2014 International Conference on Intelligent Agriculture
IPCBEE vol.63 (2014) © (2014) IACSIT Press, Singapore
DOI: 10.7763/IPCBEE. 2014. V63. 11

Innovations in Food Business: The Agribusiness and Entrepreneurship Perspective

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Abstract. The research organizations like State Agricultural Universities (SAUs) and ICAR institutes have always proved with their rigorous efforts that the food processing sector is the sunshine sector in Indian Economy. The processing of food finds its roots back in the Stone Age when the man learnt to make fire and started using it for cooking. The food processing sector in India now covers around one-third (32%) of the total food industry. With a very wide product line, India stands as one of the largest producers in fruits and vegetables, milk, livestock, fish, food grain, etc. Foreign Direct Investment (FDI) is also very lucrative in the country as 100% FDI is allowed under automatic route in food processing industry; thus making India a huge potential market for public-private partnership in food processing. The amount of FDI inflow for Food Processing Sector in India covers more than 10% of the total FDI (US$ 1128.4 million). The Ministry of Food Processing Industries (MFPI) has prepared Vision 2015 document which predicts that the size of the processed food sector is going to rise three times which can be achieved by increasing the level of processing of perishables from 6% to 20%, value addition from 20% to 35% and share in global food trade from 1.5% to 3% by 2015. This paper attempts to understand the crucial issues in the Indian food processing sector, the requirement of Public Private Partnership (PPP) projects in the sector, the initiatives taken by the government and their impacts, the major drives towards innovation in Food Processing and their outcomes.

Keywords: Food Processing Sector, Agricultural Production, Innovations in Indian Agriculture

1. Introduction

In developing countries like India, the base for agricultural growth is due to its agricultural research and innovation. This paper focuses majorily on research and innovation through the involvement of private hands along with the public sector organizations into the agribusiness by way of making big investments which are extremely important to farmers and also throws light on the Indian policies that influence research and innovation.

Both domestically and globally, the rising demand for agricultural products is leading to rising prices to the heights which were never recorded before. Concurrently the resources to fulfill these demands are either growing at slower rates or at some places, even declining. Equally worrisome, productivity growth of major food crops is leveling off (Singh and Pal 2010). All these trends generate demand for innovations to increase productivity. Indian public-sector research, international agricultural research centers, and foreign public and private research provide a flow of new technology. Increasingly, private agribusinesses in India have been playing an important role—accessing and introducing available technology, and advancing what is available with further research.

Since mid-1990s, Indian industrial and agricultural policies have changed dramatically, and the private sector has led the way for rapid economic growth in the Indian economy as a whole over the past decade. The major objectives of this paper include: (1) quantification of agribusiness innovation and research in India and (2) providing information on the economic, environmental, and poverty-reduction impacts of agribusiness innovation.

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2. Changes in Indian Agriculture

Innovations in agricultural technology and educating the farmers have greatly contributed to increases in agricultural productivity in India, with agricultural production rising at an annual rate of around 2.68 percent a year from 1961 to 2007 (Fig. 1). During the 1980s, growth rose to 3.49 percent but then sank to the long-run average of 2.69 percent for the latest period, 2000–2007. For the entire period of nearly 50 years, increased inputs (land, fertilizer, labor, machinery) accounted for 53 percent of increased output, with total factor productivity (TFP) contributing the rest. Input growth accounted for all growth in the 1960s and for 70 percent of growth in the early Green Revolution period (the 1970s). In recent years, the contribution of TFP has also increased. In the period 2000–2007, TFP growth accounted for 74 percent of output growth in agriculture while increased use of inputs accounted for only 26 percent (data reported in Fuglie 2010).

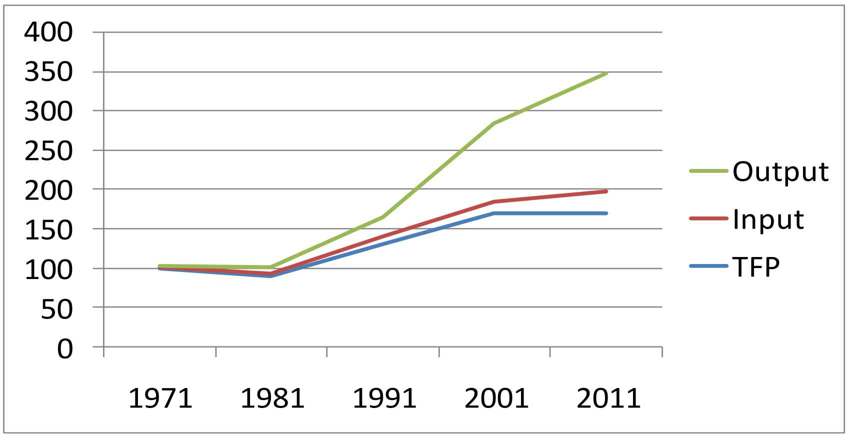

Fig. 1. - Agricultural index for India, 1961–2007 (1961 = 100)

In the last two decades—that is, since 1991—milk production has almost doubled, and egg production has increased by 150 percent (see Table 1). Within the crop sector, fruit and vegetable production has increased more rapidly than that of food grains (Singh and Pal 2010). Increases in per capita income shifted consumption from basic food grains to higher-quality and higher-value foods, such as animal protein, fruits, and vegetables. Increasing income has also led to increased demand for environmental services such as clean air and water and reduced greenhouse gas emissions, leading in turn to demands for organic food and biofuels.

Table 1: Production shares and amounts by category and selected crop yields

Table 1—	**TE 1981**	**TE 1991**	**TE 2008**
Indicator **Share in the total value of production (%)**			
Crop	75.5	70.6	67.1
Livestock	17.5	22.0	24.5
Forestry	5.2	4.7	3.6
Fishery	1.7	2.7	4.8
Agricultural production			
Food grains production (mt)	124.20	172.45	230.67
Milk production (mt)	31.60	51.23	100.87
Fish production (mt)	2.44	3.55	6.87
Egg production (billion, number)	10.06	20.10	50.66
Crop yields (tons/ha)			
Rice	1.25	1.72	2.20
Wheat	1.71	2.33	2.79
Coarse cereals	0.69	0.88	1.42
Pulses	0.46	0.58	0.64
Cotton	0.16	0.23	0.47
Groundnut	0.84	0.88	1.46

Sources: Extracted from Singh and Pal 2010; Ministry of Agriculture for the year 2008. (2011)Notes: TE indicates triennium ending; mt indicates million tons.

Farmers have also increased their use of modern inputs (see Table 2). From 1991 to 2006, fertilizer use almost doubled, use of tractors and quality seed tripled, and irrigation from tube wells has expanded substantially (the share of tube wells in irrigated area increased by 5 percent, while total irrigated area increased by 26 percent, from 66 to 83 million hectares).

Table 2. Input use in Indian agriculture, 1971–2006

Input	**1971**	**1981**	**1991**	**2001**	**2006**
Fertilizer use (kg/ha)	16.5	34.24	69.84	91.13	113.26
Number of tractors (’000)	148.2	275.9	738.4	1,221.8	2,361.2
Share of tube wells in irrigated area (%)	16.63	26.2	38.42	40.84	43.86
Quality seed distribution (’000 tons)	NA	450	575	918	1,550
Institutional credit (rupees/ha)	53.58	232.42	631.39	3,261.40	10,544.45

3. Innovations in Indian Agriculture

Agribusiness companies want to use innovation to capture or protect market shares by offering new products that buyers want (product innovations) and also by cutting costs (process innovations). In agriculture as in other economic sectors, advanced countries take advantage of technology developed in other countries, using a variety of procedures—such as licensing, buying, or simply copying—to access what others develop. When suitable technology is not readily available and identifiable, or when companies see an opportunity to improve what is available, they will invest in research to identify or develop product and process innovations.

Both for national agricultural growth and for agribusiness success, innovations and their spread are the goals. R&D is one of the costs of innovation. This section considers the rate of innovation in Indian agriculture as well as the sources of innovation. Section 3 considers private agribusiness expenditures and staff for in-country R&D.

Quantitative information on innovation is limited. To measure innovation, we used three primary sources: (1) registration of new technology, which Indian technology regulators require for many industries; (2) data on intellectual property rights, that is, patents and plant variety protection certificates; (3) supplementary data that we collected through interviews with leaders of about 100 private agribusinesses and from press articles.

Almost all new active ingredients were developed outside India, but at the beginning of 2011, Dow Agro Sciences and GVK Biosciences announced the development of new molecules to be used for fungicides and insecticides. Innovations by local pesticide companies have largely been new, low-cost ways of producing generic pesticides and new formulations of pesticides. In addition, a number of firms have developed biopesticides.

The agricultural processing and plantation sectors have introduced innovations for farmers and for consumers. The plantation crop sector has introduced new clones of tea and coffee, and new management practices. The sugar industry has new management practices and some new sugarcane varieties, and has started to produce electricity and biofuels. The biofuel industry has developed innovations such as new crops (tropical sugar beets, for example) and improved biofuels machinery, but with very limited adoption in India.

India also has become a global R&D center for food and beverages for many multinational corporations (MNCs), considering the size of the market in south Asia. Innovations from Indian R&D labs are mainly in the form of value-added products and supply chain management techniques.

3.1 Quantitative Data on Trends in Innovation

One measure of innovation in the seed industry is the number of cultivars the Department of Agriculture notified or recognized as new cultivars during various periods. This is an incomplete measure of innovation because notification is not required except for cultivars from public breeding. Government allows private companies to introduce cultivars without notification, which companies have preferred, and so only few private cultivars have been notified. Even with this partial measure, the rate of innovation holds steady from the 1980s to the 1990s but then grows rapidly after 1999 (Table 3).

Table 3—Trends in notified varieties of major field crops

Crop	**Number of notified varieties and hybrids by decade**		
	1980–1989	**1990–1999**	**2000–2010**
Rice	198	188	303
Wheat	84	66	112
Maize	43	64	113
Pearl millet	38	45	51
Sorghum	55	49	55
Cotton	72	78	95
Total	490	490	729

Source: MoA, 2011.

Notes: * Truthfully labelled varieties collected from individual firms' websites and survey (34 firms).

Another important area of innovation that can be quantified is the number of biotech genes (also known as events) and transgenic cotton hybrids. Transgenic cotton hybrids and new genes must be registered with the biosafety authority, and the rapid growth in numbers of hybrids and genes registered. The first transgenic hybrids of cotton containing the Bt[1] gene were approved in 2002. The number of transgenic hybrids containing the Bt gene increased exponentially after 2005. The private sector has developed nearly all of these hybrids. In 2002 the first Bt gene was approved for commercialization and marketed through the joint venture Mahyco-Monsanto Biotech (MMB). In 2006, new Bt genes began appearing. In May 2006, Monsanto and Mahyco produced hybrids with stacked Bt genes, Bollgard-II (BG II). In the same year, two domestic seed companies, JK Agri Genetics and Nath Seeds, had new Bt genes approved for commercialization. The JK Bt was based on an Indian public-sector Bt gene, and the Nath Bt was licensed from a Chinese firm. In 2008 and 2009, two new Bt events were approved. The first was developed by Metahelix and the second by the University of Agricultural Sciences Dharwad (UAS Dharwad)

[1] *Bt stands for Bacillus thuringiensis, a bacterium that is the source of the gene that makes this cotton poisonous to certain insects but not to other insects or mammals.*

3.2 Sources of Innovation

The innovations discussed above have come from government research programs, Indian firms' research, and foreign research. Public-sector research programs continue to make important contributions to the development of new varieties of self-pollinated crops like rice, wheat, many pulses, and oilseeds; improved dairy breeds and veterinary vaccines; and innovations in crop, pest, and resource management.

In the past, Indian firms licensed or copied agricultural innovations based on foreign technology, or foreign MNCs transferred technologies to their subsidiaries in the agricultural chemicals, tractors, and vegetable seeds industries. For example, in February 2006 UPL bought Advanta, a Netherlands-based multinational seed company, and moved its headquarters from Europe to India.

Indian firms and subsidiaries of MNCs based in India are now becoming important innovators in other countries by exporting technology developed in India. Hybrid rice cultivars are being exported to Bangladesh and Southeast Asia. Indian small tractors are being exported to the United States, Africa, and elsewhere. Generic pesticides are exported around the world. Indian biopesticides based on neem are being exported to Europe, the United States, and Asia.

Table 4—No. of field crop varieties by public & private-sector institutions in India, 2005–2010

Crops	**Truthfully labelled private hybrids**	**Notified public varieties**
	2005–2010	**2005–2010**
Rice	79a	240b
Wheat	40	95
Maize	136	87
Pearl millet	97	48
Sorghum	75	46
Cotton	255	70
Total	603	346

Sources: MoA ,2010; truthfully labelled varieties collected from individual firms' websites and survey (34 firms).

Notes: a Includes only actual hybrids released by the private sector (not open-pollinated varieties).
b Includes open-pollinated varieties (mostly), 48 of which are hybrids.

3.3 Trends in Aggregate R&D

Private agricultural R&D expenditure in India has increased from US$54 million3 in 1994/95 to $251 million in 2008/09 (Table 5). In the 1990s, private research made up about 17 percent of the total agricultural R&D in India. This has risen to a current 27–31 percent. Table 5 compares private- and public-sector research expenditure, indicating that although private research has increased more rapidly, public research expenditure still outstrips private.

Table 5—Public & private agricultural R&D investments in India, in millions (USD) of 2005

Sector shares	**1994/95**	**2008/09**[c]
Private R&D investment[a]	54	251.3
Public R&D investment[b]	271.8	563.2–688.3
Private + public R&D investment	325.8	814.5–939.6
Private share (%)	16.6	30.9–26.7
Public share (%)	83.4	69.1–73.3

Sources: [a] Private R&D from Pray and Basant 2001; Pray and Nagarajan 2011.

[b] Public investment estimate based on Beintema et al. 2008.

Notes: [c] The public-sector investment figures for 2008/09 are projected from ASTI's (2011)) last survey estimates of Indian public research in millions of 2005 US dollars. ASTI calculated 6.4 percent growth in public-sector investment between 1981 and 2003, and 2.9 percent growth between 2000 and 2003. To calculate the first numbers in column 3, we used the 2000–2003 period growth rates of 2.9 percent for public agricultural investment and projected for 2008/09 to compute the share of public-sector R&D investment in total R&D investment. To calculate the second numbers in column 3 we used the 1981–2003 period growth rate of 6.4 percent for public agricultural investment and projected for 2008/09 to compute the share of the public sector in total investment.

3.4 Food, Beverage, Tobacco, and Plantations, and the Biofuel Industries

Over the last two decades, R&D in the food industry has grown from about $14 million to $27 million. Biofuel has grown from zero in 2000 to $13 million in 2008. Sugar industry R&D has grown slowly with the exception of Shree Renuka, whose R&D accounts for most of the growth in sugar R&D between the mid-1990s and the present. Current levels and growth in agricultural processing R&D may be underestimated because some of the largest food companies, such as Ruchi Soya Industries, do not publish R&D expenditures in annual reports.

Agricultural processing industries conduct research to develop agricultural technologies and new food products, and to increase processing efficiency. Processing firms may also conduct agricultural research to improve crop quality or reduce production costs if they control land and produce crops, as tea and coffee companies do, or hold a monopsony position, as ITC does in tobacco and eucalyptus.

In India, ITC controls about 90 percent of cigarette sales, buys most cigarette tobacco, and maintains a major research program to develop tobacco varieties and management practices that reduce production costs for contract farmers and increase leaf quality. In addition, ITC is also the largest producer of paper and pulp in India and has a large research program to improve the productivity of eucalyptus production. Finally, ITC is an important part of the food industry and does product and process research for that component of the corporation.

Major companies that own tea and coffee plantations are Tata Tea, Hindustan Unilever (HUL), and Goodricke Tea. All are conducting research to produce better clones and crop management practices, and investing in developing new consumer products such as nutritionally enhanced tea (HUL), flavored teas (Tata), and instant teas that dissolve in cold water (Goodricke).

4. The Future: Lessons, Changing Agribusiness & Policy Implications

Lessons

The study shows that agricultural innovations in India have dramatically increased since the 1980s. Quantitative data show that between the 1990s and first decade of this century, the number of new seed cultivars registered in maize, wheat, and rice grew by at least 60 percent and probably doubled if private hybrids that were not registered are taken into account. Qualitative evidence suggests similar growth in innovations in the agricultural machinery, food processing, veterinary medicine, and agricultural processing industries. Indian agribusiness laboratories and experiment stations account for much of this growth although the public sector still dominates innovation in plant varieties of important crops such as rice and wheat.

Growth in private R&D was particularly dramatic in the seed and plant biotech industry, which grew more than tenfold between the mid-1990s and 2009. There was also very rapid growth in agricultural machinery, processing technologies, animal health, sugar, and biofuel. Pesticides; food, beverages, and plantations; and animal breeding and feed grew less rapidly—only doubling their real R&D. Multinational corporations made important contributions to the expansion of research in India in the seed, biotech, pesticide, agricultural machinery, and processing industries. Private innovation and research has also helped pull people out of poverty by providing more rural employment and increasing production of small farmers in some of the poorest regions of India. This dramatic growth in private-sector R&D and innovation appears to have five major causes:

1. **Market demand.** First, a major increase in demand for agricultural goods in India and around the globe has been reflected in higher prices for agricultural products and the modern agricultural inputs that agribusiness provides.
2. **Policy liberalization.** The second factor in increased private research and innovation is liberalization of policies governing investment in agriculture and agribusiness by large Indian corporations, business houses, and foreign firms. Liberalization of import and export policies governing agricultural inputs and products also contributed to growth of innovation and R&D. Liberalization began gradually in the late 1980s and accelerated in the 1990s.
3. **Advances in basic science and engineering.** The third factor that was particularly important for industries in which R&D growth was faster than sales growth (seed, biotech, and veterinary medicine) is advances in the basic sciences and engineering that form the basis for private technology development.
4. **Intellectual property rights.** The strengthening of intellectual property rights (IPRs) is probably not as important as the first three causes of growth, but it has provided greater incentives for innovation and encouraged growth of research in biotech and veterinary medicine.
5. **Government investment in research and education.** Finally, the Indian government's investment in agricultural research and higher education, along with research conducted within international agricultural research centers, provided the foundation for many developments and achievements in private R&D.

5. Conclusion

If central and state governments in India wish to encourage more research investment, it can consider the points discussed here. Firstly, both central and state governments need to have clear, less time-consuming, and relatively inexpensive regulatory approval paths for new technologies such as fertilizers, biotech plants, and crop protection chemicals. Secondly, the number of state agricultural universities (SAUs) and the students they produce have increased; however, the number of scientists at SAUs has declined, along with research funding per scientist (Jha and Kumar 2006; Singh 2000). Drastic reforms and more resources are needed in graduate education and research at SAUs to train the young scientists that private firms are asking for. Thirdly, Patent laws and plant variety protection now in operation must be enforced by the courts and state governments. Fourthly, subsidies and special export zones to develop agricultural products and inputs to compete in export markets may also be an effective use of public funds and lastly, the government agencies should consider incentives for firms to develop technologies that improve health and the rural environment.

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