Chapter 2: Literature Review and National Foresight Exercises

"India can become a global innovation leader provided we have 'technology foresight' to make the right technology choices, provided we introduce 'coherent synergy' in our science and technology related activities and provided we establish an effective 'innovation ecosystem'" - R. Chidambaram

The technological challenges faced by dairy industry in 21st century are probably even more daunting than those in last two decades. With the increasing scarcity of available resources, productivity gain is resource of growth in food processing and the primary means to satisfy increased demand of food products. In recent phase of globalisation and new supply chain, technologies continually dominate; it emerged as key area to stay competitive in global supply chain.

There has been increasing concerns about food security, clean technology, climate change and energy management in recent times adding to the complexities in technology development approach. It is despite this that technology foresight and strategic perspective planning is rarely applied in this sector. Moreover, innovation, new technologies, and the scientific research underpinning are becoming more important. Science and technology are now strategic resources to be deployed as effectively as possible. Technology foresight, as one shall see, provides a process for linking science and technology more effectively to wealth creation and improvements in the quality of life (Martin, Ben, 1999).

India is also experiencing global competition, as a result of diversification and convergence of technologies and deregulation in the proposed sector. Therefore, deployments of S&T resources and strategic investment on R&D have enhanced significance of technology foresight research.

There are various theoretical and methodological orientations of technology foresight adopted by various countries to stay in global supply chain. There are examples of the successful implementation of technology foresight exercise in the areas of agriculture,
biotechnology, nanotechnology, energy, social security, obesity and health world over.

In the preceding context, this chapter tries to build a conceptual understanding of technology foresight approach. In addition, review foresight exercises/studies or projects in different countries. The chapter analyses the different technology foresight methods. Finally, it explores the appropriate methodology that accomplishes technology foresight exercise for the dairy sector in India.

2.1 Technology Foresight in Historical Perspective

The term foresight had emerged in the writings of H.G. Wells, a journalist and novelist, in early 1900s. It can be traced to his words as he said that “it seems an odd thing to me.....that though we have thousands and thousands of professors and hundreds of thousands of students of history working upon the records of the past, there is not a single person anywhere who makes a whole-time job of estimating the future consequences of new inventions and new devices. There is not a single Professor of Foresight in the world.” H.G. Wells found significant relationships among scientific and technological inventions and long term future.

The *la prospective* or *strategic prospective* approach, a contribution from Michel Godet put him closest to the position of Well’s foresight professor in the world (Miles, 2008). Godet has evolved his approach of *la prospective* during last two decades of 20th century. He presents the ‘Greek Triangle’ in ‘Creating Futures’ a book published in 2001 and improved over the years. The strategic prospective a tool of management, enables anticipation to link with action through appropriation. The prospective thought gives content to mobilisation, maintains motivation (ie: motives for action) and nourishes strategic will.
Anticipation is defined in terms of future awareness and prospective thought; action as strategic resolve, planning; and incarnation/appropriation as joint commitment, collective mobilization, sharing of values. The strategic prospective approach led to long term futuristic thinking and initiatives world over in 1970s. The la prospective led to evolution and application of advanced methodological approach of technology foresight mainly in US, Europe and Japan.

Some of the researchers in UK undertook a study of long term futures methods and applied to the area of science and technology policy in different countries around the world. Irvin and Martin applied the terminology “Foresight” to such studies. In general, foresight exercises are intended to encourage better decisions, facilitate forward-thinking and increase preparedness for change. The strength of technology foresight lies in its ability to combine formal analyses and communication

The terminology foresight is beyond forecasting and prediction wherein it does not envisage one inevitable future, as in forecasting and prediction, but visualize alternative probable multiple futures which can be created and shaped through present actions and policy initiatives. Forecasting is mechanical process where there is option for participation.
processes. According to Ben R. Martin (1995), technology foresight is a “process involved in systematically attempting to look into the longer-term future of science, technology, the economy, the environment and society with the aim of identifying the areas of strategic research and the emerging generic technologies likely to yield the greatest economic and social benefits”.

The definition of technology foresight given by Martin is most agreed among all the definitions. The definition has six important aspects. First, foresight is a *process*, not a technique or even set of techniques. The well designed foresight exercise brings together different participants from stakeholder groups like researchers and scientists, industry and its associations, Government, Non Government Organisations (NGOs), and interest groups of farmers, labourers, consumers and cultural or religious. Secondly, the attempts to look into the future must be in a *systematic* way to be considered under the term of ‘foresight’. Thirdly, such kinds of efforts or attempts must be related to *long-term* horizon. It should be of ten or more than ten years, usually in range of five to thirty years, depends on nature of area and objectives. Fourthly, successfully always pursue an act of balancing the science or technology push with market pull. It means identifying the demands of society and economy on one hand and potential opportunities for science and technology on the other. Fifthly, the attention is towards identification of generic technologies which are emerging or still at pre-competitive level in technological development process. Therefore, the funding of research and development of such technologies is an issue on the part of Government decision making. Finally, the focus must be given to the future social and environmental benefits and adverse consequences of new technologies under development or already developed. It also gives attention to the impacts on economical or industrial situation.

Coates (1985), states that technology foresight is “a process by which one comes to a fuller understanding of the forces shaping the long-term future which should be taken into account in policy formulation, planning and decision-making. Foresight
is, therefore, closely tied to planning. It is not planning – merely a step in planning”. This approach makes some additions to the earlier existing concept of foresight. First, it emphasises on the understanding of forces shaping the future, not only science and technology, of particular field, areas and sector. Secondly, it is some how related to policy and decision making. Thirdly, it is not classical planning per se as practiced in planned economies e.g. Russia, India, etc. It is merely part of such planning.

It is important to stress that foresight is not as same as technology forecasting. Technology forecasting, after enjoying some popularity in the 1960s and early ’70s, fell somewhat into disrepute, following the general failure to foresee the 1973 oil crisis and its effects. During the second half of the 1980s, interest shifted towards foresight or la prospective. This had a different philosophical starting-point from that of traditional predictive or extrapolative forecasting. The latter assumes that there is one, unique future. It is then the task of the forecaster to predict, as accurately as possible, what this will be. By contrast, with foresight and la prospective one assumes that there are numerous (or infinite) possible futures. Exactly, the one at will arrive, depending upon the choices made in present. In other words, foresight involves a more ‘active’ attitude towards the future; countries, organizations and indeed individuals have the power to shape the future through the decisions they make in present.

The analytic and communicative features of technology foresight exercises are stressed in more recent thoughts. For instance, in a European research group on regional foresight, the foresight exercise is described as “a systematic, participatory, future intelligence-gathering and medium-term vision-building process aimed at present-day decisions and mobilising joint actions” (FOREN, 2001). Georghiou (2001) is of the view that Technology Foresight is a systematic means of assessing those scientific and technological developments which could

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4 The approach of la prospective has been pioneered by Godet (e.g. 1986 and 2001) and others in France
have a strong impact on industrial competitiveness, wealth creation and quality of
life.

Technology foresight usually has three major objectives or ‘raison d’être’ (Barré,
2002). First, Science and technology priority setting: Technology foresight is used
to direct and justify decisions on science and technology priorities and on
investment in the most promising areas. Secondly, the connectivity and efficiency
of the innovation system: technology foresight is used to ‘wire up’ the innovation
system through communication, cooperation and networking among the
developers, producers and users of technology, and also by highlighting the need
for better framework conditions, regulation and infrastructure. Finally, shared
awareness for future technologies, opportunities and strategies; technology
foresight is used to foster shared awareness of future technologies, markets and
strategies through debate about those technologies and their impact on society
(with participation of the civil society), and through better understanding of the
drivers of change. In other words, it can be stated that technology foresight
exercises contribute to the five Cs: Concentration on the longer term, improved
Coordination of the visions, intentions and actions of stakeholders, Consensus on
areas that seem promising, Communication about societal needs and opportunities
in science and technology, and Commitment to the implementation of policies that
may be appropriate in the light of the exercise. Through this contribution, a better
alignment in the articulation, execution and exploitation of research efforts can be
reached (Martin, 1995). Further, the foresight conceptual approach has been
strengthened by Miles and Keenan.

In order to explicate just what was new about Technology Foresight as it emerged
in the mid-1990s, Keenan & Miles (2008) have introduced the term “Fully-Fledged
Foresight”. Ian Miles has suggested similarities between Godet’s “Greek Triangle”
and “fully fledged foresight” despite different terminological nuances. The
similarities suggest that Technology foresight has a great deal in common with la
prospetive.
Policy-making adopts a longer-term perspective in the form of strategic planning, allowing flexibility and preparedness to deal with uncertainty, disruptive events and innovations. Another important role here is enabling greater integration and "joining-up" of discrete and compartmentalised lines of action. Foresight activities also bring material that can aid in prioritisation (and setting priorities for R&D was a key goal of many national Technology Foresight programmes). With increased need for coordination across policy areas, and mobilisation of effort across public and private actors, partnership can be fostered through the use of Foresight in planning processes.

Foresight is a set of approaches to bringing longer-term considerations into decision-making, with the process of engaging informed stakeholders in analysis and dialogue being important alongside the formal products that can be codified and disseminated.

Participative approaches involve interaction of wider ranges of stakeholders and experts in envisioning the future. This reflects several goals. (1) Enlarging the knowledge base that is drawn upon, in recognition of the point that no single body encompasses all of the knowledge required to understand future opportunities and how to seize them – especially as the world grows more complex (through advances in science and technology, through greater social differentiation, etc.). The technocratic rationale for participation lies in this distributed knowledge. But there is also a democratic rationale, (2) engagement, aimed at enhancing the democratic basis of future visions. This can give Foresight processes and recommendations more legitimacy. Related to this is (3) enlistment, the mobilisation of those involved in the process as actors that can embed the messages of the programme into their own organisations and practices.

Prospective studies involve traditional forecasting efforts, using systematic methods to explore future dynamics, enabling development of coping strategies. A critical element of much Foresight work is some matching of (present and forecast) opportunities and capabilities, framing a vision of desirable and feasible futures. These are the classic extrapolative and normative approaches, and between these are multiple scenario analyses, forging outlines of alternative development paths and possibilities.

Source: Miles (2008), drawing on Keenan & Miles (2002)
Fully fledged foresight approach uses "prospective" to cover the "anticipation" of Godet’s approach. It describes the combination of three elements, first, prospective studies of long-term opportunities and alternatives, secondly, participatory networking, and thirdly, policy orientation (Miles, 2008). The detailed conceptual model of fully fledged foresight is shown in figure 2.2.

Therefore, foresight is a "set of approaches to bringing longer-term considerations into decision-making, with the process of engaging informed stakeholders in analysis and dialogue being important alongside the formal products that can be codified and disseminated" (Miles, 2008).

2.2 Review of Technology Foresight Studies

The European Foresight Monitoring Networks Annual Report (EFMN) has identified 1400 foresight initiatives worldwide in foresight mapping exercise till September 2006. Of the 1400 initiatives, some 800 have been mapped according to a range of characteristics such as methods used, audience or type of sponsor. EFMN shows that it has recorded 1916 foresight initiatives till June 2009.

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The Netherlands has highest number of foresight initiatives till September 2006. UK and USA are the other two countries who have conducted more than 100 foresight exercises. This is followed by the Finland, France, Germany, Denmark, Belgium and Australia. The countries who have initiated and become front users of technology foresight methodologies are still leading in terms of numbers of foresight initiatives. Though, India also has a number of future studies initiatives but it has less than Ireland, Italy, Austria, and Japan as shown in figure 2.3.

The countries who have initiated foresight exercises or activities can be classified or grouped on basis of application of foresight approach and foresight initiatives undertaken, in four categories as Champions, Leaders, Learners, and Followers.

First, Champions- are front runners and vanguard of the foresight user countries. The champion countries have undertaken a number of foresight exercises in range of 50 to 160. The groups has strong knowledge base about foresight approach, methodological applications, and its relevance to policy, creating and shaping up future, and ‘wiring up’ national innovation system. The champions are Netherlands, UK, US, and France.

Leaders- leading countries who have initiated early foresight exercises and have also applied at large scale. These countries have a number of foresight initiatives in range of 10 to less than 50. The major countries as leaders are Australia, Austria, Belgium, Denmark, Finland, Germany, Ireland, Japan, Spain, Canada, and Sweden.
Figure 2.3: Worldwide foresight initiatives: a geographic distribution

Learners- are those countries who are at the learning stage with few national and regional foresight exercises. They are trying to get experience and benefits of such foresight initiatives for further taking up any foresight exercise.
These countries have few number of foresight initiatives in range of 5 to 10. The efforts are to build on own experience as well as others. The learner group is larger than other two leading groups and some of its members are India, China, South Africa, Poland, Malta, Turkey, Brazil, Venezuela, Hungary, and Czech Republic.

Followers- countries are trying to follow the experiences and approach undertaken by other group of countries. This group of foresight approach users consist of those countries who undertaken less than 5 foresight initiatives. These countries are not much convinced about the use and application of foresight. Therefore, they are at the stage of showing the foresight approach for harvesting for national interest. The followers include other than three groups and excluding those who have not applied any foresight approach. Some of the group member countries are Bulgaria, Slovenia, Ukraine, and Colombia.

The evidence from EFMN monitoring suggests that around the world major areas of future studies are Agro Food, Environment, Energy, Health, Information & Communication Technologies, Transport, Manufacturing as well as Social Sciences & Humanities. Social Science and Humanities is so far the most popular subject area covered by initiatives mapped by EFMN as shown in table 2.1. Around 25% of foresight exercises cover at least one of the areas of Energy, Environmental Technologies, and Transport. Less popular but still significant field are Agriculture and Food, Information and Communications Technologies and Health. About 85% of all initiatives are covered under these areas.
Table 2.1: Focus area of foresight initiatives world over

<table>
<thead>
<tr>
<th>Area</th>
<th>Initiative</th>
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<tbody>
<tr>
<td>Social science and humanities</td>
<td>307</td>
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<tr>
<td>Agro Food</td>
<td>195</td>
</tr>
<tr>
<td>Information and communication technologies</td>
<td>165</td>
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<tr>
<td>Environmental technologies</td>
<td>164</td>
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<tr>
<td>Energy</td>
<td>158</td>
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<td>Health</td>
<td>151</td>
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<tr>
<td>Manufacturing</td>
<td>137</td>
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<tr>
<td>Transportation</td>
<td>85</td>
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Source: EFMN report 2005-06

The individual countries have different aims for concerned national, international or regional foresight exercises. It can be viewed and analysed through some individual case studies. The regional and international foresight exercise emphasise on common and overlapping interests and objectives of the focussed countries.

2.2.1 International Technology Foresight Initiative: Future Food6

It is focussed in Bulgaria, Croatia, Czech Republic, Hungary, Romania and Slovakia, a group of countries from European Union. The multi-country foresight project was led by UNIDO in all the countries in partnership with specific institutes or organisations from each country. The project future food6 was implemented through ten work packages (WP), each of them under the responsibility of one partner of the project consortium. The consortium consisted of UNIDO, as the coordinating partner, two main advisor institutions, first, OPTI as methodology advisor, and second, WIIW
as socio-economic advisor. Six foresight and innovation expert institutions covered the target six countries.

The project has focused on *health and safe food for the future*. The future food project was undertaken from 1 February 2007 to 31 January 2009. Project was undertaken with two objectives. They are, first, to promote a new decision-making culture among managers and policy-makers in order to put quality and safety issues at the centre of the total food chain management; second, to identify future key technologies and new business models to promote the quality and safety requirements in food production, by establishing a Food Quality and Safety Platform in Central and Eastern European countries (CEE)

The ultimate goal of the project was to assist the total food chain in the CEE in general and the food industry in these countries in particular to reach international quality and safety standards, and in turn, to enhance European competitiveness vis-à-vis the rest of the world by supporting further evolution of this industry.

The major themes of the project include the areas, firstly, total food chain, following the “farm-to-fork” concept and secondly, key horizontal demands as one of the key drivers influencing the future of food products. The exercise was devoted to the identification of the major social, economic, technological, environmental and political drivers in order to map the broad context of the food industry in the year 2020.

Similarly, national foresight exercises have focussed on the food and agricultural sectors. Some of the national foresight studies in countries, such as, Denmark, France, UK, China, South Africa, and India undertaken hereafter to add to the understanding of foresight approach.

**2.2.2 Foresight in Denmark**

Technology foresight acquired attention of Danish Board of Technology in 1998 when it decided to initiate a study to analyse and assess the feasibility of a
Technology Foresight programme in Denmark, in order to provide politicians and other interested parties with a basis for developing a Danish programme.

The Danish project for technology foresight began with three objectives. First, to contribute to discussion about the need for a Danish programme for Technology Foresight by proposing a concrete model; second, to assess strengths and weaknesses associated with various approaches to Technology Foresight; and third, to communicate the results to the Danish government and parliament. Danish technology foresight program carried over three years through a project provided stakeholder as an opportunity for involvement.

Danish national foresight exercise 2015 carried out during 2001-2005 for horizon of 10 years by the Danish Ministry for Science, Technology and Innovation with specific objectives. The objectives were as follows. First was to develop insight into and prepare the system for technological and social requirements of the next 10 years. Second was to create future-oriented scenarios as a basis for priority making in research, product and process development & market development. Third was to assist in public priority-setting in the area of research, technology and competence development. The foresight project focused on seven themes, the Environment, Biological and Health Sciences, ICT, Hygiene, Nanotechnologies, Ageing and Robotics.

Five Danish technology foresight exercises namely, Pervasive Computing, Bio- and healthcare technologies, Green technologies, Nano-technology, and Hygiene were completed by year 2005. Foresight on green technologies includes ICTs, Bio and Nano whereas on creative industry includes firstly, light and sound and secondly, materials. Technology Foresight on nano-technology aimed at providing knowledge regarding the scope for nano-scientific and nano-technological developments over the next 20 years (Action Plan 2004, Ministry of Science, Technology and Innovation).

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Technology Foresight on Cognition and Robotics was given mandate, first, to formulate three to five promising development agendas for Denmark. Development agendas mean long-term vision within selected application areas in which cognitive robots will promote innovation. The second was to suggest recommendations to formulate the research, education and innovation policy (Dannemand, 2004; Rasmussen, B et al, 2007). It ensured participation of all the stakeholders as well as expertise during the foresight exercise.

Danish Nano-foresight began with the purpose of anticipating the range and scope of nanoscientific and nano-technological development in Denmark over the next 20 years (2005-2025). The foresight process systematically gathered hypotheses and statements about future research, industrial possibilities and consequences both beneficial and adverse of nano-science and nano-technology. Therefore, it resulted into certain outcomes which are reflected as the prioritised technology areas, interplay between nano technology and industry, establishing R&D centres, education and an action plan to achieve a vision.

Bio and health foresight focussed on identifying critical areas and their role in long term time horizon for Danish society, industry and market. It has identified certain key technologies such as human genomics and proteomics, stem cells, bioelectronics and related to pervasive healthcare. On the other hand, foresight on ICT has identified critical application of such technology in market, health, food, entertainment and communication. It also focussed on identified key technologies for the future.

The green technology foresight on environmental friendly agriculture (from 2001 to 2004) focussed on identifying the future environmental challenges that agriculture

http://teknologiskfremsyn.dk/download/108.ano


Background papers (in Danish), available at http://www.teknologiskfremsyn.dk
would face in Denmark and came up with certain policy suggestions on promoting technological and structural solutions which can lower the impact. It was aimed at preparing a catalogue of promising technology for agriculture sector and ways of promotion of such technologies.

Nordic Hydrogen Energy Foresight 2030 aimed at exploring promising ways, for Nordic stakeholders, for exploiting hydrogen in the drive to meet the Energy Security, Economic Growth and Environmental Protection (3Es) in long-term time horizon. It was an international cross-border foresight covering the five Nordic countries completed in year 2005. It was specifically focussed to build a Nordic Research and Innovation Area in hydrogen and fuel cells, with a bottom-up approach to the European Research Area. The foresight exercise had its objectives such as, first, to develop socio-technical vision for a future hydrogen economy and exploring pathways to commercialization of hydrogen production, distribution, storage and utilization. Second, contribute as decision support for companies, research institutes and public authorities in order to prioritize R&D and to develop effective framework policies. Third, develop and strengthen scientific and industrial networks. It has developed different future scenarios of hydrogen energy economy and its roadmap up to 2030.

The foresight exercises in Denmark are meant for identifying crucial areas of innovation, priority setting for research, education and development policy, development agenda setting, creating and developing future scenarios, developing insight and preparing system for technology and society, anticipation of technological development, preparing roadmaps and mapping existing foresight exercises.

2.2.3 Foresight in France

French Futuribles, an exercise in scenario-building for pensions in France up to 2040 set out to examine factors which might lead to shifts and discontinuities by 2040, i.e. to explore the possible futures of French society and the issues that might arise
because of an ageing population. It was completed in year 1997 to provide input for policy initiatives.

Another study, French Technology foresight was conducted between June 1999 and October 2000 with short time horizon of 5 to 10 years under the observation of Ministry of Economic, Finance and Industry. The context of study was to develop a new policy to support business efforts to adapt to major technological challenges and, at the same time, focus on optimal allocation of funds available for R&D.

The objectives of the foresight exercise were as follows. First, identify the key technologies for French industry in year 2005. As a result, government could develop an appropriate policy to foster the development of cutting edge technologies. Second, inform all companies, especially small and medium scale, about the required technological changes for companies to remain competitive and at the forefront of innovation in year 2005. It was also aimed at comparative assessment of French industry vis-à-vis others for its preparedness to face the scientific and technological challenges of 2005.

The French foresight study has successfully ensured a wide participation from public and private sector through working groups. It successfully identified 515 candidate technologies at first stage. Out of that it identified 187 significant technologies and, finally, 142 key technologies by working groups. At last, steering committee made selection of 119 key technologies in March, 2000. The participation clearly reflected the process of identification of key technologies. In addition, the internet forum and platform was meant for enhanced participation of diversified expertise.

INRA and CIRAD, as commissioners and joint project managers, have undertaken a foresight exercise on farming and food systems worldwide in 2035 (Agrimonde), over two years (2006 and 2007). The exercise was based on results of an international assessment and prospective exercise, Millennium Ecosystem Assessment, commissioned during 2001 to 2005 by UN. It was aimed to foresee the role of French and European agriculture in changing global scenarios and to pinpoint the
fundamental issues which agricultural research would face. It has provided means to both the organisations to forecast and prepare for the future in terms of public research systems and priorities as well as of their strategic position on an international level.

The foresight exercise Agrimonde has provided a space for participation from diversified backgrounds and it shared it results in French language on the 25th of February 2009 during the Salon d'Agriculture in Paris, France. There are other countries in Europe that have carried out such foresight exercises, UK is one of them. UK has been champion country in area of foresight.

2.2.4 Foresight in UK

In the words of Professor John Beddington, UK Government Chief Scientific Adviser 'the UK’s Foresight Programme aims to bridge the gap in policy making between the short and the long term'. Therefore, the role of foresight is to help government to think systematically about the future. Foresight programme began its journey in 1993 with White Paper Realising our Potential. The aim of the programme is to create sustainable competitive advantage and enhance the quality of life, by bringing together business, the science base and Government to identify and respond to emerging opportunities in markets and technologies. The Foresight programme is spearheaded by 16 panels set up to explore opportunities in different sectors of the economy. In 1995, the panels published their first reports following widespread consultation. These reports aimed to identify: the likely social, economic and market trends that will affect the UK in the medium to long term; the developments required in science, engineering and technology to best address future needs; and the implications for policy and infrastructure and for business investment strategies. The Food and Drink panel has since looked in to further details of six sub-sectors: Alcoholic Drinks, Cereals, Dairy, Fruit and Vegetables, Meat, and Soft Drinks.

The groups involved were asked to perform Foresight analyses for each of their sectors, to challenge the original panel findings and to make recommendations for
further action aimed at involving industry and academia in debate about priorities for the future (Komorowski, E, 1997).

UK foresight exercise has taken up a most ambitious project in 21st century on *Mental Capital and Wellbeing*. It drew heavily on the advice from 80 reviews of scientific and other evidences. It identifies how UK can achieve the most of them in the 21st century by tackling challenges such as learning difficulties, mental ill-health and dementia. Further, it examines what can be done to promote mental wellbeing. *Sustainable Energy Management and the Built Environment* focused endeavour. It made clear that UK needs to reduce the carbon emissions from existing buildings – housing, offices and shops – if it has to achieve the deep cuts in greenhouse-gas emission required to meet the target of 80% cut in emissions by 2050. *Tackling Obesities: Future Choices* In 2008 UK government commissioned two major new foresight projects – on the *Future of Land Use* in the UK, and another on the *Future of Food and Farming*. These are exciting endeavours given the global importance. *Land Use Futures* is examining the whole spectrum of how to use land in the UK, for agriculture, construction and recreation purpose both now and in the future. *Food and Farming Futures* is analysing future demands on the global food system. Work is well under way and will report in 2010. The Advisory Board for Foresight advises the Government Chief Scientific Adviser on the strategic direction of the Foresight Programme.

The experience of the UK foresight programme have been adapted and applied in Asian and African countries.

2.2.5 Foresight in China

The framework for *Technology Foresight towards 2020* in China has been formed on the basis of adopting the experiences of Japan, Germany, UK and Korea in the fields of technology foresight (Rongping, M and Zhongbao; R Yongchun, CJZ, *date unknown*). The first national technology foresight exercise in China has been executed by the Ministry of Science and Technology in 2003. China has undertaken a
major survey to clarify major technologies for China’s socioeconomic development for adoption in the National Guidelines for Medium- and Long-term Plans for Science and Technology Development and the 11th Five-Year Plan. The Ministry and the Chinese Academy of Sciences have been using foresight approach to attempt to gain a picture of technology development over the next decade or two. The first stage was an analysis of socioeconomic needs and science and technology trends, together with the design of the Delphi survey sheets. The second stage was analysis of the Delphi questionnaire and its results. The third comprised selection of nationally important technologies and the creation of reports (Out Look on Science Policy, 2006).

The three national institutes are responsible to Technology foresight 2020 exercise implementation. Technology foresight in the Institute of Policy and Management (IPM) of Chinese Academy of Sciences focuses on the technology towards 2020, Technology Foresight in the National Research Center for Science and Technology for Development (NRCSTD) of the Ministry of the Science and Technology focuses on the technology 2015, while Technology foresight in the Institute of Science, Shanghai Municipal Commission for Science and Technology focuses on the technology towards 2010.

The most prominent character of technology foresight exercise was that it was funded and implemented by government with medium to long-term horizon. The areas were selected out of a list of most important technologies with the criteria of strategic importance. The all six key fields undertaken for foresight exercise are information and communications, biotechnology and life sciences, new materials, energy, resources and environment, and advanced manufacturing technology. Further, the important feature was dependence of time horizon on kind of field and its importance for Chinese people and market. Three areas, information and communications, biotechnology and life science, and new materials, have time horizon for 10 years whereas others, energy, resources and environment, and advanced manufacturing technology, have 15 years of time horizon.
2.2.6 Foresight in India

The foresight initiatives in India began in 1988 with establishment of Technology Information, Forecasting and Assessment Council (TIFAC), an autonomous body under department of Science & Technology, as a ‘think tank’ to keep a watch on global technology trends and assess the preferred options for India in various important sectors. Technology Vision 2020, a major long-term technology forecasting and assessment exercise on the national level encompassing various technology areas was taken up by the think tank. A detailed survey of key areas in major infrastructure, advanced technologies with socio-economic implications was taken up. In a span of two years, over 5000 area experts from the industry, Government, R&D agencies and academia were brought together for a thorough survey of shared opinion in selected areas. Concerted action-plans were formulated on short, medium and long-term basis up to 2020 and seventeen key technology areas of prime importance to the country were addressed; around 100 sub-sectors were covered for specific details. The exercise was carried out in the backdrop of a complex and heterogeneous social milieu of India and thus a country specific vision emerged. While Technology Vision: 2020 foresight exercise has covered important technology sectors like agro-food processing, chemical industry, engineering industry, electronics, etc.

The Atlas of Ideas, a future study in year 2005-06 led by UK Demos, has tried to map where India, along with China and South Korea, is delivering and where this trend in future is likely to be evolved. Further, it has identified future opportunities for collaborations and specialisations. The whole project aimed at mapping trends of globalisation of science and innovation, forecasting the trend over next 10 to 15 years, and implication of science policy.

India 2025, a futuristic demographic scenario of India developed by Population Research Centre, Institute of Economic Growth, has projected the growth trend of population. The projection time horizon was provided for 25 years.
India Vision 2020, a foresight initiative undertaken by planning commission completed in year 2002 in form of a committee report as its outcome. The report looks into many central issues, but two issues- employment and education clearly stands out, as most significant. In order to ensure access to food and other essentials of a healthy life for all citizens, India faces the challenge of generating 200 million new employment opportunities over the next two decades. The outcome of the vision calls for moving up employment generation to the top of the nation's development agenda and marshalling all available resources to create employment opportunities for all job-seekers. Further, it identifies the sectors which offer the greatest potential for job creation as well as critical policy issues that need to be addressed in order to fully tap that potential. The second thrust area, education, is focussed for better quality education at all levels from basic literacy to hi-tech science and technology. In a way, the essential prerequisite are raising agricultural productivity and industrial quality, spurring growth of India's budding IT and biotechnology sectors, stimulating growth of manufactured and service exports, improving health and nutrition, domestic stability and quality of governance. The other important issues examined are related to population growth, food production, health, vulnerable sections of the population, transport, communication, energy self-sufficiency, water conservation and air quality, trade investment, peace, security and governance. The vision document provided different scenarios of different sectors for best results by 2020.

Vision for Biotechnology, a foresight initiative by the Department of Biotechnology to achieve the desired future in area of biotechnology. The vision states, "attaining new heights in biotechnology research, shaping biotechnology into a premier precision tool of the future for creation of wealth and ensuring social justice - specially for the welfare of the poor". In order to realise the full potential of biotechnology as a frontline area of R&D with an overwhelming impact on society, the Indian biotechnological enterprise will be systematically nurtured at three distinct levels: enhancing the knowledge base and generating highly skilled human resource, nurturing leads of potential utility and bringing bio-products to the marketplace. The
products expected to be generated would form the milestones of the vision statement. The goals are set to be achievable within ten years for a biotechnology based, environmentally sound and sustainable societal development and a bioindustrial revolution through excellence in bioscience innovations, discoveries and increasing understanding of life processes. The vision has been developed by eminent scientists from Indian community in India and abroad through a foresight methodology.

The Deutsche Bank Research led foresight initiative focussed on India’s rising position and influence in economics and politics of the world and, as a result, the impact of Indian position on Asia and world. The exercise provides a medium-term perspective about India’s significance. The results of the exercise were made available to user in 2005, when it got over.

*How India, China Redefine the Tech World Order*, a futuristic study by Forrester, has brought the technological capabilities of India that are set to bring out the changes in present US-centric world order for technology industry. This document examines how the epoch-defining interplay of accelerators and decelerators impacts the performance of both Asian giants-India & China, and will shape high-tech industry relationships between the East and the West over the next two decades (2005-2025). Through three scenarios (Chinese Mirage, Cold War II, Pax Indo-China), India remains a strong US ally, leaving China to be the wildcard in defining a new tech world order (Radjou N. et al, 2005). The exercise has provided long term perspective of technology, specifically information communication Technology.

In contrast to above discussed top to down approach, the bottom up approach of foresight involved the farmers and landless people. These were the farmers whose very livelihoods depended on the success of what they grew. The climax of the Farmer Foresight project was a citizens’ jury, which took place on a farm in B G Kere in the state of Karnataka, India, between the 6th and 10th March 2000. Jury had to decide about the genetically modified crops after hearing views of the experts, NGOs, Government representatives and corporate representatives. The ActionAid team
attempted to adapt the citizens' foresight technique to a developing world context. The new method incorporated three key elements.

- The relative advantages of a range of scenarios, such as different technological pathways, should be compared from a variety of technical, social, economic and political perspectives.

- The composition could include people drawn from all over a village, region or country (or, in principle, the world) thereby giving a jury a degree of significance for a range of societal scales.

- Rather than looking at local livelihood issues and policies, the jury should give at least as much of their attention on regional, national or global issues, depending on where the relevant decisions are taken (Murty S and Wakeford T, 2001).

Bottom up approach has helped in making foresight more inclusive and consensus building process.

2.3 Foresight Methodologies/Methods

The technology foresight methodological application emerged in 1960s and 70s in US and Japan through use of Delphi survey. Further, such methodologies became prominent in late 1980s and 1990s in Europe and other parts of the world. The basic idea in foresight exercises, built on the Japanese Delphi survey tradition, is to construct an extensive set of statements concerning future technological developments and then allow a large number of experts to react to these.

For identification of critical technologies US has applied, in late 1980s, some foresight methods such as interviews, workshops and questionnaires typically as additional aids. These were picked up by European countries such as Germany, France and the Netherlands.

UK has applied the panel approach as leading country and evolved it further. It has been adopted by different countries like Hungary, South Africa, and Ireland. The
number of panels varied (typically it is between 6 and 15). Commonly, the panel members came from various interest groups (industry, academia, government, NGOs, etc.). The panels have typically formed a relatively independent taskforce guided only by general guidelines. A wide range of formal tools and practices were used by the individual panels.

The evidence from all the foresight exercise suggests that there are three kinds of foresight method in use. These are qualitative (17), quantitative (6) and semi-quantitative (10), also called as 'foresight diamond', methods (Popper, 2008) as shown in figure 2.4. These are presented as 'foresight diamond' based on their capabilities to gather or process information based on evidence, expertise, interaction or creativity. Qualitative methods rely less on numbers and statistics. Qualitative methods are often employed where the key trends or developments are hard to capture via simplified indicators, or where such data are not available (Keenan, 2006). These are useful for stimulating creativity and intuition; essential for engagement and dialogue. On the other hand, quantitative methods rely on data and statistics. But semi quantitative methods apply mathematical principles to process the knowledge i.e. weighting ideas, systems theory (Eerola, 2008).
Quantitative data may come from statistical sources or be the products of expert judgement. For instance, in cross-impact studies experts make estimates about the probability of developments; in Delphi, the data are derived from the number of people agreeing with particular statements or forecasts. All the methods of foresight involved the respondents and participants. The number of participants involved in different methods of foresight initiatives varied. According to MFN less than 50 participants are involved in most of the foresight methods.

Figure 2.5 shows that there are fifteen (out of 32 total) most commonly applied foresight methods in different countries and regions of the world in national, regional, and international foresight exercises.
The most widely used foresight methods out of fifteen are expert panel, literature review, scenario, and questionnaire survey in descending order of numbers of foresight exercises where they were applied. The EU countries have applied expert panel, survey, literature review, brainstorming, SWOT analysis, scenario and Delphi as major methods. On the other hand, Northern American countries have made use of expert panels, future workshops, technology roadmapping (TRM), and literature review; in descending order of number of foresight exercises as shown in diagram are prominent methods. Countries like US and Canada have not applied Delphi method as much as applied by the countries of the other continents such as Asia, Europe, South
America, and Australia. The Asian countries have applied Delphi method as prominent foresight methodology. Japan has used Delphi survey most extensively. The Delphi survey is most frequently and vastly employed in Asian, European and Latin American countries.

Asian countries applied four main methods such as expert panels, literature review, megatrend analysis, and Delphi survey. In addition, they, also, made use of future workshops and brainstorming in national foresight exercises. The Asian countries are least diversified in terms of employing foresight methodologies along with least number of foresight exercises undertaken at national and regional level among all the continents in the world. The evidence suggests that all the countries have applied technology foresight methodologies according to their convenience, earlier experience with methods, available expertise, needs and objectives of the exercise, sector and area of exercise, available resources, and time horizon of the exercise. Therefore, most of the countries have modified and applied methodology differently in the same sector, on same issues, at same time, and with the same time horizon.

Ministry of Arts, Culture, Science and Technology, South Africa, has applied SWOT analysis, scenario analysis and survey of opinions on research and technology trends, and social, technological, economic, ecological and political (STEEP) factors method for national foresight exercise in areas such as agriculture, education, crime, energy, biodiversity, manufacturing, mining, tourism, and Health. The methodological approach was specifically designed to the needs of the country wherein major technological trends, issues, opportunities, challenges, and future priority areas were identified.

The foresight exercises in Denmark have used Experts reports, Workshops, interviews, Delphi survey, and internet survey for identifying crucial areas of innovation, priority setting for research, education and development policy, development agenda setting, creating and developing future scenarios, developing
insight and preparing system for technology and society, anticipation of technological development, preparing roadmaps and mapping existing foresight exercises.

French Futuribles, an exercise in scenario-building for pensions in France up to 2040 set out to examine which factors might lead to shifts and discontinuities by 2040. It has applied the brainstorming, Scenarios and literature review as methods of technology foresight. Another foresight exercise i.e. Future food6 has used a combination of foresight methodology which applied some important methods such as mobilisation, a socio-economic scenario building exercise, interviews, survey on key technologies, vision building exercise, and technology road mapping.

The Ministry of Science and Technology and the Chinese Academy of sciences has applied Delphi survey, a dominant technology foresight methodology in Asian region, particularly in Japan and Chinese foresight exercise.

Indian foresight initiatives have applied a range of foresight methodologies. India 2025, a demographic future study, in year 2001, has applied trend extrapolation, scenarios, forecasting, and general approach as foresight methodology. The methodological use is directly related to output of the study like analysis of trend and drivers, policy recommendations, and scenarios. The India vision 2020, an exercise by planning commission, in year 2002, has used Brainstorming, Expert panel, Future workshops, Megatrend analysis, and SWOT analysis. Whereas, another exercise, Vision for Biotechnology, used additional methods of foresight such as Key technologies, Expert panel, and Foresight General approach. India rising, an exercise led by Deutsche Bank Research on India, in 2005, has applied literature review, modelling and simulation, Scenario, Forecasting, and General approach along with megatrend analysis. How India, China Redefine the Tech World Order, has applied scenario and trend analysis for looking in world technology order during next two decades (2005-2025).
2.4 Suitability Foresight Methodology for Indian Dairy Industry

The methods are used according to needs of sponsors and types of sponsor in all the foresight and future studies world over. The available resources and objectives of the exercise are important determining factors in methodology selection. Therefore, methods used are directly correlated to purposes of national and international foresight exercises. Nature of desired participation is another important determining criterion (Keenan, 2006; Popper, 2006, 2008). In addition, it is essential to find the suitability for combination with other method. In other words, a complementary of foresight methods is essential for their selection and application.

For making long-term investigation methods such as trend extrapolation, simulation, and megatrend analysis are used. On the other hand, for opinion elicitation, interviews, surveys and Delphi methods are applied. Scenarios, essay writing, and science fictions are most common methods for creating and envisioning future. The methods such as TRM, multi-criteria analysis, and prioritisation techniques are exercised, in determining course of action (Miles, 2007). Consequently, SWOT analysis, STEEP analysis and Mini-Delphi methods are appropriate options as foresight methodology for academic foresight exercise. That is aimed at identifying strengths, weaknesses and opportunities as well as driving factors for dairy industry in India. The technological advancement is found to be highly useful when there is lack of available resources in application of Delphi survey. The Infopoll Designer, software, is highly useful to supplement the Delphi survey in terms of obtaining fast online responses. These methods can be supplemented by interviews with experts, and other stakeholders.

Foresight as an academic exercise has limited resources and it can not afford to be ambitious like national foresight exercise. When it comes to be part of PhD research, it gets more constricted with available funding, access to expertise and panels, objectives and purposes.
The application of foresight approach in dairy sector may give an idea about plausible future of the sector as focussed in next chapter. Therefore, it can provide an opportunity to shape the future for competitiveness.