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CONSULTANCY AND ITS RELEVANCE TO BIOTECHNOLOGY IN INDIA

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ABSTRACT

Consultancy is usually understood to be a contractual relationship between a client and a consultant. Therefore such relationships are confidential in nature. Both clients and consultants have specific roles to play to make the consultancy work successfully. Clients should be satisfied from the work of the consultants in order to make the consultancy meaningful and purposeful. Consultants should create graceful interpersonal relationships with organisations to remain acceptable. For the consultants who are working on Public Interest Cause (PIC), there may not be any written contractual agreement between the consultants and the public. Successful consultations in public domain are seen as a creative endeavour emanating from the desire of the consultants to serve the public interest cause (PIC) in the most sincere way even though there may not be any pecuniary benefits. The reports of the consultants working for public interest cause (PIC) should add value and should have potential for wealth generation. Consultancy in biotechnology in the canvas of public interest cause requires vision and perspicacity. It is a phenomenon based on highly scientific skill. The base of background information plays a dominant role in such work.

The present Indian biotechnology industry will shift from a low-knowledge-content industry to a high-knowledge-content one, if it aims to be successful in competition in the market place. The present knowledge about the future markets is inadequate, and the future itself is uncertain. Meaningful forecasting of future markets would require profound knowledge about the local situation, the world trend in scientific developments and the likely trends of change in future in markets, environment, society and politics.

Professional consultants would have enormous scope to work on a wider canvas; these would include exploiting opportunities of investment already existing, identifying and prioritising research areas on the basis of market needs, methods applied for strengthening multi-disciplinary research, incentives required to be provided to enable success in breakthrough research and in setting standards for the safe use of genetically modified organisms in research and applications. Using the reports of successful consultants, the country, the society, the State and the policy-makers would be able to intervene or take measures to promote specific areas in research or applications for the betterment of the country.

Views expressed in this paper are personal and these have nothing to do with the organisation to which the author belongs.

INTRODUCTION

Consultancy is usually understood to be a contractual relationship between a client and a consultant. Consultants are advisers who provide advice to organisations on contractual terms. Technical consultants can be engineers, scientists, project managers, information technologists, operations experts, plant designers, plant trouble-shooters, materials and energy savers and the like. All such consultants can be collectively called as the management consultants, because such consultants are primarily engaged in providing services to the organisations in connection with the latter's management either directly or indirectly. In practical life, technical consultants are being addressed also as consulting scientists, consulting engineers or simply as consultants. However, the term here has been used simply as the consultants.

Consultants provide service or render advice relating to new business plans, conceptualising new ideas or upgrading the current working system of organisations in their diverse facets. Technical consultants with strong background of or exposure to accounting, economics, marketing, jurisprudence or Intellectual Property Rights (IPR) make excellent experts to provide advice to commercial organisations in diverse specialised areas, but their primary specialisation remains sharply focussed in specific technical branches or disciplines. There is a wide range of literature on how private consultants function¹⁻¹⁰. The consultants may also work in areas of public interest cause, and in such situations the work can have direct relevance to the people and the country. While working on public interest cause, they may study current or near futuristic situations in diverse areas of public interest, and suggest courses of action with a view to benefit the public.

BROAD FEATURES OF PRIVATE CONSULTANCY

Usually consultancy is between two private individuals or organisations, and therefore, the contractual relationship is substantially confidential. Confidentiality precludes the consultants from dealing with the contractual work of similar nature of an existing client with another client. Consultants should be committed to serve the interest of their clients. Through contractual arrangements, the broad and specific details of any consultancy work brings out the job description, the working arrangements, the manner of handling results of the consultancy work, the scope of sharing the results of consultancy work between the client and the consultant including any consequent publications that may emerge from the work, the time-frame of the assignment, the manner of settling of disputes, and finally the fee or honorarium for the consultant.

The cost of consultation also covers the manner of making payments; as far as possible the broad basis of charging the client by the consultant can also be documented in the contract. The consultancy process includes the steps of making a proposal to a client or getting one from the latter, setting out and freezing the terms of the contract, accepting the consultancy job, gathering information, identifying and analysing the problems, setting objectives and work plan, working one or more solutions to the

problems, evaluating the merits and demerits of each solution in the context of client's broad requirements and capabilities, choosing or recommending the best options, working out plan of actions to implement the recommended options, submitting the first report followed by a final report, and lastly disengaging himself from the targeted consultancy job.

CLIENTS' ROLE

Before engaging a consultant, an existing organisation (client) should ascertain very correctly the current state of its business including its products, technologies, personnel, markets and financial health. It is also useful to have some critical analysis made internally to identify the issues that are bothering the existing set-up of business. The existing problems should be described factually rather than through guesswork. If good homework is done, it is anticipated that the consultants to be engaged can be very precisely told to find solutions to those problems which are bothering the organisation most, and where the organisation is looking for a solution.

The problems can be in technologies, products, markets, suppliers, customers, public perception of the business, political environment or new business proposals. While selecting a consultant, the clients must identify internally the essential problems, work on the approaches for finding a solution, prepare the criteria for evaluation of solutions, organise procedures for the resolution of the queries, float tenders to receive consultancy proposals and evaluate these against the evaluation criteria. The client also will shortlist the bidders, organise discussions and presentations, prepare additional questions or organise more presentations, narrow down the prospected bidders, discuss financial terms, negotiate the contractual terms alongwith financial commitments and time-frame of completion, and finally place the order with the chosen best consultant¹.

While choosing a consultant, besides broadly satisfying about their abilities to complete the job, due consideration should be given to the past credentials, accreditation, references, biodata of the working team, culture and compatibility of the consultants, assessment of financial and technical resourcefulness, timetable, progress measurement methods, approaches and methodologies being adopted to the problem, and finally the process of reporting the progress. It is important to state here that in a successful consultancy, the vigilance of the client in each stage of the project is as important as the inputs of the appointed consultants. The consultancy work needs to be meticulously monitored periodically and to take corrective steps with mutual consultation without substantially enlarging the terms of the contract.

Finally, when the contract of the consultancy is over, there has to be an evaluation about whether the consultant's report has delivered the requirement of the client, and whether the report clearly addresses the recommendations that are implementable and are to benefit the organisation. Even if the report does not adequately address the problems or if the solutions suggested are not appropriate, it is wiser to close the contract and settle the deal than to prolong it and make the client more dependent on the

consultant. There is always a better solution to any problem than what is presently available. Therefore, if the report is not satisfying or is not acceptable, new consultants could be looked for or new strategies could be adopted. The next time is always a better time than the last time, as the next time leaps from the springboard of the past experience.

IMPORTANCE OF PRIVATE CONSULTANCY

Our present society is characterised by accelerating technological change, new scientific discoveries and increased local competitiveness followed by fast globalisation and, therefore, increased international competition. In such a society, consultancy in industry has grown from utter necessity. The necessity is to keep pace with the speed of change, products and process obsolescence, retain competitiveness or catch up the global competition. Top managers have kept themselves open to innovations and new ideas, to remain world class in business competitiveness. In such an endeavour, the successful consultants have been playing the role of transporting new knowledge to the top executives.

Updating of knowledge and sharing of contemporary knowledge, followed by technology upgradation, accelerated through the aid of the able consultants becomes useful and productive to successful organisations. This is because acceptance and implementation of high standards in setting quality or in maintaining high minimum benchmarking standards in operations, flowing top-down is always more effective in keeping the organisations healthier. Productive consultants thus play an important role in keeping the top brass of productive management current, creative and adoptive to useful changes. Successful consultants are therefore required to be highly skilful and should have manifest ability to create most graceful interpersonal relationships with organisations to remain acceptable. Further, they develop abilities to provide practical solutions to problems to make the clients feel satisfied that the latter have gained from the consultancy.

Consequently, consultants acquire the abilities to educate their clients, as clients are seeking the transfer of sharper skills and improved knowledge into their set-up. In extreme cases, knowledge and skills acquired can be totally new to the organisations. Proficient consultants are, therefore, generally well ahead of the existing knowledge, skills and foresightedness of the clients. A good consultant, dealing with the trouble-shooting of the clients has to be a good diagnostician too, as he has to have the abilities to recognise the symptoms and understand the root cause of the problem. If the problem is well recognised, seeking solutions are greatly facilitated²⁻⁶.

PIC-CONSULTANTS

When consultants work for furthering public interest cause, no written contractual agreement may exist between the consultants and the public. The information brought out voluntarily through the reports of consultants in such situations are meant for the

public and are, therefore, not confidential. For such reports, the consultants may or may not be paid for. However, professional PIC-consultants have to have a strong self-regulation. Such self-regulation would require following a minimum code of conduct. A self-regulated consultant must uphold and advance the standards of consultancy. Consultation in the public domain must lead to value addition to the public interest cause. The consultants should therefore endeavour to maintain the highest standards of competence and integrity.

The outcome of consultancy for public cause should result in value addition to the public, and therefore to the country in some way. The consultants' reports should, therefore, be accurate, truthful, meaningful, innovative and informative. Such professional contributions should not be viewed as merely philanthropic, but as a creative endeavour emanating from the deep desire of the consultants to serve the public interest cause in the most sincere way. If these are not the grounds, then the contributions can be based on casual, inexact, non-innovative, stereotype reports and consequently these can be of limited or no worth.

CANVAS OF AND STEPS TOWARDS PIC-REPORTS

The conceptual working process of consultants or advisors working for public cause (PIC-consultants) has to concentrate on a creative consultancy canvas, which is different from private consultancy. Moreover, in such public consultancy work, the acceptability of the reports largely depend upon the enlightened public who include the entrepreneurs, the policy-makers, the promoters and the financiers of industries, besides the opinion-makers including the scientists, planners, academicians, senior bureaucrats, technologists and engineers. The conceptual working process, the canvas, the self-assessment of reports before release on specific logical criteria, and finally the rewards and benefits from such work has been depicted in the enclosed flow diagram (Fig. 1). The flow diagram is conceptual but the work plans are arranged on logical anticipation of events and milestones, and are expected to be useful.

An interactive relationship should exist between good public consultants and the receptive public. Here 'the public' includes, as stated earlier, the opinion-makers, the entrepreneurs, the existing industry, the promoters of industry, and the policy makers besides the common passive but receptive public. The products or what the public wants become the most important component of the canvas of consultants to work on. The products include products *per se* or services, for which considerable demand exists or demand can be created. Identification of products take into consideration the survey information already existing for other countries, the scientific and technological developments accessed through scientific literature, the intelligent assessment of the unmet needs of the target public, the local capabilities, the existing local infrastructure, the local skills and the local government regulations. Selection of products should take into account the potential for wealth generation, as without potential tangible benefits, there is little scope that the identified products would attract public attention. Indeed, public would not touch those products that do not have potentials for wealth creation.

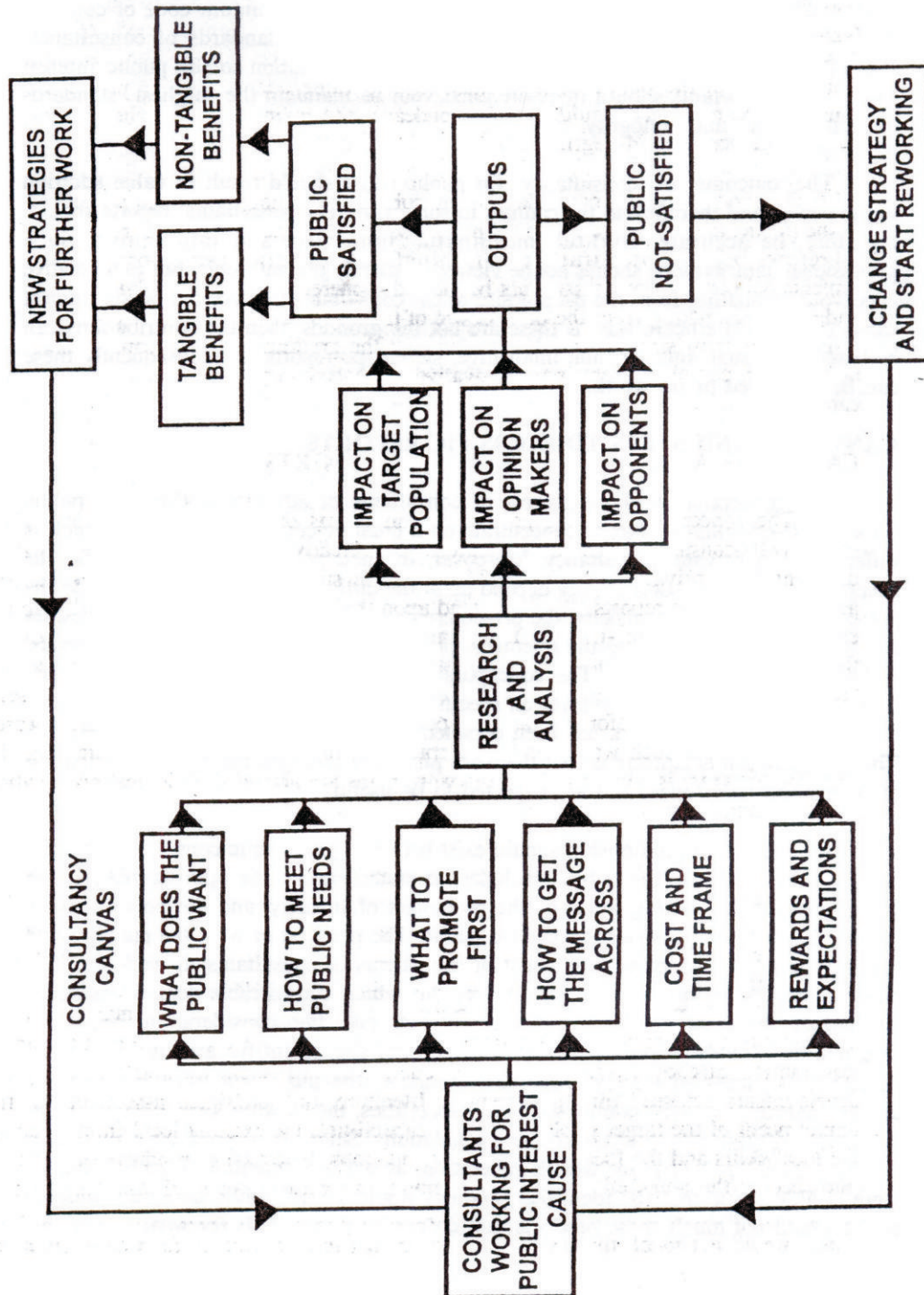


Figure 1 : Conceptual Flowsheet for Consultants Working for Public Interest Cause

Once products are identified and their requirements are projected, the next questions that arise are how to create the access of such products to the public at reasonable costs. Both the options of imports and local production should be viewed in this context with an open mind, with equal weightage to both the options so as to enable the common man to choose from what is more cost-effective to him. There could be situations, however, where preference to some options of supply may have to be accorded, taking into account other factors such as strategic considerations, use of local resources, utilisation of local labour, saving of non-replenishable natural resources, deliberate conservation of renewable forest resources etc. However, the bottom line is the cost competitiveness on international standards.

Once the products are identified, their requirements quantified and the priorities of exploring their exploitations are set by the consultants, taking into consideration all the necessary factors relevant to public interest cause or public priorities, it is necessary to take steps to promote the recommendations or findings through writings, advertisements, use of media, exhibits through posters and mailing materials to the opinion-makers or to the associations of industries. Speaking on learned platforms is another way of fast dissemination of information. Meeting the press and giving effective interviews to the journalists can also bring in faster visibility in promoting the transmission of the message, if there is enough news value in the consultancy reports.

The cost of the entire efforts must be reasonably worked out by the consultants alongwith a time-frame of completion of the task. The costs should be affordable, the time-frame reasonable and the PIC topics relevant and current or near futuristic. Intelligently with a cautious approach, the tangible as well as the intangible benefits should also be anticipated and quantified for self-reference. Usually in such work in the public domain, the tangible benefits are often inadequate, although intangible benefits are phenomenal. Consequently, the private consultants can use the public domain consultancy work to improve upon their public image, as this is expected to facilitate their receiving more private consultancy jobs. However, a living is often not assured by merely working on PIC-consultancy, as the monetary rewards are either very much delayed or may not accrue at all.

The authors against logical criteria must evaluate all public domain consultancy reports before these are released. One of the criteria of evaluation is based on the opinion of different cross-sections of the knowledgeable public. A set of good questionnaire could be devised, and opinion may be gathered either on the full report or on the well-summarised version. The key consumer segments of the public who are expected to use the report must be addressed in such evaluation system. Analysis of such feedback information and incorporation of corrective actions taken wherever feasible improves the value of the consultants' recommendations, once the reports are made public. Opinion of the correct cross-section of the opponents on the findings should also be given due consideration, because from such feed-backs useful clues for improvements are often received. Reports on PIC-consultancy should enrol people from different walks of life and they should directly be interested in furthering the cause of the findings

and recommendations of such reports. One test of success therefore is measured through more enrolments of people with time, with the contents of the consultancy reports. The enrolments could be measured through the receipt of acknowledgements, future referencing, correspondence etc.

PIC-CONSULTANCY IN BIOTECHNOLOGY

Consultancy in biotechnology in its several subsectors which fall within the public domain is rather a relatively new phenomenon in the developing countries. Biotechnology is based on highly scientific skill. Therefore, until and unless the basic scientific infrastructure including the availability of skilled manpower is in place, very little benefits can accrue from local production or local application of biotechnology. There has been general anticipation of expectations however by the public from the application of biotechnology by every country, and predictions have been made specially from the 'first world countries' that the next century would belong to biotechnology in the major facets of human activities including products in health care system, agriculture, environment management, industrial products and other specialised areas.

It is necessary at this stage to state what all activities are covered by the term biotechnology. Biotechnology encompasses techniques applied to living organisms or parts thereof to produce, identify or design substances, or to modify organisms for specific applications. Cell-fusion techniques, recombinant DNA technology, protein engineering and structure-based molecular design are considered as modern biotechnology, while simple fermentation-based activities, plant or animal cell culture, plants and animals breeding, isolation and use of materials from plants, animals and microbes etc. are considered as conventional biotechnology. Treating ores for benefaction by using microbes or concentrating toxic-ions by organisms are also considered as conventional biotechnology. Fig. 2 depicts the foundation of biotechnology and its broad present and future applications in industry the world-over.

STATUS OF BIOTECHNOLOGY APPLICATIONS IN INDIA

India has been practising conventional biotechnology for several years. The use of modern biotechnology products and processes in Indian industry is of recent origin and can be considered less than a decade old. Table 1 gives the past consumption of biotech products in India and the expected future requirements during 2000 AD and 2005 AD in monetary terms.

In Indian context, the human and animal health products would grow substantially in areas of recombinant DNA products used in therapy; there would be increase in the production of more effective vaccines and diagnostics; and larger facilities for the fractionation of blood into cellular products and non-cellular components would emerge. Among the conventional products, the production of antibiotics by fermentation will grow slowly but steadily. The above projections take these factors into consideration. In agriculture, major contribution is anticipated from the local production of increased

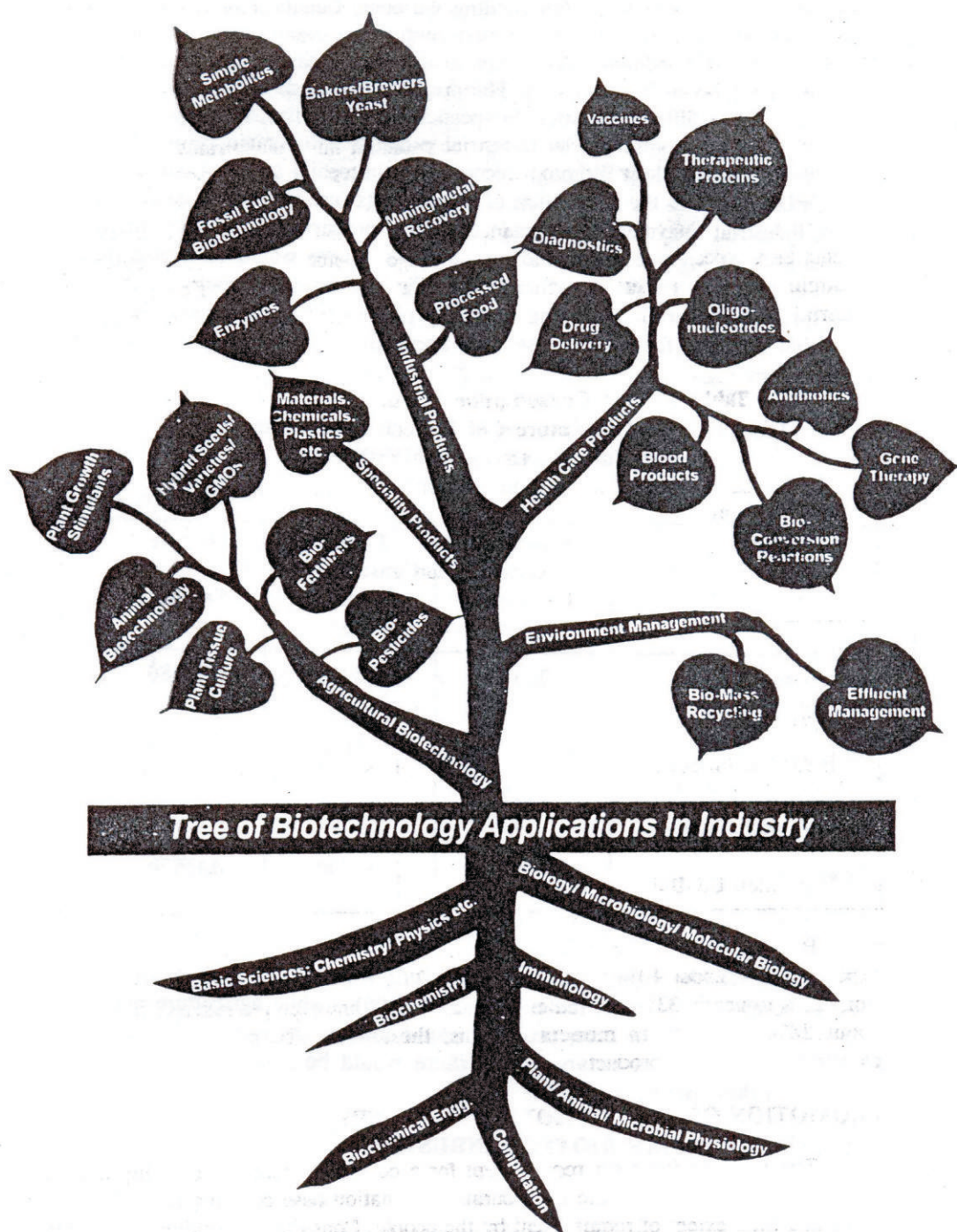


Figure 2 : Biotechnology Applications in Industry
(Conceptualised by the Author)

quantities of hybrid seeds and high-yielding varieties. Genetically modified plants/seeds are expected to emerge during the next century and would capture markets in specific sectors of seed industry. There would also be increase in the usage of bio-pesticides including botanical pesticides. The projections include besides hybrid seeds/varieties, plant tissue culture activities, bio-pesticides, bio-fertilizers and plant growth promoters. The sector represented by industrial products will remain primarily based on conventional biotechnology although recombinant microbial strains are expected to contribute substantially to the production of bio-catalysts (useful for complex chemical reactions), industrial enzymes, food-grade enzymes, production of simple microbial metabolites such as organic acids and amino acids. There would be a rise in the production of speciality enzymes and speciality oligo-nucleotides in molecular biology research, speciality materials including speciality plastics for specific uses, analytical materials and reagents for diverse use, and application of biological materials in electronic devices.

**Table 1 : Past Consumption of Biotech Products in India
and Future Consumption Estimates
(Rs. in Million)**

Particulars	Estimated Average Consumption 1997	Future Consumption Estimate 2000	Future Consumption Estimate 2005
Human and Animal Health Products	26370	35320	57480
Agriculture	20270	28880	47680
Industrial Products	24470	28500	36470
Other Biotech Products	430	1300	3970
Total	71540	94000	145870
In million US Dollars	1789	2186	3242

By 2005 AD, the comparative contributions from health care products are expected to be about 40% from the present 37% (1997), while agriculture may rise from 28% to nearly 33%; the other products would however get reduced from 35% to about 28%, although in monetary terms, there would be substantial rise in the consumption in these products, as well.

PROMOTION OF INDIAN BIOTECH INDUSTRY

The first and foremost requirement for a country to plan for entering into new industrial activities is to create an accurate information base covering identification of items and their extent of requirement by the people. Consultants working in the public

domain can work very effectively in this area, if they are conversant with the knowledge in other countries about the biotech products and processes utilised, or if they are familiar with the scientific and technological developments in biotechnology elsewhere. Such information base, along with familiarity with the factors that decide local requirements, can enable intelligent consultants to project the local requirements well in advance. If such information on identified products and their requirements worked on logical basis are available to the planners in the country, much proactive planning can be done by countries by using such information. The proactive planning includes creating infrastructure, skilled manpower, research base, conducive industrial policy, fiscal policies and other interventions which can help to move a country in the direction of creating prosperity by the application of biotechnology.

In this paper, an effort has been made to identify some biotechnology-derived products and their requirements during the next five years, so as to enable the people of the country to work further to decide on steps to be taken to enable the country to provide access to these products in their diverse use. The projections have been made based on trend analysis where past consumption existed, analysis of requirements of public in the context of their unmet needs, purchasing power of the people, the prices at which the products could be offered, the quantum of target population for specific products, the present technological base and the current capabilities of the country. The projections are objectively worked out, although the subjective assumptions and their limitations cannot be ruled out. However, as no such projection exist presently for the products in India, the figures would trigger a strong debate that would enable the country to emerge with more precision. Table 2 gives the quantitative future demand of selected biotech products during 2000 and 2005 AD. The products cover human health, agriculture, industrial products and other specialised products. Evincing interest in these studies from different angle by different classes of people to create wealth for the country is one of the aim of these projections. It is believed that if more people are enrolled in this subject, the results are expected to be productive. In this context also, the roles of consultants promoting these areas are foreseen as brighter. Near futuristic investment possibilities exist in many of these areas.

Table 2 : Demand Estimates of Selected Biotech Products

Products category and Products with measuring units		Estimated Consumption 1997	Estimated Demand 2000	Estimated Demand 2005
A. Animal and Health Care Products				
<i>Vaccines (Million doses)</i>				
1.	DPT	110	114	124
2.	DT	54	57	65
3.	Tetanus Toxoid	192	200	222

Products category and Products with measuring units		Estimated Consumption 1997	Estimated Demand 2000	Estimated Demand 2005
4.	BCG	41	43	47
5.	Oral Polio	110	160	225
6.	Measles	25	32	45
7.	Measles, Mumps, Rubella	7	8	10
8.	Hepatitis B Vaccine	7	18	45
9.	Rabies (Tissue culture based)	5	7	12
10.	Typhoid (Injectable)	0.4	0.8	2.5
<i>Diagnostics (Million tests)</i>				
11.	Early pregnancy	12	23	37
12.	Ovulation	2	4	8
13.	Estimation of T3, T4 and TSH	5	14	42
14.	HIV infection	9	17	27
15.	HBV infection	20	33	53
16.	HCV infection	3	8	12
17.	Rheumatoid diseases/disorders	0.4	0.5	1
18.	Cancer (cervix, colon, prostate, lungs, mouth etc.)	0.5	1	2
19.	Kidney function tests	34	52	104
20.	Liver function tests	35	58	116
<i>Therapeutic Recombinant Proteins</i>				
21.	Human Insulin (kgs.)	95	110	270
22.	Erythropoietin (gms.)	1500	2000	4000
23.	Interferons (million doses)	0.2	0.5	2
24.	Streptokinase (million doses)	0.5	1.5	3
<i>Antibiotics</i>				
25.	Penicillin G and V Ist crystals (MMU)	4100	6300	6300
26.	Rifampicin (tones)	260	300	380
27.	Salinomycin (tones)	80	90	110
28.	Tetracyclines (tones)	510	500	480
29.	Erythromycin (tones)	120	150	220
<i>Vitamins</i>				
30.	Vitamins B-12 (kgs.)	570	660	850
31.	Vitamins C (tones)	1200	1600	2500

Products category and Products with measuring units	Estimated Consumption 1997	Estimated Demand 2000	Estimated Demand 2005
B. Agriculture			
<i>High yielding hybrids (HYV) / Varieties (VAR) / Genetically modified seeds (GMS) (in 1000 tones)</i>			
32. Wheat	207(VAR)	220(VAR) 2(HYV)	250(VAR) 5(HYV)
33. Rice	155(VAR)	165(VAR) 1.6(HYV)	191(VAR) 2(HYV)
34. Sorghum	21(HYV) 21(VAR)	22.3(HYV) 22.3(VAR)	26(HYV) 26(VAR)
35. Pearl Millet	20(VAR)	21.2(VAR)	24.6(VAR)
36. Maize/Corn	5.2(HYV) 10.4(VAR)	5.5(HYV) 11.0(VAR)	5.0(HYV) 12.(VAR) 20(GMS)
37. Pulses (mainly peas and grams)	42.5(VAR)	45.1(VAR)	51(VAR)
38. Groundnut	78(VAR)	82.8(VAR)	95.6(VAR)
39. Mustard/Rapeseed	8.3(VAR)	8.8(VAR)	10(VAR) 2(GMS)
40. Soybean	31(VAR)	32.9(VAR)	38(VAR) 2(GMS)
41. Sunflower	6.2(VAR)	6.6(VAR)	7.7(VAR)
42. Cotton	12.4(HYV) 13.5(VAR)	13.2(HYV) 14.3(VAR)	7.5(HYV) 14(VAR) 10(GMS)
<i>Bio-fertilizers (Tonnes)</i>			
43. Rhizobium	5000	5500	6700
44. Azospirillum	3470	3500	5800
45. Azotobacter	2000	2200	2400
<i>Bio-pesticides</i>			
46. Bacillus thuringiensis (tones)	40	120	200
<i>Growth promoters / stimulants</i>			
47. Gibberillic acid (kgs.)	7000	15000	30000

Products category and Products with measuring units		Estimated Consumption 1997	Estimated Demand 2000	Estimated Demand 2005
C. Industrial products				
<i>Enzymes</i>				
48.	Industrial Enzymes (million rupees)	600	800	1300
<i>Organic acids / Amino acids (Tonnes)</i>				
49.	Lactic acids	1000	1160	1500
50.	Citric acids	11000	13000	16000
51.	Sodium Glutamate	1500	1700	2200
52.	L-lysine	1000	1200	1500
<i>Yeast / Yeast products</i>				
53.	Bakers and Brewers Yeast (tonnes of compressed fresh yeast)	22000	32000	45000

Among the health care products, there is immediate demand for cocktail vaccines of DPT with hepatitis B, hepatitis A with B, injectable polio vaccine, influenza, vericella and meningitis vaccines: technical solutions exist in all these areas and can be gainfully exploited. There is need for increased availability of typhoid vaccine. There is an unmet demand for several animal and poultry vaccines. It is roughly estimated that investment to the tune of Rs. 300 to 400 million can come in vaccines area during the next five years if local opportunities are availed of.

Disease diagnostic area is growing fast, although the country has kept investment opportunities for production neglected. Most of the diagnostic products are imported and used although local skills could be sharpened and used as competitive global advantage. Diagnostics based on monoclonals, synthetic peptides and recombinant antigens or antibodies could be made locally, as skills exist; the requirement of membranes could be met from local sources by providing encouragement to the skilful local producers. The requirement of speciality plastics could also be met from local capabilities. The intervention in policies could play a vital role in developing this industry locally. With a little readjustment, it is possible to create investment to the tune of over Rs. 500 million in diagnostic business in next five years to create a globally competitive local industry.

The area of production of therapeutic recombinant proteins is growing locally, but the speed of development is slow. Local skills can be sharpened, and with the

removal of certain impediments it is possible to create a viable and globally competitive industry in India, and investment to the tune of Rs. 0.8 to 1.00 billion could be attracted. In antibiotics area, opportunities for future investment is not bright, specially keeping in view the core competence of some Asian countries, and the policies adopted by such countries to push their products globally. However, in order to protect the local industry on scientific considerations such as maintenance of high quality standards effected by vigilant and authoritative monitoring, and introduction of stringent procedures for registration of products, it is possible to create environment for further growth of antibiotics industry locally. If such considerations are brought into play, it should be possible to induct fresh investment to the tune of over Rs. 1 billion during the next five years, besides reassuring the survival of local antibiotic industry.

In addition to the above areas, in the healthcare products sector, there exists opportunities for fresh investment in setting up facilities for the fractionation of blood products into cellular and non-cellular components, production of monoclonals, sensitised immunoglobulins peptides and effective biotechnological drug delivery systems for which over Rs. 1 billion could be invested for creating local production facilities.

Agriculture is going to be another important area for large future investment. Seeds industry alone holds possibilities of investing over Rs. 1.5 billion in another five years. Concomitantly opportunities exist for new investment in bio-fertilizers (over Rs. 200 million), biopesticides (about Rs. 300 million), pheromones, growth stimulants/promoters (over Rs. 500 million) and botanical pesticides.

Among the industrial products, new investment opportunities are foreseen in industrial enzymes (over Rs. 500 million) and in amino acids production where investment of over Rs. 700 million can come up to meet not only local needs but to cater to the export needs also. In the area of bakers and brewers yeast, opportunities for production of fresh compressed yeast do not presently exist but production of value-added NAD/NADH and speciality enzymes could be explored by using the locally available compressed yeast. In addition to the above areas of investment, there exist reasonable scope for setting up facilities for the recovery of value-added products from wastes such as proteins from milk whey, bio-gas and composted fertilizers from municipal or agricultural wastes, better methods of recycling of organic wastes, production of speciality bio-chemicals, speciality plastics that are bio-degradable etc. Opportunities thoughtfully explored can provide avenues for investment of over Rs. 1 billion in these areas too.

In summation, therefore, it can be stated that over the next five years, possibilities could be created for fresh investment of Rs. 7 to 8 billion in India that hold the promise of changing the biotech production scenario considerably. Such quantum of fresh investment if materialised, would hold the potential of providing turnover of Rs. 9 to 10 billion during the next 5 to 7 years, that could contribute towards import substitution, augmentation of local production and introduction of some new products in the global market. Consultants working for both private and public cause can certainly therefore flourish in the present context in India.

PIC-CONSULTANCY IN BIOTECHNOLOGY IN INDIA

The present Indian biotechnology industry will shift from a low-knowledge content industry to a high-knowledge content one in order to achieve market success, as the competitive advantage will come from high contents of skills and scientific base. The content of technology will be counted as indicators for sustenance, success and development in the market place. The products would be markets driven. The present knowledge about the future markets is inadequate. The predictions in different facets would require profound knowledge about the local situation, the world trend in scientific developments and the likely trends of change in future in the local markets, environment, societies and politics. The growing global population with reducing natural resources would create demand for biotechnology the world over, and the ripples would be profoundly felt in India as well.

India is anticipated to become a country beset with a population explosion, estimated at 1.5 billion persons after 40 years from today. Presently nearly 300 million Indians are malnourished and two-third of the Indian children are under-weight. The Indian productivity in agriculture is also low and is substantially dependent upon the mercy of monsoon; the agricultural land is also shrinking, the availability of water for agriculture is not substantially increasing, the stress factors (biotic and abiotic) are high and the present methods of storage and transportation of food-grains result in substantial losses. In all these areas biotechnology holds potential for increasing the productivity and for improving the existing practices.

In health care area, recombinant proteins hold the potential of saving or prolonging lives in situations, which were not possible earlier. For example in certain types of viral infections, as also in certain types of cancer, life can be prolonged considerably by the use of certain cytokines. In some life threatening systemic fungal infections, using liposomal polyene antibiotics can cure patients. Dissolving the clots by using effective thrombolytic proteins can clear heart attacks caused by thrombosis. All such therapies are the gifts of the recent time to mankind from biotechnology. Biotechnology would also guarantee a greener environment. Application of biotechnology is generally scale neutral.

Professional consultants would have enormous scope on a wide canvas to work on. Public cause consultancy would flourish in several areas such as in identifying and prioritising research areas on market need basis, in focussing the needs and the methods applied for strengthening multi-disciplinary research in institutions and industry, the necessity for and the manner of providing incentives to enable success in break-through research, identifying and ranking the policies to be adopted in intellectual property protection, the methods of recognising the innovators and speeding up the innovations, and lastly the needs for and the methods of setting standards for the safe use of genetically modified organisms in research and applications.

Predictions in information flow based on studies on biological processes and

biological systems; synthesising complex materials by recombinant DNA technology; designing and developing genetically engineered micro-organisms, plants, animals, tissues and cells for a wide range of conditions; use of enzymes for the catalysis of a large spectra of chemical reactions; and production of biopolymers using biological systems are some of the near futuristic biotechnological developmental perspectives where inroads can be made by researching by the public domain consultants in identifying, indexing and prioritising developmental work in these areas. Investments can also be made by inducting technologies where products and processes are available for purchase. A close look on the international development through information sources or first hand visits to the production sites would prove useful. In brief, information in all these facets is of vital importance for future developments. No effective report exists today in these areas and therefore, the consultant's reports could make a difference in perception for the country.

The consequence could be a deliberate channelization of resources at national level with the objective of making a technological difference in near future.

STATE AND THE PROMOTION OF PIC-CONSULTANCY

India is endowed with vast natural resources of biodiversity and has a large pool of talented people, trained in biotechnology. Union Government through the creation of the Department of Biotechnology (DBT) in February 1986 had a reinstated the firm commitment of the government to promote biotechnology in the country to generate skills and innovativeness. It is also promoting the generation, protection and promotion of biotechnologies in all facets including health care products, agriculture, industry and environmental management.

Several institutionally developed technologies have been protected by patenting and many others have been transferred to the industry. The DBT has been mandated to promote the creation of skilled manpower, support of research and setting up of R&D infrastructure, promotion of industries and creation of environment for the safe use of genetically modified organisms. Upto 31.03.1998, the DBT has spent over Rs. 8 billions¹² under various heads (Table 3).

**Table 3 : Expenses incurred by the Department of Biotechnology,
Government of India, from 1987-88 to 1997-98
(Rs. in millions)**

Head of Expenditure	Amount	% of Total Amount
Human Resource Development	699.4	8.7
R & D Infrastructure Development	2048.3	25.6
Extramural R & D Support	5265.7	65.7
Total	8013.4	100

In order to promote consultancy, DBT had been instrumental to the creation of Biotech Consortium India Limited (BCIL) with the active participation of the financial institutions and the industry. BCIL has been offering consultancy services to the industry in all facets of biotechnology promotion. Through the creation of the Technology Development Board (TDB) in the Department of Science and Technology of the Ministry of Science and Technology, mechanisms have been created to promote venture capital companies in sectors of industrial development including biotechnology. The TDB has drawn considerably from the expertise of the DBT officials in assessing projects in the area of biotechnology for funding supports, with a view to setting up new production facilities. The emergence of M/s Shantha Biotechniques Pvt. Limited, Hyderabad and M/s Bharat Biotech Limited, Hyderabad are glaring examples.

The other scientific departments within the government such as the Department of Science and Technology, Department of Scientific and Industrial Research, Council of Scientific and Industrial Research, Indian Council of Medical Research, Indian Council of Agriculture Research etc., the Ministry of Human Resource Development, the Ministry of Environment and Forests, the Ministry of Mines and Metals and the Ministry of Food Processing Industries have also programmes of supporting the cause of development of biotechnologies in its diverse facets, with DBT playing the leading role of promotion. All these efforts of the government have brought in considerable awareness and commitment within the country for reaping benefits from the use of biotechnology.

However, there appears to be the need for much more research in channelling the efforts into more specific areas where Indian strength is more than others, or where Indian public needs solutions to their unmet needs where no significant research or developmental efforts exist internationally. Such areas could be identified in agriculture, health care, environment management, mining and industrial development. It is the identification, elaboration and concerted channeling of efforts in such areas that would make India distinct from others including the first world countries.

Consultants working in areas of public concern consultancy cause can make a dent by identifying such areas, and by working out the details to help the government to take proactive steps to enable the country to move ahead. Such significant efforts between the consultants with the government are foreseen as major possibilities for making the country distinctive and progressive in promoting biotechnology applications. The Technology Information Forecasting and Assessment Council (TIFAC) which produced some reports in the past have made some efforts in these directions, which were indeed very useful. But in the dynamic world situation where knowledge is continuously being created, there is always a need for being updated, and review the past recommendations in the light of new developments.

It is foreseen in this context that situations could be created by the government to continuously involve knowledgeable people or groups for obtaining guidance for creating directions in all aspects of biotechnology including policy matters, research

and development, setting up of industries or working in strategic areas through consultancy between such people working for public interest cause, and the government.

CONCLUDING REMARKS

Private consultancy is a contractual relationship between a client and a consultant; consequently such contracts are confidential in nature. Consultants working on public interest cause on the other hand dwell on areas of public concern; their reports are usually available to the public. Such reports can enable better insights into public goods or public cause. Using such reports the policy makers can intervene or take measures to promote specific areas in research or in applications by policy regulations.

Biotechnology industry is expected to make strong inroads in the economic development of countries in near future. India can reap more benefits from biotechnology by channelling its efforts in specific areas. In this direction, the consultants working for public cause could play a very positive and proactive role by preparing reports and making them available to the people. Based on such reports, policy interventions could be made to channel efforts in research and applications in specific directions to benefit the country. *

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* **Dedication** : The article is dedicated to Dr. S. Ramachandran, formerly Secretary, Department of Biotechnology, Government of India, who was my friend, philosopher and guide in biotechnology.

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