Indian Biotech Agriculture Industry: Vision 2025
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Introduction

India is currently facing one of its most formidable economic challenges—addressing the widening demand-supply gap in food grain production. We need to act now, to avert higher inflation, rising food imports and current account deficit, and inadequate food security.

India has the highest number of hungry people in the world1. With a growing population and scarcer resources, India needs to produce more with less. Biotechnology agriculture (bio agriculture) through its wide offering landscape can provide the answers—helping improve the effectiveness of agriculture inputs, bring down input costs and increase output.

But there are many challenges before the bio agriculture industry. What is the overall potential of the industry? How can various stakeholders address the challenges of expanding the market? What kind of growth enablers are needed to realize the sector’s potential?

To answer these questions, the Confederation of Indian Industry (CII) and Accenture embarked on a journey to define the industry’s vision for 2025 and recommend the measures various stakeholders must take to realize this vision. We believe that the bio agriculture industry has the potential to scale to US$34–37 billion by 2025 if certain growth enablers are put in place.

We hope this report will trigger constructive debate and action among all stakeholders.


"Transformation of agriculture must be the top priority concern of our public policies, including science and technology policies."

—Dr. Manmohan Singh
The persistent demand-supply imbalance in India’s agriculture calls for immediate action. India needs to increase the land under cultivation to feed the rapidly growing population, improve agricultural productivity and cater to the changing food consumption pattern. Food grain production in India has failed to keep pace with the population growth. The per capita food output has been declining since the middle of the 1990s, reflecting a fall in productivity and yield. Additionally, with higher disposable incomes and changing lifestyles, Indians are spending a bigger chunk of their consumption budget on premium foods, indicating a structural shift in the dietary pattern in favor of items such as fruits, vegetables, milk, meat, eggs and fish. To cater to this increasing demand, special attention is required to increase production of nutrition-rich crops such as pulses, fruits and vegetables that were overlooked by the first Green Revolution.

On the supply side, farmland is getting scarcer. The area under cultivation has largely remained constant since 1980 and even the average farm size has decreased. Acreage has remained at 140 million hectares for 40 years, even as the number of farmers has doubled from 70 million to 140 million. The per capita availability of land has fallen from 0.91 hectare in 1951 to about 0.32 hectare in 2001, and is likely to decline further to 0.09 hectare by 2050. This decline is due to urbanization and the rise of industrial belts, growth of biofuel crops, soil erosion due to intensive and poor farming practices, and climate change.

India’s declining self-sufficiency in certain foods such as pulses and oilseeds has added to the problem. From being largely self-sufficient in oilseeds in 1993–94, the country is now the world’s second-largest importer of edible oil, spending more than US$13 billion in 2012–13. The rising consumption and stagnant yield have made India the world’s largest importer of pulses, an average Indian’s main source of nutrition. The Green Revolution of the 1960s and 1970s did not cover dryland crops such as pulses. As a result, while the food grain yield in India increased by about 400 percent between 1950–51 and 2011–12, the pulses yield rose by only 55 percent.

Accenture research estimates that food grain output will lag behind demand until 2021. This gives rise to two challenges: inadequate food security and increase in current account deficit due to lower exports and higher imports. Based on the current agricultural productivity statistics, the food grain surplus may disappear by 2020 (see figure 1). Even a small change in climate conditions or less-than-normal rain can cause a precarious food supply situation—posing threats such as runaway inflation and record imports.

The most effective solution to food insecurity is to explore the market opportunities provided by biotechnology.

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**Figure 1: Food Grains—Demand Versus Production**

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<thead>
<tr>
<th>Year</th>
<th>Annual demand</th>
<th>Annual production</th>
</tr>
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<tbody>
<tr>
<td>2004–05</td>
<td>207</td>
<td>198</td>
</tr>
<tr>
<td>2011–12</td>
<td>235</td>
<td>259</td>
</tr>
<tr>
<td>2020–21</td>
<td>281</td>
<td>281</td>
</tr>
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Figures in million ton

Sources: National Centre for Agricultural Economics and Policy Research (NCAP) policy brief, Indian Council of Agricultural Research (ICAR), January 2009; Accenture estimates; export data taken from www.apeda.gov.in
India’s bio agriculture sector is currently estimated at US$7.8 billion (including crops produced through the genetically modified (GM) technology). Biotechnology offers multiple innovative techniques to develop high-yielding crops that can counter the biotic and abiotic stress associated with Indian agriculture. Regrettably, the debate on biotechnology often gets limited to GM crops, whereas the reality is different—we need to look at the complete array of solutions provided by biotechnology and use it in a more comprehensive manner.

**High-yielding seeds**

Bio agriculture yields better results than traditional techniques while maintaining the stability and fertility of soil. High-yielding seeds significantly enhance the productivity potential and provide resistance from adverse environmental stress such as drought and salinity. They are particularly effective and relevant for a country like India that suffers from water scarcity and drought every year. High-yielding seeds also protect crops from diseases and insects. Figure 2 shows key bio agriculture technologies and their applications.
### Key Biotechnology Examples

<table>
<thead>
<tr>
<th>Key technologies</th>
<th>Brief description</th>
<th>Examples</th>
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</table>
| **Functional Genomics and Molecular Breeding**| - A technique based on gene injection from the same crop genome  
- An efficient way of introducing the desired characteristics (available within the crop genome) in the seed  
- Marker Assisted Selection (MAS) a key application used to develop hybrid crops in India through gene pyramiding and stacking | • Pusa Basmati 1  
• Samba Mahsuri  
• Swarna Sub 1                                                                                     |
| **Transgenic (GM)**                           | - Involves gene injection from a different crop genome  
- Useful for introducing the desired traits in a seed if the target traits are not available in the same genome  
- Injection of *Bacillus thuringiensis* (Bt) a key application to make crops resistant to pest attacks |                                                                                      |
| **Targeting Induced Local Lesions in Genomes (TILLING)** | - Based on deoxyribo nucleic acid (DNA) sequencing that enables identification of induced and naturally occurring variation in several species  
- A reverse genetic, nontransgenic method for improving a quality trait in a crop plant  
- Not subject to the same regulatory approval requirements as transgenic crops  
- Arabidopsis TILLING library used extensively to search for mutations in the genes of interest | • Wheat  
• Maize  
• Barley                                                                                           |
Bio fortification

Bio fortification is the development of micronutrient-rich staple crops using traditional breeding methods and modern biotechnology. Using this technique, plant breeders focus on crops, such as soybean, that have high nutritional content. This technique is advantageous for developing countries in providing necessary nutrients especially to the rural population who rarely have access to commercially fortified foods.

Nutrition

Biotechnology techniques fulfill plant micronutrient requirements by supplying organic nutrients through microorganisms and their by-products. These microorganisms doctor the natural nutrient cycle of the soil and build soil organic matter.

Pest management

Agricultural crops face a significant threat from a variety of natural enemies such as predators, parasites and pathogens. These pests can damage crops and impact the nutritional value of the produce. Biotechnology offers a solution to this problem, with minimal harm to the environment.

Wastewater utilization

Population growth, climate change, urbanization and limited freshwater resources have made wastewater a vital source of irrigation water for farmers. It is particularly important to utilize wastewater from domestic use, institutions and industries. Greywater—generated from washbasins, showers and baths—is suitable for reuse and contains nutrients important for agricultural production.

Despite the wide range of bio agriculture offerings, the Government of India has approved only GM Bt cotton seeds for commercialization since 2002. These seeds were quickly adopted by farmers, and this paved the way for the growth of bio agriculture. After the introduction of GM Bt cotton seeds, the bio agriculture sector registered a compound annual growth rate (CAGR) of 49 percent from 2003 to 2010 (see case study 1) and then slowed to 18 percent during 2009–12. Several factors have contributed to this sector losing steam. Ninety percent of the cotton area is already under Bt cotton cultivation—leaving little room for growth. Lack of new hybrids, a passive regulatory system and limited investment in research and development (R&D) too have hurt growth and innovation. The next section discusses in detail the challenges before this sector.
Case Study 1
Seeds of hope—Recollecting the success of Bt cotton in India

Bt cotton seeds are genetically modified to produce an insecticide that kills bollworm, a common cotton pest in India. The Government of India allowed Monsanto Company, an American firm, to start selling Bt cotton to local farmers in 2002. Since then, Bt cotton has pervaded cotton farming in India. Today, the Bt cotton acreage accounts for more than 90 percent of the total area under cotton cultivation. This has helped India become a net exporter of cotton.

Bt cotton has succeeded in transforming cotton into one the most productive and profitable crops in the country. However, it still requires further research because of the development of Bt cotton-resistant pests.

Key outcomes

- Cotton output increased to 35.2 million bales in 2011 from 13.7 million bales in 2002
- A 68 percent rise in per hectare yield
- A 25 point reduction in the use of pesticides, from 46 percent to 21 percent
- A 129 percent increase in farmers’ income per hectare, to INR16,000 from INR7,000 in rain-fed areas and higher in irrigated areas—by reducing costs of inputs such as pesticides
- 7 million farmers who were living below the poverty line in 2011 have benefited from cultivating Bt cotton

Figure 3: Cotton Production in India (Annual Yield)

The yield has started declining as the Bt cultivation area has reached saturation and is now spreading to “desi” areas that do not give the same yield levels.

Sources: Agriculture statistics 2012, Ministry of Agriculture; news articles; Accenture analysis
Government agencies do not have a single view on the application of GM technology in agriculture. The country also lacks a road map to leverage biotechnology. Regulatory approvals are not given on time, and multiple regulatory bodies cause inordinate delays. Currently, 91 applications for field trials are pending for approval, 44 of which are for GM food crops. To overcome such delays, the government proposed to set up Biotechnology Regulatory Authority of India (BRAI), an independent regulator under the Ministry of Science & Technology, but the proposal is still waiting for Cabinet approval.

Going ahead, the challenge for the government will be to establish an effective regulatory system and a communication mechanism on GM foods, which can help allay fears about the safety of such crops, while ensuring higher productivity and remuneration to farmers.
India’s current R&D spend on agriculture is only 0.6 percent of the total agriculture gross domestic product (GDP), which is less than the average of 1 percent spent by other developing countries. This problem of inadequate R&D spend is compounded by the need to apportion the budget between numerous public institutions. To improve the chance of converting these investments into commercially viable products, meaningful collaborations between public and private institutions are required—at an early stage of development.

However, public-private partnerships are “infested” with glitches such as lack of harmony between the individual objectives of public research centers and their alignment with agricultural challenges, long recovery period of approximately 8–10 years to commercialization and ambiguity on intellectual property (IP) ownership.

Going ahead, the challenge for the government will lie in forming mutually beneficial public-private partnerships. The real value of this can be realized only when there is a clear, identified path to market. Further, involvement of private sector scientists and industry captains in various decision-making bodies of the government will be a step in the right direction.

India clearly lacks an informed debate on the benefits of biotechnology techniques in agriculture. The current opposition to GM is largely due to the lack of understanding of the technology by a certain group of people. A comprehensive evaluation of GM technology needs to be undertaken, looking at all aspects including social, environmental and economic.

Seed pricing in India is largely determined by the government and often remains unchanged for years despite the rise in input costs. The country needs a government-approved framework to enable calculation of licensing fee or trait fee in a transparent manner.

Going ahead, the challenge for the government will be to increase awareness of bio agriculture and formulate a transparent framework to encourage farmers to embrace biotechnology.

India can learn significant lessons from other countries that have become self-sufficient after infusing bio technology in agriculture. For example, Brazil’s agriculture sector has evolved tremendously over the past few years, on the back of favorable government policies and promotion of biotechnology (see case study 2). Based on Accenture’s assessment of the methods employed by other countries and the challenges faced by India, in the next section, we have laid out measures that various stakeholders need to take to boost India’s agriculture sector.

R&D spend
India’s R&D spend on bio agriculture products is fragmented, hindering pooling of resources to conduct result-oriented research.

Lack of awareness and transparent seed pricing
Lack of information on the use of biotechnology and transparent pricing prevent farmers from using modern techniques for increased yields.
Supported by favorable government policies, the Brazilian bio agriculture sector has grown exponentially over the past few years, making a mark globally through exports.

**Key actions taken by the Brazilian government**

- **Articulated the importance of biotechnology for increasing agriculture production**
- **Envisaged a higher share for the country in agricultural exports to capitalize on the fast-growing international market**
- **Identified the use of technology such as GM crops as a key measure to increase production**

**Developed a comprehensive yet predictable regulatory system**

- Formed a single regulatory authority—Comissão Técnica Nacional de Biossegurança (CTNBio)—that provides commercial approvals within a reasonable time frame based on scientific evaluation

**Channeled investments toward R&D**

- Set up a public body—Empresa Brasileira de Pesquisa Agropecuária (Embrapa)—to undertake research, with an annual R&D budget of US$1.1 billion
- Created public-private partnerships (PPPs) to initiate joint development efforts in certain areas
- Encouraged private multinational players to develop and introduce proprietary technologies

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**Case Study 2**

**Biotech Agriculture in Brazil**

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Key outcomes and comparison with India

- An expected 168 percent rise in production by 2025 against a 30 percent increase in land under cultivation in Brazil
- 32 hectares of land under biotech crops in Brazil versus only 10 hectares in India
- 16 events approved in 2010–11 in Brazil compared with none in India since 2009
- 34 events approved so far in Brazil against six in India
- Embrapa developed GM kidney beans approved for commercialization
- Embrapa also developed a herbicide-tolerant GM soybean, jointly with BASF—a chemical company

<table>
<thead>
<tr>
<th>Food grain production (mn ton)</th>
<th>2012</th>
<th>60</th>
</tr>
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<tbody>
<tr>
<td>2025 (Expected)</td>
<td>168</td>
<td></td>
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</tbody>
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<table>
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<tr>
<th>Events (bio crops) approved for commercialization</th>
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<tbody>
<tr>
<td>2010</td>
</tr>
<tr>
<td>2011</td>
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<tr>
<th>Embrapa’s annual R&amp;D budget (US$ mn)</th>
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<tr>
<td>2006</td>
</tr>
<tr>
<td>2011</td>
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Sources: News articles; Accenture analysis
Recommendations

The bio agriculture sector has the potential to expand manifold, from US$7.8 billion today to US$34–37 billion by 2025 (see figure 4). However, to realize this market opportunity, the industry needs to implement the following growth enablers:

Figure 4: Current and Projected Market Size of the Indian Bio Agriculture Industry

Growth Levers

Current market—2012–13 | Projected market—2025 (As-is conditions) | Policy framework | Regulatory system | Infrastructure | Innovation | Targeted initiatives | Projected market—2025 (potential opportunity)
---|---|---|---|---|---|---|---
7.8 | 15–17 | 1.1 | 8.8 | 1.4 | 5.7 | 2.5 | 34–37

Note: Current market data based on Association of Biotechnology Led Enterprises (ABLE) biospectrum survey, June 2013; current bio agriculture market adjusted to include output due to existing bio agricultural products; dollar-rupee conversion rate kept constant for the projection period based on FY13 rate

Sources: Accenture Market Size Model, primary interviews
Policy Framework and Regulatory System

The policy hiatus and regulatory uncertainties in the country have impeded the growth of Indian agriculture. The government needs to streamline the regulatory system in the following ways:

• Lay out the role of various biotechnologies in solving the agricultural challenges faced by the country and identify the technologies relevant to the Indian context
• Identify priority crops where biotechnology intervention is required; identify crops for self-sufficiency and those for exports
• Form a single regulatory authority to govern all bio agriculture domains falling under various ministries and coordinate between the relevant central and state ministries for any approvals
• Reinforce the capabilities of existing supervisory committees to effectively deal with complexities associated with the evaluation of bio safety trials; ensure evaluation is based on scientific facts
• Set up procedures and targets with clearly defined timelines; check implementation and adherence to timelines

Innovation

Innovation can play a key role in the success of the bio agriculture sector by enhancing productivity, ensuring self-sufficiency of key crops and increasing farmer income. But successful innovation needs the right policies, infrastructure and market structure. Additionally, promoting cross-fertilization of knowledge and capabilities can drive new, innovative business models and attract investment. The challenges are enormous, but the opportunity the sector presents is both substantial and achievable. The following steps can be initiated for successful innovation:

• Establish a framework to take to market successful research projects developed at public institutes; ensure concerned scientists get commensurate benefits
• Increase R&D spend for public institutes; revisit existing R&D allotment methodology to ensure a critical mass for effective research
• Develop models to encourage public-private partnerships; transfer any IP generated from such partnerships to the concerned private player
• Allow private players to use underutilized public laboratories by paying a rent or service fee
• Facilitate pooling of private investments for effective R&D utilization; create a mechanism to enable private players to jointly share investments, risks and benefits
• Develop a framework for sharing licensing fee/trait fee in a transparent manner

Targeted Initiatives

Of late, the bio agriculture sector has been in the news for all the wrong reasons—controversies and growing opposition to GM seeds. In India’s case, this has been exacerbated by the lack of dissemination of science-based information to all stakeholders to enable them to engage in an objective and transparent debate. The following steps can be initiated:

• Develop a strategic plan for public communication to improve understanding of biotechnology and its products
• Work toward achieving public support and consumer acceptance for biotech-enabled agriculture products
• Spread awareness of the use and benefits of bio technology among farmers
  - Form official groups for farmers to ensure their views and concerns are adequately represented
  - Take initiatives to cater to farmers’ need for funding such as providing low-interest loans for purchase of equipment
About CII

The Confederation of Indian Industry (CII) works to create and sustain an environment conducive to the growth of industry in India, partnering industry and government alike through advisory and consultative processes. CII is a non-government, not-for-profit, industry led and industry managed organisation, playing a proactive role in India’s development process. Founded over 115 years ago, it is India’s premier business association, with a direct membership of over 8100 organisations from the private as well as public sectors, including SMEs and MNCs, and an indirect membership of over 90,000 companies from around 400 national and regional sectoral associations.

CII catalyses change by working closely with government on policy issues, enhancing efficiency, competitiveness and expanding business opportunities for industry through a range of specialised services and global linkages. It also provides a platform for sectoral consensus building and networking. Major emphasis is laid on projecting a positive image of business, assisting industry to identify and execute corporate citizenship programmes. Partnerships with over 120 NGOs across the country carry forward our initiatives in integrated and inclusive development, which include health, education, livelihood, diversity management, skill development and environment, to name a few.

With 64 offices in India, 9 overseas in Australia, Austria, China, France, Germany, Japan, Singapore, UK, and USA, and institutional partnerships with 223 counterpart organisations in 90 countries, CII serves as a reference point for Indian industry and the international business community.

About Accenture

Accenture is a global management consulting, technology services and outsourcing company, with approximately 275,000 people serving clients in more than 120 countries. Combining unparalleled experience, comprehensive capabilities across all industries and business functions, and extensive research on the world’s most successful companies, Accenture collaborates with clients to help them become high-performance businesses and governments. The company generated net revenues of US$28.6 billion for the fiscal year ended Aug. 31, 2013. Its home page is www.accenture.com.

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