New Biotechnology and Genetic Engineering In Science and Technology Policy of Turkey

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Summary

In this paper, it will be explained the conceptual framework and the main concepts of the Science and Technology Policy of Turkey designed in the years of 1990s. And then, it will be dealt with the matter of policy implementation. In this context, it will be tried to extract some consequences in respect of "getting the benefit of existing opportunities or creating new opportunities in new biotechnology and genetic engineering through coping with the challenges".

The Science and Technology Policy of Turkey: A Brief Outlook

The main documents that will be scrutinized to understand the general conceptual framework of the Science and Technology Policy of Turkey (**S&TPT**) designed in the years of 1990s are:

- **“The Turkish Science and Technology Policy: 1993-2003”** (TÜBİTAK, 1993),
- “**The Project of Impetus for Science and Technology**” (TÜBİTAK, 1996), and
- “**The Science and Technology Policy of Turkey**” (TÜBITAK, 1997),

The **“Turkish Science and Technology Policy: 1993-2003”** (TÜBİTAK, 1993), designed by the Scientific and Technical Research Council of Turkey (TÜBİTAK) and then approved by the **Supreme Council for Science and Technology (SCST)**[1] at its meeting of 3rd February of 1993, can be considered as a starting-point document for the Science and Technology Policy of Turkey in the years of 1990s. The policy declared with this document was elaborated and based upon a solid ground, in the year 1995, with the “**Project of Impetus for Science and Technology**” (TÜBİTAK, 1995) within the scope of Structural Transformation Projects involved by the **7th Five-Year Development Plan (1996-2000)**.

And then, the conceptual framework, the main concepts and targets of the S&TPT were reviewed once more and put forward explicitly by TÜBİTAK, as a working document titled “**The Science and Technology Policy of Turkey**” (TÜBITAK, 1997), for the meeting of the SCST held on 25th August of 1997. At this meeting, the SCST, approving this review and taking into consideration the agile requirements of Turkey, has come to some crucial decisions**.** These decisions can be considered as an ‘action plan’ for the implementation of the S&TPT. At its meetings of 2nd June of 1998 and 25th December of 1999, the SCST made some additions and amendments to these decisions.

The conceptual framework that the S&TPT depends on will be summarized below.

The Conceptual Framework of the Science and Technology Policy of Turkey

The S&TPT depends on some **techno-economic analyses** made on **Global Processes**, such as ‘Transition to Information Society’, ‘Globalisation’ and ‘Regional Polarisation’, and **the existing situation of Turkey**. Systemic approach, in designing of it, was used. In this section, it will be tried to put forward the general framework of those analyses.

[1] The Supreme Council for Science and Technology (SCST), authorized by the law as the highest policy-making body, has a key role in Turkish Science and Technology System. It was established in 1983.

The SCST is chaired by the Prime Minister and comprised of the Ministers of Defence, Finance, Education, Health, Forestry, Agriculture and Rural Affairs, Industry and Trade; the President of the Higher Education Council; the Under-secretaries of the State Planning Organization, Treasury, and Foreign Trade; the President of the Scientific and Technical Research Council of Turkey (TUBITAK) and one of his deputies; the President of the Nuclear Energy Council of Turkey; the General Director of the Broadcasting Corporation of Turkey; and the President of the Union of Chambers of Commerce and Industry of Turkey. TUBITAK acts as the general secretariat to SCST.

On the Global Processes:
Towards The Information Society…

According to the analysis made by TÜBİTAK acting as the designer of the S&TPT: *"Human beings are witnessing today a historical process that is considered by some, in respect of its social, political, and economical effects, as a new revolution equivalent to the British Industrial Revolution. Some calls it a transition period to a new age, namely, age of information, thereby, to the post-industrial society -the information society. This new age has been characterized by the radical changes in technology basis of the production and labour process. Information technology based on improvements in microelectronics, computer, telecommunication and network technologies is playing a determinant role in these changes."*[2]

Then it is pointed out that, *"Information technology has been accompanied by its offspring-technologies such as flexible production and flexible automation technologies, and by the other new, pervasive generic technologies such as advanced material technologies based on the improvements in material sciences, and <u>new biotechnology [and genetic engineering] based on comprehensive developments in molecular biology, genetics and biochemistry. And, it is expected that new biotechnology, particularly, genetic engineering, is likely to play a key role in the 21st Century, that is comparable to the role of information technology of today</u>.*

*"Radical changes in the technology basis of labour process (it can be red as '**Fordist** labour process') are leading to radical changes in the pattern of mass production, which is the dominant perception of production system in market economies. The changes in the Fordist labour process, which started in Japan's automobile and electronic industry and then spread to all market economies and, nearly, all industrial sectors, are so comprehensive it has been argued that the Fordist labour process, and, thereby, the production system based on it, are evolving into new ones*[3]*.*

"In addition to the changes in technology basis of the production and labour process, the technology content of this process and the products is increasing progressively. Technology has become a productive power substituting muscular power completely and brain power to some extent. It is also changing the nature of all production forces [factors] including raw materials and means of production. Therefore its relative importance among the forces [factors] of production is increasing progressively."

As it is known, the technology is **embodied knowledge**, so we could say that the relative significance of **the knowledge as an input** is increasing progressively. A MERIT Study (Cowan, R. 2000) puts it explicitly: *"For some, at the present time, it seems that the knowledge is in some sense qualitatively more important than ever before as an input. So it is argued that we are moving towards a new 'knowledge economy', in which the role and significance of knowledge for economic*

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[2] We can find the arguments of this analysis, for example, in Freeman. In words of C. Freeman (1989): "The effects of information technology are so universal affecting every single sector of the economy, that they may be legitimately described as a change of 'techno-economic paradigm' providing scope everywhere for renewal of productivity increases through a combination of organizational, social and technical innovations and for a broad range of new and improved products and services."

3 We can find the arguments of this analysis in many distinguished authors of our era. In Piore and Sabel's terms (1984), '**mass production**' is evolving into a new production system, namely, '**flexible specialization**'. According to Kaplinsky (1989), we are witnessing the transition to a new era, namely, the era of '**systemofacture**' and, thereby, to a new labour process: '**systemofacturing labour process**'. In Freeman's terms (1989), we are witnessing ***"a change of techno-economic paradigm"*** and, as a consequence of this change, some radical *"changes in organization and structure of both firms and industries, which accompany the introduction of information and telecommunication technologies".*

activities has fundamentally changed. And for the others, the extent to which knowledge lies at the heart of growth does seem to be of a different order of magnitude than has been the case historically (with periodic exceptions of course) but, to be more precise, it should be made a change in terminology from 'knowledge-based' to 'knowledge-driven' while emphasising that current contributions of knowledge are very much to the dynamics of our economy."

Whatever it is called, 'knowledge-based' or 'knowledge-driven', *"the dynamics of the economy are coming to rest less on investments in physical capital and more and more on learning or investments in knowledge creation."* (Cowan, R. 2000) In this respect, it can be said that the techno-economic analysis that the S&TPT has depended on, in context of the transition process to Information Society, is still valid.

At the end of the analysis, as a consequence, it is said that, *"In context of those technological changes, it is obvious that the countries having superiority in technology and science are progressing towards an absolute domination in industry and all other economical activities. In short, technology* [it can be red as 'knowledge'] *has become the only key to the international competitive advantage. Thereby, superiority in science and technology is the determinant factor in increasing the welfare of society and improving the standard of living."*

On Globalisation…

On the process of 'Globalisation', it is said that, *"Another process that human beings are witnessing today is 'Globalisation'. The most remarkable milestone of this process is the **Final Act of the Uruguay Round**[4] aiming at liberalization of the trade all over the world."*

In respect of the Final Act, it is pointed out that, *"The most important agreements covered by the Final Act are **the Agreement on Trade-Related Aspects of Intellectual Property Rights** and **the***

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[4] "The Final Act Embodying the Results of the Uruguay Round of Multilateral Trade Negotiations is 550 pages long and contains legal texts which spell out the results of the negotiations since the Round was launched in Punta del Este, Uruguay, in September 1986. In addition to the texts of the agreements, the Final Act also contains texts of Ministerial Decisions and Declarations, which further clarify certain provisions of some of the agreements. The Uruguay Round was a global negotiation with a global result. (GATT, 1994)" It covers

- Agreement Establishing the World Trade Organization
- General Agreement on Tariffs and Trade
- Agreement on Agriculture
- The Decision on Measures Concerning the Possible Negative Effects of the Reform Programme on Least-Developed and Net Food-Importing Developing Countries
- Agreement on Textiles and Clothing
- Agreement o Technical Barriers to Trade
- Agreement on Trade-Related Investment Measures
- Agreement on Anti-Dumping
- Agreement on Customs Valuation
- Agreement on Preshipment Inspection
- Agreement on Rules of Origin
- Agreement on Import Licensing Procedures
- Agreement on Subsidies and Countervailing Measures
- Agreement on Safeguards
- General Agreement on Trade in Services
- Agreement on Trade-Related Aspects of Intellectual Property Rights, Including Trade in Counterfeit Goods
- Understanding on Rules and Procedures Governing the Settlement of Disputes
- Decision on Achieving Greater Coherence in Global Economic Policy-making
- Trade Policy Review Mechanism
- New Agreement on Government Procurement

The Agreement, signed in April 15, 1994 by the parties of Uruguay Round of Multilateral Trade Negotiations, was approved by the Grand National Assembly of Turkey in January 26, 1995 by the Law: no 4067.

***Agreement on Subsidies and Countervailing Measures**. The former brings about an international law system that protects intellectual property rights globally. The latter settles for which economical activities a government shall grant subsidy, or under what conditions and to what extent subsidies may be granted. It covers the subsidies ('assistance') for research activities conducted by firms or by higher education or research establishments on a contract basis with firms, and also contains the **countervailing measures** applicable globally for the states that do not follow the rules.*

And then, as a consequence, it is added that, *"In a world where the conventional protectionism has been broken up, the determinant factor in international competition will be the ability of **the transformation of an idea into a marketable product or service, a new or improved manufacturing or distribution process, or a new method of social service**, namely, **the ability of innovation** (EC, 1995). This ability, in last analysis, depends on the ability of nations in science and technology, particularly, in the pervasive generic technologies of our era, namely, informatics, new biotechnology and genetic engineering, and the technologies of advanced materials."*

As it is known, the all rules of the Final Act of Uruguay Round will come into force in the Year 2005.

On Regional Polarization…

On the process of the 'Regional Polarization', it is said that, *"While the 'Globalisation process' is progressing, it seems that a political process based on **national motives** is gaining ground all over the world. Moreover, the nations perceiving that they could not be competitive one by one in world market place are tending to form regional blocks."*

The European Community's R&D policy is given as a remarkable argument for this approach: *"For the 'total competitiveness' of the Member Countries, the EC's R&D policy, in accordance with Article 130f(1) of the Treaty establishing the EC, should address, as a matter of priority, problems of society**, improving the international competitiveness of Community's industry*** [underlined by us]*, sustainable development, job creation, the quality of life and globalisation of knowledge, contributing to the development and implementation of the Community's policies and **the role of the Community in the world as a focal point of scientific and technological excellence*** [underlined by us]."[5]

After this argument, a deduction comes: *"It seems that when the blocks accomplish the political and legal infrastructure of organizing their in-block single markets, countries those are not involved in any block and, furthermore, have not any competence in science and technology will hardly have a chance to survive."*

The Existing Situation of Turkey in Context of Global Processes

After those techno-economic analyses, the existing situation of Turkey is evaluated, and the consequence deduced is put forward explicitly: "*In regard to the global processes analysed it can be said that, science and technology have become the key factors in competitive advantage of nations as well as in competition among the firms. Thereby, the countries having superiority in*

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[5] "Common Position (EC) Adopted by the Council on 12 February with a View to Adopting Decision of the European Parliament and of the Council Concerning the Fifth Framework Programme of the European Community for Research, Technological Development and Demonstration Activities (1998-2002); Annex I"

science and technology are progressing towards dominating the information age and the future world, too.

"The countries, such as Turkey, do not have any active role in those processes that carry the seeds of 21st Century, but they are directly affected by the consequences of them, and they, inevitably, will continue to be influenced deeply. Turkey, in respect of those global processes, has to cope with many problems. Among them, the most vital one is to catch up with technological changes of the age. However, Turkey's challenge has two fronts in this respect. Turkey, which inherited the Ottoman Empire that had missed the evolutionary process towards an industrial society after the British Industrial Revolution, has not surpassed the industrialization threshold yet. Now, while the industrial societies are evolving into information societies, it has to face the problem of keeping up with technological changes leading the new age as well as the problem of overcoming that historical gap. ***The performance of Turkey in solving these two problems simultaneously will determine her future.***

"To cope with these two formidable problems at the same time necessitates gaining ability in science and technology. ***Gaining ability in science and technology and creating a country that dominates science and technology is the only strategic choice of Turkey. That is the main target in the national science and technology policy****."*

The Main Concepts of the Science and Technology Policy of Turkey

Gaining Ability in Science and Technology

What has been intended with the phrase of "gaining ability in science and technology"? We can find the answer in the documents cited before: *"As a concept, it does not only involve acquiring excellence in scientific and technological research. It also covers gaining ability '****to transform the scientific and technological findings into economical and social benefit****'. A nation can gain an advantage over others in the world market place if only she has such ability."*

And added: *"In the design of the S&TPT, the ability '****to transform the scientific and technological findings into economical and social benefit'*** *has been taken as the* ***innovation ability."***

To be prim and precise, it can be said that the definition of '**innovation**' concept proposed by OECD has been modified to some extent in the S&TPT.

As it is known, as a concept, 'innovation' denotes both a process and its result. According to the definition proposed by OECD (1993; 1997), innovation, as a process, involves *"the transformation of an idea into a marketable product or service, a new or improved manufacturing or distribution process, or a new method of social service."* On the other hand, when the word 'innovation' is used to refer to new or improved product, equipment or service, which is successful on the market, it denotes the result of the process.

In the definition, the emphasis, either as a process or as a result, is on the '**marketability**'. The created innovation can be incremental or radical, but it has to be marketable.

Another remarkable point in the definition is that there has not been any implication on the '**idea**'. The idea, as long as a marketable result is obtained, can be related to conventional technologies as well as be related to advanced or high technologies. It can never even be related to technology. Nevertheless, in our era, scientific and technological contents of almost all products, methods, or services, which will be the subject for an innovation process, have increased considerably and, it seems that, are increasing continuously on the basis of generic technologies. Under these circumstances, innovation process itself is increasingly becoming more linked to technology and, of

course, to science as the source of modern technology. As an OECD Report has cited (OECD, 1998b):
"The innovation process is drawing more and more on advances in knowledge by the science base, although there is no linear relationship between the two. Analysis in the United States shows a threefold increase in publication citations in patents delivered over the period 1987-94, an indication of stronger links between science and innovation."
In other words, the new ideas and new findings in science and technology have become the main source of innovation. So, the innovators/entrepreneurs are to understand and adopt the new technologies, sooner or later.
On that account, we can say that, in the final analysis, **innovation, as a concept, denotes the transformation of science and technology into an economic or social benefit 'just in time' for the market and the needs of society** (Göker, A. 1998a, b). In this context, gaining ability in technological innovation is crucial. This is the challenge for both entrepreneur and nation in our era as Porter has said (1991):
"Revolutionary new technologies (information systems, bioengineering, new materials, super fast microchips, and others) provide the opportunity for an era of innovation and improving productivity in virtually all industries that may well be unprecedented in industrial history. We have only to accept the challenge and act upon it."
It has been considered that Turkey has to accept this challenge and the S&TPT has been devised for it.

Enhancing the **ability in S&T**, and, thereby, **the innovation ability** of the nation or creating those abilities include some crucial measures pertaining to legal and institutional restructuring. In this respect, it should be pointed out that the process of gaining ability in **innovation** is not a simple technical process and/or a linear process, and it cannot be limited to learning and absorbing the new technologies -i.e. technology transfer. It is much more complex than this. Gaining ability in innovation also involves many cultural, social, economical and political aspects and components, interactions amongst those components, and mechanisms for interaction; in shortly, it necessitates a specific system, namely, a **national system of innovation**, and, therefore, a **systemic approach**.

The matter of innovation has been taken in this context and in a systemic approach in the S&TPT.

The National System of Innovation and Systemic Approach

In this point, in regard to the "globalisation" process, it can be asked whether we need a **national** system, indeed. C. Freeman (1995) replies to the question:
*"Contrary to some recent work on so-called 'globalisation', **national*** [underlined by us] *and regional systems of innovation remain an essential domain of economic analysis. Their importance derives from the networks of relationships, which are necessary for any firm to innovate. Whilst external international connections are certainly of growing importance, the influence of the national education system, industrial relations, technical and scientific institutions, government policies, cultural traditions and many other national institutions is fundamental."*

For that matter, Ricardo Galli and Morris Teubal (1997) say:
"The concept of national system had a well-defined meaning in the past when basic decisions concerning the science, technology, and innovation policies of a given country were taken essentially at a national level. Nevertheless, increasingly, international linkages are dominant in science as well as in innovation and diffusion processes, leading National Systems of Innovation are to become ever more open systems. Thus the term may appear a mismatch to the current real

geographic size and space of technical systems supporting innovation in any specific sector, which might be mostly international.

...

"Nevertheless, the concept of ***national system*** [underlined by us] *maintains its significance not only because it is shaped by national characteristics -size, social and economic development, sectorial specialization, endowment of resources, cultural traditions- but also since the required adaptation to the new paradigm is still largely done at the national level."*

M. Porter (1991) puts the matter explicitly:

"... Firms will not ultimately succeed unless they base their strategies on improvement and innovation, a willingness to compete, and ***realistic understanding of their national environment and how to improve it. The view that globalisation eliminates the importance of the home base rests on false premises...*** [underlined by us].

"As globalisation of competition has intensified, some have begun to argue a diminished role for nations. Instead, internationalisation and the removal of protection and other distortions to competition arguably make nations, if anything, more important. National differences in character and culture, far from being threatened by global competition, prove integral to success in it.

"It is the creation of knowledge and the capacity to act, which are the result of a process that is highly localized, that determines competitive success."

As an OECD Report (1998a) has also argued that:

"Imported technology is no substitute for a sound science base and domestic innovative capacity when determining long-run technological performance. The emphasis must be on assimilation of know-how through learning by doing and learning by research."

Now the question is which instrument enables us to perform *"a process"* that should be *"highly localized for creation of knowledge and the capacity to act"*, or, to create *"a sound science base and domestic innovative capacity",* and to *"learn by doing and learn by research"*. **The national system of innovation enables us, indeed**. In our opinion, the matter is so evident that there is no need any additional explanation, and it is also explicit that the first step for a nation aiming at being innovative should be to lay the necessary building blocks of the national system of innovation. **And, the S&TPT takes the matter in hand in this manner.**

Science and Technology System and the Innovation System…

In this point, it should be noticed that the science and technology system and the innovation system are not identical. The innovation system, in a sense, is a product of the interaction between the science and technology system and the production system. And, as the innovation system develops, interaction between other two systems increases and the innovation ability of the nation rises. If the science and technology system, namely, Higher Education and the Research and [Experimental] Development System, has been isolated from production system, we cannot talk about the existence of any innovation system. In other words, innovation system necessitates the very existence of other two systems and the **interaction** between them.

Furthermore, we need some mechanisms -or some interfaces or transition zones- and intermediary agents for this interaction. University-industry corporate research centres, incubators, technoparks, technology centres, technology counsellors and consultants, information networks are the well-known examples of them. But the innovation system is still not so simple and has not completed yet. At these interaction zones, we will encounter the human problem; e.g. 'corporate research' is a matter of culture and we need training. Furthermore, creating the building blocks of the innovation system, such as 'corporate research centres' and 'incubators', and the activities conducted there, need financial support and, generally, **public assistance**. This requirement list goes on to great extent.

We think that it will be helpful to reach an understanding on the 'concept of national system of innovation' because this subject is the focal point in designing of the S&TPT in the years of 1990s. According to C. Freeman (1995): *"the first person to use the expression 'national system of innovation' was Bengt-Åke Lundvall… However, (as Lundvall himself points out) the idea actually goes back at least to Friedrich List's conception of* ***'The National System of Political Economy'****, which might just as well have been called 'National System of Innovation"*.

Lundvall himself (1992) defines the concept of national system of innovation as *"all parts and aspects of the economic structure and the institutional set-up affecting learning as well as searching and exploring."* According to him *"the production system, the marketing system and the system of finance present themselves as subsystems in which learning takes place"* and *"determining in detail which subsystems and social institutions should be included, or excluded, in the analysis of the system is a task involving historical analysis as well as theoretical considerations...* ***a definition of the system of innovation must be kept open and flexible regarding which subsystems should be included and which processes should be studied.*** [Underlined by us]*"*

Freeman (1987) himself defines the national system of innovation as *"the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies."*

According to Patel and Pavitt (1994), who build their concept on the insights of Freeman, Lundvall and Nelson, 'concept of national system of innovation' can be defined as follows: *"the national institutions, their incentive structures and their competencies, that determine the rate and direction of technological learning (or the volume and the composition of change -generating activities) in a country."*
Regarding the concrete circumstances of Turkey and her starting point, in policy design for Turkey, this concept has been taken in a broader sense and deliberately descriptive manner as follows (TÜBİTAK, 1997):

A system comprised of national institutions that have the following abilities:
- Ability to access to and adopt the new technologies,
- Ability to improve existing products, and to design new ones,
- Ability to improve existing production processes, and to design new ones,
- Ability to design and produce the means of production or capital goods needed for the improved or newly designed production processes,
- Ability to maintain technological R&D activities feeding the mentioned improvement, design and production processes; and ability to conduct basic research as the main source of those technologies,
- Ability to improve existing organization methods [soft technologies] arranging the relations within and between research, development, design, production (manufacturing), and marketing compartments and reproducing those relations at a technologically higher level."

It is obvious that national system of innovation contains all of the institutions necessary for creating and maintaining those abilities. In other words, **the system is comprised of not only**
- Enterprises conducting innovative activities, and providing engineering, consulting and design services;
- Mechanisms for technology transfer (diffusion, assimilation and utilization);

- Universities conducting basic research, and the public research bodies conducting mission-oriented basic research;
- Professional research bodies such as laboratories of the enterprises conducting in-house research, and contract research centres, corporate research centres or corporate research consortia, generally, conducting industrial research and pre-competitive development activity;
- Education-training institutions;
- Quality assessment institutions on education and research;
- Technological facilities such as wind tunnels, simulators, accelerators, and so on.

But also includes;

- Information networks, and centres providing special information services;
- Institutions related to standards and quality control; national metrology system; national notification-accreditation-certification system;
- Incubators / technology development centres, technoparks / science parks, and advanced industry parks, near by the universities or public research institutions, creating an **interactive and conducive environment** between research potential of universities or research institutions and creative-innovative entrepreneurs / enterprises based on advanced technologies;
- Demonstration centres for diffusion of tangible technologies;
- Technology counsellors and technology centres that will meet the technology requirements of enterprises and carry on the new scientific and/or technological findings to them in a **conceivable form** so that they can use and convert these findings into marketable products.
- Patent offices and the other institutions protecting intellectual property rights;
- Technological attachés;
- **Consulting bodies and firms** for consultative services on following special subjects:
- Evaluating the feasibility of new business ideas and assessing the viability of new business opportunities;
- Developing the business strategy/business plans;
- Organizing the funding and access to financial resources;
- Marketing, particularly, for the enterprises operating in international markets;
- Patenting;
- Technology auditing to help companies become more competitive in the market place and so enable them to achieve growth and develop their businesses;
- Operations auditing aiming at improving the operational performance of companies and inculcating them a permanent process of continuous improvement;
- Assistance in the implementation of a range of concepts such as 'Just-in-Time' and 'Total Quality Management';
- Software development, data processing, and/or software and information procurement;
- Innovation management, management and exploitation of R&D, and human resource development;
- Assistance in identifying, gathering and dissemination of information on global best practices, and in developing appropriate benchmarking practices.
- Financial institutions providing **seed capital funding** to highly skilled individuals or teams, and to new businesses with relatively long development phase, often involving new technology;
- Incentive mechanisms for technological innovation investments;
- Grant mechanisms for scientific research conducted by universities and in-house R&D activities of enterprises;
- Assistance or grant mechanisms for setting up contract research companies or centres, cooperative research centres or consortia, and for encouraging enterprises to conduct corporate research and to participate in corporate research programs;
- Assistance or grant mechanisms for creating interactive and conducive environments such as incubators, technoparks, demonstration or exhibition centres, information centres and networks;

- Institutions or foundations sharing the risks of the enterprises, on the base of their technologically innovative and creative projects, through credits repayable provided that the resulting product is commercialised successfully;
- Financial institutions for provision of additional equity funding through the **venture capital funds,** which have the resources and management skills to make commercial investments in growth-oriented enterprises.

All institutions or mechanisms mentioned above are the necessary components of national system of innovation, and the second group is, at least, as important as the first group in creating innovative capability in the country.

Furthermore, governments have significant responsibilities in designing national science and technology policies -and national innovation policies that go along with- and in policy implementation. In last analysis, national science and technology policies are designed for the reorganization of national resources, especially public resources, according to the priorities determined by those policies. And this requires, in the process of designing those policies, a consensus among different interest groups. The role of government starts here.

Many diverse institutions, individuals and sectors participate in policy implementation. The success of this multi-actor play depends on orchestration, which is mainly on the government's responsibility.
In this respect, it can be said that the government herself is a main component and has a key position in national system of innovation.
Caracostas and Müldür (1998) put the exceptional role of the governments in national system of innovation, clearly: *"... difficulties which arise from the features of investment in R&D and innovation, it would seem to be wishful thinking to imagine that scientific and technological progress could be adequately funded in all the market economies without some form of government assistance."*
In terms of the S&TPT: "*For a country, such as Turkey, that has not established all the necessary building blocks for a national system of innovation the role of government becomes very important in creating the suitable environment and climate, and the appropriate policy tools, for encouraging innovation."*

In shortly, creating a national system of innovation and gaining ability in innovation is a matter of new arrangements related to scientific, technological, educational, financial, legal, administrative institutions and infrastructure. As a much more important point than this, it is a matter of restructuring the enterprise itself. Science and technology policy should respond all these requirements in a systemic approach.

As an OECD Report (1998a) mentioned before has put forward:

*"To realize the full potential of innovation in fuelling growth, technology policy should be an integral part of overall economic policy. Innovation activities are dependent not only on the effective production, circulation and absorption of new knowledge, but also on the framework conditions for learning, financing, regulating, etc. Technology policies need to operate in a stable macroeconomic environment and complementary reforms in other fields. These include **competition policies** which enhance innovation-driving competition but also facilitate collaborative research; **education and training policies** which develop the necessary human capital; **regulatory policies** which lessen administrative burdens and institutional rigidities; **financial and fiscal policies** which ease the flow of capital to small firms; **labour market policies** which enhance the mobility of personnel and strengthen knowledge flows; **communication policies** which maximize the*

dissemination of information; and ***foreign investment and trade policies*** *which further technology diffusion on a global basis. New approaches or institutional arrangements may also be needed to coordinate these policies."*

The systemic approach has been the basic point underlined significantly in the S&TPT, indeed. It has emphasized that *"gaining ability in innovation does not only involve scientific or technological aspects, but also includes many cultural, social, economical and political aspects and components, interactions amongst those components, and mechanisms for interaction; in shortly, it necessitates a specific system, namely, a* ***national system of innovation****."*

Thereby, **establishing the national system of innovation** with all basic components and restructuring of the existing ones is the focal point of the **Science and Technology Policy of Turkey**, in the years of 1990s, aiming at creating a Turkey that

- Has enhanced her ability in science and technology, and
- Has gained capability of transforming science and technology to economical and social benefit, and
- Has got the respectability among the countries that contribute to the World's science and technology, to that common inheritance of humanity.

A Concrete Base for Gaining Ability in Science, Technology and Innovation…

There should be a concrete base on which the ability in science, technology and innovation can be achieved. It may be new industrial and/or infrastructure investments, and /or considerable, mission oriented research projects. Why do we need such a concrete base?

It has been pointed out the increasing role of technology, and that the technology is **embodied knowledge**. It is known that the determinant component of this embodied knowledge is **tacit knowledge**. We must conceive the nature of this kind of knowledge, and how it is accessed, adopted, and recreated or reproduced at a higher level. The recent MERIT Study (June, 2000) commissioned by the European Commission puts it explicitly:

"Most of the innovation that has economic impact is recombination of existing knowledge into new products and processes. For recombination to work well as a process itself, agents must have rapid, easy, cheap access to a large amount and wide variety of knowledge. This indicates the importance of knowledge diffusion or distribution. But equally, it must be stressed that central to the effective diffusion of knowledge is its absorption by new agents. Tacit knowledge is central to the process of absorption. Tacit knowledge is stored in the brains of people or the routines of organizations…"

And now, let us remember again the OECD remark cited before:

"Imported technology is no substitute for a sound science base and domestic innovative capacity when determining long-run technological performance. The emphasis must be on assimilation of know-how [that is '**tacit knowledge**'] *through learning by doing and learning by research."*

The key phrase here, is that *'learning by doing and learning by research'*. The **Project of Impetus for Science and Technology** was targeting to create a concrete base for *'learning by doing and learning by research'*, and seven specific fields of investment were being proposed in order to create this concrete base. These specific fields are

- **Construction of the National Information Infrastructure** needed for carrying the society to information society of the 21st Century and related **Telematic Services Network**; and gaining ability in information and telecommunication (**IT**) technologies through participating this construction process;
- **R&D in Flexible Manufacturing / Flexible Automation Technologies**, which are the offspring-technologies of information technology, for learning these technologies by research, and for enabling the Turkish Manufacturing Industry to innovate its labour process;
- **Upgrading the Existing Railway System on the base of High-Speed Train Technologies**; and gaining ability in related technologies including the information technology, specific to this field, through participating this upgrading process;
- **Aerospace Industry, and related R&D on the base of selected products**; and gaining ability in selected aerospace technologies including remote sensing technologies and avionics;
- **R&D in Genetic Engineering and New Biotechnology, and project based applications** for gaining ability in this field;
- **R&D in Environmentally Sound Technologies, Energy Conserving and Efficient-Use Technologies, Environmentally Sound Energy Technologies**; and related nation-wide applications;
- **R&D in Advanced Materials**; and related industries.

As it can be seen, some of these investments reflect a demand-pull strategy while the others reflect a technology-push strategy, and it can be said that there has been a certain approach of harmonisation in these suggestions.

It should also be noticed that many of them are converging the **technological priority areas** suggested by the **Turkish Science and Technology Policy: 1993- 2003**. Taking into account the existing capabilities of Turkey and the scientific and technological trends and forecasts in the World, the following generic technologies, in general, have been accepted as **having priority**:

- Informatics,
- Technologies of Advanced Materials,
- Biotechnology, and
- Aerospace Technologies.

In addition to these investment suggestions, the Project for Impetus, in regard of the enhancing **S&T ability**, and, thereby, **the innovation ability** of the nation, includes some crucial measures pertaining to legal and institutional restructuring, in scope of the 'National System of Innovation' concept.

Policy Implementation…

It has been tried to give a brief explanation about the S&TPT, its conceptual framework, main concepts and targets. And now, we have come to the critical question: What is the actual situation in policy implementation? What happened, for example, in the fields of those investment fields proposed?

- Two reports on informatics policy were prepared by an expert group under the commission of The Turkish Academy of Sciences (TÜBA), TUBITAK and the Technology

Development Foundation of Turkey (TTGV), and issued in the Years 1995 and 1996. And then, a **master plan** was prepared by TUBITAK, with the participation of some distinguished experts from the public and private sector enterprises, for the **construction of the National Information Infrastructure**. Preparation stage of the Master Plan[6] including a technology foresight study in related sectors was accomplished at the end of the Year 1999.

- A conceptual study on "**Flexible Manufacturing / Flexible Automation Technologies"** commissioned by TUBITAK in the Year 1994 was reviewed and issued again in the Year 1996.

- A conceptual study on "**High-Speed Train Systems and Technologies**" commissioned by TUBITAK was issued in the Year 1996.

- A policy report on aviation science, technology and industry was prepared by an expert group under the commission of TUBITAK, and issued in the Year 1995.

- A comprehensive policy report on molecular biology, genetic technology and biotechnology, including detailed proposals for Turkey, was prepared by an expert group under the commission of TUBA, TUBITAK and TTGV, and issued in the Year 1995.

- A comprehensive policy report on energy technologies, particularly on **sustainable energy sources and clean energy technologies**, including detailed proposals for Turkey, was prepared by an expert group under the commission of TUBITAK and TTGV, and issued in the Year 1998. And then another comprehensive policy report on **clean production, clean product and environmentally sound technologies**, also including detailed proposals for Turkey, was prepared by another expert group under the commission of TUBITAK and TTGV, and issued in the Year 1999.

- A policy report on advanced materials and their technologies, including detailed proposals for Turkey, was prepared by an expert group under the commission of TUBA, TUBITAK and TTGV, and issued in the Year 1996.

There have been some other policy studies commissioned by TUBITAK and/or with the participation of TUBA and/or TTGV and issued after the Project of Impetus. **But all the reports including the Master Plan on National Information Infrastructure have been put on the shelf, and the proposals involved by them are still over there.** Of course, it does not mean that nothing has been done. Some important legal and institutional arrangements proposed within the framework of the S&TPT have already been implemented. Examples include

- Launching the Government's **R&D Assistance Program for the Industrial Companies** by the Decree of the Government in force as from June 1, 1995, as amended/added by the Decree in force as from November 4, 1998.
- Founding the **Turkish Patent Institute** by the Decree-Law no.544 in force as from June 24, 1994.
- New legislation pertaining to the **Protection of Patent Rights and Utility Models, Industrial Designs, Geographical Signs, Trademarks, and the Protection of Intellectual Property Rights in Software** come into force in 1995.

[6] Master Plan documents are accessible through http://www.tuena.tubitak.gov.tr

- Launching the **Program for Founding the University and Industry Cooperate Research Centres** by the Decree of **TUBITAK** at the end of 1996.
- **Founding the National Accreditation Council** by the Law no: 4457 of October 27, 1999 in force as November 4, 1999.
- Setting up the **National Academic Network in 1998** by TUBITAK.

It is also known that some efforts are being made for spreading the **'Venture Capital Investment Partnerships'**. But, in final analysis, an observer could easily say that all those were the results of individual attempts or efforts, and that the policy implementation has suffered from the lack of systemic integrity and continuity. As a matter of fact, our observer could also point out some other important legal and institutional arrangements that should have been done for the National System of Innovation to work well have not been implemented. Examples include

- Issuing The Law of Technology Development Districts that will be create convinient sircumstances for interaction, networking and clustering;
- New Legislative and Institutional Arrangements for Improving the Brainpower Resources, such as
    - Improving the Universities to a Level of Universal Quality in the Fields of Higher Education and Scientific Research;
    - Encouraging the Research Personnel; and Solving the Matter of 'Mobility';
    - Training Academic Personnel; and Improving the Scholarship Systems for Doctorate and Post-Doctorate.
- New Legislation for Restructuring the Public Research Institutions;
- Legislative and Institutional Arrangements needed for Establishing a National Research and Development Budget System;
- Establishing an Efficient Technology and Innovation Support System for the Small and Medium Sized [Industrial] Enterprises (SMEs);
- Reviewing the Public Procurement Policy in Respect of Encouraging the Industrial Research and Precompetitive Development Activities in Turkey;
- Establishing the National Aerospace Council for Improving the Scientific and Technological Ability of the Country in this Field;
- Enlarging the Scope of **R&D Assistance Program** in order to involve the Agricultural Research…

As a much more important point, Turkey has not made any **Technology Foresight Study** [7] **at the macro economic level**, and this is the single country example, among the OECD countries, that has not made such a study yet.

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[7] "Technology foresight is concerned with the role of the technology in construction a desirable but achievable long term future for the Country and identifying the critical/strategic decisions which must be taken now to make the achievement of this vision more probable.

It is a process for bringing together scientists, engineers, industrialists, Government officials and others to identify the areas of strategic research and the emerging technologies likely to yield the greatest economic and social benefit for the Country.

"In the technology foresight process the participants work towards creating a shared vision of the future they would like to achieve and developing a consensus on research priorities.

"Technology foresight does not forecast the future but the process can ensure that the strategic choices made now regarding the prioritisation of national STI investment are 'future proofed'. The technology foresight findings show the route to continued economic growth, wealth creation and improved standards of living. (**Technology Foresight Ireland,** April 1999)

Why is it so? Why have **the Master Plan on National Information Infrastructure** and the other policy reports, involving proposals on gaining ability in genetic engineering, advanced materials, aviation technologies, and sustainable energy technologies, been put on the shelf? Why does the policy implementation suffer from the lack of systemic integrity and continuity?

Our observer could also easily say that the reason is the lack of **political power** conceiving the vital importance of gaining ability in science, technology and innovation and the determinant significance of the systemic approach in this process. This observation may be true but now the question is what the reason for this lack of awareness is.

It is known that our economy is **not a producing economy** in the best sense of the term and, thereby, couldn't create sufficient demand for gaining ability in innovation, technology and science, and sufficient pressure on political power, in this respect. Only a producing economy strongly needs technology development and innovation. So, we should search the reason for this lack of awareness in the nature of our economy. There may be an S&TP proposed or foreseen but there will be no chance for success in implementation unless a convenient climate cannot be created for a producing economy.

Conclusion

It can also be extracted some consequences from the conceptual framework of the S&TPT and its implementation, in respect of the subject that we have discussed. For the first, getting the benefit of existing opportunities or creating new opportunities in biotechnology and genetic engineering through coping with the challenges is a matter of policy, but this policy should be an integral part of overall Science, Technology and Innovation Policy of the country. In this respect, the main concepts of the S&TPT such as "gaining ability in science, technology and innovation", "national system of innovation", "systemic approach", and "creating a concrete base for gaining ability in science, technology and innovation" are all valid for this sectorial policy, too.

In context of biotechnology and genetic engineering, these concepts could be red as

- Gaining ability in molecular biology, biochemistry, new biotechnology, genetic engineering and tissue engineering, molecular electronics and nanotechnology, etc.
- Establishing the sectorial system of innovation as an integral part of the National System of Innovation, and in this context, stimulating networking and clustering at sectorial level.
- Designing and implementing the sectorial policy as an integral part of the S&TPT and thereby the overall economic policy.
- And, creating a concrete base or reason for gaining ability in new biotechnology, genetic engineering, etc.

The most critical concept among them is the last one. If there has been no concrete reason in terms of economic and social benefit for gaining ability in new biotechnology and genetic engineering, the policy that has been designed for it will remain on the shelf. However, Turkey has a good reason for gaining ability in new biotechnology and genetic engineering. It is the **South Eastern Anatolian Project**.

In respect of genetic engineering or new biotechnology, it is obvious that gaining ability in those fields is much more important for agricultural sector than for the other sectors of economy. The possibilities created by new biotechnology and genetic engineering will enable humanity to harness the forces of nature in agricultural production, and to create new agricultural products designed by human kind. The nations dominating new biotechnology and genetic engineering will dominate the agricultural production of the Future's World. In terms of the Project for Impetus: *"For Turkey, as a country that has launched the* ***South Eastern Anatolian Project,*** *which is an agriculture-based restructuring mega project, gaining ability in new biotechnology* and genetic engineering *is not only critical but vital. It should be understood that this project will not create any considerable value in the future for national economy unless gaining ability in genetic engineering."* South Eastern Anatolian Project could be a very concrete base for gaining ability in genetic engineering and new biotechnology, and should have been so.

Of course, the revolutionary transformation in the agricultural production system is not merely depending on new biotechnology but also on the advances in informatics.

An OTA Report (1995), in respect of the *"changing environment for agricultural research"*, points out that: *"New biotechnology and* ***information technology in particular*** [underlined by us] *are yielding powerful research tools that can be applied to questions in a wide range of scientific disciplines."*

National Environmental Technology Strategy Document of the USA (NSTC, 1997), under the motto of **"Bridge to a Sustainable Future**", puts the matter explicitly: *"...Farmers will belong to a broadly diversified agricultural business community. From 1995 to 2020 they will have shifted from single crop commodity production to speciality crop and integrated farming systems.* ***The electronic age farmer will have increased the use of information systems*** [underlined by us] *to guide crop selections and production decisions.* ***Computerized farm equipment using global positioning systems and remote sensing*** [underlined by us] *will facilitate precision farming with a greater reliance on environmentally benign fertilizers and pest control methods. In general, farm equipment will be less polluting, crops will be adapted to a wider range of climactic conditions, and farmers will produce a wider variety of food, fibre, energy, and crops for industrial use while using soils, water, and fertilizers efficiently."*

In this respect, gaining ability in new biotechnology and genetic engineering within the framework of South Eastern Anatolian Project should be considered together with the matter of gaining ability in information technology, in a systemic integrity. The success depends on this integrity.

Furthermore, Turkey has some facilities that should be used. As it is known that The Ministry of Agriculture and Rural Affairs have more than 50 research institutes scattered geographically all over the country. Similarly, there have been approximately 30 faculties of agricultural engineering and veterinary having a similar, scattered geographic allocation. In regard to these facilities, a convenient restructuring policy, to be designed and implemented in systemic approach, and that will particularly cover human resources management, networking and clustering, and funding, can create a huge potential in technology development and extension activities.

But, in order to be able to create ability in new biotechnology and genetic engineering on the concrete base of **South Eastern Anatolian Project** and to activate the existing facilities will depend on thinking with the terms of producing economy[8] and being able to create convenient climate for it.□

[8] "Agricultural research is also as much about development of industrial products such as printing ink from soybeans and other crops as it is about development of high-yielding wheat varieties" [USDA, 1998].

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