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Evolution of Biotechnology in India: (Re-) Emergent Form of Governance

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Abstract

Scientists often introduce metaphors and entities, carve out spaces and bring forth new technologies that either disrupt or exist outside the realms of existing structures of governance and statecraft. Knowledge production has a complicated relationship with social context, material condition and political mandate and vice versa. This paper enquires into the process of evolution of the biotechnological programme with the emergence of newer forms of governing structures and hierarchies in India. The paper engages with the archival records of forty years (from the mid-40s to mid-80s) related to the governance of biotechnology in the country. The paper observes the process of metaphor construction around biotechnological research, during three different phases of biotechnological interventions. These metaphors as technoscientific trope create the conditions for bureaucratic interactions, set agendas for the scientific programmes and national/international collaborations. By engaging with the textual nature of these interactions, the paper attempts to articulate the process of formalisation of the structure of governance for biotechnology in India. The paper utilises the theoretical framework of assemblage to articulate the evolving forms of biopolitics during various biotechnological epochs in the country.

Keywords: Biopolitics, History of biotechnology, Metaphors and Science, Governance

1 Introduction

This paper examines the process of historical evolution of the forms and structures of governance for biological entities with the emergence of the ‘biotechnology’ programme in India. By engaging with the materiality of archival documents from the mid-40s to mid-80s, the paper explores how the metaphor of ‘biotechnology’ was constructed. These records utilise biotechnology as a techno-scientific trope for creating meaning and urgencies for the interaction between various actors such as scientists and bureaucrats from national and international governing bodies. By engaging with the textual nature of these

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interactions, the metaphor of 'biotechnology' became central to set the tone of bureaucratic interactions, formulating a narrative of futuristic growth, setting the agenda for development and forging ties with international agencies. The entangled interaction between various social actors and material objects are mediated through metaphors, co-created agency, structures and the forms of politics and governance. These scientific advancements were entangled with socio-political norms and hierarchies. It facilitated the production of a new socio-political order and got (re)produced by the new social order and so on.

The production of knowledge would be fused with a material embodiment, social aggregations and organisational structure. The paper attempts to rearticulate the process of knowledge production in relationship with the policy mandate during three different epochs. It further enquiries into the process through which the evolution of the specific trajectory of biological research shaped the newer forms of governance or vice versa. The biotechnological research introduced the biopolitical gaze in the policy mandate. With the evolution of biotechnological research, the body in different forms became the site for state intervention and manifestation of power. Through sophisticated biotechnological tools and techniques, bodies were nominalised, stratified and regularised by the state. Through these three phases, the paper has attempted to understand the (re)emergence of biopolitical forms with the evolution of biotechnological advancements.

The entanglement between biotechnological advancements and the emergence of new forms of governance cannot be articulated by the traditional sociological or political sciences framework. The paper utilises the theoretical framework of assemblage to articulate the (re)emergence of newer forms of governance meshed with the biotechnological innovations. It does provide a vantage point to understand the complex historical interactions between social actors and material objects. It creates a lucid and over-encompassing space for the interactions between human and non-human agents. These interactions lead to the emergence of biopolitical forms, with the evolution of biotechnological tools and techniques.

The paper has relied on the theoretical framework of assemblage for the articulation of biopolitics and its relationship with biotechnological programmes during different phases. The framework has facilitated the theorisation of power relationships developed through

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diverse, ever-evolving, non-deterministic interactions taking place within the assemblage. The dynamics of these interactions within the assemblage were created by urgencies, crisis, solution, and power dynamics within its connectives (Rabinow, 2000). It has further assisted in developing an articulation about the ever-shifting power relationship, as a response to the dynamics of the assemblage. The dynamics of these interactions has further shaped the trajectory of the discipline in the country.

The paper is divided into four sections, focusing on three different phases of policy mandate related to the governance of biological entities. The second section of the paper focuses on the role of science and technology during the post-World War reconstruction phase of the colonial era. In 1943, A.V. Hill, a Nobel laureate and biological secretary of Royal Society, London, was invited by the British government ruling the Indian subcontinent. Prof. Hill was invited to provide consultancy on the status of science and technology in the country. For the section, the paper has relied on the archival records of the visit, reports and recommendations by A.V. Hill published by the Royal Society. It further explored the secondary material available on Hill's report on the status of science in the country (Hill, 1945, 1946). Hill's report was one of the first reports evaluating the status of science and technology in India. It further prescribed policy initiatives concerning reconstruction and future development of the country. Hill's recommendations were significantly responsible for the inception of biopolitics as a tool of governance in the country. Hill's recommendation argued for drawing the focus on body politics as a tool for reconstruction and governance.

For the third section, the paper focuses on the policy initiatives in the post-Independence era. It attempts to explore the linkages between the policy directives and the scientific discourse of that time. It enquiries into the role of emerging scientific tools and techniques, in shaping the biopolitical form of governance in India. During this phase, the mandate for science policy was set by the Department of Science and Technology (henceforth DST), a regulatory body for the governance of science and technology in the country. This section builds its understanding through keynote addresses by the Prime Minister, National Committee on Science and Technology and plenary sessions at Indian Science Congress that did provide reflections about the priorities set by the government for the biotechnological research, scientists and experts involved in biotechnological research and

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allied technologies. The phase had significance for 'scaling-up' the ontology of biotechnological programmes in the country.

The fourth section of the paper focuses on the inception of the Department of Biotechnology (henceforth DBT), a dedicated centralised governing body for the sector of biotechnology. As a material, the section has utilised the Report of the Working Group, constituted by the Planning Commission for the eighth five-year plan[1] (Report of the Working Group, 1989). It was a classified report. The report discusses the priorities set for the sector of biotechnology for the first five years. The formation of DBT was one of the significant landmarks in formalising a biopolitical institution in the country. The country got a centralised, dedicated department that set the mandate, regulated and controlled the biotechnological research initiatives.

2 Reconstruction Phase: Colonial Era, 'Quadrilateral Dilemma' and the Inception of Biopolitics

This paper intends to explore the forms of biopolitical initiatives in India with the evolutionary trajectories of biotechnological research in the country. The dynamics between humans and microbes has changed significantly after the discovery of microbial culture by Louis Pasteur and the discovery of enzymes from cell-free extract of yeast by Eduard Buchner (Demain, 2000; Ben-Menahem, 2009, pp. 2005-2008). Subsequent experiments explicated that these tiny little organisms were mediating various aspects of our day-to-day lives. From the fermentation of food and beverages to the production of life-threatening toxic chemicals, these organisms were found to be influencing our day-to-day processes of life. By the early twentieth century, occupations such as wine preparation, having involvement of microbes, got a makeover in their operational settings and found linkages with laboratories. India was not untouched with the transformations taking place in the west. Many Indian scientists were travelling to England for their higher

1. In India, national economic planning is done for every five years. It proposes an economic plan for the next five years, and after every five years, these plans are assessed by the Planning Commission of India.

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education, with a desire to replicate the success which they witnessed in the West in the Indian context (Parthasarathi, 1992; Burma, 2011).

Globally biochemistry was the precursor to modern biology and biotechnology. In general, biochemistry as a discipline tends to enquire into the chemical processes within life forms. Indian scientists trained in western institutions began to explore their spaces within the new biochemical paradigm. In the 1930s, a few of the prominent names who pioneered biochemical education and research in India were Biresh Chandra Guha from Calcutta University, V.K. Giri from Indian Institute of Science (henceforth IISc), Bangalore and M. Damodaran at Madras University (Ramasarma, 2007). Though Biresh Chandra Guha was considered as the father of biochemistry in India, yet his contemporaries were matching his steps in biochemical research on vitamins, nutrients, and so on (Chatterjee, 2004). As these individuals pioneered the field of biochemistry in India, most of these individuals were associated with the ‘first in India’ tag for their research in the discipline (Ramasarma, 2007); (Chatterjee, 2004). Hence, the initial phase of biochemistry was dedicated to the few interested individuals attempting to extend their expertise and research skills, which they honed during their education and training in the West.

Though these were fragmented efforts in the area of biochemistry, yet these individual efforts were labouring to replicate the western success in India. New institutions of biochemistry in the form of new departments/centres/chairs started getting recognition within the university premises. Institutes such as IISc, Calcutta University, and Madras University started courses in biochemistry. Still, the fragmented efforts had to rely on the dedication and drive of individual scientists to achieve the desired success in biochemistry. Except for a few committees, there was no coordinated effort from the government to regulate and support biochemical research in the country. Biochemical research, at that time, was lying at the periphery of the scientific discourse in the country (Burma, 2011). This scenario drastically changed after the arrival of Prof. A. V. Hill’s report.

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2.1 Quadrilateral Dilemma: Throwing the Spotlight on the Biological Crisis

During the early phase of the twentieth century, science was heavily linked with economic prosperity and political strength of the country. Scientific researchers were oriented to create new economic opportunities and resolve the bottlenecks in the existing arrangement. Hence, the role of scientists, scientific institutions, and policymakers started to become crucial in shaping the future trajectory of the country. One of the significant moves was the arrival of the biological secretary of the Royal Society, London and a Nobel laureate, A. V. Hill in India. Hill was invited in 1943 by the colonial government to provide consultancy on the status of science and technology in the country (Hill, 1945; Anon., 1946). The pressure was mounting on the colonial government from India for the post-World War reconstruction of the country. The context of the invitation to A.V. Hill had an undertone of post-World War reconstruction of a colony.

The Royal Society published a note saying ‘At the request of the Government of India (GOI), the council of the Society give permission for the biological secretary, Professor A.V.Hill to go to India and advise the government there on scientific matters (Visit to India by the Biological Secretary Notes & Records 4, 1946).’ In 1943, Hill was deputed in India for five months. During his visit, Hill met most of the prominent Indian scientists working in diverse scientific areas of research in the country. Hill pointed out four critical areas of immediate concern from the government. These four critical areas were population, nutrition, health and agriculture. He coined a new term to address these four critical areas collectively as a ‘Quadrilateral Dilemma’ (Kumar, 2008). The term Hill coined as ‘Quadrilateral Dilemma,’ created much stir in the policy circles. To find the solution for the perceived crisis, Hill recommended overhauling in the existing structure of governance for science and technology programmes in the country. He further argued for policy measures to bring biological beings and biological research to the centre of the scientific discourse.

The report further asked for a balance between market initiatives and state control. He argued for government support for scientific and technological research (Visvanathan, 1985). The state should balance between government support and government control over scientific research. Hill emphasised on the need for a centralised institution for planning and regulation. Hill’s recommendation led to the formation of the Department of Planning and Development (henceforth DPD), a centralised body which provided

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comprehensive planning, guidance and support to scientific research programmes. It led to the formation of six boards under the flagship of the department. These six autonomous research boards had their research focus on medicine, agriculture, natural resources, engineering industry and war (Visvanathan, 1985).

A. V. Hill's report was one of the significant moments in science policy, which emphasised the importance of biological research during the reconstruction phase. It created urgency around various aspects of life forms, nutrition, health, population, etc (Sinha, 2009). The biological crisis was given priority over the physical, chemical and infrastructure challenges in the country. Hill's report played the pivotal role in reorganising the fragmented research efforts by individual scientists researching in the areas of nutrition, biochemistry and health. Subsequently, life forms were brought under the microscope within the confinements of the laboratory. The Centre for Agriculture and Biosciences International (CABI) acknowledges the impact of Hill's report and describes it as a valuable report for the history of biology and agriculture in the country. It asserted that the people interested in understanding the history of plant breeding in India would always have a keen interest in Hill's report (Das, 2018).

2.2 Inception of Biopolitical Programmes: Indian Scenario

Many eminent historians of science have emphasised the impact of Hill's report on the governance of scientific institutions. Shiva Visvanathan and Deepak Kumar have extensively dealt with the consequences of Hill's recommendations. They further emphasised on the centralisation of the governance structure as one of the effects of the report (Kumar, 2008; Visvanathan, 1985). None of these works has elaborated on the biopolitical aspect of Hill's report. Hill has argued in his report that India should re-organise its policy framework to deal with the 'Quadrilateral Dilemma' (Kumar D., 2001). As Kumar argued, 'according to the Prof. A.V. Hill 'the fundamental problems of India were not really physical, chemical or technological, but a complex of biological ones referring to population, health, nutrition and agriculture all acting and reacting with another' (Kumar D., 2000).

The other significant shift was 'scientification' of the Indian policy discourse. During the first half of the twentieth century, 'Science' was considered to provide solutions for the

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abysmal socio-economic conditions in the country. Scientists were incorporated into prominent government positions to articulate solutions for the socio-economic crisis in the country. In 1944, B.C. Guha, a biochemical scientist, was appointed as technical advisor to the Food Department in GOI. He played a pivotal role in launching a nationwide nutritional survey in 1935. Till 1935, there was very little quantitative information about the nutritional status of the population. A central committee titled as the 'Indian Nutritional Committee' was formed and Guha was appointed as the convener and secretary of the committee. Under his leadership, a nutritional survey was conducted at different locations of the country (Sen, 2005). Simultaneously, the Indian Research Fund Association (now ICMR) also launched a 'Nutritional Advisor Committee' which was later recognised as 'National Nutritional Advisory Committee' (Patwardhan, 1947). Eventually, in 1944, two regional research units for nutritional research were established, one at Bombay (now Mumbai) and another one at Dacca (now Dhaka). These surveys were one of the first biopolitical interventions in which bodies were nominalised and stratified on the national scale.

The dominant discourse around nutritional research argued for the increment in the calorie content of an average Indian diet. A group of biochemists, including Guha, argued otherwise and staunchly stood for the nutritional balance in the average Indian food plate. As a technical advisor, Guha envisaged establishing a food technological research institute in the country. In 1950, The Council of Scientific and Industrial Research (CSIR) with assistance from the maharaja of Mysore established the Central Food Technological Research Institute (CFTRI) in Mysore. B.C. Guha was inducted in the executive council of the institute (Chatterjee, 2004). Apart from institutional development, the Nutritional Research Laboratory (NRL), Coonoor and All India Institute of Hygiene and Public Health (AIIHPH), Calcutta were providing training and short-term courses at their facilities from the early 1940s (Patwardhan, 1947). These efforts had emphasised the significance and urgency to take up biological research seriously in the country before Hill's arrival. Hill's report functioned as a stimulus, which streamlines the fragmented efforts under the flagship of DPD.

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2.3 Summary

Hill's report marked the urgency around the areas such as health, food and nutrition and brought the spotlight on the researchers, scientists, and practitioners working in the above-highlighted areas. These experts from different disciplines brought their practices, tools, methods and funding opportunities to form an interdisciplinary space. There was churning within the space to devise possible solutions for the 'Quadrilateral Dilemma (Kumar, 2008).' The interdisciplinary space was formed by an assemblage of experts from diverse fields such as physiologists, nutritionists, agriculturists, biochemists and bureaucrats. All of them had oriented themselves to the pursuit of solutions for the biological crisis mentioned in Hill's report (Visvanathan, 1985). The metaphor of 'Quadrilateral Dilemma' oriented the science-policy framework for the next four decades. The interdisciplinary space created an assemblage facilitating all kinds of subject and object interactions. These interactions were non-deterministic and minor. The trajectory of the discipline was determined by the location of actors and their interactions within the assemblage.

With the emergence of novel techniques of biochemistry, with higher predictive success, biochemistry dominated the assemblage of interdisciplinary space that was looking for solutions. Various institutes started introducing new departments, centres, chairs and courses in biochemistry. The rise of biochemistry as a discipline paved the way for the (re)production of a new socio-political aggregation. Hill's recommendation catalysed the emergence of new social aggregation. The focus on biological research brought the focus on the body as a site for intervention and governance. In this sense, the interdisciplinary space of biochemistry formed an assemblage of smooth connectives. As American anthropologist Paul Robinow argues, an assemblage would emerge out of a much smaller decision, a decision that was not sure of their conditions, not wholly determined. The new social aggregation catalysed existing actors, things, and institutions into a new mode of existence in the new assemblages (Rabinow, 2000). The new social structure and hierarchies in subsequent times created conditions for the emergence of newer (biopolitical) forms of governance.

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3. Department of Science and Technology: 'Scale-Up' Era and the Steering Committees

3.1 Scale-Up

In the post-Independence scenario, the legacy of Hill's recommendation is reflected in the structures of governance in succeeding years. Due to the impact of Hill's emphasis, centralised planning, control and power became the hallmark of Indian science policy in the post-Independence era. Those six boards formed under the flagship of DPD were transformed into formal governing bodies in the form of councils and departments. The Indian Council for Medical Research (henceforth ICMR), and Indian Council for Agricultural Research (henceforth ICAR) were providing centralised funding and control for the agricultural and health care research in the country (Visvanathan, 1985).

This philosophy of central planning and funding laid the ground for a large scale revolution in the field of agriculture and food security. During the decades of the 50s and the 60s, the country witnessed extreme government interventions in the areas of agriculture, food and nutrition. These interventions cumulated into large scale programmes in the field of agriculture and dairy production as 'Green Revolution'[1] and 'White Revolution'[2]. One of the primary focuses of these programmes was to gain knowledge about the hybrid variety of seeds, development of chemical fertilisers and register best practices for the selected crops in the country (Chakravarti, 1973). In the wake of extensive centralised planning and control, local practices were neglected and excluded from the whole process.

This negligence of local practices and local knowledge emerged as one of the most substantial criticisms of these two large scale government programmes (Singh, 2004). These programmes were case study examples of the Foucauldian relationship between 'knowledge' and 'power'. All critical decisions from crop choices, seed procurement,

1. Worldwide, the Green Revolution was aimed to increase agricultural yields. In the 1960s, India for the first time introduced hybrid seeds, coupled with improved systems of irrigation, and the introduction of chemical fertilisers to increase the yield of average Indian farmers.

2. The National Dairy Development Board launched a project to overhaul the dairy production in the country in the 1970s. Within a few years of the project, India went from being a milk deficient nation to become a milk surplus nation in the world.

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agricultural practices, and cultivation processes had central control and regulation by the state or by its allied institutions. Despite the criticism, the large scale initiatives in the area of food and agriculture such as ‘Green Revolution’ and ‘White Revolution’ partially resolved the food and nutritional crisis in the country.

Apart from centralisation, these large-scale revolutions in the field of agriculture changed the cropping pattern in the country. The High Yielding Variety-Seeds Programme (HYVP) had its focus on a bunch of crops. In the long run, very few crops such as wheat, rice and jowar (sorghum), showed a steep growth under the programme (Dhanagare, 1987). It pushed millets (regional crops) outside the food plate of the average Indian consumers (Singh, 2004; Chakravarti, 1973). Another government programme that affected the production and consumption of an average Indian household was the Public Distribution System. Through PDS, the government procured specific crops from the farmers and distributed them to the masses through fair price shops (Mooij, 1994). The scheme providing food security was conceived under the Essential Commodity Act 1955 (India, 1955). The government procures a few food items, like wheat, rice, edible oil and sugar, in a large quantity for distribution. PDS further marginalised the regional crops with its procurement policy.

The scaling up interventions in the field of agriculture opened up space for chemical engineers to intervene and set up food processing units, sugar mills and edible oil refineries in various parts of the country. The knowledge and expertise gained in the areas of biochemistry and biochemical engineering provided an external push to pursue research in the areas of food processing and fermentation technology. These developments introduced chemical engineers to food-based industries and evolved Biochemical Engineering as a separate engineering discipline. The introduction of Chemical Engineering brought the research focus to the ‘scaling-up’ of biochemical practices.

In India, engineering education under Biochemical Engineering was part of the final year elective or specialisation in the discipline of Chemical Engineering from 1952-63. Till 1963, there was no separate bachelor's programme in Biochemical Engineering. Three significant institutes and universities, namely Jadavpur University, Kolkata, Harcourt Butler Technical Institute (now HBTU), Kanpur and University Department of Chemical

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Technology (now ICT), Mumbai offered a full-fledged bachelors degree in technology in food and fermentation technology/biochemical engineering from 1963-1965 (T. K. Ghose, 1979); Department of Food Engineering and Technology, ICT, (Mumbai, 2019). All three institutes and universities have the legacy of providing engineering education from the colonial era. At the same time, the University Grants Commission (UGC) Committee on Biochemistry was formed under the leadership of B.C. Guha in 1959. The UGC Committee aimed to promote biochemical education and research in the university space. It was the untimely death of Prof. Guha in 1962 that hindered the pace of the process.

Technological creativity and institutional support in the areas of life sciences have ushered in new possibilities. Now, the manipulation of the life forms was not limited to searching for solutions for the 'Quadrilateral Dilemma' or nutritional crisis. It has instead created solutions in new avenues of life. These new movements in biochemical technologies were strengthened by the newly introduced molecular techniques in biology. The manipulation of life forms was linked with national progress and economic growth. Now, the life forms were trained to 'scale-up' to extract more significant economic benefits. These programmes have 'scaled-up' the ontology of the biological programmes.

3.2 The Steering Committees and Bureaucracy

This section emphasises the role of bureaucracy and governance during the 70s and early 80s. These were the years when most of the funds for research came from the GOI. Private participation in research was almost abysmal. Hence, the government had significant stakes in decision making. Therefore, the role of bureaucrats became very significant in shaping the trajectory of the discipline. There was no dedicated institutional mechanism in the government to respond to the developmental aspirations of biotechnology research in the country. Biotechnological programmes were supported and regulated through 'steering committees'. There were steering committees under the DST, a centralised governing body commissioned in 1973 for laying policy measures, execution and controlling scientific programmes in the country. Some of these committees were either issue-based or interest-based bodies such as 'steering committee' on the '*Fuels from Biomass'* programme (IIT, 1980). In the wake of such structural constraints, the interest of the government, the interest of a particular bureaucrat and his approach towards a particular issue became an important factor in decision making (T. K. Ghose, 1979).

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One of the significant reflections about the government's expectations from scientists can be drawn from the keynote address by the then Prime Minister Mrs Indira Gandhi at the 63rd Indian Science Congress held at Vishakhapatnam in 1976. The congress was headed by Dr. M.S. Swaminathan, one of the architects of the HYVP programme in the Green Revolution. It was for the first time since its inception that the Indian Science Congress adopted a focal theme relevant to the national interest. Rural development was the focal theme for the 63rd congress. Mrs. Gandhi, the keynote speaker, in her inaugural address emphasised on the significance of the rural turn in scientific policy discourse (Titus, 1976; Agarwal, 1976). The Green Revolution and government-directed interventions introduced energy-intensive agricultural technologies and practices in rural India. It was the call for the scientific community to explore the possibilities of decentralised energy resources for rural India. A few non-conventional energy themes, solar energy, wind energy and bioconversion echoed in the plenary sessions. In 1977, N.M. Swani from the Indian Institute of Technology Delhi (henceforth IIT Delhi) submitted a proposal to set up a centre for advanced studies in 'energy'. The centre was proposed to function under the leadership of M.S. Sodha, a renowned physicist and energy expert (Swani, 1977).

Almost after one year, P. N. Haksar, Chairman of the National Committee on Science and Technology in the Planning Commission of India, echoed similar views in front of an international audience. In 1977, P. N. Haksar, having a keen interest in renewable energy resources, addressed an international gathering convened to discuss the production of non-conventional energy sources through bioconversion. Renewable energy resources were considered a solution to the energy crisis during that time. During his keynote address at the conference on renewable energy in IIT Delhi, Haksar asserted that scientists should have social and economic awareness. Haksar asserted that, in the absence of social and economic awareness, a technological solution for social change had the potential to create new social problems. During the conference, Haksar cautioned the scientists to be grounded and avoid over-enthusiasm around any potentially lucrative breakthrough (Ghose T., Biochemical Engineering and Bioconversion, 1978). Haksar did try to point out the limitations of the relationship between bureaucracy and scientists, 'It is heart-breaking to make our political culture sensitive to the needs of our very talented scientist and technologist. It is frustrating to make our scientist and technologist sensitive

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to the problem of interaction between science and society in the specific and concrete context of India as they are (Ghose T., 1978).'

There were two significant reflections drawn from the address of then Prime Minister, Mrs. Indira Gandhi, P. N. Haksar and the plenary session at Indian Science Congress. First, there was an energy deficit in rural India post-Green Revolution experiences. It highlighted the significance of non-conventional energy resources as a decentralised recourse for energy. The second significant reflections drawn from P. N. Haksar's address was about the importance of 'scale-up' and 'replicability.' He considers replicability of biotechnological research to a 'pilot-scale' plant as the benchmark of success. A pilot-scale plant has the potential to replicate the results of a research project beyond the laboratory premises to the field area. It has the potential to penetrate the findings of a biotechnological programme into the remotest location of the country.

Renewable resources created through biochemical treatment generated much buzz in the policy circles and scientific communities. Renewable energy was observed as a decentralised energy resource and a potential solution to the energy crisis in the country. The Biochemical Engineering practices have brought a new set of tools, techniques and research experts to manipulate and organise the biological entities in large scale bioreactors. T. K. Ghose was one of the prominent names who had made a significant contribution to the flourishing biochemical engineering in the country. He played the pivotal role in establishing biochemical engineering as a separate engineering discipline at Jadavpur University, Calcutta, and HBTI, Kanpur in 1963-65. Within two years, Prof. Ghose moved out from HBTI and joined the Swiss Federal Institute of Technology (now ETH), Zurich for higher studies. After returning from SFIT, he joined the Department Of Chemical Engineering at IIT Delhi in 1968. He used his research experience and training to initiate research projects in the area of bioconversion of cellulosic materials at IIT Delhi. In 1974, he played an instrumental role in stitching collaboration between SFIT, Zurich and Biochemical Engineering Research Centre (BERC) at IIT Delhi. This collaboration between the two institutions was able to provide BERC technological assistance and access to the international research community working in the areas of non-conventional energy resources (Ghose, 1978).

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3.3 Summary

As the research focus, BERC picked a few themes of non-conventional energy resources. Hydrogen fuel cell, Synthetic Natural Gas (SNG) and bio-fuels by bioconversion of the cellulosic substances, were some aspects of primary research focus at the centre. Within five years, BERC was able to place itself on the global map as a non-conventional energy research centre. The centre commissioned a pilot-scale plant for the production of 500 litres of biofuels every 24 hours (IIT, 1980). It was one of the first experiences in India in the production of second-generation biofuels. The steering committee on the *'fuel from biomass'* appointed the centre as one of the chief executors of the programme. These developments put research centres such as BERC on the global map of Biochemical Engineering. The centre was given the further responsibility to provide technical consultation for setting up a pilot-scale plant for biofuels at other universities and institutions (IIT, 1980). The centre was able to engage with the metaphor of 'scale-up' and 'replicability' coined by the government. Through assistance from Chemical Engineering tools, the state was able to spread the biotechnological programme to the remotest locations in the country. The penetration and replication of such a biotechnological programme strengthened the central control and power over the state subjects.

In the process, chemical engineers, who were situated on the periphery of the biotechnological assemblage, got the central position to steer the discourse of the energy crisis in the country. They had the immense experience of 'scaling-up' and commissioning a pilot-scale plant for a variety of chemical processes. Breaking disciplinary boundaries, they brought the tools and techniques of chemical engineering to the discipline of biology. They brought large scale bioreactors at the centre of the assemblage of the biochemical epoch. At least in that time, engineers sidelined the biochemists, which were focused on finding the breakthroughs within the laboratory settings. The large scale bioreactors and pilot-scale plants became the hallmark of that era. The introduction of engineering techniques 'scaled-up' the ontology of the biotechnology programme.

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4. The Inception of the DBT: Reorganising Knowledge and Power

Since the mid-seventies, institutions supported by DST were taking up research related to biotechnology in the form of biochemistry, biochemical engineering and molecular biology. All these biotechnological initiatives have influenced the trajectory of biotechnology in India. Before the inception of DBT, DST was the focal point for the governance and regulation of biotechnological programmes. The model of governance within DST was in the form of high-level committees and steering committees. These committees were formed by the group of bureaucrats, experts and scientists working with a specific research problem.

By the mid-seventies, the interest in recombinant DNA technology and the advancements in biochemical engineering had substantially increased the importance of biotechnology in the country. In 1982, the National Biotechnological Board (henceforth NBTB) was set up within the DST to integrate and regulate research work in the fields of biotechnology (Ghose, 2000). DST had provided secretarial service to NBTB within its premises. Within a period of six months, two significant events, the International Genetic Congress in December 1983 and International Biotechnology Conference in April 1984, were held in Delhi, India. Both events critically influenced the trajectory of biotechnology in the country and emphasised the presence of India at the global biotechnological scenario. The enthusiastic reception and the excitement around the idea of biotechnology had significantly increased the volume of biotechnological research. There was a need to have an independent body for the governance and regulation that could anchor as a focal point to integrate the biotechnological projects. To govern, regulate, and fund the biotechnological initiative, the government established a separate department of DBT in India.

In 1986, the DBT, with a committed policy mandate, had regularised and formalised biotechnology education and research across the country. In that sense, the arrival of DBT reorganised the power centres of biochemical epochs and further concentrated them within itself in an institutional manner (Ramachandran, 1991). Therefore, it was a step forward in the direction of the institutionalisation of biotechnological research. It was expected that the DBT would emerge as a governing body with focused research initiatives in the area of biotechnology. The DBT had adopted vaccination and

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immunisation as a National Technological Mission (NTM). For the execution of the mission, it identified two significant initiatives. First, it urgently wanted to strengthen the existing infrastructure and create some new infrastructure. Second, it took up the mandate to create a human resource base for biotechnology research (Anon., 1989).

4.1 Developing Human Resources and Infrastructure

DBT has started sponsoring teaching programmes for the postgraduate and doctoral students in biotechnology in 17 selected universities/ institutions across the country. A national level entrance test was designed for the selection of the students to fill up the seats in these universities. All the selected students were offered a scholarship in the form of a monthly stipend. Within five years, due to the high demand for the course, the number jumped up to 25 universities (Anon., 1989); (Ghose, 2000).

Within four years, NBTB identified the need to upgrade the infrastructural facility for the mission. It was identified that a few existing infrastructure facilities required upgradation and some new infrastructure facilities had to be set up. DBT had the policy directive to promote research related to immunology and vaccination. It proposed to commission a few dedicated institutions with the mandate for participation in the National Technological Mission. The DBT conceptualised three new institutes as premium institutions focusing on advanced level research. These three institutes were the National Institute of Immunology (henceforth NII), New Delhi, the National Facility for Animal Tissue and Cell Culture (Henceforth NFATCC), Pune and the Institute of Microbial Technology (henceforth IMTECH), Chandigarh. DBT directly controlled these three autonomous institutions (Anon., 1989).

DBT took up vaccination and the production of vaccines as an immediate priority. Supporting DBT, the GOI launched a universal immunisation programme in 1985, having a focus on vaccine-preventable diseases. The mission came to promote and undertake R&D activities for vaccination. DBT set the goal to achieve 85% coverage of children and 100% coverage of pregnant women by 1995. Having experience in the storage and distribution system, the Ministry of Health and Family Welfare (MoHFW) joined DBT for the joint implementing of the mission. DBT was given the responsibility for the research and development of new and improved vaccines (Ramachandran, 1991). DBT decided to

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collaborate with the Institut Merieux, Lyon, France to set up a Joint Sector Unit (JSU) as Indian Vaccines Corporation Limited (IVCL) in Gurgaon, Haryana. Another Public Sector Unit (PSU), the Bharat Immunological and Biological Corporation Limited (BIBCL) was set up in collaboration with the technical consultancy and cooperation of the Institute of Poliomyelitis and Viral Encephalitis (IPVE), Moscow, Russia (then USSR) (Anon., 1989).

4.2 Immunological Research and Vaccination Programme

NII was one of the premium institutions that DBT decided to set up with the given mandate to participate in the National Technological Mission on vaccination and immunisation. NII has its roots in immunological research. A working group at the Immunological Centre in the Department of Biochemistry at the All India Institute of Medical Sciences (AIIMS), World Health Organisation (WHO) and Indian Council of Medical Research (ICMR) came together to set up the National Institute of Immunology in New Delhi (Raghupathy, 1991). One of the aims of setting up NII was to boost the healthcare initiatives proposed by the DBT in the eighth five-year plan. Within five years after its inception, NII developed 14 laboratories with 45 scientists and approximately 45 PhD students, technical and administrative staff (Raghupathy, 1991).

The government has identified population growth as one of the significant challenges for the future growth and development of the country. NII designed projects for the development of safe reversible long-acting and low-cost fertility controlling vaccines. NII had the mandate to develop excellent methods of controlling fertility in both humans and animals (Ramachandran, 1991). Generally, vaccines were developed to generate immunity against foreign antigens. The birth control vaccine proposed to counteract the hormones or proteins which were critically responsible for fertility (Talwar, 1987).

The aim of the vaccination programme was not only limited to the production of a contraceptive vaccine but to develop a new immunological approach that could be extended to develop immunity against internal disorders such as diabetes, rheumatoid arthritis, and so on. The institute was striving to device an injectable technique that would render the semen free of sperms without affecting libido and the production of male sex hormones. The vaccine was named as ‘Tulsar’ and was marketed by Karnataka Antibiotic and Pharmaceuticals Limited (KAPLTD), Bangalore (Raghupathy, 1991). It was claimed

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that the drug had received new drug authorisation from the Drug Controller of India (DCI), (Raghupathy, 1991).

4.3 Summary

By pointing out at the various historical epochs of biotechnological research, the paper has tried to demonstrate the very complicated relationship between biotechnological advancements and the (re)emerging structure of governance of that time. Biotechnology has always been an assemblage of an interdisciplinary space that has experts, researchers, research focus, tools and techniques from different disciplinary locations. Every historical epoch of biotechnology was oriented around a particular form of experts, research skills, tools and techniques. There was the domination of a disciplinary orientation within biotechnology, but biotechnology was never reduced to a particular disciplinary approach dominating the interdisciplinary space. The dynamics and interactions among various inter-disciplinary locations have steered the course of biotechnology in India.

The governance of biological entities had a very complicated relationship with biotechnological research and projects. The biotechnological tools and techniques were evolved, responding to the ‘metaphor’ and ‘urgencies’ constructed by the government in every historical period. They were the outcome of a complex yet small and non-deterministic subject-and-object interactions. The new biotechnological tools create conditions for the construction of new ‘metaphors’ for the subsequent biopolitical regimes and set new challenges for the experts, scientists and bureaucrats. Biotechnology, as an interdisciplinary space, reorganised itself around the new ‘metaphor’ or vice versa. It is a complex process through which biotechnology facilitated the (re)production of new biopolitical regimes.

The inception of biopolitical regimes aimed to have greater control and power over the state subjects through intervening in and manipulating the biological aspects of their lives. The coinage of the term ‘Quadrilateral Dilemma’ highlighted the unfathomable aspect of the biological processes. Hill’s recommendation called for attention towards the puzzling and obscure health, nutritional, and agriculture situation during that period. It became the priority for the government to look for the mechanisms to provide greater control over the

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biological crisis. It further oriented its policies and promoted research that can provide access to the dietary choices, consumption patterns and nutritional status of the people. Large scale surveys in the form of nutritional surveys generated quantitative data about the food habits, nutritional data and health situation in various parts of the country. Biology became the site for the (re)production of 'power' and 'control' over the masses. Biologists and biochemists engaged in developing more sophisticated tools and techniques that gave rise to the bio-political regimes.

During subsequent phases, the government established more significant control over the biological processes with the evolution of new biochemical and biotechnological programmes. These tools constantly reinvented themselves and opened up new avenues of lives for the (re)production of 'power' and 'control.' In the post-Independence phase, large scale revolutions were partially able to overcome the nutritional crisis by ensuring food security. Food security, as a biopolitical intervention, controlled the dietary habits and consumption pattern of the people. The evolution of biotechnological tools has facilitated the biopolitical regimes to strengthen their control and power by intervening in the personal spheres of their lives.

The inception of DBT was marked by control and power over biotechnological initiatives. Biotechnology was the new metaphor that reorganised biochemical, molecular biology, genetics and biochemical engineering projects around itself. There was a tectonic shift in the structure of governance of biological entities after the inception of DBT. The previous regimes consisted of councils, boards and steering committees. In the era of DBT, this balance was gone. DBT had control over all kinds of biotechnological programmes in the country, encompassing education, infrastructure and the content of the research projects.

The content of biotechnological projects supported by DBT did reflect the concentration of power. Biotechnology was not limited to the exploitation of the microbes, improving the nutritional content of the crop, developing high-nutritional varieties and breeding the animals. DBT-driven projects had the intention to impregnate deeper into the personal spheres of state subjects. Government through DBT and its projects has a clear intention to discipline the personal choices, such as the subjects' sexual behaviour, choices of health care and choices of offspring. The National Technological Mission in the form of the universal vaccination project and immuno-contraceptive projects left little room for the

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state subjects to avoid the programmes. With the evolution of sophisticated biological tools and technologies, the government re-adjusted itself and initiated programmes that intended to provide control over the public and private lives of the state subjects.

5 Conclusion

The trajectory of biopolitics in the country had a complicated relationship with the evolution of biotechnological institutions in the country. The evolution of sophisticated techniques and knowledge about the biological entities facilitated the development of the biopolitical institutions in the country. New biopolitical institutions and technologies facilitated greater control over the biological aspects of the state subjects. Through various biological epochs, this paper has demonstrated the complicated relationship between ‘knowledge’ and ‘power’. Scientists and experts in every phase introduced novel entities that existed outside the governance regimes of that time.

Biotechnology was an assemblage of smooth connectives formed by experts, tools, techniques and biopolitical priorities. This was an assemblage that reoriented itself based on the complex interaction between biological knowledge and policy directives. The historical evolution of bio-political institutions was closely linked with the development of novel biotechnological techniques and tools. The biopolitics of every biotechnological epoch engaged with the scientific methods and techniques that could provide greater centralised control. Most of the biotechnological programmes were organised around the metaphor coined by the biopolitical institutions of that time. The metaphors created urgencies and set the priorities for subsequent biotechnological research.

During the reconstruction phase, biochemists existed at the periphery. Hill’s recommendations had significantly changed the location of the biochemist in the discourse. Biochemists reorganised the biotechnological discourse around the metaphor of ‘Quadrilateral Dilemma’ or biological crisis. It was the historic moment in science policy, which emphasised a research focus on the biological aspect of the state subjects. It should be marked as a biopolitical turn in the Indian science policy.

In the post-Independence phase, chemical engineers were not part of the biotechnological discourse. They were brought to the centre of the discourse as they could respond to the metaphor of ‘scale-up’ and ‘replicability.’ The discourse of biotechnology evolved as an

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interdisciplinary space guided by the biopolitical directives. Biopolitical institutions create urgencies and set the tone for the discourses in biotechnology. During every phase, the interaction between scientists, experts, and bureaucrats was guided by certain 'metaphors'. These metaphors were constructed by the government accounting the 'priorities', 'urgencies', 'solutions', and 'crisis' during that time.

The novel molecular biological techniques and evolution of recombinant DNA techniques offered greater predictive success in biotechnological research. These techniques were able to provide a concentration of power for the biopolitical regimes. The newer of biopolitical regimes promoted the biotechnological projects that would offer greater central control and concentration of power. The manipulation of the microbes, developing transgenic varieties of animals/crops and universal vaccination programme proposed greater control over biological processes of living entities. The projects promoted by DBT had the objective to impregnate deeper into the biological processes of the state subjects. The sophisticated biotechnological techniques affected the public and personal lives of the people. Eventually, the lifestyle choices, health care choices and choice of the number of progeny became the site for state intervention. The evolution of biotechnological research in India facilitated the emergence of biopolitical regimes that could penetrate deeper into the biological processes of the life forms.

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