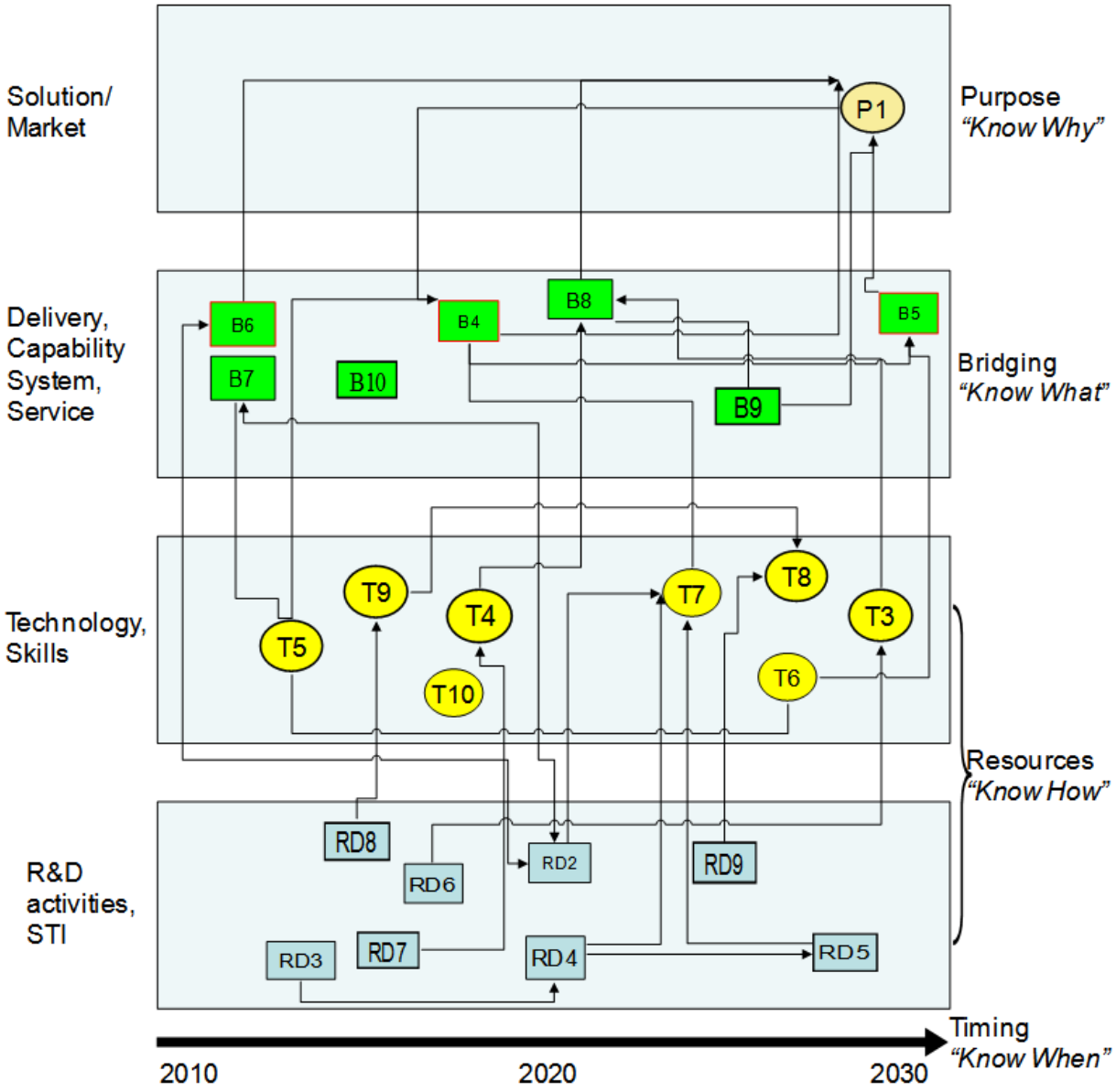


Categorisation and Prioritisation Table for *Wellness and Prevention*

Purpose*	**Bridging**	**Technology**	**R&D**
Birth control (M)	Regulation of natural products	Probiotics	Vaccines
Climate change (E) - adaptation - control	Birth control	Nutraceuticals	Biomarker profiles
Customised foods (M)	Waste recycling	Biomarker profiles	Embryo screening
Early diagnosis (M)	Intensive local food production	Gene and DNA banking	Genetic response to disease
Eradicating diseases of poverty (M)	Biotreatment of acid mine water	Medical records in microchip implant	Gene therapy
Healthy lifestyle	Self medication	Microchip sensor	Pharmacogenomics
Customised medication (M)	Control of biopiracy	Drug delivery systems	Pharma-plants – anti-oxidants
Pollution-free environment (E)	Conforming society	Vaccines enhanced by nanotech	Water enhancement
New medications (M)	Bio-prospecting	Personal genetic profiles	Immune system boosters
Water supply security (E)	Traditional knowledge systems	Single cell proteins, and other biochemicals, from waste	
Animal wellness (M)	Metro Open Spaces System (MOSS)	Smart manufacturing technology	
Medical tourism	Biodiversity conservation	Biopesticides	
	Post-harvest food treatment	Plants to enhance the atmosphere (produce and absorb)	
	Re-skilling	Biodegradable packaging	
	Companion animals	Bioinformatics	

* M = related to Medical wellness
E = related to Environmental wellness

Final TRM for *Wellness and Prevention*



TRM KEY

Purpose layer

P1 Minimise the impact of malnutrition in the context of urban poverty

Bridging layer

B1 Regulation of natural products
B2 Intensive local food production
B3 Post-harvest food processing
B4 Initiate market awareness for e.g. brown chicken meat
B5 Market fully aware of health benefits of a range of foods
B6 Establish a virtual nutragenomics institute / initiative
B7 Get political support for nutritionally-enhanced foods (NEF)
B8 Appropriate food labelling
B9 Pre and post market monitoring and assessment

Technology layer

T1 Nutraceuticals
T2 Nutragenomics
T3 Nutritionally-enhanced foods
T4 Formulation of plants into food for the consumer
T5 Further development of intensive local garden farming, e.g. hydroponics
T6 Rooftop, waterless gardens
T7 Personalised chips (read your genetic profile, store nutritional markers)
T8 Generic food scanner to assess match against personal profile
T9 Food-specific scanners for problematic foods, e.g. tomato, gluten

R&D layer

R1 Diet that promotes health for urban poor
R2 Identify genetic variables in the SA population that relate to nutrition (at the DNA level)
R3 Develop a priority list of foods for further investigation
R4 Identify effect profiles for top priority foods (at the gene expression level)
R5 Identify effect profiles for mid priority foods
R6 Produce nutritionally-enhanced foods on a pilot scale (and have some under development)
R7 Indentify a few indigenous plants with good nutritional properties that we can cultivate
R8 Develop food scanning technology for individual foods (dip stick)
R9 Develop comprehensive food scanning technologies, linked to personal profiles

Links

The relationships between the nodes are depicted by links in the TRM. The nature of these relationships is set out below.

B4 & B5:	Time
B4 & T7:	Awareness creation, promotion
B6 & R2:	Coordinate research (B6 links to all Rs)
B7 & R2:	lobby to get legislation
B7 & R3:	Lobby to get legislation
B7 & T5:	Promotion and support by government
T3 & B8:	Clinical trials, premarket assessment, post market monitoring
T3 & R6:	Commercialisation
T4 & B8:	Regulatory compliance
T5 & B4:	Promote, training, awareness
T6 & B5:	Marketing, promotion, distribution
T6 & T5:	Time
T7 & R2:	Commercialisation
T7 & R4:	Commercialisation
T7 & R5:	Commercialisation
T9 & T8:	Further development
R3 & R4:	Dependency
R7 & T4:	Taking food and formulating it
R8 & T9:	Commercialisation
R9 & T8:	Commercialisation

4.3.2 Opportunities for Wellness and Prevention SMMEs

Node/link	SMME description
T3 B8	Label production; Reference laboratories to validate labels; Clinical trials
T3 R6	NEF manufacture; NEF distribution
T4 B8	Label production; Reference laboratories to validate labels
T5 B4	Promote, train, and create awareness concerning local garden farming
T5 B7	NGO to promote setting up local garden farming
T5 T6	Technology transfer for local garden farming, and waterless growing
T5	Grow and supply seedlings
T5	Supply seeds, fertilizers, etc
T6 B5	Marketing, distribution, etc. of waterless garden products
T7 B4	Promotion, awareness creation, and distribution of the microchips

T7 R2, 4, 5	Microchip manufacture; Microchip distribution; Microchip-related services, e.g. reading microchips
T7	Design and manufacture of combination microchips
T8 R9	Scanner design; Scanner manufacture; Scanner distribution; Scanner-related services
T9 R8	Scanner design; Scanner manufacture; Scanner distribution; Scanner-related services

4.3.3 Action plans for the Wellness and Prevention TRM and SMMEs

To kick-start the Wellness and Prevention TRM the following actions are required during the first 2½ years:

Item	What	How	Who
1	Establish a trust to focus on biotech for urban malnutrition	Call a meeting/ workshop of nutritionists, health professionals, government officials, researchers, SMMEs, overseas people who are experienced	Jane and others
2	Form an executive board and a steering committee for the trust	The trust will manage a large research fund to direct research (financed by TIA?).	Trust
3	Set up a secretariat for the trust	The secretariat may reside within TIA. It would have three focus areas: 1) Identify ongoing R&D needs 2) Commercialisation 3) Industry development (e.g. marketing, training, awareness raising in communities) Each focus area will require a manager. Training and communication will be very important. Researchers are not entrepreneurs, so the managers must find them.	Trust
4	Set up research agenda and coordinate the research	Through a technical steering committee including: - End users - Researchers - Entrepreneurs (who will commercialise)	Trust
5	Lobby at political level		Manager of trust
6	Commercialise existing enhanced food	Packaged indigenous vegetables, seeds, fertilisers, etc	SMME

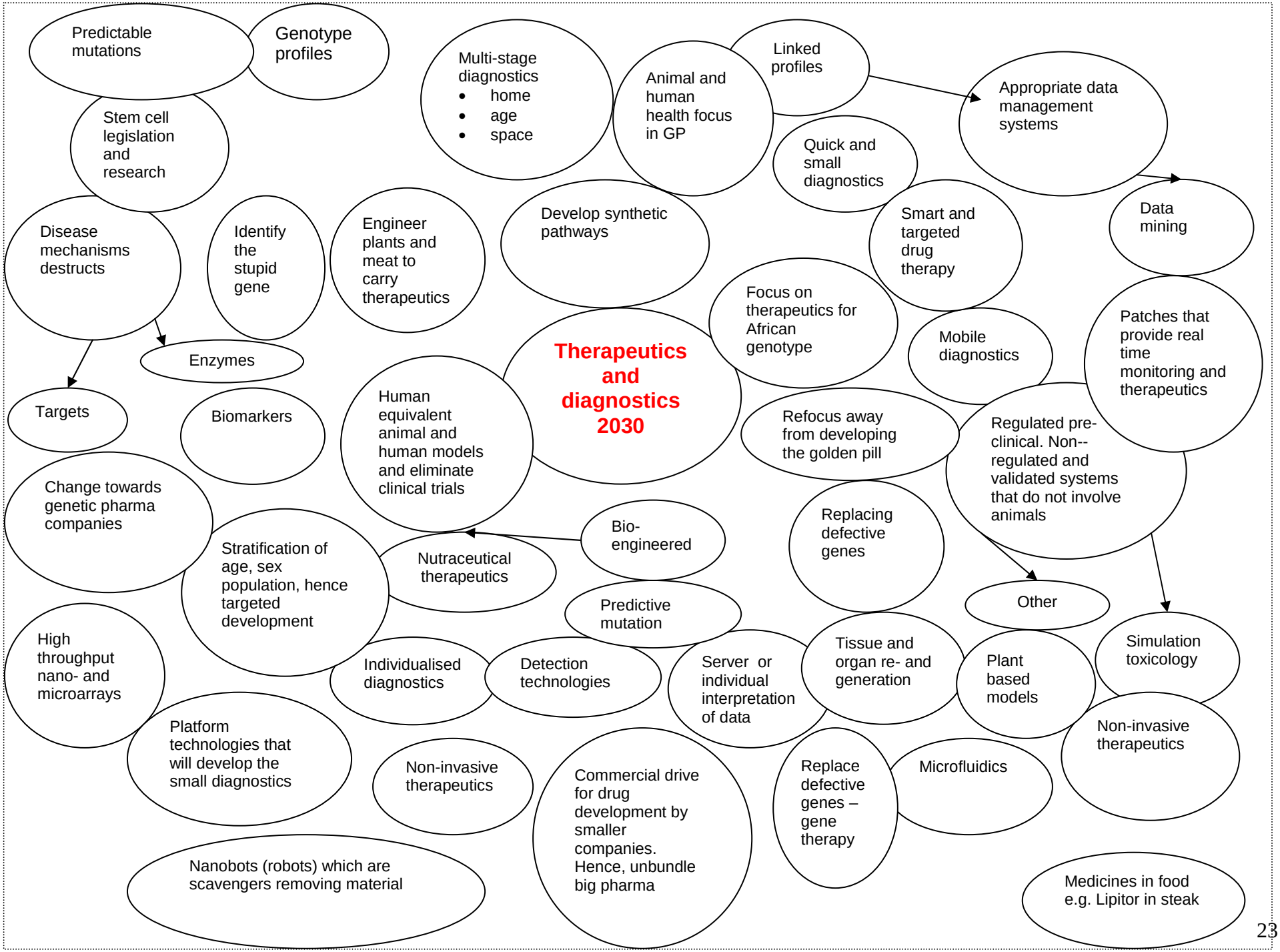
Action Plan for SMME establishment in the first 2½ years:

Item	What	How	Who
1	Find entrepreneurs		Commercialisation manager from Trust
2	Provide training to entrepreneurs	Training required for opportunities such as: - Indigenous gardens - Nurseries to grow seedlings - Growers - Distribution	

4.4 Group 3: Diagnostics and Therapeutics

4.4.1 Building the Diagnostics and Therapeutics TRM

Futures wheel for *Diagnostics and Therapeutics*


Predictable mutations
Genotype profiles
Stem cell legislation and research
Multi-stage diagnostics
home
age
space
Animal and human health focus in GP
Linked profiles
Appropriate data management systems
Quick and small diagnostics
Smart and targeted drug therapy
Data mining
Disease mechanisms destructs
Identify the stupid gene
Engineer plants and meat to carry therapeutics
Develop synthetic pathways
Focus on therapeutics for African genotype
Mobile diagnostics
Patches that provide real time monitoring and therapeutics
Enzymes
Therapeutics and diagnostics 2030
Targets
Biomarkers
Human equivalent animal and human models and eliminate clinical trials
Refocus away from developing the golden pill
Regulated pre-clinical. Non--regulated and validated systems that do not involve animals
Change towards genetic pharma companies
Stratification of age, sex population, hence targeted development
Nutraceutical therapeutics
Bio-engineered
Replacing defective genes
Other
Predictive mutation
High throughput nano- and microarrays
Individualised diagnostics
Detection technologies
Server or individual interpretation of data
Tissue and organ re- and generation
Plant based models
Simulation toxicology
Platform technologies that will develop the small diagnostics
Non-invasive therapeutics
Commercial drive for drug development by smaller companies. Hence, unbundle big pharma
Replace defective genes – gene therapy
Microfluidics
Non-invasive therapeutics
Nanobots (robots) which are scavengers removing material
Medicines in food e.g. Lipitor in steak

Categorisation and Prioritisation Table for *Diagnostics and Therapeutics*

Purpose	Bridging	Technology	R&D
P1 – Personalised therapeutics and diagnostics	B1 - Validation	T1 - Pre-clinical, non animal clinical trial testing	R1 - Sensitivity enhanced diagnostics – applies to all technologies
P2- Home-based therapeutics and diagnostics	B2 - Miniaturisation platform	T2 - Non human clinical trial models	R2 - Micro-fluidics and nano-fluidics
P3 - Diagnostics for antibiotics, growth stimulants at point of use – rapid diagnostics. Use in animal biotech	B3 - Skills and expertise	T3 - Non invasive diagnostic imaging	R3 - Novel administration methods
P4 - ICT technology, sophisticated telemedicine, database management – include in genomic platform. Including data protection systems	B4 - Funding is likely to come from private funding. Initially, personalised medicines can only be afforded by the rich and with time, will be used to develop medicines for the masses	T4 - Non-invasive therapies	R4 - Research into miniaturisation
P5 - Personalised smart chips	B5 - Public sector funding to produce personalised medicines	T5 - Micro-arrays	R5 - Micro-electronic engineering
P6 - As a result of genotyping, forensics will improve	B6 - A tax incentive/breaks for SMMEs to collaborate on personalised medicines	T6 - Nano-arrays	R6 - Biomarkers
P7 - Training and skills development – addresses the human pipeline	B7 - Consolidation of strategies and assets that will decrease the risk of high risk biotechnology companies and increases their attractiveness .	T7 - Nano-bots (P3 – in vivo diagnostics)	R7 - Bionics into olfactory research to create the bionic nose
P8 - Dedicated bio-financial sector	B8 - To achieve B7, you need a bad economy	T8 - Real time and continuous monitoring	R8 - Bioinformatics
P9 - Environmental diagnostics	B9 - A new funding model where government places ½ % of retirement annuity into a Biotech run by a sophisticated VC that focuses on the biotech economy.	T9 - Miniaturisation for diagnostics	R9 - Material sciences
P10 - Targeted therapy including delivery and mopping	B10 - Miniaturisation capability that will address the nanotechnologies required. The capability can be derived from inward TT or locally generated through research	T10 - Rapid diagnostics	
P11 - Nutritional therapeutics	B11 - Smart manufacturing	T11 - Bionics	
	B12 - 2-way technology transfer	T12 - Genomics	
	B13 - IP management	T13 - Proteomics	

The table above was produced by first transferring issues from the Futures Wheel. These are highlighted in yellow. In some cases, issues from the Futures Wheel were reformulated and/or combined before entering them in the table. Then further issues/nodes were added as the TRM was built.

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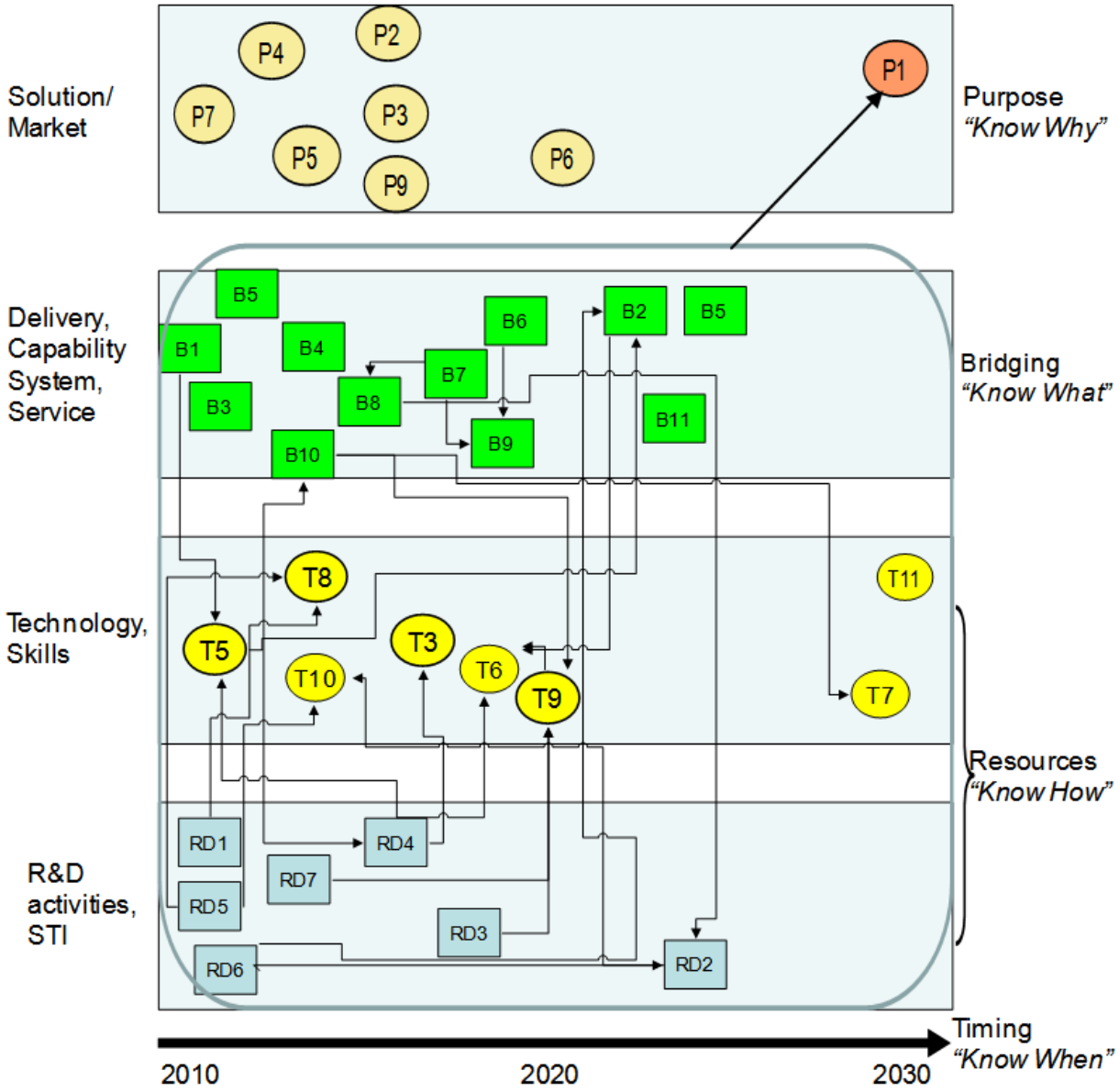
Final TRM for *Diagnostics and Therapeutics*



TRM Key

Purpose layer

P1 Personalised therapeutics and diagnostics
P2 Home-based therapeutics and diagnostics
P3 Diagnostics for antibiotics, growth stimulants at point of use – rapid diagnostics. Use in animal biotech

The group first focused on P1 and built a TRM around this purpose. The group then also started developing a TRM for P2 and P3, but found that these produced a TRM that was substantially the same as what had been produced for P1.

Bridging layer

B1 Validation
B2 Miniaturisation platform

B3 Skills and expertise
B4 Funding is likely to come from private funding. Initially, personalised medicines can only be afforded by the rich and with time, will be used to develop medicines for the masses
B5 Public sector funding to produce personalised medicines
B6 A tax incentive/breaks for SMMEs to collaborate on personalised medicines
B7 Consolidation of strategies and assets that will decrease the risk of high risk biotechnology companies and increases their attractiveness .
B8 To achieve B7, you need a bad economy,
B9 A new funding model where government places ½% of retirement annuity into a biotech run by a sophisticated VC that focuses on the biotech economy.
B10 Miniaturisation capability that will address the nanotechnologies required. The capability can be derived from inward TT or locally generated through research
B11 Smart manufacturing

Technology layer
T3 Non invasive diagnostic imaging
T5 Micro-arrays
T6 Nano-arrays
T7 Nano-bots (in vivo diagnostics)
T8 Real time and continuous monitoring
T9 Miniaturisation for diagnostics
T10 Rapid diagnostics
T11 Bionics

R&D layer
R1 Sensitivity enhanced diagnostics – applies to all technologies
R2 Micro-fluidics and nano-fluidics
R3 Novel administration methods
R4 Research into miniaturisation
R5 Micro-electronic engineering
R6 Biomarkers
R7 Bionics into olfactory research to create the bionic nose

Some general issues:
- Advanced systems for testing "Junk DNA"
- There is no infrastructure to test magnets, traditional and herbal medicines
- Biotech research with a 24 hour day time zone partnership where research takes place between all continents
- Personal data security
- Not enough cross talk between academia and the private sector. The tensions between the two areas kill innovation.
- The current KPIs for S&T measure and reward for the wrong things. The current system creates a highly competitive environment which does not encourage collaboration.
- SA policy issues that relate to research and that relate to industry are mixed. This has resulted in a dilution of resources. As a result, the sectors end up competing with one another. In the end, academics compete with the private sector.

4.4.2 Opportunities for Diagnostics and Therapeutics SMMEs

The group first focused on the need for a funding instrument, and posed the question:

How would the funding instrument be established?

- Set up the fund as a legal entity with an internal and independent governance structure
- Should be enabled to accept philanthropic donations
- Should enable companies to make CSI contributions
- Need to stimulate private funding
- Tax breaks and incentives for companies and individuals
- Listed company which goes through an IPO
- Government departments can help to seed the fund, but should not be able to control. This is an autonomous organisation
- Establish angel networks and funding
- Target South Africans abroad, many of which have emotional ties with SA and they could be mobilised to contribute funds to the fund.
- Establish a SA office of investment in which there is a biotech person who drives biotech funding (Queensland example)
- Training programmes for investors across the sectors – hence target bankers, investment companies, mining houses etc.
- Need to promote the public understanding of biotech at the high-end, sophisticated-level decision makers, especially investors
- Develop sophisticated, packaged information material
- Develop an excellent management team
- Improve perception – showcase SA successes. This involves marketing the biotech industry
- Biotech industry does not sell itself well by not telling potential investors when they will realise their investment. Rather, the small financial successes should be emphasised
- VC should not be driven by the research, but more by the market and market pull
- Consolidation of the financial sector

The following SMME opportunities would be stimulated by the establishment of the above funding instrument:

- Legal VC entity – a commercial entity which eventually gets listed
- Sophisticated and specialised recruitment agencies
- Smart training companies and incubators
- Specialised insurance company e.g. product liability insurance. SA needs independent insurance companies that understand the biotech environment
- Biomanufacturing plants
- Develop a tool for biotech for each sector to determine the impact of the biotech – IT tools for biotech investments

- Company that takes over the national survey that creates baseline data for SA (garbage in and garbage out)
    - Research should be coupled with the DST and industry information coupled with the dti
- Marketing and advertising companies
- African market intelligence
- Training company that brings in ancillary industries to lecture, and to demonstrate the size of the industry

4.4.3 Action plans for the Diagnostics and Therapeutics TRM and SMMEs

To kick-start the Diagnostics and Therapeutics TRM the following actions are required during the first 2½ years:

	Action	Date	Who
1	Find a champion who will create a consortium of researchers	Day 1	Researcher
2	Establish a legal entity	6 months	
3	Scan the industry for current opportunities and technologies to understand the landscape – locally and internationally	3 – 6 months	Institution/ champion
4	Write a proposal and find a mechanism to bring people together	3 – 6 months	
5	Source funding	3 – 6 months	
6	Obtain buy in from GP and national government to assist to drive the research area	1 year	
7	Approach pharma to create a market pull – validate the market pull	6 – 12 months	
8	Define what the product is and what it can do	3 months	
9	Establish a network of stakeholders – identify who is doing what where and who is in different areas of the technology development		
10	Skills development programme for biotechnology SMMEs and professionals	1 year	
11	Consolidate academic research and industry – create PPP	1½ years	
12	Prioritise research	6 months	
13	Mobilise government to make science and market information portals available to private companies	1 year	
14	Start the research and implement	1 year	
15	Plan on how to grow the research area	1½ – 2 years	

Action Plan for SMME establishment in the first 2½ years:

	Action	Date	Who
1	Identify an international expert to establish the fund	3 months	
2	Establish a holding company that will give access to funding to a variety companies. The associated companies benefit from the presence created by the funding company	6 months	
3	Source local people to work in the fund – these could come from any industry sector	8 months	
4	Develop an investment attraction strategy – government could seed the fund	6 months	
5	Mobilise funds through international networks – targeting CSIR and donor money, SA networks	12 months	
6	Establish biotech portals in major financial hubs that have an interest in biotech	12 – 24 months	
7	Develop a strategy to separate the research from the business environment while still promoting communication. The aims between the two areas need to be calibrated	24 months	

Annex 1: Details of Participants

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Annex 2: Workshop Programme

A Biotechnology Foresight exercise for the Gauteng Second Workshop Agenda

Held on Wednesday & Thursday, 4 & 5 March 2009 at Centurion Lake Hotel, Centurion.

Day 1

09h00 Welcome & self-introductions

09h30 In plenary
- Brief overview of COFISA
- Review of Biotechnology Foresight Process to date
- Explanation of process to be followed (Agenda)
- Introduction to Technology Road-Mapping (TRM)

10h45 Tea

11h00 In plenary
- Review and characterisation of biotechnology opportunities identified in 1st workshop (for 2030!)
- Selection of TRM working groups (based on expertise and chosen opportunities)

12h00 In working groups
- Create Futures Wheel (FW) for chosen Opportunity

13h00 Lunch

14h00 In working groups
- Re-categorise FW outputs as nodes under four TRM headers (table)
- Prioritise (based on solutions-pull, not technology push), & populate TRM at 2030
- Work back along TRM rows adding missing nodes

15h30 Tea

15h45 In working groups
- Work back along TRM rows adding links between nodes

19h00 Networking supper

Day 2

09h00 Welcome & Review of Process

09h10 In working groups
- Identify criteria/attributes of all nodes and links of TRM
- Summarise TRM for report-back

10h00 In plenary
- Groups report back on TRMs
- Presentation and discussion: “SMME opportunities, promotion, etc related to TRMs”

11h00 Tea

11h15 In working groups
- Identify opportunities for SMMEs for each node, link, criterion and attribute of TRM

13h00 Lunch

14h00 In working groups
- Develop action plans to “kick-start” SMME & TRM opportunities

15h15 Tea

15h45 In plenary
- Report back on SMME opportunities and wrap up discussion.

16h00 Thank you and close

Annex 3: Composition of working groups

Group 1: Adaptation and Adoption Cluster

Name	Organisation
Thembinkosi Semwayo	Kcrucible
Ben Durham	DST
Sabine Hellyer	AEC Amersham
Geci Karuri-Sebina	National Treasury
Jan Mentz	UP
Thiru Naidoo-Swettenham	World Bank Institute

Group 2: Wellness and Prevention

Name	Organisation
Peter Greenwood	Non-Zero-Sum Development
Steve Mitchell	Water Research Commission
Joe Molete	BioPAD
Jane Morris	African Centre for Gene Technologies
Chandu Patel	Rand Water
Kasimbo Simango	eGolibio

Group 3: Diagnostics and Therapeutics

Name	Organisation
Sibongile Gumbi	Smart Innovation
Richard J. Brown	BioPad
Dusty Gardiner	CSIR
Karren Nel	Design Biologix
Antonel Olckers	DNAbiotec
Dakshina Reddy	ACRO