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State policy, agricultural research and transformation of Indian agriculture with reference to basic food-crops, 1947-75

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List of Abbreviations

Agricultural Extension Officer (**AEO**)

Agro-Economic Research Center (**AERC**)

All India Congress Committee (**AICC**)

All India Coordinated Rice Improvement Project (**AICRIP**)

Bharatiya Janata Party (**BJP**)

Center for International Studies (**CIS**)

Central Maize and Wheat Research Institute (**CIMMYT**)

Central Rice Research Institute (**CRRI**)

Communist Party of India (**CPI**)

Council of Scientific and Industrial Research (**CSIR**)

District Agricultural Officer (**DAO**)

Food and Agricultural Organization of the United Nations (**FAO**)

Five Year Plans (**FYP**)

High-yielding variety (**HYV**)

Indian Agricultural Research Institute (**IARI**)

Intensive Agriculture Development Program (**IADP**)

Indian Council of Agricultural Research (**ICAR**)

Indian National Congress (**INC**)

International Crop Research Institute for the Semi-Arid Tropics (**ICRISAT**)

Massachusetts Institute of Technology (**MIT**)

National Academy of Science (**NAS**)

National Chemical Laboratory (**NCL**)

National Development Council (**NDC**)

National Education Commission (**NEC**)

National Metallurgical Laboratory (**NML**)

National Planning Committee/Commission (**NPC**)

National Research Development Council (**NRDC**)

Rashtriya Swayamsevaksevak Sangha(**RSS**)

Scientific Advisory Committee to the Cabinet (**SACC**)

State Agricultural University (**SAU**)

US (**United States**)

United States Agency for International Development (**USAID**)

United States Department of Agriculture (**USDA**)

University Grant Commission (**UGC**)

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Abstract

Looking through the prism of technoscientific research, the dissertation provides a historical understanding of the process of agricultural modernization in India during the period 1947 to 1975. The narrative is set at the backdrop of the Cold War politics, India's drive for economic and social development, gradual capitalization and chemicalization of agriculture worldwide and international exchanges of knowledge, skill and manpower. In a period marked by close interaction between the political and technoscientific establishments, the dissertation demonstrates how they helped to constitute each other. The cooperation between political and technoscientific wings of the Indian state, the dissertation argues, stemmed largely from mutual interests. The scientists as a professional community were eager to actively participate in the economic development of the newly independent nation-state. In doing so they wanted to ensure continuous government patronage, funding for their projects and access to international collaborations. With very little research opportunity in the private sector, government funding was crucial for the professional advancement of any scientists in India. Agricultural scientists, therefore, tried with various amount of success to claim a good portion of budgetary allocations. They would be particularly successful in doing so with the introduction of the green revolution technology in the mid-1960s. On the other hand, the primary interests of the Indian government in employing a large pool of scientists and engineers were to find fast and effective solutions to a whole range of social, economic and political problems facing the new state. To the modernizers, technoscientific approach looked increasingly more attractive when compared with immensely more complex, expensive path of structural reforms.

The need for modernization is a defining characteristic of the new nation-state. But though largely unanimous about modernization as a normative goal, historical actors rarely

agreed on the descriptive part. The dissertation, therefore, explores specifically how different political, social and professional groups variously interpreted the concept of a 'modern' agriculture and the ways in which the process of modernization was related to 'tradition' and 'indigenous'. Policy-makers and scientists largely defined 'indigenous' in an economic sense, referring mainly to material, natural and intellectual resources available within the political boundaries of the country. The way agricultural policy documents used the term 'indigenous' during this period had almost no epistemological connotation. Policymakers and scientists in India, in general selectively appropriated, and largely re-interpreted what constituted India's tradition in the making of 'modern' India. The dissertation discusses in detail how the planners, scientists and politicians used both the terms till the mid-1960s to etch out an agricultural development model for India that was arguably more commensurable with its social, economic and ecological needs.

The first decade and a half of India's history of agricultural modernization shows features that were different from the chemical and capital-intensive development model of N.W. Europe and the Corn Belt of the American mid-west. The dissertation explains the differences largely in terms of priorities: the Indian planners and scientists' choice of agricultural technology was not driven so much by a concern to quickly transform the Indian countryside as a test-case vindicating the viability of capitalist means over communist economy; it was rather goals, such as social equity, large-scale industrialization and limitations of resources and infrastructure, not to mention agro-ecological specificities, which shaped the main contour of India's agricultural development plans.

For a country like India, which took to the course of planned development, planning 'experts', scientists and engineers achieved great significance in development planning. Their identity as 'rational' beings made them most eligible to plan the right path for the teeming millions. The dissertation analyzes what it meant to be an 'expert' in India during this period and the role that technoscientific experts specifically played in the process of agricultural modernization of India. In an age marked by ever-growing importance of scientists and 'scientific' knowledge, the dissertation locates their approaches to 'indigenous knowledge' and local farming practices.

The dissertation also explores whether with the coming of the green revolution technology, the Indian government's intended use of science and technology as the primary tool to understand and solve the food question led to issues of marginalization. Thus, apart from investigating the technological limitations that inhibited the intended uses of technoscientific research as a panacea to complex issues, the dissertation also reexamines how did the scientists responded to problems faced by farmers who had limited financial means and thus could not afford adopting a new technology; or what did agricultural modernization mean for farmers in the moisture-stressed regions of India. Apart from explaining the unprecedented scale of international collaboration that green revolution made possible, the dissertation also writes the history of dissenting scientists who critiqued the green revolution and looked for alternative means.

The primary contribution of this dissertation is to situate the history of agricultural research in the political, economic and social history of India in the first three decades after its independence. The very nature of the time period, however, takes this history beyond India's geo-political boundary and connects it to international events. It is, however, the specific context of India-political, economic, social, and ecological, more than any foreign influences that shaped the direction of agricultural development during this period. Thus, this dissertation is beyond everything a history of India-its people, institutions, and nature.

Preface

This is a history of agricultural research in India-narrating and explaining its changing contour since the country's independence through the coming of the green revolution technology in the mid-1960s. The narrative concludes with the tumultuous years of 1970s when amidst war and suspension of the parliament, the nation achieved self-sufficiency in wheat production. The period also witnessed the emergence of regional parties of farmers who strongly advocated fiscal policies that would be conducive to the application of energy and capital-intensive technology in the farming of food-crops. Rice and wheat, as the staple diet of the people of the region, are at the heart of this historical narrative, which helps to bring together the world of farmers, agricultural scientists, philanthropists, and statesmen from across the geographical boundaries of India, USA, Mexico and Philippines. The narrative also spans a number of academic disciplines. Commonly interpreted as an 'applied' science, agricultural science is not considered as *one* academic discipline, but is constitutive of a 'large set of locales and identities'.[1] Of the sciences that this broad field includes, this history concentrates on research conducted in the following: genetics, plant physiology, and chemistry.[2]

There are two primary concerns that have guided this historical narrative: 1) to understand the interaction of the technoscientific register and the political register. Doing this helps a historian identify how the registers have constituted each other. Though the scientific and the political establishment had been keen to control their interactions at a discursive level,

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[1] Deborah Fitzgerald, 'Matering Nature and Yeoman: Agricultural Science in the Twentieth Century' in John Kriege and Dominique Pestre ed., *Science in the Twentieth Century* (Harwood Academic Publishers, 1997) p.701

[2] The other constituent disciplines would be botany, livestock breeding, nutrition, parasitology, and bacteriology

regarding ‘reason’ as the only touchstone on which to base their decisions about policy, they could rarely achieve so. Thus, the world of the ‘experts’ was constantly ‘interfered’ with the more ‘unreasonable’ and hence, intractable world of social, political, and ecological issues. This leads us to our second concern: 2) what happened when the ‘experts’-political and technological-tried to rationalize, systematize and even coalesce everything into a narrative of production and efficiency? This research studies the reception, contestation and impact of the process from the perspective of the Indian farmers, agricultural scientists and consumers.

Scientific research and cultivation of rice and wheat underwent significant changes that were brought about by the modernizing imperative of the Indian state, the Cold War politics and the gradual capitalization of Indian agriculture. The technoscientific research in turn shaped, resolved and often opened up new areas of concern for the state, transnational agencies and for capital. The political-administrative apparatus, the transnational agencies working in India, and the scientific community all wanted to use science and technology to serve various purposes: as a ‘tool’ to achieve modernization, to rationalize ‘tradition’ through incorporation of scientific spirit, to make ‘indigenous’ resources more economically profitable and more. They considered science as ‘panacea’ to solve a large number of social, economic, political issues and what they interpreted as ecological ‘constraints’. But in practice the political and technoscientific establishment did not possess resources or enough mastery over scientific matters to exert complete control over the agricultural world, undermining their goal of using science as a tool to accomplish desired ends.[3]

[3] David Arnold, *Science, Technology and Medicine in Colonial India* (Cambridge University Press, 2000)

Agricultural scientists, both from India and the US, were closely involved with the modernization of Indian agriculture since the time India achieved independence from the British rule. With the outbreak of war with Pakistan and in response to the political position taken by the US government, the Indian administration wanted the American scientists to leave the country by the early 1970s. Over this approximately three decades of agricultural history, the definition of what constituted a 'modern' agriculture would be a highly contested issue among different groups of politicians, policy-makers and scientists, cutting across national boundaries. Though the debate over agricultural modernization achieved a degree of closure in the late 1960s, with the widespread introduction of capital-intensive inputs in Indian agriculture that increasingly depended on use of non-renewable energy, it opened up new concerns regarding environmental impact, socio-economic and regional marginalization caused by the new technology. Thus, though enthusiasm about the green revolution technology has given way to the recent fascination with agbiotechnology, its ramifications still inform our understanding of technology's role in agricultural development.

Though few individuals in India, at least in terms of policy formulation, ever doubted the need to raise food-crop production, the technoscientific means adopted to achieve that goal constantly changed during the period under review. It evolved with the changing planning priorities of the state, with farmers' growing political significance in national politics, and with the changing dynamics of international power politics. Amidst the trans-national context of the Cold War, with its exchanges of students, professionals and technology across national boundaries, this driven by specific circumstances in India that shaped the content of agricultural research. At the intersection of the nation-state, it's planning priorities and in the context of international politics, research agendas, expertise, and uses of agricultural inputs were transformed.

Scholars have generally emphasized a political economic understanding of Indian agriculture, which often tends to miss the ecological aspect of technological solutions. Missing the ecological angle is especially easy in writing the history of a period that has been dubbed as an ‘age of ecological innocence’ in regards to the apathy that the country’s political leaders displayed towards environmental concerns. The dissertation, however, argues that the ‘innocence’ prevailed not in terms of lacking knowledge about ecology, but in the ways that experts thought that they could use technology to harness natural resources for human consumption. While experts occasionally interspersed, discussions of agricultural modernization with concerns about soil erosion, but it soon gave away to the more aggressive claims of promoters during green revolution years, without developing into any systematic theory about sustainable agriculture. The research during decades of the green revolution, therefore, concentrated not on evolving different varieties of grains suitable to various ecological specificities, but on tailoring the most congenial ecology to fit the needs of the new technology. By studying these transformations in relation to each other, we can examine the cultural and ecological aspects of the technoscientific innovations in relation to its political and economic matrix; secondly, this history illustrates how technoscientific research became the site for realizing the political and economic ambitions of several actors involved with the project of agricultural modernization.

There have been many influential accounts about India’s agriculture that are mainly concerned with interpreting the role of capital and use of energy-intensive inputs as the logic of production. From such a perspective, the presence of features, such as mechanization, chemical fertilizers, fertilizer-responsive hybrid seeds and pesticides are seen as the mark of a modern agricultural sector. A modern agriculture is defined as a product of scientific research, geared towards mastering nature and channeling natural forces towards greater yield. For the proponents of this model of agricultural development, any production system that lacked or only had limited use of these features, as had largely been the case with pre-green revolution India, was seen as continuing with traditional agriculture, with little role for scientific research.[4]

Using research reports and policy documents from the pre-green revolution period, I argue instead that limited use of capital-intensive inputs could be interpreted not as a refusal to incorporate science and technology for development purposes, but as the state's reluctance to fully incorporate the development model that had been widely adopted by the farmers of the Corn belt of the US and NW Europe. In studying India's agricultural modernization at the confluence of political economic, ecological perspectives, we will better understand the specificities of the food-crop production and agricultural research in India. In contrasting the ways of agricultural development in the 'West' with the model that can be abstracted from the Indian context, we get, as Francesca Bray has suggested in her study of Asian rice economies, 'a spectrum of agricultural systems, each using land, labor and capital with a different degree of intensity which in some measure determines its dynamic evolution and its pattern of adaptation to such phenomena as modern capitalism.'[5]

Since agricultural production in India was dominated by small farmers who practiced labor-intensive rather than capital-intensive ways of farming, agricultural innovations in India

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[4] For a detailed discussion on how 'experts' were coming up with models for creating a 'modern' agriculture see, A.T. Mosher, *To create a modern agriculture: organization and planning* (Agricultural Development Council, 1971)

[5] Francesca Bray, *The Rice Economies: Technology and Development in Asian Societies* (Basil Blackwell, 1986)

concentrated on evolving cheaper, less-energy-intensive biological and chemical inputs. Scientific research, moreover, was not all about quantity, but about quality too-which led Indian scientists to look not only for fertilizer-responsive varieties but also to develop scented, elongated rice and amber colored, soft wheat. The goal of agro-ecological adaptation was no less important than high-yield or disease-resistance. Equally important was the goal of 'social equity' that inhibited the adoption of a capital-intensive model because it considered such a path of agricultural development to be beyond the adoptive capacity of majority of farmers. Thus, ecology, material condition of farmers and political economic objectives of the Indian state are all part of my study in understanding the development and agricultural science and technology in postcolonial India.

Driven by multiple concerns, unlike the high-yield focus of the later green revolution technology, the agricultural scientists during this earlier period drew from various farming practices of different parts of the world.[6] They derived insight from multiple techniques, for example, combining 'organic' resources with the synthetic fertilizers and sophisticated technology that were more common in the more capitalized agricultural systems. Scientists experimented with both foreign and 'indigenous' varieties of seeds as possible sources of genetic variations, which they hoped to incorporate into the improved varieties of cereals. In understanding the nature of the agricultural research in postcolonial India, it is, therefore, necessary to look beyond the rigid binaries of organic/inorganic, foreign/indigenous and modern/traditional etc. Focusing on their interactions, instead, would help us to see post colonial Indian agriculture as a range of prevalent conditions and not in terms of a uniform closed system.

[6] 'The expression 'agricultural practices' refers to all systems that farmers use to meet the basic needs of plants and animals (water, seeds, nutrients) in order to maximize output. Thus, it includes the skills to perform simple operations (such as plowing), the knowledge of optimal timing of operations, and the knowledge of the best succession of different crops (rotation).' For a detailed discussion see Giovanni Federico, *Feeding the World: An Economic History of Agriculture, 1800-2000* (Princeton University Press, 2005) Ch.6

The use of the term 'indigenous' is problematic and hence requires some explanation. I do not claim that indigenous agronomy was a coherent and systematic theory of agronomy that was discursively available to peasants and scientists. I agree with Akhil Gupta's formulation of the term indigenous as 'culturally constituted recipes for dealing with the varying conditions and exigencies encountered in farming practices.'[7] Scientists and policy-makers of the era did not evidently bothered with a sophisticated theoretical formulation of what they meant by their usage of the term 'indigenous'. Official documents mostly used the term 'indigenous' to refer to inputs available within the geographical boundaries of India and largely known to the farmers. In absence of a systematic repository of knowledge about 'indigenous' practices, agricultural scientists often used their own knowledge about existing farming practices and organic resources to think about their effectiveness and further improvised on these in their laboratories. Scientists endorsed indigenous agronomic practices and resources only when these met the physical, economic and social requirements and not because they wanted to defend these knowledge and practices in the name of indigenousness. In the work of the Indian agricultural scientists of independent India, therefore, it is very difficult to locate instances of 'postcolonial hybridities' of the kind that anthropologist, Akhil Gupta found in the daily rhetoric and practices of farmers in villages of North India even in the 1980s, or, that Gyan Prakash argued were evident in the work of scientists in the early twentieth century in the subcontinent.[8] Indigenous practices or resources rarely made their way into the scientific practices of agricultural research labs of independent India.

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[7] Akhil Gupta, *Postcolonial developments*: *Agriculture in the Making of Modern India* (Duke University Press, 1998) p. 181

[8] Gyan Prakash, *Another Reason: Science and the Imagination of Modern India* (Princeton University Press, 1999)

Through a close analysis of cereal research, I have primarily tried to decode the black box of agricultural science and contextualize it beyond the scientists' laboratories and experimental fields. Because rice and wheat were staple food-crops of the nation, the state monitored these relatively closely, and low grain yield in India was the subject of international concern. Since rice and wheat were not cash crops, their production practices showed uneven penetration of capital across or even within regions. So, it is possible to study a whole range of farming conditions and associated development of technology, pattern of resource usages by farmers and region-specific research work by scientists. A more practical reason for choosing rice and wheat to study the modernization process was availability of data. As we have learnt from the work of another agricultural historian, David Ludden that we inherit evidence on agriculture in proportion to its success and that we have most data where the state penetrated most minutely. Thus the volume of data on rice and wheat, being the staple crop surpass any of that on other cereals. A similar trend was noticeable in the colonial period when the state produced more texts on cash crops and plantations than for food crops because the state was more involved with the former for its revenue generating capacity than the latter, which was the domain of the small peasants, outside the purview of the state machinery.[9] The annual reports on rice and wheat research offer invaluable resources for exploring the connections between scientific researches, specifically agricultural research, with what happened beyond the laboratory and experimental fields. The rice and wheat seeds-its immense varieties, its varied responses to fertilizer application, and vulnerability and resistance to pests and diseases, its agro-climatic adaptations,

[9] David Ludden, 'Agricultural Production and Indian History' in Ludden ed., *Agricultural Production and Indian History* (Oxford, Oxford University Press, 1994) 4. Ludden argued that the colonial state was more concerned with issues such as revenue, property law, marketing and credit. Relatively few data, Ludden points out, concern issues most critical for farmers, such as subsistence strategies and resource management.

and its cultural, social and economic connotations-all make these interesting and significant for an academic pursuit.

Selecting rice and wheat as my subject of investigation in a way determined the institutions of scientific investigations where I would focus in my work. CRRI and IARI represented the most important centers of rice and wheat research in independent India. Located in the southern part of the national capital-New Delhi, Indian Agricultural Research Institute's (IARI) geographic location is indicative of its central position in Indian agriculture. It has been one of the leading centers of agricultural research in independent India that contributed significantly to the modernization of agricultural production. The other important, though somewhat younger institute of cereal research, is the Central Rice Research Institute (CRRI) at Orissa. Both the institutes participated in several significant research projects at the national and international level during the years following India's independence. For instance, CRRI scientists undertook countrywide surveys to build up large rice collections of both popular and exotic varieties that helped in the making of gene banks. CRRI also served as the main center of the Food and Agricultural Organization (FAO) sponsored multi-national rice hybridization project involving *Indica* and Japonica varieties, before the advent of the hybrid dwarf varieties of rice from Philippines. The project was the first international collaboration of scientists to evolve improved strains of rice by bringing together qualities of different varieties.

Both CRRI and IRRI are part of the central research institutes in India i.e. these are administratively controlled by Indian Council of Agricultural Research (ICAR) and not by state governments. A brief discussion here of the structures and functions of the Indian agricultural research system illustrates the nature of one of the largest agricultural science establishments in the world. The Indian agricultural research effort has three institutional bases: ICAR, the State

Agricultural University (SAU) system, and private industry.[10] The ICAR was set up in 1929 on the recommendation of the Royal Commission on Agriculture. It was always more research oriented than SAU, with forty-one Research Institutes (such as IARI and CRRI) under its administrative control and seventy-one All India Coordinated Research Projects spread over 1291 cooperating centers all over the country.[11]

In 1948, India had 17 agricultural colleges and only 160 postgraduate students. The second National Education Commission (1964-66), headed by University Grant Commission Chairman Dr. D.S Kothari, recommended the establishment of at least one Agricultural University in each of the Indian states. India followed the recommendation of the Education Commission: the agricultural universities set up at the state-level evolved into an elaborate nation-wide system, consisting of twenty-six universities. The SAU concept owes much to the U.S. Land Grant college model. The second Indo-American team (1959), headed by the vice-president of the ICAR, Dr. M.S. Randhawa, specified actions towards that end. It recommended that agricultural universities at the state level should address the twin needs of increasing agricultural production and improving the farmer's life. These two objectives, they pointed out, could be met through the land grant model of integrating teaching, research and extension. They strongly advised that all the existing agricultural colleges, veterinary colleges, home science colleges as well as the State experimental stations should be integrated with the SAU in such a manner 'that one agricultural programme for the entire State will be developed under the general direction and administration of the agricultural university.' In their report they advocated that the

[10] The last continues to be dwarfed in comparison to the other two in financial outlay, research staff and scope of research.

[11] N.C.B. Nath & L. Misra ed., *Transfer of Technology in Indian Agriculture: Experience of Agricultural Universities* (Indus, 1992); M.S. Randhawa, *A history of the Indian Council of Agricultural Research, 1929-1979* (New Delhi : Indian Council of Agricultural Research, 1979)

Government of India should provide no financial aid to a state for an agricultural university unless and until the state had passed appropriate legislation and statutes to adopt the essential land-grant concepts and principles to Indian conditions.[12]

I decided to weave my history of postcolonial Indian agricultural research around te Indian Agricultural Research Institute and Central Rice Research Institute because much of the drama of Indian agricultural research took place here. The scientists were trying to address the need for producing more food with limited capital. Their task was further complicated by the cultural preferences of consumers, the economic condition of the majority of its farmers, and the ecological variance that characterized cereal cultivation in India. The same institutes served as the primary abode of the new seeds from Mexico and Philippines, though other agricultural universities that were modeled according to the American land-grant universities also played crucial role in adapting the new technology in different agro-ecological zones of the country. Moreover since IARI and CRRI were under the directives of the Central Government, their history best embodied the relationship between the scientists and a postcolonial state-its underlying tension, patronage and responsibilities. The Chairpersons of various departments of IARI and CRRI, were renowned figures in Indian agriculture and after playing crucial roles in India's agricultural development these men went on to head international research institutes such as IRRI, CIMMYT, ICRISAT etc. Thus these two institutions effectively served as nodal points to study flow of knowledge, technique and manpower between regional, national and transnational levels.

[12] Hadley Read, *Partners with India: Building Agricultural Universities* (Illinois, 1974) pp. 35-36

Built in 1934, IARI's sprawling green New Delhi campus and striking red buildings is an imposing presence to which the success of the green revolution (in making India self-sufficient in food-grains) has lent an additional aura. The tall clock tower which looms over the campus serves as the most popular representation of the institute. It rises from the building, which houses the main library of this research institute. The library contains in its archive, the records of all agricultural research projects that the scientists have had undertaken, ever since its foundation. It houses innumerable journals, both academic and semi-popular in content, reports of several committees constituted to reform the research establishments of the country, government documents pertaining to agricultural policy and valuable secondary sources on Indian agriculture. No other institutes anywhere else in the world has so much on Indian agriculture under a single roof. Materials stored in the IARI library have been extensively used to write this dissertation, especially the sections on wheat research.

Established in April 1946, CRRI was the product of the last years of colonial rule in India. Its establishment is associated with the tragic history of the Bengal famine in which, one-third of the population of the province perished.[13] The famine was caused by the devastating outbreak of epiphytotic brown spot disease of rice (*Helminthosporium spp)* in 1942. The impact of massive crop loss on people was further aggravated by the failure of the colonial administration. In the aftermath of the famine, intense public criticism forced the British government to take several measures, one of which was the establishment of CRRI at Cuttack. It was set up to intensify research on rice so that crop failures of such magnitude could be prevented in the future. The library at CRRI is far less grandiose. Much smaller than the IARI, it

[13] Paul R. Greenough, *Prosperity and misery in modern Bengal : the famine of 1943-1944* (Oxford University Press, 1982)

however preserves the documents more carefully and systematically. The annual reports of rice research conducted at CRRI have been used in my dissertation as crucial primary sources to analyze the content and goal of rice research in postcolonial India and the factors influencing it. CRRI library is also a significant source on the FAO and IRRI's involvement with India's agricultural research.

Since the mid-1960s, the path of agricultural development that Indian researchers had followed since independence underwent a major shift, involving greater usages of capital and energy-intensive technology, price incentives to farmers, subsidies for agricultural inputs etc. The scholars have generally studied the changes have been as caused by domestic and international factors. But few studies have been done on the nature of the changes itself, apart from documenting a shift in political and economic policy, for example, a significant increase in the use of capital-intensive inputs, adoption of the policy of selective application etc. But how can we characterize the changes that marked the government of India's approach to the food question? I argue in chapter three that what we witness was the 'technical-rendering' of the food question-a process that was further bolstered by the famines occurring around the mid-1960s, the ongoing food-population debate, and an increasing international pressure that was matched by the growing importance of domestic forces who favored capital-intensive reforms over institutional ones. Under the circumstance, availability of food was no more embedded in a broader social, economic and political question, but seen solely in terms of higher production-a technical issue amenable to solution courtesy the new green revolution technological package available in North America.

The last segment of my work studies how the new technological knowledge was transferred into India through international collaborations among scientific communities, building new universities model on land grant universities of the US that would serve as the nodal points of dissemination, through private foundation-government network. This flow of knowledge that was accomplished through international exchanges of scientists, through training in the use and practice of the new technology at national and international institutes, and through reconstitution of professional identities based on who pursued and defended the new technology would, however, carry serious issues of marginalization. New categories would be enforced, courtesy the introduction of the new technology, which would redefine the place of scientists, farmers and regions in the new development discourse. Eager to disavow that the new technology had any biases, the policy documents of both private and government agencies, explained their preferences in terms of national need or technological requirements. Such preferences became explicit in the research work and professional life of the agricultural scientist, carrying grave threats of marginalization. Issues of marginalization, however, received little attention from either the government or the scientific community during the period under study. Even political parties articulating farmers' interests, Akhil Gupta pointed out, were rarely vocal about farmers who were left out of the profit incurred from the new technology.[14]

Though a number of studies have been done towards understanding which segment of Indian farmers benefitted from the introduction of the new technology, relatively little effort has been invested in understanding whether the farmers extend any influence in deciding the ways of agricultural modernization. Though history of peasant movement and politics in India have recorded the former's response to various fiscal, political and institutional reforms, there has been very little work done to understand the role that farmers' played in determining the direction of agricultural research in India. In the final chapter of this dissertation I have tried to

[14] Akhil Gupta, *Postcolonial developments*, Ch. 1

understand the economic structure of the farming community in India and the nature of their interaction with the government and the scientific community, specifically in terms of technoscientific innovations.

Though the narrative mainly revolves around the history of agricultural science and technology, the introductory chapter gives a general account of the role that technology and science were meant to play in the cultural and economic modernization of the country. This intellectual history ties into instances of scientific techniques that were used in the modernization of the handicrafts industries of rural India. It will help us to understand how a number of leading figures of independent India, including Prime Minister, Jawaharlal Nehru, envisioned science and technology could transform India without uprooting its traditional moorings. Some of the ideas explored in the panoramic breadth of the first chapter help to contextualize the action of such Indian actors, who were involved with the modernization of Indian agriculture. Not all ideas would materialize, more importantly there would be contradiction between ideas and action, but nevertheless the trajectory of technoscientific development in independent India could not be studied without knowing how it conjured up in the mind of several persons from the turn of the twentieth century.

Chapter1

Science, Technology and the Making of 'Modern' India

The ideologues of independent India were animated with an intense desire to turn the country into a modern nation-state. The forces of modernity unleashed by practices of science and technology, Prime Minister Jawaharlal Nehru dreamt, would not be restricted to economic sphere alone, but would revolutionize the cultural life of the citizens of the new republic. India's pursuit of modernity as a normative goal was in fact as old as its struggle for self-rule. Economic development, as the index of modernity, and as a concomitant to social reforms had been at the heart of the liberation discourse of the Indian middle-class against colonial rule.[1] But beyond a normative consensus, scholars have found that historical actors had rarely agreed upon the descriptive part of the modernization process.[2] Thus, without risking some amount of generalization and simplification it is difficult to neatly categorize proponents into groups and label them of as holding similar opinions, on such things among others, as the place of 'tradition' in 'modern' India, the use of the 'indigenous', the goal of social equity in economic development.[3]

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[1] Gyan Prakash, *Another Reason*: *Science and the Imagination of Modern India* (Princeton University Press, 1999), p. 187.

[2] Sunil Kilhani, for instance, discusses three different current, each with its own idea of India's future that existed among group of people who favored versions of industrial modernity. See, Kilhani, *The Idea of India* (Farrar, Straus, Giroux, 1997) pp.70-71.

[3] For instance, the western observers who came to India, Nick Cullather writes in the *Hungry World* (2010), rarely agreed on the development path of the new nation; though they believed in the necessity of modernization and the important role that science and technology needed to play in the whole scheme of thing, the observers, however, differed on whether to emphasize community development projects or to go for an entirely technocentric productionist strategy. More on this will be discussed in the next chapter. Similarly, Nehru though differing greatly with Gandhi on the broader philosophy of industrialization had was more than willing to incorporate his ideas in the village development projects of independent India. On the other hand he bitterly differed with renowned Physicist Meghnad Saha on the ways science and technology was being put to use with the demise of colonial rule from the country, though, both of them technically belonged to the same pro-modern and pro-technoscience camp. For a

From the historical records it is evident that simultaneous to the tumultuous political process of claiming and stabilizing the national space, politicians, scientists, and economists among others strongly debated over the nature of India's modernization and the path it would take. Though a degree of consensus had already been reached over the universal nature of 'science' around 1930s, the leadership of the new nation-state still grappled as how to strategically and philosophically address the issues of 'tradition' in the making of 'modern' India.[4] The ongoing debate over the nature and place of 'tradition' in independent India could be traced back in the literature produced by late colonial intellectuals on development. Eager to prove that their ideas were in keeping with Indian traditions or conditions, the 'modernizers' who believed in the use of machinery and the need for industrialization responded to allegations of westernization with a claim of 'indigenism'. They insisted that they have a plan for development that would take an 'Indian' and not a 'foreign' path.[5] Thus Nehru, as one of the chief advocate for a modern India, had been careful to draw a distinction between Western form of modernity and a form of modernity more adaptable to the Indian context.[6]

Though frequently critical of many aspects of western modernity, Nehru, however, was emphatic on modernity having a universal valence, as did science. As claiming a difference from western modernity was a political imperative, so was the argument stressing on its universality: It would help Nehru to counter Europe's claim to 'exceptional *internal* characteristics that

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description of Nehru-Saha debate, see Robert S. Anderson, *Nucleus and the Nation*: *Scientists, International Networks, and Power in India* (University of Chicago Press, 2010) and Abha Sur, *Dispersed Radiance: Caste, Gender, and Modern Science in India* (Navayana, 2011).

[4] Benzamin Zachariah, 'Uses of Scientific Argument: The Case of 'Development' in India, c.1930-1950' in *Economic and Political Weekly*, Vol, 36, No. 39 (2001) pp.3689-3702.

[5] Benzamin Zachariah, Nehru (Routledge, 2004).

[6] Benzamin Zachariah, 'Uses of Scientific Argument' p. 3690.

allowed it to supersede, through its rationality, all other cultures.'[7] He, however, never elaborated on what he considered to be the more universal aspects of modernity vis-à-vis its more malleable specific ones. It is in the making of a national version that we notice his keenness to incorporate what he understood as valuable aspects of 'Indian tradition'. Spiritualism without a religious foil would be one such novel introduction by Nehru to India's drive for cultural modernization. Confined largely to intellectual musings, these ideas merely reflected how Nehru envisioned social engineering his countrymen into modern Indians-spiritual, but not given to religious bigotry and infused with scientific values.

This narrative, however, is not about the history of modernization as a study-of-differences between India vis-à-vis the West. It does not venture to essentialize the developmental experience of the West and thereby prepare 'taxonomy' of modernity. The experiences of modernization historically had been varied, contested and mediated by social, economic and political context. Saying that it, however, needs to be mentioned that modernization as a theory and development as a model of economic and social measures insisted on using European history as a 'historical' template that charted the future of humanity itself . This approach was also evident among the American social scientists who generally considered the disparate countries of the 'third' world as faced with broadly similar problems, and therefore amenable to a broadly similar theoretical conceptualization and policies.[8]

However, notwithstanding the flow of men, money and material from the U.S., it was not solely foreign influences that directed India's development course. It is clear from contemporary

[7] Nils Gilman, *Mandarins of the Future: Modernization Theory in Cold War America* (The Johns Hopkins University Press, 2007) p.28.

[8] Nils Gilman, *Mandarins of the Future*, p.28, 34.

official documents that various interplay of interests, contemporary political and economic exigencies as well ideological commitment shaped India's discourse and practices of development. [9] For example, rather than capital-intensive resources, the practical and ideological underpinnings motivated most members of the political, planning and technoscientific establishment to advocate usages of 'indigenous' material in large number of technological projects, especially in raising the productivity of India's food-crop production and in the revival of the village industries and traditional handicrafts; Moreover, in spite of its emphasis on import-substitution and self-sufficiency at the policy-making level, the government instead of solely prioritizing economic production planned to reconcile rapid growth rate with an equally important quest for social equity. Under the circumstances, the Government of India had to decide whether to emulate a capital and energy intensive development model that promised high economic growth, but accorded little or no place to ideas of social development, social equity, use of cheap indigenous resources, and to 'tradition';[10] or make an attempt to' re-invent'

[9] To understand the 'regional' aspects of India's modernization process, see K. Sivaramakrishnan & Arun Agarwal ed., *Regional Modernities: The Cultural Politics of Development in India* (Stanford University Press, 2003). Nils Gilman in his study of the history of modernization pointed out that the term 'modernization indicated Ataturk's intention to turn Turkey toward a Western model of modernity as a way of revitalizing the decadent fortunes of the Turkish people who had just been defeated in World War I by the Western power.' Ataturk's ideas of modernization were very different from his contemporary from China, Sun Yat-Sen's use of the term development too. What Sun meant by development was 'government-directed augmentation of the economy', but for Ataturk it was 'steering of *social change* toward a terminus defined by the Western example.' See, Nils Gilman, *Mandarins of the Future*, p.31

[10] W.W. Rostow, *The Stages of Economic Growth: A Non-Communist Manifesto* (Cambridge University Press, 1971), p.19. Though the proponent of the modernization theory often argued that the scope of modernization went beyond strict economic development to encompass the social, cultural and the political aspects but, since the early 1950s, developmental economists equated aggregate national income growth (NIG) with increased prosperity. Increased output of goods and services became a proxy for improvement in human capacities and conditions. It was only in 1962 that the Economic and Social Council of the UN (Ecosoc), for the first time, recommended the integration of both social and economic aspects of development. It was only in the second United Nation Development Decade that serious initiative was taken to merge the two. The International Development Strategy (October 1970) called for a global strategy, based on joint and concentrated action in all spheres of economic and social life. The turning point came with an almost simultaneous UN resolution establishing a project for the identification of a unified approach to planning and development, 'which would fully integrate the economic and social components in the formulation of policies and programs.' Gustavo Esteva, 'Development' in Wolfgang Sachs ed., *The Development Dictionary: A Guide to Knowledge as Power* (Zed Books, 2010); John M. Staatz & Carl E.

traditions for the purposes of cultural modernization, recast the 'indigenous' in terms of scientific practices, and make consistent attempt to keep the goal of equity within the ken of economic development.

Emerging from the self-demeaning experience of subjection to a long period colonial rule, many in India's administrative echelon, including Nehru, was almost obsessed with the idea that India's pursuit of economic and social development should neither appear as a plagiarization of the West nor subservient to its interests. In the context of the ongoing Cold War, a concern about neo-colonial pressures looked even more justified to the members of the Planning Commission.[11] The first-five year plan, for instance, categorically pointed out that 'of the total flow of private capital from the United States in 1947-49 about 78 per cent went to underdeveloped countries but 90 per cent of this was directed to investment in extractive industries working for export to the advanced industrial countries.'[12] India's development regime was thus careful of not replicating the centre-periphery model of the colonial regime. Accompanying this skepticism was an urge to form a distinct identity as an emerging power with its own set of priorities and lineages. As the initiator of the non-aligned movement (NAM), the political leadership in India refused to be seen as a lackey of any political-economic bloc. Its policies and practices should apparently be such that would fit-in with the image of the country as 'greatly-admired' model among the nations of the developing world. Thus, much of the plans and actions of politicians, scientists and policymakers directed towards India's development would be better understood when put into the context of contemporary political economy,

Eicher, 'Agricultural Development Ideas in Historical Perspective' in Eicher & Staatz ed., *International Agricultural Development* (The Johns Hopkins University Press, 1998) p.9

[11] Benzamin Zachariah, Nehru p. 20.

[12] http://www.planningcommission.gov.in/plans/planrel/fiveyr/index9.html

especially, if we factor-in the skepticism with which many in the Congress Party interpreted the 'imperatives of capitalist production' as have had contributed to imperialism.[13]

Unlike what is commonly assumed that with the adoption of the first-five year plan (1951-1956) basic industries overrode any concern about revival of village-industries or traditional crafts, the period, in fact, witnessed a renewal of discussion over Gandhian economics, which in absence of the man himself was joined by other activist-ideologues sharing his ideas, such as J.C. Kumarappa, J.P. Narayan, Ernst Schumacher etc. At independence, the discussion on village-based economy as the traditional basis of Indian society went beyond from merely being an exercise in rhetoric to being incorporated as part of development practices. The idea that this could be made possible did not come entirely from either Nehru or the member of the Indian Planning Commission. A large part of it was derived from the work of Gandhians themselves. For instance, Kumarappa sought to establish the practicability of the village-based economy on the basis of the scientific wisdom of the principles of economic on which it rested. Trained in economics at Columbia University, Kumarappa was far from rejecting conceptions of 'modernity', 'science' or 'economic', however, he proposed to consider modernity in a longer time-frame. He argued that the Gandhian idea of making the village self-sufficient should not be taken to imply that the artisans should be left to themselves-restricted by the older technologies. He proposed instead that assistance of scientific research be harnessed to village problems.[14] In saying so, Kumrappa would help to bridge the otherwise unfathomable gap that a scientist like M.N. Saha or constitutionalist like B.R. Ambedkar felt about Gandhian economics or the role of handicraft/village industries. Saha, for instance, would vehemently resist going back to an age of

[13] Sunil Kilhani, India p.72.

[14] Quoted from Benzamin Zachariah, 'Uses of Scientific Argument' p. 3692.

bullock carts and spinning wheels.[15] Ambedkar, on the other hand, shared with Gandhi no romanticism about Indian villages. Severely affected by practices of untouchability, while growing up in a Maharastrian village in western part of India, Ambedkar regarded Indian villages as wells of ignorance.[16]

At the backdrop of these political and intellectual exchanges, this chapter, therefore, ventures to analyze, using contemporary political and development rhetoric, science and technology documents and technoscientific projects, what the historical actors meant when they wanted to be 'modern' and how they grappled with the politically and culturally sensitive issue of tradition. Was modernity as pursued and practiced by the independent state after all a 'derivate discourse' of western modernity, with little space for tradition, as had so often been argued.[17] To some scholars the displacement of Gandhian thoughts and of use of tradition was evident in the intellectual thoughts and development plans of leaders like Jawaharlal Nehru, in whose imagination 'modern' India was apparently all about huge steel industries and hydro-electric dams that came to dot India's landscape. Their preferred development discourse had little to do, scholars had been saying, with Gandhi's plan for an India based on village-republics and traditional crafts using indigenous resources. [18]

Recent scholars have commented on the analytical necessity of treating 'indigenous' not as a closed system, but more as evolving practices that varied across region and community and

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[15] Abha Sur, *Dispersed Radiance* Ch.3.

[16] Valerian Rodrigues ed., *The Essential Writings of B. R. Ambedkar* (Oxford University Press, 2002).

[17] Partha Chatterjee, *Nationalist Thought and the Colonial World: A Derivative Discourse* (University of Minnesota Press, 1993.)

[18] Michael Adas, *Dominance by Design: Technological Imperatives and America's Civilizing Mission* (Harvard University Press, 2009) Ch.5.

is part of the traditional lineages of the region.[19] The concepts of tradition and indigenous, therefore, not only overlap, but share a close bonding with religion too. The pervasive presence of religious ideas had been located in the long tradition of the country's knowledge about medicine, natural resources and agriculture. Such a religiously informed understanding of the country's 'scientific' achievement could be located in writings of the Orientalists and nationalists who claimed for the revival of 'Hindu' science as opposed to the 'dark age' of Muslim rule. Under a more secular administration of independent India, how would the state accommodate tradition with all its religious trappings in its development discourses-in the making of the 'modern' India that they aspired for?

Nehru found incorporation of tradition indispensable in the making of modern India. Aware that he was writing about a country with one of the oldest civilisation in the world, Nehru remarked that in India 'old established traditions cannot be easily scrapped or dispensed with'. He doubted the desirability of such an act, especially in the context of the national movement when tradition was being used to rouse 'a people to a high pitch of effort and sacrifice.' Under the circumstance, the wisest thing to do would be to accept it; it should, however, be 'adapted and transformed to meet new conditions and ways of thoughts, and at the same time new traditions have to be built up.'[20] To recast tradition in the mould of modernity, he selectively borrowed ideas from post-enlightenment rationalism and socialism. Re-inventing 'tradition' in this way would be very much part of India's cultural modernization as Prime Minister Nehru went on stressing the need for 'scientific humanism'.

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[19] Akhil Gupta, *Postcolonial Developments: Agriculture in the Making of Modern India* (Duke University Press, 1998).

[20] Nehru, *Discovery of India*, (John Day Press, 1946) ch.3.

Evidently, the crosscurrents of discourse on modernity and tradition shaped the use of science and technology in development plans of independent India. Whereas the basic industries followed largely the growth model of the developing countries-a fact picked up by many to point how India neglected its tradition and copied the West, the political leadership, however, tirelessly reiterated that the development ethos guiding these projects was very different, especially from those that were conducted under capitalist enterprise. Benjamin Zachariah, for instance, finds in the contemporary development debate an 'emotive significance' that was not entirely concerned with 'economic development', but of a possible India related to ideas of regeneration and progress. Although much of these ideas were catalyzed by 'contemporary worldwide discussions about how to manage economics or how to industrialize quickly' especially, ideas of John Keynes and W.W. Rostow-but these debates 'contained and incorporated far wider concerns'.[21]

The Indian nationalists-politicians and scientists- liked to thought in terms of nation-building project, rather than speak narrowly in terms of economic profit. Thus, plans for industrialization expressed broader social concerns, a strong belief in the benevolent role of science and technology, and on following an 'indigenous' path of development. Much of these remained confined at the ideational level though, particularly in the sector dealing with the basic industries.

Thus, to study how much of these ideas were translated into practice, and how the state grappled with questions pertaining to modernity, modernization and place of tradition in its discourse of development, we have to turn to the history of development of the agricultural sector and of village industries in independent India. In building a 'modern' India, its leaders

[21] Benzamin Zachariah, 'Uses of Scientific Argument' p.3690.

found it prudent to reconstitute a version of traditional India, rather than trying to search for an 'authentic' version, if there were any. We will also try to understand how the role of the 'indigenous' and capital-energy intensive resources and that of traditional knowledge and practices in India's economic development were articulated by members of the political and scientific establishment? Finally, we would explore how the espousal of the universalistic values of science would be used with varying success by individuals and institutions to legitimize development projects.

'Modern' India and the 'Need' for Science and Technology

With independence, science and technology emerged as the common underlying matrix of social and economic development of the new state. 'Need for science', Srirupa Roy observed in her study of postcolonial nationalism, became 'the most common expression of postcolonial needs discourse in Nehruvian India.' Such a discourse defined the nation-state as 'a collection of persistent and unfulfilled problems, failures, and needs' that were meant to be solved through the 'application of the objective methodologies and neutral rationalities of science.'[22] Such needs for change were most palpable in the social and economic life of the nation, prompting the newly sworn-in Prime Minister to consider using science and technology in replacing the old framework of colonial governance and mentality with a new framework that embodied the spirit of progress or modernity.

The pages of *Discovery of India* are replete with Nehru's ruminations on lack of modernity in contemporary India. He, however, did not explain this lacuna in terms any essential cultural attributes of the Indian civilisation-as did Max Weber, for instance, in explaining

[22] Srirupa Roy, *Beyond Belief*: *India and the Politics of Postcolonial Nationalism* (Duke University Press, 2007) ch.3.

absence of economic rationalism in India.[23] Nehru did not dither from critiquing India's caste system as an evil and root of much its problem. He was categorical in his pronouncement that the growing rigidity and the exclusiveness of the Indian social structure were represented chiefly by the caste system;[24] Nehru, however, did not see India's caste system as an essential feature of its religious life. Rigid caste system, in Nehru's framework of historical understanding, emerged only with the end of the first millennium. In fact, the long historical cycle of the subcontinent that begins with the Indus Valley Civilisation, and ends with the first Turko-Afghan invasions of the eleventh century witnessed, writes Nehru in the *Discovery*, a period which saw the flowering of a great civilisation, rich and vigorous, marked by some astonishing achievements in the fields of philosophy, literature, drama, art, science and mathematics. The economy expanded and prospered, and there were widespread trade and cultural contacts with many parts of the world. It was thus on historical conjuncture rather than on any kind of cultural essentialism that Nehru based his analysis of India's stagnation and decline. The subsequent failure of Indian society to match up to the universal historical norm of development was entirely explicable according to Nehru by the circumstances of colonial rule: it was because the dominant foreign power consistently impeded the growth of the forces of modernity that Indian society was found it impossible to develop.[25]

As the stultification of the national life appeared to Nehru as externally imposed, rather than something intrinsic, he was confident that the empowerment of the nationalists and a judicious application of science and technology would provide India with the necessary

[23] Max Weber, *The Religion of India* (The Free Press, 1958).

[24] Chatterjee, *Nationalist Thought and the Colonial World*, p. 133.

[25] Chatterjee, ibid.

environment conducive to social and economic development. It was only a matter of time that India would be able to resume its normal course of development. On the social front, science and technology was expected to help replace irrationality with 'scientific temperament'; Nehru considered this crucial in the making of 'modern' Indians; and on the economic front-it should contribute in building a vigorous, prosperous economy to overcome underdevelopment inflicted by years of colonial rule. It was only in achieving these two objectives that India could be considered a modern, developed nation. Being rational was equivalent to being modern in Nehru's mind that could be achieved through a planned application of science and technology. Moreover science and technology held to Nehru promise of social and economic changes without the dislocation and violence witnessed in other revolutions.[26]

It, however, took the Indian government more than a decade after independence to come up with a policy document to clarify how exactly it wanted to cultivate science, and use it for economic development and social modernisation. [27] The Scientific Policy Resolution (1958), as the document came to be known, was drafted by the famous physicist and the architect of the atomic programme in India, Homi Jehangir Bhabha. [28] With adoption of the document by the Indian Parliament, the Government of India stated officially that it would be its responsibilities to foster, promote, and sustain science and scientific research in the country, by all appropriate means. With little or no corporate research, scientific and technological work became a public sector project in India. Most of the research laboratories were set up under government initiative

[26] In a speech broadcasted by All India Radio in 1952, Nehru pointed out 'We must aim at a classless society, based on cooperative effort, with opportunities for all. To realise this we have to pursue peaceful methods in a democratic way.' Nehru, *Building New India* (Prime Minister's speeches, Government Papers, Kolkata).

[27] www.dst.gov.in/stsysindia/spr1958.htm *Scientific Policy Resolution 1958* (New Delhi, the 4th March 1958/13th Phalguna, 1879).

[28] Anderson, *Nucleus and Nation*, p.254.

and scientists were government employees. The independent state became an impartial arbiter to decide what research would best meet national needs, rather than serve private profit. The resolution took a comprehensive approach by emphasising all aspects of science and technology development: pure research to widen knowledge about nature, applied research to make economic use of scientific knowledge, and more extensive systems of scientific and technical education to train Indians in scientific spirit and technical skill. The 1958 Resolution carefully distinguished 'cultivation' of science from doing scientific research. The former had broader social implications, which indicated the government's commitment not only to professional practices of science, but also to infuse the daily life of the common man with the light of 'scientism'. A country enamoured in tradition for so long evidently needed (according to its policymakers) the inculcation of scientific values to feel connected to modern economic development.

To meet the expanding industrial application of science and technology, the government promised to ensure an adequate supply of research scientists of highest quality. Leaders planned to fulfil this promise through several means, such as public recognition of science as an important component of the nation's strength. This they thought would encourage more young Indians to opt for science and engineering as a career.[29] Moreover, to give added leverage to the scientific and industrial research institutes, the Prime Minister and the Minister for Natural Resources and Scientific Research appointed themselves as the President and the Vice-President of the Governing Body of the Council for Scientific and Industrial Research (CSIR) that had been responsible for promoting, guiding and coordinating scientific and industrial research. The

[29] S.S. Bhatnagar, *The Report of the Scientific Man-power Committee,* (New Delhi, CSIR, 1949).

close association of Nehru with the prominent scientists of CSIR, at both the official and personal level, conferred a vital political weight to the scientific community.[30]

As India veered towards socialism, the activities of its government progressively increased and it needed more science graduates to staff its technical posts. Rather than leaving matters such as transport, communications, fuel, power etc, up to individual or private enterprise, the government gradually brought these under public sector management. All these activities required the use of huge scientific and technical manpower. The government decided to promptly initiate programme for the training of scientific and technical personnel to address the growing needs. To accommodate the planned expansion of scientific and technical education, either new research institutes were opened up, such as the national laboratories and regional polytechnics, or the existing ones were made more capacious.[31]

Table 1.1 Total National Expenditure on Research & Development

Year	Expenditure (Rs. Millions)	Percentage of G.N.P
1948-49	11.0	0.18
1958-59	22.93	0.35
1968-69	1075.06	0.63
1978-79	5462.01	0.63
1988-89	30778.00	1.01

Source: R&D Statistics (New Delhi, Department of Science & Technology, 1986-87)

[30] V.V. Krishna pointed out that this 'science-politics 'nexus' under the leadership of Nehru contributed to S&T infrastructure growth and in assigning an important role to S&T in the political agenda.' Krishna, 'A Portrait of the Scientific Community in India: Historical Growth and Contemporary Problems' in Jacques Gaillard, V. V. Krishna, and Roland Waast ed., *Scientific Communities in the Developing World* (Sage Publications) p. 245.

[31] S.S. Bhatnagar, *Report of the Scientific Man-power Committee.*

Table 1.2 Expenditure on Research & Development (Sector-wise breakup)

Rupees in Millions

	1948-49	1950-51	1965-66	1970-71	1975-76
Central Sector	11.0	46.8	624.5	1124.7	2876.1
State Sector	N/A	N/A	35.1	125.8	267.3
Private Sector	N/A	N/A	24.3	145.9	423.5
Total	11.0	46.8	683.9	1396.4	3566.9

Source: R&D Statistics (New Delhi, Department of Science & Technology, 1976-77)

Notwithstanding the purely utilitarian purposes that might have provided the initial impetus behind setting up research institutes, more abstract ideals as ‘acquisition and dissemination of knowledge’ and ‘discovery of new knowledge’ recurred in SPR and in uttering national leaders, such as of Nehru. Similarly, though it was very clear to both the government and to the scientific communities that state patronage and institutional back-up would be indispensable to do ‘big’ science, (as was required by the state for large-scale industrialisation) the government at least acknowledged that huge institutions ran the potential risk of stifling individual initiative. The SPR was cautious that not only was it important to build world class institutes, but also to ensure an atmosphere of academic freedom for those who choose to be a ‘lone inventor.’[32]

[32] Bhatnagar, for instance pointed out in his speech at National Physics Laboratory (NPL), ‘those who long for the lone worker in the basement room with his wax and string and gas-blowing torch can have them. I believe that the essential spirit of the old days, the freedom of inquiry and the time for that, can be obtained even in the pressure of great new physical and organisational techniques.’ Quoted from Shiv Visvanathan, *Organising for Science: The Making of an Industrial Research Laboratory*, (Oxford University Press, 1985) p.143.

The 1958 resolution therefore serves as an archetypical example of how the nascent Indian state sought to balance, even if somewhat precariously, the demands of large scale industrialisation with a romantic vision of science. The resolution repeatedly referred to science as a benevolent entity with material and cultural benefits that the Indian government should bring to the people of the country. The intention to use science both for increasing production and social development made SPR a unique document: it planned to use science for industrial purposes and at the same time aspired to go beyond any specific productionist purpose. This approach was further evident from how Indian leaders visualised the role of science, scientists and engineers both as facilitators of country's economic development and as catalysts to social transformation of independent Indians.

Inculcation of scientific spirit among Indians had been a very significant part of the nation-building project. Its significance, it can be argued, partly came from the need to counter the perception that Indians were essentially other-worldly. Max Weber, for instance, found this other-worldliness ('flight from the world', as he called it) very common to all orthodox and heterodox Hindu thought order. Along with 'caste ties', 'authoritative fixity' and the 'dogma of the unalterability of the world order', Weber argued that a 'devalued sense of the world' discouraged growth of a 'rational' economic ethic, or spirit of capitalism in India.[33] Nehru without explicitly blaming Indian religions for India's economic stagnation, however, discouraged 'too much dependence on supernatural factors', which he considered might lead, as it had often in the past to a 'loss of self-reliance in man and to a blunting of his capacity and

[33] Weber, *The Religion of India*, p.326; *idem*, *The Protestant Ethic: The Spirit of Capitalism* (Roxbury, 2002), p. lxiv.

creative ability.'[34] In the making of a modern mind, Nehru urged that Indians should discard to 'a large extent the philosophical approach of the ancients, their search for ultimate reality, as well as the devotionalism and mysticism of the medieval period.'[35]

According to Nehru, the 'Spirit of the Age' (Zeitgeist/Yugadharma), demanded that people should be governed by a practical idealism.[36] A 'better' type of the modern mind needed to be practical and pragmatic, qualities that could be achieved through nurturing a 'scientific background, a scientific approach, a scientific mind and scientific temper.'[37] The Prime Minister was hoping to transform India from a 'static' to a dynamic, modern society, one imbued with rationalism. Nehru's high regard for rationalism stemmed from his belief that it embodied 'the temper and approach of science'. He admired contemporary scientists, technicians, and engineers as 'King Philosophers' and considered rationality as a gift of these intellectuals, a product of their minds, which modern nations should help to spread across society in a systematic and deliberate way. He urged all people to 'possess an engineering approach (or a scientific approach) to the problem facing them'. Such an approach would help in systematic way of thinking and use of reasoning to arrive at the 'reality'.[38] Rationality, Nehru was convinced, should be part of a conscious master plan for the ordering or modernisation of society.

In Nehru's exaltation of scientists and engineers, however, lurked the danger of prioritizing the role of 'expert' over the masses and civil administrators. The members of the

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[34] Nehru, *Discovery of India*, p.513.

[35] Chatterjee, *Nationalist Thought and the Colonial World*, p.138.

[36] Chatterjee, Ibid.

[37] Nehru, opening ceremony, Rare Earth Factory (Bombay, 24th December 1953), G.P. collection, National Library, Kolkata, India (GPNL).

[38] Nehru, Silver Jubilee of Central Board of Irrigation, 17 November 1952 (GPNL).

Indian Planning Commission, for instance, were looked upon as a kind of 'expert' in development matters. Nehru expected that the members because of their dispassionate and scientific approach would be most eligible to decide what would be the appropriate development path for India. Though theoretically committed to make planning a social process in which, at least in some parts, every citizen should have the opportunity to participate, it would, however, be difficult to overlook the preponderance of the experts in the entire planning mechanism. Each subcommittee of the Planning Commission was staffed and assisted by professionals with expertise on various subjects. In fact one of the most crucial factors behind the commission's enormous authority over lay person and even over various government ministries was definitely the huge amount of expert data at its disposal.

The only significant effort made to incorporate political voices at the drafting stage of the development plans was through the institution of the National Development Council (NDC), which was platform comprising of the members of the commission as well as the Chief Ministers and other important ministers of the center and the states. As the council was constituted not of elected representatives, but hand-picked by the Prime Minister, the NDC could have been expected to play a political role in balancing of the authority of the Planning Commission. But, officially it merely acted as a conduit to bring to the table their understanding of the ground reality. In a federal structure with a strong center, the influence exerted by the Planning Commission with the backing of the Prime Minister ensured that main contour of the development plans were drawn largely by experts-maintaining a safe, detached distance from the rigmarole of political process.

The powerful group that formed around Nehru, sharing and influencing much of his vision, consisted of prominent scientists, such as Physicist-Statistician P. C. Mahalanobis, Physicist H.J. Bhabha, the architect of CSIR, S.S. Bhatnagar etc. Scientists were not only seen as crucial for their expertise in technoscientific matter, but also to mould the cultural identity of the new nation. Scientists and engineers became the ideal of the 'new' society who would inspire the masses to conform to the norm of modernity and rationalism.

Thus, in spite of all the populist rhetoric of the age, 'masses' all too often entered the picture 'only as the somewhat abstract ultimate beneficiary' whose active participation was rarely envisaged by either the political or the technocratic establishment.[39] In consonance to its plan to bring science to the masses, the Planning Commission made provisions for the establishment of *Vigyan Mandirs* or rural science laboratories in the villages. The term *Vigyan Mandir* can be best translated as 'temple of science,' a phrase that implies the exalted status of science learning in India, equivalent to worshipping a god.[40] The object of the *Vigyan Mandir* scheme was to create popular interest in scientific development, to disseminate scientific information, and to bring applications of science closer to the everyday life of the rural population. By the end of the Second Plan, in the early 1960s, India had set up thirty-nine *Vigyan Mandirs* to make science more socially relevant, and hundreds of others were being planned. These institutions made available simple literature on agriculture and public health matters, plus exhibits of insects, preserved specimens, and models for illustrating plant diseases. These *Vigyan Mandirs* demonstrated hand-operated spraying and testing equipment for insecticides and fungicides to villagers, giving them the first introductions to the use of expensive agro-chemical

[39] Zachariah, EPW (2001) p.3697. See also, Jahnavi Phalke, *Science, State-Formation and Development: The Organisation of Nuclear Research in India 1838-1859* (Unpublished Dissertation, Georgia Institute of Technology, December 2007) p. 45.

[40] When J.C. Bose established the first laboratory for Indians to practice science in Kolkata during the British period, he also named it Vigyan Mandir. Even today it is popularly called Bose Vigyan Mandir. To refer to these rural institutes as *mandirs* equated science learning to religious worship, something to be done in a temple.

inputs. The Indian government established these centres for popular dissemination of science in close association with educational institutions under community development projects, so as to infuse scientific practices in day-to-day life of the common Indians, from school-age children to adult farmers.[41]

Along with scientific temper, Nehru insisted that citizens of modern India should work on fostering a new work culture. In a colonial society which Nehru criticised as a 'static' society, it was the administrators and lawyers who played the most important part. In modern India, however, Nehru envisioned the engineers to be the 'basic elements' in building up of the country.[42] He discounted the kind of thinking that grew out of lawyers and administrators as not being closely related to work. It was rather what he thought as 'ordering about other people to do work.' Nehru's call to engineers was to individually take up cudgel to build a modern nation and also to inspire others to work.[43]

Nehru's grandiose scheme of economic and social development with the aid of modern science and technology, however, remained lacking in many aspects. Limited finances, bureaucratisation and lack of private endeavour slowed the pace of development. But as the leader of the nation, Nehru was untiring in his exhortation of the virtues of modern science and technology. He imagined that its proper application, keeping in mind the specific needs of the country, would be successful in removing much of the ailments that were plaguing India's industries, agriculture and culture.

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[41] *Second five-year plan*, ch.24.

[42] Nehru, opening ceremony, Asian Training Centre, Roorkee, November 25, 1955 (GPNL).

[43] Nehru, Institution of Engineers, 12 February 1950 (GPNL).

Nehru was not alone in his 'tryst' with science. His contemporaries, irrespective of ideological convictions, both in India and in other newly independent countries kept a similar trust in the transforming capacity of science and technology.[44] Moreover, the work of the development theorists in the USA helped to further bolster the potential use of science and technology as a tool of economic prosperity. In his inauguration speech on January 20, 1949, President Harry S. Truman eloquently declared that a 'bold new program', encompassing the benefits of American scientific advances and industrial progress, would be applied for the improvement and growth of underdeveloped areas.[45] The President was confident that successful application of specialised knowledge and skill would relieve the suffering of the masses in the developing world. He believed that greater agricultural and industrial production is the key to prosperity and peace, in achieving which scientific and technical knowledge would play a crucial role.[46] A particularly appealing aspect of the President's speech was his suggestion that people who had so long been categorised by the European colonialists as uncivilised, uneducated and backward, could now in fact work towards development and vertical progress in the hierarchy of states.[47] Historians and critics of the development doctrine look back at this programme, more popularly known as the 'point 4'[48], as having inaugurated the 'development age.'[49]

[44] Nasser's Egypt and Sukarno's Indonesia are typical examples. Parthasarathi, *Acquisition and Development of Technology*, p.1. In fact, these countries were so overwhelmed by their necessities to increase economic production that they were oblivious to ecological concerns, an attitude, which Ramachandra Guha has termed as 'ecological innocence', Ramchandra Guha, *Environmentalism: A Global History* (Longman, 1999) p.63.

[45] Truman did not elaborate on how he designated 'underdeveloped' areas. He hoped that a program could be planned whereby American technical aid would go to the 'peace loving' people of the world.

[46] http://www.trumanlibrary.org/whistlestop/50yr_archive/inagural20jan1949.htm

[47] Truman's contention was that backwardness was not a given permanence, a static entity, but rather a condition of unrealised potential which could change through science and technology and judicious investment of capital.

[48] Technical assistance was the number four agenda mentioned in the inaugural speech. The other three being support to the United Nations, world economic recovery, and collective defense against aggression.

The unquestioned desirability of economic growth that was evident in the development rhetoric was closely linked to the revitalised faith in science and technology.[50] The United States government and few US private organisations, such as the Rockefeller and the Ford Foundation played crucial roles in application of this development model in India.[51] US assistance mainly came in the form of financial and technological aid. Science and technology, the participating US agencies believed, would assist the underdeveloped nations to shift away from their dependence on natural forces, which observers dismissed as not having the rationality, slickness and efficiency of modern science. W.W. Rostow, the patron-saint of the development' theory vociferously recommended that twentieth-century humans should come to regard the physical environment not as 'a factor given by nature and providence, but as an ordered world which, if rationally understood, can be manipulated in ways which yield productive change…'[52] Reflecting that same mindset, this particular developmental paradigm was biased against

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[49] Gilbert Rist, *The History of Development*: *From Western Origins to Global Faith* (Zed Books, 2009) p.71.

[50] To understand how integral economic growth was to the rhetoric of development see: United Nations, Report on International Definition and Measurement of Standards and Levels of Living, 1954.

[51] In the years following the Second World War, United States was by far the most resourceful country in the capitalist bloc capable of undertaking extensive development projects in war ravaged Europe and in newly independent countries of Asia. Though each of these agencies had its own separate spheres of interests in India, such as the Ford Foundation concentrated on works of community development, the Rockefeller Foundation gave priority to building scientific research institutes and the Technical Cooperation Mission under the initiative of the US government dabbled in various kinds of technical projects, they were, however, convinced of the necessity of development, in the growth of free-market economy, in the need to resist the spread of communist ideology. Their common interests have been commented upon by many a scholars, such as Anderson et al ed., *Science, Politics, and the Agricultural Revolution in Asia* (Westview Press, 1982); George Rosen, *Western Economists and Eastern Societies: Agents of Change in South Asia, 1950-1970* (Johns Hopkins Press, 1985); Mark T. Berger, *The Battle for Asia: From Decolonization to Globalization* (Routledge, 2003); Though studied mainly from the perspectives of philanthropy and war against hunger, Hewa and Stapleton ed., *Globalisation, Philanthropy, and Civil Society* and Nick Cullather, *The Hungry World* could not escape including the political ideology that motivated the actions of the development agencies during this period. Moreover, all these private and government agencies believed in the efficacy of exploring the latest technoscientific knowledge that was in use in the developed countries. The goal was to mould the recipients in the image of the donor. This was best evident in building Indian agricultural research institutes as a prototype of American land grant institutes.

[52] Rostow, *The Stages of Economic Growth*, p.19.

handicraft because it rarely made any explicit use of large scale technology or scientific principles. Backwardness, it argued was to be eliminated through development, which was a 'better' way of organising man and nature, based on the rich insights of up-to-date science.

The drive to advance big industry in the developed countries was paralleled by an equally powerful project to reorganise society along scientific lines, applying the principles of rationality, empiricism and enlightenment to human society. Many of the new independent nations, heavily committed to development, joined 'experts' during this period in embracing science as an attractive instrument to remake their people in the image of what they believed was an advanced form of man, 'freeing' them from the irregularities linked to gender, race, 'traditional' values, and autonomous opinions. [53] The agenda of transforming men and society were encouraged as crucial to the development projects. Modern societies were treated as discrete objects that would be bereft of all its natural, historical and social references that were not conducive to economic development. The new societies as opposed to the traditional ones would be cosmopolitan, mobile, controlling of the environment, secular, welcoming of change, and characterised by a complex division of labour.[54]

The development model, on its adoption, promised a prosperous and modern society. Its proponents stressed on its universal applicability and drew attention to the underlying simplicity of the model. The claim to universal replication, however, necessitated that its proponents gloss over all regional characteristics that might act as potential hindrances to the path of development.

[53] Claude Alvares, 'Science' in, Wolfgang Sachs ed.,*The Development Dictionary a Guide to Knowledge as Power* (Zed Books, 2010). Alex Inkeles, 'Making Men Modern: On the Causes and Consequences of Individual Change in Six Developing Countries,' American Journal of Sociology 75 (1969), 208-225.

[54] A traditional society, by contrast, was inward looking, inert, passive toward nature, superstitious, fearful of change, and economically simple. All of the countries of Latin America, Asia, and Africa were brought under the single category of 'traditional.' Gilman, *Mandarins of the Future*.

In extending technological and financial aid, the US government and the private agencies expected that the recipient countries would generally adopt the ways and means endorsed in the development discourse.

Historically, David Ludden pointed out in his study on India's development regime, India have shared the 'cognitive terrain' with the developed countries in term of the following precepts: 1) ruling powers that claim progress as a goal 2) 'people' whose conditions must be improved 3) an ideology of science that controls principles and techniques to effect and measure progress, and 4) self-declared, enlightened leaders who would use state power for development. [55] Beyond these generalized notions about development, however, at the level of practices many variations were visible. For a country like India driven by its own complex social, economic and political dynamics and its engagement with the question of modernity and tradition, the adoption of this development model was only partial and selective. Even with the adoption of the capital-intensive technological package of the green revolution days, its dissemination would be selective-limited by agro-ecology, infrastructure and economic condition.

<u>Foreign Technology and Technological Autonomy</u>

______In the initial years after independence, India did not have the technological capacity to equip its industries. The country, therefore, encouraged import of foreign technologies through tax benefits and other fiscal measures. A specific kind of technology transfer, known as the 'turn-key' technology, took place between India and the developed countries. Typically, in such a case, suppliers from Northern countries would transfer complete factories and industrial plants, installing equipment and then training technical personnel of the purchasing country to operate

[55] David Ludden, 'India's Development Regime' in Nicholas Dirk (ed.), Colonialism and Culture, 262-63.

and maintain it. In some cases, the supplier's technical personnel themselves operated and maintained the plant for quite some time, before local technical personnel were able to 'take over' the plant. As a historian of Indian science and technology has argued, all the early mining, power, steel and chemical plants in India that came up during the late 1950s and early 1960s, were built with this type of technology transfer.[56]

The other logic used in accepting foreign technologies was that as a late starter in the history of industrialization, India should be open to benefits from the technological knowledge bank that had already been developed by industrialized countries. Technology transfer and foreign technical collaboration, however, always remained a highly contentious issue in India's development, because it problematized the concept of 'technological autonomy' that national leaders held so dear. The dilemma was that India needed basic industries for its economic growth but did not have the technical know-how to build them up. For that it needed to borrow both man and material from the already industrialized countries. But a continuous borrowing of foreign technology only reinforced India's dependence and delayed the goal of 'technical autonomy'.[57]

A number of research sectors that had to heavily depend on foreign collaborations often justified it on grounds of either a quicker take off, or stressed on the ultimate benefits that it was imagined to bring for the country. For instance, H.J. Bhabha, later dubbed as the 'Father of Indian Nuclear Programme', held much hope for the role of atomic energy in raising people's

[56] Ashok Parthasarathi, *Acquisition and Development of Technology: The Indian Experience, (CPR Lecture Series 2003-04, Center for Policy Research, New Delhi, April 2004),* p.2.

[57] See, Physicist Meghnad Saha's letter to Prime Minister Jawaharlal Nehru on question of 'Technical Autonomy' and collaboration with German engineers in iron and steel industry. Saha to Nehru, 5 Dec 1953, Saha Papers (SP), Nehru Memorial Library, New Delhi, India.

living standards to levels comparable to that of the industrially advanced countries.[58] In absence of any national tradition of atomic research, such a feat could be achieved, Bhabha argued, only if the country imported 'one or two really first-class men from abroad for a limited period…' to give '…experimental work in Nuclear Physics and Cosmic rays a great fillip.'[59] On the other hand, Meghnad Saha, who had been a vociferous advocate of 'national initiative', insisted that India first needed to address the 'dearth of good mechanics, laboratory men'. He drew attention to the lack of engineering and manufacturing firms for the production of 'machinery, electrical goods, scientific instruments or chemicals.'[60] Saha insisted that Indian scientists and technologists should be associated at all stages of a scientific project, and pointed out to Nehru that there could be no development of atomic energy in India without the development of an atomic instruments industry, and of associated chemical and metallurgical industries.[61] Saha's plans for self-reliance went beyond the question of expedient uses of technology; he insisted on technological development being based on socialist economic planning. Saha, therefore, not only challenged foreign control over India's technological development but also 'distorted concentration of capital'.[62]

Bhabha in turn was so convinced about atomic energy's role in India's development that he unhesitatingly asked for more resources, demanded absolute autonomy to avoid any interference from the country's political establishment, and adopted a veneer of secrecy on their

[58] Robert. S. Anderson, *Building Scientific Institutions in India: Saha and Bhabha* (McGill University, 1975) pp.66-87.

[59] Bhabha to Saha, 25 Jan 1947, SP.

[60] Saha to Bhabha, undated draft, File 68, 'Correspondence with Bhabha', SP.

[61] Sur, 'Scientism and Social Justice', p.101. His idea of possible sources of power was, therefore not the atom, but the rivers (and fossil fuel) of eastern India.

[62] Bhabha and Saha's differences have been studied in detail by Anderson, *Building Scientific Institutions in India*

activities at Trombay Atomic Research Centre that kept them immune from any unwonted queries from fellow scientists.[63] Bhabha, later in his career, attempted to balance the role of 'indigenous' efforts and 'foreign' collaboration in following terms: 'indigenous science and technology plays the part of an engine in an aircraft, while foreign collaboration can play the part of a booster. A booster…can give a plane an assisted take-off, but it will be incapable of independent flight unless it is powered by engines of its own.'[64] The planning documents bore no evidence that at the policymaking level foreign assistance was discouraged, but, while agreeing on the role of advanced technology on securing higher productivity, the Planning Commission at the same time insisted on techniques especially suited to local conditions; they pointed out that the problem was not merely one adopting and applying the processes and techniques developed elsewhere, but of developing new techniques specially suited to local conditions.[65]

Under the charged atmosphere of the Cold War, the issue of foreign technological assistance became further politicized. Though foreign assistance was a consistent feature in India's economic development, especially in sectors related to atomic energy, heavy industries and in agriculture, there was a palpable ambivalence about it among the political leaders that did not escape the American officials either. After inaugurating the Technical Cooperation Programme in India on January 5, 1952,[66] the American Ambassador to India, Chester Bowles,[67]

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[63] Saha was highly critical of this secrecy that the Atomic energy project enjoyed, see, Sur, 'Scientism and Social Justice' and Anderson, *Nucleus and Nation*.

[64] Bhabha, 'Science and the Problems of Development', p.548.

[65] The Planning Commission of India, *First Five Year Plan*, ch.1.

[66] This treaty was in continuation to the General Agreement for Technical Cooperation signed on behalf of the two governments at New Delhi on December 28, 1950.

[67] Bowles was the third U.S. Ambassador to India, who wrote profusely on the Indian situations and the need for American aid to ameliorate the situation. For biographical work on Bowles see, Richard P Dauer, *A North-South Mind in an East-West World: Chester Bowles and the Making of United States Cold War Foreign Policy, 1951-1969*

reported back home how sensitive the Indian leaders, especially Nehru, were about receiving any kind of foreign aid. Merely the proposal for accepting Western assistance, Bowles recalled, risked evoking a feeling of submission to a stronger power. [68] Indian leaders wanted to rapidly modernize their people and living conditions, and sought technological and scientific assistance to achieve that aim smoothly and in a reasonable period of time, but they were haunted by the specter of being subjected to a political camp in the ongoing Cold War politics of entente formations. Similar views were expressed in the October 1956 conference of U.S. Consuls General and political officers in India. The participants concluded that although 'many responsible Indians desire close ties with the West and although India's need for foreign aid will be great for several years, the psychological barriers to accepting such close cooperation and assistance are very great. It has to be recognized as a political fact, the American political officers argued that due to a lifetime of struggle against colonialism, Indians generally have a very strong objection to the slightest hint of foreign influence or control-they do not even like to have foreigners managing factories in India.'[69]

Thus, factors such as the pressure of Cold War politics, the historically felt need to have modern industries, the desire for technical autonomy -all motivated the Indian government towards adopting a balanced program of research, covering every sector of the economy under state patronage. For promotion of scientific and industrial research, the plan was to set up eleven national research laboratories under state patronage. Most of these research laboratories were

(Praeger, 2005) and Howard B Schaffer, *Chester Bowles: New Dealer in the Cold War* (Harvard University Press, 1993).

[68] Chester Bowles, *Ambassador's Report* (Harper & Brothers, 1954) p.131.

[69] Foreign Service Despatch from Embassy New Delhi to Department of State, Washington, October 17, 1956, 469.7 Records of the International Cooperation Administration, NARA.

built up as specialized institutions dealing with problems of specific industries such as metallurgy, fuel, food technology, drugs, glass and ceramics, roads, building, leather, and electro-chemical technology.[70] The National Laboratories were intended to study ways to improve techniques to increase production and also ways to augment national resources by substituting cheap and abundant materials for those in short supply and by finding new purposes for unutilized materials.[71]

As capital always seemed to be at a short supply for decades after independence and certainly in those early years, planners, therefore, strongly emphasized not only on the goal of developing technology through national effort, but also on making better uses of 'indigenous' raw material. For instance, the Central Leather Research Institute investigated possible methods to make more use of indigenous tanning materials and to develop substitutes for materials like wattle bark, which India did not produce in any significant quantity. In the face of persistent shortages of cereal crops, the Central Food Technological Research Institute undertook a series of investigations into the nutritive value of various Indian foods, roots and tubers that might be processed and fortified to substitute for cereals. To assist the paint and varnish industry and in manufacturing of phosphate fertilizers, the National Chemical Laboratory (NCL) conducted research to replace Tung oil with 'Kamala' seed oil (*Mallotus philippensis*), which grew profusely in India. The National Metallurgical Laboratory (NML) investigated different types of ores found in various parts of the country and studied alloy steels of interest to production in

[70]The National Physical laboratory and the National Chemical laboratory, however, were to deal with general industrial problems, especially addressing fields such as radio and electronics industries for which no specific foundation had yet been built up. The planners would propose the building up of three other nation laboratories under the second plan period. These were a Radio and Electronics Research Institutes, a Mechanical Engineering Research Institute, with special emphasis on the study of problems of cottage and small-scale industries, and a Central Salt Research Station.

[71] *First five-year plan*, ch.28.

metallurgical industries. National Fuel Research Institute conducted widespread surveys to determine the national availability of coal, which turned out to be crucial for the large power plants that the post-independence government was setting up.[72]

The insistence on usages of ‘indigenous’ material, however, did not in anyways implied an ideological abhorrence of the ‘foreign’ scientific communities. In the initial years, several of these labs had foreign scientists as head of their institute. For instance, in 1948 S.S. Bhatnagar, who was responsible for setting up the chain of national laboratories, appointed George Sachs, an American metallurgist, as director of NML. He also appointed British chemist J.W. McBain, as director of the NCL and the Austrian-American glass scientist N.J. Kriedl as the Director of Central Glass and Ceramics Research Institute in Calcutta. [73] As long as Nehru lived several foreign experts such as Niels Bohr, Joseph Needham, J.B.S Haldane and others visited India on short-programs. Critics of foreign control, as we see in case of Saha too, were open to the idea of foreign collaboration at a personal level, but had reservations about such collaborations on a government level, as it implied a kind of dependence and loss of self-reliance.[74]

Much has been written on the indubitable importance given to industrialization in the development of Indian economy after independence.[75] Nehru’s view that no country could be

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[72] Ibid.

[73] Bhatnagar’s initial choice for the NCL post, however, was chemist Salimuzzaman Siddiqui. Siddiqui’s appointment was coveted both by Indian industrialists and chemists because they thought he would enable the lab to interpret and apply to modern problems the rich potential of Indian pharmacopoeia, natural products, and indigenous knowledge. However, other political considerations overrode Siddiqui’s expertise with ‘indigenous’ knowledge, in deciding against his appointment. Anderson, *Nucleus and Nation,* pp.156-157.

[74] Anderson, *Building Scientific Institutions*, pp.100-101.

[75] See for instance, Dieter Rothermund, *An economic history of India*: *from Pre-colonial times to 1991* (Routledge, 1993) ch.10; B.R. Tomlinson, *The economy of modern India*, 1860-1970 (Cambridge University Press, 1996) Ch.4; Dharma Kumar, Tapan Raychaudhuri, Meghnad Desai, *Cambridge economic history of India* (Cambridge University Press, 1984) p.954.

politically and economically independent unless it was highly industrialized had been quoted umpteenth number of times to illustrate the primacy accorded to capital-intensive technology by the new government. Industrialization was evidently considered indispensable by Nehru not only to achieve or maintain high standards of living and liquidate poverty, but also not to 'upset the world's equilibrium and encourage the aggressive tendencies of more developed countries.'[76] Partha Chatterjee used Nehru's exhortations on 'spirit of the age' to argue that for the Indian Prime Minister, 'the question of a choice between two alternative paths of economic development, one based on large-scale heavy industry and the other on decentralised small-scale industry, simply did not arise.'[77]

The importance of reviving cottage industries and village industries, practiced for centuries by artisans and craftsmen in Indian villages and town, have been seen as more concomitant to Gandhi's ideas of economic development, rather than to the economic vision of modern India. However, the planning documents and the Industrial Policy Resolution of 1948 and 1956 carried substantial evidences of provisions made for the development of various types of small-scale industries India. The first three five year plans, roughly covering the period from 1951-66, allotted 2, 4 and 2.8 percent of the total expenditure of each plan respectively for its development.[78] The moderate investment figures can and will be interpreted by many as indicative of the relative insignificance of the sector compared to say heavy industries. It would, however, be misleading to use these figures to ascertain the role played by cottage/village

[76] Nehru, *Discovery of India*, p.413.

[77] Chatterjee, *Nationalist Thought and the Colonial World*, p.144.

[78] From the fourth five year plan to the sixth (1969-1985), village and small industries received 1.9, 1.5 and 1.3 percent respectively. Paul Brass, *The Politics of India since Independence*, (Cambridge University Press, 1994) p.274.

industries in the initial two decades of India's independence for following reasons: first, cottage industries were not meant to cost as much as the highly mechanized basic industries. If it did, it would have flouted the basic principle that governed its existence. Cottage/village industries were meant to create employment, (especially to women folk) without costing much, using simple tools and local products. [79] Secondly, cottage industries were surely not planned to be an alternative for large-scale industrialization; thus, it would be wrong to find parity in investments made for their respective development.

The economic and technological impetus to the small-scale industries were planned with an assumption that these would provide 'immediate and permanent employment on a large scale at relatively small capital cost, meet a substantial part of the increased demand for consumer goods and simple producer's goods, facilitate mobilization of resources of capital and skill, which might otherwise remain inadequately utilized and bring about integration of the development of these industries with the rural economy on the one hand and large-scale industry on the other.' The small industries were also expected to offer 'a method of ensuring more equitable distribution of the national income and avoiding some of the problems that unplanned urbanisation tends to create.' However, it was only with 'improvement in techniques and organisation' and not in its use in its existing form that these industries offer possibilities of growing into an 'efficient and progressive decentralized sector of the economy', the planners explained.[80]

The plan to create more employment through revitalizing handicraft industries could be traced back beyond Gandhi to the thoughts of the nationalist economists of the late nineteenth

[79] Women were specifically mentioned in the first five year plan, ch.25.

[80] *Third five year plan,* Ch. 25.

and the early twentieth century. By the end of the nineteenth century, most of the indigenous industries of India had either decayed beyond recovery or were on the road to ultimate ruin, while modern industry was yet to reach considerable proportions. The early Indian national leaders bemoaned the fact that the 'industrial prostration' of the Indians under colonial rule was the result of the conjunction of these two factors. Evidently, spinning and weaving and other handicrafts had provided whole-time or part-time employment to millions of men and women, but with the deliberate destruction of Indian handicrafts, there was an increased 'rustication' of the country. It resulted not only in an overdependence on agriculture for livelihood, but also a 'loss of power, and intelligence, and self-defence.' To the nationalist leaders, this lack of indigenous industry as an alternative means of income also helped to explain the repeated famines of colonial India. Thus, they made protection, rehabilitation, reorganization, and modernization of handicrafts into an important plank in their program for halting further regression in the material condition of the masses and for the economic revival of the country.[81]

To Gandhi India's traditional cottage industries, unlike the machineries of modern civilization, which engendered 'greed and want' and widespread unemployment, appeared ideal for the country's economic development as these were labor-intensive, used simple tools and were local resource-based.[82] Gandhi's critique of modern civilization was put in the language of an economic theory by a German economist, Ernst Schumacher. Schumacher's ideas of

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[81] Bipan Chandra, *Rise and Growth of Economic Nationalism: Economic Policies of Indian National Leadership, 1880-1905* (PPH, 1966) pp.55-65.

[82] For Gandhi's ideas on machinery and modern civilisation see, Bhikhu Parekh, *Gandhi's Political Philosophy: a Critical Examination* (University of Notre Dame Press, 1989) pp.14-35; Bhikhu Parekh, *Colonialism, Tradition and Reform: An Analysis of Gandhi's Political Discourse* (Sage, 2003), pp.71-105; O.P. Misra, *Economic thought of Gandhi and Nehru: a Comparative Analysis*(New Delhi, 1995); Anthony J. Parel ed., *Hind swaraj and other writings* (Cambridge University Press, 2009) Parekh (Political Philosophy, p.22) pointed out that Gandhi was unwilling to barter 'people's sanity, self-respect and the right to work' for 'increased leisure or of cheaper goods' that industrialization promised.

'intermediate technology', which was argued to be best applicable in the context of developing countries, were selectively put to use by the Indian government in the technological development of its cottage industries. Throughout the 1950s and 1960s, Jayaprakash Narayan, a Congress-Socialist leader was one of the early supporters of Schumacher's ideas in India. The two soon build up a personal and ideological rapport.[83] Convinced of the applicability of Schumacher's ideas in the context of India's development, Jayaprakash informed Prime Minister Nehru of Schumacher's work. Consequently, in January 1961Schumacher was invited to be a speaker at an international seminar on 'Paths to Economic Growth' held in Poona. In 1962, following prompting from Nehru, Jayaprakash invited Schumacher to come to India for six months as advisor to the Planning Commission. [84] It was evidently during this trip that Schumacher came to realize the need to develop a level of technology 'appropriate' to the needs and resources of a developing society; he specifically mentioned four characteristics of a technology: it would be small in scale so that it could fit into small market situations; it would be simple, so that sophisticated manufacturing skills, organization and finance would be unnecessary; it would not be capital-intensive, and would therefore keep the cost per workplace down; and it should be non-violent, which meant that an appropriate technology would be one that was completely under human control, that it would not have unintended side effects, and that it would not cause social or environmental disruption.[85]

Though it is evident that Schumacher's ideas did not influence the technological development of the Indian economic sector in its entirety, his ideas had an impact on the

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[83] George McRobie, *JP and EFS: A Most Productive Friendship*, Box 1 Folder 8 (E. F. Schumacher Archives, New Economics Institute, Barrington, Massachusetts, USA).

[84] Weber, *Gandhi as Disciple and Mentor*, ch.11.

[85] Ian Smillie, *Mastering the Machine Revisited: Poverty, Aid and Technology* (London, 2000) p. 90.

development of cottage industries in independent India. This was especially so because neither Schumacher nor his immediate successor, George McRobie were dogmatic in defining appropriate technology; they insisted that it was by no means certain that all the criteria could be satisfied in every case; any one of them, or combination of them would be valuable for the purpose.[86] Development of cottage industries in India reflected this flexibility; without explicitly committing itself to non-violence, the government found it economically prudent to advocate alternative technologies for cottage industries. Such technology being more labor-intensive helped to increase employment; it raised productivity with little capital-investments, and created products that would meet the needs of the economically disadvantageous.[87]

These ideas would be further brought into fruition through government's support for village industries in rural development programs. The planners were aware that rural arts and crafts had both social and economic significance; economically, it would not only help to arrest increasing pressure of population on land, but also use local raw materials and simple techniques to supply goods to the local markets.[88] In fostering organic unity and culture of the villages, the government expected that village printing, embroidery, pottery, and the crafts of tribal people, would continue to play an important role, just as it had done in the past. All these prompted

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[86] Smillie, 'The Case for Appropriate Technology: A Reply to R.S. Eckaus.' p. 91, *Essays in Science and Technology* 3 (4), 1987, pp. 101-109.

[87] Stewart, 'The Case for Appropriate Technology', p. 103.

[88] The following village industries were drawn up by the Planning Commission in consultation with experts: village oil industry, soap-making with neem oil (because the oil is inedible, anti-septic and *neem* trees, *azadirachta indica* have been widely available in India), paddy husking, palm and cane *gur* industry, leather industry, woolen blankets, high-grade hand-made paper, bee-keeping, and cottage match industry.

extension of government patronage in the development of these crafts, which it admitted to have suffered much from the economic development of the past few decades.[89]

The government's plan to revive cottage industries was closely associated with the spirit of self-reliance. Though from the outset, it might seem that the idea of self-reliance had a Gandhian lineage, which it had, but, there was a difference in how it was defined by Gandhi and by government of independent India. For Gandhi swadeshi or self-reliance was a mean to fight dependence on British goods, capitalism and also materialism. He defined it as the 'spirit in us which restricts us to the use and service of our immediate surroundings to the exclusion of the more remote…In that of economics I should use only those things that are produced by my immediate neighbours and serve those industries by making them efficient and complete where they might be found wanting…'[90] The two most important elements that linked Gandhi's espousal of swadeshi to his plans for cottage industries were that the society must be capable of supplying the basic minimum needs of the people without dependence on external sources, and maximum uses of indigenous resources and technology.[91] For Gandhi, as we see from his definition of the swadeshi, by 'external' sources not only meant foreign imports, but also anything beyond the immediate neighborhood. This was in congruence with his idea of an India made up of self-reliant village republics. But for most leaders of independent India, the call for self-reliance did not hinge on anything that insular. Their insistence on using indigenous resources came more from a practical concern of saving valuable foreign exchange and developing national capacity. The government of India planned to use its research establishments

[89] *First five year plan*,ch.24.

[90] M. K Gandhi and Anand T. Hingorani, *Socialism of My Conception* (Bombay, 1966) p.70.

[91] It, however, did not ask for complete absence of trade with other countries. Misra, *Economic thought of Gandhi and Nehru*, p. 22.

and natural resources to revamp the ailing handicraft sector and turn it into a valuable foreign-exchange earner.

With that view in mind, the Central Government constituted a Handicrafts Board with advisory powers.[92] The planners realized that apart from financing handicraft industries, the government needed to organize research to develop it. Research in handicrafts would involve study of local art, skill and tradition, as well as the study of materials. This would mean developing a number of institutions across different parts of the country to undertake research on handicraft production. Planners also urged the Central Government to consider the possibility of establishing a central institute for the study and preparation of designs, which could work in co-operation with arts and crafts schools, institutions like *Shantiniketan*, and industrial departments in several States.[93]

Given that the technical development of cottage and rural industries constituted a significant part of India's anticipated economic development, the newly founded national laboratories were expected to play a decisive role towards that end. Since cottage and rural industries did not have the requisite finance to create their own research and development departments, the national laboratories brought the latest technology within their reach, aiming to help medium and small-scale producers to reduce costs and improve quality of their products. Other than these, a Central Research Institute for Village Industries under the All-India Khadi

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[92] Similar other all-India Boards were constituted by the Indian government to deal with the problems of the handloom industry, *khadi* and village industries, small-scale industries, sericulture and the coir industry.

[93] *First Five Year Plan*, ch.25.

and Village Industries Board was established in western India at Wardha that worked on developing and designing products and tools to be used by small-scale industries.[94]

Thus, the independent Indian government made a selective appropriation of Gandhi's ideas of cottage industries. Instead of using it as an alternative, however, the Indian government encouraged its simultaneous growth by integrating it with institutionalized research establishment. Nehru suggested coordination between the two types of industries in India's economic development, arguing that industrialization could play a complementary role in the growth of cottage industries. He wrote, 'Without industrialisation no country can have political or economic freedom, and even cottage industries cannot develop to any large extent if economic freedom is absent… the development of cottage industries is helped greatly by the supply of cheap power and suitable machinery for cottage use which are obtainable from the working of large scale enterprises. To some extent, handicrafts and large-scale industrial enterprises are complementary to each other. The problem before the country, therefore, is one of coordinated growth in both directions and the avoidance, so far as possible of conflict between cottage industry and large-scale industry.'[95]

A coordination between cottage and large scale industries was attempted through a 'common production programme' that reserved areas of production for each, levied cesses on the big industries to develop related small enterprises, and gave a price advantage to the smaller

[94] *Third Five Year Plan*, ch.25.

[95] A.M. Zaidi and S.G, Zaidi ed., *The Foundations of Indian Economic Planning: an Attempt at Reshaping the Destiny of 600 Million Indians* (S.Chand, 1979) p.386.

units through differential taxation, subsidies, sales rebates, etc.[96] At the level of policy formulation, the Indian state would continuously claim that its goal was not to let the handicraft and village industries perish in face of the demand for rapid industrialization, but rather to bring small enterprise within the fold of state patronage and make those economically productive by instilling technological improvement. This could be seen as an extension of the state authority in a previously unorganized sector through the formation of government sponsored credit cooperatives and organization of training facilities. No attempt, however, was undertaken at the government level to bring about a large scale mechanization or mass production of handicrafts in factories.

Unlike in the case of big factories, the research enterprises for the small-scale industries concentrated upon producing low-cost, simple equipments that were build using locally-available resources. For instance, to meet the requirements of yarns for handlooms, instead of setting up mechanized mills, the government encouraged researchers on devising a technically sound and low-cost *charkha*. The second-five year plan reported that technical tests were being conducted on what came to be known as 'Ambar charkha', a three-unit spinning set consisting of a carding machine, a drawing machine and a four-spindle spinning wheel. The Khadi and Village Industries Board launched a pilot program, which included in its initial phase more that hundred training centers across the country to train people on use of technically improved charkhas and production of the same. Similar steps were taken to popularize hand-pounded paddy instead of using power-driven rice mills. As advised by the Rice Milling and the Village and Small Scale Industries Committee (KVIC), the government proposed that all power driven rice mills should

[96] From the third five year plan, however, the government would start reconsidering the subsidies and rebates and instead concentrate more on 'positive' assistance such as supply of raw material and organization of technological training.

be licensed and that no new mills should be allowed to be set up nor expansion of capacity of the existing mills allowed, except where it was considered absolutely essential in the public interest in special circumstances. This however meant that the level of technical efficiency and output of hand-pounded rice needed to be improved upon. A scheme was undertaken to come up with improved 'Assam dhenkis' and winnowing fans. [97]

The vegetable oil industry was also incorporated within the ambit of small-scale industry and instead of using mechanical power to crush oil seeds at the mills, the government insisted on using the traditional *ghani* technology. A *ghani* though varying in designs over regions was essentially a 'mortar-and-pestle device made of stone or wood that uses a perambulating animal to extract oil under pressure from oil-bearing seeds…'[98] whose existence could be traced back to Sanskrit texts of Panini of the sixth century BC. In the 1930, when the All India Village Industries Association was formed in Wardha with the backing of Mahatma Gandhi, Jhaverbhai Patel was put in charge of improving the *ghani* oil sector. The best features of six regional designs were put together and tested by building models, to yield the Maganvadi *ghani* in 1943. This incorporated improvements which, Gandhiji wrote, 'have lessened the labour of both men and animals who work at the *ghani* and at the same time have improved the output of oil.'[99] Further technical improvements on this model led to the Wardha *ghani* in 1954.

By 1958, some 5,800 improved Wardha *ghani*s had been introduced by the KVIC, and in the next decade the figure had risen to over 32,500. The popularity of the *ghani* comes from its overall high working efficiency and reduction in cost. The provision of automatic stirring and of

[97] *Second five year plan*, ch.20.

[98] K.T. Achaya, *A Historical Dictionary of Indian Food* (Oxford University Press, 2003) p.77.

[99] Gandhi, *Harijan*, 2 September, 1939.

an oil drain both reduced the strain on the artisan. The pestle did not have to be removed each time, so one person could look after two *ghani*s. The strain on the animal was reduced by the introduction of ball-bearings in the pestle cap, and the provision of a trenched track in which to move. Capital and recurring costs were both reduced. While the cost of the *ghani* itself was unaltered, the low pestle meant that a very high shed was not needed. Besides, the availability of replaceable standard parts had the advantage that the whole *ghani* did not have to be replaced. It was not that improvisation of *ghani* stopped with this; in 1968, KVIC recommended that electric power be introduced to replace bullock power to give a better monetary return to the oilmen, without compromising the flavor of oil or driving anybody to unemployment.[100]

Cultural Modernization and the Scientific Temper

With all his fascination for a modern state populated by rational modern men, Nehru's attitude to modernity was marked by significant ambivalences that surfaced in spite of all his optimism. He observed that modern civilization that developed first in the West and spread elsewhere 'produces an unstable society which gradually loses its vitality. Life advances in many fields and yet loses its grip; it becomes more artificial…'[101] As the 'basic' cause of this decadence, Nehru identified spiritual malaise, 'something effecting the mind and spirit of man.'[102] Nehru earnestly believed that India is the place, where with her own tradition of spirituality, the destabilizing effects of modernization could be curbed. In the cultural regeneration of Indians, therefore, spiritualism substituted religious traditions to counter undesirable impacts of modernization on society. Being part of the modernization plan,

[100] K.T. Achaya, *Ghani: The Traditional Oil Mill of India* (Pennsylvania, 1993) pp.49-88.

[101] Nehru, *Discovery of India*, p.554.

[102] Nehru, *Discovery of India*, p.555.

spiritualism was considered as not antithetical to rationalism or to science in general. Science and spiritualism would coexist in any modern Indian, as was the expressed desire of Nehru. He termed this coexistence as 'scientific humanism'.[103]

A convincing conceptual coalescence of science with spiritualism required Nehru to redefine both. The much coveted scientific spirit, Nehru pointed out, should not limit man into exploring the material world, rather it should help to face life with 'the temper and approach of science allied to philosophy and with reference to all that lies beyond.'[104] Through this reformulation, Nehru attempted to find a harmony between the world of fact and world of spirit. According to Nehru's own admission, it was through his idea of scientific humanism that he tried to find an answer to the much vexed question of how to reconcile the phenomenal life of the world with the inner spiritual life of the individual. It was only through practicing scientific humanism that I see Nehru trying to bridge the private domain of spiritualism with the public domain of science. A modern Indian, inspired by scientific humanism, would be a reflection of the synthesis of both these worlds.

As science, spiritualism needed a redefinition too and Nehru especially had to distinguish that spiritualism was not something dependent on supernatural factors; it was a 'necessary' faith 'in things of the spirit which are beyond the scope of our physical world, some reliance on moral, spiritual and idealistic conceptions'; he considered faith necessary for without it there would be 'no anchorage, no objectives or purpose in life.'[105] In the cultivation of this spiritualism, Nehru saw no giving away to feeling of abstention, the much-criticized 'otherworldliness' of Indians,

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[103] Nehru, *Discovery of India*, p.514.

[104] Ibid.

[105] Nehru, *Discovery of India*, p.513.

but rather the 'detachment' of a 'matured' civilization. He explained that, 'as a man grows to maturity he is not entirely engrossed in, or satisfied with, the external objective world. He seeks also some inner meanings, some psychological and physical satisfactions. So also with peoples and civilizations as they mature and grow adult. Every civilization and every people exhibit these parallel streams of an external and internal life.' Thus, Nehru found in India, as elsewhere, these two streams of thoughts and actions-the acceptance of life and detachment from it- developing side by side, with the emphasis on the one or the other varying in different periods.[106]

Nehru located this spiritualism in an idealized construction of India's past and in the achievement of its people. Without any visible effort to historicize his observations, Nehru wrote, '…the buoyant energy and love of life and nature of our forefathers, their love of truth and beauty and freedom, the basic values that they set up, their understanding of life's mysterious ways, their toleration of other ways than theirs…'[107] These selective gleaning of 'Indian traditions' well-suited Nehru's vision of a modern India; it was spiritual without being dogmatic or biased to any particular religion; it was material in its proclamation for love of life without being crudely acquisitive, and above all it successfully demonstrated Nehru's hypothesis that India's capitulation to foreign domination or present backwardness was not something

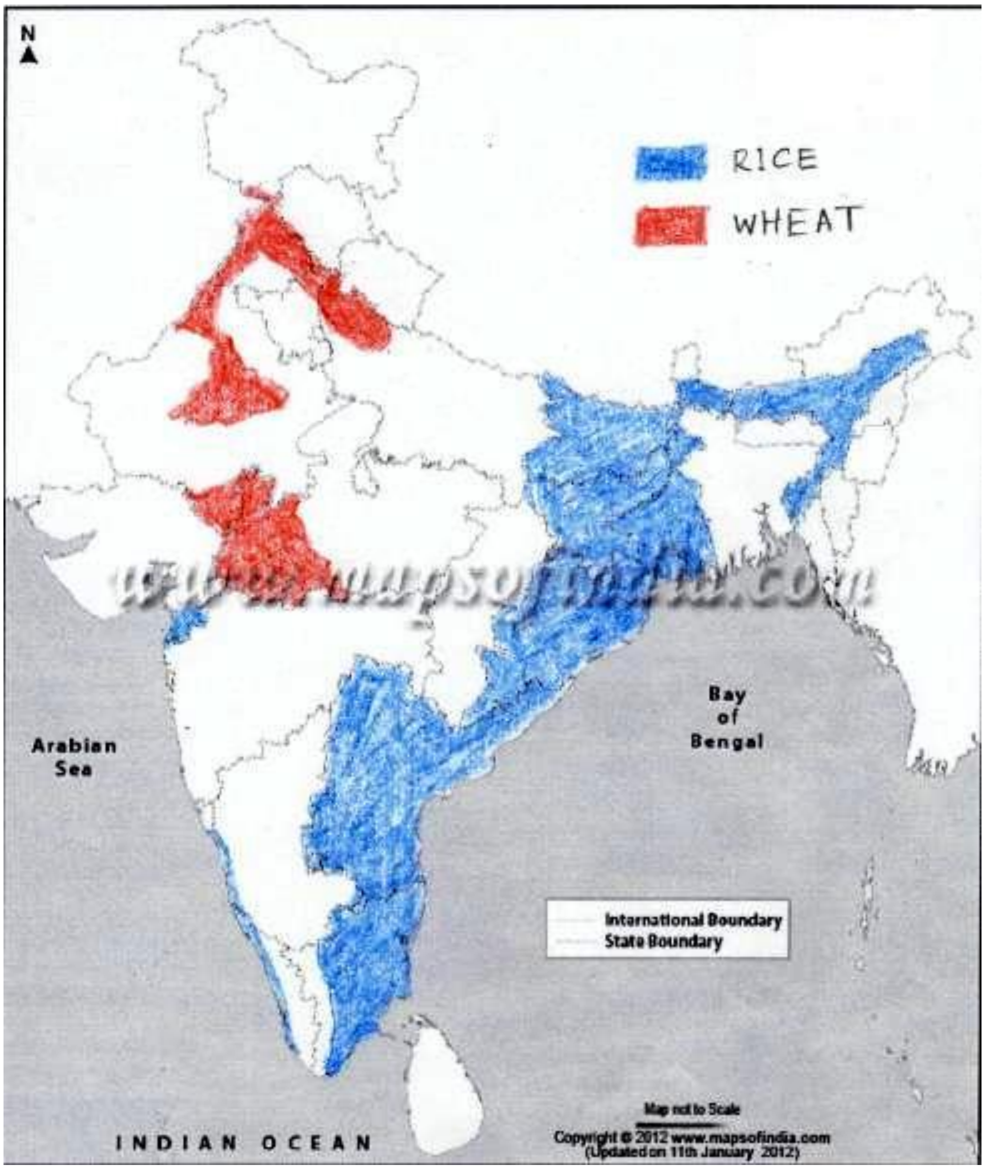
[106] Nehru, *Discovery of India*, p.81.

[107] Nehru, *Discovery of India*, p.509.

inherent to the character of its people, but because of conjectural social, economic and political factors.

Of the actors who were involved with formulating development policies and conducting scientific research in India during this period, few if any doubted that science and technology had a transformative role to play. But, what remained a relatively contested issue was in what ways should techno-scientific research be put into use so that higher production could be achieved without stretching the economic means of the practitioners, cultivators, consumers and then state? On the political front the state did not want to compromise with its goal of social equity because doing so carried the danger of causing large scale fissures in an already class-caste ridden Indian society. Apart from political-economic concerns that characterized much of the technoscientific effort during this period, there were significant cultural and ecological issues. Though the modernizing elite was more often than not convinced about the potential use of techno-science as a tool to mold cultural specificities according to own requirements, and overcome ecological constraints, it could not, and therein lies the most important lesson of this historical study.

Fig 2.1 Rice & Wheat: Agricultural Production Area of India c. 1970



Chapter 2

Looking Past the Green Revolution: Agricultural Research and the Modernization of Indian Agriculture

Independent India was a hungry nation. With the transfer of power on August 1947, the national government inherited from the British a starving and malnutritioned populace. In colonial India, famine was a recurrent feature -caused by inclement weather and aggravated by a callous colonial administration. Jawaharlal Nehru remembered his utter shock at witnessing famished Indians dying in the streets of Calcutta in the Bengal Famine of 1943, vindicating his understanding of the despicable futility of the British rule over India.[1] After independence, the task of eliminating starvation and preventing famine assumed crucial policy significance for the national government. The Planning Commission of India, for instance, pointed out that 'for the large sections of the community which live near the margin of subsistence, a certain minimum supply of food grains at reasonable prices (would) constitute the rock-bottom of the standard of living.'[2] A successful execution of the 'food for all' policy would help, the Indian government expected, in distinguishing it from the incompetent foreign regime of the past, and, bolster its moral legitimacy to rule.

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[1] Jawaharlal Nehru, *The Discovery of India* (The John Day company, 1946); Economist Amartya Sen described, how in the famine of 1943, abject poverty condemned millions in India to what he called a 'disentitlement' to food. The crux of Sen's theory of famines is that fairly rapid changes in the economy (especially in the agricultural sector) plunge certain of the poorer vulnerable groups in a society into an exchange entitlement situation characterized by insufficient purchasing power to buy enough food. This can happen either by the collapse of a person's endowment (e.g. loss of crops in the case of cultivators, animals in the case of pastoralists or physical ability to work in the case of laborers) or by an increase in the cost of food capable of reducing the exchange options below that of enough food. A.K.Sen, *Poverty and Famines: An Essay on Entitlement and Deprivation* (OUP, 1981); John Abraham, *Food and Development: The Political Economy of Hunger and the Modern Diet* (WWF & Kogan Page Ltd, 1991).

[2] Planning Commission of India, *First Five Year Plan* (FYP) (New Delhi, Government of India, 1952), Ch.11.

Moreover, because of the commitment of Indian government to large scale industrialization, its planners inextricably linked the need for larger food-crop production to the question of industrialization. Food-crops were not grown in India as an export commodity, thus, neither rice nor wheat was a potential foreign exchange earner such as jute. Not valuable as source of capital, the Planning Commission of India, therefore, explained the significance of food in terms of sustaining the huge labor force working in industries and construction jobs. It was expected that working men would have bigger food requirements, which have to come not directly from the families, but from the marketable surplus available in the system, necessitating increased food production.[3] National food production and its proper distribution were seen as critical for industrial development, so the first FYP (1951-56) aimed to keep food prices at a level accessible to the population. The government knew that even a moderate shortfall in the supply of food grains would likely to raise their prices more than proportionately, leading directly to increases in the cost of living and in production costs across the economy.[4]

In spite of its emphasis on providing food for all, it has been forcefully argued by many that the Indian government showed little enthusiasm to invest significant amount of capital to augment the country's food-crop production. The recurrent observations made by various social scientists, scientists, bureaucrats and others, both from India and outside, had been that the national leadership was prioritizing industrial development over food-crop production, ignoring

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[3] *First FYP,* Ch.11.

[4] At the same time, the planners insisted that there should be a growing demand for food, because falling food prices were indicative of insufficient investment effort and low purchasing power in the community. The Indian nationalists under the British rule and the national government in the initial years after independence would share the same skepticism about rising food price. Bipan Chandra pointed out that the protagonists of economic nationalism in India argued that the price rise was not a sign of the higher purchasing power of the masses but a grave symptom of falling national production and declining agriculture. Bipan Chandra, *The Rise and Growth of Economic Nationalism in India*: *Economic policies of Indian national leadership, 1880-1905* (People's Pub. House, 1966) p. 37.

wheat over jute and was more eager to peruse the goal of social equity than to raise production. It is evident from these narratives that relevance accorded to capital investment is the most defining characteristics of any 'modern' agricultural system, and India was no exception-its presence meant a 'modern' agricultural sector and its absence implied, without a doubt, a traditional production system. According to its very definition, a modern agricultural production system would have a highly mechanized countryside, where farmers would be integrated with larger economic system beyond its immediate locality, uses of biological and chemical inputs, such as hybrid seeds, chemical fertilizers and pesticides would be rampant and profit-driven. Moreover, these inputs would be systematically studied and improved by technoscientific experts at research laboratories; markets and not individual farmers or inter-farmer informal exchange network would be the source of these inputs anymore.

According to this analytical framework, therefore, it was only with the Green Revolution of the mid-1960s that Indian farmers and scientists would get to witness and more importantly participate in a modern agricultural production system. The new technology based on sophisticated breeding methods, stipulated agronomic practices, emphasizing on the use of capital-intensive input, and advocating high prices of food-crops to encourage investment heralded the beginning of modern agriculture in India. The period that preceded the coming of the green revolution was bereft of most of these features. Not blessed by large-scale capital investment-either by the state or private corporations, it was seen by scholars to be deprived of the fruits of technoscientific research too. If raising production was the sole criterion of receiving attention from the scholars studying India' s agricultural system, then, institutional reforms, such as land reforms and village cooperatives were certainly a failure compared to the Green Revolution technology. But, nonetheless it has merited extensive reviews from political economists, historians, sociologists, policy analysts etc. Interpreted as being central to the Indian government's economic policy during these years, its close association with the state mechanism made it a significant object of study.

On the other hand, because of far less investment made in agricultural science, the Indian state have been portrayed as unenthusiastic about its application in raising agricultural production. The first task, therefore, is to locate science and technological research in the state's plan towards augmenting yield of food-crops and not just cash-crop. If we can successfully argue that the Indian state was indeed interested about agricultural science, we can then ask how exactly it planned on using its scientific establishment. Instead of concluding that with limited availability of capital, scientific research had almost a non-descript place in agricultural development policy, we can shift our focus from primacy generally accorded to capital-intensive inputs into studying the research conducted on use of cheaper, locally available biological and chemical resources. In doing that, we make a significant departure from studying the history of all agricultural modernization in term of the 'Western' model, which historically developed mainly in NW Europe and corn-belt of the American Midwest, keeping in consideration only farmers, who owned large or medium size farms, capable of high capital investment.[5]

Studying the nature of food-crop research in pre-green revolution independent India would help us to see how a government, not keen to thoroughly capitalize the food sector was, yet, committed to use of science and technology for variety of development purposes, including raising production. Science and technology, contemporary political leaders and India's scientists believed, was neither eastern nor western, but universal. But as the social and economic context

[5] Francesca Bray, *The Rice Economies: Technology and Development in Asian Societies* (University of California Press, 1994).

of each nation-state differed, so did its development plans and the way its government considered using technoscience in the fulfillment of those development objectives. The Indian government and its research establishment, for instance, worked towards formulating a research policy that would allow them to use scientific principles to its economic advantage, according to its planning objectives and without having to enter into a political-military alliance with any Cold War power blocs.

The complexity that pervaded India's agricultural research establishment, therefore, raises the crucial question as to what was the nature of technoscientific development of India's food-crop sector before the coming of the green revolution technology?-did it turn its face from any usages of capital intensive resources, or was there a selective appropriation? Did use of cheap indigenous inputs implied a commitment towards 'traditional' agricultural practices, or did 'modern' India shared a rather uneasy relation with 'tradition' as embodied in ancient texts on farming and in the varying practices of farmers? Lastly, including agroecological factors, such as lodging nature of the existing seed varieties, pattern of rainfall, moisture stress etc in our analysis help us to understand beyond the political and economic compulsion of the time, and, in doing so it gives us a more comprehensive understanding of the practices and inputs recommended by agricultural scientists during this period.

Table 2.1 Trends in Area and Production of Wheat & Rice in India, 1956-1989

*Measured in million hectares **Measured in million tons

Year	India (Rice)		India (Wheat)	
	Area*	Production**	Area*	Production**
1955/56	31.52	27.56	12.37	8.76
1960/61	N/A	N/A	12.93	11.00
1964/65	36.46	39.31	13.42	12.26
1967/68	36.44	37.61	14.99	16.54
1970/71	37.59	42.22	18.24	23.83
1975/76	39.48	48.74	20.45	28.84
1978/79	39.42	42.33	22.64	35.51
1988/89	41.86	70.67	24.90	53.99

Source: Estimates of Area and Production of Principal Crops in India, *Indian Agricultural Statistics*, and *Fertilizer Statistics*, 1955/56 through 1989/90

The U.S Involvement in Indian Agriculture and the Cold War Imperatives

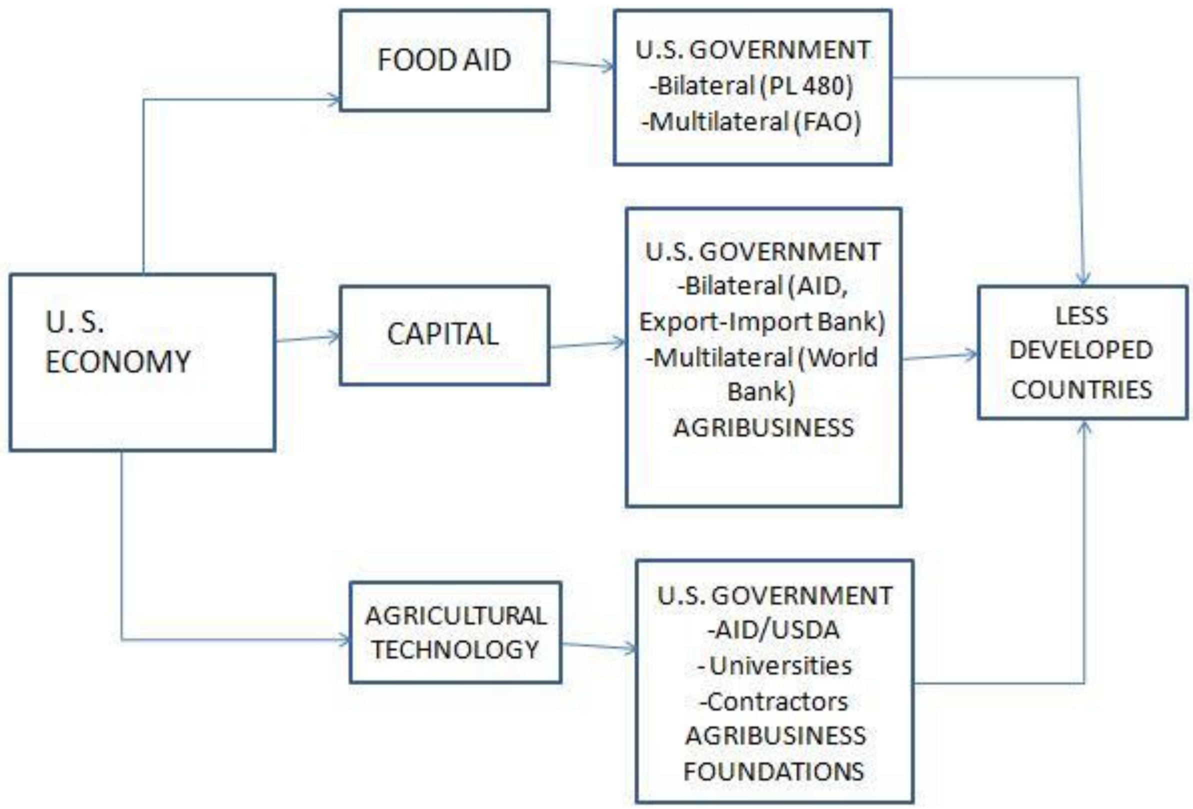
By late 1950, India was caught in the grips of its most serious food shortage since independence. Drought, preceded by floods, spread to several locations in northern states. Reports arrived from Bengal and Assam, documenting hundreds of deaths due to malnutrition and starvation. 'We should live on the food we produced after two years, or die in the attempt,' Nehru had declared in 1949. Two years later, Nehru visited ravaged districts and reportedly asked inhabitants of one village, 'Why do you shout slogans in my praise, when I cannot feed you to keep strong?'[6] As drought widened, food production plummeted, and pressures on supply intensified. Black markets and corrupt handling of the government's procurement and rationing efforts only exacerbated the disaster. The initial calculations showed that India needed to import six million tons of food-grains. It was only by reducing daily rations to nine ounces per person, stretching foreign exchange resources to the limit, and arranging for purchases from abroad, India was able to reduce its grain deficit to two million tons. It had to turn to the US with a request for these two million tons of wheat. America's prompt sanction of wheat for India helped to ease the food situation.

The decision of the US government to extend food aid was, however, not solely governed by humanitarian concerns at relieving distress. The ongoing Cold War gave a political context to the policy of food aid. Within the Truman administration, Henry F. Grady, the US Ambassador to India, had vociferously, yet unsuccessfully, advocated the necessity of US aid to Indian agriculture for the political and economic stability of the country. The political nature of the US aid is brought out even more clearly in the State Department's decision to help the Indian government in carrying out the Grow More Food policy soon after the Communist's victory in China, and with the outbreak of the Korean War. [7]

[6] Dennis Merrill, *Bread and the Ballot: The United States and India's Economic Development, 1947-1963* (University of North Carolina Press, 1990) p. 61.

[7] Dennis Merrill, *Bread and the Ballot*, p. 77.

Fig 2.2 Major Agricultural Resource Flows: U.S. Economy to Less Developed Countries like India



George McGhee's June 1950 proposals for 'Economic Aid to South Asia and the Near East,'[8] which Truman approved at the wake of the Korean War, focused almost wholly upon agricultural programs. In his August 1950 memo to the president, McGhee also noted in passing that the 'first emphasis' of the South Asia program would be toward achieving a 'prompt and

[8] He was the Assistant Secretary of State for Near Eastern, South Asian, and African Affairs from June 1949 to December 1951.

substantial improvement in the indigenous food supply.' McGhee argued that the development of food security was a prerequisite for social and political stability in the region.[9] As a consequence to all these policy initiatives, American diplomats signed a $4.5 million Indo-American Technical Agreement in December 1950.

The major US foundations were quick to join in the struggle for Asia. Leaders of both the Rockefeller and the Ford Foundations believed that expanding their international missions was critical to the nation's interest. John Cowles,[10] a member of the Ford Foundation's Board of Trustees, frantically responded, '…If we lose India, as we lost China, we shall certainly lose South East Asia with the repercussions running all the way through Africa. It is difficult under such circumstances to see how Japan could be held in line, and it would not be too long before we would find ourselves driven back into (a) 'citadel'.[11] At this critical juncture, Ambassador Chester Bowles arrived and became involved in the Indian planning process. Chester Bowles considered India to be a 'perfect test Point IV concept'. He pointed out all the reasons why India should receive technical aid: it is the 'second largest country in world in a key strategic position in Asia. Present government devoted (to) democratic way, sound development program ready to go, great natural resources, willing people. Short on food, capital, (and) technical know-how.' Bowles' incessant anxiety was that if the United States did not adequately help the democratic government, Indian citizens would sink into deep despair that would mark an open invitation to

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[9] Merrill, *Bread and the Ballot*, p.76.

[10] He was the Publisher of the Minneapolis Star, Tribune and the Look Magazine and one of the first 'outsiders' in the board of trustees of the Ford Foundation.

[11] George Rosen, *Western Economists and Eastern Societies*: *Agents of Change in South Asia, 1950-1970* (The Johns Hopkins University Press, 1985) p.11.

the Communists waiting to take over. [12] Bowles immediately set out in search of a way to put US aid money to work.

Under Bowles initiative, a bilateral treaty was signed between the Indian and the US government on 5 January 1952. It brought India under the coverage of the Technical Cooperation Program, also known as the Point Four program of the US government. It formally established a joint fund of $54 million for the purchase of supplies and hiring of technicians not available in India.[13] According to the terms of the Agreement, US government decided to help India strengthen the system of agricultural research and education.

Sympathetic to Bowles' plans, Paul Hoffman, director of the Ford Foundation, encouraged the ambassador to visit Indian government project sites in the districts of Etowah and Faridabad, which had recently undertaken reformist approaches to rural development.[14] Building on the Etowah-Faridabad examples, Bowles envisioned a program of 'community development' that would divide India into a series of 'development areas'.[15] In these areas, promoters would supply farmers with improved seed, tools, irrigation facilities, and fertilizers. Village-level workers, one for every 5 or so villages, would help distribute these items and teach peasant cultivators how to use them. On Thanksgiving Day, 1951, Bowles presented to Nehru a rough

[12] 891.00 TA/2: Telegram. The Ambassador in India (Bowles) to the Department of State. New Delhi, February 21, 1952, http://digital.library.wisc.edu/1711.dl/FRUS.FRUS195254v11p2

[13] An equal amount in Indian rupees was set aside to pay for the program's local costs. *United States Treaties and Other International Agreements*, Vol. 3 Part 2 p. 2921.

[14] Merrill, *Bread and the Ballot*, pp.82-83.

[15] Each area comprised a population of 150,000 to 300,000 people and would eventually revolve around a newly established central town of perhaps 5000 to 10000 inhabitants. The town as in the case of the Faridabad experiment, would house administrative offices, small industries, a hospital, and serve as the HQs for agricultural, health, and educational services; and a system of newly constructed roads would radiate outward to serve as vital connecting links to the countryside.

draft of the proposal. It called for the creation of an All India 'Development Authority' to implement a wide-ranging Community Development Program (CDP) that would raise health and literacy standards, expand agricultural extension, and generally improved rural living conditions. The principal economic and social aims of CDP were to increase food production, to improve the quality of life of rural India, and to lay the groundwork for India's capitalistic development. Politically, the American ambassador hoped that these development projects would make non-communist India a stable and reliable friend of the US. [16]

The Rockefeller Foundation's specific involvement with India started towards the end of 1951, when it sponsored a team of agricultural specialists- Warren Weaver, J. George Harrar and Paul G. Manglesdorf to India.[17] The Rockefellers, unlike the Ford Foundation, did not involve itself in the CDP. It preferred concentrating on agricultural research to help evolve improved varieties of food-grains. They believed that students benefiting from the new postgraduate curriculum of IARI, which they helped to open in 1956, would be able to contribute more directly towards developing Indian agriculture, than any effort to reconstruct India's countryside.[18] The Rockefeller Foundation might have considered the rural development projects too ambitious in scope and time, and not entirely focused on the more crucial problem of low production. Their conviction on the efficacy of a specifically production-centric technological

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[16] Merrill, *Bread and the Ballot*, p.84.

[17] Both Hararr and Manglesdorf were American agricultural scientists associated crucially with the Mexican Agricultural Program. They came from land grant system, worked in agricultural experiment stations and held positions within the United Stated Department of Agriculture. Thus, it can safely be assumed that they would bring in their experiences of American agriculture in assessing and transforming the agricultural scenario in India, just as they did in Mexico. For Rockefeller's role in transferring the land grant system to Mexico see, Deborah Fitzgerald, 'Exporting American Agriculture: The Rockefeller Foundation in Mexico, 1943-53', *Social Studies of Science*, Vol. 16, No. 3 (Aug., 1986), p. 457-483.

[18] Gary R. Hess, 'The Role of American Philanthropic Foundations in India's Road to Globalization During the Cold War Era,' in *Globalization, Philanthropy, and Civil Society: Toward a New Political Culture in the Twenty-First Century*, ed. Soma Hewa & Darwin H. Stapleton (Springer, 2005) p.55.

approach was especially bolstered by Rockefeller's success in making Mexico self-sufficient in corn by 1948.[19]

Consequently, the Agricultural Development Council, an organization attached to the Rockefeller Foundation appointed John W. Mellor as visiting research fellow to India in 1959. He argued that increased use of fertilizers, increased water control, further research into crops and techniques and the expansion of human capital in agriculture would lead to direct gains in agricultural employment, output and productivity. This new pattern of per capita income would lead, arguably, to major structural changes within the economy. A higher rate of agricultural production, Mellor pointed out, would help to ensure improved dietary standards and larger expenditure on consumer goods. The resulting growth of a labor-intensive industry would let India shake off the dead weight of massive unemployment, Mellor believed. [20]

The actions of the Rockefeller Foundation in India was based on the assumption that the urgency of raising agricultural production warranted it being treated separately from the more complex problem of rural development; Bowles and the Ford Foundation, however, did not deem such a separation appropriate. Agricultural production, for them, was part of a larger social problem. Where all the three actors agreed, however, was in their belief that agricultural improvements could not possibly ignore greater capital investment in technological development. The Rockefeller Foundation insisted on immediate capacity-building and international collaboration towards technology transfer; the Ford Foundation, on the other hand, was more willing to satisfy the urgent technological needs through import, rather than

[19] For a detail history of the Mexican Agricultural Program and the role of the Rockefeller Foundation see: Joseph Cotter, *Troubled harvest: agronomy and revolution in Mexico, 1880-2002* (Praeger, 2003).

[20] Russell Stevenson & Virginia Locke, *The Agricultural Development Council* (Winrock International Institute for Agricultural Development, 1989) p.50-52.

immediately start building research institutes in India; Bowles wanted technological assistance to complement community development projects. For Bowles the ideal way to modernize India's agricultural sector would be to combine institutional reforms with use of advanced technology. He insisted that India's use of advance technology and improved tools should not depend entirely on import; it should rather plan on how to use local expertise.[21]

Table 2.2 India: An Estimate of Food-grain and Fertilizer Requirements, 1952/53-1979/80*

Year	Estimated Population**	Estimated food grain requirements	Increment in food-grain requirements above 1952/53	Estimated fertilizer requirements to produce 50% of food-grain increment		Food-grain availability per person***	
				N	P_2O_5	Lbs/yr	cal/yr
1952/53	370,000,000	66,100,500	0	100,000	10,000	316	1388
1959/60	398,632,000	72,800,000	6,700,000	352,000	143,000	319	1400
1964/65	424,177,000	80,200,000	14,100,000	628,000	288,000	330	1450
1969/70	451,359,000	88,300,000	22,200,000	932,000	448,000	341	1500
1974/75	480,283,000	96,900,000	30,800,000	255,000	618,000	352	1550
1979/80	511,062,000	106,100,000	40,000,000	600,000	800,000	363	1600

* Prepared by the Foreign Agricultural Services, United States Department of Agriculture, July 1954. This estimate assumed that 50% of the increment in food-grain requirements above 1952/53 would be met by increased production from expansion of the area sown, improvements in irrigation, and all other approved cultural practices except chemical fertilizer, and that the other half of the increment would come from increased use of chemical fertilizer.

**Net increase in population computed at 1.25% annually.
***Computed at 87.5 percent of food-grain requirements to adjust for seed, waste, and industrial waste.

[21] For instance, under TCM, the projects for improved agricultural tools for Indian farmers specified that local artisans and blacksmiths should be employed for the purpose. *Indo-US Technical Cooperation Program Report* (IARI, New Delhi, 1959).

Apart from Cold War imperatives and economic logic behind desiring a change in the agricultural situation of the developing world, the US government and the private foundations were confident that they had sufficient technological experience to help bring about this change in the developing countries. With the establishment of the land grant institutes since the middle of the nineteenth century, the United States continued to enjoy the benefits of a concerted effort towards agricultural education, research and extension. During the Second World War a greater emphasis on agricultural science and technology helped to change further American agriculture; agricultural acreage expanded about 5 percent and productivity increased by 11 percent, largely because of the increased use of hybrid seeds, pesticides, insecticides, fertilizer and mechanization. It changed American farming from being a way of life to one pursued largely for economic gain. At the end of the Second World War when a devastated Europe was famine-stricken and looked to the US for agricultural commodities, the latter was the only one with enough resources to bring about a change in the developing world.[22] High-yielding seeds, which constituted an important part of agricultural development, were already being commercially produced in the US. The American experts drew from their past technological experience with hybrid corn to produce in high-yielding, disease and insect resistant varieties for other developing countries.

Confident that expensive biological and chemical inputs could create the same opulence for other countries, the US agencies sought to undertake a speedy 'modernization' of Indian agriculture. Instead of analyzing deep seated problems within India's unique historic context, these experts attempted to graft their development model on India. In reality, the complexity and variations of Indian agriculture made it unlikely that any measures could prove to be a perfect

[22] R. Douglas Hurt, *American Agriculture: A Brief History* (Iowa State University, 1994) Ch.6 &7.

universal panacea. The desire to try an already tested model for India often blinded the supporters of industrial agriculture to the complexities of tropical agriculture that were reduced into some enumerated *essential* features. Rather than treating farm components as an interconnected whole, the reductionism broke it down, comparing each component with that of more advanced nations.

'Modernizing' Tropical Agriculture

In an agro-climatic demarcation of the world, India belongs in the tropical zone, which biologists commonly assumed to offer a climate less favorable to agriculture and human settlement than that of temperate zones. In the absence of adequate artificial irrigation facilities, rainfall seemed to represent the most significant factor in tropical agriculture. For most agricultural scientists, this dependence on nature, rather than on irrigation and techno-science, made India's food system backward from its very beginning, in comparison to agricultural practices in Europe, North America and Japan. India's subsistence farmers in small farms practiced a type of tropical agriculture involving extremely small financial resources. The low levels of capital investment in tropical farming prohibited the use of expensive industrial products such as chemical fertilizers and agricultural machineries. Poor farmers maintained soil fertility through regular fallowing or by applying manure, in the form of household and animal refuse, on heavily cropped homestead farms and gardens. Experts in industrial agriculture usually scorned this tropical agriculture as 'associated with under-developed farm technology'.[23]

Historian Francesca Bray has discussed how the Western model of agricultural development was traditionally presented vis-à-vis the 'static' Asiatic societies. She writes that

[23] Anthony Youdeowei, ed., *Introduction to Tropical Agriculture* (Longman, 1986); Harold Tempany and D.H. Grist, *An introduction to tropical agriculture* (Longman, 1958).

'the concepts of the Asiatic Mode of Production, of hydraulic societies and of Asian feudalism all presumed that an essentially unchanging rural world was for centuries systematically drained of its riches by political elite, thus discouraging any tendencies towards development.' Outside experts drew on the historical experience of the New World's grain belts and of Northwestern Europe (in particular the Netherlands and Britain where 'high farming', scientific methods and mechanization made especially rapid progress). While tropical wetland rice cultivation did not fit principles of efficiency following the western model, Bray argued, the specific agro-economic conditions prevailing in the tropics proved the long-term utility of their practices.[24]

Operating from the perspective of developed countries, agricultural experts tend to reduce the diversity of tropical agricultural practices to a simple categorization of 'several common features'. As their 'first task,' these scientists sought to find a 'satisfactory classification or checklist of the principal factor affecting agricultural productivity,' so they could ensure 'proper diagnosis and prescription for any particular situation'. [25] Robert F. Chandler, head of the International Rice Research Institute (IRRI), for instance, tried to delineate all the *common* factors which would help '*any* country that is plagued by low yields and a rice deficit' transition to a modernized, successful rice production program. As an example, he pointed out that for many decades the Philippines had never enjoyed 'a high national average rice yield.' Philippine agriculture needed to overcome this backwardness through four elements, Chandler wrote: 'credit, the transfer of the new technology (including a massive publicity program), price support for rice, and the provision of low-cost fertilizer.' Chandler graphically portrayed how leaders had selected pilot barrios (villages) within municipalities for their

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[24] Francesca Bray, *The Rice Economies* pp. 6-16.

[25] Max F. Millikan & David Hapgood, *No Easy Harvest: No Easy Harvest: The Dilemma of Agriculture in Underdeveloped Countries* (Little Brown, 1967).

'progressiveness'. One trained technician was assigned to five or six barrios, picking out the better farmers and getting them to experiment with a new package of practices on their land. Technicians would advise farmers on the appropriate pesticide use and fertilizer application for their particular soil type, while conducting widespread trials of improved varieties of seeds.[26]

Similar to Philippines' experience with the IRRI, the Rockefeller Foundation's team after its two month long survey of Mexico identified the major problems of Mexican agriculture and recommended technical-research based solutions, such as: improvement of soil management and tilling practices; introduction, selection, and development of superior varieties of grains and legumes, and control of pests and diseases on a national scale. The general nature of the recommendations indicate how unproblemetically uniform the developing countries appeared to the developed ones. It is not to claim that developing countries were not plagued by common set of problems, but the simplified nature of the assessment becomes apparent at the realization that no local specificities were taken into consideration while formulating the 'panacea'. As one historian aptly observed, the Rockefeller Foundation in advocating expensive practices or technological inputs for adoptions, safely assumed that most Mexican farmers had financial an infrastructural provisions similar to the United States.[27] The preferred solutions, evidently, did not provide alternatives for those who did not fit into their typology. Clearly, agricultural development did not care for 'lost souls' as it was seen as commercial enterprise and not a charity.[28]

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[26] Robert F. Chandler, *Rice in the Tropics: A guide to the development of national programs* (Westview Press, 1979).

[27] Fitzgerald, 'Exporting American Agriculture' p.464.

[28] Eugene Davenport, Dean of the Agricultural College at the University of Illinois (1895-1922) remarked, 'There will always be lost souls in farming... and there will be men not worth saving; for this is public business and not charity. Quoted from, Fitzgerald, 'Exporting American Agriculture' p.462.

The specter of rising populations and consequent land crunch provided the context for the rhetoric of agricultural modernization that repeatedly stressed the significance of fertilizer in transforming the food production scenario.[29] India's signing of the TCP with the United States government was vital in leading the way for expanded fertilizer import and technical trials. [30] Committed 'to bring about an increase in agricultural production', the very first project initiated by the TCP in India was to supply free fertilizers to the farmers. [31] In 1954, when the program of fertilizer demonstration was initiated, India did not produce either urea or ammonium sulfate Nitrate. The idea was to import these from the US until India's own fertilizer factory at Sindhri could start producing these indigenously. The mission aimed to popularize commercial fertilizers by laying out demonstration plots in cultivators' fields, thus demonstrating the usefulness of these modern products. This phase of agricultural outreach in India became the world's largest fertilizer demonstration program, allowing scientists to collect volumes of data on fertilizer use in India under different soil and climatic conditions.[32]

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[29] As C. Subramaniam would categorically state, 'To produce more food with less fertilizer is as impossible a task as to produce more steel with less iron ore…' Quoted from Varshney, *Development, and the Countryside*, p.53.

[30] James M. Blume, Soil Research and Fertilizer Projects, October 1955. 469.7 Records of the International Cooperation Administration (NARA) Box 2.

[31] *Technical Cooperation Program Report* (1959) p.18, 21. Throughout the second half of the nineteenth century, United States Department of Agriculture distributed exotic germplasm free of costs to the American farmers. This had been a common practice to test and convince farmers to use new biological-chemical inputs. In the US, the private seed traders seriously objected to such free distribution. In India, however, we do not find any evidences for resistance. This was primarily due to the fact that distribution of chemical fertilizers in India did not reach the proportion of seed distributions in the US, so the nascent private fertilizer sector did not feel threatened by scale of such effort. As distributions were aimed at convincing farmers to use chemical fertilizers, rather than cater to a preexisting demand as was in the US, the fertilizer companies stood to benefit and not lose from it. See, Jack Kloppenburg, *First the Seed*: *The Political Economy of Plant Biotechnology, 1492-2000* (Cambridge University Press, 1988) pp. 61-65.

[32] There were about 200,000 three-plot demonstrations each year. Results from 50,000 demonstrations were summarized and published district-wise, State-wise, soil-wise and year wise. M.S. Randhawa, *A History of Agriculture in India* (New Delhi : Indian Council of Agricultural Research, 1980-1986) p. 281.

During 1954-56, researchers under TCP conducted extensive experiments on soil fertility and fertilizer, believing that the results could inform 'intelligent long term planning on fertilizer needs and use in Indian agriculture.'[33] The mission also established a cartographic and a radiotracer laboratory at the IARI that could conduct national-level soil surveys and prepare soil maps. The TCP opened twenty-four soil testing service centers throughout India, which would receive soil samples from farmers for testing, then give specific recommendations and advice on what kind and amount of fertilizers the farmers should use on different crops. [34] These activities marked the beginning of a systematic study of soil types and soil nutrients in independent India.

This fertilizer-centric chemical analysis of the soil types replaced the more generic knowledge that Indian farmers possessed about physical properties of various kinds of soil, use of manure and on crop production over the centuries. Agricultural treatises, such as *Krishi-Parashara* (300BC -300AD) and *Kashyapiyakrisisukti* (700AD-800AD) show that agriculturalists in India based their assessments of soil on its physical and biological properties. For instance, the description of a 'good' land in *Kashyapiyakrisisukti* was that it should be devoid of stones and bones; a pliant (plastic) clay, very unctuous (greasy) with reddish and black hue, and glossy with water; neither too deep nor too shallow; water absorbent, and replete with beneficial organisms such as earthworms, thickly set and compact, and heavy when it was lifted.[35] Devoid of any use of sophisticated technique or analytical framework, the treatises were

[33] During 1954-55, scientists conducted 895 experiments on wheat with Nitrogen and Phosphate at the Community Development project centers. IARI, *Annual Report, 1955-56* (New Delhi, IARI).

[34] For instance, in the Indian state of Uttar Pradesh, soil survey maps were made in 12 districts such as Aligarh, Kanpur, Gorakhpur, Banaras, Bareilly etc. Once these maps were ready, the experts considered that it would be possible to locate the major soil regions found in each district, which would furnish important information regarding soil resources, manure, chemical composition and nutrient status of soil varieties. 'Soil Research in U.P.', The Times of India (1861-current), March 29, 1954, http://www.proquest.com/ (accessed April20, 2011).

[35] J.R. McNeil and Verena Winiwarter ed., *Soils and Societies: Perspectives from environmental history* (The White Horse Press, 2006) p. 27.

more based on observation of successful agricultural practices and trial and error method. It seems to be more of a compilation of collective knowledge that did not make any discernible distinction between knowledge generated by an expert and information collected from the farmers. The soil surveys of the TCM on the contrary were not only based on use of sophisticated technology but largely ignored any possibility of farmers as sources of knowledge. Information on soil would be collected, analyzed and commented upon by the experts so that the farmers could be a beneficiary of this new knowledge.

Though the American scientists working in agricultural projects in India were largely instrumental in initiating large-scale fertilizer trials, there were many Indians who equally shared with them the conviction that an effective transformation in food-crop production could only be brought through extensive use of fertilizers and sophisticated technology. The work of TCP was particularly facilitated by the enthusiastic participation of many Indian scientists, such as Dr. N.P. Dutta and Dr. P.C. Raheja. Trained in American universities, they demonstrated much interest in the fertilizer field-trials conducted under the guidance of US experts. As the Chair of the Department of Agronomy at the IARI, Raheja played a very useful role in involving his institution in the projects conducted by the TCP.

As projects under TCP pushed for greater fertilizer use, many important Indian officials often found it useful to blame farmers solely for limited application of fertilizers in Indian agriculture. They saw in this the sole cause of lagging productivity of India's food-crop sector. P.N. Thapar, the Secretary to the Indian government's Ministry of Food and Agriculture, for instance, complained to the US agricultural attaché stationed at New Delhi of the lack of fertilizer applications and other improved farming practices that were holding back Indian agriculture, compared to its neighbor, China. He squarely blamed prejudices and religious beliefs of farmers for perpetuating this backwardness. [36] Many like Thapar found in US's technological help a deliverance from the quagmire of peasant's backwardness that were supposedly holding back Indian agriculture.

The TCP's work on agricultural development also became an important part of the development plan of the Indian government, which was aiming for an increase of 7.6 million tons in production of food grains over the first five-year plan period (1951-56).[37] It planned to reach the proposed target through development programs involving major and minor irrigation works, extension of cultivation, reclamation of barren lands, and 'intensive' farming. [38] The plan for intensive cultivation grew out of contemporary agricultural research, which focused on developing improved seeds, facilitating high-doses of fertilizer usages, and on adopting effective measures against pests and diseases. The Planning Commission reports optimistically calculated that between 1951 and 1956, India could increase cereal production by a total of 6.51 million tons, with 1.21 million tons of that total coming from use of better seeds, manures, and fertilizers.[39] The plans bear similar other evidences of government's encouragement to

[36] Agriculture Service Report from Senior Agricultural Attaché to the Department of Agriculture, Washington, July 7, 1956 469.7 Records of the International Cooperation Administration (NARA), Box 1.

[37] Of this, 2 and 4 million tons would be wheat and rice respectively.

[38] Yet, while the plan was to emphasize institutional reforms to modernize the nation's agricultural system, the Indian government simultaneously considered accelerating agricultural production through increasing the yield per acre, rather than bringing more land under cultivation. 'Extension of cultivation can be an important factor in stepping up agricultural production over a period of time, for meeting the immediate needs of the nation, however, reliance has to be placed mainly on increasing production from the existing area by improving yields.' First FYP, Ch.9.

[39] First FYP, Ch.14.

'technological farming', using latest research on 'biochemical inputs', as well as mechanical inputs such as tube wells, tractors, and threshers.[40]

The plan to introduce 'technological farming' probably came from the awareness that the country faced diminishing options for increasing total area under cultivation. Putting the remaining fallow land into agriculture might help increase production of coarse grains, but the country really needed to increase the production of superior grains such as rice, wheat and maize. The members of the Commission anticipated a rise in national income that would increase demand for those crops, and so they focused on such techniques that helped to raise yields by making agricultural production more efficient, rather than simply multiplying acreage. The second FYP (1956-61) extended those assumptions in projecting a further ten-million ton rise in grain production, of which 3.5 million tons would come from use of improved seeds and wider application of fertilizers and manures.

The Planning Commission reports seem to indicate that the India government had plans to gradually increase the consumption of fertilizers through stepping up domestic production, rather than leap-frog into a capital-intensive phase of agricultural development based primarily on foreign investment and assistance. Thus, any news of high production mark reached at Sindri Fertilizer factory received widest coverage in the national press. As the most important public sector initiative towards chemical fertilizer production, Sindri came to symbolize national pride-indicating what India was capable of achieving in terms of self-sufficiency, higher food production, and technological sophistication.

[40] Sumit Roy, *Agriculture and Technology in Developing Countries: India and Nigeria* (Sage Publications, 1990) Ch.1.

Though routinely praised in the press for its service to the Indian farmers[41], fertilizer factories similar to Sindri, either under public or private sector initiatives would be far between, keeping fertilizer production low throughout the period.[42] Of the many reasons limiting the growth of a domestic fertilizer industry, the important one was inadequate government funds for such investments. Scholars have repeatedly pointed out the reluctance of Prime Minister Nehru and that of the Planning Commission in diverting scarce foreign exchange from building heavy industries to either importing fertilizer or to set up fertilizer industries.[43] Moreover as no understanding could be reached with foreign investors over distribution and pricing rights of chemical fertilizers during this period, there was little chance of private capital supplementing public sector initiative in building fertilizer factories in India.[44]

A serious crop failure, soon after the launching of the second FYP, however, reinforced the debate on the best way to push up the yields; policymakers and national leaders argued whether to stick to institutional reforms and less capital-intensive strategy or to shift to a more intensive use of chemical fertilizers. [45] Facing acute food shortage and sharp rise in prices in 1957, the Indian government responded by setting up a Food Grains Enquiry Committee. Its

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[41] 'Sindri's Plant Capacity Exceeds Limits', The Times of India, November 13, 1954; 'New Coke Oven Plant at Sindri Opened', The Times of India, November 29, 1954 (accessed April25, 2011).

[42] India's production of nitrogenous fertilizers in 1,000 million tons would be 11.0 in 1951, 81.8 in 1956, 151.7 in 1961-62 and sharply rose to 222.0 million tons in 1963-64. The data is taken from *Indian Agriculture in Brief*, 11th ed., Ministry of Agriculture, New Delhi, 1971.

[43] Both Ashutosh Varshney and Francine Frankel have given a detail account from the perspective of a political economist as to why there was not enough public investment made towards the growth of chemical fertilizer industry in India before the coming of the green revolution technology.

[44] For a detail on breakdown of such negotiations between the Indian government and a consortium of US oil, chemical, and engineering companies see: Ashok Kapoor, *International Business Negotiations: A Study in India* (New York University Press, 1970).

[45] Grain output fell by 10 per cent in 1957-58, causing a 50% price rise as compared to 1955-57 grain prices. Planning Commission of India, *Second Five Year Plan* (New Delhi, Government of India, 1952), Ch.1.

head, A. Mehta, was highly skeptical that India could possibly reach the Second Plan's higher food production target. To improve the production scenario, the Committee urged the Indian government to expand agricultural research facilities, to ensure better application of research results by strengthening the extension service and back it up with proper credit facilities for farmers. Given existing resource constraints, the Committee favored the idea of concentrating efforts on the better farms only in areas with the greatest potential for improvement. [46] Following such a capital-intensive and selective development strategy, however, had two important consequences: first, it meant going against the principle of social equity, considered so integral to social and economic planning in the first decade-and-a-half after India's independence and[47] secondly, it would divest the industrial sector of precious foreign exchange, which would have to be spend on either importing synthetic fertilizers, or in setting up factories to enlarge the quantity of its domestic production.

To the members of the Planning Commission the consequences of following a thoroughly capital and chemical intensive agricultural policy appeared unacceptable, because it would mean compromising the two most important goals of independent India-import substitution in basic industries and quest for a social and economic system based on social equity. With agriculture claiming a share on already scarce foreign exchange, India would hardly be in a position to realize its goal of being the industrial hub of Asia. [48] Accepting Mehta Committee's

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[46] Ministry of Food and Agriculture, *Report of the Food grains Enquiry Committee* (New Delhi, 1957).

[47] Debates over this highly selective approach would become a recurrent theme in discussions by all the committees constituted by the Indian government, the foreign agencies who were working in the subcontinent and also in the chemical industry associated with agriculture. The Indian government would continue paying lip service to this advice until the launching of the Intensive Agricultural Development Program (IADP) in 1961. Frankel, *India's Political Economy*, p.181.

[48] See Nick Cullather's discussion on P.C. Mohalanobis, the architect of the second FYP in India, *Hungry World*, Ch.7.

recommendation for a selective approach in matter of fertilizer distribution would contradict with the principles of socialism in which most members of the Planning Commission members were publicly committed to. It was a widely known fact that Nehru as the chair of the Planning Commission hand- picked its members based on their political orientation. All of them considered the process of development in broader terms, rather than simply economic growth. Thus, the chief concern of the Planning Commission was the transformation of the existing social order and the establishment of an egalitarian and socialist pattern of modern society.[49]

Thus bypassing the Mehta Committee's report, the Planning Commission continued to urge scientists of national research institutes to come up with cheaper, 'indigenous' alternatives to expensive or imported ones. Instead of selective approach they wanted the improved farming techniques to be largely applicable to various regions of India with differing precipitations and soil types and to be used by farmers of varying economic capacity. The decision of not adoption a capital-intensive technological approach was, however, not easily taken. Agricultural policy turned out to be a fulcrum of power struggle between the 'state bosses', the central Ministry of Food and Agriculture and the 'right-of-center' and the 'left-of-center' factions of the ruling Congress Party. As the constitutional responsibility pertaining to agricultural development was jointly shared by the state and the central government, the former representing the interests of the local elites of large farmers and merchants tried to persuade on an agricultural policy based on 'scientific principles'. They urged on for 'remunerative prices for rice and wheat in order to provide an incentive (to farmers) for increased private investment in improved inputs.'[50] A.P. Jain, the Food and Agriculture Minister, before tendering his resignation taking full

[49] F. Frankel, Ch.4.

[50] Quoted from George Rosen, p. 73.

responsibility for the dire food situation prevailing in the country, urged that there should be greater investments in seeds, pesticides, fertilizers.'[51]

Though there might had been little disagreement over the necessity of basing agricultural production on 'scientific principles', but the real bone of contention was the difference in interpretation as to what goals scientific research would accomplish. Would it concentrate on evolving a technological package constitutive entirely of capital-intensive inputs and designed for well-irrigated fertile tracts of the country alone, or would it be concentrating on evolving inputs based on indigenous resources that did not vie with industries for resources, or seriously jeopardize the goal of social equity. Known for his indispensability in winning elections, the 'state bosses' found it hard to ignore the policy preferences of Prime Minister Nehru. [52] Nehru personally played a decisive role in the adoption of an equity based and less-capital intensive agricultural model. Under this policy, use of chemical fertilizers was encouraged, but not made an essential constituent of what the state meant by modern agriculture.

Rather than claiming that this emphasis on less capital-intensive development model would mean a rejection of agricultural science and technology, as had so commonly been assumed in so many of the narratives on Indian's agriculture, I would argue that it influenced the work of researchers at the CRRI and the IARI to grow in a particular direction that emphasized uses of cheap organic resources, and wide agroecological adaptations. Raising yield became part of a broader democratic dream of improving the condition of rural India, encourage participation of villagers and infusing the daily agricultural practices with benefits of modern research.

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[51] Frankel, 1978, p.147

[52] This, however, does not mean Nehru was always successful in carrying out his ideas. He dismally failed to make his party adopt the plan to form village cooperatives. The center-to-right elements in the Congress Party of India resented it as precursor to collectivization measures. *The Philosophy of Mr. Nehru: As Revealed in a series of intimate talks with R.K. Karanjia* (George Allen & Unwin Limited, 1966).

However, it was not the objectives of the state alone that solely influenced the research work of contemporary scientists. A political economic approach to development tend to exclude the influence that ecology and cultural preferences of consumers might have had played on formulation of research projects. A search for a slender, aromatic rice variety was as important as obtaining high-yield; similarly, before formulating high doses of fertilizer applications designed towards bumper crop the scientists had to ensure that the existing varieties were responsive to such doses. Moreover evolving high-yield varieties suitable to the well-irrigated field condition was not sufficient because large part of India either had bad drainage or suffered from moisture-stress. Thus, the problems of agricultural scientists were complex and the solutions thus had to be varied and not always easily found in terms of obtaining high-yield.

India as a Laboratory of Agricultural Modernization

At the second annual meeting of the newly formed Board of Agriculture, held at the Pusa Research Institute in January 1906, Sir Albert Howard, as head of the Botanical section, was asked to prepare an outline of future work which could apply to the whole India. Barely four years after this first official assignment, in December 1909, the book entitles *Wheat in India* appeared. By 1924 Albert Howard and his wife Louise E. Howard were jointly responsible for writing something like thirty one papers on wheat cultivation in India. The Howards showed unusual sensitivity to the various specificities of cultivating wheat in India. In his outline, Howard urged other scientists to keep into consideration not only various agricultural practices concerned in the production of wheat in India, but also the ‘great range in climatic conditions’ in the various tracts in which wheat was grown. His contention was that ‘the length of the growth period and the moisture conditions are the chief factors in the production of Indian wheat, and these materially influence the varieties grown and the practices of the various agricultural tracts.’

Stressing on the need to know why so many different practices prevailed in various wheat growing regions, Howard pointed out that 'the smallest differences in procedure are closely bound up with differences in local conditions,' such as monsoon rainfall, soil moisture, temperature, growth period, average size of the farmers' holdings etc. All these factors influenced the kind of seed varieties that were used by majority of Indian farmers as well as the methods employed in harvesting, threshing and in the storage of the produce. These methods, Howard cautioned other fellow scientists, might 'appear very primitive at first sight, but they are simple and efficient.'[53]

Howards' observation about wheat can as well be extended to understand the dynamics of rice cultivation in India. Grown over 75 million acres, rice cultivation extends from 8 degree to 35 degree N latitude, covering varying conditions of rainfall, altitude and climate. Over the centuries, cultivators have selected numerous rice varieties, such as *Dharical, Dular* and the *Tilak Kacheri*, which were adapted to different soil types, topography and agronomic practices in eastern India. More than wide adaptability, farmers have concentrated rather on selecting rice varieties that were suitable to specific agroclimatic condition. For instance, in the dryland of Medinipur district of West Bengal, farmers cultivated upland varieties like *Kelas* and *Bhutmuri* that needed no irrigation to grow. Similarly, farmers in South India preferred growing varieties like *Kappakar* and *Samba Mosanam* because these were tolerant to the clayey soil of Madurai and ill-drained tracts of Trichy districts respectively.[54]

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[53] Albert Howard, *Wheat in India: Its Production, Varieties, and Improvement* (Thacker, Spink and Co., 1909).

[54] Dr. K. Rajukkannu, Dr. A. Sathya and Oswald Quintal, *The Diversity of Traditional Rice Varieties in India-A Focus on Tamil Nadu* (Penang, Pesticide Action Network Asia and the Pacific, 2009) www.panap.net.

Unlike wheat, the high-yielding varieties of which Howard claimed could not be easily grown in India because of restricted supply of soil moisture and the short period of growth, rice had always been a relatively high-yielding crop. Characteristics that determine the yield potential of rice cultivars are the nodal number of 'productive' tillers per hill panicle density i.e. number of grains per panicle and grain weight. Among the local varieties in cultivation, *Punjab-sal, Bahupuri, Jugal, Kabiraj-sal* and *Darka-sal* all had a mean panicle weight of 4g or more. Of these, *Punjabi-sal* and *Kabiraj* had high particle density too. But most of these varieties being long straw yielding ones were useful for farmers for thatching their homes and as fodders were, however, prone to lodging. Most of the existing 'indica' varieties in cultivation were inherently prone to the problem of 'lodging,' excess growth that caused stalks fall to the ground with high doses of fertilizer application. Researchers explained this problem by suggesting that over centuries in Asia, an unconscious selection had produced crops able to grow moderately well at low nutrient levels but which lost most of their capacity to respond to applications of fertilizer for higher fertility.[55]

The problem of lodging would remain a prohibitive factor for India's adoption of any agricultural development models premised on high fertilizer application till the coming of the dwarf varieties in the 1960s. For instance, soon after independence, some Indian experts tried copying the Japanese method of rice cultivation to raise production. Many in India regarded Japan as an instance worthy of emulation, the only Asian country which was comparable with the West for its achievements. [56] But when comparing Japanese methods with the practices

[55] D.H. Grist, *Rice* (Longman 1975)

[56] In 1953, Dr. N. Parthasarathy, Director of CRRI, pointed out how India's yield of 913 pounds of rice per acre paled into insignificance when compared with Japan's record yield of nearly 3200 lb per acre. Dr. N. Parthasarathy, 'Recent Developments in the Methods of Rice Cultivation in India,' *Current Science*, May 1953, 22:5.

followed in India, the CRRI scientists found that Japanese practices of field manuring actually reduced the yield in comparison to local recommended methods.[57] This discovery prompted a series of experiments to ascertain the relative efficacy of different types of manures and fertilizers for the traditional rice varieties grown in India. CRRI investigators concluded that Indian rice farmers would get maximum yield by applying doses of between 20 and 40 lb. of nitrogen per acre.[58] Indian researchers found that to make traditional varieties produce more, high doses of nitrogen could be counterproductive; the 'optimum' result came from sufficient supplies of organic manure without chemical fertilizers.[59]

The CRRI scientists were aware that to significantly push up the yield of food-crops, it would be necessary to concentrate on breeding more fertilizer-responsive varieties. Such varieties, they hoped, would facilitate application of relatively higher doses of fertilizer. The CRRI director, Dr. Ramiah requested the FAO to initiate a hybridization program to produce 'improved' varieties of seeds that would not lodge to fertilizer application. The FAO's International Rice Commission decided that the program should develop hybrids between the Indian (*indica*) lowland rice and the Japanese (japonica) strain. In doing this they wanted to bring together the qualities of both the varieties and overcome their respective limitations. *Indica* had a long grain, was adapted to hot climates and poor soils, but did not respond well to fertilizers. On

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[57] *CRRI Annual Report 1953-54* (Central Rice Research Institute, Indian Council of Agricultural Research, Cuttack, India).

[58] *CRRI Annual Report, 1951-56*.

[59] Discussant, M.V. Vacchani:With a dose of 20-30 lbs. of nitrogen per acre an increase of about 300-500 lbs. of paddy per acre is generally obtained and this dose is considered as the optimum. *Proceedings of the Indian Science Congress*, 1960, Vol: 47.

the other hand, *japonica* had a short round grain, was adapted to cooler climates, needed good soils, had stiff straw, and produced very high yields in response to fertilizers. [60]

Most of the varieties bred under the FAO scheme were initially suitable only for irrigated and fertile lands, excluding thereby large tracts of land that were dependent on rainfall in India. Researchers therefore evaluated these promising strains for their performance under moisture stress conditions. The objective (in light of the policy of social equity) was not to restrict cultivation of these high yielding varieties among well-endowed farmers, owning or having access to well-irrigated and fertile tracts, but to reach a larger geographic and economic cross-sections. The rainfed ecosystem, however, had its own set of problems that made cultivation of the newly bred varieties a challenging task for the scientists. Not only was there the high possibility of the crop yield suffering from moisture stress, the weed problem was more severe because of low rainfall. Diseases like blast and brown spot occurred more frequently. All these limitations needed immediate attention from the scientific community if the benefits of growing the new varieties were to be made available to farmers of these regions. Courtesy the widespread practice of Mendelian genetics since the early years of the twentieth century, it was already clear to the Indian scientists by the 1950s that the capacity to resist conditions of drought is genotypic and could, therefore, be controlled through the incorporation of specific genes for resistance to droughts in desirable varieties with good yield.

Just like drought, large tracts of farm land situated in the deltaic and coastal parts of India suffered from flood and from saline and alkaline soil too. Water-logged submerged areas impaired total dry matter production, caused high tiller mortality and spikelet sterility and created difficulty in fertilizer management. Rice growers in these regions especially had to

[60] CRRI Annual Report, 1950-51.

contend with the problem of soil salinity that affected crop in the field at any stage of its growth. There were discoloration and often leaves slowly dried up and drooped from plant. Scientists realized that they needed to counter these conditions with varieties that would be able to give good yield, yet capable of withstanding submersion for a particular length of time as were lowland varieties, such as *Jabra*, *Lakshmi dighal*, and *Pantara*, which grew upto 18 inches above water in seasonal wetlands. All these experiments were conducted with the purpose of developing 'all-purpose' cereals that would cater to diverse farming situations across India. It culminated with the release of N.P800 series of disease-resistant wheat varieties in 1959 by plant breeder B.P. Pal and pathologist K.C. Mehta. For eighteen years the duo made multiple crosses on a large scale to bring together resistance to all three rusts, combining it with suitable agronomic attributes and adaptability to Indian conditions.[61]

The varieties, which developed under the FAO project, however, only partially succeeded in attaining its objectives: widely adapted to grow in various agro-climatic conditions and resistant to diseases, they soon regained the low response characters of the *indica* varieties that the scientists had been hoping to evade. The cultural preference of consumers for slender varieties prompted the abandonment of the original goal of a fixed rice type with high fertilizer-responsiveness similar to the japonica varieties, and resulted in selecting back towards the indica parent. Controlling the quality of the improved cultivars was another problem that continued to plague Indian agriculture until the government decided to pass the seed act in 1966 to start specifying and labeling the 'minimum limits of germination and purity'.[62] The lack of quality control was aggravated by the very limited number of seed farms in contemporary India. The

[61] B.P. Pal, *Wheat and Roses* (ICAR, 1976). It was the first variety in the world with concurrent resistance to stem, leaf and stripe rusts.

[62] The Seeds Act, 1966 http://agricoop.nic.in/seedsact.htm

Indian government was committed to a system of decentralized multiplication and distribution process, entrusted to the hands of the village cooperatives, with it supervising from the outset. The arrangement, however, proved inadequate to satisfy India's growing need for improved varieties of seeds. Rice and wheat cultivation in India continued depending mostly on seeds available on-farm or as part of inter-farmer commerce, as was in mid-nineteenth century USA.

The use of synthetic fertilizers though championed by many for its role in achieving high-yield remained controversial for its role in soil depletion. In 1947, Dr. S.C. Chang of Ministry of Agriculture and Forestry of China along with couple of other agricultural scientists remarked that continued use of ammonium sulfate might cause deterioration of fertility and decline in rice yields.[63] In the following year, scientists D. Rhind and U. Tin of Department of Agriculture, Burma (Myanmar) published an article in *Nature*, noting that 112 kg/ha per annum of ammonium sulfate gave yields always significantly higher than those not treated, but, after the first three years the increase in yield declined from a maximum of 1190kg/ha to a minimum of 360 kg/ha. These observations suggested that the balance between nitrogen and other fertilizing elements required judicious adjustments.[64] That the Indian Planners were undoubtedly informed of such findings is clear from their recommendation that chemical fertilizers, especially ammonium sulfate, should be used *only* in conjunction with bulky organic manures. They publicly expressed a fear that continuous application of chemical fertilizers, in absence of any

[63] M.L. Jackson, and S.C. Chang, 'Anhydrous ammonia retention by soils as influenced by depth of application. soil texture, moisture content, pH value, and tilth.' *Journal of American Society of Agronomy* 1947, 39: 623-33.

[64] D. Rhind & U. Tin, 'Results of the Continuous Use of an Ammonium Phosphate Fertilizer on Rice in Lower Burma' *Nature* 161, 105-106 (17 January 1948).

bulky organic manure, would lead to soil deterioration and progressively lower yields over a number of years.[65]

Sections of Indian farmers had shared the concern of scientists and the planners about unbridled usage of chemical fertilizers on soil fertility. Anthropological work done on Indian agriculture showed that farmers found chemical fertilizers problematic at different levels-it affects the taste (swad) of the food, dries up the soil, and plants can't take hold of the land, strength of land declines etc. In such rhetoric, the anthropologist has traced the influence of 'indigenous' humoral or substantist theory, which is very different from the language of bio-science.[66] The Indian scientific community and planning commission members had, however, not borrowed from any 'indigenous' episteme in either critiquing chemical fertilizers or endorsing organic manure. They rather preferred borrowing selectively from the argument of a well-known, English botanist, Albert Howard who wrote on organic ways of farming and contributed significantly to the 'early organic movement' in England.

Howard was sharply critical of high applications of synthetic fertilizers to the soil. Howard traced the origin of what he termed as the 'NPK mentality' back to the late nineteenth century when 'the use of artificial manures became firmly welded into the work and outlook of the Experiment Stations…' Howard insisted that in focusing on use of chemical manures, promoters had overlooked two key factors, the preservation of soil fertility and the quality of the produce.[67] Howard wrote several books elucidating his stand on organic fertilizers of which, *An*

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[65] *First FYP*, Ch. 18.

[66] Akhil Gupta, *Postcolonial Developments-Agriculture in the Making of Modern India* (Duke University Press, 2003) pp.4-5.

[67] Albert Howard, *An Agricultural Testament* (Oxford university press, 1940) Ch.13

Agricultural Testament, turned to be most influential. Published in England in 1940, it was well-known to most contemporary agricultural scientists.[68] From the annual research reports of IARI and CRRI, it is evident that Indian scientists shared some of Howard's concern about the impact of continuous use of chemical fertilizers on farm soil, as they were experimenting on it for a decade after independence. [69] However, an emphasis on organic fertilizers did not imply that Indian scientists or policymakers were trying to fit Indian agriculture along the philosophical contours of the organic movement. They did not share the activists' conviction that *any* chemical, mechanistic or purely economic approach to agriculture was inadequate and potentially harmful. Advocating a cautious and balanced approach, the scientists betrayed no such belief that human beings should seek through science to work with the God-given natural order rather than exploiting the environment out of greed. The appeal of the organic fertilizers to the scientists and policy-makers in India lay in its cheap availability and wide applicability, rather than symbolizing in any ways the goodness of rural life over urban encroachment, as was among the proponents of the organic movement in England.[70]

Apart from concerns regarding soil erosion, a far graver problem that encouraged usages of organic manure was the high costs of importing synthetic fertilizers. Since India did not have a natural source for good quality sulfur, the government faced apparent limitations in plans for indigenously producing ammonium sulfate. The Program of Industrial Development (1951-56) proposed to double the production of sulfuric acid. Yet even those increased levels would leave

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[68] *Proceedings of the Indian Science Congress*, 1954, Vol: 41.

[69] Skepticism about fertilizer as a modern panacea continued into modern times, as expressed not by governmental policymakers, but rather by environmental activists such as Vandana Shiva, Claude Alvares and others.

[70] Philip Conford, 'The Myth of Neglect: Responses to the Early Organic Movement, 1930-1950', *The Agricultural History Review*, Vol. 50, No. 1 (2002), pp. 89-106.

a gap between Indian consumption and production, which would have to be made good by imports. *Chemical Age*, the journal of India's Chemical Manufacturers Association, wrote in a special issue prior to the country's second FYP that importation was not the best option when compared to building indigenous means. The magazine pointed out that most sulfur deposits were located in the USA, which the magazine worried had not been consistently friendly to India.[71]

During the second plan (1956-61), importing chemical fertilizers became an even more costly proposition because of the closure of the Suez Canal. The price of ammonium sulfate rose by Rs.35 per ton due to the increased cost of indigenous production, the increase in general tariff of ocean freight for import of fertilizers, and extra costs connected to diverting shipments after the Suez closure. Thus, India's agricultural ministry continued to express particular interest in the value of using compost manure for stepping up production.[72]

Compared to China and Japan, experimenting with composting was generally a dwindling practice among farmers and scientists in contemporary India. Most farmers did apply some amount of organic manure to their field and knew the uses of humus, but rarely was it sufficiently, or as 'experts' claimed, systematically applied. Ancient Indian texts, such as *Krishi-Parashara* (Agriculture by Parashara), *Vrishkayurveda* (The Science of Plant Life) and Kashyapiyakrishisukti (A Treatise on Agriculture by Kashyapa) among others carried several references to practices of organic manuring. Most of these agricultural practices recommended in these texts were, however, lost over the centuries. After independence, neither the Indian government, nor the agricultural scientists showed any interest in reviving this body of

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[71] *Chemical Age of India*, October 1954.

[72] Planning Commission of India, *Third Five Year Plan* (Government of India, 1952), Ch.19.

knowledge as part of India's 'scientific' heritage. Thus, *Kunapajala* and other popular organic manure of the past remained outside the purview of scientific research. This might apparently look incongruous with the government's plan of using traditional/indigenous inputs in achieving higher crop yield. The answer could be found in the very careful use of the word indigenous or tradition made by the Indian scientists and policy-makers. They used it interchangeably in referring to natural resources that were available within India's geo-political boundary. Being part of the national heritage or popular body of knowledge did not guarantee incorporation in the scientific practices of modern India. Preferences for organic manure stemmed from a political-economic consideration, rather than from any simple urge to revive/reinstate India's past. Scientists and especially policy-makers evidently harbored doubts about aspects of industrial agriculture, but they were unrelenting to show their commitment to modern science rather than to either 'Indian' or 'Hindu' science. Thus, Indian scientists found it more professionally acceptable to follow the recommendations of Albert Howard's book, *The Waste Products of Agriculture: their Utilization as Humus,*[73] which was based on his systematic study of composting at the Indore Laboratory.[74]

The acceptability of Howard's work to the Indian scientists probably also had to do with the fact that he standardized the process of composting animal manure and vegetable residue that he learnt from ancient texts. This enabled him and later scientists to comprehend and better control the intricate bio-chemical and biological processes going on in the compost heaps. The

[73] *Howard's interest in composting, incidentally, was aroused in observing that most* Indian villages *had an* intensely fertile belt around it. This, he analyzed, was due to the depositing of night-soil, as contrasted with the much poorer fields beyond.

[74] http://journeytoforever.org/farm_library/HI/HItoc.html Louise E. Howard, *Sir Albert Howard in India* (London, Faber & Faber, 1953) Ch.6. The Indore process as it came to be known took its name after the Indian State in which it originated, as a 'grateful remembrance' to all that the Indore court did to make Howard's task in Central India 'easier and more pleasant'. Sir Albert Howard, *An Agricultural Testament* (Oxford University Press, 1943) Ch.4.

emphasis on standardization, which comprised the core of any scientific experiment, however, stood in sharp contrast to most of the manuring recipes mentioned in the ancient texts. For instance, in the constitution of *Kunapajala* no standard formulation was prescribed in any of the *Vrikshayurvedas*. This flexibility might have been helpful for farmers, who was free to use locally available substitutes, but did not match the standard of scientific exactitude coveted by contemporary scientists.[75]

On Howard's retirement, his place was taken by Dr. A. C. Acharya, who initiated on a nation-wide scale the work of composting both town and village wastes in India under the government initiative.[76] After independence, the government anticipated that better usages of sewage and sullage could irrigate over 34,000 acres of land and yield about 56,000 tons of additional food-grains. Like Howard, however, it noted with frustration that in rural areas nightsoil and urine were not generally being utilized as manure. It stressed on the necessity of devising new latrine for villagers that would be hygienic, convenient, fly-proof and portable. To keep down the expenses, the planners suggested these latrines be build using local materials and financed through the sale of the manure that would be made available. [77] In doing this, the administration tried to ensure a cheap source of nitrogen and at the same time keep the countryside clean. But, considering the fact that human waste had largely been an anathema in

[75] YL Nene, 'Potential of Some Methods Described in Vrikshayurvedas in Crop Yield Increase and Disease Management' in Asian Agri-History Vol. 16, No. 1, 2012 (45–54).

[76] Howard, *Sir Albert Howard in India*, Ch.1.
[77] *First FYP*, Ch. 18.

many societies, and definitely to Indians, there is scanty evidence that this turned out to be an effective measure to raise yield.[78]

As human waste turned out to be an unreliable source of manure, the government concentrated more on animal manure. It made plans to train men in techniques of compost-making and appoint them as compost inspectors for each of the country's National Extension and Community Project blocks.[79]The state governments of Punjab, Madhya Pradesh, Bombay, Bihar, Orissa, Mysore, Hyderabad, PEPSU and Madhya Bharat modified their Municipal Acts to require municipalities to convert all available refuse into compost manure. During the Gram Sudhar Saptah (Village Development/Improvement Week) celebrated on the first week of October to commemorate Mahatma Gandhi's birthday, villagers participated in community development schemes, including digging compost pits and composting of refuse.[80] The scientists recommended using compost as basal manure followed by a spray of chemical nitrogen wherever possible. However, the use of FYM suffered owing to its limited availability. Though far cheaper than chemical fertilizers, it was not easily available to all farmers because its availability was dependent on owning a large herd of cattle. Moreover manures from cattle were also used as fuel. To poor to buy kerosene, farmers depended on manure cakes to cook meals every day.

To supplement the limited availability of FYM, scientists started experimenting on green manures. A study on the relative efficacy of organic fertilizers in 1951 revealed that the inclusion of a legume such as peas in the crop rotation definitely increased the yields of the subsequent

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78 For an interesting discussion on general apathy about human waste see, Gene Logsdon, *Holy Shit: Managing Manure to Save Mankind* (Chelsea Green Publishing, 2010) Ch. 16 and 18.

79 *Report of the Activities of the Ministry of Food and Agriculture* (Government of India, 1956-57).

80 *Report on the Activities of the Ministry of Food and Agriculture*, 1951-52, 1952-53.

crops. Scientists concluded that by introducing pulses and other leguminous crops, small cultivators could not only improve their soil's nitrogen contents, but also produce an important source of protein to an otherwise protein deficient population. Experiments on the effects of manuring on the nutritive quality of rice demonstrated that the thiamine (Vitamin B) content of rice obtained with green manure was higher than the nutritive value of rice from unmanured plots, proving that it was more effective in this regard than ammonium sulfate.[81]

Several additional benefits of planting green manure crops were experimentally proven by a research project conducted in 1955-56 that showed most of them to be considerably drought resistant, making them suitable for use in the upland rice fields that had minimal artificial irrigation. A few types of green manure, such as Sesbania aculeate (dhaincha), proved resistant to the water-logging commonly seen in low lying areas along India's coast. Such wide adaptability of green manure plants made them a very effective practical substitute for chemical fertilizers, which were much more expensive and needed perfectly-regulated water regimes to be effective.[82]

Discussions over the potential of indigenous manures spilled outside the confine of the national laboratories into national forums, such as the Indian Science Congress. The plant pathologist, Dr. S.P. Ray Chaudhury, for instance commented on the options that indigenous manures, such as rock phosphate, bonemeal, nitre-earth, gypsum and non-edible oil cakes offered for extensive use on crops. Chaudhury reported in detail on experiments that Indian scientists had conducted to judge the usefulness of each of these organic manures in different types of soil in India. For instance, the tests indicated that inexpensive rock phosphate was useful in acid soils

[81] *CRRI Annual Report, 1950-51*.

[82] *CRRI Annual Report, 1955-56*.

and in combination with organic matter, particularly on paddy soils. Field experiments also supported use of bonemeal, as having a beneficial effect on acid soils, and in combination with organic matter on paddy.[83] With about 85.5 million tons of gypsum reserve, it was extensively used in many parts of the country, particularly where Gangetic alluvium from long-term irrigation had created alkaline problems in the soil. Even scientists, such as Dr. A.D. Desai, who saw 'no escape from the use of artificial fertilizers like ammonium sulfate and superphosphate', endorsed use of gypsum as a substitute material when there were shortages of organic fertilizers.[84]

It is through the use of biological and chemical inputs, especially that of seeds and fertilizers that we have tried to locate and understand the role of scientific research in the development of agriculture of independent India. It is clear from the narrative that the close association of agricultural science with India's agricultural development did not have to wait till the coming of the green revolution. The agricultural scientists and the Indian government were keen to apply the results of agricultural research to raise the productivity of cereal ever since independence. It would, therefore, amount to misinterpretation of historical facts, if we label pre-green revolution Indian cereal research as perpetuation of the 'traditional' or the upholding of the 'indigenous', just because it did not accept use of synthetic fertilizers as the only way of raising soil fertility or for including usages of organic manure. Moreover, in the official documents, 'indigenous' was not essentialized into a singular model of doing agriculture; it rather implied an emphasis on locally available resources. The emphasis was based purely on utilitarian ground and showed little commitment to India's tradition per se. Neither the spirit of nationalism nor

[83] Bonemeal was such a good source of superphosphate that the Indian government banned its export. First FYP, Ch.18.

[84] Indian Science Congress proceedings (1954), Discussion: Indigenous Manuring Materials and Fertilizers.

that of revivalism could be traced in the use of organic inputs, which were tested strictly as per modern scientific practices. This history of food-crop research, therefore, helps to de-center the common narrative of agricultural modernization that dominates most political-economic view of postcolonial Indian state.

Chapter 3

Hunger and Technical Rendering of the Food Question

Soon after the second five-year plan was launched in 1956, the country faced severe difficulties in several fronts. By late 1957 India's foreign exchange difficulties reached 'crisis' proportions.[1] In response, the Indian government cut all, but the most crucial plan projects and placed restrictions on the importation of nonessential items. The closure of the Suez Canal increased the costs of transportation of India's export and import goods, and proved to be a great impediment for India's foreign trade. Moreover, there were severe droughts in Eastern India. In 1957-58 foodgrain output declined by ten percent and its prices registered an increase of fifty percent from October 1955 to August 1957. All India Congress Committee (AICC) in its annual meeting underlined that it was urgently necessary to regard self-sufficiency in food as an integral part of national self-defense.[2] The government agreed, but the issue was how to raise agricultural productivity? There was unanimity over the goal but not the means. Different parties that were associated with the food and agricultural sector such as the foreign agencies, the Ministry of Food and Agriculture, the Planning Commission, and various farming groups had their own standpoint regarding the matter. The government of India dispatched two study teams to China in 1956 to study that nation's revolutionary cooperative movement. By imitating the

[1] While Indian planners had originally predicted a manageable balance of payments deficit of about $550 million for the five-year period, the aggregate deficit reached $400 million during the first two years of the plan alone. Dennis Merrill, *Bread and the Ballot: The United States and India's Economic Development, 1947-1963 (University of North Carolina Press, c1990)* p. 141.

[2] Indian National Congress, *Resolutions on Economic Policy, Programme and Allied Matters* (1924-1969), p. 105.

Chinese example of labor-intensive, cooperative agriculture, Indian planners reasoned that their nation could raise production with only limited financial investment.[3]

At the Nagpur meeting of AICC in 1959-60, a resolution was adopted by the Working Committee of the Congress Party calling for land ceilings (outlining the maximum amount of land that a farmer can own), service cooperatives to provide farmers with tractors, fertilizers, seeds etc. at convenient prices, urged joint cultivation to overcome the difficulties of cultivating small parcels of land and insisted on state trading in food grains.[4] The call for cooperative agriculture predictably met stiff resistance from Indian landowners, particularly politically influential, large planters. Nehru later lamented that the Nagpur resolution had to be put into deep freeze because of reactions within the Congress Party and other 'feudal' interests, who interpreted plans for cooperatives as a move towards collectivization, which they apprehended would take away their land.[5]

In midst of this discontent, confusion and half-heartedness that marked the institutional reforms, the Ford Foundation Team visited the country in 1959 to inspect the food situation and recommend measures towards its 'development'. The Foundation Team evaluated the food situation in terms of food production vis-à-vis the rising population of the country. [6] In terms of

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[3] India, Ministry of Food and Agriculture, *Report of the Indian Delegation to China on Agricultural Planning and Techniques* (New Delhi, 1956); India, Planning Commission, *Report of the Indian Delegation to China on Agrarian Cooperatives* (New Delhi, 1957).

[4] *The Philosophy of Mr. Nehru*: As revealed in a series of intimate talks with R.K. Karanjia (Geroge Allen & Unwin Ltd, 1966) pp.155-156.

[5] *The Philosophy of Mr. Nehru*, p.157.

[6] John H. Perkins has related the document to a tradition of PNST theory, 'By placing the problem in the population arena, the report was linked to the what was described earlier as the population-national security theory (PNST): population growth in the third world, according to the theory, was causing instability, and increasing food supplies, while providing birth control was the way to end that dangerous political mix that could lead to communist revolution.' John H. Perkins, *Geopolitics and the Green Revolution: Wheat, Genes, and the Cold War* (Oxford University Press, 1997) pp. 181-182.

plain figures they could foresee a crisis situation-India needed more than ten million tons of food to feed its growing population! The Foundation estimated that India would need about 110 million tons of food grains to permit a net daily consumption of per person of 15 ounces and 3 ounces of pulses for the prospective population of 480 million.[7] Based on these facts and figures, the Foundation experts concluded that food production must, on an average, increase at the rate of 8.2 per cent per year for the next seven years.

Advocating ‘an all-out emergency’ program to reach the target of 110 million tons, the Foundation saw improving agricultural production through large-scale adoption of capital-intensive biochemical resources such as improved varieties of seeds, fertilizers and pesticides as the only solution of the food crisis in India. They suggested that the Indian government give credit and undertake water conservation and price support measures to facilitate introduction of the bio-chemical resources. They wanted adequate number of personnel trained and assigned to the job of increasing production. Thus a hierarchy of experts was proposed to transfer knowledge from the laboratories to the peasants. Moreover, to make the new production program work, the Foundation-experts recommended an effective coordination among all involved participants from planners to farmers.

Recognizing that India did not have adequate amounts of new seeds, fertilizers, and pesticides to fulfill the demand, the report strongly advised the Indian government that, instead of dribbling the resources across the entire country, it should concentrate these advanced resources in areas that were adequately equipped to utilize them. Following this strategy meant that the resources should be pumped into areas already enjoying a relative advantage on account

[7] The Foundation derived the figure of 110 million tons as follows: Consumption requirements for cereals and pulses-88 million tons; Seed, feed and wastage-12.6 million tons and stock requirements and safety margins-9.4 million tons. The Agricultural Production Team (sponsored by the Ford Foundation), *Report on India’s Food Crisis and Steps to Meet It* (Government of India, 1959), p.12.

of good irrigation facilities, fertile soil, active credit infrastructure etc.[8] The Ford experts' recommendation, however, conflicted with the long-standing position of the Indian government against any such 'selective' policies. The Planning Commission and the socialist elements within the national leadership had been consistently disapproving, as we have seen, selective approach as economically imprudent and against the principle of social equity.

With a possible technical solution to the food question at hand, the Foundation experts in their report discouraged land reforms as a way of improving the Indian agrarian sector. They considered 'insecurity of tenure' brought about by land ceiling measures as having a 'retarding' effect on food production. They did not want to destabilize the landed peasantry or put them through a period uncertainty over land tenure issues as they trusted this group of farmers as possible patrons/consumers of capital-intensive inputs. The Foundation representatives hoped that if the well-off farmers could be assured that no further reforms would risk their possession, they would be encouraged to make the requisite investment in acquiring the new inputs. To allay any doubt that they were not sympathetic to the plight of the landless peasants, the Foundation-experts remarked that 'We recognize the need for considering programmes for the relief of those who have no land, and of those who cultivate too little land.' But they found it 'imperative' to achieve this objective in 'ways that will not retard the increases in food production which are vital to national welfare.' The Report specifically pointed out that 'care should be exercised' so as not to break up farms that are 'efficiently and productively operated'.

Indian agricultural officers were influenced by a similar approach to land reforms as it became evident to a researcher during her field work in Tamil Nadu. She wrote that the agricultural officers she interviewed never mentioned land reform themselves. Whenever she

[8] *Report on India's Food Crisis and Steps to Meet It*, p. 19.

would bring it up as an issue they would say that 'it was not necessary.' Agricultural officers did not see land reforms as being related to production, except negatively. They reportedly commented that if the government takes away land from the better-off farmers, 'this could only decrease production because the poor will not have the facilities to cultivate properly.' The author somewhat despairingly commented that in many of the interviews, she felt that the officers being interviewed might have been quoting straight from texts from the United States, or those thoroughly written by westernized Indians. In such schemes of thing, the idea of cooperative farming to help small holders apparently took a backseat compared to plans for technological development or price support to encourage larger farmers to grow the high-yielding varieties.[9]

Thus in the plea for increased food production that was urged in the name of national needs such as population growth, defense and development, a technocentric solution (backed by price support) was given precedence over a more complex and time-consuming social-political and economic measure such as land reforms. To develop what they considered an 'efficient' agriculture, they wanted only the 'intelligent and capable' farmers to assume leadership of the new program. How would it be determined which farmers fall into this category of 'intelligent and capable'? The experts followed a cyclic, self-referential logic here. Any farmer adopting the new technology was considered 'progressive' and 'progressive' farmers were by extension of the same logic expected to adopt the new technology.[10]

I would argue in this chapter that the strategy of agricultural development as proposed by the Ford Foundation team exemplifies the process of 'technical rendering' of the food question.

[9] Joan P. Mencher, *Agriculture and Social Structure in Tamil Nadu: Past Origins, Present Transformations and Future Prospects* (Allied Publishers Pvt. Ltd, 1978) p. 240.

[10] *Report on India's Food Crisis and Steps to Meet It*, p. 29.

In identifying low productivity as the main problem of Indian agriculture at the exclusion of all other structural and institutional constraints and in focusing on capital-intensive technoscientific means as the only panacea for the food crisis, it manifested what James Ferguson and Tania Murray Li had argued in their studies on development at Lesotho and Indonesia, as parallel practices of ‘problematization’ and ‘rendering technical’.[11] These two practices, the authors argued, should be studied together to understand development projects undertaken by experts with ‘the will to improve’. The practices of problematization focus on identifying ‘deficiencies’ that need to be rectified. Both Ferguson and Li suggested that the identification of a problem is intimately linked to the availability of a solution. They co-emerge within a governmental assemblage in which certain sorts of diagnoses, prescriptions, and techniques are available to the expert who is properly trained. Other than the Ford Foundation Report, I will analyze the Indian Department of Agriculture’s report on the food situation[12] and the Approach Paper[13] presented by the Planning Commission of India to understand the implementation of the two practices.

Fergusson and Li go on to argue that questions that are rendered technical are simultaneously rendered non-political. For the most part, experts entrusted with ‘improvement’ tend to exclude the structure of political-economic relations from their diagnoses and prescriptions. This feature led James Ferguson to describe the apparatus of planned development as an ‘anti-politics machine’ that ‘insistently repos[es] political questions of land, resources,

[11] James Ferguson, *Anti-Politics Machine: Development, Depoliticization, and Bureaucratic Power in Lesotho* (University of Minnesota Press, 1994); Tania Murray Li, *The Will to Improve: Governmentality, Development, and the Practice of Politics* (Duke University Press, 2007).

[12] *Agricultural Development: Problems and Perspective* (India, Ministry of Food and Agriculture, Department of Agriculture, April 1965).

[13] *Approach to Agricultural Development in the Fourth Five Year Plan* (Ministry of Food and Agriculture, 1964).

jobs, or wages as technical 'problems' responsive to the technical 'development intervention.'[14] Experts, Li pointed out, are trained to frame problems in technical terms. Their claims to expertise depend on their capacity to diagnose problems in ways that match the kinds of solution that fall within their repertoire.[15]

Li has argued that technical rendering of development issues often benefit the ruling faction or contribute to the existence of the state. Fergusson observed that development 'may also very effectively squash political challenges to the system' by its insistent reposing of political questions in technical term.[16] In this chapter, I will explore how similar trends were observed in the Indian context: the issues of famine and starvation created what Akhil Gupta has termed a 'crisis of sovereignty'[17], which the government tried to diffuse through reposing famine and droughts as questions of technological backwardness. An all out effort was made on behalf of the government to transfer the new seeds and related resources to augment production.

'Selective' Approach and the Wind of Change

Following publication of the 1959 Ford Foundation report, Sherman Johnson of the USDA reportedly had a long conservation with Indian Prime Minister Nehru over the observers' recommendation of ways to meet the food 'crisis'. Johnson later remembered Nehru's initial reluctance in admitting that the Indian situation could be seen as a crisis situation. But once Johnson made clear to Nehru that in the coming years, India would face a food deficit of ten million tons (a shortfall that could not be met through import alone), the Prime Minister

[14] Ferguson, *Anti-Politics Machine*, p. 270.

[15] Murray Li, *The Will to Improve*, Introduction.

[16] Ferguson, *Anti-Politics Machine: Agriculture in the Making of Modern India (Duke University Press, 1998)* p.270

[17] Akhil Gupta, *Postcolonial Developments*, pp. 34-35.

reportedly gave up and decided to endorse the recommendation for distributing capital-intensive resources in selected districts of India.

Johnson's account of his interview with Nehru reveals interesting facets of the food question when read along with a more academic work, for example, that of Francine Frankel's magnum opus, *India's Political Economy*. Frankel concentrates on a more complex set of political and economic causes to understand the reasons that prompted the Government of India to launch the Intensive Agriculture Development Program (IADP) in 1961.[18] Johnson, however, stressed on a more simplistic and humane account behind IADP. He explained his success in convincing Nehru and the Indian government to selective use of capital-intensive resources, not in term of how it would have helped the Indian government to pacify different agrarian groups, but, how it would help towards prevention of hunger. Thus to foreign agencies working in India, the emphasis was to present and interpret issues in apolitical context-more in terms of development.

A brief description of IADP would help us to contextualize how it reflected the recommendations of the Ford Foundation Team and introduced new trends that contradicted with agricultural policies of the past. For instance, the Indian government took steps to saturate the entire cultivated areas of selected districts, with improved varieties of biochemical resources. Policymakers ensured that the total requirements of inputs were made available at the appropriate time and at places, within easy reach of the farmers. Leaders stimulated an additional flow of credit, to meet the demands (at least for short-term loans) of all cultivators participating in the program. The Planning Commission wanted these districts not only to be centers of higher

[18] Francine Frankel, *India's Political Economy: 1947-2004* (Oxford University Press, 2005) pp.179-82.

production but also to be models, where they tested the adoption of new agricultural methods and innovations at the block and the village level.[19]

To the proponents of selective approach and capital-intensive resources, the IADP looked promising, as it started showing some expected results. For instance, the use of fertilizers as an 'essential' ingredient of the package of 'improved' practices, increased in significant quantity over the years, and many of the IADP districts led the way in this rising rate of application of fertilizers. Ludhiana district was exemplary in this matter as there, the rate of application of nitrogenous fertilizers per hectare of wheat increased from 100 kg in 1961-62 to 136 kg in 1963-64. In the case of phosphate fertilizers too, the rate of application increased from just 58 kg per hectare in the first two years, up to the recommended rate of 104 kg per hectare. [20]

Use of new seed varieties also showed promise. At the end of the Second Plan, the estimated area planted with improved varieties of seeds was 55 million acres. The Planning Commission expected that it would increase to 148 million acres in the course of the Third Plan. The Ministry of Food and Agriculture proposed to establish a Seed Corporation to ensure seed production at selected farms, under conditions of efficient management, to maintain purity and maximum yield. The Government of India also started considering legislation for controlling the quality of seeds and regulating their production, marketing and movement.[21] Thus from a decentralized seed production of the yesteryears, this constituted a massive shift. Seeds, as mean of production, had been produced and stored by farmers with very little or no state intervention. Any improvement brought about was gradual, and rarely planned by a centralized authority,

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[19] *Third Five Year Plan* (Planning Commission, Government of India) Ch. 19.

[20] *Second Report on Intensive Agricultural District Program, 1960-65* (Department of Agriculture, Government of India) pp.24-25.

[21] *Third Five Year Plan*, Ch.19.

making them an open resource, not subjected to a regulated quality control or standardization. Popular consumption patterns, instead of state legislation or expert opinions, played a more crucial role in regulating the type of seeds that the farmers cultivated. Seed, as Kloppenburg pointed out has a unique position in the production process-it is both the mean of production and the final product.[22] In the technical rendering of the question of hunger, it was this aspect of seed as the mean of production rather than its quality as the final product-the food-that received more attention from the scientists. Scientists in their effort to increase yield was keen to lay down norm for attributes related to higher production; this necessitated a central agency with the authority to impose certain standards to come into being. Yield is a more quantifiable component (than taste) of a production process that made the technical experts to claim it as their domain. Thus when definition of good taste remained a subjective and varied attribute worldwide, what constituted good yield was very strictly defined and imposed through legislation.

Greater use of fertilizers and seeds, however, were not sufficient to create any immediate relief for the nation's food crisis. This was partly because, following the selective approach, there were very few districts where the IADP program was introduced, and there was great regional disparity as to the amount of cropped area that could be brought under the new plans for extensive use of fertilizers and high-yielding varieties of seeds. For example, in the West Godavari district, 83.7 per cent of the gross cropped area was covered by IADP, but in Sambalpur, Bhandara and Cachar the percentage fell to 7.2, 8.5 and 10 respectively. Of the fourteen districts under IADP, only two (Aligarh in Uttar Pradesh and Ludhiana in Punjab) were entirely devoted to wheat cultivation, while Pali in Rajasthan had both millet and wheat among the crops cultivated. Moreover, it is essential to note that the development program covered only

[22] Jack Kloppenburg, *First the Seed: The Political Economy of Plant Biotechnology* (University of Wisconsin Press, 2004) p.xiv.

314 blocks out of the total number of 5240 blocks into which the country was divided in 1964-65. The gross cropped area of these districts was about 8.1 million hectares, which formed a little over five percent of the total cultivated area in the country. [23] The implementation of the new policy was at such a miniscule scale that its impact was hardly visible.

Agricultural production showed little progress in 1960-61 and 1961-62, and then actually declined in the next two years. Food prices rose rapidly, unchecked even by grain imports from the United States. Nehru was jittery about the food situation. Not sure what exactly went wrong, he said to the Indian Parliament, 'I am…naturally disappointed at many things, more especially our performance in agriculture…You may of course apportion blame between the Planning Commission, the Government of India, myself and the state governments.' At various places and times, he admitted that all the elements of the institutional strategy-land reforms, cooperatives, panchayats-had failed. [24] China's attack on India in 1962 came as a sudden jolt to the political leadership of the country. Nehru, already distraught by the food crisis, linked the drive for national defense to the quest for agricultural prosperity. He pointed out that the 'fact that we produce enough in our agricultural sector is as important as guns…Real war is governed by scientific advance. Today you want scientific knowledge; you want scientific processes for production.' [25] Thus under pressure situation, the national leadership expressed a lack of confidence in a slow paced, gradual institutional reforms as a mean of improving agricultural production. Technoscientific means, in moments of crisis, appeared as a more reliable and quicker deliverer.

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[23] *Second Report on Intensive Agricultural District Program, 1960-65*, p. 5

[24] Ashutosh Varshney gave a detail analysis of why the institutional strategy failed. *Democracy, Development, and the Countryside*: *Urban-Rural Struggles in India* (Cambridge University Press, 1998) Ch.2.

[25] Jawaharlal Nehru, *Development is Defense* (Government of India, February 1963).

To enable science and technology to have a greater bearing on agricultural production, the Third Plan (1961-66), provided for an outlay of Rs.280 million to agricultural research in Indian laboratories. For cereals, the central government undertook to develop its own research facilities on a regional basis, in addition to the agricultural knowledge gained from the United States and other foreign powers. This regional or local approach was in endorsement of the recommendations of the Ford Foundation Production Team. Indian government wanted to connect the mission of agricultural colleges to specific blocks in their vicinity, to assure that research could directly contribute to increased agricultural production. In 1963, A.D. Pandit, the Vice President of Indian Council of Agricultural Research, proposed ways to orient research to solving farmers' most basic problems rather than indulge in cultivation of science. He advocated that India, as a developing country, should concentrate more of its scientific resources on applied research, which should be based on the body of fundamental research already available from developed countries. Pandit observed that India's central institutes such as IARI had larger resources of scientific personnel and equipment, which made them relatively well-equipped to undertake fundamental research. But he emphasized that smaller state institutions should concentrate on applied research for regions with distinct geographical/climatic characteristics; when those scientists came across any problems of fundamental research in their work, they should refer such issues to the larger central institutes. Thus, Pandit envisioned a projected model of Indian agricultural science research that was supposed to work as a two-tier system, in which the responsibility to generate knowledge would be in the hands of relatively fewer institutes, whereas, the other centers of research would carry on with the practical applications of the research results. India, it was pointed out, was challenged in terms of resources to support a large number of research institutes of international standards to perform fundamental research on various major crops. Instead, India should engage in scientific dialogue with countries, which already had the expertise and the experience, to receive the latest oeuvre of scientific knowledge and then experiment on ways of applying it to the national context. India's central institutes such as the IARI and the CRRI became examples of this pattern of technology transfer. These institutes were expected to undertake crop research of national importance, utilizing the knowledge received from various international institutes such as CIMMYT and IRRI. Under the new scheme of development, they were expected to make their contributions to the knowledge pool by making international findings in agricultural research more locally adaptable. The country's regional institutes would assist in that search for local agro-ecological adaptations by organizing numerous field trials, experiments and farm demonstrations. [26]

In 1963, Indian government requested an international Agricultural Research Review Team to undertake a survey of the nation's research establishments and to suggest ways to make that knowledge system more effective in solving the food crisis. The team, comprising eminent scientists from India, U.K. and the USA, and led by Dr. M. W. Parker, a senior agricultural scientist of the U.S. Department of Agriculture, submitted its report on March 1964. According to the recommendation of the Research Review Team, the Indian Council of Agricultural Research should be given the necessary powers to develop and administer a national program of agriculture and food research commensurate with the country's needs. This was a clear shift from the prevalent system in which Indian agricultural research institutes conducted theoretical research even when it did not have immediate visible application. The dominance of theoretical science instead of need-based research came to be disregarded as a colonial hang-over, reflecting the British style of higher education, which the Review Team argued, neglected the practical

[26] A.D. Pandit, 'Orient Research to Farmers' Problems.' *Indian Farming*, August 1963.

application of technical knowledge.[27] To guarantee a greater impact of technoscience on the food question, the Review Team pointed out the importance of having India's best scientific talents attracted to agriculture, which was not the case till then. The best minds went to engineering, medical science or in civil services. The team considered that the situation could be remedied by taking steps towards raising the status of agricultural research by providing the agricultural scientists better salary, recognition and greater autonomy. To enable the agricultural scientists to act, independent of the Indian bureaucracy, the 1964 report recommended that the executive head of the ICAR should be a career scientist, instead of a member of the Indian Civil Service, as was the custom.

Within two months of the publication of the research review report, the country went through a political transition, as Prime Minister Nehru succumbed to a heart attack on May 1964. Lal Bahadur Shastri succeeded Nehru as the next prime minister of India in June 1964. Confronted with stiff food price rises all over the country, the new prime minister immediately set up a Price Commission under his chief secretary L.K. Jha to get expert views on price policy for the 1964/65 season. Jha argued in his report that while the immediate crisis might be addressed with proposals for price controls, state trading, and rationing, reaching a more long-term solution to the food problem demanded a substantial increase in production.[28] These recommendations of the Price Commission incidentally reflected the opinions of India's food minister, C. Subramaniam, who had just been transferred from the steel ministry by Prime Minister with the hope that he would successfully replicate his industrial production successes in

[27] Uma Lele and Arthur A. Goldsmith, 'The Development of National Agricultural Research Capacity: India's experience with the Rockefeller Foundation and its Significance for Africa' in *Economic Development and Cultural Change* Vol.37, No.2 (January 1984) pp.305-43.

[28] Interview, L.K. Jha, Washington, D.C., January 11, 1973. Quoted from Francine Frankel, *India's Political Economy* p. 258.

the new ministry too.[29] The fact that the Prime Minister and the future Food and Agriculture Minister thought that the success of the Steel sector could be replicated in matters of agriculture too reveals the technocratic mindset. It clearly brings out how the whole food question and, in that matter, the question of non-availability of food specifically was equated with the technical question of production increase. The parallels simply ignored the social and agro-ecological complexity of the food question. Application of better techniques is enough to remove the production glut of steel, but food availability is related not only to production but also to efficient distribution and the question of entitlement.

As the new food minister and faced with multiple crisis, Subramaniam found a technical rendering of the food question as the most feasible option. He called this the 'new agricultural strategy,' which was defined by a national commitment to capital-intensive technological resources, backed by price incentives and organizational reforms. One of the first statements that he made immediately after becoming the Union Food and Agricultural Minister was that every country that had improved its agriculture, had done so only by introducing modern science and technology into farming, and that India could not be an exception. [30] The fulcrum of his technocratic approach to agriculture would be fertilizer and better seeds.[31] To make the Indian farmers increasingly use capital-intensive biochemical resources, Subramaniam wanted the Indian government to give them price incentives. As a crucial constituent of his technocratic approach, Subramaniam was eager to give agricultural scientists a central role in the new agricultural strategy. The new strategy was a trailblazer in many aspects and therefore

[29] C. Subramaniam, *Hands of Destiny: The Green Revolution* (Bharatiya Vidya Bhavan, 1995).

[30] C. Subramaniam, *Hands of Destiny*, pp.107-108.

[31] 'To produce more food with less fertilizer is as impossible a task as to produce more steel with less iron ore…Better seeds for agriculture are as crucial as better machine tools for industry…This is really a problem of attitude.' Quoted from Varshney, *Development, and the Countryside*, p.53.

politicians, economists, and scientists soon joined in the debate over the suitability, shortcomings, and implications of the new agricultural strategy. The outcome of this debate over the new policy will soon be influenced by both agrarian and non-agrarian questions such as acute food shortages, painfully high food prices, Indo-Pak war, and international diplomatic and economic pressure.

Troubled Time and the New Seeds

By fall 1964, Union Ministers openly declared that the country was passing through a 'national calamity' in terms of food process. In spite of the bleak situation, Subramaniam as food minister remained publicly optimistic that the 'crisis would blow over in two to three months,' thanks to substantial aid flowing from the United States and better harvesting of crops in India that he thought would help to bring down the present high-prices.[32] Contrary to his optimism, the food situation only deteriorated further. The rising food prices shook confidence in the national government among all communities of citizens, to varying degrees. The opposition parties, except the right wing Swatantra Party, took advantage of the general swing of national opinion, seizing the opportunity to pass a no-confidence motion against the Congress government in the Lower House of the Indian Parliament.[33]

The national press remarked with some amount of bitterness that the no-confidence motion was only successful in introducing some amount of chaos in the legislative body; it failed to give a concrete alternative as how to tackle the food crisis. [34] Faced with such animosity from

[32] *Times of India*, August 23, 1964, p. 4.

[33] As the move on no-confidence was mainly organized by the Communist Party of India, the Swatantra Party, a rightist group was unwilling to be a part of it.

[34] *Times of India*, September 8, 1964.

the opposition members of Parliament, the Union Food Minister aggressively blamed them for accentuating the food crisis. Subramaniam argued that the 'crisis of confidence' manifested among the non-Congress Member of Parliament had been actually creating a 'scarcity atmosphere' and further helping the traders to sell food at unjustly inflated prices. In other words, the government blamed the opposition parties for contributing to the rampant black-marketing that became a common occurrence. [35]

The effort of the Union Food Minister to deflect the attack of the Opposition through strategies of counterattack proved futile. To add to the drama of the situation, the Communist leaders from South India went on to hold a personal fast in the lobbies of the Indian Parliament, in protest against the Central Government's alleged nonchalance to the people of Kerala suffering under the food crisis. Since Kerala was always a stronghold of the Communists, the leaders of that state took a leading role in both houses of the Parliament to strongly critique the food policy of the government. The Communist party led a nationwide agitation against rising prices. Demonstrators appeared in the thousands, and police soon made about 1300 arrests to keep the situation from spiraling out of control. There were student riots in different parts of India. [36]

While conceding that stagnating output since 1961/1962 could be a possible reason for the food shortages, government planners, however, insisted that price increases of the present magnitude could not be explained entirely by shortfalls in production. They assigned greater blame to hoarding activities by the 'farmer-trader axis'. The Prime Minister, the Cabinet, and even the Congress Party's Working Committee all accepted the Planning Commission's

[35] *Times of India*, September 11, 1964.

[36] Frankel, *India's Political Economy*, p.249.

assessment. This explanatory stance taken by the Commission seriously questioned the possibility of solving the food crisis entirely through technoscientific means because the latter did not dwell on questions like who has 'control over the means of production, and structures of law and force that support systematic inequalities.'[37] By questioning the technical rendering of the food question, the Planning Commission members brought to the forefront more complex political and economic questions that were not originally addressed by the Food Minister, the Research Review Team or the Ford Foundation members. It was not ignorance about the complexity of the food question that prompted the kind of response that it repeatedly did from the agents of capital-intensive development of Indian agriculture. It was rather, in my argument, the very awareness of the difficulty of a holistic appraisal of the agrarian scenario that discouraged them to do so. They wanted a quick-fix remedy, which they knew will not be possible if political and economic issues were addressed. Moreover, as Fergusson argued in his study on Lesotho, the development agencies that worked in such contexts, down played political conflicts within a nation-state because resolving such conflicts did not fall within their domain of expertise or authority.[38] The experts associated with the developing agencies, Tania Murray Li argues, 'are trained to frame problems in technical terms. Their claims to expertise depend on their capacity to diagnose problems in ways that match the kinds of solution that fall within their repertoire.' [39] The Food Minister Subramaniam's approach to the food question is another classic example of the kind of development logic that both Li and Fergusson discussed in their respective books on Indonesia and Lesotho.

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[37] Tania Murray Li, *The Will to Improve*, p.11.

[38] Ferguson, *Anti-Politics Machine*, p.72.

[39] Tania Murray Li, *The Will to Improve*, p.7.

Subramaniam as the food minister emphasized that the real answer to the spiraling prices was to increase production. He urged the government to return to the market approach of providing price incentives to private investment, while substantially increasing outlays on yield-enhancing inputs, especially chemical fertilizers.[40] In January 1965, Subramaniam presented the framework of the new agricultural policy to the annual session of the Congress Party at Durgapur. In the meeting he vociferously argued that even though the 'immediate' concern, in face of the food crisis, happens to be food distribution, 'the food problem cannot be solved unless the agricultural production programme is attended to and we achieve results and produce more to increase the availability of food to meet the needs of the people.' He defined the 'future programme' of Indian agriculture entirely in terms of 'need for scientific agriculture' that would be composed of extensive fertilizer use, bigger seed farms, plant protection, improved elements etc. He planned the growth of entire administrative, research and extension sectors to facilitate the use of the aforementioned components of what he called 'scientific agriculture'.[41]

But it did not prove easy for Subramaniam to push through his plans for scientific agriculture. As he later reported, the main bone of contention in the session was, whether the new emphasis on production through capital-intensive means in his plans amounted to abandoning Socialist principles and the goal of social equity. The State Chief Ministers supported Subramianiam and his policy, whereas, the more left inclined members of the Congress Party demanded a return to what they called 'Nehru's ideals.' The session, however, ended on a compromising note. A resolution was passed that reaffirmed the goal of making

[40] Frankel, *India's Political Economy*, p.257.

[41] *Agricultural Development: Problems and Perspectives* (Ministry of Food and Agriculture, Department of Agriculture, April 1965), Appendix I.

progress towards an ideal socialist society, but at the same time recognizing the need for rapidly stimulating the base of farm production. [42]

Subramaniam realized in 1965 that if he could successfully reorganize the ICAR, along the lines recommended by the Agricultural Research Review Team, that would make his task easier of reorienting India's agricultural research establishments to fit his plan for scientific agriculture and also make the institutes more responsive to immediate local requirements. The first step towards that was taken when he replaced the civil servant who was in charge of ICAR with a scientist, Dr. B.P. Pal as the Director General. By replacing a bureaucrat with a scientist at the helm of ICAR, Subramaniam hoped to ensure that future agricultural research establishments would not be tied down by unnecessary red tape or limited by a narrow administrative mindset. As a career scientist, Pal was expected to display a better grasp of any problems facing a researcher or a research project and take quick actions accordingly. Next, Subramaniam transferred all the national agricultural research institutes, including IARI, out of the Department of Agriculture and to the new jurisdiction of ICAR. Through this move, Subramaniam intended to achieve two objectives, to facilitate centralization while also restricting bureaucratic influence on agricultural research, education and extension services. Through centralization, he hoped to increase the influence of international experts in reshaping India's agricultural research. The more decentralized a research structure is, the more difficult it is to impose a homogenous model. Under the FAO initiative, India was already involved in international germplasm transfer, and Subramaniam hoped that his initiatives at reorganization and centralization would further strengthen such efforts. He discouraged fragmentation of research efforts and urged scientists to concentrate scientific resources on solving a few basic questions that were thought to be closely

[42] Subramaniam, *Hands of Destiny*, pp.115-116.

related to problems of increased production. As a mark of highest technocratic triumph, the ICAR was given all the necessary powers to develop and administer a national program of agriculture and food research that would be commensurate with the country's needs. Through disassociating agricultural research institutes from rest of the civil administration, by narrowing down its focus on technicalities and concentrating expertise only on solvable problems, the new agricultural strategy successfully accomplished a thorough technical rendering of the food crisis.

Agriculture was placed under the concurrent list of the Indian constitution, making the center and the states jointly responsible for its development.[43] Thus to ensure that the new policies had an all-India effect, Subramaniam took measures reforming the ways that state agencies conducted agricultural research and extension. Once the government placed the central research institutes under the jurisdiction of the Union Ministry of Agriculture, policymakers also moved to place the state-level research organizations under the jurisdiction of the respective State departments of agriculture. In fact, Subramaniam decided that the best approach would be to transfer the entire research function out of the state departments and into the new agricultural universities which were to be established in every state. [44]

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[43] For the subjects under Union and State lists, the central government and the state governments were responsible respectively.

[44] The Constitution of India has stipulated agriculture as a 'state' subject, which has given the state governments the 'primary' responsibility to conduct agricultural research, education and extension. It has bestowed the central government at New Delhi with the 'ultimate' responsibility in agricultural matters, which would include its right to intervene in case of 'national emergency' or in 'public interests.' The political discourse of 'national interest' is commonly used to expand the power vis-à-vis the states. Entry 33 of the Concurrent List stipulates that the center can take over food production and distribution (normally under state control) if the national interest is interpreted to demand central control. Pritam Singh, *Federalism, Nationalism and Development: India and the Punjab Economy* (Routledge, 2008) Ch.5. Entry 14 of the State List of the Indian constitution makes the states of India responsible for 'agriculture, including agricultural education and research, protection against pests and prevention of plant disease.' His analysis, however, shown that the center has had overwhelming powers in deciding the agricultural policies that a state government pursues. This power sometimes went beyond the constitutional powers granted to the center for intervening in the agricultural sector.

More than 31 million U.S. dollar, 11 million Indian rupees, 700 man years of U.S staff time were spent in helping India build this re-envisioned system of agricultural research and education, including the creation of eight new agricultural universities. Six American land-grant universities helped establish India's new agricultural schools. [45] Both India's host government and the United States Agency for International Development (USAID) wanted to ensure the survival of India's new schools; they worried that political instability made it virtually impossible to sustain a high level of support for a developing institution for much longer than two to three years. In supporting India's new agricultural universities, USAID wanted to ensure that its technical assistance had a direct impact on the country, both politically and economically. They hoped their aid would snowball, through a 'critical mass effect,' and formulated several indicators to measure the value. One priority assigned to India's new universities was to produce more master's degree graduates and doctorates. The professor's primary function was defined as the creation and accumulation of new knowledge; in devoting intensive effort to improving the quality of research, India expected its scientists to focus on identifying and solving the country's most significant agricultural problems. Through improved physical facilities and higher pay scales, universities hoped to induce better professors to stay. The universities made changes in the curriculum to ensure that all students acquired a basic fundamental understanding of the State's agriculture and the underlying basic sciences. This new structure was intended to allow greater flexibility for both students and professors, and to eliminate all of the

[45] Govind Ballabh Pant University of Agriculture and Technology and the University of Illinois ,Punjab Agricultural University and the Ohio State University, Andhra Pradesh Agricultural University and Kansas State University, University of Udaipur and the Ohio State University, Jawaharlal Nehru Krishi Vishwa Vidyalaya at Jabalpur and the University of Illinois, Orissa University of Agriculture and Technology and the University of Missouri, University of Agricultural Sciences, Bangalore, and the University of Tennessee, and Maharashtra Agricultural University and the Pennsylvania State University. For detail on the establishment of these universities see: Hadley Read, *Partners with India* (University of Illinois, at Urbana-Champaign, College of Agriculture for the Council of United States Universities for Rural Development in India, 1974).

previous duplication. In emulation of America's land-grant institutions, extension was defined as an important activity of India's new agriculture universities. But during this phase, the experts made no attempt at two-way communication; there was no interest in incorporating farmers' knowledge in the improvement of Indian agriculture. The focus of the new agricultural institutes was to 'develop' experts in the western mould, who would be dominating arbitrators of change, rather than facilitators of cooperative efforts; they visualized the farmer as a passive and malleable recipient of technical information. [46]

Mexican Agricultural Program: Model for Developing Countries

Subramaniam wrote in his memoir that in the spring of 1965, Dr. Ralph Cummings of the Rockefeller Foundation came to visit him as it became known that the Minister was prepared to consider new approaches to agriculture based on the new advances in science and technology. The Rockefeller Foundation had already been testing the high-yielding wheat and maize seed varieties in various experimental farms of IARI, following the success of their Mexican program.[47] Twenty years of work in developing, first, the disease resistant seeds and then, the fertilizer-responsive dwarf varieties of wheat, convinced the scientists and officials associated with the Mexican project that, doing the same in case of India would help to significantly raise yield and eventually make India self-sufficient in food. In the transfer of technology, therefore, the experts assumed a certain uniformity of contexts. They assumed that the success of a piece or a package of technology could be replicated with investments in training scientists of the developing countries at land-grant institutions, modeling institutions of the host countries in

[46] *Building Institutions to Serve Agriculture: A Summary Report of the C.I.C-A.I.D* (Committee on Institutional Cooperation, Purdue University) pp. 51-52.

[47] For a detail history of the Mexican Agricultural Program and the role of the Rockefeller Foundation and the American science see: Joseph Cotter, *Troubled harvest: agronomy and revolution in Mexico, 1880-2002* (Praeger, 2003).

accordance to the philosophy of the former and in molding attitudes favorable towards capitalization of agriculture. This is not to say they started with a deliberate intention of replication. But their objective was to disseminate those practices, institutions and technology that they have seen to succeed in their own country.[48]

The success of the new technology, in significantly bringing down Mexico's corn and wheat import went a long way in boosting the claim that, technology on being effectively used could modernize agricultural production and thereby fight hunger. Historian Deborah Fitzgerald argued in her article that though as early as 1948 Mexico stopped importing corn, due in large part to the use of improved seeds, less than 12 percent of Mexican farmers used hybrid seeds to cultivate their land, even as late as 1963. Most of the corn in Mexico continued to grow in subsistence level farms, which were not in a position to adopt that were expensive practices such as hybrid seeds, fertilizers and irrigations mandatory in the new cultivating practices. In contrast to the corn project the wheat program was more successful because, Fitzgerald showed how the wheat farmers in terms of their affluence, access to resources, and interest in experimental practices resembled American hybrid corn adopters rather than other Mexican farmers.[49]

Moreover, at the euphoria of the moment no body stopped to ponder whether freedom from food import is equivalent to freedom from hunger and whether Mexico was at all successful in achieving the later objective. The scientists, bureaucrats and politicians who harped on the technical success of the Mexican program in boosting up production, did not enquire whether it

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[48] Deborah Fitzgerald pointed out that, in 1940s the agencies in case of transferring the American model of agriculture to the Mexican context exhibited the same kind of prior assumptions that, there existed a parallel group of Mexican farmers, who practiced a capital-intensive, market-oriented agriculture that was entrenched in a network of commercial and public institutions. She also gives a detail account of how Mexican scientists were given training at American Land grant Universities. 'Exporting American Agriculture: The Rockefeller Foundation in Mexico, 1943-53', *Social Studies of Science*, Vol. 16, No. 3 (Aug., 1986), pp. 457-483.

[49] Deborah Fitzgerald, 'Exporting American Agriculture', pp.467-69.

was followed by an efficient food distribution chain and if the people had the purchasing capacity to buy the food thus produced. The complexity inherent in the question of hunger was deliberately reduced and dealt only in terms of production, because it was the only part that was amenable to a technical solution, with which the experts were familiar.

This conviction, that the new research developed for Mexico could be beneficial in addressing India's national farm crisis, appeared quite plainly in the arguments of American scientists in mid-1960s. In 1967, for example, American scientists E.C. Stakman, Richard Bradfield and Paul C. Mangelsdorf wrote a book crediting science and technology with creating an 'agricultural revolution' in Mexico from 1943 to 1963 that succeeded in conquering hunger. Their account read like a fairy tale, with the good (in this case, technoscience) winning over evil (hunger), thanks to the valiant struggle of the heroes, the scientists. Their moral-laden account linked modern science to efficiency and contrasted hard work versus laziness in producing striking contrasts of wealth and poverty. This book promised that modern research could ensure a bright future for all, other than the traditionalists who were too non-enterprising or too skeptical to embrace change.

Stakman, Bradfield, and Mangelsdorf suggested that the triumph of science over hunger in Mexico could be extended to various other parts of the world, including the developing nations of South and Central America and Asia. [50] Not coincidentally, all three authors had helped lead the Rockefeller Foundation's agricultural program in Mexico, and their account reflected their dual convictions that their efforts had directly led to raising agricultural yields in Mexico and that the principles held equal promise to do the same in other parts of the world.

[50] E.C. Stakman, Richard Bradfield and Paul C. Mangelsdorf, *Campaigns Against Hunger* (The Belknap Press, 1967).

Similar to the literature on food-population discourse, the authors used graphic metaphors to give an account of technoscientific mastery over vagaries of nature and population explosion. The authors in extolling how science and technology helps man to fight destructive elements of nature-from pests/diseases to soil infertility- reiterated the conviction of the developmental theorists. We need to remind ourselves, as we discussed in chapter one, Rostow's belief that development especially technology and science would help developing countries to overcome their dependence on nature and attain a mastery over it. This definitely held much promise for the developing countries which had been fighting too long the ravages of nature in form of droughts, floods and pests attack. The means to tame nature to human needs looked so accessible and alluring.

Religious references, especially biblical anecdotes were repeatedly stressed to drive home their arguments on the benevolent nature of the new technology and how a man, in being enterprising with the technology, would be performing his religious duty and not doing so amounted to laziness and thus being irreverent towards biblical injunctions. By helping the destitute, they suggested, the agricultural scientific revolution was embracing a Christian duty. By giving a poor country agrarian self-sufficiency, the scientists wrote, technoscience fulfilled of the prayer 'Give us this day our daily bread.'[51] They argued that the 'heart-warming revolution' had helped to make the land more bountiful for the land-loving Mexican farmers. Unlike a political coup, this revolution had been 'bloodless,' with a 'constantly accelerating momentum' that brought more and more benefits to its neighbors, both near and far. The authors' celebration of the apolitical nature of the new technical revolution further vindicates Fergusson's observation that in the development rhetoric, questions that are rendered in technical terms are

[51] E.C. Stakman et al., *Campaigns Against Hunger*, Ch.5.

simultaneously rendered non-political. The success stories of so-called technical revolutions came to be bleached of its political and social content. Such de-contextualization helped to show-case that the new technology was applicable with same success in any parts of the world.

In proclaiming the gains achieved through a scientific revolution in farming, Stakman, Bradfield, and Mangelsdorf made assertions that played into a larger context of international political arguments over agriculture. During these years, theorists such as Wolf Ladejinsky vigorously urged the need for land reforms to counter communist infiltrations in the developing countries.[52] These scientists, like the members of the Ford Foundation team suggested, instead, that while land redistribution might satisfy the hunger of the landless for land, such measures did not automatically satisfy their hunger for food. This argument proved to be an effective ploy against the Communist call for giving more land to the people in the developing world.

Like India in the early 1960s, Mexico in 1940 was confronted with two inexorable facts: mounting population and relatively fewer arable lands. Apart from the problem of having little per-capita land under cultivation, the yield per acre was also low, and there was very little land still available for possible reclamation. Speaking as American scientists, Stakman, Bradfield, and Mangelsdorf argued that such difficult circumstances made the use of technoscience as the only logical step, that the 'wise' leaders of Mexico felt obligated to help their people by initiating a technical revolution in agriculture. To supplement land reforms, Mexico's Minister of Agriculture and the Sub-secretary of Agriculture were 'conscious' that their country faced an

[52] Wolf Ladejinsky, 'Agrarian reform in Asia', *Foreign Affairs*, Vol. 4 (Apr 1964.) pp. 445-461.

urgent need to produce *more* food and had the *enterprise* to ask for help where *help was needed*.[53]

In the early 1940s, the political leaders of Mexico urged the Rockefeller Foundation to provide them with technical assistance, and the Foundation appointed a three-man commission. Paul Mangelsdorf was a distinguished plant geneticist and breeder, Richard Bradfield was an eminent specialist in agronomy and soils, while E.C. Stakman was a plant pathologist. Those three were charged with studying Mexico's food needs and agricultural potential, and then assisting with the technological and scientific aspects of agricultural change. Their operations in Mexico started in February 1943 and by 1956, that country had become independent of the need to import foreign wheat. The three scientists attributed victory in this Mexican agricultural revolution to a 'Big Three' set of technoscience measures: the adoption of better seed varieties, better soil management, and better protection against destructive diseases, voracious insects and noxious weeds. Over subsequent years, advocates would define these three biochemical introductions (better varieties of seeds, fertilizers and pesticides) as the core of the technological package that they claimed could revolutionize international production and potentially eliminate widespread hunger. [54]

The Rockefeller Foundation appointed George Harrar to take charge of its Mexican program. Working with a group of Mexican scientists such as Jose Rodriguez, Leonel Robles, Benjamin Ortega and Jose Guevara, Harrar succeeded in breeding wheat varieties that had higher yield potential and were resistant to stem rusts disease. Those advantageous varieties definitely increased the total wheat production in Mexico for a few years. But after 1958, the national

[53] E.C. Stakman et al., *Campaigns Against Hunger*, Ch.1.

[54] E.C. Stakman et al., *Campaigns Against Hunger*, Ch.9.

yield leveled off; observers reported that the newly improved varieties fell to the ground when 80 kg of nitrogen or more was applied to the soil. Norman Borlaug, a plant pathologist and a wheat specialist who joined the Mexican program in October 1944, was already experimenting with the idea that use of semidwarf varieties could overcome this problem of 'lodging' and thus facilitate greater use of fertilizer in the field. [55] In 1954, he was responsible for initiating the first extensive breeding program to develop semidwarf spring wheat varieties in Mexico, by crossing Norin 10 and Brevor lines with Mexican spring wheat varieties.[56] Further experiments resulted in 1955 in a new type of wheat with higher yield potential, increased number of fertile florets per spikelet, and a larger number of tillers per plant. This experimental variety would serve as the basis for subsequent important developments in commercial wheat, such as Pitic 62 and Penjamo 62, which Mexican farmers started growing after 1962. These were followed by the release of Sonora 63, Sonora 64, Mayo 64, Lerma Rojo 64 and other varieties. [57]

The story of the agricultural revolution in Mexico connects directly with the history of India in the mid-1960s. This connection was not incidental but deliberate. According to S.P. Kohli and R.G. Anderson, the Coordinator and the Joint Coordinator of All-India Coordinated Wheat Improvement Programme, by the early 1960s, the new high-yielding varieties from Mexico came to be introduced in India. During 1962-63, scientists associated with the International Wheat Rust Nursery observed a number of dwarf wheat varieties of Mexican origin. In 1963, at the invitation of the Government of India, Norman Borlaug came to visit the

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[55] He was put in charge of the wheat program in March, 1945.

[56] Borlaug had received the Norin 10 X Brevor lines from Vogel who had been studying dwarfness in these varieties. For a detail account see John H Perkins, *Geopolitics and the Green Revolution: Wheat, Genes, and the Cold War* (Oxford University Press, 1997) Ch.10.

[57] D.S. Athwal, 'Rice and Wheat in Global Food Needs', *The Quarterly Review of Biology*, Vol.46, No.1 (March 1971) pp.1-34.

wheat-growing areas in India. On his return to Mexico, Dr. Borlaug sent bulk qualities of seeds of four Mexican dwarf wheat varieties for trial in India. Scientists at IARI sent this material for evaluations at several different testing stations, and based on those observations made during the cropping season of 1963-64, researchers selected a few new dwarf wheat varieties for further investigation. In particular, the Mexican wheat varieties Lerma Rojo and Sonora 64 seemed potentially suitable to the varying conditions prevailing in the different parts of India, and so India selected those two varieties for restricted seed imports during 1965.[58] The group in favor of importing the new seeds from Mexico for their cultivation in India, made arrangements to bring in 250 tons of Sonora 64 and Lerma Rojo, to arrive in time for planting in the fall of 1966. The scientists hoped that this amount of seed would be sufficient to cultivate about 2900 hectares (about 7,100 acres) in the 1965-66 cropping season. [59]

National Crisis and the Dwarf Varieties

On April 1965, as IARI celebrated its sixtieth anniversary, Pakistani incursions occurred in the Rann of Kutch area at the western part of India. The volatile situation added to the national anxiety about the food situation. How can an army, much less a nation, face its enemy with empty stomach? C. Subramaniam, the Minister for Food and Agriculture, continuously argued that faced with this national emergency, it was even more necessary to conduct scientific work on these new seed varieties. He confidently declared that given the right type of political and administrative support and academic freedom, India's research workers could convert theoretical knowledge into tangible advances in the food sector.[60] M.S. Swaminathan, head of the Division

[58] S.P. Kohli and R.G. Anderson, 'New Amber Seeded Wheats', *Indian Farming* (August 1967) pp.28-29.

[59] Perkins, *Geopolitics and the Green Revolution*, p.241.

[60] C. Subramaniam, '60 Years of Agricultural Research', *Indian Farming* (April 1965).

of Botany at IARI, pointed out how rapid advances in agronomic practices, especially in fertilizer application and water management, was making possible to obtain very high yields from the Mexican dwarf varieties of wheat. He recounted in several occasions the stories of spectacular yield in trials conducted at farms in Delhi, Uttar Pradesh, Punjab, and Bihar, where the varieties Lerma Rojo 64A, Sonora 63 & 64, and Mayo 64, all reportedly yielded 5000 pounds per acre.[61]

On the basis of such evidences of high yields, the members of the 4th All- India Wheat Research Workers' seminar judged the Mexican variety Lerma Rojo to be suitable for cultivation under high levels of fertility in India. Lerma Rojo reportedly gave not only phenomenal high yields but it was also the only commercial wheat variety available in India that was most resistant to rust, smut, and lodging problems. Moreover, the scientists argued that though it was a semi-dwarf wheat variety, its straw yields were comparable to those of the Indian varieties because of its profuse tillering. The researchers publicized this aspect of Lerma Rojo to make it more acceptable to the Indian farmers, who needed the straw for their cattle, in absence of adequate grazing ground.

Armed with all these experimental data on the yield capacity of the new cultivars, Dr. Ralph Cummings of the Rockefeller Foundation, (as mentioned earlier in the chapter) came to visit Subramaniam in 1965. Cummings reportedly expressed concerns at the persistent doubts at various governmental levels about the new high-yielding varieties. What dismayed him the most was the skepticism of the scientific establishment-significant number of researchers resented the introduction of the new seeds as they were not sure what sort of new pests and diseases might develop with the dissemination of the Mexican varieties. Cummings complained that many

[61] M.S. Swaminathan, 'Plant Breeding Opens New Vistas in Crop Production', *Indian Farming* (April 1965)

scientists resisted the new seeds out of excess caution, even though two years had passed since the new seeds had been introduced, and the new wheat varieties had performed well on the research farms without the emergence of any adverse factors. Cummings also mentioned that new varieties of rice were available and were under experimentation in various laboratories and research farms, but that no decision had been taken at either the scientific, administrative or political levels as to what was to be done with these varieties. Subramaniam wrote in his memoir that once he heard Cummings' message, he decided to proceed with the formulation of a strategy to utilize these new varieties. He established three panels: a scientists' panel, a panel of agricultural economists, and a panel of agricultural administrators, to initiate a country-wide discussion on the suitability of the introduction of the new varieties to solve the food crisis.[62]

As a raging debate took place between various groups on the new seeds alongside border skirmishes with Pakistan, the four-year agreement that Indian leaders had made with President Kennedy on P.L. 480 came to an end.[63] To make matters worse, it was apparent by late July that the year's main monsoon had failed over northern India. By the middle of 1965, the food situation and the swirling debate around it had thrown open several important questions as to the fundamental causes of crisis. At both the national and international level, and between India's ruling parties and the opposition, observers agreed without ambiguity that there was an essential agricultural crisis. Differences arose, however, over what caused the crisis. People hoped that identifying a cause would facilitate the process of finding a solution. This in turn would quicken the pace of development of modern India that got momentarily stalled by unwonted circumstances.

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[62] Subramaniam, *Hands of Destiny*, p.133.

[63] To get an idea of the debate see Subramaniam, *Hands of Destiny*, Ch.11.

National daily newspapers reflected this sense of concern at what had caused the crisis. The successive failures of the monsoons in different parts of India definitely contributed to the worsening food scenario, but the main critique against the government was that an insufficient monsoon should not be the sufficient cause of widespread famines that stalked Indian countryside. Attacking the government's procurement policy, the *Times of India* argued that 'political expediency and the fear of doing anything which might alienate the middle range and rich peasant and lose the ruling party a large number of votes at the next general election have prevented most of the states from taking the procurement programme seriously.' [64]Thus, through mid-1965, the main complaint was that the famine was the result of a dismal procurement policy. It was argued that the Indian government did not display administrative efficiency or acumen to build up a food reserve to fight against possible weather vagaries. Given that droughts and floods were not uncommon in India, the unpreparedness of the national government became the butt of much public criticism. The ex-Union Food Minister, A.P. Jain and the economist B.R. Shenoy among others, however, joined Subramaniam in locating the locus of the crisis not in an administrative failure but in what they saw as the long-term technical backwardness of Indian agriculture. They argued that the Indian government must seek long-term remedies for food scarcity by investing in research for greater agricultural production. They wanted measures that would help farmers get financial resources, essential supplies, and cheaper fertilizers, which could help bring a reasonable return on their produce. [65]

The day after celebrating the nineteenth Independence Day, the Indian Parliament opened its monsoon session on 16th August 1965 amidst a 'swirl of anxiety' about the prevalent food

[64] Times of India, July 22, 1965.

[65] Times of India, August 19, 1964, September 3, 1964.

situation. The national dailies reported on the way in which the Opposition members took the government to the task. So bitter and sometime violent was their behavior that in the state legislative assemblies at Bihar and Maharashtra, the Speakers were forced to suspend almost all the Opposition members.[66]

In the midst of all these anxieties, the Food and Agriculture Ministry was preparing an Approach Paper to the proposed Fourth Plan (1966-71), which recommended a comprehensive outline for the new agricultural strategy, stressing not only the price incentives but also the new technology to be introduced. In this vision, new inputs like fertilizers and plant protection chemicals would be used in a few regions that had assured rainfall and sufficient irrigation, where such investments could return the maximum production.[67] That policy would mean 'favouring' areas which were already comparatively well developed with regard to irrigation. There was huge opposition from the Planning Commission and the Finance Ministry[68] who argued against it on two grounds; adopting the new agricultural strategy would have meant sidelining long-standing issues of regional equity and socialist principle that defined Nehruvian India and it would also have meant greater demand on tight foreign currency situation for importing the expensive inputs. The Ministry of Food and Agriculture, however, overrode significant opposition to adopt the new strategy. The proponents of the new technology effectively used the critical food and political situation to argue that their model of agricultural development would be successful in increasing agricultural production and thereby fight both enemies-hunger at home and the invading army at the border.

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[66] Times of India, August 16, 1965.

[67] *Approach to Agricultural Development*, pp.15-18.

[68] Subramaniam, *Hands of Destiny*, p.116.

On September 6, 1965, a sense of emergency descended on the nation, as the President of Pakistan, General Ayub Khan declared a full-fledged war against India, escalating from the intermittent border skirmishes that had already been taking place. A week later, the U.S. suspended all military and economic aid to both belligerents. In the context of the Cold War, the suspension of aid did not go down well with the members of India's political establishment. H.N. Mukherjee, the communist M.P from West Bengal, considered the suspension of aid as the American way of 'arm twisting' the Indian government. He argued that the U.S. attitude towards the Indo-Pakistan conflict over Kashmir had shown 'where we are likely to stand if we depend on aid.' [69]

In October 1965, in a speech to the nation, the Prime Minister correlated the need for greater food production with the preservation of India's freedom. He told listeners that just as the jawan (soldier) is '…staking his life for the country' similarly, the kisan (farmer) should '…give their toil and their sweat.' Shastri's speech brought out the desperation of India's situation. He urged that every bit of land should be cultivated, 'a well-kept kitchen garden should be a matter of pride to every household…' He asked ordinary consumers to practice self-restraint and not to hold parties, dinners and lunches, because these 'are not in tune with the time at all.' He wanted public opinion to 'encourage austerity'. He called upon women to economize on consumption of wheat and use instead maize, barley or gram. [70]

[69] Parliamentary Debates, 12 November 1965.

[70] Lal Bahadur Shastri, *Produce More Food and Preserve our Freedom*, Broadcast over A.I.R, Delhi, October 10. 1965.

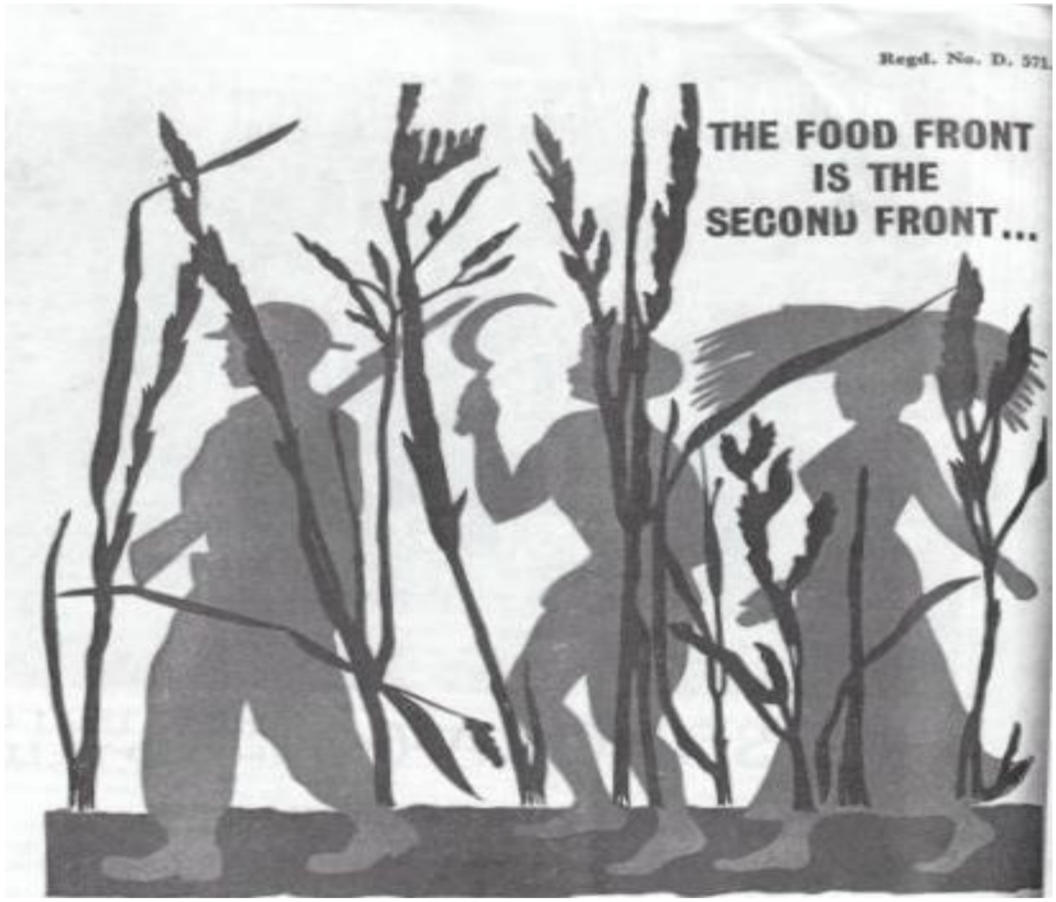

Fig. 3.1 Food and Defense: With the war going on between the Indian and the Pakistani army, defense and agriculture were considered 'uppermost' needs of India. In the words of the Prime Minister, Shastri, the food front is almost as vital as the military front.

Shastri anticipated that the winter of 1965 would serve as a crucial turning point. He warned that whatever India would be able to do in the agricultural front during the coming three or four weeks would determine the fortunes of the country in the coming year. He wanted agricultural work to be undertaken on a war footing. To underline the gravity of the situation, Shastri drew close parallels between the war front and the food front. The Prime Minister talked about a scheme in which groups of villages would be entrusted to officials whose responsibility it would be to keep in close and direct touch with the farmers and to do everything possible to resolve their difficulties. He urged entire districts to work as a team, with ‘a sense of dedication in the same manner as a soldier on the battlefront.’ Shastri visualized the District Officer as equivalent to a military commander, who had to organize the drive and achieve the production target. The Prime Minister assured his audience that these efforts would be successful if officials ‘apply themselves to the task not merely as a part of their duty but also as a part of the deep obligation which they owe to the country at this critical hour.’ [71]

Subramaniam stood by the Prime Minister, promoting the greater use of modern agricultural science and technology as vital to the nation’s security and development. He pointed out that ‘the inadequacy of our agricultural production has thrown a grave challenge to the nation engaged in the task of its economic growth and in the increasing responsibilities of its defense. It is a challenge to our will to live in prosperity and freedom…Our men of science are called upon to provide the ideas and leadership for bringing into the field methods and techniques which will effect a breakthrough in our agriculture and sustain its dynamic growth.’ [72] At another occasion, the Food Minister pointed out more categorically that, ‘…we must remind ourselves that there is an enemy lurking still-the enemy of ignorance, poverty and obscurantism. This enemy has to be fought and fought to a finish…The scientific revolution has a great role to play in making our society strong and successful. Research has to be organized in a bold and purposive manner to this end.’ [73]

For the first time in the nation’s history, the scientists were under an intense political spotlight. Those researchers who were pinning great hopes on the Mexican dwarfs knew they

[71] Shastri, *Produce More Food and Preserve our Freedom*.

[72] C. Subramaniam, ‘Message’, *Indian Farming* 15, no.7 (1965) p. 2.

[73] C. Subramaniam, ‘India on the Eve of Breakthrough in Agriculture’, *Indian Farming* 15 (November 1965) Quoted from Perkins, *Geopolitics and the Green Revolution* p. 243.

had to show some impressive results, in order to justify this huge import of seeds and chemical fertilizers during a period of acute foreign exchange crisis. Gradual worsening of the food situation made their task doubly difficult. In November 1965, the central government declared that its policy would be to prioritize conservation and equity, meaning that whatever food was available should go around as equitably as possible. Food shortages reached such an acute proportion that Prime Minister Shastri had to request each Indian family to skip a meal every week. This was no temporary or one-time request made by the Indian Prime Minister. The Government of India officially dubbed it as the 'missing-a-meal' campaign. Indians had long been used to fasting because of religious reasons. Moreover, Gandhi had given fasts a political significance in fighting the British rule. But it was striking to have an independent, democratic government officially incorporate fasting as a strategy to overcome a desperate food shortage. Government publicity campaigns sought to project the move in a positive light, emphasizing that nations seeking development and facing crises of scarcity and security have always demanded extraordinary sacrifices from their people. Indian traditions had long unquestionably established austerity as a high virtue, a cultural fact that came in handy to justify the 'missing-a-meal' campaign. Columnists in national dailies, with surprising glibness, argued the 'virtue of missing-a-meal' in cutting down on overly-rich diets, wherever there is 'excess consumption as to create a climate of austerity and sacrifice.' The Shastri government also advocated a reduction in entertainment to grapple with the food crisis. The idea was to curtail food consumption as an integral part of any social and religious ceremony in India. [74]

[74] Till the late 1980s the wedding cards in India had a line towards the end, which stated that the number of invitees had been in accordance with the government regulation. This declaration could be traced back to the days of food scarcity under Shastri when it was made forbidden to invite more than a stipulated number of people in any ceremony where food would be served.

As winter was setting in, the specter of having to further curtail food rations from 12 ounces to 10 or even 8 ounces per day was turning into a reality, unless India could manage to get more food from the U.S. as part of the P.L.480 agreement. In the second week of November 1965, Subramaniam, the Union Food Minister, had to admit publicly that while every effort would be made to reduce India's dependence on food imports, the country currently had *no alternative* but to import as much food as possible. The minister emphasized the gravity of the situation; due to the drop in agricultural production in 1962-63 and 1963-64, he reported, India had already exhausted all buffer stocks of food grains. The recent widespread droughts seemed likely to cause a further fall in production in various parts of the country, especially in the Hindi-heartland of northern India, which had always been the sheet-anchor of the Congress Party in any election. US food shipments, which would allow the Government of India to provide cheap food to the masses in the Indo-Gangetic plain, thus became a guarantee of political stability in India and indirectly underwrote the continuation of its Congress government.

Under the circumstances, the Indian Cabinet authorized the Union Food Minister to accept standing offers of American technical aid and to reach an understanding with Orville Freeman, the U.S. Secretary of Agriculture, in order to ensure adequate supplies of grain. [75] On November 1965, Subramaniam and Freeman were both in Rome to attend a FAO meeting. They took the chance to sign a memorandum of understanding. The terms of the 'Treaty of Rome 1965' were kept secret until 1976, but according to Subramaniam's version, he told Freeman that India would need about 10 million tons of grain. Freeman did not make a specific commitment but suggested that Subramaniam should visit Washington towards the end of December. At that

[75] James Warner Bjorkman, 'Public Law 480 and the Policies of Self-Help and Short-Tether: Indo-American Relations, 1965-68' in Lloyd I. Rudolph & Susanne Hoeber Rudolph ed., *Making U.S. Foreign Policy Toward South Asia: Regional Imperatives and the Imperial Presidency* (Indiana University Press, 2008) pp.385.

point, Freeman hinted, 'some sort of agreement might be reached…with regard to the steps which…India would be taking and correspondingly what USA should do to assist in the implementation of the Plan and in the interim period.' [76]

India had been receiving food under the P.L. 480 since 1954, [77] but Freeman's reluctance to commit immediately to the possibility of further food aid can be traced back to a gradual shift in policy regarding foreign aid in the Johnson administration since late 1963. Orville Freeman, the Secretary of the U.S. Department of Agriculture, played a crucial role in molding the U.S. policy towards India's food scarcity. In later years, Freeman recalled that it was during the Johnson era that American policymakers began to think about the idea of making internal agricultural development a condition of Public Law 480 for the recipient countries. Freeman made repeated public pronouncements in the tune that 'we've (USA) got to get the agriculture of these countries moving because of their total economic development depends on their agriculture, and yet they are ignoring their agriculture…' According to Freeman, the US administration began to realize that these countries were not efficiently utilizing the food aid that they were receiving and were not ready to invest in their own agriculture. There was a concern that poor nations were getting to depend on this food, as if America would 'always be there to bail them out and they could put their resources to something else…' Once American policymakers identified such trends as a problem, they began to shift from the way in which America had been handling its aid towards India.[78]

[76] C. Subramaniam, *Hands of Destiny*, Ch.14.

[77] The Agricultural Trade Development and Assistance Act of 1954 authorized the 'sale' of American farm surpluses to other countries on concessional terms.

[78] Transcript, *Orville Freeman Oral History Interview III*, 7/21/69, by T.H. Baker, Internet copy, LBJ Library, July 21, 1969.

As the American President procrastinated over releasing the food aid, the delay added to the misery of the common Indians and infuriated the political establishment. On December 1, 1965, participating in the Parliamentary debate over the food situation and drought conditions, Indrajit Gupta, a Member of Parliament belonging to the Communist Party of India (C.P.I), explicitly 'deplored the continued dependence of the government on import of food grains…' He urged the government not to keep the Parliamentary debate confined to the matter of finding a short-term solution to a crisis linked to the failure of rains or occurrence of droughts in any particular year. He instead urged the government to tackle food scarcity as a grave long-term problem. Mr. P.K. Deo, an elected member from Orissa, one of the poorer states of India, emotionally argued, 'I had the misfortune of seeing the Bengal Famine…let there not be a repetition of that famine in free India. At that time we criticized the British raj and that it was a man-made famine. But if such a thing is allowed to be repeated in…free India, all the fingers will point at these gentlemen who are responsible for taking this country to this abyss.' Even K.D. Malaviya, a senior member of the Congress Party, unhesitatingly pointed out that this dependence on P.L. 480 was 'grossly unjust and inconsistent (with the) slogan of self-reliance' that India had raise after the Indo-Pakistan War. [79]

National dailies published innumerable letters to the editors highlighting the ignominy of the situation. For example, one view, as published in the *Times of India* on December 6, 1965, suggested that 'both politically and economically it would be extremely dangerous for India to continue to depend on the US for a solution to the chronic food problem.' Readers lashed out at the government for its 'platitudinous assertions about the goal of self sufficiency' at the beginning of each year and how the Food Minister always had to eat his words at the end, when

[79] Parliamentary Debates, December 2, 1965.

for one reason or the other the goal remained as elusive as before. [80] Thus shades of mood betrayed in all these instances was one of impatience at government's ineptitude in handling the situation, anger and frustration at being subjected to ignominy of foreign pressure and sadness at the realization that even independence has failed to alleviate hunger. The general tone was that something effective must be done and that too without delay. The dominant trend of institutional reform that was expected to change the agricultural scenario did not deliver-not in time and certainly not in desired efficacy. The effort of the Indian scientists also appeared insignificant in face of enormity of the present crisis. The alternative that looked promising was the new inputs that several agencies started pushing at this point. It was not entirely the success of the new varieties but to a great extent the failure of the other means to quickly and effectively diffuse the crisis that influenced the decision in favor of the former.

It was apparently only with one positive note that the year came to an end: the war between India and Pakistan reached an inconclusive end. Lal Bahadur Shastri flew to Tashkent to sign a treaty with Pakistan under Soviet mediation. The treaty was successfully concluded, but Shastri very suddenly died the very next day on January 11, 1966. What followed Shastri's death was a long and intense power struggle between several factions, intrigue, disappointments and the subsequent succession of Indira Gandhi, daughter of Jawaharlal Nehru, as the Prime Minister of India. In order to tackle the food situation and the internal and external pressure arising out of it, Indira's leadership would continue the significant changes started by Shastri in science and agricultural policy. But changes did not amount to an entire overhauling of the value system that guided the Indian governance in the first two decades after independence. During the late 1960s, changes and continuities coexisted in complex ways.

[80] Times of India, December 6, 1965.

Famine, Overpopulation and Technoscientific Solution

Indira Gandhi's coming to power in India coincided with the food-population debate reaching a climax in the developed world. From 1960 onwards, as a series of food crisis and even famines visited several parts of the Third World with alarming consistency, a string of publications by various observers tried to reach a consensus on the possible solution of the situation.[81] India, with her long history of hunger and starvation, was at the center of this food and population discourse. [82]

In 1966, the National Academy of Sciences of the United States of America arranged a symposium at Washington D.C. on the *Prospects of the World Food Supply.* Roger Revelle of the Harvard Center for Population Studies described the world food supply as precariously out of balance with the rising population. Humanity as a result, he thought, was living at 'the edge of the knife'. That metaphor dramatically brought out the uncertainty of the age. Nobody knew for sure how soon the delicate balance between the population and food supply would reach the point of no redemption. Population experts who were basically statisticians, policy makers, and agricultural scientists and thus used to scientific and factual certainty were troubled by this living on 'the edge of the knife.'

The food-population discourse introduced new markers of identifying the developing world. Along with the conventional use of calculating the per-capita Gross National Product to

[81] For a list of publications during this period on food and population discourse see, Sterling Wortman & Ralph W. Cummings Jr., *To Feed This World: The Challenge and the Strategy* (The Johns Hopkins University Press, 1978), pp. 85-87.

[82] The term 'hunger' is synonymous with 'undernutrition'. By under-nutrition is meant an insufficient per caput calorie intake, due to inadequate quantity of food available to the individual. Malnutrition refers to the quality of the diet. While the quantity may be sufficient, it may be unbalanced, that is, it may be composed heavily of cereals and starchy foods, such as potatoes and cassava, with too few of the protective foods, such as meat, fruit, and vegetables. FAO, *Six Billions to Feed*, World Food Problems. No.4 (Rome, 1962).

evaluate how a country was faring in comparison to the world's developed nations, it also became the norm to distinguish underdeveloped countries in term of their birth rates. Statistical analysis suggested that in almost all cases, underdeveloped countries had a birth rate of more than 34 per thousand people per year. In comparison, the birth rates in developed countries had always been less than 30, ranging downward to 13. Moreover, populations in the underdeveloped regions doubled in an average of just 18 to 27 years; whereas in the developed nations, doubling occurred over 55 to 88 years. Consumption patterns even differed; Third World peoples ate mostly cereals instead of the high protein, vegetable and fruit-concentrated meals that had become normal in the developed countries. [83]

Scholars prescribed ways for these developing countries to bring about a better balance between population and food supplies in the future. The depth of the crisis, the population experts claimed, merited the seriousness of steps taken in a wartime footing. Roger Revelle's expert advice was that underdeveloped nations needed to attack the problem on four fronts: 1) a vigorous campaign of human fertility control to reduce the rate of population growth, 2) expansion of the area of cultivated land and an increase of cropping intensity to the maximum extent possible, 3) increases in crop yields per unit area of cultivated land, and 4) development of all economically feasible ways of increasing the amount of high-quality protein in the average man/woman's diet. [84]

The proposals were an embodiment of extreme measures. Promoters advocated a vigorous mobilization to gain an effective control over human fertility. This proposed *reduction* of the rate of population growth should be accompanied by measures directed at *increasing* the

[83] Roger Revelle, *Population and Food Supplies: The Edge of the Knife in Prospects of the World Food Supply: A Symposium* (Washington D.C., National Academy of Sciences, 1966).

[84] Roger Revelle, *Population and Food Supplies.*

land yield to 'the maximum extent possible.' Thus, land fertility was a desirable outcome, as opposed to human fertility. *Control* over humans' reproductive system was desirable, vis-à-vis *expansion* of the area of cultivated land. The underlying argument was that uncontrolled population growth and food scarcity were destroying the harmonious relationship between man and land. To bring back that harmony, ingenuity was needed, to make land productivity outpace the needs of man.

In 1966, the U.S. President's Science Advisory Committee (PSAC) started a fresh study of the world food situation. The study had special importance because it appeared at a time when the world was very concerned about the second consecutive year of drought in India. The PSAC summarized its concerns and solutions in four basic conclusions: It argued that the scale, severity, and duration of the world food problem were so great that a massive, long-range, innovative effort unprecedented in human history would be required to master it. The PSAC conveyed a palpable sense of urgency, without prescribing a shortcut solution to the problem. It was not still widely evident whether the potential use of technoscience would succeed against this chronic concern. Furthermore, economists and population experts had already confronted the US government with scathing criticism, suggesting that over the long term, negative effects resulted from ameliorative measures such as short-term food aid and superficial technology transfer that was not properly integrated into a developing country's native soil. The PSAC responded by pointing out that for the immediate future, the shortfall in food supply was critical, and therefore that developing nations should immediately initiate programs of population control. PSAC's next recommendation was that agricultural development and economic development should be undertaken simultaneously, rather than as alternatives. The report suggested launching a two pronged attack on the population and food problems, since the two matters were inextricably connected. In this all-out mobilization against the world food problem, the PSAC gave a clarion call for a united approach. They wanted the U.S. government to use its food aid to make countries such as India to reconsider their ways of boosting agricultural production.

Indira Gandhi, under tremendous pressure at home and from abroad, was raring to produce tangible results without allowing for much ado. To her, the immediate crisis made it a dire necessity to use science and technology for more utilitarian purposes, rather than for the sake of education and culture as had Jawaharlal Nehru, her father. [85] Her frustration and anguish became clear in her speech to the nation on 12 June 1966: 'A combination of circumstances, aggravated by war and drought, has temporarily slowed down, almost halted, economic growth…The balance of payments crisis has rendered industrial capacity idle and compelled retrenchment…Exports have come to a rest. Prices have moved up steeply. There is frustration, agitation, uncertainty. Above all, the people are in distress.' [86] At this moment of desperation, she constantly reminded fellow politicians and scientists that the need of the hour was to increase production, especially food production. She pointed out to the Chief Ministers and agricultural ministers that 'Unless we increase agricultural production rapidly, control our population, and thus achieve self-sufficiency in the next few years, we will have forfeited our right to call

[85] Robert S. Anderson remarked, 'One of the few avenues of new actions open to Indira Gandhi was to change the government's approach to applications of science and to talk more about technology and technical solutions in the economy.' *Nucleus and Nation: Scientists, International Networks, and Power in India* (University of Chicago Press, 2010), p.375.

[86]Indira Gandhi, *The Years of Challenge: Selected Speeches of Indira Gandhi, January 1966-August1969* (Director, Publications Div, Ministry of Information & Broadcasting, GOI, New Delhi, 1971.

ourselves a free country, let alone a great country. We must become self-reliant. Aid and help should be a temporary phase.' [87]

Both Subramaniam and Swaminathan later recounted that Indira Gandhi gave them the full support necessary to implement the 'green revolution' technological package in India. Under tremendous pressure, both at home and from the outside world, to show perceptible increases in production in the agrarian sector, the Prime Minister grabbed onto the promises made by the new technological package. The new technology seemed well suited to the priorities of the contemporary agricultural policy, such as building adequate grain reserves, and stimulating greater production through science-based research.[88] This commensurability of means and goals helped the supporters of the new technological package to champion wider dissemination of the new seeds from Mexico and start new research projects at IARI and CRRI to facilitate better adaptation of the new varieties. This political support proved to be crucial for India's embrace of the fledgling technology. Drawing on his vast experience of working with several government agencies, Norman Borlaug was categorical that 'technology alone isn't the answer. It's got to be hooked to economic and to political decisions.' [89]

[87] From a speech at a conference of State Chief Ministers and Agriculture Ministers, New Delhi, April 9, 1966. *The Years of Challenge: Selected Speeches of Indira Gandhi, January 1966-August 1969* (Director, Publications Div, Ministry of Information & Broadcasting, GOI, New Delhi, 1971).

[88] M.S.Swaminathan, *Indira Gandhi and Freedom from Hunger*, Mc Dougall Memorial Lecture of the United Nation on 'Eradication of Hunger' (F.A.O, November 1981).

[89] Food and Our Future: A Conversation with Dr. Norman E. Borlaug. Pg.9 Inter-Regional Financial Group Inc.

Fig. 3.2 Prime Minister with IARI scientists: Dr. M.S. Swaminathan introducing the IARI scientists to the Prime Minister, Indira Gandhi, 1968

For about the next couple of years, droughts would continue to haunt several parts of India, but at the same time reports started pouring in about how much more the new seeds yielded in comparison to the traditional varieties. Though the success of the new varieties were crucially depended on having adequate irrigation and sufficient fertilizer, which were unfortunately lacking in India, these positive accounts gave proponents of the new technology extra ammunition to push for its further dissemination. By January 1966, in issues of *The Indian Farming*, scientists were well into discussions of the relative merits and demerits of the earlier varieties vis-à-vis the newly introduced Mexican wheat varieties. The high-yield capacity of the new varieties became the lynchpin of the publicity campaign that soon became a part of the dissemination effort. [90]

Despite the news of spectacular yield being achieved disparately by individual farmers, Swaminathan expressed dismay in *Indian Farming* that it is not being replicated in other parts of India to avert famine. In fact, in the fall of 1966, the national dailies were reporting that Uttar Pradesh was experiencing the 'worst drought in history.' Failure of monsoon rains had caused a loss of more than 1.1 billion rupees in that autumn alone. The government estimated that a population of 60 million in 75,000 villages would find it difficult to make both ends meet.[91] On October 17, the executive committee of the Congress Parliamentary Party expressed 'serious concern' at the 'unprecedented drought.' Prime Minister Indira Gandhi and Subramaniam, the Union Food Minister, admitted that the food situation in the neighboring states of both Uttar Pradesh and Bihar were 'extremely difficult'. Rice crops had completely dried up in the area. There were difficulties in feeding the cattle because fodder was not available. [92]In other parts of India, the food situation was equally grave. In Madhya Pradesh, 6.3 million acres of cultivated land lay fallow in the middle of 1967 as severe drought stalked the land. Cultivators refused to sow, since under such conditions, seeds would simply dry out. By the summer of 1967, headlines in the national dailies announced that acute food crisis posed a threat to West Bengal's government.

[90] That the new varieties gave higher yield over the older ones constituted the principal claim of its supporters. Environmentalists such as Vandana Shiva used the same claim as the main plank of her critique against the new varieties. She argued that the new technology had a reductionist approach. On emphasizing only the production of grain as the most important part of cultivation, it not only failed to see farming system as a whole but also externalized the cost of the technology's impact on environment. Vandana Shiva, *The Violence of the Green Revolution* (Zed Books, 1992) Ch. 8.

[91] *Times of India*, 13 October, 1966.

[92] *Times of India*, October 18, 1966.

It was only after 1966-67 that adoption of the new varieties started to show results after. The area planted with the new varieties spread from 504,000 hectares in 1966-67 to over 10 million hectares in 1972-73. Correspondingly, India's reliance on food grain imports began to drop, from 4.7 percent of its total food supply in 1960-61 to 0.8 percent in 1972-73. Similar changes occurred with rice production, as dwarf varieties that responded well to fertilizer came into production. [93]

Table 3.1 Rice: Agricultural Production Area of India (May 1970)

All units are in hundred thousand

	Rural Population	Crop Land**	Food-grains***	Rice ***	Yield(Rice)**	Farm size, average**
E. Uttar P & Bihar	75,750	15,670	16, 960	7,840	8.41	1.6
W. Bengal, Coastal Orissa & Andhra P	41,100	8, 910	8,620	6,800	11.50	1.7
Assam, Manipur, Tripura	13,740	3,130	2,390	2,270	9.69	2.0
Interior Orissa, E. Madhya P & Maharashtra	24,840	12,650	10,880	6,670	9.37	3.5
Coastal Andhra & Madras	28,250	7,290	6,330	3,740	14.41	3.5
W. Coast Area	28,500	7,200	3,470	2,050	14.17	2.0

* This table was prepared by Carl C. Malone, May 1970. UIUC archive Box.26

**Measured in hectare

***Measured in quintals

[93] Perkins, *Geopolitics and the Green Revolution*, p. 245.

Table 3.2 Wheat: Agricultural Production Area of India (May 1970)*

All units are in hundred thousand

	Rural Population	Crop Land**	Food-grains***	Wheat ***	Yield(Wheat)**	Farm size, average**
Punjab, Haryana, N.W. Uttar Pradesh	29,890	10,740	10,090	3,360	12.03	3.3
Central & W. Uttar Pradesh, N. Rajasthan, Madhya Pradesh	33,730	11,190	12,770	2,580	8.64	2.1
W. Madhya Pradesh, S.E. Rajasthan	20,490	10,060	9,930	3,150	6.38	3.7

*This table was prepared by Carl C. Malone, May 1970. UIUC archive Box.26

**Measured in hectare

***Measured in quintals

Looking back at the turbulent last two years, in a speech to the scientists at IARI on February 1968, Prime Minister Indira Gandhi observed that ‘A large part of the work of a modern government has to do with science. It is only through science that we can transform into reality the hopes we have held out to our people…the agricultural scientist has a specially vital contribution to make to our plans of economic development.’ It was through public announcements such as this that the political establishment acknowledged the growing role of technical experts in the solution of national problems. Casting national problems in technical terms made them amenable to technological solutions, without bringing in a whole set of social-economic and political issues. The likelihood of eradicating hunger by means of new technology (just because it resulted in greater crop production) impressed the national leaders sufficiently into thinking that technoscience would provide further leeway of solving other complex and persistent problems. Gandhi was glad that rural India had shed its ‘apathy’ in adopting the new technological package, and she credited the scientists for making this possible. This she thought could be done in other fields too if the countrymen could be convinced of the potential of science and technology based solution and educated to accept such expert solutions. The Prime Minister declared that ‘…the greatest task before the agricultural scientist and before the Government in general is to ensure that there is no set-back in the new program.’ She was anxious that if the new seeds failed to function as promised, the ‘farmer’s hard-won trust in modern practices will be shaken and he might retreat into his shell of traditionalism.’ [94] Such failure in the agricultural front would not only be disastrous for the food question but would affect negatively other areas of state policy-making. But a technical rendition of the food problem did not solve the whole

[94] Speech at the IARI, ND, February 10, 1968. *The Years of Challenge: Selected Speeches of Indira Gandhi, January 1966-August 1969* (Director, Publications Div, Ministry of Information & Broadcasting, GOI, ND, 1971).

slew of issues that would confront the scientists as the new technology would be set for dissemination in different parts of India. The next chapter would discuss how the scientific establishment grappled with those issues, using various technologies available to them, with mixed success.

Chapter 4

The New Technology: Promises, Problems and Prognosis

Since its introduction in the 1960s, the green revolution technology had been the subject of much debate that had cut across the boundaries of nations, disciplines and professions. Considering how long the technology had been in use in a wide range of countries and social systems, the assessments understandably had been varied and often contradictory too. Proponents of the technology have primarily praised it for easing the food situation in terms of high yield and for bringing economic benefits to many. It continues to be courted as a symbol of technological breakthrough that helped to 'modernize' agricultural sector of the developing world. Many saw in the green revolution technology not only a mean to raise yield, but also way to transport farmers from their pit of 'traditionalism' to a sunlit zone of modernity. Convinced of its beneficial impact on society and economy, some scholars see the new technology as a work of philanthropy by its patron.[1] Its critiques, however, see in its dissemination a cause for further stratifications along economic lines, widespread and irreversible environmental degradation, and also an act of political conspiracy.[2] Notwithstanding the almost staggering amount of work written on the green revolution, the impact of the technology on the agricultural scientists and the

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[1] Soma Hewa and Darwin Stapleton ed., *Globalization, Philanthropy, and Civil Society: Toward a New Political Culture in the Twenty-First Century* (Springer, 2005).

[2] Vandana Shiva, *The Violence of Green Revolution: Third World Agriculture, Ecology and Politics* (Zed Books, 1992); Biplab Dasgupta, *Agrarian Change and the New Technology in India* (UNRISD Report No. 77.3, Geneva, 1977); B.H. Farmer, 'Perspectives on the 'Green Revolution' in South Asia', *Modern South Asian Studies*, 1986, Vol. 20, No.1, pp.175-199; C.J. Baker, 'Frogs and Farmers: The Green Revolution in India, and its Murky Past', pp.37-51 in Bayliss-Smith and S. Wanmali eds., *Understanding Green Revolution: Agrarian Change and Development Planning in South Asia* (Cambridge University Press, 1984); Andrew Pearse, *Seeds of Plenty, Seeds of Want: Social and Economic Implications of the Green Revolution* (Clarendon Press, 1980); Michael Schluter, *Differential Rates of Adoption of the New Seed Varieties in India: the Problem of the Small Farm* (Cornell University, 1971); E. Feder, 'McNamara's Little Green Revolution: World Bank Scheme for Self-Liquidation of Third World Peasantry', *Economic and Political Weekly*, Vol.11 pp. 532-41; A.G. Frank, 'Reflections on Green, Red and White Revolutions in India', *Economic and Political Weekly*, Vol.8 pp.119-24; Kathleen Gough, 'The 'Green Revolution' in South India and North Vietnam', *Social Scientist* no. 61 pp.48-64.

work they did to make it acceptable to the farmers and consumers is yet to be studied. Working on the new technology and contributing to its successful dissemination became the mark of a good scientist, as cultivating the new varieties became the sign of being a 'progressive' farmer. Placing the new technological package at the heart of India's food crop research and cultivation, would, however, carry serious issues of marginalization that the chapter wishes to study.

The introduction of the green revolution technology in India was largely facilitated by a shift in the government's planning objectives. Apart from adoption of such policies as price support to the farmers, fertilizer subsidy etc, there occurred what Francine Frankel has termed as 'retreat from social goals' of planning.[3] The impact of the simultaneous shelving of the active perusal of the goal of social equity and adoption of the principle of 'selective' application of capital-intensive agricultural inputs on agricultural research have not been substantially studied by scholars so far.[4] The slogan of the new technology evidently was 'to build on the best' and to ensure market profitability of the new crops as well as private gain of the individual. A study focusing on the interaction of research work of scientists with the economic objectives of the new technology brings out the embedded environmental, cultural and social biases of the modernization project, which significantly changed India's agricultural landscape.

Political economists working on Indian agriculture have already pointed out that the demand for the new varieties did not come initially from any organized interest group or social classes;[5] there is no evidence to argue that a market for the new technology already existed.

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[3] Frankel, *India's Political Economy: 1947-2004* (Oxford University Press, 2005) Ch.6.

[4] John H. Perkins in his book, *Geopolitics and the Green Revolution* has studied only the internal development of agricultural science as a discipline that facilitated the breeding of dwarf varieties.

[5] Ashutosh Varshney, *Democracy, Development and the Countryside: Urban-Rural Struggles in India* (Cambridge University Press, 1998) Ch. 3.

Thus, in order to create a market demand, the 'experts' first needed to demonstrate that the cultivators would profit from sowing the new dwarf seeds and in applying fertilizers. Agricultural scientists needed to create, what historian Nick Cullather has termed as, the 'psychology of abundance.' Instances of spectacular growth and hence of private profit would, experts believed, help the Indian farmers to transform from the 'pathological, leisure-oriented' being to the profit-maximizing 'rational man'.[6] Thus, annual reports of CRRI and IARI are strewn with instances of researches conducted on economy of fertilizer applications, level of fertilizer applications and gross profit that could be incurred from such applications of inputs.

But, not all farmers would be initially convinced or have the capacity to make the transition to a more capitalized ways of farming. Endowed with limited resources and much infrastructural constraints, the government was not only selective about regions where the new technology would be introduced, but wanted to draw up a psychological and cultural profile of farmers who would be interested to take the 'risk' of adopting the new varieties. These farmers would become the so-called pioneer users of the new technology and showcased at various points of time for their success with the new technology. The search for the 'progressive' farmers willing to take the risk of trying a new technology, unlike others who were too cowed down by the spectre of crop failure, however, carried a strong possibility of marginalization. Though it had been a point of intense argument among scholars, policy-makers and government officials as to whether such marginalization was intentional, it had, however, definitely led to policy-formulations benefitting those who could take advantage of the technology, rather than improving the conditions of those who fell outside the scope of the new technology.

[6] Nick Cullather, *The Hungry World*: *America's Cold War Battle against Poverty in Asia* (Harvard University Press, 2010) Ch.5.

The stories of cooperation among members of the scientific community dominated most account of the green revolution in India. But, people who played significant role in the dissemination of the new technology admit of stiff resistance that came not only from bureaucrats and policymakers but also from scientists. And this sounds obvious, considering the fact that rarely in history of scientific and technology was there innovations, without some amount of resistance. However, the main problem with such accounts of resistance in case of the green revolution technology in India is that these are generally very generic. Rarely were researchers specified who opposed to the introduction of the new technology; neither were their argument part of robust academic debate among peer professionals. The dismissive approach taken towards the critique of the new technology prompted me to ask whether, the community of agricultural scientists at this juncture experienced a cleavage based on the assumption as to who could be labelled and trusted as 'experts' on the new technology and the nameless 'detractors' of the new ways of farming who were constituted as the 'other'. This chapter, therefore, takes up as one of the theme the process of consensus building around the green revolution technology among the agricultural scientists in India.

Accomplishing the 'real revolution'

In the summer of 1965, Borlaug enthusiastically announced to J.A. Pelissier, the Head of the Product Research Division of ESSO Research and Engineering Company-a significant member of the Rockefeller group of industries that 'with the application of fertilizer on an enormous scale,' he and his researchers were at the verge of 'trigger(ing)' of a 'real revolution' in wheat production.[7] His enthusiasm about the fertilizer-responsive varieties made him

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[7] Though not elaborated in so many words, Borlaug's insistence on portraying the technological breakthrough as the 'real' revolution can be read as implying its greater revolutionary potential over the political revolutions that the

confident that soon farmers of the developing world would realize the benefits of increased fertilizer use, and start 'clamoring for fertilizers.' The success with the new technology in Mexico made Borlaug confident and somewhat aggressive-he was reluctant to gradually increase the levels of fertilizer use in South Asia, instead, for India he was ambitious to create demonstrations that would be 'spectacular and shocking to both farmers and government officials.' 'We want to kill old ideas and methods', Borlaug wrote expectantly, 'and substitute dynamic new methods in one stroke. We want these first semi-commercial demonstrations to be so shocking that they will destroy old ideas of wheat production at one sweep.' Borlaug strongly advocated that the fertilizer industry, specifically ESSO representatives, should play an 'enormous role' in the upcoming revolutionary changes. His advice was 'selling' to the governments of developing nations the overall merits of policy of promoting more fertilizer production, pricing, and credits arrangements that were in balance with the basic prices paid for wheat grain. [8]

Many agricultural scientists, working on the green revolution technology in India was no less keen on using chemical fertilizers to accomplish a 'dramatic' increase in yield, as well as to create a 'dramatic' psychological impact on the minds of the farmers involved. J.S. Kanwar, the Deputy Director General of Soils, Agronomy and Engineering division of the IARI, was one to share Borlaug's enthusiasm for chemical fertilizers. He considered fertilizers to be the 'kingpin' of the new agricultural strategy, which would provide a much-desired end to India's nagging food crisis and population pressure on land. Without any foreseeable increase in the country's amount of land under cultivation, India could only grow, he believed, by increasing the

communists groups had been working for. William Gaud was more explicit about it when he coined the term 'green revolution' as opposed to the ongoing 'red revolution'.

[8] Borlaug to Mr. J.A. Pelissier, July 26, 1965. Box 5/20 Norman Borlaug Papers, Special Collections, Iowa State University.

productivity per unit area and per unit time, which could be achieved only through intensive use of fertilizers. Borrowing from the work of American researcher Donald G. Ibach, Kanwar made the following observations that where average fertilizer application had previously been very low, applying one ton of nitrogen could yield the same results as cultivating 20 to 25 hectares of unmanured wheat or paddy fields. To Kanwar, the 'most important barometer of the agricultural progress' of the country turned out to be how much fertilizer Indian farmers were consuming.[9]

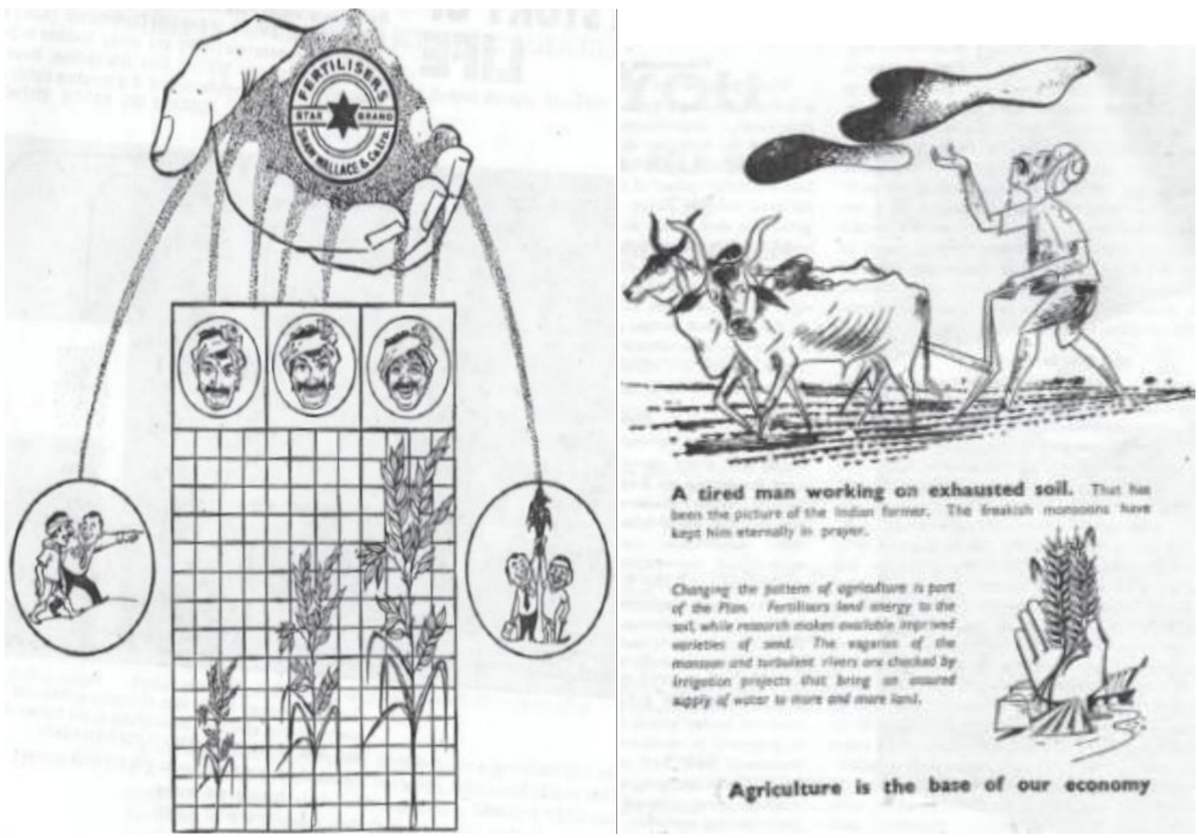

Fig.4.1 Happy Farmers, Helpless Farmers: These two advertisements published roughly around same time in an agricultural periodical show the revolutionary changes that fertilizers are capable of bringing into the life of the farmers. It would produce increasing amount of yield with balanced application of NPK fertilizer mixtures. The figure on the left shows how the grin on the farmer's face turns into a hearty laugh as he shifts from using nitrogen alone to a mix of nitrogen-phosphate and then to nitrogen-phosphate-potassium. The figure on the right represents the assumption popular in the pro-fertilizer lobby as to how the use of synthetic manure has freed the farmers from the uncertainties of Indian monsoon.

[9] J.S. Kanwar, 'Fertilizer-'The Kingpin in Agriculture', *Indian Farming*, March 1969, pp. 5-10.

Scientists who held similar views, such as Kanwar's, argued that many farmers in India would find high doses of fertilizer use acceptable if the following conditions were met: farmers need to get loans to buy fertilizers, if fertilizers came at a cheaper price, and if the use of fertilizers could be shown to be profitable. Amidst much debate and discussion, the government of India took steps to subsidize the cost of chemical fertilizers in the late 1960s so that the farmers could gain access at a relatively economical price and enjoy the resulting profit from higher yields. Policymakers also moved to provide adequate amounts of credit; the central government recommended giving each farmer a credit amount of Rs. 202 to buy fertilizer for every acre that he cultivated. In 1966-67, when the Agriculture Department and the Cooperative Department of the Punjab State government worked out their estimates for bringing 250000 acres under the new HYV program, they calculated that the new system would require fifteen million kilograms of nitrogen, seven and a half million kilograms of phosphate and five million kilograms of potassium. Under the government's tentative credit scheme, supplying that amount of fertilizer would require cooperative credits worth Rs. 50.5 million, out of a total estimated expenditure of Rs.75.5 million in Punjab alone. The Central Government could see the enormity of the demand in the light of limited resources.[10] But this did not apparently dissuade the government. The financial commitment though enormous, however, appeared a lighter burden to have, rather than the perpetual food crisis that one scholar argued, had put the government in face of a 'crisis of sovereignty'[11]

[10] *Planning and implementation in agriculture: studies on HYV program*. Vol. II (Mexican Wheat in Punjab State), (Ahmedabad, IIM, 1967).

[11] Akhil Gupta, *Postcolonial Development: Agriculture in the Making of Modern India* (Duke University Press, 1998) pg. 35.

These were the days of rising prominence of agricultural economists as it was in the first two decades of the twentieth century in the USA. Agricultural research was not the only field, however, that experienced an increasing role of economists; from the mid-1960s there was this general concern as to whether Indian research laboratories were adequately responding to the economic 'needs' of the nation-state. In his last visit to India, P.M.S. Blackett wanted Atma Ram, the Director General of CSIR to propose a new advisory body with an economist in it for Prime Minister Indira Gandhi so that research could be more closely related to economic growth. He strongly argued that '…scientists are not free to do whatever they wish, certainly not in the field of applied science…'[12] Moreover, to facilitate an in-depth communication between the economic and scientific goals, a body of scientists was closely integrated with the administrative apparatus of the state.[13]

Thus, as economically profitability became the crux of doing scientific research, agricultural economists with researchers from other branches of agricultural science developed a new 'framework of persuasion' based on their endorsement of high-doses of fertilizer application. They marshaled evidence by which ordinary people would be 'inclined to change the way they did things, and in particular to adopt a product or practice that was developed or promoted by a rationalizing elite'.[14] Bill C. Wright, an agricultural economist of the Rockefeller Foundation and R.B.L. Bharadwaj used data gathered by agronomists of the All-India Coordinated Wheat Improvement Project to argue that fertilizer use on irrigated dwarf wheat was

[12] Robert S. Anderson, 'Empire's Setting Sun? Patrick Blackett and Military and Scientific Development of India', *Economic and Political Weekly* 36, No. 39 (2001).

[13] Robert S. Anderson, *Nucleus and the Nation: Scientists, International Networks, and Power in India* (University of Chicago Press, 2010) Ch. 19.

[14] Deborah Fitzgerald, 'Accounting for Change: Farmers and the Modernizing State' in Catherine McNicol Stock & Robert D. Johnston ed., *The Countryside in the Age of the Modern State* (Cornell University Press, 2001) p.192.

highly economical for farmers. They calculated that with the price of wheat at Rs.75 per quintal and nitrogen at Rs. 2 per kilogram, farmers would gain a net profit of Rs. 825 per hectare for an application of 40 kg per hectare, a profit of Rs. 547 for 80 kg of fertilizer, and Rs. 112 for 120 kg. It was only when use of nitrogen went beyond 120 kg per hectare that there was a negative return of Rs. 157.50 for every forty kilograms of additional fertilizers.[15] P.N. Saxena, another scientist of IARI, also emphasized the great monetary returns of chemical fertilizers. He calculated that new varieties of grain, combined with the advantages of nitrogen fertilizer, could give Indian farmers a net profit per hectare in the range of Rs. 900-1000, a sharp contrast to a per-hectare profit of only around Rs. 300 for the local varieties. He calculated that Indian farmers would achieve the highest return by cultivating the Mexican variety, S-227, which would give back Rs.6 for every rupee invested.[16] Agricultural economists argue that their numerical and quantitative insight into the agricultural questions would help the farmers to rise above the 'romantic and impractical ideas' that usually guide farm practices.[17]

The primacy accorded to economic profit in the work of agricultural economists set off a chain of event that impacted other branches of agricultural science. It not only prompted a whole new set of agronomic experiments on fertilizer placements, recording fertilizer responses and the like, but also encouraged plant morphological research to go in a particular direction. It was seen by the scientists that high fertilizer responsiveness of the new varieties was chiefly due to its short stiff culm, which helped the plant to withstand lodging better than the tall indigenous varieties. The short and stiff culm of the new varieties is because of dwarf-inducing-genes. With

[15] Bill C. Wright & R.B.L Bharadwaj, 'Fertilizer Needs of Wheat', *Indian Farming*, March 1969, pp. 15-20.

[16] P.N. Saxena, 'Fertilizer Needs of Mexican Wheats', *Indian Farming*, August 1967, pp. 40-42.

[17] Deborah Fitzgerald, 'Accounting for Change' p.194.

increasing number of this particular type of gene in the plant meant even shorter and stiffer culm and thus more immunity to lodging. Scientists therefore portrayed the progress in cereal research as a consistent advance from the one-gene to two-gene and subsequently three gene-varieties. By 1968, the two-gene varieties that had been released for cultivation could not withstand nitrogen doses above 100-120 kilogram per hectare; scientists considered these varieties to have reached a 'yield plateau'. In a constant pursuit of higher yields, the scientists found it unacceptable, when a certain yield level became a constant or the norm, because it then fails to indicate advancement any more. It thereby exposes the limitations of existing technology as a savior and deliverer from hunger.

Researchers therefore quickly undertook projects in developing three-gene dwarf lines to break the yield barriers.[18] To give additional validity to their work, scientists working on the new seeds pointed out that the short varieties were better suited to the plants' water requirements, especially in the main wheat areas of north-west India, where the temperature rose fast and hot and dry winds began to blow from the end of February. Consequently, the plants were prone to lose much energy through respiration. Ideally, irrigation in March-April should have been of great help in promoting good grain development, but such watering caused tall varieties to suffer lodging problems. By contrast, scientists pointed out, introduction of dwarf varieties let farmers irrigate plants during their latter stages of growth without causing lodging.[19]

[18] Scientific Report of IARI, Division of Genetics, (New Delhi, IARI, 1968).
[19] S.S. Bains, M.S. Swaminathan, K.N. Singh, 'Success with Late-Sown Wheat', *Indian Farming*, August 1967, pp.5.

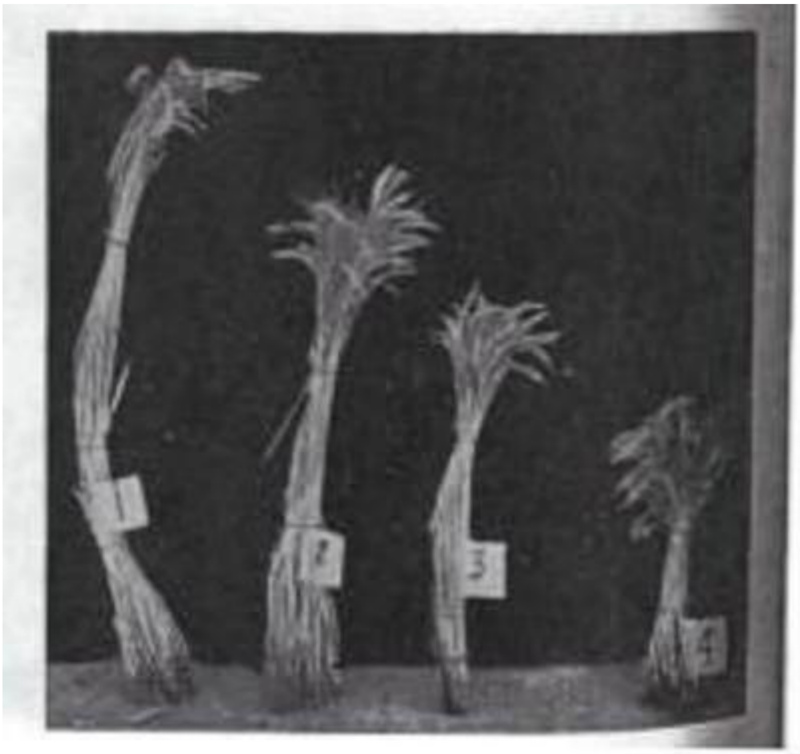

Fig 4.2 The Normal and the Dwarf: Normal wheat plant (1) and plants having one, two and three genes for dwarfing

Notwithstanding the economic and ecological justifications that the scientists forwarded endorsing the cultivation of the new varieties, the political context of its introduction continued to create furor in the minds of many Indians. Especially, chemical fertilizers as one of the basic ingredient of the technological package remained the butt of widespread controversy. On December 10, 1965, when President Johnson authorized a shipment of 1.5 million tons of wheat to India to help fight the famine situation, he also gave a loan of $50 million to the Indian government so that the latter could import fertilizers from the US. According to the terms of the food loan, the Indian government would contribute a matching amount for the purpose of fertilizer import.[20] The U.S. government also wanted Indira Gandhi to devaluate the rupee, in order to facilitate private fertilizer companies hoping to increase business in India. The Indian government in turn had to assure a climate conducive to private investment in the country.[21] In the minds of many Indians, these measures evidently taken in response to American pressure did not go down well with the image of a sovereign nation. The opposition parties and the members of the All-India Congress Committee (AICC) were vehemently critical of the Central Government for bowing down to international pressures. Critics of Subramaniam described his fertilizer policy as based on 'bondage to the U.S.A'. Many delegates to the Congress Committee meeting at Jaipur in Rajasthan demanded scrapping the collaboration schemes involving partnership with foreign companies which happened to be mostly American. The members suggested that India concentrate on resolving its agricultural problems through alternative indigenous solutions, such as greater use of native organic fertilizers, greater reliance on domestic companies and government operation. Critics despaired over the prospect of India's continued dependence on food imports and dependence on foreign companies for fertilizers. The members of AICC directed their heaviest barrage of criticism at Subramaniam for having agreed to give fertilizer companies considerable freedom in pricing and distribution, particularly in those new segments involving foreign collaboration. The Congress President, Kamraj, singled out the American International Oil Company's plans to establish a fertilizer factory in Madras as a bad example. He objected to the 'blank check' the Government had given such foreign private firms in the matter of marketing chemical fertilizers. Kamraj said that to allow these firms the freedom to sell a scarce and vital commodity 'at any price they could get was wholly unacceptable'. In his Presidential address delivered at the beginning of the conference, Kamraj

[20] 11 December, 1965 Times of India.

[21] Airgram on Commodity Loan-Fertilizer, 2/24/66. NARA.

had restated the familiar socialist goals of public sector production and price control over essential commodities. The political pressure placed on India's government by Kamraj and his colleagues was so intense that the Union Food and Agricultural Minister reportedly offered his resignation.[22]

No less than the political furor, technical crisis of various types made the prospect of synthetic fertilizers production appear rather dim at the time. The country continued to face serious power shortages, especially in the drought-affected areas, which hampered the electrolytic hydrogen processes of the fertilizer plants. The difficulties in importing sulfur continued, along with problems in obtaining rock phosphate for fertilizer manufacturing. US Department of State, however, remained confident that notwithstanding all the initial hiccups and resistances, the Indian government would continue following the desired lines. The impetus behind the change, many in the US administration felt, was coming from multiple influential sources in India consisting of scientists, bureaucrats, ministers and eventually from politically important farmers' parties. One State Department representative, for instance, pointed out in a February 1966 confidential aerogram that 'an influential group within the Government of India is pushing for many of the reforms in fertilizer, credit and seed production which the U.S. is also urging…' The letter also said that the State Department would be willing to go as far as to assist in the installation of production equipments in fertilizer plants of India. The State Department's interest in use of chemical fertilizer was equally matched by the enthusiasm shown by a group of agricultural scientists, who wanted to build on the 'spectacular breakthrough' achieved through the new technology.

[22] United States Department of Agriculture, Foreign Agricultural Service, 17 February 1966. NARA.

It seemed plausible to scientists that with high doses of synthetic fertilizers and use of dwarf varieties they could increase the yield by four to fourteen-folds. They believed that even farmers with small parcels of land could achieve that gain with increased use of fertilizers, adequate irrigation, and short-duration varieties of crops. Given India's limited land supplies, use of intensive fertilizer along with multiple cropping seemed to be the best option to them.[23] Members on the Indian government's Fertilizer Distribution Enquiry Committee, headed by B.S. Sivaraman, shared the same view. This Committee argued that chemical fertilizers were particularly important where land for cultivation per family was limited to a small acreage, as in India. These leaders warned that the intensive cultivation of crops, as practiced in India, would deplete the soil unless the nutrients were replaced by massive doses of chemical fertilizers. The Committee wrote that given the 'unrestricted growth in our population,' needs for greater agricultural production had made it imperative that farmers use chemical fertilizers.[24]

Thus, the initial success of chemical fertilizers and the new seeds in raising the yield in selective parts of India completely changed the dynamics of the fertilizer-use debate. So long reservations were expressed from different quarters against excessive dependence on chemical fertilizers on the ground that its capital-intensive nature might act as a deterrent to its use by the small farmers, who dominate the Indian countryside. Now, on the contrary, small acreage was considered conducive to its use. Moreover, the constant anxiety about soil depletion because of excessive use of chemicals, as we have seen, was widely prevalent in the policy-making and scientific establishment. Now the argument was turned on to its head to point out that without adequate amount of fertilizers, soil depletion would get worse.

[23] Carol P. Streeter, *Multiple Cropping is the Answer-Best Hope of Small Farmers in the Tropic*. University of Illinois at Urbana-Champaign.

[24] M.S. Randhawa, *A History of Agriculture in India* (ICAR, 1986) Vol.4, Ch.26.

With the launching of the new package, India's agricultural policy-makers initiated a program of concerted and centralized research to adapt its constituent ingredients to Indian conditions. To make the package popular with farmers and teach them how to use the new resources to get the best result, the government encouraged national demonstrations, extension services, and training programs. The Division of Agricultural Extension that was set up in 1960 gave training to post-graduate students on techniques of extension. The extension officials applied teachings of rural sociology, educational psychology, home economics and audio-visual medium to instruct the farmers on the new techniques.[25]

At the advice of the Scientists' Panel, the Union Minister of Food and Agriculture initiated the All India Coordinated Research Projects on wheat in 1964 and on rice in 1965. These projects encouraged interdisciplinary and inter-institutional co-operations. Plant breeders, geneticists, agronomists, agricultural chemists and plant protection scientists worked in close collaborations to ensure that the disciplines had a combined impact towards the success of the new techniques. In each project, research scientists from the central institutes such as IARI and CRRI, from several state departments of agriculture, and from nine of the country's leading agricultural universities worked as a team with an ICAR-appointed project coordinator who was the research leader, responsible for fostering cooperation and coordination among participating institutions. The scientists aspired to develop a system, which had a built-in mechanism for continuous assessment of achievements and impediments in the form of an annual workshop, attended by participating scientists.[26]

[25] A.R. Khan, *New Extension Techniques: Help in Popularising Scientific* Agriculture, *Indian Farming*, April 1965
[26] Fourth five year plan; S.V.S. Shastry, 'The All India Coordinated Rice Improvement Project' in A.H. Moseman ed., *National Agricultural Research System in Asia* (The Agricultural Development Council, 1971).

R.G. Anderson of the Rockefeller Foundation later recalled in a meeting with the agricultural scientists of India that by late August 1966, they had successfully ‘revamped’ the entire crop testing system. Under the old ‘static’ system, Anderson noted, Indian scientists in a series of micro-and macro trials essentially tested the same seed varieties for a successive three seasons in five agro-climatic zones of the country. The reorganization instead called for a series of low-cost tests that would initially screen many varieties at just a few locations. In the next year, scientists would then choose those varieties that performed best for more complex tests known as the Uniform Regional Trials, tests conducted in each of India’s five agricultural zones. The superior varieties in these wide zonal adaptation tests were finally tested in a National Trial on a countrywide basis. To release any new varieties the scientists, however, did not wait until the results of such National trials were available to them; they started promoting new varieties for cultivation based on the Uniform Trial results. These structural changes in the way agricultural tests were conducted before the introduction of new varieties indicate two things: the scientists who were patronizing the new varieties were very eager to introduce them for large scale cultivation as soon as possible. Driven to register a tangible increase in production they were impatient to linger the trial for long. Secondly, the seeds were not meant to be cultivated over a wide agro-ecological variation across the nation. Thus, the emphasis was on conducting regional experiments with ‘uniform’ characteristics, rather that subject the seeds to the wide variation. Thus, following Anderson’s account, the sole purpose of the national trials was to provide exposure about the new varieties to scientists in other zones. [27]

[27] R.G. Anderson, *Wheat Position Paper* (Rockefeller Archive, Box 27, Folder 153).

'A cooperative movement among scientists'

The Rockefeller and the Ford Foundations and the Technical Cooperation Mission, were closely involved in the dissemination and further improvement of the new technology in India. These agencies brought in scientists from abroad to work with their Indian counterparts in multiple aspects of cereal research. They provided training opportunities for India's scientific staff, plus equipment to facilitate 'production-oriented' work in Indian laboratories. This external support proved instrumental in bringing in most of the new germplasm to Indian laboratories from CIMMYT and IRRI. Some of the key Indian scientists associated with the green revolution technology, such as Swaminathan, Joshi and Gautam, fondly remembered that it was almost like a 'cooperative movement among scientists.'[28]

At the time of the introduction of the new technology, individual episodes highlight the way foreign scientists worked with their Indian counterparts. For instance, in 1965-66, when agronomic work with dwarf wheat began in India, Bert A. Krantz of the Rockefeller Foundation was primarily responsible for developing the initial agronomic trials. These trials helped to demonstrate the production potential of new exotic varieties and clarified new agronomic practices that were required for these dwarf varieties. After Krantz's departure, his Rockefeller colleague, Bill Wright became responsible for expanding the scope of experimentations conducted on the dwarf seeds. More than that, Wright trained Indian workers in the proper field plot techniques and assisted workers in laying out and planning the experiments. In the initial years after the introduction of the new technology, he even helped to transport seed drill and other equipments to each location. Anderson later gratefully remarked that, Wright's supervision

[28] M.S. Swaminathan ed., *The Wheat Revolution: A Dialogue* (Macmillan 1993).

'greatly increased the precision of these experiments and the reliability of reported data.'[29] Scientists who worked with Wright later corroborated this account of cooperation between Rockefeller representatives and Indian participants.[30]

Indian and foreign scientists similarly collaborated on cases of plant pathology and cereal improvement projects. For instance, in 1967-68 when ICAR initiated an all-India wheat rust surveillance project at the IARI, the Rockefeller and the Ford Foundations assumed major responsibility for bringing in experts to work in the project. Responding to the request by the IARI Director, Foundations' scientists such as B.L. Renfro, R.D. Wilcoxson and Eugene Saari came to India to guide research on wheat pathology. The Rockefeller Foundation took a further initiative to train considerable numbers of young Indian scientists, providing several with fellowships and scholarships to receive advanced training in the new technology and scientific practices. With Rockefeller funding, Indian researchers traveled to American universities and also to CIMMYT and IRRI, to learn new techniques.

IRRI was set up with the multiple purposes of help speeding up the development and dissemination of improved rice production technology for the humid tropics; it also shared with the government of the developing countries the responsibility of training staff and strengthening rice research institutions and extension services in rice growing countries.[31] Once India initiated the All India Coordinated Rice Improvement Project in April of 1965, the International Rice Research Institute started assisting the project by making available valuable breeding materials and providing short-term consultancies of Institute scientists. Multiple contracts were signed

[29] R.G. Anderson, *Wheat Position Paper*, ibid.

[30] M.S. Swaminathan ed.,*The Wheat Revolution.*

[31] *The All India Coordinated Rice Improvement Project-An Assessment* (Rockefeller Archive, Box 6, Folder 36).

between IRRI, US-AID, and the government of India ensuring that staff scientists of IRRI, would move to Andhra Pradesh Agricultural University at Rajendranagar to cooperate with the rice project.

International agencies that offered technical assistance and training for Indian scientists helped to create a core group of Indian researchers who maintained and promoted faith in the promise of the new technology. A good number of Indian scientists was no keener to receive advance training in international institutions as it promised them exposure and possibilities of professional accomplishments. It gave them a foray into some of the best agricultural research institutes of the world and they grabbed the chance to collaborate with prominent scientists in their field.[32] A closer probing into the interactions of the Indian agricultural scientists with their foreign counterparts during this period shows that the dynamic of the relationship was, however, not amenable to simple characterizations. For instance, it was not solely an act of intellectual dependence on the part of Indian scientists; similarly, it would be a mistake to essentialize the involvement of international scientists as an act driven solely by hegemonizing intent. Though, international recognition, especially recognition coming from foreign experts was held in high esteem in India, the Indian agricultural scientists proved highly skilled in making this international contacts work to their advantage. They used it not only to further state patronage in favor of the new technology, but also to curve out an influential niche for them.

[32] There are, however, instances of disapproval expressed by the Indian scientists at the utility of training provided by American universities. Under TCM, from 1951 to 1965, 217 Indians came to the U.S to take training on twenty-one disciplines. Of these trainees, fifty-eight were agriculturalists. The training was mainly theoretical in nature. The following facts will give an idea of the utility of these trainings; forty-eight percent of the trainees refused to comment. Nine percent of the participants categorically pointed out that practical training should have got more emphasis; courses taught to them should have included latest facts in the discipline. Large number of them thought that the training imparted should have been designed keeping in mind the particular problems faced by Indian agriculture. *Returned U.S.A.I.D Participants* (Mysore Government. 1968).

In 1964, just few months before the launching of the All-India Coordinated Program on Wheat Research, M.S. Swaminathan sent a letter to Norman Borlaug, fervently requesting him to attend a symposium of Indian wheat scientists. He pointed out to Borlaug that the Coordinated Program was being initiated along the lines Borlaug had advocated; it was, therefore, 'essential' for Borlaug to pay Indian scientists a visit, so that he could 'review all that had been done and to *decide* the lines on which (Indians) should proceed further.' Swaminathan praised Borlaug for playing a 'very significant role in changing the face of Mexican agriculture,' suggesting that his *guidance* and presence would similarly be very important to India-'struggling to learn how to increase yields.' An uncritical reading of Swaminathan's mail might portray him as representing the lower rung of an international hierarchy of technoscientific expertise, with Borlaug as the archetypical dominating 'West'. But, what Swaminathan says later in his mail would help to change our interpretation of this apparently simple equation.

Swaminathan stated that he was keen to use Borlaug's presence to provide an 'impetus to the progressive forces' that favored the use of the new techniques as opposed to critics, who condemned the use of capital-intensive resources as it was incompatible with the principle of social equity. Swaminathan hoped that Borlaug's visible support would help convince the Indian government to continue its policy of using high-yielding varieties of seeds, fertilizers, and other means of intensive cultivation. In particular, Swaminathan wanted India's Union Minister for Food and Agriculture to hear Borlaug's lecture about the advantages created by coordinated research on new seed varieties on agricultural production, to impress the minister with the importance of this topic.[33] It was not uncommon to find more such examples of scientists from

[33] M.S. Swaminathan to Norman Borlaug, 21 November, 1964, Box 7/30 Norman Borlaug Papers, (Special Collections, Iowa State University).

developing countries using the stature, aura and the influence of the scientists from the West to push their own agenda or gain a better leverage in their bargain with other institutions of the state.[34] The face of a more renowned scientist often helped agricultural scientists in India to give more coherence to their fledgling community and add prestige to their discipline, which was definitely not at par in terms of resource and autonomy accorded to industrial or atomic research. This is clearly expressed in a letter that S.M. Gandhi, a wheat specialist working on dryland varieties of wheat around the western state of Rajasthan in India, wrote to Borlaug. In the letter, Gandhi enthusiastically pointed out that Borlaug's winning of the Nobel Prize would be a decisive factor in accelerating the Green Revolution and in turn vindicate the position of the Indian scientists working with the new technology.

Throughout the late 1960s and 1970s, other Indian scientists would address letters to Borlaug, treating him as a preceptor, a kind of 'guru' from whom the Indian scientists were keen and happy to receive any instructions on the new technology and scientific practices. Dr. S.M. Gandhi wrote to Borlaug in 1971 that the 'Indian programme is fortunate in having your active association and whatever little has been achieved, is mainly because of your *blessings* and guidance.' Gandhi was proud of the magnitude and dimension of the Indian program and was almost sure that there was an immense possibility of bringing out still better varieties. But Gandhi believed that such progress could only come if India continued working with CIMMYT.[35] Statements like these were indicative of the pride that the Indian scientist took in

[34] A little more than a decade before this, P.C. Mahalanobis-the physicist-turn-planner remarked to his protégé, Pitambar Pant, that his collaboration with leading economists of the West, such as Ragnar Frisch, Jan Tinbergen, Oskar Lange among others, had given him a 'useful political weapon': 'trained and experienced economists can help us a great deal in speaking their own language to Indian economists (which we are unable to do); and in carrying conviction to administrators and political leaders'. Quoted from Sunil Kilhani, *The Idea of India* p. 85.
[35] S.M. Gandhi to Norman Borlaug, 7 January, 1971, Box 15/8 Norman Borlaug Papers (Special Collections, Iowa State University).

being associated with international institutes. Such attitudes were revealing of the power hierarchy that had always been deeply embedded in any international exchanges of men, material, and knowledge. The one located at the receiving end displayed, more often than not, a keenness to be recognized and approved by the imparting agency, which could be an individual, institution, or a country.

This gratification at winning recognition from agricultural scientists of developed countries (of whom Borlaug was the most important representative) often evoked strong emotional responses from Indian scientists. In December 1970, after receiving a commemorative medal for his contribution to research on high-yielding varieties, Ram Dhan Singh, former cerealist and the principal of Punjab Agricultural College and Research Institute at Lyallpur, wrote to Borlaug, 'My vocabulary fails me to find adequate words to thank you for your letter…and for the gift of a silver medal…' To researchers such as Singh, Borlaug's achievements appeared extraordinary, almost magical.[36] Singh addressed Borlaug as the 'Prince magician of wheat breeders', a 'savior of many human from threatening hunger' who was even destined to be canonized for his efforts.[37] Sing's communication with Borlaug was far from the measured tone of professional exchange of courtesies among peers. The eulogies that Singh used to refer to Borlaug makes it clear that it was not the recognition that he received for his work alone that moved him so much, as did the medal coming from Borlaug himself.

Though, the awards were surely not designed to overwhelm the recipients, but it did more than recognizing their talent. It played an important role in distinguishing those scientists, who

[36] Incidentally Ram Dhan Singh's was a highly reputed scientist who bred the wheat variety C 306. This particular variety was very popular because of its chapatti-making quality and high drought tolerance.

[37] Ram Dhan Singh to Norman Borlaug, 19 December, 1970, Box 13/37 Norman Borlaug Papers, (Special Collections, Iowa State University).

worked, amidst much odd, on dissemination of the new technological package, apart from other agricultural scientists. It was instituted by the Mexican government to commemorate the achievements of the green revolution technology and was meant to be specifically awarded to those scientists who have furthered the cause of the technology. Thus, in 1970 Borlaug wrote to Swaminathan, sending him a few coins for distribution among Indian breeders and scientists who have played a 'major role in capitalizing the yield potential of the dwarf wheats', as a token of '*his* deep appreciation and regard'.[38]

The practice of rewarding scientists associated with the Green Revolution continued even at the non-governmental level. In 1972, R. Glenn Anderson, the wheat scientist in charge of the Rockefeller Foundation's program in India, wrote to Dr. M.M. Rao of the Coromandel Fertilizer Limited Company, giving his 'strictly confidential' assessment of the top Indian scientists who had been working on the new technology.[39] Anderson's list primarily praised those breeders who had helped to either introduce or improve the high-yielding varieties. Anderson promoted scientists such as V.S. Mathur, whose program was responsible for contributing most of the high-yielding varieties released in contemporary India; J.P. Srivastava, who was responsible for increasing seed production at a critical period of the new program; D. R. Vasudeva, who developed the variety C-306 that was subsequently grown across much of dry North India; and S.P. Singh, who evolved varieties suitable for dryland cultivation in Madhya Pradesh. In addition to those key researchers, Anderson also highly recommended Indian coordinators in charge of the high-yielding varieties program, such as S.P. Kohli and M.V. Rao. He gave further tribute to

[38] Norman Borlaug to M.S. Swaminathan, 2 December, 1970. Box 13/37 Norman Borlaug Papers (Special Collections, Iowa State University). Only nonscientist to receive the coin was B. Sivaraman, the Cabinet Secretary of Government of India. Sivaraman as the Secretary of Agriculture played a crucial role in assisting the Union Food and Agricultural Minister, C. Subramaniam in the adoption the new technological package.

[39] The Coromandel Fertilisers Ltd. played a crucial role in the Green Revolution. The chemical fertilizer, diammonium phosphate produced at this factory 1967 onwards contributed to the fertilizer needs of the country.

the pathologist L.M. Joshi, who collaborated with Dr. Saari of the Ford Foundation in developing good disease surveillance throughout India, and agronomist R.B.L. Bhardwaj, who worked with B. Krantz and Bill Wright of the Rockefeller Foundation.[40]

This account of a close collaboration among agricultural scientists might give a false impression that within the research community itself, there was no substantive opposition or challenge to the introduction of the new technological package. In reality, the first-generation scientists working on 'green revolution' technology faced a very challenging situation. They bore the responsibility to prove that the technology was capable of increasing the yield and could be adapted to Indian conditions, making it worth the investment of money. Sensitive of any criticism of their approach, most of these early proponents interpreted opposition only as an expression of malice towards the new technology, reflecting a stubborn unwillingness to change. For instance, sharp debates arose between researchers who favored using high-doses of fertilizers, and those who criticized this approach to increasing yield potential. In 1966, David Hopper, the economist appointed by the Rockefeller Foundation at the IARI, pointed out that research results suggested that new agricultural technology simply did not raise output to any significant level above the practices that the top 20 per cent of Indian farmers were already using. Hopper concluded that at the current prices and with expected risks and rates of return, the use of fertilizers was only 'marginally profitable' in India.[41] Given such data from on trials conducted on several Mexican varieties such as Sonora 63, Sonora 64 and Lerma Rojo in the crop year 1964-65, Hopper wrote to Borlaug, the Planning Commission of India had come to

[40] R. Glenn Anderson to M.M. Rao, Box 16/63 15 November 1972. Norman Borlaug Papers, (Special Collections, Iowa State University).

[41] George Rosen, *Western Economists and Eastern Societies: Agents of Change in South Asia, 1950-70* (The Johns Hopkins University Press, 1985) Ch.4.

question the Agricultural Ministry's policy of concentrating the use of nitrogen, which was in short supply, primarily in the areas where the exotic varieties would be grown. Hopper insisted that scientists still needed to come up with 'hard information that will indicate the potential of the Mexican varieties to respond to nitrogen (and other nutrients)…' [42] Hopper's criticism did not go down well with his counterparts working directly in agricultural science. A.H. Moseman of the Technical Cooperation Mission wrote to Borlaug, 'Dave (David Hopper) seems to feel that we lack reliable field data to support the increases in yields and also the economic justifications for the higher applications…I feel that economists and other professional people with little or no experience with biological factors are furnishing superficial assessments of a problem area they understand poorly.'[43]

Yet even within the scientific community, doubters spoke up. Dr. R.H. Richharia, director of the Central Rice Research Institute (CRRI) in Cuttack, developed clonal propagation of rice, a method that improved indigenous varieties by instilling hybrid vigor in them. Yet Richharia understood that each region in India already used seed varieties which were suited to the soil, climate and other variations of the area, varieties that should not be neglected, in favor of dwarf varieties, in the pursuit for greater yield. He opposed the introduction of the dwarf varieties, which he felt were susceptible to pests and would not be suited to Indian conditions. Due to this criticism, Richharia was shunted out of CRRI, and the Madhya Pradesh Rice Research Institute (MPRRI) which he headed was also summarily shut down. In fact, the only memory of his extensive work is the germplasm bank at Indira Gandhi Agricultural University,

[42] David Hopper to Norman Borlaug, letter dated 10 February, 1966, Box 5/41 Norman Borlaug Papers (Special Collections, Iowa State University).

[43] A.H. Moseman to Norman Borlaug, letter dated 10 February, 1967, Box 5/41 Norman Borlaug Papers (Special Collections, Iowa State University).

which now contains over 22,500 accessions of rice from Madhya Pradesh, over 19,000 of which were collected under his supervision and called the Raipur collection.[44]

The controversy that spilled out in 1971 over the claims made by Swaminathan on the protein content on a dwarf mutant variety, *Sharbati Sonora* is another example of how the question of yield was prioritized to dismiss charges related to any other aspect of the new technology. In the July issue of that year, the editorial article of the 'Young Scientist'-a bulletin published by the Pusa branch of the Association of Scientific Workers of India, questioned the IARI's 'tall claims' about the protein content of the new dwarf mutant variety, *Sharbati Sonora.* Although the Director of IARI, M.S. Swaminathan, reportedly claimed that 'the protein content of wheat has thus been made highly comparable to the protein content of milk,' that claim remained unsubstantiated by the 'CIMMYT News of July-August 1969. The 'Young Scientist' editorial also expressed a disappointment at how the wheat revolution had actually aggravated the problem of protein deficiency, by causing a drop of 16 per cent in pulse production. The journal asserted that 'India's present need is to increase the production of pulses that they are available to the poor at a low price.'[45] Facing such criticism, the scientists working on the new varieties closed rank to refute the allegations vehemently. A sympathetic Borlaug wrote to Swaminathan with a sense of camaraderie, 'I resent the way that my name and that of my organization CIMMYT, was used in the Times of India article to discredit you and IARI…' Borlaug's contention was that whoever has doubted Swaminathan's research 'does not have

[44] It is not easy to find material on Dr. Richharia. While engaged in archival research at CRRI, Cuttack I did try to bring in the topic in my conversation with the acting Director, Dr. S.G. Sharma. The effort went futile. I have used an electronic version (Accessed 12/15/2010) of Dr. Richharia's interview with The Illustrated Weekly, titled 'Crushed but not defeated' (23 March, 1986): http://www.satavic.org/richharia.htm
Bharat Dogra, en eminent environmentalist in India has written a book on Richharia, *The life and work of Dr. R.H. Richharia* (1991).

[45] IARI's 'Tall claims' questioned by own scientists, Times of India, 19 July 1971.

IARI's, or the Government of India or the people of India's interest at heart. It is obviously organized by someone who has little regard for the future role of agricultural science to the improvement of the standard of living of the people of India.' Borlaug found it ironical that the new agricultural technology should encounter such criticism, after the 'tremendous achievements that have been made in increasing wheat production' and the 'very great role' that Swaminathan, personally, and IARI had played in 'revolutionizing' wheat production.[46]

When confronted with criticism, agricultural scientists working on the new technology became generally defensive; the tendency was to denounce the critics as opponents of progress, who had little to do with science and did not keep in mind the best interests in India's peoples. On a separate occasion, Borlaug wrote to Dr. M.S. Randhawa, the Vice-Chancellor of the Punjab Agricultural University, that 'I have been trying to battle against their vicious campaigns as best as I could, but nor always effectively, for they can devote their entire tine to writing about such nonsense while my colleagues and I must spend most of our energies and time on conducting research and extending the Green Revolution to other countries.' Borlaug insisted that the scientists working on the new technology should always 'keep up the good work,' continuing their research without being distracted by the impulse to answer critics. Producing techniques to ensure 'record breaking yields,' Borlaug thought, would be the most fitting reply to any criticism.[47] Evidence of sheer productivity, he supposed, would be sufficient to erase any other deficiencies of the new technology.

The 'ideal' type: farmers, farming tracts and flavors

[46] Borlaug to Swaminathan, Letter dated 2 August, 1971. Box 15/8 Norman Borlaug Papers (Special Collections, Iowa State University).

[47] Borlaug to Randhawa, Letter dated 29 July, 1971. Box 15/8 Norman Borlaug Papers (Special Collections, Iowa State University).

In 1967, Kanwar Mohinderpal Singh, a farmer from the Delhi region became a familiar name to many. His claim to fame rested in the fact that he harvested nearly 8.4 tons of crops per hectare, which was the highest yield so far recorded anywhere in the world in 1967 for a crop of 150 days duration. Eager to project Singh's achievement as an instance worthy of emulation by other farmers, Dr. M.S. Swaminathan, the Director of IARI and Dr. S.P. Kohli, the Coordinator of the All India Coordinated Trial often mentioned him in their reports. Singh was even introduced to Borlaug, perhaps with an intention to convince the scientist of the potential of Indian farmers with the new biochemical inputs. Similar other anecdotes continued to circulate over the years about how farmers who had started growing high-yielding varieties in their fields had experienced miraculous growth. In one of his article in the *Indian Farming*, Swaminathan accounted to the readers what a principal of a leading agricultural college in India recently said to him about the yield capacity of the new varieties. The principal is said to have remarked that had a student in 1963 answered an exam question about how much wheat yields were possible with a reply of '50 *maunds* (1850kg) per acre', the principal would have surely failed him. But time has changed, the principal reflected, and if today a student had answered '150 *maunds* (5550 kg) per acre', the principal would not be able to dismiss the answer, knowing that such a yield could very well be a possibility because of the green revolution. [48] These anecdotes make it clear that of all the characteristics of the new technology, its capacity to give a much higher yield, was the most coveted one.

Reports started to come in various parts of India on farmers cultivating the new varieties, but as earlier accounted, it was still not enough to cover all the food shortages reached due the droughts of the last few years. More farmers need to take to the new varieties and scientists and

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[48] *Indian Farming*, August 1967.

policymakers needed to know as to who would and who wouldn't. They wanted systematic studies explaining farmers' response towards the new seeds and use of chemical fertilizers. This information was imperative for the successful dissemination of the new technology in targeted regions of India.

In 1967, Indian Journal of Agricultural Science reported a study conducted on the 'attitude of farmers' toward 'Taichung Native I at the University of Kalyani at West Bengal. The study was evidently done by a couple of researchers to explain how the nature and the extent of the farmers' participation determined the success of the new varieties. A positive attitude, scientists pointed out, could very well imply the farmers' willingness to try the new technological package in their farm. The study specifically tried to locate the role certain social-cultural variables play in shaping farmers' response to the new technology, especially the dwarf hybrid varieties. The study conducted over twelve villages, selecting twenty farmers from each village, used Chi-square test to find out possible association between the farmers' attitude and each of the social and cultural values. At the end of their study, they could in fact statistically confirm their hypothesis that it was 'comparatively younger, school-educated farmers who are members of a joint family, have cultivation as the main occupation and possess medium land and medium income are generally more favourably disposed toward the high-yielding varieties of rice.' In confirming the social and cultural characteristics of farmers accepting the new technology, the study stated that it was 'progressive farmers (who) adopt(ed) the high-yielding varieties for improving their financial conditions.' Studies like these would help those working on the new technology to specifically focus on those farmers who came from similar social, economic and cultural background at the expense of those who did not. Those who adopted the new technology, therefore, were portrayed by the supporters of the new technology as 'progressive' or 'risk-taking farmers' as opposed to the more traditional-minded 'risk-averse' cultivators.

Whether farmers were willing to take 'risks' or at least approach the question of investing in the new technology with an extent of 'risk-neutrality' became an important topic of discussion over the green revolution years. A 'risk neutral' farmer was good for capitalist development in agriculture, because such a farmer, regardless of the extent of variability in returns, would try to maximize average or expected net returns, resulting, according to the agricultural economists, to the highest returns over long run. In contrast a 'risk-averse' farmer would not be keen to invest and would be willing to forego some expected returns, if that meant reducing the variability of his income stream. As instilling higher production through investment in the new technology was slowly gaining ground among professional circles of agricultural scientists and economists, the image of a 'risk-neutral' farmer gained significance. This might help us to understand the importance that scientists accorded to Kunwar Mahinderpal. He was applauded not only for receiving high-yield, but also for proving that with investment comes the return.[49]

Some economists wanted to see such an attitude not only among farmers, but also on the part of the state administration. One of them pointed out- with exasperation and some amount of urgency- that time in India is of 'desperately' short supply, as the country had been caught in a 'fateful race between population growth and economic development.' Thus, India could not learn through experimentation any more, as had been the case in the last two decades after independence, with a 'callous squandering of her precious time.' It, instead, needed to take

[49] Agricultural economists in a study conducted towards the later years of 1970s, however, strongly argued that to encourage greater investment in agriculture there should be effective crop insurance system, which would enable the farmers to shift the risks to the insurance system as a whole rather keep it on their own shoulder. Hans. P. Binswanger, 'Risk Attitudes of Rural Households in Semi-Arid Tropical India', *Economic and Political Weekly*, Vol.13, No.25 (Jun. 24, 1978) pp.A49-A62.

'calculated risks.' The author went on to remark, with certain amount of relief, that it was precisely what the country did when it decided to adopt, so widely and so successfully, the miracle rice and wheat on a massive scale. In doing so, the author pointed out, 'it dispensed with the much longer process of initial trials and experiments under local conditions, ran the risks of diseases to which the new varieties might have been susceptible and took whatever precautionary measures she could to cope with whatever diseases might break out.' He considered this 'trade-off-of traditional safety for the time she could salvage' as 'perfectly sensible' and deserved to be repeated in a great many other programs and activities.[50]

Without adequate measures of crop insurance, encouraging farmers to invest in the new varieties definitely indicate that the proponents of the new varieties were encouraging the farmers to ignore the possibilities of crop loss, and put more faith on a better economic return. No matter how good might had been the economic prospect of the new technology, the possibility of crop failure was no less in the early days of green revolution in India. Focusing on the dissemination of the new varieties in the water-assured areas alone might have diminished the chance of crop loss due to droughts, but the threat of pest attack or outbreak of diseases was very much present. The infrastructure to fight widespread pest or disease incidence was absent or at best in a rudimentary state in different parts of India. Under such circumstances, a resourceful farmer like Kunwar Mahinderpal, might be willing to take the risk of cultivating the new varieties, because one crop loss would not have turned him to a destitute, as it would in case of a more resource-challenged farmers. In case of the latter he would be more 'obsessed' with some particular set of problems involved in pursuing livelihood, rather than the more 'straightforward'

[50] Sudhir Sen, *A richer Harvest: New Horizons for Developing Countries* (Tata McGraw-Hill, 1974) p.72.

dream of making a profit.[51] Based on such observations, many studies on the green revolution technology in India have commented on its class character, arguing that the technology had been biased in favour of the 'rich' farmers, who not only had resources to invest in higher return from soil, but were also better equipped to fight the risk of crop loss through greater expenditure in buying pesticides. In its portrayal of enterprising and progressive farmers, the proponents of the new technology, however, refused to see any class biases. In their appraisal of the technology too, they saw no inherent class preference. Sen, for instance, used statistical data to argue that 61 percent of the beneficiaries of irrigation-a necessary component of the technological package, were the small farmers, owning less than an acre to five acres of land.[52]

If the psychological profile of a progressive farmer came to dominate the rhetoric of many scientists, economists and politicians with the introduction of the new technology, a similar trend was noticed in the search for fertile and well-irrigated farming tracts that conformed to the slogan that the new technology would be 'build on the best'. The package nature of the inputs-each sharing a symbiotic relationship with others, made it crucially important that to get most out of the new technology, use of high doses of fertilizers should be complemented by regular irrigation and use of pesticides. The first two inputs were meant for high-yield and the last one protected the lush growth of the crop from pest-attacks that became more frequent with the introduction of the new varieties. Unlike chemical fertilizers, which had for long been part of national debate on agricultural development, the introduction of the new technology brought into sharp focus the necessity of well-irrigated farms. The Central Government at New Delhi made it very clear to the state governments that they should only select blocks for further development

[51] For a detail discussion, see Pearse, *Seeds of Plenty* pp 6-25.

[52] B. Sen, 'Opportunities in the Green Revolution', *Economic and Political Weekly*, Vol. 5, No. 13 (Mar. 28, 1970), pp. A33-A40.

that already had eighty percent of the cultivable area under irrigation and with an adequate drainage facility to keep the area immune from floods.

Table 4.1 India: HYV Wheat

Percent

	Uttar Pradesh	Punjab	Bihar	Haryana	Other	Total
1966/67	67	11	5	3	15	100
1967/68	54	22	6	3	15	100
1968/69	53	21	6	5	15	100
1969/70	33	30	9	9	20	100
1970/71	30	24	14	10	23	100
1971/72	28	22	15	10	25	100
1972/73	31	19	16	10	24	100
1973/74	31	18	15	9	27	100
1974/75	33	16	14	9	29	100

The figure demonstrates how the cultivation of HYV wheat was highly concentrated in certain regions of India. Source: Foreign Agricultural Economic Report No. 96 p.37

Scholars writing on the economic impact of the green revolution pointed out that the adoption of new technology was centered almost entirely on Punjab, Haryana Western Uttar Pradesh and Tamil Nadu- regions that had irrigation, proper drainage, and sunny seasons, and that did not suffer from attacks of pests and disease, which could benefit from the new technology.[53] Focused more on increasing yield through implementing the new technology, rather than overcome its rigid input specificities, majority of agricultural scientists during this period showed certain consistent trends. For instance, they directed their breeding effort mainly in evolving varieties suitable for fertile, irrigated tracts; the period saw little effort to breed varieties suitable for either moisture-stressed or flood-prone region of the country, though such regions were common than irrigated ones. From the point of ecology, it resulted into monocropping and enhanced the possibility of widespread pest attack. With overcropping in irrigated tracts, it also brought down the water-table of the regions, and resulted, as some scholars argue, in inter-regional economic disparity.

The difficult anomaly between the water requirement of the new seeds and the general irrigation situation in India became apparent in its North-Eastern states of West Bengal, Orissa, Bihar and Easter Uttar Pradesh. Over sixty percent of India's rice production came from these states, yet introduction of dwarf rice seeds were very slow in the region because of its scant irrigation facilities. The rainfall pattern of the eastern region simply could not support intensive winter cropping. With the available implements and draft animals, unless there were pre-monsoon showers, farmers found it difficult to prepare the land for timely sowing.[54] The meager irrigation facilities of the Northern Hill Zone posed a similar kind of hindrance in the

[53] Biplab Dasgupta, *Agrarian Change and the New Technology*; B.H. Farmer, 'Perspectives on the 'Green Revolution' in South Asia'; C.J. Baker, 'Frogs and Farmers'; Andrew Pearse, *Seeds of Plenty, Seeds of Want*; Michael Schluter, *Differential Rates of Adoption of the New Seed Varieties in India.*

[54] A.S. Kahlon and Karam Singh, 'Eastern Region: Potential, Constraints and Development Strategy', *Economic and Political Weekly*, Vol. 19, No.4, Jan 28, 1984, pp. 174-80.

introduction of S-227 and E.5878. These Mexican wheat varieties were termed the 'Hill wheats of the future' by the scientists for their high yield that went up to 75 *maunds* (2775 Kg) per acre. With 'high requirements' in terms of irrigation and fertilizer these varieties, however, found little scope in the North Hill Zone.

In insisting on irrigation to create the ideal farming condition, the scientists and other proponents of the new technology have had ignored existing class-caste politics and bad maintenance that made farmers' access to water a problematic issue even in regions with assured water supply. In a study of Indian irrigation policy for UNRISD, Elizabeth Whitcombe reported that in tours of more than 600 Blocks, it was rare to find more than a third of the state tubewells in working order. She also reported that state tubewell users complained of too little water, especially the problem of reductions without warning, and poor servicing of machinery. Meanwhile, it was only the larger farmers who had good access to the private tubewells.[55] Power shortages and a low availability of electricity in the rural areas further limited the development of tubewells and their actual advantages.[56] In a study of agricultural problems in India's eastern region, researchers Kahlon and Singh pointed out that of the 197,550 shallow tubewells reported in West Bengal, only 24,900 were energized.[57]

In the years following the introduction of the green revolution technology, agricultural scientists in India made intermittent effort to grapple with the problem of moisture-stress, mainly

[55] Andrew Pearse, *Seeds of Plenty, Seeds of Want* pp.86-88; Elizabeth Whitcombe, 'Notes on Indian Policy' (UNRISD, 1974); John W. Mellor and T.V. Moorti, 'The Dilemma of State Tube-Wells', *Economic and Political Weekly*, March 1971, Vol., VI, No. 13. Daniel Thorner accounts how 'rich and powerful' farmers in general receive more than their share of water due to their influence over the administration of water distribution, 'The Weak and Strong on the Sarda Canal' in D. Thorner ed., *Land and Labour in Asia*,1962.

[56] Akhil Gupta writes how in the early 1990s, lack of reliable supply of electricity continued to determined the use of water resources in a number of ways. *Postcolonial Developments*, pp. 272-73.

[57] A.S. Kahlon and Karam Singh, 'Eastern Region'.

through breeding, morphological restructuring and soil compaction methods. The challenge came in finding ways to grow the new crops in upland areas that had on average less than 1100 mm of rainfall and that often lacked reservoirs, where in any case slopes made it hard to store the precious water received during monsoons.[58] In 1966, scientists at CRRI started experimenting with the use of a proctor compactor, to test whether soil compaction could help increase grain yield by decreasing downward slope runoff and by increasing the soil's capacity for water retention and the uptake of fertilizers such as nitrogen, phosphorus and native iron.[59]

While CRRI conducted these experiments on the potential advantages of soil compaction, their primary research concentrated on the ongoing search for new varieties that could give high yields under moisture stress. Plant physiologists, soil scientists, and plant breeders collaborated to develop a series of early maturing rice varieties such as CR. 125 and CR. 143, which they hoped would be well adapted to upland areas with low rainfall.[60] Researchers in the laboratories of Punjab Agricultural University and IARI also worked to breed new varieties, such as C.306, K.65, N.P.889, and N.P. 890, specifically designed to withstand moisture stress and yet give high yield. In several rainfed centers of the zone, researchers started special coordinated trials of the Mexican wheat variety S.227, to find out whether the high yield of that dwarf strain could be replicated under moisture stress.[61]

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[58] In any case, in South India which is predominantly flat and has innumerable water reservoirs, it still remained a problem because a very long stretch of drought, like the one India witnessed in late 1960s, was enough to tax to limit the capacities of such reservoirs as source of water for cultivation.

[59] Annual Technical Report of the CRRI, 1968.

[60] Annual Technical Report of the CRRI, 1972.

[61] P.N. Narula, 'Improved varieties for eastern India', *Indian Farming,* August 1967.

In 1967, the agronomists at CRRI started experimenting with breeding drought-resistant high-yielding rice varieties. Scientists tested several crosses of rice seeds made between proven drought-resistant varieties (such as N.22 and Ch.45) and Taichung Native 1 (TN1), the short stiff variety that responded well to high levels of fertilizer application. In developing rice varieties for moisture stress conditions, scientists particularly sought to incorporate the characteristic of rapid senescence or 'biological aging' of leaves, which helped reduce both the amount of oxygen transported to the rhizosphere , the soil surrounding the root of the plant and the loss of energy through respiration, particularly during key stages of grain development.

Plant physiologists made a distinction between varieties that had drought tolerance and varieties that could be designed to be made capable of avoiding drought.[62] Under the leadership of M.S. Swaminathan and R.D. Asana, scientists at the IARI used the new genetic tools that were available to them to reconstruct the morphological architecture and developmental rhythm of crops to help varieties such as Chotti Lerma (a selection of the Mexican variety, S.331) and Kalyansona (a selection of the Mexican variety, S.227) not only survive but also produce well under low moisture availability. Asana and his IARI colleagues developed wheat varieties capable of avoiding drought. These varieties had a large number of grains in the main tiller, a good root system that helped them draw water from far below the surface, and about seven leaves horizontally-set to block sun rays and retain the dew in the ground. IARI research showed that without irrigation, plant varieties tended to lose some tillering capacity, meaning that plant population largely consisted of main axis shoots. To compensate for this problem, Swaminathan and his associates at the IARI evolved grain varieties that had fewer but larger ears or that had

[62] Drought tolerance implied an ability of a plant to survive the effects of dehydration of its cells due to certain attributes of protoplasm and to resume growth when moisture is again available. Drought avoidance indicated avoidance of dehydration of tissues by intake of water and/or reduction in its loss and continuance of growth. Deep root system, sensitive stomatal mechanism and thick cuticular surface of leaf are involved in drought avoidance.

branched ears. Scientists were also working on developing 'Triticale,' a hybrid form of wheat and rye well-suited for non-irrigated areas; triticale offered all the characteristics of wheat, while incorporating the drought resistant quality of rye.[63]

Notwithstanding these instances, the period witnessed a far more systematic and intensive effort at evolving and testing varieties for fertilized and well-irrigated soil of specific agro-ecological zones of India. It comes out clearly in the wide variations seen in the number of national trials conducted in the country's different agro-climatic zones. In the crop cycle of 1970-71, scientists tested their new varieties in the high fertility-irrigated areas under the five zones. The North Western Plains zone, which had the advantages of highly fertile soil and widespread irrigation, received nine different trials. By contrast, scientists conducted only two trials in the North Eastern Plains zone, which had fertile soil but relied on water supplies from rain. Researchers also performed only two trials in the Peninsular zone and the Northern Hills zone, while the Central zone was lucky to get four.[64] During the following year, researchers continued this skewed distribution of effort, conducting eleven trials in the North Western Plains zone, six at the Central zone, five in the Peninsular zone, four in the North Eastern Plains, and just two trials in the Northern Hill zone.[65]

Scientists looking back at the first phase of the green revolution in India have later tried to explain the reasons behind neglecting the rain-fed regions in contemporary research work. Scientist K.S. Gill admitted that up to the late 1970s, scientists concentrated on developing

[63] R.D. Asana, 'Growth Habits of Crops of Non-Irrigated Areas-Important Characteristics of Plant Type' and M.S. Swaminathan, 'New Frontiers in Unirrigated Farming', *Indian Farming,* August 1968.

[64] *Brief Report on the Results of the Coordinated Wheat Varietal Tests Conducted during 1970-71.* Processed and Compiled by the Wheat Research Coordination Center, All India Coordinated Wheat Improvement Project. (Indian Council of Agricultural Research & Indian Agricultural Research Institute, New Delhi).

[65] Ibid, *Brief Report,* 1972-73.

varieties suited to high-fertility conditions. Breeders developed only eight varieties specifically appropriate for rain-fed growing regions with low fertility.[66] In the 1970-71 coordinated national trials, researchers conducted only twelve tests under low fertility-rainfed conditions, compared to twenty-one trials conducted at high fertility-irrigated regions. Researchers themselves admitted that they would need to increase the number of trials conducted in the unirrigated regions in order to be able to draw any ‘worthwhile’ inferences on the adaptability of the new varieties to moisture stress.[67] But they failed to take this next step; in fact, in later years, the number of trials for the low-fertility rainfed regions actually decreased to sixteen and of that, only eleven trials officially submitted data.[68]

By the late 1980s, scientists who were associated with the Green Revolution in India (including Norman Borlaug) had the chance to reflect on the successes and limitations of the new technology. In the course of the conversation, Dr. Tandon admitted that the development of rainfed varieties was one area where scientists had done very little. He blamed this on the lack of research facilities and a lack of dedicated scientists who were willing to work on the problem for a length of time without expecting quick results. Under the existing system of research assessment, there was little backing for experimenters who labored for a decade or more without tangible progress. Tandon admitted that scientists had been keener to conduct research under irrigated conditions, where their efforts bore quick and visible fruits. But as Tandon also noted, even when scientists did develop a few good varieties to grow in rainfed conditions short on irrigation, India had no seed production program to make those seeds widely available. Tandon

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[66] K.S. Gill, *Research on Dwarf Wheat* (Punjab Agricultural University, 1977) p.38.

[67] *Brief Report, 1970-71*.

[68] *Brief Report*, 1972-73.

lamented that not a single variety had entered the seed production chain for many years. He linked the problem to economics, noting that '…by and large, the rainfed farmer is a poor farmer. He is not capable of purchasing seed, and unless there is a demand, the commercial agencies do not go in for seed production…The seed producers want high profit… (They) would like to produce varieties with a better yield than the one ton that can be obtained under rainfed conditions.'[69]

Irrigated and well-fertilized land, which promoters of the new technology hailed as the mark of true progress, however, became a source of concern for many as they proved to be conducive to pest incidence. To maintain the appropriateness of these fertile irrigated tracts for the cultivation of the new seed varieties, there arose the additional need of pest control, which scientists planned to achieve primarily through application of high doses of pesticides. Necessity of using chemical pesticides, not only intensified the critique that most of the inputs are beyond the purchasing capacity of small farmers, but also brought forth sharp retort from environmentalists.

While on an official tour of India's northern hilly states, M.S. Randhawa, the Director General of the country's Intensive Agriculture Area Program, drew a sharp contrast between the new grains and traditional varieties. Randhawa wrote, 'Below the white mountains was a stretch of terraced fields covered with dark green and pale green strips of wheat. The dark green wheat had been fertilized with calcium ammonium nitrate and super-phosphate and gave promise of a bumper crop. The pale green wheat was not fertilized, and had a poor stand and the size of the ears was also small.' Randhawa surmised that nitrogen was changing the landscape of the Punjab

[69] M.S. Swaminathan (ed.) *The Wheat Revolution* (Macmillan 1993).

Himalaya and found this change very gratifying.[70] The fields sown with the new rice and wheat varieties uniquely displayed to many, just like Randhawa, 'the arrival of modernity'.[71] The dark shoot, stubby looking plants aside the thin pale-green strips was a visible metaphoric representation of modernity and tradition. What remained a less appealing feature and perhaps, therefore, not mentioned in the writings of Randhawa was that the new varieties with 'dark green leaves' produced an ecological condition in the fields that was more favorable to diseases and pests.

A large number of dwarf wheat varieties, such as Kalyansona, PV 18 and Sonalika though highly resistant to rusts under field conditions at the time of their release, soon became susceptible to a new virulence of the rust pathogen. This caused great concern among many. For instance, in 1966 A.H. Moseman, the assistant administrator for the Technical Cooperation and Research, observed that although important people in the Indian administration such as the Agricultural Secretary Sivaraman might think that availability of the Taiwan rice and Mexican wheat varieties had largely resolved India's food problems, the country was really facing a potentially 'unhealthy situation' of practicing large-scale 'one variety' agriculture. Moseman wanted still wider dissemination of the dwarf varieties, but what 'seriously concerned' him was, India's lack of technological capability to meet the challenges of a series of destructive new diseases that might attack the crops. He wrote to international institutes, such as the IRRI to help strengthen India's national research capacity to fight such calamities.[72] In response to Moseman's request, in October 1967, a team of four scientists from IRRI and Japan surveyed the

[70] M.S. Randhawa, 'The Miracle of Nitrogen', *Indian Farming*, June 1965.

[71] Nick Cullather, *The Hungry World*, p. 159.

[72] A.H. Moseman to Norman Borlaug, September 29, 1966. Box 5/34 Norman Borlaug Papers (Special Collections, Iowa State University).

rice crop to assess the effect of diseases and insects on the new varieties grown in India. They too observed that the high-yielding varieties IR-8 and TN1 often had 'more plant hopper and cutworm infestations, which appeared to be due to their lush growth and thick stands.' The team expressed anguish at the inadequacy of existing pest-control practices of average Indian farmers to handle this additional burden.[73]

Within a year after the establishment of the Division of Agricultural Chemicals of the IARI, the scientists reported in 1967 of successfully developing a thiocyanate group of insecticides, using 'indigenous' raw materials and technical knowhow. The India's National Research Development Council (NRDC) offered an exclusive right for the production of the material to Camphor and Allied Products, a public-sector undertaking at Bareilly in Uttar Pradesh. In its 1969 scientific report, the government's Division of Agricultural Chemicals reported that commercial production of this pesticide in India was saving the country foreign exchange worth 2 million annually in Indian currency.[74] In a similar effort, researchers converted domestic industrial wastes to develop a pesticide, 'Solbar', to fight against powdery mildew in wheat.

In 1971, the Ford Foundation sponsored an outside review team sent to study the plant protection scenario in India. After concluding their study, the review team endorsed the principle of extensive use of pesticides. The team advised India's national government to build up a close cooperation and mutual understanding with the pesticide industry, which would help that industry prosper and supply farmers with good quality formulations. In response to the review team's report, Ford Foundation urged India's policy-makers to take steps to popularize the use of

[73] 'Report on The All India Coordinated Rice Improvement Project', *Indian Farming*, November 1968.

[74] Scientific Report of IARI, Division of Agricultural Chemicals, 1969.

pesticide. It advised the government to develop larger domestic agro-industries for the production of pesticides, which would generate additional sources of employment for the people and also employ local villagers in the ground application of pesticides.[75]

However, in practice, farmers' use of pesticide remained far from satisfactory. By March 1974, the level of pesticide consumption was only 45,000 tones.[76] Several reasons influenced low consumption of pesticides in Indian agriculture. Farmers could adopt such techniques only if they had access to chemicals at affordable rates and individual Indian farmers rarely had the means to own the equipment for aerial spraying.[77] Though much cheaper than aerial spraying equipments, non-availability of dusting and spraying equipment also discouraged the uses of pesticides. Although arrangements are frequently made by the development block officials to keep some equipment in their offices for use by farmers, the frequent complaint was that their number had been inadequate, their breakdown rate was high and users did not return them in time.[78]

Moreover, the spraying of chemicals over a vast acreage under various agro-ecological conditions posed larger environmental questions. The option of aerial spraying was already

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[75] Ford Foundation, however, was careful to mention that 'the breeding of rice varieties for insect and disease resistance is the most economical and effective control measure.' A.A. Johnson, *An Assessment of Prospects for Increasing Rice Production in India* (March 1971).

[76] In a sample in West Godavari, Andhra Pradesh, only 30 per cent of the total stock of fungicides and insecticides was sold, and in another sample from Tikamgarh, Madhya Pradesh, the corresponding figure was 20 per cent. Quoted from Biplab Dasgupta, *Agrarian Change and the New Technology in India*, pg. 67.

[77] In 1970/72, only 2.73 million acres of cultivated land was covered by aerial spraying, a quarter of it by the state owned Agro-Aviation Corporation. *Organization, Evaluation Study of the High-Yielding Varieties Programme, 1968-69* (Delhi, Government of India, Planning Commission, Programme Evaluation, 1970).

[78] AERC, *A Study of the High-Yielding Varieties Programme*, Rabi 1968-69, Waltair, December 1969.

spurring much criticism in the United States.[79] The publication of Rachel Carson's Silent Spring was already causing much commotion in the America. In the 1970, for instance, there were already questions being raised in the Lower House of the Indian Parliament about the safety of using DDT specifically and pesticides in general. Several MPs repeatedly exhorted the Minister of State for Food and Agriculture, A.P. Shinde to reply why India was continuing with its use of DDT when many other countries have stopped using it on grounds of toxicity. The Minister pointed out that under the Insecticides Act[80] passed by the Indian Parliament steps had already been taken to look into the matter and a joint committee of CSIR and ICAR was constituted to intensify research efforts 'to prevent the harmful effect of insecticides.'[81] In 1973, Robert F. Chandler, the Director of IRRI himself admitted that pests had been adapting to selective breeding; in Mexico, races of wheat stem rust changed six times between 1943 and 1965.[82]

As agricultural scientists tried to find cheaper alternatives to imported chemical fertilizers through uses of indigenous resources, they similarly tried to control crop loss through breeding pest resistant varieties and biological control. Dr. V.P. Rao, the entomologist-in-charge of the Commonwealth Institute of Biological Control at Bangalore, argued that although the initial expense of biological control might appear to be somewhat high for India, it would still cost less

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[79] As early as 1958, when the U.S. Department of Agriculture decided to spray chlorinated hydrocarbons from the air and ground over 20 to 30 million acres in eight to ten southern states, conservationists vehemently protested against its impact on the wildlife. Even Assistant Secretary of the Interior Ross Leffler wrote to Secretary of Agriculture Ezra Taft Benson, to urge limits on aerial spraying. Widely read magazines, including *Reader's Digest* and *Life*, and newspapers such as the *New York Times* took a stance against aerial sprayings. Edmund Russell, *War and Nature: Fighting Humans and Insects with Chemicals from World War I to Silent Spring* (Cambridge University Press, 2001) Ch.11.

[80] http://www.hrdpnet.in/live/hrdpmp/hrdpmaster/idrm/content/e7388/e7801/e8026/infoboxContent8028/INSECTICIDESACT1968.pdf

[81] The Times of India, November 20, 1970.

[82] R.F. Chandler, 'The Scientific Basis for the Increased Yield Capacity of Rice and Wheat' in T.K. Poleman and D.K. Fairbairn eds., *Food, Population and Employment* (Praeger, 1973).

than the investments needed for using insecticides. By the early 1970s Indian scientists were trying to use indigenous parasites for biological control of rice pests.[83] Just like in the US, however, integrated pest control (IPC) measures, rather than biological control became the preferred mean among the Indian scientists.[84] The latter, scientists argued, gave them a chance to perfect an 'appropriate' admixture of chemical, genetic, agronomic and biological methods. This judicious combination of various means, they argued, would be an improvement on both chemical and biological ways of control. Biological control was already under attack from various scientists for being marginally effective against targeted insect pests.[85] Moreover, a reduced dependence on chemicals in IPC meant less danger to the consumer and environment.[86] Other than these methods, agricultural scientists at IARI and CRRI who were involved with the All-India Coordinated Rice Improvement Project (AICRIP) worked on breeding pest and disease resistant varieties.

Scientists were more successful in breeding disease resistant varieties. Though, there were few of pest resistant rice varieties, CR.94, MR.1550 and MR.1624, which gave multiple resistances to gall-midge, leaf-hopper, stem-borer, bacterial blight and tungro-virus, use of pesticides gradually increased in India, especially in those parts with widespread cultivation of the new seeds, high use of fertilizers and intensive irrigation. One such place was Punjab, where

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[83] V.P. Rao, Some Practical Aspects of Biological Control, Norman Borlaug Papers (Special Collections, Iowa State University).

[84] For a detailed discussion of debate among entomologists supporting biological control and integrated pest control see, Paolo Palladino, *Entomology, Ecology and Agriculture: The Making of Scientific Careers in North America, 1885-1985 (*Routledge, 1996).

[85] Entomologists Albert Turnbull and Donald Chant suggested that less than a third of all introductions of natural enemies had succeeded to control the damage caused by the targeted insect pest. This, they argued was because the introductions often ran counter to the theoretical precepts supposedly informing them, and because they regarded the theory to be unsound in any case. Paolo Palladino, ibid, p.122.

[86] M.S. Swaminathan, *Science and the Conquest of Hunger* (Concept Publishing House, 1983) p.258.

the new technologies had been widely disseminated. By the early 1980s, environmental activist Vandana Shiva pointed out that previously insignificant insects and pests gradually grow into major problems. In 1964, scientists first recorded rice leaf folder, enaphalorrocis medinalis, as a 'minor' infestation. By 1967, however, it had appeared in epidemic form in Kapurthala, and by 1983, had spread to all rice-growing areas of the state and caused heavy losses. Shiva cited similar instances of the white-backed plant hopper (Sogatella fureifers), which evidently first appeared in 1966 but became severe from 1972 onwards. Similarly, problems with the brown plant hopper (Nilanparvate lugene), rice thrips, earcutting caterpillars, and other new insect pests turned from minor to major problems.[87]

As the production of an ideal farming tract-well irrigated, free of pests, and highly fertile continued to be fraught with widespread controversy, so was the search for old flavor in new varieties. In addition to worrying about fertilizer responsiveness, yield, and resistance to disease and pests, agricultural scientists also had to consider making the new grains palatable to the consumers. A significant section of the middle-class Indian consumers found the red-seeded Mexican wheat and the small grains of Philippines rice with high gluten content to be incompatible with their taste preferences. Villagers in India, especially the farmers, had been accustomed to red and thick-grained rice, because that helped them to keep full for a longer time in the fields. The demand for slender, scented rice and amber wheat had been largely limited to the urban population and middle and upper middle class of rural India. But in an emerging industrial society, these were sections, which dominated economically and socially. It was, therefore, clear to the scientists that the success or failure of the new seeds at the consumption junction depended on whether consumers would be willing to buy these varieties. If the farmers

[87] Shiva, *The Violence of the Green Revolution*, pp. 62-65.

found the new varieties not appreciated in the market, they would refuse to grow it, even if they received high-yield from these varieties.

Fig 4.3 Prime Minister at the Gamma Garden: The Prime Minister observing the chromosomes of wheat at the IARI Gamma Garden. It was by affecting the chromosomes through Gamma rays that the wheat variety Sharbati Sonora was evolved.

The scientists' prediction about consumer reaction and farmers' responses turned out to be correct. Dr. S.P. Kohli, the coordinator of the All India Wheat Improvement Program, wrote to Borlaug in 1967 that the farmers preferred to cultivate the amber-seeded dwarf wheats to the red-seeded ones, because consumer preferences for amber wheat meant that red wheat was fetching Rs.15-50 less per quintal. Though farmers grew amber-seeded wheat varieties on almost 2000 acres of land in the winter of 1966, it proved to be inadequate to meet demand. According to Kohli, the farmers who grew the red-seeded varieties did so only reluctantly.[88] The prospect of the red wheat varieties received a further set back from the initial decision of the Indian government to pay higher procurement prices for amber grain. Realizing that this could act as a tremendous detriment in the popularization of the new dwarf seeds, especially at a time when there was not enough dwarf seeds with desirable characteristics to substitute the Mexican ones, Dr. M.S. Swaminathan persuaded the Union government's Food Secretary to equalize prices in 1968. Reminiscencing years later, Swaminathan pointed out that this decision turned out to be very significant in persuading Indian farmers to grow the red-seeded high-yielding varieties.[89]

In terms of technology, agricultural scientists at CRRI and IARI used the technique of hybridization and induced mutation to make the new varieties look and taste like the old ones. CRRI scientists collected varieties of scented rice from all parts of India, but realized that all the existing varieties were tall and weak at straws. Such morphological characteristics made these varieties, as have been earlier pointed out, potentially low yield. They therefore started crossing scented varieties with high-yielding types, trying to reach the goal of breeding short and stiff-strawed selections with scented grain.[90]

Research on induced mutation was conducted in various parts of the world in the 1960s, especially in Japan, Korea, France and Italy. Many scientists were exploring the idea of using atomic rays to induce mutations that would bring quick desirable changes in crops. In 1964, the FAO and the International Atomic Energy Agency (IAEA), in cooperation with the European Association for Research on Plant Breeding, organized a technical meeting on the use of induced

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[88] Dr. S.P. Kohli to Dr. Norman Borlaug, 22 August 1967 Box 5/41Norman Borlaug Papers (Special Collections, Iowa State University).

[89] Swaminathan ed., *Wheat Revolution*, pp.22.

[90] CRRI, Annual Report, 1972.

mutations in plant breeding. In the meeting, scientists discussed the possibility of using artificial mutagenesis not only to supplement conventional methods of plant breeding, but also serve as a powerful means of developing a 'more fundamental approach to the improvement of domesticated plants through the possibility of re-patterning their genetic architecture and so moulding them even more closely to the increasingly stringent requirements of man.'[91] In India, agricultural scientists working at the IARI with Dr. Swaminathan, found induced mutation useful tool for changing the color of Mexican wheat from red to amber. The use of atomic mutation for agricultural purposes helped to reinforce government of India's commitment to peaceful use of atom. Homi Bhabha, the architect of the atomic program in India was a member of the scientific advisory committee of the IAEA too; Bhabha and the atomic energy research institute (BARC) that he helped to set up in India would contribute significantly in the use of atomic technology in agricultural development, as would the IAEA internationally.

Though application of induced mutation to change grain color was helpful in advancing the acceptability of the new varieties among farmers and consumers alike, Borlaug did not seem keen to invest research time in exploring aesthetic qualities, such as grain color or slenderness of varieties. He thought these characteristics of seed to be of secondary importance compared to grain yield. He considered the whole aspect of quality preference to be more academic than scientific. He, however, did endorse research on improving the chapatti-making and chapatti-keeping qualities of the new high-yielding varieties because chapatti, like Mexican tortillas, was very integral to Indian meal especially in the North-Western states, the wheat-belt of the nation. He also insisted that Indian scientists start working on ways to produce grains with 13 to 15 per cent of protein at a yield level of 80 pounds or above. Borlaug considered this aspect of research

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[91] *The Use of Induced Mutations in Plant Breeding: Report of the FAO/IAEA Technical Meeting* (Pergamon Press, 1965).

to be vital; since Indian diets consisted primarily of cereals, scientists aimed to improve the average person's nutrition by increasing the protein content of cereals. This, however, became problematic with the high-yielding varieties, because scientists found to their dismay that increasing yields made the percentage of protein in cereals drop. The high-yielding varieties therefore faced the challenge of being nutritionally deficient. The scientists started working on increasing protein content and protein quality through breeding.[92]

With assistance from the Rockefeller Foundation, geneticists at the IARI in 1966 set up a new laboratory fully equipped with automatic amino acid and protein acid analyzers. Researchers used these machines to screen large exotic collections of wheat with high protein content and then crossed the material with indigenous varieties such as N.P. 839 and C.306. These crosses resulted in wheat with protein content of 19 to 21 per cent in the F_1 generation. The protein content that was thus achieved was as high as in certain pulses.[93] In the case of rice, scientists used the local variety, Dular, which scientists found to possess about 12 per cent protein, as a donor to improve the high protein cultures of rice. In 1973, researchers tested these enriched protein varieties to see how these performed in terms of yields. The objective was to make quality commensurate with quantity in all the new varieties of rice and wheat.[94]

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[92] Norman E. Borlaug, A Brief Report on Progress being made by the Indian Coordinates Wheat Improvement Program, Box 5/41 Norman Borlaug Papers (Special Collections, Iowa State University).

[93] IARI Annual Report, Division of Genetics, 1966.

[94] CRRI, Annual Report, 1972.

Fig 4.4 A Group of Happy Politicians: An exceptionally happy Prime Minister receiving the special postage stamps, celebrating the success of the green revolution from the Union Minister of Communication, 1968

Driven by evidence of high-yield and claim of good quality, the dissemination of the green revolution technology seemingly went uninhibited till the mid-1970s. The aggregate wheat and rice output increased from 10.39 million tons to 23.83 million tons and 32.59 million tons to 42.23 million tons respectively during the period from 1965/66 to 1970/71.[95] Import of food crop dwindled carrying with it the impression that India's sovereignty was now safe. No one-either an institution or individual-could anymore theoretically hold its government or its people in 'short-tether'. Whatever the new technology symbolized-high yield, 'progressive' farmers who were receptive to new inputs, irrigated and fertile soil, carried an appeal to other countries which were seemingly standing at a cross-road of traditionalism and modernity, just as India supposedly did

[95] Government of India, Ministry of Agriculture, *Indian Agriculture in Brief* (Delhi, 1973, 1974).

in the mid-1960s. Out of this heart of complacency, however, rose the most significant economic, political, social and environmental critiques of the green revolution technology. A significant thread that ran through most of these critical reviews tried to explore the relationship of the farmers with the new technology. Farmers' knowledge, farmers' participation, farmers' marginalization-all became very crucial issues in the appraisal of the new technology. The conclusion of this dissertation would, therefore, not only problematize what it meant to be a farmer in independent India, but also dwell on its fractured identity and often incompatible interests to understand the nature of its participation in India's agricultural development since independence through the green revolution.

Coda: Where is the Cultivator in Indian Agricultural Research?

The history of agricultural research in postcolonial India from 1947-75, analyzed in this dissertation, has demonstrated that the scientists and the policymakers repeatedly referred to the cultivator's interests as an important criterion of policy-formulations. As achieving social equity had been an important goal, references to farmers' interests especially that of the small farmers, were abundant in policy documents. In deciding the ways and means of modernizing Indian agriculture, the planners made arguments based on *their* understanding of peasants' interest. This however brings forth two important questions: how did the governmental agencies determined accurately what would be in the interests of the peasants, especially, when the Indian farming community is so deeply stratified based on its economic means? In various regions of India subsistent farmers had been coexisting with big landlords but they definitely did not pursue similar economic interests. The other question is: In a deeply stratified world of the Indian countryside whose interest came to dominate over the other? In various chapters of the dissertation, I have repeatedly mentioned, how administrators and political leaders often considered Indian farmers to be as object of reforms rather than any active agent of change. In the conclusion, I will summarize how this attitude influenced the farmers' role in the formulation of policies and dissemination of the new technology.

Before going in to a detail sketching of the farmers' role or lack of role, let us briefly discuss the agrarian structure at the time of independence.[1] In 1947, at the apex of the agrarian structure was a landlord class, not necessarily owners in the strict sense, since they might be

[1] The following paragraphs on the agrarian structure has been extensively borrowed from Terence J. Byres, 'The Political Economy of Technological Innovation in Indian Agriculture' in Robert S. Anderson et al ed., *Science, Politics, and Agricultural Revolution in Asia*

occupancy tenants, but with superior property rights in the soil which allowed them to lease out land and to extract a surplus in the form of rent. Within this class, there were two broad groups, which could be found in all parts of India: a class of large, usually absentee landlords, who tended to hold land in more than one village; and one of smaller normally resident proprietors, who typically held land in one village. India's agrarian structure had two other major components, a peasantry and a class of landless laborers, and a third, a stratum of village artisans and craftsmen.

Among the peasantry some differentiation was fairly evident, varying in degree from region to region, and being most marked where commercialization had penetrated furthest. Rich peasants were part-owners and part-tenants, whose land was frequently fragmented. They accumulated capital to a certain extent, were market oriented, and were substantial employers of wage labors. Rich peasants were not 'masters of the countryside' at independence and they were not to be clearly seen in all parts of India.[2] But they did, however, have some of the attributes of dominance. The middle peasant stratum was also made up of part-owners and part tenants. They held their land in scattered pieces, were not market oriented, and employed small amounts of wage labor at peak periods. Poor peasants partly owned and partly rented, but were tenants to a greater degree than other peasants. They were particularly likely to be sharecroppers and especially so in eastern India. Among poor peasants, fragmentation was rife; access to credit was via the village moneylender, at usurious interest rates, and the level of indebtedness was high; market orientation took the form of marketing a 'distress surplus' rather than a true commercial surplus. An important characteristic of poor peasants was the degree to which they had to supply

[2] The landlord class was still very much in command. It was still the dominant class par excellence.

their labor to others in order to survive. Such labor might be forced, unpaid labor, extracted by landlords as a condition of tenancy.

There had been landless laborers in India since Mughal times, that is, from around fifteenth century. In 1950-51, fifteen per cent of all agricultural families in India were without land. Among laborers it is important to distinguish two categories: permanent or attached laborers, or those who were hired for a single crop season for a single operation, or on a daily basis.[3] At independence, there were, of course, virtually no mechanized operations for such labor to work on. It is important to remember that the rural proletariat was composed of both totally landless laborers and poor peasants, but that the latter's possession of land effectively prevented a correspondence of interests between the two.

Between the early 1950s and the mid-1960s, India's agrarian structure underwent certain changes. Despite a remarkable range of delaying tactics and a host of devices to retain more land than the law allowed, the largest semi-feudal landlords, who had been allies of the British in British India and the bulwark of the princes in princely India-experienced, via land reform, a blow from which they never quite recovered. From among them a small group emerged which was ripe for transformation into capitalist farmers. The medium-to smaller landlords, who were often resident and sometimes cultivating, received no such blow. Here was another, larger group within the landlord class which might take to capitalist farming if conditions were appropriate. But these tendencies within the landlord class were nowhere on a scale sufficient to suggest the possibility of widespread 'capitalism from above'.

[3] Daniel Thorner and Alice Thorner, 'Employer-Labourer Relationships in Agriculture', in Daniel Thorner and Alice Thorner eds., *Land and Labour in India* (Asia Publishing House, 1962), pp. 22-26

There was a quickening of differentiation among the peasantry over these years. Agriculture grew at around three per cent per annum, there was some extension of the irrigated area, some limited development of the forces of production and some rise in commercialization. By far the greatest beneficiaries of these changes, and of land reform, were the rich peasants. They were stabilized as independent proprietors and were on the way to becoming, in many areas of India, the new dominant class in the emerging agrarian structure. Rich peasants were well on the way to becoming masters of the Indian countryside especially in northwest India, in Punjab, Haryana, and western U.P. Since these were the location of the largest concentration of marketed surpluses rich peasants had growing influence in the polity. They showed themselves to be eminently capable of exercising political power, not only in the village, but also at the level of district, state, and center. Middle peasants must have participated, to a degree, in any advancement, but poor peasants, landless laborers, and village artisans and craftsmen gained very little from land reform or from the other changes that were afoot. In 1950s there was a mass eviction of tenants, when fear of future land reform was strong, and efforts were made to secure as much land for personal cultivation as possible.[4] Of landless laborers the third plan document commented: 'in some areas their condition may have actually worsened'.[5] With such glaring differences in economic means and status it was not possible to have a singular policy of agricultural modernization.

Myron Weiner who studied the big landlords on the one hand and the small peasantry and the landless on the other concluded that neither group had any impact on policy formulation related to land-ceilings and cooperative farming. As for policy implementation, the landlords

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[4] Kalpana Bardhan, 'Rural Employment, Wages and Labour Markets in India: A Survey of Research-I. Size and Composition of Rural Working Force', *Economic and Political Weekly* 12, no.26 (25 June 1977)

[5] Government of India, Planning Commission, *Third Five Year Plan* (Delhi, 1961), p.375

were unorganized and powerful enough to defeat full implementation. The small peasants and the landless were not organized enough: they affected neither policy formulation nor policy implementation.[6] This lack of farmer's role in the making and implementation of agricultural policy can be explained in terms of lack of power. The Indian state and its policymakers thought that reforms would be successful in empowering the peasants. In spite of the good intentions the land reforms were not a sweeping success. Moreover land reforms can be a good starting point of the empowerment project but the farmers can only gain agency when initiatives come from them through a process of self-awareness. This is not an easy task to accomplish, not simply because 'the average Indian farmer is poor and backward' but it has been argued by rural sociologists that people who have been under the domination of local power elites or colonial regimes cannot be expected-when regimes change-to suddenly be willing and able to come to a negotiation table with their former despots.[7]

Apart from facilitating cooperation between international scientists, the American government sent Peace Corps volunteers to aid in disseminating the new technology in Indian villages. Officials at Washington D.C. apprehended that it would not be easy to make the farmers of a traditional society like India to change their farming practices and adopt the new technological package. American observers perceived India to have an age-old environment, where traditional village societies with an all-pervasive local culture controlled even farming practices. Westerners considered it a radical and daring act for traditional farmers in developing nations to embrace innovation, contrasting them to farmers in Iowa who could switch crops or

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[6] Myron Weiner, *Party Building in a New Nation: The Congress Party of India* (Chicago University Press, 1968)

[7] Ricardo Ramirez and Maria Fernandez, *Local Participation in policy: Perspectives from FAO experience* (LSP Working Paper No.42) http://www.fao.org/es/esw/lsp/cd/img/docs/LSPWP42.pdf

machinery without undue fear of reprisal from the keepers of their own culture. American Peace Corps volunteers in India went to villages varying in size from fifty to about three thousand people. In each village, a 'progressive' farmer offered the volunteer free housing and a piece of land on which to demonstrate hybrid varieties. Each volunteer worked with three to eight farmers, helping them plant new hybrid varieties. The Peace Corps did not want volunteers to wait for the local farmers to declare their interests in high-yielding varieties; instead, the 'best' volunteers were expected to venture forth and make their expertise available by contacting farmers still growing traditional varieties. The Peace Corps believed that initiating a successful relationship between the farmers and volunteers would be helpful in promoting adoption of the new practices and propagation of high-yielding varieties. Peace Corps volunteers were also instructed to work on creating a new mentality among traditional farmers who had the bad reputation of being averse to new things. Beyond their duty to teach farmers how to apply fertilizers, volunteers in villages were also supposed to instill in each farmer the confidence to 'demand from the bureaucracy the supplies and advice that are rightly his…' The Peace Corps program sought to create bottom-up pressure on Indian government agencies by generating a popular demand for the availability of more fertilizer across the country. Western program leaders hoped that this would force Indian policy-makers to embrace programs favoring agriculture centered on capital-intensive resources.[8]

The farming conditions in different parts of India were beset with many problems (as we have thoroughly discussed in the preceding chapters), the national and state governments and the foreign agencies undertook several projects with the hope of addressing the problems but little

[8] David Hapgood, Meridan Bennett, Peggy Anderson, *Rural Action: Towards Experiments in Food Production*. Peace Corps Faculty Paper No. 3, March 1969; Robert L. Gaudino, *The uncomfortable learning : some Americans in India* (Popular Prakashan, 1974)

effort was invested in enabling the farmers to 'own the process of resolving it'[9] Development cooperation has often ignored this fundamental notion of ownership by creating intermediating organizations rather than helping those who own problems to gain agency to resolve them. This is especially evident in the development and management of agricultural extension agency in India.

Fig 5.1 Picture perfect: a happy farmer, a progressive farmer, a risk-taking farmer

[9] P. Checkland and J. Scholes, *Soft systems methodology in action* (John Wiley & Sons, 1990)

The extension system has gone through several organization changes since its origin in the broad-based Community Development Program in the 1960s. But, it has maintained the norms of hierarchy, linear top-down transfer of knowledge (technology) from research, through extension to farmers. The Training and Visit (T&V) system is the best and most recent example in extension methodology, introduced as an institutional change by the Department of Agriculture in Indian states in the late 1970s. The T&V system rests on 'the assumption that an outside agency can accurately assess what is good for rural people and that the solution to rural underdevelopment and poverty is the provision of science-based technical knowledge.'[10] This institution with perfect hierarchy continues to constitute the functional basis of the 'technology-society interface'. The history of agricultural research reveals an implicit hierarchy in the generation of knowledge and technology, as well as the dissemination and utilization of this technology in the society.[11]

In the agricultural research system, scientist or research manager makes decisions for public welfare. This decision is informed by the economic rationale of cost-benefit analysis, legitimizes the public servant's (here the experts') capacity to make decisions about the direction and content of technological change in agriculture. Here, the service or mission of the agricultural research organization is clearly defined-it could be national food security, export competitiveness, or more specifically, land-saving technologies, etc. Indian farmers whose techniques were primitive; whose main concern was subsistence was rarely thought competent to play a role in national missions. They were encouraged to participate in nation-wide

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[10] Ulrich Nitsch, *From Diffusion of Innovations to mutual learning-the changing role of agricultural advisory services* (Swedish University of Agricultural Sciences, 1994)

[11] Rajeswari S. Raina, 'Institutions for Agricultural Research and Extension' in *International Journal of Technology Management & Sustainable Development* (Vol.2, Issue 3, 2003) pp.97-116

development activities but were not expected to be partners of scientists and policymakers in formulating ways and means of national progress.

Managers and experts have well-defined roles within the administrative monolith. This administrative rationalism is ‘the problem-solving discourse’ which emphasizes the role of the expert rather than the citizen or producer/consumer in social problem solving and which stresses social relationships of hierarchy rather than equality or competition.[12]

A key instrument deployed effectively in the decision-making mode of administrative rationalism is the complacency of the bureaucracy and expertise. There is concern and reassurance. The hierarchy of science and technology, flowing from State, down to policy-maker, scientist, extensionist, and further down to the ultimate adopter, is perfectly maintained. Scholars writing on agricultural extension, such as Rasheed Sulaiman have pointed out that the importance of client involvement in planning and management of extension has often been handled as tokenism.[13] The common strategy has been of inviting farmers to some meetings. In most regions and crops, the clients and their representatives are too weak to articulate their concerns. Extension has a primary responsibility of strengthening the clients’ hands by facilitating the formation of strong and articulate farmers’ organizations. In India, the problem had been two folds: the extension agencies have rarely played the role of organizing farmers as an effective pressure group. The Peace Corps volunteers who went to India to facilitate agricultural development made some effort in organizing farmers to pressurize the government agencies to be more pro-active towards distribution of bio-chemical inputs. Otherwise, it will not

[12] J.S. Dryzek, *The Politics of the Earth-Environmental Discourses* (Oxford University Press, 1997)

[13] Rasheed Sulaiman V., ‘Restructuring Agricultural Extension in India’ in Suresh Pal, Mruthyunjaya, P.K. Joshi and Raka Saxena ed., *Institutional Change in Indian Agriculture* (NCAP 2003)

be till 1970s that the farmers organize themselves to effectively demand political and economic leverage. Both Ashutosh Varshney and Akhil Gupta have studied that process in their respective first books. The second important issue is when the farmers had been organized even then the deep economic stratification within the farming community made the platforms more a vehicle for the rich land-owning peasantry. The small peasants and the landless who constituted the majority still did not have any effective say in policy-formulation.

In evaluating, how far the extension research findings have influenced the research priority setting or research problem identification, I have the following observations to make: The relevance of organized extension was acknowledged quite early after independence. The external aid for agricultural development emphasized the need for extension in the 1950s. But the reasons that have been identified behind this extension bias has nothing to do with bringing the farmers into a partnership with the scientists to determine what would be the best for the relevant farming communities. Extension services have rather developed on the misplaced confidence in the relevance of modern technology and based on the view that peasant farming is economically irrational and that ignorance made small farmers hold on to traditional methods. Both assumptions led to the conclusion that the first step in agricultural development should be to establish mechanisms to diffuse the inventory of modern technology directly to end users.

Why the agricultural extension service did not emerge as an effective conduit between the farmers and the scientists becomes clear through this study made on agriculture and social structure in Tamil Nadu.[14] The author portrayed how bureaucratic trappings have turned extension or in that matter any constructive communication with the cultivators a dysfunctional

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[14] Joan P. Mencher, *Agriculture and social structure in Tamil Nadu: Past origins, present transformations, and future prospects* (Carolina Academic Press, 1978)

process. During her field work the extension workers pointed out to her that they do 'whatever the government says and whatever my superior asks, we do.' This same mentality was evident even among the officers higher up the ladder; each followed directive from above without paying heed to the locales. In a graphic language the interviewee observed, 'Commissioners and others are pawns in the politicians' hands. Instead of bettering the work, they try to satisfy the Ministers by furnishing them with statistics, statistics of no base and truth.'[15]

The farmers remained remote from officials. It was not something that they chose but it was the outcome of the way that the extension officials functioned. Joan P. Mencher wrote in her study on Tamil Nadu that 'On the whole… most of the agricultural extension officers [AEO] would prefer to avoid actually going out and talking to farmers in the field. It is more convenient, as well as more prestigious, to sit in one's office and talk to the farmer's who come, or sit on the verandah of a well-to-do landowner sipping tea and talking.[16] Working with poor, illiterate, or semi-literate farmers requires a kind of dedication on the part of the AEO's which, Joan P. Mencher rarely found among extension officials.[17]

I agree with Mencher's observation that the main focus of the programs in Indian agriculture has been to reach production targets especially after the mid-1960s. The target of increasing production overtook all other social and economic considerations. The experts focused on understanding agricultural problems only in terms of technological backwardness and designed program not from the point of view of the people for whom the program was designated but from the successful achievement of targets, there was no self-correcting

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[15] Joan P. Mencher, *Agriculture and social structure in Tamil Nadu*, p.255

[16] Joan P. Mencher, *Agriculture and social structure in Tamil Nadu*, p.263

[17] Joan P. Mencher, *Agriculture and social structure in Tamil Nadu*, p.264

mechanism built into the system.[18] Moreover targets were never set-up locally or after taking local feed-back.[19] An extension worker pointed out to Mencher, 'You see, somehow our higher officers, every year, they go over and bring out a target without knowing the potentiality, but in the hope that something better will be done than last year.'[20]

In the early 1990s, in a round table with various scientists associated with the development of the green revolution technology, a researcher pointed out 'whatever solutions we come up with, the farmer will have to be at the center of it. There is no alternative and no choice.'[21] The scientist concerned insisted that all technology must be 'based on the farmer's requirement, his demands, and his ability to convert that technology into practice'. But all this appears to be mere rhetoric when the same scientist makes the following observation that 'we have found it necessary to focus on the farmer in the irrigated, productive areas because they are more rewarding. We have a result-oriented program and that has to continue.' Thus it is same privileged farmers of yesteryears that continued to get attention from the scientists. It is they who reap most of the benefits of market, price-support, credit system and advance technology whereas the more impoverished majority continuity to languish in face of bureaucratic and technocratic disdain.

Scholars have tried various explanations as to why apparently the research efforts are biased towards solving the problems of the richer farmers to the neglect of the poor. Class affiliations could be a strong possibility- the rich farmers and the researcher do come from the

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[18] Joan P. Mencher, *Agriculture and social structure in Tamil Nadu*, p.265

[19] Targets were set in the Directorate of Agriculture and passed down to the District Agricultural Officers.

[20] Joan P. Mencher, *Agriculture and social structure in Tamil Nadu*, p.264

[21] M.S. Swaminathan, Wheat Revolution, p.94

same class; 'they have an instinctive empathy'. There had also been what is called 'a demand pull for research solutions' -the customer knew what he wanted and articulated it. He had the where-withal to adopt newer solutions and both the ability and willingness to take risks. On the contrary, poor farmers were less articulate, solutions had a larger number of constraints to reckon with and researchers faced a greater risk of failure in their efforts. In a limited number of occasions where research was successful, adoption was chancy. [22]

Actors, who are involved in technology generation, are conceptually put into three distinct sets: the scientists, the managers of the technology generation system and the farmers. The last mentioned is not one but as we have discussed consist of many sub-sets. Each of them has a distinct point of view. Scientists generally look for peer recognition, have bias towards number oriented problems, like to tackle areas where there are greater chances of success and have been trained in a 'telling' rather than 'listening' culture. The last characteristics often made them impatient to criticism. We have seen in chapter four, the reluctance of scientists working with the green revolution technology to heed to any complaint against what they recommended. The managers were more often than not concerned principally about how to balance national and regional concerns. The farmers on the other hand had a unique risk perception not always known or understood by the research system. The risk perception varies with the sub-set; the poor being more vulnerable are not the most willing to experiment with new techniques or practices. Crop failure can hurt him like no other because he has meager purchasing capacity and his 'entitlement' to food is based on whatever little he produces in his field. Moreover and very important for people involved with generating new technology is that technology preference is

[22] N.C.B. Nath & L. Misra ed., *Transfer of Technology in Indian Agriculture: Experience of Agricultural Universities* (Indus 1992)

not same among farmers. Economic conditions of the farmers, agro-ecological constraints and potentials of the farming conditions all determine what set of technologies would be preferred over the other.

In a study conducted to ascertain the possible sources of ideas for research projects show that in institutions under the ICAR and in the agricultural universities only a third of the research problems owe their origin in farmer problems and field observations together. Nearly twenty percent of the research problems in ICAR controlled institutes originate from the intention to make journal publications. Individuals like project leaders also played important role in formulation of research agenda.[23]

Scholars have also argued that the scientists from IRRI and CRRI, who came work in Asian countries, though 'well qualified' according to the commonly accepted standards of academic research, had a deep understanding or appreciation of either the logic of indigenous practices of rice cultivation or the socio-economic contexts in which Asian cultivators operated.[24] The centralist research model followed by these international research institutes disregarded that valuable research and technological innovations can also originate under local initiative.[25]

Scholars who strongly argue in favor of putting the farmers first in the formulation of a research policy or in the establishment of an extension program do so citing instances from history on farmers' role as 'primary innovators and experimenters'. Over the previous hundred

[23] N.C.B. Nath & L. Misra ed., *Transfer of Technology in Indian Agriculture*, p.23

[24] Anderson ed., Science, *Politics, and the Agricultural Revolution in Asia*, p.7

[25] Anderson ed., Science, *Politics, and the Agricultural Revolution in Asia*, p.8

years, numerous ‘unknown’ farmers had been developing and propagating new techniques. This trend continued even with the professionalization of agricultural research following the creation of the Rothamsted Experimental Station in England in 1843 and of the Land Grant Colleges in the USA.[26]

This school of scholars, however, argue that the top-down ‘transfer of technology’ (from now TT) approach has come to replace bottom-up ‘farmers first’ (from now FF) approaches to development. They point out that there exist certain fundamental differences in the two approaches. For instance, TT always favor ‘simple, uniform, controlled’ farming conditions over ‘complex, diverse, risk-prone’ FF approach. The two approaches differ in their objective-the primary goal of TT is to ensure transfer of technology but the FF approach focuses on empowerment of farmers. When technology transfer is the prime motive then the type of technology used is strictly fixed but where the main concern is empower the farmer, the idea is to use what is suitable for the purpose. Gordon Conway has termed the latter approach as A la carte![27]

In case of India the profit that came out of using the green revolution technology definitely benefitted a section of farmers. It is a historical fact that the farmers’ movements of the 1970s successfully pressured the Indian government in favor of agricultural policies that were highly responsive to farmers’ needs. But, these farming groups had done very little to make the political or the techno-scientific establishment address the plight of the less-privileged farmers. Thus over the years of the green revolution the farming movement rarely demanded for crop

[26] Gordon Conway, *The doubly green revolution: food for all in the twenty-first century* (Penguin, 1997) Ch.10

[27] Gordon Conway, *The doubly green revolution*, Ch.10

varieties that farmers in the moisture-stressed region would find help; farmers' movement though keen to obtain subsidies on fertilizers showed utter apathy to develop cheap, locally available resources, which the more resource-challenged farmer might useful. Farmers' political groups had been by far more concerned about fiscal benefits than in ensuring a sustainable agricultural policy. It is fancy and easy to depict farmers as a group of people with uniformity of interests and pit them either in against or in support of the technocratic measures. But, in doing we tend to extrapolate the interests of the few over many and marginalize from the development discourse the concerns, contexts and challenge of living a life as a small farmer.

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