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Investment and Returns in Indian Agricultural Research: A Theoretical Investigation.

N Kiruthika*

Department of Agricultural Economics, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India.

Review Article

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*For Correspondence

Department of Agricultural Economics, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India.

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ABSTRACT

The nation is striving to find ways and means to keep its burgeoning population adequately fed. On the one hand it is facing the problem of declining productivity and on the other, challenges posed by liberalization. In such a scenario, leveraging the available natural resources and existing infrastructure is the only way to make the ends meet. Management of the already built infrastructure in harmony with natural systems is the clarion call of the day. Knowledge of the extent of existing infrastructure and natural resources is one of the most basic pre-requisites to utilize them effectively and in a sustainable manner. Through agricultural research and development welfare improvement has been realized. This paper highlights the research, confronts faced and the benefits that was taken place in Indian agriculture.

INTRODUCTION

The future of Indian agriculture will be one of knowledge and technology intensive and wider dissemination of the same can not be accomplished in isolation. Even though the share of agriculture in GDP has declined to one-fifth from one-half at the time of Independence, agriculture remains the predominant sector in terms of employment and livelihood provision for more than half of India's workforce engaged in it as the principal occupation [1]. Agriculture still contributes significantly to export earnings and supplies raw materials to many industries. To achieve a higher rate of agricultural growth in order to meet the demands of increasing population (expected to reach 1.63 billion by 2050), technological advancement will be very critical.

The advances in biotechnology and their integration with plant breeding will pave the way for achieving higher yield crops. In the significant advances India has made in agriculture during the past half-a-century, the role of agricultural input industry is very significant. The expansion in the use of seed, fertilizer, agrochemicals, irrigation and agricultural machinery industry has occurred parallel with the growth in productivity of rice, wheat, cotton, corn, sunflower, soybean, sugarcane and vegetables. While the public sector R&D, extension, and seed supply has made substantial contributions to food and non-food crops production, agri-business companies have been working with government to reach out to farmers in the supply of agricultural inputs used from sowing to harvest.

Agricultural science has always played a critical role in economic progress in both developed and developing economies. Through agricultural R&D, welfare improvement has been realized in the form of lower food prices to domestic population, improved nutrition, expansion in rural employment, agricultural exports and enhanced level of foreign exchange, competitiveness of agricultural commodities in the world markets and strong growth linkages with rest of the economy. During the green revolution period, adoption of new technologies has helped to improve the income distribution across income classes [2].

Royal Agricultural Society of England, founded during 1790s in UK, paved the way for growth of experimental farming. Almost 150 years have passed since US public-sector agricultural research and development (R&D) began in earnest with the establishment of the US Department of Agriculture. Subsequently, in US agriculture, Public and Private agricultural R&D played a major role in bringing about changes.

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India saw the beginning of scientific farming with the establishment of Department of Agriculture in each Indian province in 1880 under the British rule. Next step was to establish Imperial Agricultural Research Institute to foster agricultural research and education and decentralization of agricultural developmental activities to the Provincial Governments in response to Montague–Chelmsford Reform (1919). When the country got independence, in the efforts to develop country's agriculture, promotion of agricultural R&D was considered as the most important one. The agricultural review team chaired by Dr M.W. Parker of USDA (1963) suggested far-reaching changes in organization and management of agricultural research in the country.

The research centres across the country came under the one roof of Indian Council of Agricultural Research. Corresponding changes occurred at the state level with the transfer of research and education to State Agricultural Universities (SAUs). All these efforts culminated in the development of agriculture as a modern sector along with rest of the economy and agriculture emerged as key sector. This paper highlights the research, confronts faced and the benefits that was taken place in Indian agriculture.

Research in Indian Agriculture – Confronts and Achievements

Indian agriculture faces daunting challenges. The constraints of low productivity in agriculture were realized and thus, central and state governments emphasized the need for accelerated development of agriculture. Despite national food surpluses, wide spread poverty and hunger remain because the growth of agriculture and the national economy have not adequately benefited the poor, policy reform alone will not be enough to increase agricultural growth and to make it more equitable. The policy reforms must be accompanied by appropriate and efficient investments in public goods such as rural infrastructure, irrigation, agricultural research and extension, and the education and health of rural people. India has proven in the past that agricultural growth can be success fully achieved with the right public investments, even when economy wide policies were unfavorable towards agriculture. Thus, India's promise of the future lies in combining policy reform with the right levels and kinds of public investments.

Technological change has been the main engine of agricultural growth in India. Strong empirical evidence provides support that high levels of R&D lead to high productivity and therefore improved economic performance. R&D was found to translate into significant rates of return in primary and service sectors, registering as high as 60 per cent [3]. The Total Factor Productivity (TFP) growth, which was the main driving force for the overall growth of agricultural output during 1980s in India, has started slowing down in recent years. Various authors have estimated growth in TFP of agriculture in India [4,5,6]. The growth rates range from 0.9 to 4.0. In few cases, there are negative growths also. The slowdown in TFP is a reflection of poor contribution by agricultural research and almost a near non-performance by public extension system.

Indian policymakers have created one of the largest agricultural R&D systems in the world. The knowledge and technologies generated by investment in R&D was primarily responsible for the green revolution and achieving food security for the huge population. Despite success of green revolution, India still houses one-fourth of the world's hungry and poor and 40 per cent of the world's malnourished children and women [7]. The NSSO-2005 survey revealed that 40 per cent of the farmers would relinquish farming if provided alternate options. This is mainly because the economic viability of farming is threatened.

Public Sector Research in Indian Agriculture

Indian NARS has a huge scientific workforce of 21869 scientists [8] and ranks fourth in the world in terms of total investments in public R&D, following USA, Japan and China [9]. The positive impact of research can be seen from the decline in the real prices of food grains since green revolution. Many studies have established the high rates of return to agricultural research investment in India [10, 11].

An examination of facts and figures clearly establishes that agricultural research during the second half the 20th century has been remarkably successful. The success of any organization depends largely on the commitment of people who work for the organization. A lion's share of the funds go to salary and allowances of regular employees (about 75% of financial support provided by the state government) and, of the remaining 15 per cent, large part of it is used for meeting the operating costs. Only 10 per cent of the total budgetary provision is available for infrastructure which is hardly sufficient to meet the upkeep of the existing infrastructure. Obviously, modernization of research infrastructure is not moving forward at a pace, it is expected to move. The SAUs receive 60 to 70 per cent of the budget from the respective state governments; it covers three fourths of the salary of staff and the remaining part is met from ICAR and other sources. Though about 20 per cent of the funding comes from ICAR, almost 70 per cent is allocated under All India Coordinated Research Projects. The state government allocates 10-15 million annually under Part II Plan schemes exclusively meant for funding research projects of immediate importance or for creating specific infrastructure. This provision can also be reduced unexpectedly (in a financial year) by either the State Planning Commission whose approval is necessary for budgetary allocation or by Agricultural Secretary to accommodate other purposes within the agricultural ministry. Even-though the annual

growth rate of research expenditure is estimated to be 7 per cent, the annual salary increments, increases in dearness allowance and rise in the cost of operating costs just compensate the enhanced budget. But, the growth in allocation to research in real terms is much smaller [12].

Private Sector Research in Indian Agriculture

The private sector in India has also made large investments in research and development relevant to agriculture. This investment has increased rap idly over time. The amount of agricultural research and development in the private sector is now approximately half the amount in the public sector [4].

The national agricultural R&D system has undergone a structural transformation with the enlarged role of private sector during the past two decades. One of the significant developments is the entry of MNCs making a sizeable investment in research on seed, agrochemicals and agricultural machinery.

The private sector investment in agricultural R&D has been accompanied by consolidation of chemical, seed and biotechnology companies. With the decontrol of regulations, the private research expenditure increased by 70 per cent between 1985 and 1995 [13] in India and the momentum is continuing. In the year 1991, private sector investment on research was only of 231.7 million and by 2009, the investment got multiplied by almost 14 times. The companies which have made investment in agricultural research fall in the categories of seeds, fertilizers, agrochemicals, agricultural machinery and sugar. While machinery, seeds, and agrochemicals categories have shown an increasing trend in R&D investment, fertilizer and sugar companies have not raised the level of research investment over the years.

The liberalization of Indian economy since early 1990s has opened up opportunities for MNCs dealing with agro-inputs, seeds and agricultural machinery to expand their activities in India and many of them have launched joint ventures. Thus, the private sector agricultural research has achieved a credible performance contributing to increase in TFP in Indian agriculture. R&D on fertilizers can be categorized as one relating to fertilizer production and the other relating to consumption.

On the production side, research comprises fertilizer production processes, product development, and market research and supply chain and is carried out by both public sector and private sector R&D units of the respective fertilizer manufacturing companies. Besides 9 large public sector fertilizer companies, 15 private sector fertilizer companies have established strong in-house R&D centres. Over the years, to ensure that it is well prepared to meet the challenges of fast-changing world and remain the market leader in the industry, the fertilizer R&D centres are involved in the in-depth surveys to understand the market demand and plan their production. These centres are spearheaded by highly qualified and experienced scientists; engineers and technologists.

Now the emphasis of private sector R&D units of fertilizer companies is on creativity and ingenuity to develop products most suitable for the end-users. They are also seeking the recognition by the Department of Scientific and Industrial Research, Govt. of India and look for obtaining patents and allow the researchers to publish scientific papers. R&D in micro irrigation is getting priority in investment. Private companies having known the huge market ahead for micro irrigation are investing sizeable quantum of funds on R&D in micro irrigation.

Returns and outcomes to the Research in Indian Agriculture

The growth of TFP in Indian crop agriculture is associated predominantly with improved technology. With the advent of the Green Revolution, access to high yielding varieties and the associated public research system became the major sources for growth in TFP. The ease with which farmers could identify superior varieties reduced the role of extension.

Private sector research and modern inputs were important during this period. The returns estimated for public agricultural research are high and consistent with evidence from other studies. The returns to investment in public sector agricultural research and extension programs are high far higher than the average returns from public sector investment in India. Several types of investments are associated with and contribute to TFP growth. Public agricultural research explains nearly 30 per cent of TFP growth between 1956 and 1987 and almost half of it since the Green Revolution [4].

Expansion in the private sector R&D has been motivated primarily by advances in biotechnology-strengthened IPRs, globalization of markets, and new opportunities to collaborate with public sector institutions. Recent years have witnessed a different story with more farmers using hybrid seeds of cotton, maize, millets, sunflower and vegetables with rice hybrid slowly picking up. The private sector strengthens their activities by sourcing breeder seed from ICAR and SAUs.

The performance of private sector in seed production business has become superior as the private firms have been commercializing and marketing new varieties more efficiently through their networks than the public sector does. Fertilizer products are largely the outcome of R&D efforts of the private sector, particularly the MNCs. The consumption of chemical fertilizers has doubled in a period of fifteen years. The industry is developing fast in terms of using the latest world class technology in manufacturing processes to prepare innovative new products. For significant yield losses in food grains due to pests and non-essential herbs, agrochemicals application has proved to be an effective solution. The dynamics of product development in agro-chemicals show that newer and newer products are being introduced in the market due to technological advancements and competition.

Leading national and multinational companies apart, a number of small sized companies are involved in production and sale of agro-inputs. For the production of inputs such as bio-pesticides, bio-manures, bio-fertilizers, small machinery and implements, the small companies source the technologies developed at the public research institutions. The continuous quest for higher productivity in the global agricultural markets has a direct effect on the demand for engine powered products. Private R&D develops current generation equipment providing farmers with all levels of power and higher efficiencies. The new models of machinery are expected to be more productive. Now, a number of databases are available and used for forecasting the models. Currently, there are about 19 tractor manufacturers in India (Agricultural Research Data Book, 2009).

Economic surplus approach was used to project the welfare benefits of adopting *Bt* eggplant in India, Bangladesh, and the Philippines [14]. The welfare benefits were estimated at $411 million, $37 million, and $28 million for India, Bangladesh and the Philippines, respectively. The distribution of the benefits for consumers and producers was about 57% and 43% of the total surplus respectively.

Krishna and Qaim [15] examined the potential impacts of Bt eggplant on economic surplus and farmers' health in India. They used the economic surplus model to project the welfare and distribution effects among eggplant farmers, consumers and the innovating company. Additionally to the economic surplus effects, the authors also estimated the potential impact of Bt eggplant technology on farmers' health through reduced insecticide exposure. The authors employed econometric model to estimate the impact of insecticide sprays on pesticide poisonings. Simulations showed that the aggregate economic surplus gains of Bt hybrids could be around US $108 million year. The study found that consumers will capture a larger share of the gains, but farmers and the innovating company benefit too.

Kumar et al. [16] examined the potential economic benefits of Bt brinjal hybrids in India in terms of yield gain, reduction in insecticide use and increase in net returns per hectare. The potential economic benefits of Bt brinjal and its distribution between producers and consumers have been estimated using the economic surplus method. The estimated showed that adoption of Bt brinjal could raise consumer surplus by Rs 381 crore and producer surplus by Rs 196 crore annually with adoption rate of 15 percent. The gains in economic surplus have been distributed between consumer and producer in the ratio of 66:34.

Advancing Agricultural Innovation through Public-Private Partnerships

Public–Private Partnerships (PPPs) in agricultural R&D are being increasingly viewed as an effective means of conducting advanced research, developing new technologies, and deploying new products for the benefit of small-scale, resource-poor farmers. PPP is any research collaboration between public and private sector entities in which partners jointly plan and execute activities with a view to accomplishing agreed upon objectives while sharing the costs, risks, and benefits incurred in the process. Public investment in productivity-enhancing agricultural R&D has been declining in most of the world outside China.

Private investments and capability, on the other hand, continue to grow. These trends open up the need and opportunities for R&D partnerships that pool assets to farmers' benefit. While the public sector provides strength in crop improvement, private organizations contribute expertise in plant sciences, genomics, bioinformatics, and the marketing and delivery of products and services. PPP in agricultural R&D is increasingly emerging as an effective means of conducting research in frontline areas of science and technology, commercializing new technologies, and deploying new products for the benefit of small-scale farmers, food-insecure consumers and other marginalized groups [17]. The partnerships offer a means of tapping the strengths of various partners and channelling knowledge and resources into areas where they can address complex development problems. The private sector plays a particularly critical role in spurring agricultural R&D, especially when combined with public sector initiatives within mature markets with strong intellectual property rights (IPR) to protect returns on investment. This synergetic effect enables returns on investment by taking advantage of the private sector's technical expertise, and the public sector's knowledge of local needs and networks [18].

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CONCLUSION

The future of Indian agriculture will be one of knowledge and technology intensive and wider dissemination of the same can not be accomplished in isolation. All categories of players, viz. public and private, and large and small must be involved in promoting the technologies. The agro-input industry has to closely work with government to realize the objectives. Policy environment must ensure a continuous encouragement to the private sector for attracting more investment. Mechanisms can be evolved for accreditation of private R&D, MOU for forging functional relationships and protocols for transferring/sharing technologies, materials and unique facilities. There is ample scope for intensifying human resource development through initiation of fellowships and professorial chairs by the private sector in focused areas of research. Private sector has a good amount of expertise which can be used in agricultural management process within NARS.

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