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INDIAN SEED INDUSTRY

Connecting with Farmers for over 50 years

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Foreword

The Green Revolution has played a transformational role in the resurgence of Indian Agriculture, making India self- sufficient in food grains as well as a net exporter. Over the past decade, India's seed industry has witnessed a remarkable progress in key fields of high-yielding crops, hybrids, crop biotechnology, among several others. Despite the shrinking agricultural land base, India's food output has grown steadily to reach 264 million tonnes of food grains during 2013-14, which has encouraged Indian farmers to grow more food grains per unit of land, thereby significantly increasing their productivity and profitability.

However, for India to achieve food and nutritional security for its 1.25 billion citizens, it is critical for our agriculture sector to overcome low productivity levels despite challenges of depleting land resources, rain-fed irrigation and climate change.

The Indian commercial seed industry has grown at a CAGR of 18% over the past decade to become a USD 3 billion industry. The industry has witnessed tremendous growth following rapid developments in the crop segments such as cotton, rice, maize, vegetables, wheat and pulses. Further, R&D progress in commercial crops such as cotton has enabled India to emerge as the new global leader in cotton production. However, in order to leverage the true potential of this sector, it is critical to replicate these success stories across other key crop segments as well.

In order to achieve our future food and nutrition security requirements, we must multiply these efforts and focus on scale-neutral research, develop varieties specific to regions, enhance our extension activities to increase lab-to-land transfer. Apart from promoting high yielding varieties of crops, we must also foster efficient agricultural practices to yield maximum returns by introducing crop varieties which use fewer natural resources (especially water), encouraging precision agriculture and farm mechanization, as well as partnering with farmers to reduce the lab-to-land differences in yields. Given the rapid evolution of the Indian Dairy sector, it is vital to tap the immense economic potential of the forage crops, including silage crops, which are expected to emerge as a multi-crore business opportunity.

At the policy level, a visionary approach is required amongst industry, Government as well as research and environmental communities towards establishing a sustainable ecosystem that will yield optimal economic, environmental and societal benefits for all stakeholders.

YES BANK, in partnership with the National Seed Association of India, is privileged to be associated with the prestigious Indian Seed Congress 2015, as Knowledge Partners. On this occasion, I am pleased to present the YES BANK-NSAI report 'Indian Seed Industry- Connecting with the farmers for more than 50 years' which provides an extensive review of the industry. I am confident that this publication will be a useful reference for seed industry, Government institutions and stakeholders across the agri value chain.

Sincerely,

Rana Kapoor
MD & CEO YES BANK

Message

Seed industry in India has traversed its foundation stages and is currently at an inflection point to scale up into growth phase. While the learning curve has been steep at times, today we are part of a vibrant seed industry with a strong foundation to takeoff into growth phase.

The progress achieved since the New policy on seed development 1988 and national seed policy 2002 in terms of developing capacities by Indian seed industry in terms of R&D, product development, supply chain management and quality assurance has been phenomenal which has positioned India as the fifth largest seed industry globally. Both public and private sector had played a vital role in laying a strong foundation to Indian seed industry, which is poised to become an important global player in the future. Indian industry has also been very fast in development and adaptation of new technologies to Indian context, while our farmers have been highly agile in adopting new varieties and hybrids which have delivered value.

The adoption of Bt Cotton hybrids in the last 10 years to the current 95% levels is a case in a point which shows the strength of Indian farming community. Further the progress made in other crops like Corn, Rice, Bajra, Okra, Tomato, Chillies, etc., has also been very promising with new hybrids and varieties providing good advantage in quality and productivity. However much needs to be achieved in terms of realization of true potential for developing superior varieties and hybrids in combination with improved crop management practices to make agriculture a profitable enterprise to farmers.

The Knowledge Report for Indian Seed Congress, 2015 prepared by YES Bank provides a snapshot of the dynamics of Indian seed industry and its growth journey very effectively. I commend the efforts the YES Bank team for bringing this industry research report , which will be useful to all the stakeholders of the seed industry.

M. Prabhakara Rao
President, NSAI and
CMD, Nuziveedu Seeds Ltd.

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Overview of Global Seed Sector Evolution & Current Status

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1. Overview of Global Seed Sector- Evolution & Current Status

The global commercial seed market was valued at USD 45 billion by International Seed Federation (ISF) in the year 2013 and is growing at a CAGR of around 5 percent. The global market for commercial seeds is expected to reach USD 72 billion by 2020. The major countries for seed globally are USA, China, France, Brazil, Canada, India, Japan, Germany, Argentina and Italy. Global seed industry has evolved into a multibillion dollar industry due to pioneering researches in biotechnology & is now in a position to meet the demand of diverse agro intensive cropping systems.

The corn/maize was the largest consumed commercial seed, accounting for USD 20 billion of revenue in 2013. The growth in corn is attributed due to its increased use as livestock feed and in ethanol production. Soybean, as a cheaper source of protein, is the next largest commercial seed accounting for revenue in excess of USD 8 billion in 2013. Other common commercial seeds include cotton, canola and cereals.

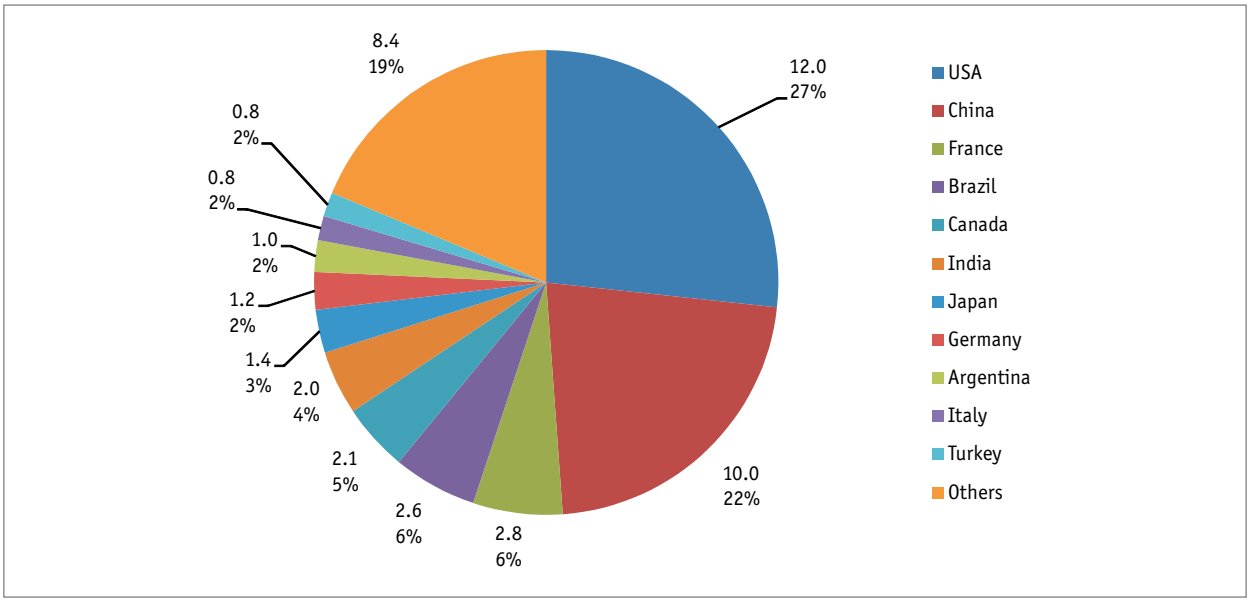
The major market for commercially produced seeds is OECD (Organization for Economic Cooperation and Development) countries with 43% share. Currently, US & EU represent the single largest markets for processed seeds (by value) driven by widespread penetration of high-value genetically modified (GM) and hybrid seeds; however EU market is close to saturation and has seen a significant (10%) decline in consumption over last four years, whereas Africa & Asia are showing increased growth. The seed consumption in Asia & Africa has doubled since 1990s.

The global seed market is given an impetus by GM field crops, which have grown by 22% over the last five years (+5% for vegetable seeds and conventional field crops seeds). Commercial GM crops have been grown since 1996 and since then, the share of GM seeds in the global seeds market has been increasing. The global biotechnology (GM) seeds market was valued at USD 21.5 billion in 2013 and is expected to reach USD 42.5 billion by 2020, growing at a CAGR of 10.3% from 2014 to 2020.

The Asia-Pacific market is projected to witness the fastest growth in the next 5 years, driven by the increasing penetration of hybrid & GM seeds. Countries such as India, China, Thailand, Indonesia, and Philippines are strategically positioned to become the hub of seed sector development in the coming decade.

North America was the largest regional market for commercial seeds with market revenue of USD13.96 billion in 2013. Europe is expected to remain a moderate market, owing to the high degree of regulatory intervention persistent in the region. Asia pacific and Latin America are expected to witness significant market growth at an estimated CAGR of over 7% from 2014 to 2020.

Estimated Value of Seed Industry in major countries for the year 2012 (Figures in USD Billion)



Source: ISF June 2013 update, YES BANK Analysis

France, Netherlands and United States are the major seeds exporting countries globally. The major seed importing countries are United States, Germany and France.

Major Seed Exporting Countries (Year 2012)

	Quantity (MT)				Value (USD Million)			
Country	Field Crops	Vegetable Crops	Flower Seed	Total	Field Crops	Vegetable Crops	Flower Seed	Total
France	586,289	8,084	287	**594,660**	1,437	349	18	**1,804**
Netherlands	119,862	11,596	1931	**133,389**	256	1,255	72	**1,583**
United States	364,117	17,626	726	**382,469**	930	529	72	**1,531**
Germany	100,752	1,271	1271	**103,294**	638	58	31	**727**
Chile	50,125	1,271	1809	**53743**	218	150	20	**388**

Source: ISF 2013, YES BANK Analysis

Major Seed Importing Countries (Year 2012)

	Quantity (MT)				Value (USD Million)			
Country	Field Crops	Vegetable Crops	Flower Seed	Total	Field Crops	Vegetable Crops	Flower Seed	Total
United States	232,340	14,616	468	**247,424**	873	369	70	**1,312**
Germany	178,954	4,148	744	**183,846**	590	90	20	**700**
France	135,980	5,908	406	**142,294**	540	137	10	**687**
Netherlands	150,340	15,398	732	**166,470**	263	373	49	**687**
Italy	206,124	5,539	130	**211,793**	242	170	10	**422**

Source: ISF 2013, YES BANK Analysis

The global seed industry constitutes of approximately 1500 players. The top three seed companies- Monsanto, DuPont & Syngenta together account for around 40% of the worldwide proprietary seed market.

Global Seed Industry by Leading Players

	Company	Sales USD Million 2014	Sales USD Million 2011
1	Monsanto (USA)	10,740	8,953
2	DuPont Pioneer (USA)	8,217 (2014)	6,261
3	Syngenta (Switzerland)	3,204 (2013)	3,185
4	Vilmorin (France) (Groupe Limagrain)	2,040 (2013-14)	1,670
5	WinField (USA) (Land O Lakes)		1,346
6	KWS (Germany)	1,602 (2013-14)	1,226
7	Bayer Cropscience (Germany)	1,293 (2013)	1,140
8	Dow AgroSciences (USA)	1,642 (2013)	1,074
9	Sakata (Japan)	534 (May 2014)	548
10	Takii & Company (Japan)		548
	Total Top 10	**~30 Billion USD**	**~ 26 Billion USD**
	Global Seed Industry size	**~45 Billion USD**	**34.55 Billion USD**

Conversion Rate of 1.36 USD/Euro for 2013-14 for Vilmorin and KWS conversions
Conversion Rate of 0.0099 JPY/USD for Sakata
Source: ETC Group, Phillips McDougall; Current Sales sourced from company annual reports

Consolidation of International Seed Industry

Among the global top ten seed companies, four are based in USA, four are based in Europe and two in Japan. The global market is dominated by a few large companies, also active in the agrochemical sector. Presently Monsanto, DuPont, Syngenta, Bayer, Dow & BASF (The "Big Six") collectively own or partially own hundreds of formerly-independent seed companies.

Global Seed Companies: No of Acquisitions (Period 2007-2011)

Companies	No of Acquisitions
Vilmorin	15
Dow	14
Monsanto	12
Bayer	11
Syngenta	10
Dupont	7
Advanta	7
Nufarm	6

Source: PhillipsMcDougall

Evolution of the market share of the biggest seed companies in the world

1985	USD Million		1996	USD Million		2009	USD Million		2012	USD Million	
Company	**Net Sales**	**% of Global seed market**	**Company**	**Net Sales**	**% of Global seed market**	**Company**	**Net Sales**	**% of Global seed market**	**Company**	**Net Sales**	**% of Global seed market**
Pioneer	735	4.1	Pioneer	1500	5	Monsanto	7297	17.4	Monsanto (Usa)	9800	21.8
Sandoz	290	1.6	Novartis	900	3	Dupont Pioneer	4700	11.2	Dupont Pioneer (USA)	7000	15.5
Dekalb	201	1.1	Limagrain	650	2.2	Syngenta	2564	6.1	Syngenta (Switzerland)	3200	7.1
Upjohn's Asgrow Seed Co	200	1.1	Advanta	460	1.5	Limagrain	1155	2.8	Limagrain (France)	1700	3.8
Limagrain	180	1	Seminis	375	1.3	KWS	920	2.2	Winfield (USA)	1300	3.5
Shell's Nickerson Seeds	175	1	Takii	320	1.1	Bayer	645	1.5	KWS (Denmark)	1300	2.9
Takii	175	1	Sakata	300	1	Dow	635	1.5	Dow (USA)	1000	2.90
Ciba Geigy	152	0.8	Kws	255	0.9	Sakata	485	1.2	Bayer (Germany)	0.4	2.2
Vander Have	150	0.8	Dekalb	250	0.8	Land o'lakes	?	?	Sakata (Japan)	0.4	1
Total Share in Global Seed Market (GSM)		**12.5%**			**16.7%**			**>44%**			**62%**

Source: Elaboration by EP Policy Department B, based on Schenkelaars et al. 2011; Fugeray-Scarbel and Lemarié, 2013 (to be published); Ducros et al., 2013.

Overview of Global R&D in crop biotechnology

R&D in Seed sector can be broadly classified into two major types:-

- ✓ Genetic improvement for development of new varieties/hybrids through conventional plant breeding and biotechnologies. While conventional breeding involves 6-7 years or generations of selection from diverse genetic pool to achieve genetic uniformity, followed by evaluation trials in several locations for identification and release of a product, genetic engineering and biotechnologies involve introduction of new traits hitherto not available in the original plants.

- ✓ Promoting Crop management systems and agronomy for enabling expression of desired traits built into the hybrid/variety

Therefore the value addition in a seed in terms of encapsulation of superior genetic traits is done by both conventional Plant breeding and Biotechnologies. However Biotechnologies have become key drivers in terms of acceleration of breeding cycles and by bringing together additional traits from diverse populations to create value for incorporation of desirable traits like tolerance to biotic (Pests and diseases) and abiotic stresses (Drought, Salinity, etc.) on top of the superior varieties and hybrids developed through conventional breeding.

Key facts about global crop biotechnology [i]

Key Trends	Description
2013 was the 18th year of successful commercialization of biotech crops	Biotech crops were first commercialized in 1996. Hectarage of biotech crops has increased every single year between 1996 to 2013, with 12 years of double-digit growth rates. An unprecedented cumulative hectarage of more than 1.5 billion hectares have been successfully cultivated, an area that is 50% more than the total land mass of China or the United States.
Biotech crop hectares increased by more than 100-fold from 1.7 million hectares in 1996, to over 175 million hectares in 2013	This makes biotech crops the fastest adopted crop technology in recent times. In 2013, hectarage of biotech crops grew by 5 million hectares, at an annual growth rate of 3%.
Number of countries growing biotech crops and stacked traits	Of the 27 countries which planted biotech crops in 2013, 19 were developing and 8 were industrial countries. Stacked traits occupied 47.1 million hectares, or 27%.
For the second consecutive year, in 2013, developing countries planted more hectares than industrial countries.	Notably, developing countries grew more, 54% (94 million hectares) of global biotech crops in 2013 than industrial countries at 46% (81 million hectares). Successful public/private partnerships were established by several countries including Brazil, Bangladesh and Indonesia.
Number of farmers growing biotech crops	In 2013, a record 18 million farmers, up 0.7 million from 2012, grew biotech crops – remarkably over 90%, or over 16.5 million, were small resource-poor farmers in developing countries. In 2013, a record 7.5 million small farmers in China and another 7.3 million in India, elected to plant more than 15 million hectares of Bt cotton, because of the significant benefits it offers.

[i] *ISAAA- The International Service for the Acquisition of Agri-biotech Applications*

The top 5 countries planting biotech crops – deployment of the first drought tolerant maize and stacked HT/IR soybean	The US continued to be the lead country with 70.1 million hectares, with an average ~90% adoption across all crops. Importantly, the first biotech drought tolerant maize was planted by 2,000 US farmers on 50,000 hectares. Brazil was ranked second, and for the fifth consecutive year, was the engine of growth globally, increasing its hectarage of biotech crops more than any other country – an impressive record increase of 3.7 million hectares, up 10% from 2012, reaching 40.3 million hectares. Brazil also planted the first stacked HT/IR soybean in a record-breaking 2.2 million hectare launch, and its home-grown virus-resistant biotech bean is ready for commercialization. Argentina retained its third place with 24.4 million hectares. India, which displaced Canada for the fourth place had a record 11 million hectares of Bt cotton with an adoption rate of 95%. Canada was fifth at 10.8 million hectares with decreased plantings of canola but maintained a high adoption rate of 96%. In 2013, each of the top 5 countries planted more than 10 million hectares providing a broad, solid foundation for future growth.
Status of biotech crops in Africa	The continent continued to make progress with South Africa benefiting from biotech crops for more than a decade. Both Burkina Faso and Sudan increased their Bt cotton hectarage by an impressive 50% and 300%, respectively, in 2013. Seven countries (Cameroon, Egypt, Ghana, Kenya, Malawi, Nigeria and Uganda) conducted field trials, the penultimate step prior to approval for commercialization. Importantly, the WEMA project is scheduled to deliver the first biotech drought tolerant maize to Africa in 2017.
Status of biotech crops in the EU	Five EU countries planted a record 148,013 hectares of biotech Bt maize, up 15% from 2012. Spain led the EU with 136,962 hectares of Bt maize, up 18% from 2012 with a record 31% adoption rate in 2013.
Benefits offered by biotech crops	Biotech crops contributed to Food Security, Sustainability and the Environment/Climate Change by: ✓ increasing crop production valued at US$116.9 billion ✓ a better environment, by saving 497 million kg a.i. of pesticides ✓ in 2012 alone reducing CO2 emissions by 26.7 billion kg, ✓ conserving biodiversity by saving 123 million hectares of land from 1996-2012 ✓ and helped alleviate poverty for >16.5 million small farmers
Future Prospects	Cautiously optimistic with more modest annual gains expected due to the already high rates of adoption (90% or more) in the principal biotech crops in mature markets in both developing and industrial countries. Bangladesh, Indonesia and Panama approved biotech crop planting in 2013 with plans for commercialization in 2014.

Source: ISAAA- 2014

Comparison of Global and Indian Seed industry

The global seeds industry has changed dramatically over the past century, with farmers increasing the amount of purchased seed instead of using seed saved from the previous harvest. Advances in seed technology have accelerated through crop hybridization and marker-assisted breeding in 1980s. Since 1996 the industry has been further shaped by the introduction of genetically modified (GM) crops. The global seeds market has almost tripled from the year 2000, reaching approximately US$ 45 billion in 2014. Growth has occurred in both conventional and genetically modified seeds over that period, with cumulative growth rates of ~100% and ~600%, respectively.

Industry structure globally is skewed towards large MNC companies who control almost 94% of global seed supply directly or through their subsidiaries. Top seed companies globally have background of agrochemicals as their core business offering and seeds business comprise a small portion of that. Prior to 1980 Monsanto was not majorly involved in seed industry and now it is the world's largest seed company. Other top seed companies like Dupont, Syngenta, Dow, Winfield and Bayer too have similar chemicals and agrochemicals background. Share of the seed business for these companies is around 20%. Most of these companies have added seed businesses to their portfolio through acquisition route. France based Limagrain, Staka and Takii based out of Japan have pure play seed business as their core business segment. Focus of the global giants is mainly on seed traits and GM technology. Since intellectual property laws are well established in USA and EU markets, advanced seed technologies are available for the farmers.

Seed industry in India took shape in public sector through 1960s and private sector from 1980s when liberalization started. Majority of the local Indian seed companies have pure play seed business as their core business and focused research on fewer crops. Public sector R&D firms mainly focused on varietal improvements of crops like rice, wheat, pulses etc, private sector focused on crop hybridization, GM technologies in select crops like cotton, corn, hybrid rice, sorghum, pearl millet and vegetables. Large acquisitions in Indian seed industry have not taken place except few small deals. Some global seed companies have started acquiring local Indian firms that specialize in specific crops and markets.

Industry structure of Indian and Global seed companies

Development	Global Seed Industry	Indian Seed Industry
Global size of seed market (2014)	Valued around USD 45 bn, seed industry is mainly controlled by agrochemical giants like Monsanto, Syngenta, DuPont, Bayer etc	Valued at around USD 3 bn, Indian market is dominated by private players like Nuziveedu seeds, Advanta, PHI seeds, Mahyco, Ankur, Rasi Seeds, Bioseed etc who dominate crops like hybrid cotton, hybrid corn and public sector companies like NSC, SFCI and SSCs who concentrate on OPVs like rice, wheat and pulses.
Core competencies	Majorly agrochemical companies with seed business added through acquisitions.	Pure play seed business established mostly in post 1980s era with liberalization.
Innovation & R&D	Seed firms invest very high amounts (15-17% of turnover) in R&D to bring latest technology and products to the farmers.	Indian firms spend far less (0-3%) as there are no strong laws that protect high value research products. Few firms have succeeded in investments in R&D and commercialization of crops. (Ex: Kaveri Seeds invested around 1.5% of turnover in 2013-14)
Introduction of hybrids	First hybridized crops were introduced in 1920s bringing tremendous yields. In 1953 Watson and Crick discovered the structure of DNA. This would soon lead to the advent of marker assisted breeding and to a revolution in the science of crop improvement.	Though hybridization started much earlier, it was only in 1980s that India adopted wide range hybrids in crops. New Policy on Seed Development (1988) and the economy wide New Industrial Policy (1991), encouraged private-sector participation in higher-value segments of the seed market. These reforms led to an expansion of private investment in the breeding and marketing of hybrids of sorghum and pearl millet during the mid-1980s, maize in the early 1990s, cotton in the early 2000s, and rice in the mid-2000s
Introduction of GM technology	In 1983 the first genetically modified plant was produced and commercially released in 1996.	GM technology is allowed only in cotton in India and approved for commercial cultivation in 2002. This technology not yet approved for food crops yet.
Yields comparison (MT/Ha)- 2013	Corn- 5.1 Soybean- 2.4 Wheat- 2.9 Rice- 2.9 Cotton yield 764 kg/Ha	Corn- 2.6 Soybean- 1.2 Wheat- 3.0 Rice- 2.4 Cotton-529Kg/Ha

Overview of Indian Seed Industry 2



2. Overview of Indian Seed Industry

The Indian seed market is one of the largest globally and is almost exclusively supplied by locally produced seeds. Farmers retain seeds of major food crops (wheat, rice, sorghum, millet, corn, and pulses) and commercial crops for many years to use them in their farms year after year. The seed replacement rate in most crops is very low, with the exception of cotton and some vegetables. The use of hybrid seeds is mostly confined to cotton, and to some extent to corn, millet, sunflower, and few vegetables. However, awareness about the high yield and quality of produce from hybrid seeds is attracting farmers to switch over to hybrids. The Indian seed industry used to be dominated by public sector seed companies. However, following the easing of government regulations and the implementation of a new seed policy in 1988, the private sector seed companies have started playing a major role in seed development and marketing. More recently, the government's decision to embrace biotechnology as a means of achieving food security has attracted several leading biotechnology-focused multinational seed companies to India.

Public Sector Seeds Companies

Public sector involvement in the seed industry on a national scale began at the beginning of the "green revolution" with the establishment of the National Seed Corporation (NSC) in 1963, which was charged with the responsibility of promoting seed industry development from production through processing, storage and marketing, and establishing a system of quality control. Before that, the Indian seed industry was little developed apart from a small number of private companies dealing with high value vegetable and flower seeds. In the initial years of operation, the NSC concerned itself mainly with foundation seed production and with seed certification after the enactment of Seed Act in 1966. The State Seed Corporations (SSC) were established later with support from the World Bank, initially in nine states, and later expanded to cover 20 states, for production and handling of seed in their respective states. The role of public sector seed companies is now mostly confined to certified seeds of high volume, low value segment of high yielding varieties of cereals, pulses, and cotton with a limited presence in the high value hybrid sectors of cotton, cereals, and vegetables. Wheat and paddy seed constitutes a major share of the seeds handled by them.

Private Sector Seed Companies

Easing of government regulations in the late 1980s spurred enormous development within the seed industry by attracting several foreign seed companies to India. The private players identified potential crops for hybridization and started research and development activities. Typically they concentrated on hybrids, mainly corn, cotton, sunflower, vegetables, and flowers (more recently on rice), and they now account for a major share of commercial production of these seeds in India. The basic reason for the private sector's focus on these crops is that it involves repeat purchase by farmers every season, low production volume of hybrids and higher margins.

Currently, some 1500 hybrids of field crops and vegetables are being marketed, as truthfully labeled seeds, mostly by private seed companies. The private seed sector now comprises some twenty or so large players (with sales turnover exceeding Rs. 200 Cr), several medium companies (sales turn over between Rs. 200 Cr and 20 Cr), and a large number of small, unorganized players (sales turnover less than Rs. 20 Cr) with local presence.

The private seed industry is now undergoing a transition following the Indian government's focus on biotechnology research, as a means of increasing agricultural production and also driven by trends in the domestic and world seed market. Intensifying international competition, increasing R&D costs, and the complexity of biotechnology have lead to increased consolidation of the Indian seed industry with several of the large and medium companies merging or being taken over by multinational seed companies. Most large multinational seed companies now have their presence in India (either as a joint venture or with 100 percent equity) with their main focus on biotechnology. These include Monsanto, DuPont, Bayer CropScience, Syngenta, Advanta, Dow Agro etc.

Private seed production is largely centered around Bangalore for vegetable crops and Hyderabad for field crops, particularly cotton seeds. The emergence of these two seed production centers is due to ideal climatic conditions, better infrastructure, the technology and research leadership, and the expertise of the two regions' seed farmers in manipulating crops for perfectly synchronized flowering. The initial focus of many of these companies has been cotton, for which genetically modified (Bt.) hybrids have already been approved by the Indian government for commercial cultivation, with other bio-engineered crops in the pipeline. Most of these companies have licensing agreement with Mahyco-Monsanto Biotech for the Bt gene; while some companies (JK Agri Genetics, Nath Seeds, Metahelix etc) have developed their own Bt technology with local or global R&D partnerships.

Current Status

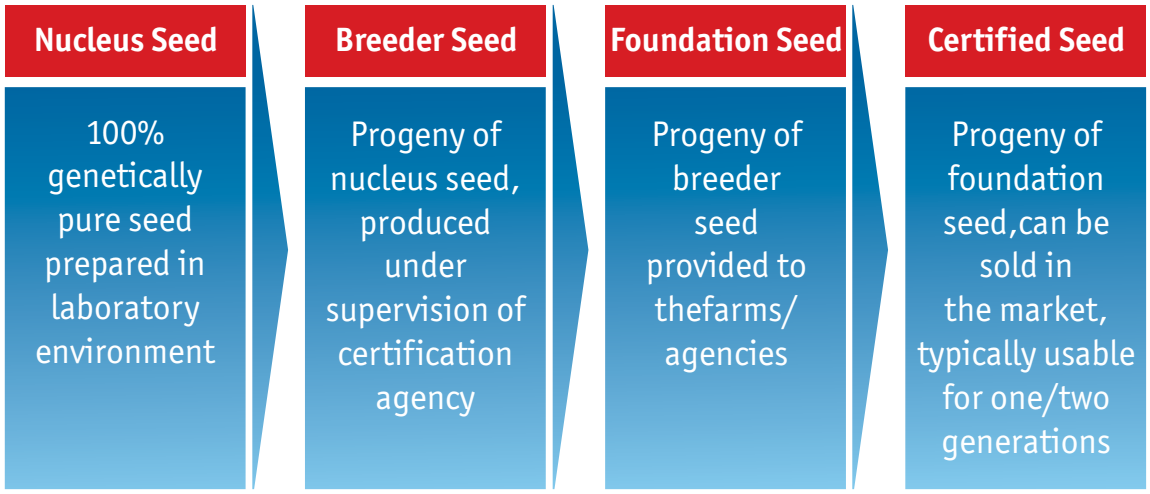
Domestic seed market is estimated at Rs 180 billion as of 2013-14. The Indian seeds market has seen rapid growth in recent years due to policy on allowance of Bt Cotton in the domestic market, several seed players expanded their presence and reach in the domestic market. Increased marketing efforts, rising farmer awareness, higher penetration of basic irrigation infrastructure driven by government investment and increasing farm incomes (driven both by higher production and higher procurement prices) have all played a part in the sustained increase in the consumption of market-purchased seeds. Both the government sector, comprising 20 state seeds corporations and one national level seeds corporation (National Seeds Corporation of India (State Farms Corporation of India now merged with NSC), as well as the private sector have played a role in the increasing availability of quality seeds in the market. The public sector has largely been focused on ensuring the availability of a variety of seeds of food crops (including cereals, oilseeds and pulses) which are relatively higher volume, lower margin products. Whereas, the private sector has been a dominant player in the hybrids space, particularly in crops such as cotton, maize, sorghum, millet, rice, sunflower and vegetables, especially in recent years.

Seeds can broadly be classified into varieties, hybrids and GM seeds, based on how the seeds are developed and their genetic characteristics.

A seed typically takes five to seven years to hit the market

Seed development is a complicated process, requiring a high degree of supervision and control to maintain the genetic purity of the seed. After development in the laboratory, which can take between 3 to 5 years, and before reaching the market, a seed goes through four stages:

Stages in creating a Marketable Seed



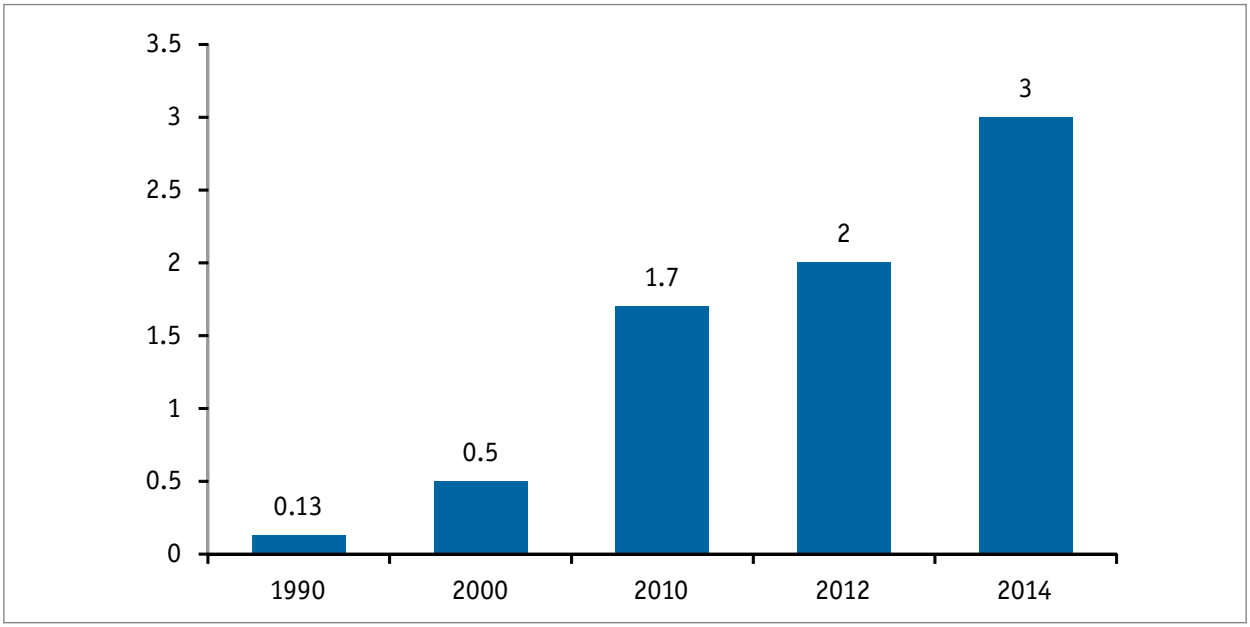
Source: Dept of Agriculture and Cooperation, YES BANK Analysis

Indian Commercial Private Seed Industry Size (2013)

Crop	Seed Industry Size (Rs billion)	Crop Area (mn hectare)
Cotton	46	11.4
Wheat	19.8	30.6
Paddy	16	42
Maize	11	9.7
Groundnut	9	4
Soya	7.7	12.2
Vegetables	8	8
Others	2	50.7
Total	**119.5**	**168.7**

Source: Phillip Capital India, YES BANK Analysis

Indian Industry Size (In USD Billion)



Source: Industry Sources, YES BANK Analysis

Major Seed Companies in India and indicative turnovers

S.no	Company	Turnover FY13/FY14 (INR Cr)
1	Advanta Seeds*	1512
2	Nuziveedu Seeds	1200
3	Kaveri Seeds	1011
4	PHI Seeds	800
5	NSC- National Seeds Corporation	738
6	Mahyco Monsanto Biotech	650
7	Mahyco Seeds	600
8	Syngenta Seeds	600
9	SFCI**- State Farms Corporation of India	512
10	Ankur Seeds	500
11	Shriram Bioseed	457
12	Bayer India	420
13	Rasi Seeds	400
14	Monsanto India Limited (Corn)	366
15	Krishidhan Seeds	350
16	Ajith Seeds	300
17	Monsanto Holdings (Cotton, Seminis vegetables)	300

S.no	Company	Turnover FY13/FY14 (INR Cr)
18	Tulasi Seeds	225
19	Metahelix	225
20	SeedWorks India	200
21	Nunhems India	250
22	J.K. Agri Genetics	189
23	Ganga Kaveri Seeds	200
24	Namdhari Seeds	120
25	Bejo Sheetal/ Safal Seeds/ Kalash Seeds	70
26	Indo American Seeds	50
27	State Seed Corporations	3000
	Top 27 companies	**INR ~15250 Cr**
	Total Industry Size	**INR ~18250 Cr**
*- Including global sales, standalone sales are INR 83 Cr. **- SFCI merged with NSC effective 1st April, 2014.		

Source: Annual reports of listed entities, Approximate figures quoted by industry sources, YES BANK Analysis

The domestic seeds market is expected to see 15-17 per cent growth over the next three years, crossing Rs 200 billion by 2016-17. The growth in the market will be driven by a combination of factors:

- ✓ A larger addressable market as a result of an expected increase in area under irrigation as well as new crop management techniques that allow higher cropping intensity

- ✓ Higher expenditure per hectare on seeds, driven by higher realisations as well as increasing use of hybrid seeds across crops including maize, cotton, bajra, paddy and vegetables.

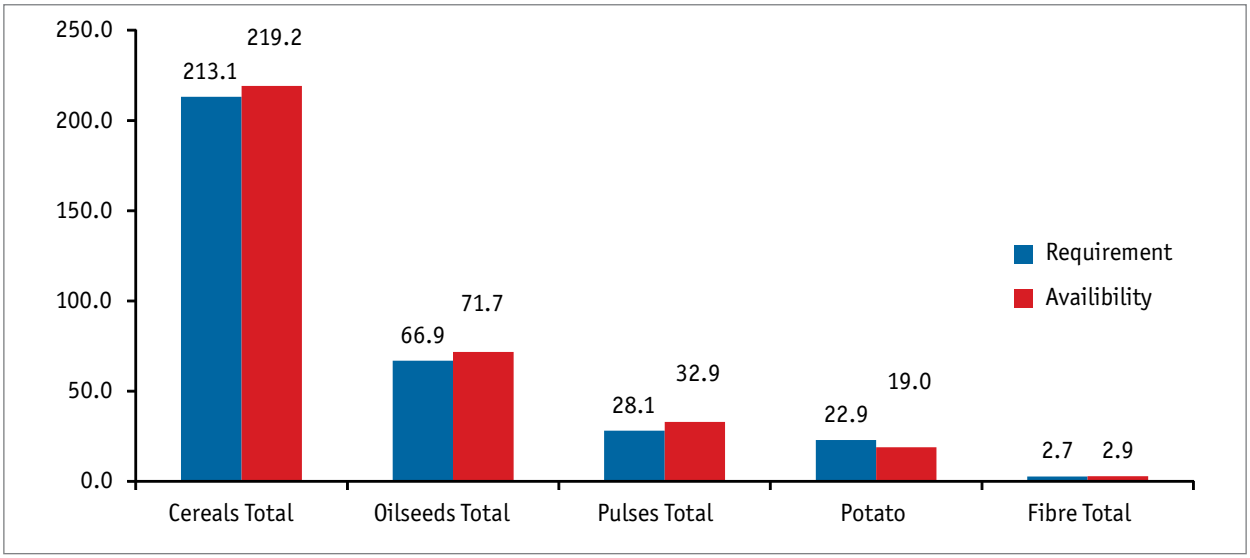
- ✓ Increased penetration of market purchased seed: Increasing preference from consumers/farmers for genetic and physical purity of seed, which is developed by well-established seed companies with strengths in R&D and product development. Hybrids have 100% seed replacement rates as F2 seed can not be used for the next season and hybrid vigour is expressed only in one generation (F1 hybrid seed or market purchased seed).

- ✓ The demand for branded seeds which guarantee high genetic and physical purity from farmers is increasing as seed is the fundamental input to agriculture which contributes 25% -30% of the overall productivity. It is to be noted that all other inputs like nutrients, water, labour, pesticides, management and credit are applied to the plant which develops from the seed, which makes it a vital ingredient to the economic progress. Further the shift of consumer behavior for improved branded seeds helps farmers mitigate the yield and quality risks which are inherent to agriculture operations. An improved seed with superior traits coupled with good management practices therefore establishes a good crop stand and protects farmers to a great extent from various agro-climatic risks for realizing a profitable agriculture.

- ✓ Although seed requirements of the country as per National seed plan 2014 and other Min of Agriculture sources are being met regularly, the organized seed sector is currently able to tap the demand for quality seed with high genetic and physical purity only to an extent of 28%-30% as per SRRs published by Government sources and a great potential exists for the seed industry to produce and market superior seeds of high quality. In addition to the above there is a great potential with increasing Hybrid seed penetration in various States. Further improvement in cropping intensities under better crop management systems and agronomic practices will also promote demand for improved seeds.

- ✓ The strength of R&D based on a strong foundation of germplasm and genetic diversity developed inherently by a seeds organization is a critical success factor for the growth of any seed company. Companies which are built on strong fundamentals of conventional plant breeding with capabilities for biotechnology integration and which have gained expertise product introductions and lifecycles have a competitive advantage over others. Such companies/organizations both in private and public sector will be in a position to develop comprehensive range of seeds required for diverse requirements of farmers. Further as seed production happens through agriculture, companies which also have mastered the supply chain management over years of delivering quality seed to farmers will thrive better than their peers.

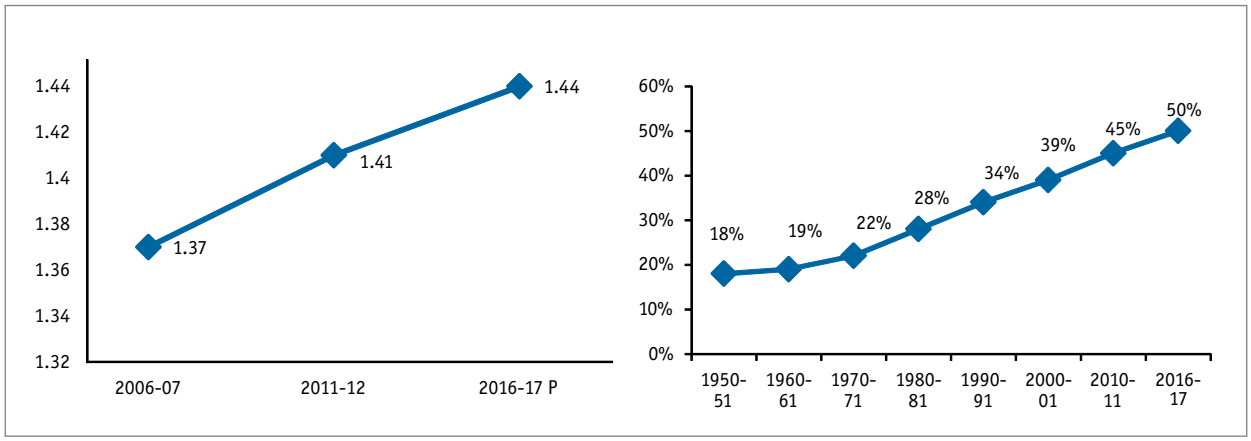
Requirement & Availability of Major Crop Seeds in India in the Year 2013-14 (In Lakh Qtl.)



Source: Ministry of Agriculture, YES BANK Analysis

A steady expected increase in the area under irrigation as well higher cropping intensity will both drive the consumption of seeds:

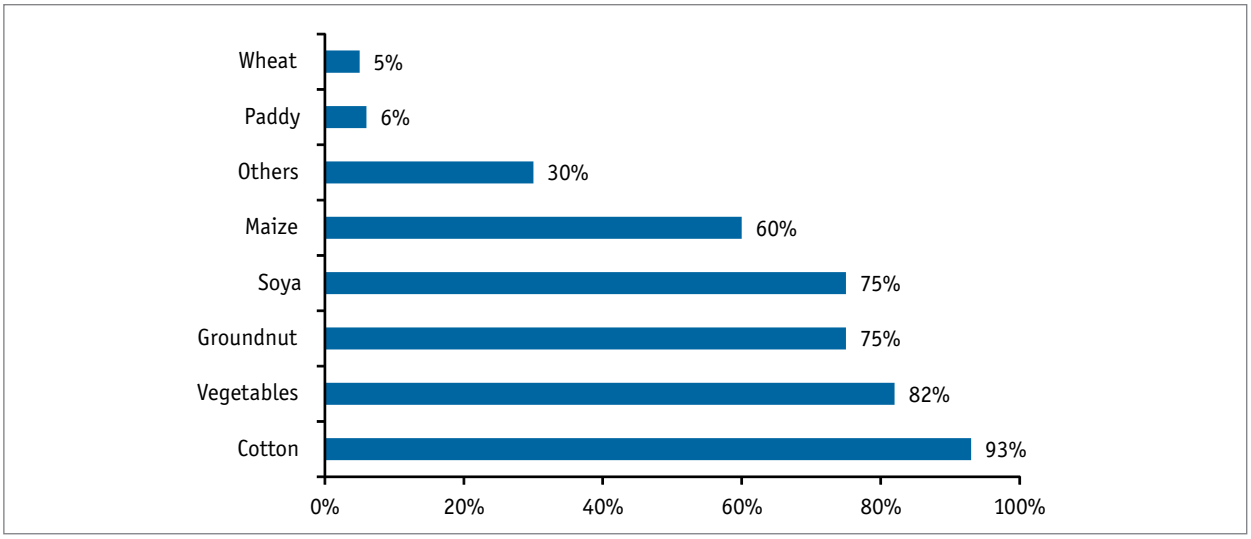
Cropping intensity (Times) and Irrigation penetration (Net area irrigated by net sown area) over time



Source: MOA, YES BANK Analysis

Hybrid seeds in cross pollinated crops give higher yield, hence, greater emphasis is given to hybrid seeds to improve crops productivity.

Hybridization of Major Crops in India

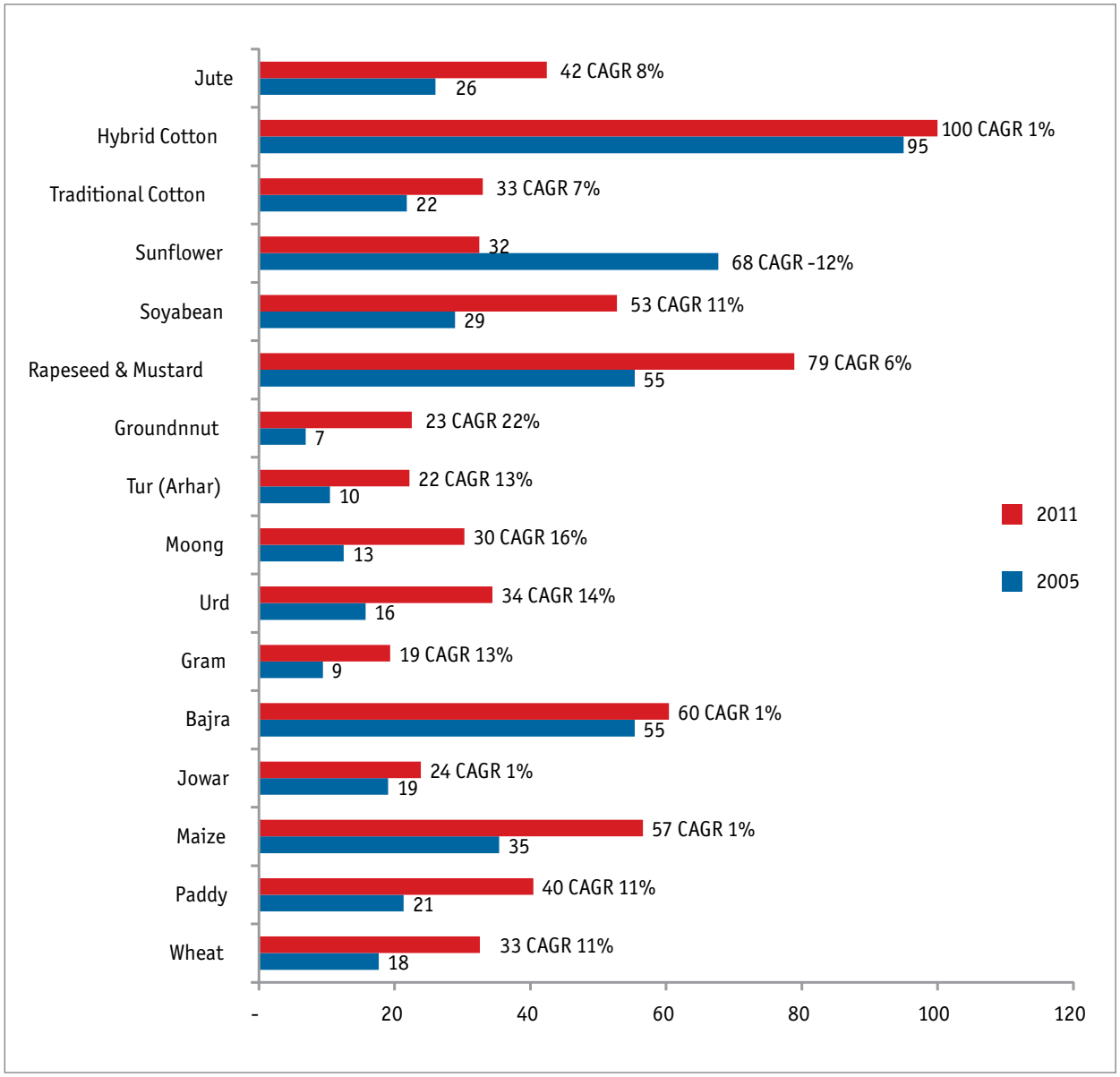


Source: MOA, YES BANK Analysis

Seed replacement rates have been increasing across most crops

The penetration of market-purchased seeds is determined by Seed Replacement Rates (SRR). The SRR is defined as the percentage of the cultivated area which is sown with market-purchased seeds (or new, quality seeds) as opposed to farm-saved seeds. By and large, higher seed replacement rates are associated with higher yields, and typically SRRs are higher in crops where the use of HYVs and particularly hybrids is more prevalent.

Seed Replacement Rates for selected crops



Source: MOA, GOI, YES BANK Analysis

Public Seed Industry

20 state seed corporations (SSCs) and one national level corporation National Seed Corporation (State Farm Corporation of India merged with NSC in 2014) comprise the public sector in seeds. Public sector companies are largely confined to certified seeds of high-volume and low volume products such as pulses, rice and wheat. Research and Development in the public sector is under the aegis of the Indian Council of Agricultural Research (ICAR) and state agricultural universities (SAUs). There are 20 seed certification agencies and 100 states owned seed testing labs.

Private Seed Industry

The Private sector is mainly focused on high value GM and hybrid seeds like cotton, cereals, millets and vegetables. There are around 500 players in the seed industry with small companies having fragmented and local presence. Many big companies are having colorations with the global partners. The private seed sector now comprises some twenty or so large players (with sales turnover exceeding Rs. 200 Cr), several medium companies (sales turnover between Rs. 200 Cr and Rs 20 Cr), and a large number of small, unorganized players (sales turnover less than Rs. 20 Cr) with local presence.

Private firms in the Indian seed and agbiotech industries can be classified into five categories based on their R&D capabilities, sales revenues, and sales volumes, as follows:

- ✓ **Technology firms** are suppliers of traits, transgenic events, and other technologies that are accessed from both India and foreign countries and provided to Indian seed companies. These firms generally do not have their own seed production and marketing operations, but specialize in licensing their products to other, more downstream firms. Examples include Mahyco-Monsanto Biotech, Metahelix etc

- ✓ **Trading companies** are firms that multiply, distribute, and market publicly developed crop varieties and hybrids, and generally have no in-house R&D capacity.

- ✓ **Small-sized seed firms** are similar to trading companies but often augment their production and marketing activities with small breeding programs that rely on technology accessed from other (usually domestic) public or private sources to develop hybrids and varieties that are sold under the firm's brand.

- ✓ **Medium-sized seed firms** are larger than their smaller-sized counterparts in terms of sales revenues and volumes, but are also distinct in that they manage higher levels of R&D capacity, usually in the form of proprietary crop-breeding programs that combine in-house R&D expertise with technologies from other public and private sources.

- ✓ **Multinational firms** are larger, highly integrated enterprises with interests in: (1) seed, agbiotech, and agrichemicals; (2) substantial levels of R&D capacity both in India and abroad; and/or (3) varying degrees of vertical integration that bring together upstream operations in product development (traits, chemicals) with downstream operations in product marketing (seed, chemicals). Examples include many of the "big six" multinational firms: BASF, Bayer CropScience, Dow Agrosciences, Dupont, Monsanto, and Syngenta.

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Seed Regulation in India 3



3. Seed Regulation in India

Seed Regulations & Seed related laws in India	Key Points
Seeds Act (1966)	Passed by the Indian Parliament in 1966 was designed to create a 'Climate' for making good quality seed available to cultivators. The major legislative measures involved under the Act are Seeds rules framed in 1968, Seeds (Control) order, formulated in 1983 after including seeds as an essential commodity. Seeds of food crops, oil crops, cotton seeds, seeds of cattle fodder and all types of vegetative propagating material are included under the act. A total of twenty five clauses have been mentioned in the act. The legislation could be broadly divided into two groups i.e. sanctioning legislation and regulatory legislation. Post the enactment of Seed Act in 1966 and framing of seeds rules in 1968 amendments were brought to the Seed Act in 1972, 1973, 1974 and 1981.
Seeds (Control) Order, 1983	The inclusion of seeds as an essential commodity item under the Essential Commodity Act, 1955 brought the Seeds (Control) Order. The ministry of civil supplies earlier has declared the seed for sowing or planting materials of food crops, fruits, vegetables, cattle fodder and jute to be essential commodities in exercise of power conferred by Section 2(a) of Essential Commodities Act, 1955. The order confers power to the Central Govt. to control, and regulate production, supply and distribution of essential commodities.
New Seed Development Policy (NSDP) 1988-89	The New Seed Development Policy was formulated to provide Indian farmers with access to the best available seeds and planting materials of domestic as well as imported quality. The policy permits the import of selected seeds under Open General License (OGL), to make available to the farmers high quality seeds to maximize yield and productivity. The policy allows import under OGL of items such as seeds of oilseed crops, pulses, coarse grains, vegetables, flowers, ornamental plants, tubers, bulbs, cuttings and saplings of flowers.
Protection of Plant Varieties and Farmers Right Act, 2001	The Protection of Plant Varieties and Farmers Rights Act, 2001 (and rules, which were released in 2003), provide for the protection of intellectual property rights of seed manufacturers, who are required to register /notify the seed which they want to be placed under protection. After due diligence, and establishment of the fact, protection is granted to the variety for a period of 15 years. This legislation ensures not only the protection on intellectual property rights of the company incurring the cost of research and development (in the market at large), but also those of the farmer whose land is being utilised for the production of the concerned seeds.

Seed Regulations & Seed related laws in India	Key Points
National Seed Policy, 2002	National seeds policy was formulated in the year, 2002 to provide an appropriate climate for the seed industry to utilize available and prospective opportunities, safeguarding the interest of farmers and conservation of the biodiversity. The policy raised India's share in the global seed trade by facilitating advanced scientific aspects such as biotechnology to farmers and as a result, in March 2002, the first transgenic Bt. cotton was approved for commercial cultivation in India.
Protection of Plant Varieties Rules, 2003	The rules were enforced for the smooth implementation of the Act, 2001. The rules provide detailed procedures while applying for protection, ways of administering the national gene fund, procedure on application for compensation, procedure to alter the denomination of a registered variety, procedure for cancellation of certificate and all other procedures to be implemented as per the provisions given in the PPV & FR Act, 2001
Seed Bill 2004	With a view to repealing and replacing the Seed Act 1966, the Seed Bill 2004 was introduced. Among others, one of the notable exemptions provided in the Bill with regard to farmers' seed was: "Nothing in this Act shall restrict the right of the farmer to save, use, exchange, share or sell his farm seeds and planting material, except that he shall not sell such seed or planting material under a brand name or which does not conform to the minimum prescribed limit of germination, physical purity, genetic purity". An amended Seed Bill was introduced in 2008 has not been enacted thus far. Therefore, the Seed Act 1966 and its amendments are still in force.

Comparison between Seed Bill 2004 and PPV & FR Act, 2001

Seed Bill, 2004	PPV & FR Act, 2001
Farmer has to claim compensation from a consumer court and redressal under the Consumer Protection Act, 1986	Farmer get compensation from the PPV authority which is all the more simpler
Does not require the declaration of origin of variety along with pedigree details	Requires the declaration of origin of variety along with pedigree details
Does not grant any recognition to the contribution of farmers	Provides rewards for farmers contribution and also the benefit sharing
Seed dealers are not under any obligation to provide reasonable seed supply to farmers	Provides compulsory licensing which safeguards the interests of farming community to ensure adequate seed supply at reasonable price on the Government.
Grant of provisional registration is considered a major draw back	No such provisions have been given

Source: CICR, Nagpur

Statutory bodies of Indian Seed Industry

Statutory Body	Function
State Seed Certification Agencies (SSCA)	The State Seed Certification Agencies (SSCAs) are responsible for seed certification in the concerned states. The SSCAs make field inspections and conduct seed tests required for seed certification.
Central Seed Certification Board (CSCB)	Central Seed Certification Board (CSCB) advises the state governments and their SSCAs on the matters of seed certification.
State Seed Certification Board (SSCB)	Each state has a State Seed Certification Board which supervises the activities of its SSCA.
Protection of Plant Varieties and Farmers Rights Authority (PPV & FRA)	The PPV and FR Authority (Protection of Plant Varieties and Farmer's Rights Authority) is the central body that sets distinctiveness, uniformity and stability (DUS) test guidelines for the registration of 57 crop species covering cereals, pulses, millets, oilseeds, spices, vegetables, flowers, medicinal plants and fibre crops. The authority receives applications under three broad headers; new varieties, existing or extant varieties which existed prior to the existence of the Act, and farmer varieties.
National Seed Research and Training Centre (NSRTC)	National Seed Research and Training Centre (NSRTC) located at Varanasi and is the Central Seed Testing Laboratory (CSTL) under Seeds Act and also a Referral laboratory for courts in India.

Source: CICR, Nagpur

Issues and Challenges-Indian Seed Industry

✓ **Intellectual Property Rights (IPR) of Indian Seed Industry**

The Plant Varieties and Farmers' Rights (PPV&FR) Act of 2001 is the governing law of IPR for the Indian seed industry introduced recently. In addition, the amendment to the Indian Patent Act, 1970 being revised in the year 2002 and 2005, to make Indian laws compliant with the Trade-Related Aspects of Intellectual Property Rights (TRIPS) agreement allowed patenting in the agriculture sector. For replicating the success of the private investment in low volume vegetable seeds to crops like cereal, oilseeds and pulses strong enforcement of strong legal IPRs are required. This in turn would influence the seed companies to substantially boost their R&D spends.

✓ **R&D Investment is Low in India**

High R&D investments are crucial to the success of the Indian seed industry. However, the proportion of the revenues going for R&D activities for Indian companies is much lower than the global peers (around 17 percent for Monsanto) compared to 1.5 percent (Kaveri Seeds). In the public space though the R&D is being done in research institutes and agricultural colleges, commercialization of the successful varieties is an issue.

✓ **Forecasting Market Demand and Inventory Management**

The demand forecasting for the vegetable seeds and BT cotton is one of the key issue for the industry leading to high unsold stocks to be stored as an inventory for the next year. Typically the inventory period for the unsold seed is around 8-9 months.

✓ **Regulatory Uncertainty**

The regulatory uncertainty in India regarding GM crops is affecting the private sector participation for research and development and innovation for cereals and other food crops. Biotechnology companies are planning to invest up to INR 600Cr annually up from INR 200Cr in the recent past due to government recent decision of the field trials of GM crops in India.

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Major Crop Segments of Indian Seed Industry- Analysis of Bt cotton, Hybrid rice, Hybrid corn, Hybrid vegetables

4



4. Major Crop Segments of Indian Seed Industry- Analysis of Bt cotton, Hybrid rice, Hybrid corn, Hybrid vegetables

Bt Cotton[ii]

Introduction to Bt cotton in India

Bt cotton is genetically modified cotton crop that expresses an insecticidal protein whose gene has been derived from a soil bacterium called *Bacillus thuringiensis*, commonly referred as Bt. The Bt strains produce three types of insecticidal toxins, crystal (Cry) toxins, cytolytic (Cyt) toxins and vegetatively expressed insecticidal proteins (vip). These toxins are highly specific to certain insect species. The Bt gene cry1Ac was used to develop the first Bt-cotton variety. The gene was transferred into the genome of cotton using a bacterium called *Agrobacterium tumefasciens*. The transformed cells were developed into a full GM plant now called Bt-cotton. In general, Cry1Ac toxins are highly specific to insects at species level, and are not known to cause any harm to non-target species such as fish, birds, farm animals and human beings.

Need for Bt Cotton in India

a. Cotton is a long duration crop and is attacked by large number of insect pests
b. The three bollworms, American bollworm, *Helicoverpa armigera*, Pink bollworm *Pectinophora gossypiella* and the Spotted bollworms, *Earias vittella* and *Earias insulana* are major pests and cause serious threat to cotton production
c. High usage of insecticides resulting in high cost of cultivation and environmental issues. About 9400 MT of insecticides worth Rs 747 crores were used only for bollworm control in 2001.
d. Bollworms, especially the pink and spotted bollworms are hidden feeders and generally do not come into direct contact with insecticide sprays.
e. The American bollworm which comes into contact with insecticides, partially, has developed resistance to almost all the insecticides recommended for its control in all regions of the world.
f. Nearly 90% of all insecticides in Pakistan and about 50.0% of all insecticides in India were being unsuccessfully used for cotton pest control, until the year 2001, before Bt cotton was introduced. Of these insecticides about 70.0% was for bollworm control and the rest for sap-sucking insects.
g. Resistant sources are unavailable in the germplasm and resistance breeding has been unsuccessful.

[ii] *Bt Cotton, Q&A, Dr. K.R. Kranthi, Central Institute for Cotton Research, Nagpur*

Developers of Bt cotton technology in India

Six Bt cotton events have been approved thus far in India for commercial cultivation. There are four Bt Cotton events expressing Cry1Ac, one event with Cry1C, and one event with Cry2Ab2.

Approved Bt cotton developers in India

Event Name and Code	Trade Name	Company
Cotton - Gossypium hirsutum L. : 6 Events		
Name: BNLA-601 Code: not available	not available	Central Institute for Cotton Research and University of Agricultural Sciences Dharwad (India)
Name: Event1 Code: not available	JK 1	JK Agri Genetics Ltd (India)
Name: GFM Cry1A Code: GTL-GFM311-7	not available	Nath Seeds/Global Transgenes Ltd (India)
Name: MLS 9124 Code: not available	not available	Metahelix Life Sciences Pvt. Ltd (India)
Name: MON15985 Code: MON-15985-7	Bollgard II™ Cotton	Monsanto Company (including fully and partly owned companies)
Name: MON531 Code: MON-ØØ531-6	Bollgard™ Cotton, Ingard™	Monsanto Company (including fully and partly owned companies)

Source: ISAAA

Number of Bt hybrids available in India

The Bt-cotton technology was first approved in 2002 by the GEAC for commercial cultivation in central and south Indian cotton–growing zones in India in the form of three hybrids (MECH-12, MECH-162, and MECH-184). Subsequently, the GEAC approved RCH-2 (Rasi seeds) in 2004, for cultivation in the central and southern zones.

In 2005, another 16 hybrids were approved. Thus, the total reached to 20 Bt hybrids, with 6 for north, 12 for central and 9 for south India, thus making available the technology for entire country. Realizing the immense potential of the technology, several Indian Seed companies rushed forward as sub-licensees of the technology to acquire the rights to incorporate the cry1Ac gene into their own hybrids. By 2006, the total number of hybrids reached 62, with an additional approval of 38 more hybrids from 15 companies, which also included the commercial release of two new Cry1Ac based events, GFM-Cry1A of China and Event-1 of JK seeds. By May 2012 there were 1128 Bt cotton hybrids available in the market.

Mahyco Monsanto Biotech (India) Limited, a 50:50 joint venture between Mahyco and Monsanto Holdings Pvt. Ltd. has sub-licensed the Bollgard II and Bollgard technologies to 28 Indian seed companies each of whom has introduced the Bollgard technology into their own germplasm[iii].

[iii] *Mahyco Monsanto Biotech website*

Impact of Bt cotton in India

Cotton is one of the key crops considered to be integral part of India. India by far has the largest cultivable area (about 12 million hectares) under cultivation in the world and it is the largest producer followed by China & US. India will produce about 40 million bales of cotton lint during 2014-15 above China which is around 29-30 million bales. The productivity of Cotton has gone up from one of the lowest in the world (about 320 Kg/Ha) to about 529 Kg/Ha during 2013-14. Cotton area was on the decline in India because of frequent bollworm infestation and outbreaks. The area declined from an average of 8.7 mi Ha in 2001 to a meager 7.67 mi Ha in 2002 and 2003. With the advent of Bt-cotton, this area increased to 12 mi Ha in 2014. Thus there was an additional increase of at least 4 mi Ha because of the introduction of Bt-cotton.

Cotton area in some states increased significantly in three states, Gujarat, AP (including Telangana) and Maharashtra. The area in Gujarat was 16.87 lakh hectares in 2001, but, it increased to 30.23 lakh hectares by 2011. The area in Maharashtra was 29.8 lakh hectares in 2001, which increased to 40.91 lakh hectares by 2011. The area in Andhra Pradesh was only 10.0 lakh hectares in 2001, but increased to 18.8 lakh hectares by 2011.

Growth of Bt Cotton over 2002-2014

Year	Area (mi Ha)	Yield (Kg/Ha)	% of Bt Cotton
2002-03	7.67	302	0.6
2012-13	11.98	518	93
2014-15	12.0	565	95

Source: CICR- Central Institute for Cotton Research, ISAAA, YES BANK analysis

State wise increase of crop area under Bt cotton in India

The major gains in production have been mainly from Gujarat, AP and Maharashtra, the key growing regions with high adoption of Bt cotton hybrids.

Progress of %Area under Bt cotton and Current production in India

State	2002 (%)	2003 (%)	2004 (%)	2005 (%)	2006	2007	2011	2014-15 Area Lakh Ha	2014-15 Production (Lakh bales)
Punjab				7	21	50	94	4.5	14
Haryana				2	8	46	92	6.39	25
Rajasthan				1	1	10	70	4.16	17
Gujarat	1	3	7	10	19	35	74	30.06	125
Maharashtra		1	7	22	57	82	96	41.92	85
MP		2	14	22	49	80	99	5.79	18
AP		1	8	27	68	84	99	23.87	77
Karnataka	1	1	4	6	12	27	74	7.6	28
TN		3	12	12	38	67	82	0.7	5
All India								117	400

Source: CICR, CCI. 2014-15 area and production included Bt and traditional cotton.

Global impact of Bt cotton on yields

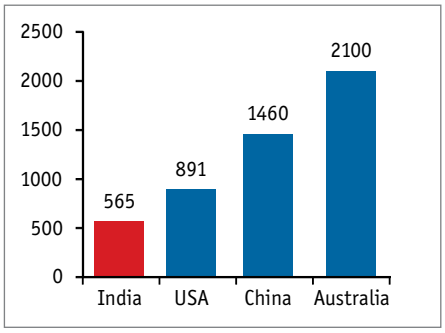
The yield increases range from 47 to 93% in the four major countries which are cultivating Bt-cotton.

Progress of Global Bt Cotton yields

Country	Year of release	GM cotton area (Lakh Ha)-2010	Total cotton area (2010)	% of GM cotton	Yield before GM cotton (Kg/Ha)	Yield in 2014 (Kg/ Ha)	% yield increase
India	2002	94	111.4	95	292	565	93
USA	1995	40	43.3	92	602	891	48
China	1997	35	51.5	61	890	1460	64
Australia	1996	5	5.9	85	1425	2100	47

Source: International Cotton Advisory Committee, ICAC, Washington

Yield comparison of Bt cotton (2014)



Source: USDA, ICAC and YES BANK analysis

Future versions of Bt cotton

Monsanto's Bt-cotton technology Bollgard-II contains Cry1Ac + Cry2Ab. Dow agro Sciences are conducting trials with Wide-strike (Cry1Ac + Cry1F + pat); Bayer, India have initiated trials with twin-link (Cry1Ab + Cry2Ae + pat) and JK Agri Genetics have started trials on Cry1Ac+Cry1EC. The vip3A gene is yet another toxin that is likely to be pyramided with the existing toxins.

Key players in Bt cotton

Company	No. of packets sold (450gr) in 2014 (mi)	Key brand names
Nuziveedu Seeds	10	Mallika, Bhakti, Malini, Balwan, Uttam, Shilpa, Super Raksha
Kaveri Seeds	6	Jaadoo, Jackpot, ATM, Singha etc
Mahyco	4	MRC 7351, Dr Brent, Chaitanya, Nikki etc
Ajith Seeds	2	Ajeet 11, Ajeet 111, Ajeet 155, Ajeet 199 etc
Ankur Seeds	2	Ankur 651, Ankur-09, Ankur 2534, Ankur-2226
Rasi Seeds	3	RCH 134, RCH 656, RCH 650, RCH 602 etc
Bioseed	2	Yuva, Bindass
Total industry size	**45 million packets**	

Source: Industry, YES BANK analysis

Hybrid Rice [iv]

Rice is staple food of more than 65 % of Indian population. It accounts for about 40 % of total food grain production and 45 % of total cereal production in the country. In order to meet the domestic demand of the increasing population the present day production of 106 million tons (2014) of milled rice has to be increased to 125 million tons by the year 2030. Since the yield of high yielding varieties (HYVs) of rice is on the decline, it is rather difficult to achieve this target with the present day inbred varieties. Therefore, to sustain the self sufficiency in rice, additional production of 1.2 million tons is needed every year. Among the limited options, hybrid technology is the only proven technology currently available for stepping up rice production significantly.

The rice hybrids, recently introduced in cultivation, on an average, give 10 to 15 q/ha additional yield over the conventional varieties (about 20 % increase). Therefore, the introduction of hybrids and popularization of their production technology are feasible and readily adoptable to achieve targeted production. India has Hybrid rice penetration of about 6% at the end of 2014. Generous support of policy makers, liberal funding from donors and creation of research infrastructure enabled India to become second country in the world after China to develop and commercialize hybrid rice. In India, in 2014, hybrid rice occupied 2.5 million hectares of area from 0.5 million Ha in 2004 and contributed additional rice production of about 5 to 6 million tons. Besides China and India, the hybrid rice technology has also been adopted in other countries of the world.

Area under hybrid rice in different countries (2003-2013)

Country	Area (Ha)- 2003	Area (Ha)- 2012/2013
India	280,000	2,500,000
China	15,215,000	17,000,000
Vietnam	480,000	610,000
Bangladesh	40,000*	670,000
Philippines	208,342	160,000
Myanmar	50,000	860,000
Indonesia	20,000	600,000
USA	20,000	
Others	50,000	
World total		160,000,000

*Source: Dept of Agriculture and Cooperation, YES BANK analysis. *- Area in 2000*

Constraints in Hybrid Rice production[v]

Constraints	Key issues
Technology Constrains	✓ Marginal heterosis of the available hybrids ✓ Narrow genetic base of the female parental lines ✓ Diversified consumer preferences for grain quality ✓ Very few hybrids in late duration and limited choice of hybrids for unfavourable agro-climatic zones ✓ Susceptibility of parental lines to major pests & diseases
Social and Economic constraints	✓ Higher initial seed cost increasing the burden on small and medium farmers ✓ Farmers are paid lower market price by the millers/traders for hybrid rice
Policy constraints	✓ No uniform subsidy component on hybrid seed cost ✓ Restrictions on providing subsidy only to the Govt. notified hybrids ✓ Lack of focused extension strategy

Source: Directorate of Rice Research

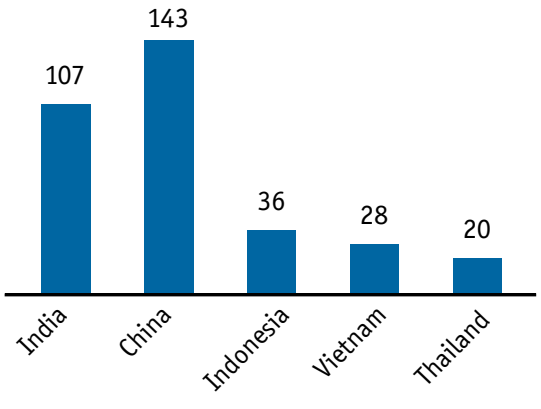
[iv] *Guidelines for Seed Production of Hybrid Rice, Department of Agriculture & Cooperation*

[v] *Hybrid Rice Research and Development in India, AS Hari Prasad, BC Viraktamath and T Mohapatra from Directorate of Rice Research, Hyder abad and Central Rice Research Institute, Cuttack, India*

Future Hybrid Rice Strategies

Research Strategies	Seed Production Strategies	Technology transfer strategies
✓ Development of parental lines that can produce highly heterotic rice hybrids ✓ Development of heterotic gene pools (a concept well exploited in corn needs to be explored in hybrid rice development) ✓ Diversification of CMS sources ✓ Identification of alternate sources suitable for hybrid seed production ✓ Human resource development through exposure visits and training programmes	✓ Refining the seed production technology to enhance the seed yields, so that cost of hybrid rice seed can be reduced. ✓ Involvement of seed agencies in the public sector, NGOs, and farmers cooperatives along with private seed sector ✓ Strengthening the existing institutional mechanism for the production and supply of breeder, foundation, and certified seed	✓ Extension agencies to play greater role in creating much needed awareness among the farmers about the advantages of cultivating hybrid rice through various innovative strategies. ✓ Identification and popularization of promising hybrids for different states from the available released and notified hybrids

Source: Directorate of Rice Research

Factors favourable for Hybrid rice in India	Key rice producing countries (mi MT, 2013)
✓ New generation rice hybrids are devoid of many of the drawbacks of the earlier released hybrids. ✓ Public policy in favour of increased private sector participation in R&D ✓ Increasingly receptive farming community for adoption of hybrid technology. ✓ Subsidy on seed cost for notified hybrids ✓ Abundance of qualified scientific and technical manpower in MNC, Private and Public rice R&D institutions.	

Source: Industry, YES BANK analysis

Key players in Hybrid Rice

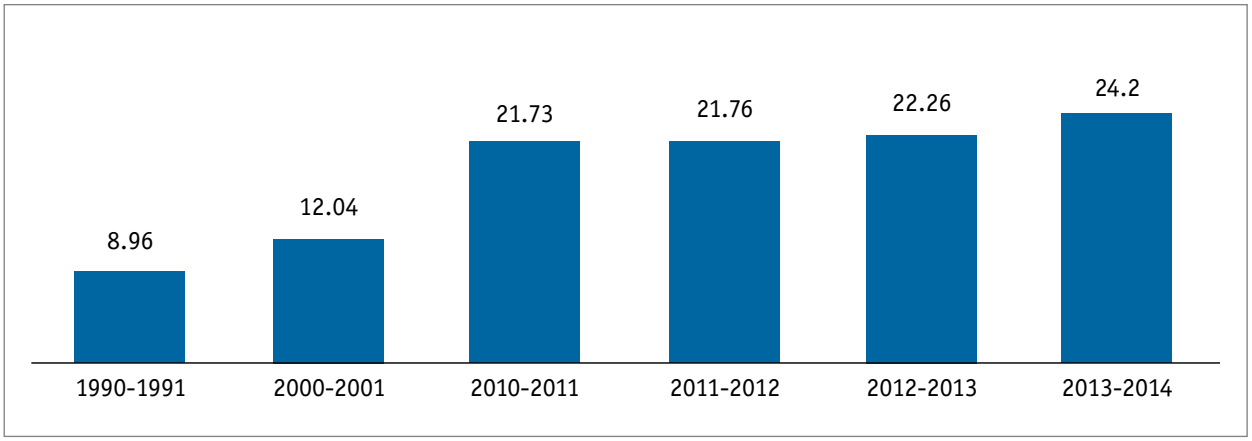
Company	Key brand names
Bayer Bio Sciences	Arize 6129 Gold, Arize Swift, Arize 6444 etc
PHI Seeds	PHB71, 27P31, 27P52, 29P38, 27P63, 25P25
Mahyco Ltd.	Raftaar Suruchi, Dhandev Suruchi, Dhananjay Suruchi, Shahi Dawat
US AgriSeeds	US 311,312,316,328, and 383
Metahelix	Dhanya 775, 748
Nuziveedu Seeds	Kanak,Saurabh,Moti, MotiGold, Karishma
JK Agri Genetics Ltd.	JKRH-401, JKRH-2020, JKRH-1220, JKRH-3333
Syngenta Seeds	Sahyadri (Public hybrid), NK-5251, 3325, 5017, 6301, 6302
Public Sector	KRH-2, DRRH-2/3, Pusa RH-10, Sahyadri
Advanta India Ltd	PAC-801, PAC-832

Hybrid Maize [vi]

Maize was the first major cereal crop in human civilization to be affected by hybridization. It is the most widely distributed crop of world being grown in diverse seasons and ecologies with highest production and productivity among food cereals. It is grown in about 166 countries occupying 165 mi Ha area with production of more than 800 million tons and productivity of 5.1 tons/ha. It is used worldwide for about 3500 products of different uses as feed (61%), food (17%) and also serves as a source of basic raw material of number of industries (22%) viz., starch, ethanol, oil, alcoholic beverages, food sweeteners, pharma, cosmetics etc. No other cereal can be used in such many ways as maize.

In India maize has higher growth rate among food crops contributing 5% area, 2.4% production to world maize output and Rs. 155 billion to Indian agriculture GDP. In India as per the latest report (2013-14), maize area, production and productivity is 9.3 mi Ha, 24.2mi MT and 2.6 MT/Ha, respectively.

Maize production in India from 1990 to 2014 (in million tonnes)



Source: Dept of Agriculture and Cooperation, Govt of India

[vi] *India Maize Summit 2014 report, Directorate of Maize Research- Vision 2050*

The maize production has increased >14 times from a mere 1.73mi MT (1950-51). The demand for maize will touch 42 mi MT by 2025 as per the trade predictions. Maize is accounting over 9% of the total cereals and occupied third place after rice and wheat. It is the crop of future as mentioned by the father of the Green Revolution, renowned Nobel laureate Dr. Norman E. Borlaug.

In India, almost all 28 states grow maize, but 60% of its area concentrated in 6 major states i.e., Andhra Pradesh (including Telangana), Uttar Pradesh, Karnataka, Rajasthan, Bihar and Madhya Pradesh. Maize production is dominated by Andhra Pradesh and Karnataka, producing 37 per cent of India's maize in 2012-13. Area under hybrid seeds in 2013-14 is estimated to be 60 per cent of the total area under maize cultivation. Andhra Pradesh has the highest yield followed by Tamil Nadu due to majority of the area being covered under Single Cross Hybrids (SCH).

State wise area and production of maize during 2012-13

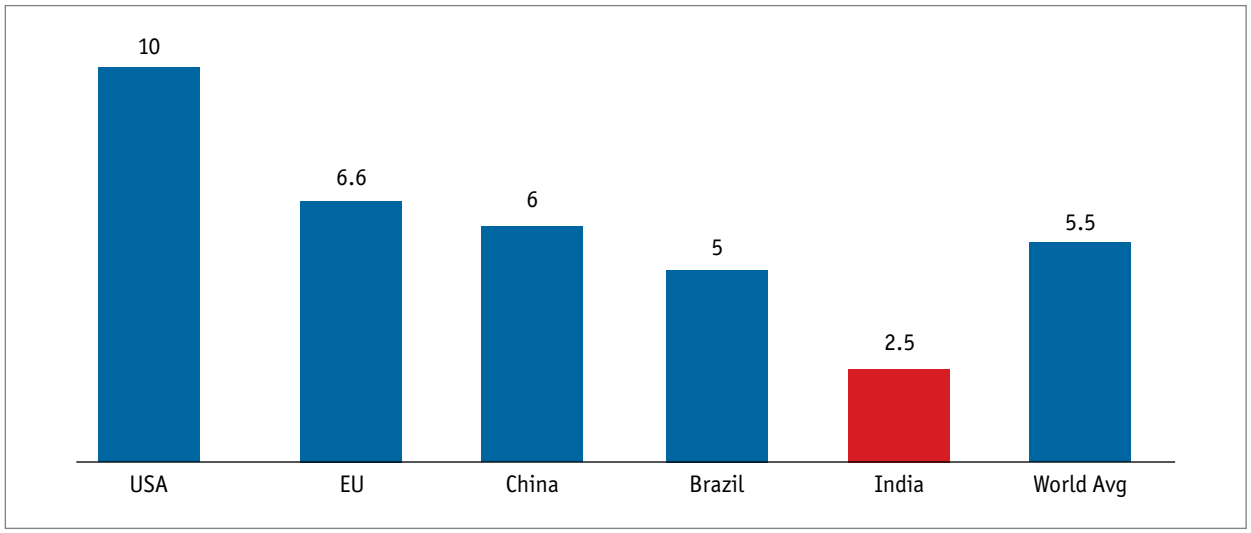
State	Area under Hybrids	Area (mi Ha)	Production (mi MT)	Yield (MT/Ha)
Karnataka	100%	1.3	4.4	3.5
Rajasthan	25%	1.1	2.1	1.8
Madhya Pradesh	16%	0.8	1	1.2
Maharashtra	100%	0.9	2.6	2.9
Andhra Pradesh	100%	0.7	4	5.3
Uttar Pradesh	21%	0.8	1.1	1.5
Bihar	80%	0.6	1.4	2.2
Gujarat	21%	0.5	0.8	1.6
Tamilnadu	100%	0.2	1	4.5
Others	60%	1.6	3.3	2.1
All India	60%	8.6	21.7	2.5

Source: Dept of Agriculture and Cooperation

USA has the highest productivity at 10MT/Ha when compared with the global average of 5.5 MT/Ha due to 85 percent of the area under Bt-SCH (Single Cross Hybrids) and remaining 15 per cent under SCH seeds backed by temperate climate and long duration crop. The yield in EU nations is as high as 6.6 MT/Ha due to 100 per cent area under SCH, temperate climatic conditions and long duration crop. The yield in China is low at 6MT/Ha when compared to USA and EU nations due to sub-tropical climate and medium duration crop. Brazil has lower yield at 5MT/Ha due to dependence on rainfall and tropical climatic conditions.

The differences in yield across the globe are mainly due to environmental, technological, economic and organizational factors. In most developed countries the climate is temperate; likewise they use sufficient inputs and a well mechanized system for the maize production.
In India, the yield is half of the global average. Constraints for low productivity include: erratic climate resulting in either drought or floods, majority production is during rain fed kharif season, only 30% of area under SCH in India.

Comparison of Indian and Global Maize yields (MT/Ha)



Source: USDA

Key Drivers of Maize industry in India

Multiplicity of maize usage in everyday life would increase manifold

Presently, only 25% of maize is used as foodgrain, while remaining 75% is used to meet non-food demand, viz. bio fuels, poultry feed, animal feed, brewing alcohol, starch based wet milling industries and other industrial uses.

Expansion in area under hybrids would transform Indian maize scenario

Hybrids constitute just 60% of total plantings in a given year in India. This estimated to go up to 90% of the total area by 2050 providing a major boost to the maize seed industry.

Private sector R&D would lead to enhanced investment in maize research

The enhanced investment in maize by global seed companies would flow into India through technology transfer and Public-Private Partnerships in the next fifty years to develop maize.

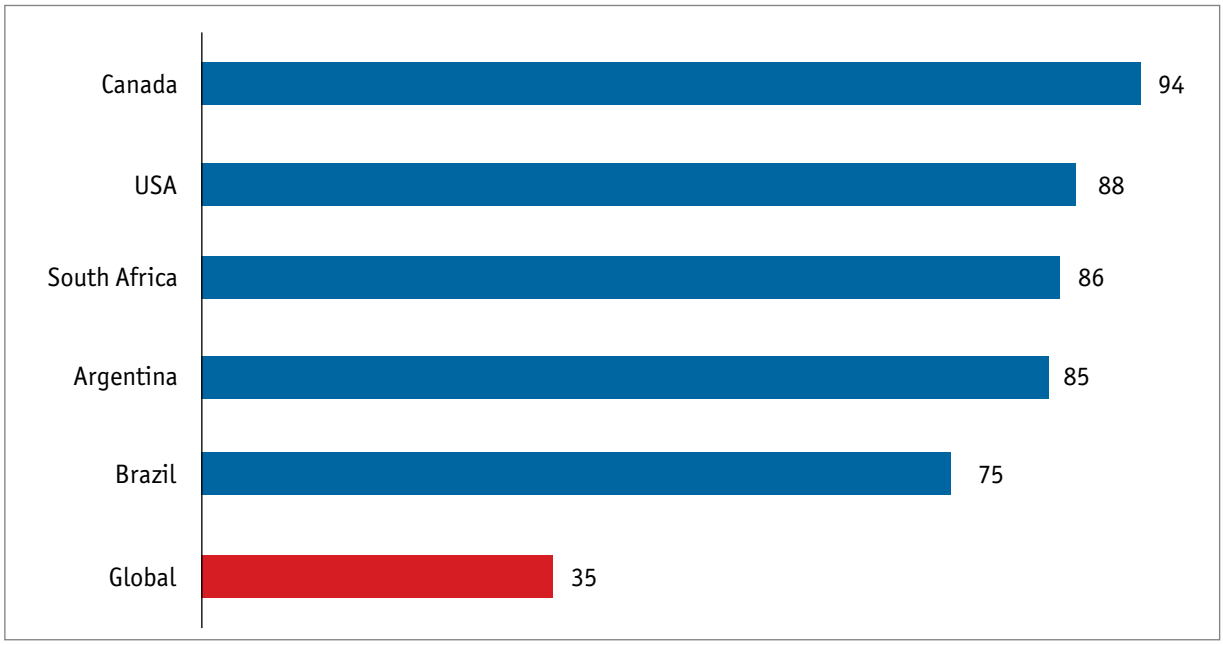
Next generation agronomics would provide superior on-farm solutions

A genotype, however superior it may be, cannot achieve its full potential unless it is put into an enabling agronomic context. In future, comprehensive agronomic service packs would be available combining the best of precision agriculture technologies with intelligent management practices.

Global expansion of genetically engineered maize cultivars offer new R&D opportunities

Today, hybrids with transgenic traits are planted in 17 countries in an area of 55.1 million ha, which amounts to 35% of global maize acreage. India is yet to take a firm stand on commercialization of GM traits in food crops. Currently, in India, multi-locational field trials of transgenic maize are going on for insect resistance and herbicide tolerance traits by private sector developers. Stem borer resistant transgenic maize developed by the Directorate of Maize Research is also undergoing greenhouse trials.

Penetration of GM maize crop in key countries (in %)



Source: ISAAA

Opportunities in Maize towards 2050

Genetic engineering and gene stacking By 2050, the area under transgenic cultivars would enlarge manifolds in India and the world. This would necessitate a shift from the present day genetic engineering to the futuristic 'genome engineering'.

Maize technologies that are possible for future development

2013	2020	2030	2040	2050
✓ Insect resistance (Bt) ✓ Herbicide tolerance ✓ Enhanced lysine ✓ Modified amylase ✓ Drought tolerance	✓ Insect resistance (RNAi) ✓ Low phytate ✓ High nitrogen use efficiency ✓ Herbicidal hybridization system ✓ High oil	✓ Salinity tolerance ✓ Fungal resistance ✓ Virus resistance ✓ Nutritional enhancement ✓ Nematode resistance	✓ Modified cellulose ✓ Comprehensive nutrient efficiency ✓ Heat tolerance ✓ Cold tolerance ✓ Enhanced yield	✓ Nitrogen fixation ability ✓ Ratooning ability ✓ Fixation of heterosis ✓ Bio-plastics ✓ Molecular pharming

Source: Directorate of Maize Research

Key players in Hybrid Maize

Company	Key brand names
PHI Seeds	30V92, 30B07,30B11,30R77,31Y45,P3501,P3785 P3441,P3540,
Monsanto	Dekalb® 900M Gold, DKC 9081, Dekalb Pinnacle, Super 900M, Supreme, I-lishell, Prabal
Syngenta	NK-6240, NK-61, NK-21
Nuziveedu Seeds	Bond, Sunny,Dragon, Suvarna, Krishna
Kaveri Seeds	Kaveri 225, 2288 (Ekka), 244+, 50, 25K55, 25K60, 25K45 (Bumper)
Total industry size	100,000 MT

Source: Industry, YES BANK analysis

Hybrid Vegetables [vii]

The vegetable seeds market is characterized by intense competition with numerous small and large players competing on the basis of product performance, continuous research and development, introduction of new traits and attainment of intellectual property rights and protection. The leading companies in the global vegetable seed sector valued approximately at USD 8 billion and include Vilmorin & Cie (Limagrain group), Monsanto, Syngenta AG and Bayer Crop Science among others.

Global leaders in vegetable seed markets and their sales

Company	Sales of Vegetable seed (million US Dollar)
Monsanto	752
Vilmorin & Cie	635
Syngenta	545
Nunhems (Bayer group)	389
Rijk Zwaan	316
Top 5 companies turnover	2.63 Billion USD (~2.33 Billion Euro)

Source: Vilmorin & Cie annual report 2013-14

In vegetables most of the public sector varieties and hybrids are replaced by private sector varieties and hybrids, seed production of which is solely done by the specific seed companies. Indian companies are mainly concentrating on vegetables like tomato, cabbage, brinjal, chilli, okra and cucurbits where the seed production of OPVs and hybrids is comparatively easy and more profitable. Private seed corporations are spending 10-12% of their turnover in R&D. Medium sized seed companies annual investment in R&D is growing 20% annually.

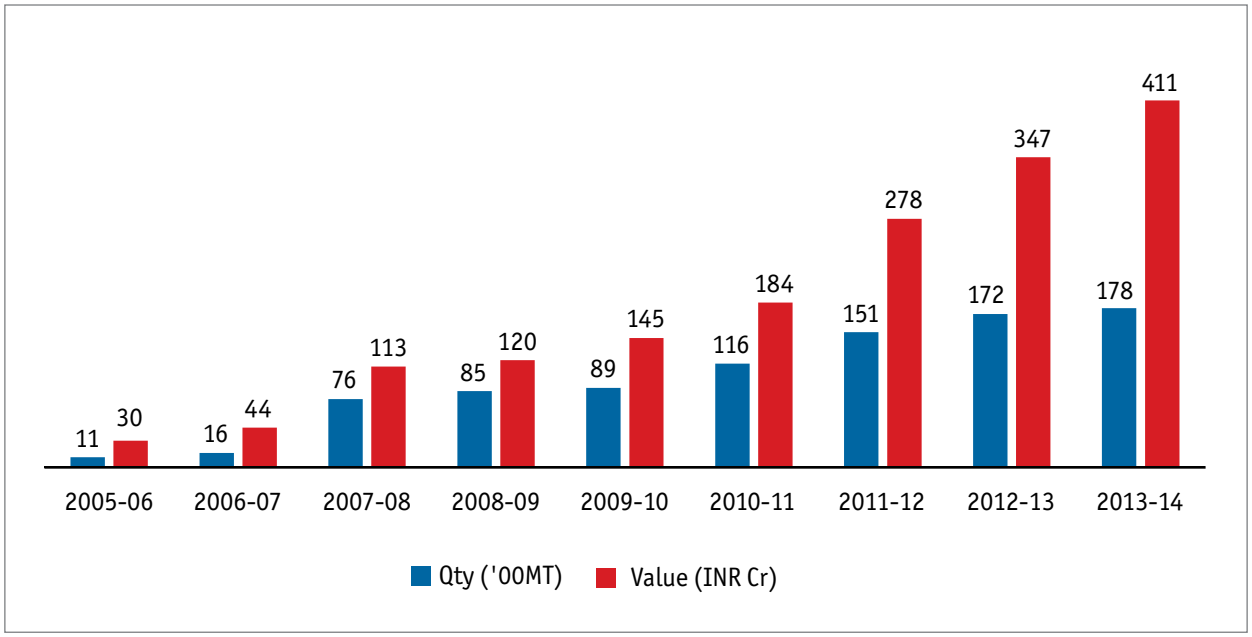
There has been an increase of 200% in Indian vegetable hybrid seed market during 1998-2014. The estimated turnover of Indian seed industry (INR 2000Cr) is approximately four percent of the global seed turnover. The vegetable seed business in India, at present, amounts for INR 2000 Cr accounting for 6% value wise share of different crops in Indian seed business.

[vii] *Indian Vegetable Seeds Industry: Status And Challenges, A V V Koundinya and P Pradeep Kumar, Department of Vegetable Crops, BCKV. Vision 2030, Indian Institute of Vegetable Research, Varanasi.*

India Facts and Figures

The country has exported 17817 MT of fruits and vegetables seeds (largely OPVs) to the world for the worth of Rs. 410 crores during the year 2013-14.

Fruits and Vegetable Seed exports from India



Source: APEDA

Major Export Destinations (2013-14): Pakistan, USA, Bangladesh, Netherland, Japan, and Thailand were major importing countries of Indian seeds during the same period.

Factors promoting vegetable seed industry

1) Ever Increasing Demand

The worldwide production of vegetables has doubled over the past quarter century and the value of global trade in vegetables now exceeds that of cereals. India is emerging as the second largest producer of vegetables and production has been increased almost three times from 58.5 million MT in 1991-92 to 163 million MT in 2013-14. Increase in yield is mainly attributed to expanding areas under high yielding vegetable varieties and hybrids. Total cultivated area under vegetables has been increased from 5.59 mi Ha in 1991-92 to 9.4 mi Ha in 2013-14. Finally, it leads to ever increasing demand for the quality vegetable seed. Moreover, the yield of crops are higher when produced from replaced seeds than own saved seeds.

Seed replacement rates are high for vegetables like cabbage (100%), tomato (99.3%) compared to other cereals and oil seeds. Total quantity of vegetable seeds produced in the country is not sufficient to meet the country's ever increasing demand. Currently quality seeds are met to the extent of 20% only. Framers themselves meet the 75% through own saved seeds. India is still importing the vegetable seeds from other countries major being radish followed by cabbage and pea. India has imported 13451 MT of fruits and vegetables seed valuing INR 480 Cr in the year 20013-14.

Seed Replacement Rates (SRR) in major vegetables

Crop	SRR (%)
Cabbage	100
Cauliflower	86
Chillies	84
Okra	92
Tomato	99

Source: Indian Institute of Vegetable Research

2) Varied Agro Climatic Conditions

India is blessed with assorted agro climatic conditions ranging from tropical to temperate which make possible the cultivation and seed production of all most all vegetables belonging to different temperature regimes. Seed production of warm season vegetables is possible in Indian plains and Deccan Plateau and seed production of winter vegetables like cabbage, cauliflower, broccoli, beetroot, European carrot and radish is possible in hill stations of Himalayan range. Some winter vegetables like Onion, Asiatic Carrot, Asiatic Radish and tropical cauliflower produce seeds during winter season in North Indian Plains and Solanaceous vegetables, Cucurbits and Legumes set seeds throughout the year under South Indian conditions.

3) Skilled labour availability for Hybrid seed production

Vegetable seed production particularly hybrid seed production demands much labour needed for performing various cultural operations requiring specially trained and skilled labour. India is ranked second in hand pollinated vegetable seed production in Asia next to China. Average number of man-days per acre required for hybrid seed production of various vegetables as follows: tomato- 480; Chilli-1800; Okra-180; brinjal-600; cucurbits-150 to 450. India is having huge human resources availing at reasonably cheaper rates compared to other countries.

4) Vast Domestic and International market

Due to high profits in vegetable cultivation area under vegetable cultivation is expanding enormously year by year. This creates huge demand for vegetable seed in the market. Requirement of the seed of open pollinated varieties is increased to 48000 MT in 2005 from 30550 MT in 2001-02 and the requirement of hybrid vegetable seed is increased from 346.2 MT in 2001-02 to 994 MT in 2005. This must have further increased due to increase in area to 9.4 mi Ha in 2013-14. Today, hybrids are fast replacing the open pollinated varieties (OPV) largely due to higher yield, uniformity and their improved quality. For instance India is second largest user of hybrid tomato seed after USA. Vegetable seeds of either OPV or hybrids from India are having large demand in foreign countries like Pakistan, Bangladesh and Saudi Arabia.

Key players in Vegetables

Company	Tomato	Cabbage/ Caulifower	Brinjal	Chilli	Okra	Cucurbits
Seminis Seeds (Monsanto)	Ayushman, Prasun, Saksham, Abhilash	Green Challenger, Green Flash, Green Voyager, Barkha, Megha	Harihar, Manjari, Shamli	Wonder Hot, Sitara, Golden Hot		Malini, Padmini, Apporva, Black Boy
Syngenta Seeds	Abhinav, Anup, Avinash-2, All Rounder	Pawas, Suhasini, Kimaya, BC-64, BC-73, BC-79		Roshni, Agnirekha, Hotline, Volcano	OH-016, OH-152	
Namdhari Seeds	NS 6970, NS 503 (T 395), NS 524, NS 54	Ns 165, NS 151, NS 195, NS 25. NS 133, NS 66, NS 106, NS 90	Arka Kusumakar+, Arka Nidhi+, Ns 381, NS 329	NS 1523, NS 238, Ns 203, NS 436	Arka-Anamika (OP), NS 531, NS 819, NS 818	NS 469T, NS 477 (H 217), IB 20, Ns 411
US AgriSeeds	US 618, US 1080, US 1196, US 2175	US 5010, US 178, US 5002		US 341, US 635, US 323	US 7109, US 419, US 7136, US 7902, US 7909	US 6205, US 6207, US 15, US 58, US 6001, US 134, US 3, US 39, US 2144, US 2146
Nuziveedu Seeds	Abhijay, Bhagya, Shriya, Varuna, Sona, Mithili, Himaraj	Riya, Nuzi-Snowwhite, Ashish, Meera		Nuzi -61 Arun -99 Palnadu Hot	Rohini, Marvel	Shalini, Kareena, Taj, Vikram, Rakhi
Bejo Sheetal	BSS 834, Tomato BSS 488, BSS 802, BSS 803	Gonzales, Fieldman, Invento, Amazing, Deepa	Janak, Vicky (BSS-472), Kalyan, BSS 465 Chaya, BSS-630	Chilly BSS 213 (Siddhi), Chilly BSS 267 (Zankar), Chilly BSS 445(Jyoti), Chilly Garima BSS 378	BSS 893, BSS 898, BSS 828, Indranil	Ridge Gourd Anamika, Bitter Gourd Prachi, Bottle - Gourd Akash, Sowmya, Watermelon Bejo-2000, MuskMelon BSS 361

Source: Industry, YES BANK analysis

R&D in private and public sector- An overview

5



5. R&D in private and public sector- An overview

The Green Revolution when introduced in the 1960's revolutionized agriculture in India and seed was the most critical component through which technology was transferred to the farmers. Traditional varieties of plants were replaced with hybrid varieties and traditional fertilizers gave way to chemical fertilizers and pesticides. The success of the revolution has been primarily designated to the seeds that were developed through extensive research by public sector institutions during that time. The involvement of private sector was minimal.

However, in the recent years, the role of private sector in research and development has increased, but is still limited to specific crops including cotton, corn, rice, millets and horticultural crops. Success stories like those of Kaveri seeds have been instrumental in emphasizing the need of research in the sector. R&D activities have paid off extremely well, increasing the revenues manifold. Contribution to food grains- specifically rice and wheat is minimal and major R&D activities are being done by public institutions.

Private sector focus has been on genetic improvements in hybrids, which typically lasts for 1 year, and hence enables companies to recover their costs on R&D as farmers need to buy the seeds every year. Since rice and wheat are varieties and not hybrids, farmers use their own seed instead of buying commercial seed, thus limiting the private sector opportunity. Unless there are stark differences in yields and quality parameters through newly developed varieties or the cost of producing and storing seeds becomes relatively higher, farmers do not have much incentive to buy seeds every year. Hybrid rice penetration in India though growing is limited to 6% of crop area.

Seed R&D has a long gestation and requires consistent investments to come out with a bumper product. So majority of private sector R&D is focused towards hybridization of crops like cotton, corn, and vegetables which have shorter gestations. Contrary to this, national and state research centers have come out with specific research on numerous crops including all commodity classes, however, the benefits of research are unable to reach out to the farmers due to limited access.

In India, GM crops till today have been restricted to Bt cotton. The commercial cultivation of Bt cotton was approved by the government in early 2002. Since then, no other crop has been given permission for commercial cultivation. The uncertainty in regulatory environment prevailing in India has been a major deterrent for private sector to make huge investments in R&D.

R&D Future Prospects

Considering that Indian farm sizes are predominated by small and marginal farmlands, development of improved varieties that are scale-neutral would help increase the feasibility of improved seed varieties to small farms as well.

Synergies emerge from collaborative efforts towards a common goal of enhancing R&D in the seed industry. Thus public and private should join hands to leverage their respective strengths in terms of their expertise and investments to develop the seed R&D. Presently, there are few projects being run on PPP mode and historically the partnership between KRBL and IARI has been a huge success. KRBL was amongst the first in the industry to form an association with Pusa Institute, for developing better varieties of Basmati. The close association with research institutions assisted them in launching the newly developed Basmati variety Pusa 1121. This variety met with huge success. Currently IARI has tied up with some 15 companies – including Kaveri Seeds, Bioseed, Metahelix and KRBL – for multiplication of breeder and foundation seeds of Pusa-1509 under a public-private-partnership program. More of such programs need to be implemented.

As a single crop, cotton has attracted the maximum number of seed companies. Fewer companies have diversified into cereals and specifically pulses. Pulses are a focus crop for India, given that it is a major import for the country. Yield enhancement and diversification programs are underway to make India self sustainable in pulses. Thus, special focus in the form of incentives may be provided to seed companies to orient their research towards pulses as well.

R&D is the most critical endeavor for a seed company. It takes a huge amount of investment and more than 5-7 years to commercialize a hybrid. With most Indian seed companies being small, R&D efforts are not very effective. Even after a hybrid is successful, challenges remain in retaining the purity of hybrid season after season. R&D efforts need to be market oriented to meet the needs of the end consumer, so that when the variety is released it is accepted in the market. Most companies limit their research to obtaining new cultivars, however an important aspect is development and extension of better growing techniques.

At the policy level, a visionary thinking is required amongst industry, Government as well as research and environmental communities towards a sustainable ecosystem that will yield optimal economic, environmental and societal benefits for the country. This holds true for GM crops more than any other technology. Also progressive measures need to be implemented to ensure that farmers are fully aware of the benefits of this technology and how it can serve their cause, thereby eliminating the widespread mistrust that exists over the use of biotech crops. Further the presence of several stakeholders in this field in an unregulated environment poses risks on the safe usage of this complex technology, which requires extensive study and testing before being mainstreamed.

6. Financials of the Indian Seed Industry

INR MM	Advanta*		JK Agri		Kaveri Seed Company		Monsanto India		National Seeds		State Farms Corporation	
	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
Revenue	11,793	14,315	1,847	1,885	7,108	10,024	4,424	5,818	6,848	7,211	4,680	5,121
EBITDA	1,870	2,439	217	273	1,444	2,299	866	1,580	695	860	619	636
EBITDA Margin	15.9%	17.0%	11.7%	14.5%	20.3%	22.9%	19.6%	27.2%	10.2%	11.9%	13.2%	12.4%
PAT	419	855	90	119	1,299	2,106	673	1,229	443	541	426	418
PAT Margin	3.6%	6.0%	4.9%	6.3%	18.3%	21.0%	15.2%	21.1%	6.5%	7.5%	9.1%	8.2%
Long Term Debt	4,496	4,622	228	149	8	8	NA	NA	NA	NA	14	22
Short Term Debt	1,299	3,765	391	286	NA	NA	NA	NA	311	50	NA	NA
Total Debt	5,795	8,387	619	435	8	8	NA	NA	311	50	14	22

**Balance sheet as of 31st Dec 2013, Company Balance Sheets in Public Domain*

Average revenue growth for these companies over the last two years is 18%. EBITDA margin for these companies have ranged between 13-15%.

7. Key Mergers and Acquisition in the Global & Indian Seed Industry

There have been a series of robust shakeups in the agri inputs sector in general globally and also seed sector in specific; pointing to a consolidation phase again. The acquisitions have been more noticed in the MNC space thereby reinforcing the fact that the top 5 players are going to play a dominant role going forward in both technology as well as market share.

GLOBAL M&A in Seed Industry

2015
Bayer Crop Science has agreed to acquire the seed business of Brazilian agricultural business, Cooperativa Central Gaúcha (CCGL -Cruz Alta)
2014
Groupe Limagrain, the largest seed and plant breeding company in the European Union, has invested up to USD 60 million for a 28% stake in SeedCo
Bayer Crop Science announced that it has entered into an agreement to purchase the seed business of Granar S.A., based in Encarnacion, Paraguay
Bayer Crop Science agreed to acquire Argentine seed treatment business Biagro Group
Bayer Crop Science and French genomics company Cellectis' US subsidiary, Cellectis Plant Science, agreed two new deals covering gene editing in plants
Dow AgroSciences has signed a binding agreement to purchase Coodetec's seeds business.
DuPont seed subsidiary DuPont Pioneer entered into a research collaboration with the US charitable organisation, Two Blades Foundation
The Brazilian competition authorities conditionally approved Monsanto's licensing of its GM insect-resistant and herbicide-tolerant Intacta RR 2 Pro soybeans to Bayer Crop Science.
Barkley Seed Inc. announced its acquisition of the Desert Durum Wheat Research Program from Monsanto Company.
Syngenta acquired Italian durum wheat seed company Società Produttori Sementi.
Syngenta acquired lettuce germplasm from US lettuce breeding company Eagle Research and Development.
Syngenta agreed to acquire the winter wheat and winter oilseed rape breeding and business operations from the Swedish group, Lantmännen.
The Alf Christianson Seed Co. and Sakata Seed America Inc merged and the newly formed entity retains the Sakata Seed America name.
Vilmorin & Cie SA undertook full takeover of Seed Asia based in Bangkok, Thailand.

M&A in Seed Industry in India

2014
SeedCo has agreed to sell 60% of its shares in Africa's only cottonseed company, Quton, to Mahyco from India
W.Atlee Burpee Company has picked up an undisclosed stake in Indus Seeds, a Bangalore based producer and exporter of seeds.
Ruchi Soya Industries entered into a joint venture with D. J. Hendrick International Inc. (DJHI), a Canadian soyabean research company, and KMDI International, a Japanese trader and marketer of food-grade soyabeans, to increase the yield of soya seeds in India.



8. Innovations in Indian seed industry

The private seed sector in India holds a 76 percent share of market volume; hence there is scope further growth. Only one-quarter of all seed transactions in India are conducted in the formal organised market, indicating that there are growth opportunities in the informal market where seed provisioning relies on farmer-to-farmer exchanges and farmer-saved seed/ heirloom seed in the informal market. It is the private sector that is making major investments in R&D. Central and state governments should consider increasing funding for public sector research, while continuing the liberalization of foreign investment and trade in technology in the agricultural input sector

Innovation and competition in the downstream seed market (who produce and distribute seeds) will depend on commercialization times, product performance and spillovers, as well as on the terms and conditions of licensing agreements, the scope of patent protection, the ownership of elite germplasm and the design of appropriate business models for the Indian market. Transformative technology platforms, such as hybrids will be particularly important in this scenario, especially for reaching small-scale, resource-poor farmers in India's more marginal agro-ecologies.

Hybrids may provide a stepping stone for private investment in other crop improvement technologies embedded in the hybrids, including transgenic technologies for drought tolerance, salinity tolerance and insect resistance.

Some Recent Innovations in Indian Seed Industry

Company	Innovations
Advanta India Ltd.	RNAi and other cutting edge technological interventions to develop insect-pest, diseases & viruses tolerant tomato hybrids for Indian & International markets
Ankur Seeds Pvt. Ltd	Third generation RNAi for engineering Tomato leaf curl (ToLCV) and tospovirus (GBNV) resistance in tomato.
Bejo Sheetal Seeds Pvt. Ltd	Development of 'Herbicide and Stress tolerance' Transgenic Onion.
Geo Biotechnologies Pvt Ltd	Association Mapping and Whole Genome Marker Assisted Recurrent Selection for Development of Abiotic Stress Resilient Maize.
Geo Biotechnologies Pvt Ltd	Development of F1 hybrid Tomato with high shelf life
Global Transgene	Generation, evaluation and regulatory appraisal of selected transgenic events for enhanced tolerance against lepidopteran insect pests in cotton, rice and brinjal (Phase – 1 and II)
IARI	Validation of serological diagnostic reagents and kits for plant viruses affecting horticultural crops

Company	Innovations
Indo-American Hybrid Seeds (India) Pvt. Ltd	Utilization of marker assisted selection for development of salt tolerant hybrids in rice (Oryza sativa)
Kaveri Seed Company Ltd	Development of Biotic stress resistant Rice through conjunct use of Bio- and Hybrid Technologies
Kaveri Seed Company Ltd	Marker-assisted dissection of genetic basis of yield and improving yield potential under drought stress in maize
Krishidhan Seeds Private Ltd.	Genomics assisted accelerated product development of high yielding pigeonpea hybrids
Maharashtra Hybrid Seeds Company Ltd.	Development of Sucking Insect Pest tolerant Rice and Cotton
Maharashtra Hybrid Seeds Company Ltd.	Stress tolerant rice
Metahelix Life Sciences Ltd.	Deregulation trials of transgenic rice events expressing Metahelix synthetic Cry1C, Cry1Ac and Cry1Ab genes for tolerance to rice yellow stem borer, Scirpophagaincertulas
Metahelix Life Sciences Ltd.	Deregulation Trials I of Transgenic Maize Events Expressing Metahelix Synthetic Cry1C, Cry1Ac and Cry1Ab Genes for Tolerance to Stem and Cob Borers.
Nirmal Seeds Pvt Ltd	Development of nutritionally improved mustard (Brassica juncea) Varieties/ hybrids having low erucic acid and low glucosinolate Content using marker assisted selection
Nirmal Seeds Pvt Ltd	Development of Viral resistant okra using RNAi approach
Nirmal Seeds Pvt. Ltd	Development of Okra varieties resistant to YVMV using Marker assisted selection
Sri Biotechnolgy Laboratories	Development of Actinomycetes based metabolites as delivery systems for soil health management in Groundnut (Arachis Hypogaea)
Sri biotech Laboratories	Control of shoot and fruit borer insect pest(Leucinodes orbonalis)in Brinjal throughRNA interference
Xcelris Labs Ltd.	Development of drought and saline tolerant high biomass yielding Bamboo plants as energy crop

Source: Report by BIRAC Innnovators "Going Forward (Sept 2014)", YES BANK Analysis



9. Indian Seed Industry-Future Prospects and Road Map for 2025

It is quite clear from the Indian food output statistics that we have achieved great success in sustaining our food output to save the nation's food security. During 2013-14 India has achieved a food grain output of 264 million tons and horticulture output of 277 million tons. This is exemplary performance from Indian farmers with able support from seed industry, Govt and other stakeholders. The same cannot be told for the coming decades as the food output is growing in small percentage but at a decelerating pace. Key food grains like rice and wheat have recorded 2% fall in yields in 2013-14 seasons. This paves clear way for need for more innovations from seed industry and innovative management of our crop agronomy. Either way, the role for Indian seed industry stakeholders is critical one on two fronts, Research and Development in the backend and engaging farmers at the front to produce more from same or less land.

Looking at the global seed industry which is growing healthily at around 9% CAGR over the last five years, it needs to be deliberated amongst all the stakeholders on the role of crop biotechnology and introduction of wider gamut of GM technology for food and non food crops. Market for GM crops has grown at 17% CAGR over the past five years. A stronger regime of intellectual property rights is clearly required to encourage investments and innovations in seed industry.

Powerful levers for future growth

The increase in food needs will create huge market for quality seeds

The growth in the world population and the evolution of food habits towards increased consumption of luxury foods (meat, dairy, proteins etc), vegetables and fruits are leading to a significant increase in the need for agricultural raw materials including quality seeds. By the year 2050, global food production will therefore need to be increased by 70% in order to feed more than 9 billion people and thus meet the needs of the world's growing population (Source: FAO- Food and Agriculture Organization).

Growing use of commercial seeds will continue

Farmers are using commercial seeds than own seeds, and their use can considerably improve crop yields. Slow erosion of arable land on a world scale, because of urbanization, desertification, and the overall deterioration in soil quality will further boost demand for commercial seed. Crops like hybrid rice, corn, forage seeds, vegetable seeds will contribute to future growth.

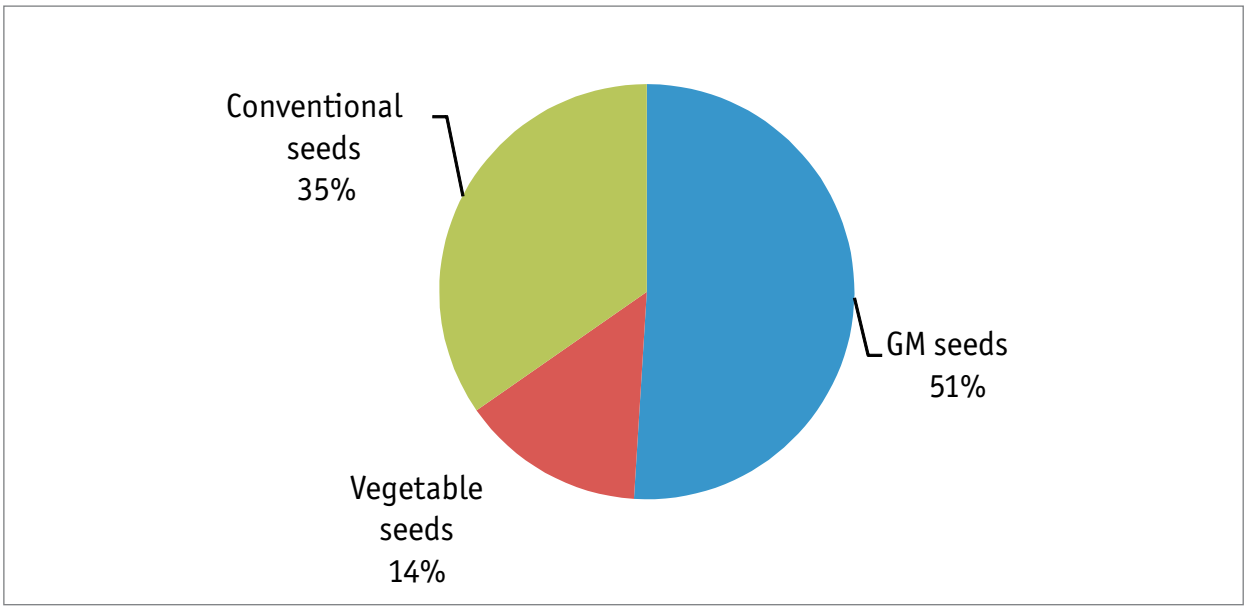
Industrial agriculture and farm mechanization will open new markets for India

In industrial agriculture farmer gets connected directly to the industry through an interface established by seed industry ensuring desired raw material supply. Commercial seeds provide the guarantee of raw material production perfectly adapted to industrial quality specifications. Mechanization will further help in cutting down on cultivation costs and ensures timely harvest. Industries like food processing with tomato purees, fresh cut fruits, salads, fruit juices can get a boost with industrial agriculture. Precision agriculture like growing green house vegetables also open up new markets. This is a huge untapped market and Central and state govts are already working on these lines.

A seeds market to be driven globally and locally by genetically modified seeds

The technology of genetically modified seeds has become indispensable in several areas of the world, with the market growing fast in volume. GM seeds occupied more than 50% of the global commercial seed market. Indian Govt and industry stakeholders needs to quickly take commercial decision on GM crops to save the future of our food output.

Global market for commercial seeds in 2013 (Global market is around 45 billion USD)



Source: ISAAA

The development of luxury foods segments

Indians have started consuming more dairy, poultry and fish in the recent years and this is growing steadily. This has opened new markets for high quality milk, dairy products, chicken and fish intensive production systems. As with any modern integrated and intensive production system, high quality feed and fodder are critical inputs. Protein rich corn for poultry, nutrient rich corn, lucern fodder for dairy animals that can be used for fresh as well as silage, corn and soya grain with low feed conversion ratio are some of the market requirements and seed industry should focus more towards these emerging opportunities.

Way forward for 2025

- ✓ Biotech traits and plant breeding to be the focus of majority of private and public seed industry players. Value addition of biotechnology is the only tool to save our food security and meet growing food demands.
- ✓ Increase in Seed replacement rates for high yielding varieties in rice and increased expansion of corn, vegetables and rice hybrids will pave way for next growth
- ✓ High density planting techniques will help growth in adoption of hybrids in cotton, corn and bajra (for silage)
- ✓ Farm mechanization should be on the high priority list for all seed companies in India. Mechanization of cotton, corn, rice will pave way for specialized farm services business in India. Industry should focus on developing the crop management techniques to enable smooth adoption of farm machinery in Indian farms.
- ✓ Forage crops including silage crops will be a multi crore business opportunity that has not been tapped yet. As Indian dairy sector evolves, demand for high quality forage/silage seeds will grow tremendously.
- ✓ Industrial crops like corn (animal feeds), sorghum (biomass, ethanol),tomato, chilly, salad vegetables (processing industry) will open new networks between seed industry, farmers and food industry.

10. CEO speaks- top trends that will change Indian seed industry landscape

M. Prabhakara Rao
CMD
NUZIVEEDU SEEDS

1. What regulatory changes/ implications do you foresee on seed industry, if the new seed bill in present form is enacted this year? What changes you would like to propose.

a. The enactment of seed bill should enable a standards based market environment and help in growing this market. Accredited institutional mechanisms in public or private sector to locally provide for validation of compliance and conformance to minimum published standards of seed quality should be enabled. Thus every sale of seed in the country should be in line with the provisions of the new seed bill. The Government should plan and provision for adequate resources and infrastructure both at State and local level for monitoring the sale of spurious seeds through parallel channels in the guise of sale of seed by farmers.

2. What are the key plans of your company in near-term and long-term? Which crops and markets you see growing?

a. NSL is geared up to meet the increasing demand for quality seeds in the country with an overall goal of improving profitability of farmers. In this direction we plan to further strengthen our Hybrid programs in the near term in [Cotton, Maize, Paddy, Bajra and vegetables]

3. What are the technology and innovation triggers which will spur demand for high quality improved seeds in the country?

a. New Plant Breeding Technologies, Improved agronomic practices and use of Information and communication Technologies are expected to foster innovation in the seed sector and demand for quality seeds.

4. What are the new initiatives that your company has implemented during last few years that have benefited farmers economically?

a. NSL has undertaken initiatives both as a part of its business and CSR. We believe that our CSR initiatives in the form of a PPP with Government of Maharashtra and our Direct Seeded Rice project in Andhra Pradesh have benefited farmers in realizing higher incomes.

5. What are the key growth areas for the domestic industry & export markets? What are your suggestions to the Govt.?

a. Seeds are primary input to agriculture and should be the key driver for a profitable agriculture and prosperous India. India has a potential to become a global seed industry hub in view of its genetic diversity and varied agro-climatic conditions for certain crops. Government should enable strengthening of domestic sector by incentivizing R&D and product development initiatives in PPP mode.

6. What are the challenges for the farmers today to make more income per acre? What steps do you suggest to make him move upwards in income status?

a. Right mix of quality inputs, good agronomic practices and systematic crop management delivered in a balanced climatic condition are key ingredients for profitable agriculture. Farmers face challenges at each of the steps to access the above ingredients and climatic vagaries in the specific context of India.

7. Is India on par with global industry in technology and R&D? Any suggestions to Government to promote and incentivize domestic seed industry to make India as the global seed production hub?

a. Indian companies are developing strengths in Breeding and development of superior varieties and hybrids on par with global majors. However as Biotech research is capital intensive, largely multinational companies are able to invest and develop suitable technologies and traits which are being licensed to domestic companies. The Indian public sector can collaborate in a big way for development of suitable traits without any risk to environment while focusing on betterment of economic condition of Indian farmer.

8. Prime Minister Modi has given a call for "More crop per drop", what is your company's plan to breed and develop seeds for sustainable productivity?

a. NSL has been working developing drought tolerance traits as a part of its breeding program and promoting low-carbon, low resource technologies like Direct Seeded Rice since 2013-14. We will endeavor to work further in this direction to promote climate resilient and sustainable technologies and inputs.

9. What policy you would suggest for growth of Agriculture and Seed Sector.

a. The overall policy framework in India towards agriculture and seed industry should be centered on making Agriculture as a profitable enterprise which contributes to growth on economically and ecologically sustainable basis.

Satish Joshi

CEO
East West seeds

1. What regulatory changes/ implications do you foresee on seed industry, if the new seed bill in present form is enacted this year? What changes you would like to propose.
   - Registration formalities to be simplified.
   - Amendment in Seed Act. (Maintaining manual records).
   - Seed Nursery business accountability.
   - Supply in Seed count has to be permitted officially.
   - Liberal policy for import of seeds.
   - Treated Coriander seed to be should not be considered as Spices for custom duty.

2. What are the key plans of your company in near-term and long-term? Which crops and markets you see growing?
   - Sweet Corn-Maharashtra, Gujarat, Madhya Pradesh, Karnataka etc.
   - Papaya- Andhra Pradesh, Maharashtra, Karnataka, etc.
   - Sponge Gourd-Uttar Pradesh, Punjab, Haryana, Bihar, West Bengal etc.

3. What are the technology and innovation triggers which will spur demand for high quality improved seeds in the country?
   - Encrusted Onion & Marigold seeds, Pelleted Watermelon seeds.
   - Multiple disease and Drought resistance breeding.

4. What are the new initiatives that your company has implemented during last few year that have benefited farmers economically?
   - Encrusted Onion & Marigold seeds.

5. What are the key growth areas for the domestic industry & export markets? What are your suggestions to the Govt.?
   - Set Processing Industries for perishable & seasonal Vegetables.
   - Enhance fresh vegetables and fruit export.

6. What are the challenges for the farmers today to make more income per acre? What steps do you suggest to make him move upwards in income status?
   - Water and labor are limiting factor in Agriculture.
   - Promote Mechanization
   - Educate Farming community about water use efficiency (Water Conservation, Usage of Drip Irrigation, Mulch etc.)

7. Is India on par with global industry in technology and R&D? Any suggestions to Government to promote and incentivize domestic seed industry to make India as the global seed production hub ?
   - No. Improve Irrigation facilities

8. Prime minister Modi has given a call for "More crop per drop", What are your company's plan to breed and develop seeds for sustainable productivity?
   - Drought resistance breeding program.

9. What policy you would suggest for growth of Agriculture and Seed Sector.
   - Support price for all vegetable.
   - Creating facility for Transport, Electricity and Cold storage.
   - Encourage export of Vegetables.
   - Improve per-capita consumption of Vegetables and fruits.

Bhupen
CEO
UPL Limited

1. What regulatory changes/ implications do you foresee on seed industry, if the new seed bill in present form is enacted this year? What changes you would like to propose.
   - Broadly new seed bill is very progressive step. Certain modifications which has been discussed in last few meetings since last year if incorporated then farmers and seed industry both will benefit.

2. What are the key plans of your company in near-term and long-term? Which crops and markets you see growing?
   - Our organization Advanta intend to grow 50% to 60% . Prime crops are Hybrid Rice, Hybrid Oil Seed, Hybrid Corn and Forages with some participation in cotton

3. What are the technology and innovation triggers which will spur demand for high quality improved seeds in the country?
   - Mechanization and precision farming, market connect would surely lead to high demand quality improved seed

4. What are the new initiatives that your company has implemented during last few year that have benefited farmers economically?
   - Two important initiatives, Project Tiger and Kamdhenu (forages) project

5. What are the key growth areas for the domestic industry & export markets? What are your suggestions to the Govt.?
   - Govt need to evolve regulatory norms, import export joint vision to be evolved between Agricultural ministry and NSAI members with detailed road map and goal setting

6. What are the challenges for the farmers today to make more income per acre? What steps do you suggest to make him move upwards in income status?
   - Less availability of labourers and cost of labour going up
   - Farmers need to go high adaptation of mechanization and seeds having features of minimizing labour requirement

7. Is India on par with global industry in technology and R&D? Any suggestions to Government to promote and incentivize domestic seed industry to make India as the global seed production hub ?
   - Yes and No depending on comparison with developed countries or developing countries. India is miles ahead of African, Asian and few American countries but need to catch up with some of the European countries. India has potential to become global seed industry hub.
   - Require comprehensive strategic plan in place which fits into current Govt vision of making India Agricultural strong

8. Prime minister Modi has given a call for "More crop per drop", What are your company's plan to breed and develop seeds for sustainable productivity?
   - Our company Advanta is working on short duration crop which will mitigate risk of weak monsoon at later stage
   - Group company UPL is working on technique of UPDT which allows water sensation in soil for longer period of time which is under testing process and ready to launch later this year.

9. What policy you would suggest for growth of Agriculture and Seed Sector.
   - Agriculture and Seed sector to grow together with regular mechanism across key crop state. For instance cotton is grown in state like Gujarat, MP,Maharashtra and AP so if these state together evolve and join the mechanism for introduction of key techniques it will help.
   - Same for corn state and rice state with uniform approach should evolved

M.G.Shembekar
MD
Ankur Seeds Pvt. Ltd.

1. What regulatory changes/ implications do you foresee on seed industry, if the new seed bill in present form is enacted this year? What changes you would like to propose.
   - New Seed Bill should be simple and friendly for all stake holders. It should boast genuine Industry players having good infrastructure and research base. Atmosphere should be created to make available quality seeds to the farmers. Label claim and performance guarantee should not increase illegitimate and wrong claims. Nor farmers should be exploited. Balance has to strike. Necessary changes suggested by NSAI should be incorporated.

2. What are the key plans of your company in near-term and long-term? Which crops and markets you see growing?
   - Seed Industry is fast growing industry. We at Ankur expects growth of 20 to 25 % p.a. Major crops include Hy Cotton, Hy Rice & Vegetable Seeds. To acquire desired market share in weak areas is our goal.

3. What are the technology and innovation triggers which will spur demand for high quality improved seeds in the country?
   - Value addition technologies for improving shelf life and storage of agriculture produce and innovation through mechanized farming technologies would lead to high demand for quality improved seeds

4. What are the new initiatives that your company has implemented during last few year that have benefited farmers economically?
   - Ankur is conducting farmers workshops for imparting training for adoption of scientific agronomical practices for increasing yield, new concepts like High Density Cotton.

5. What are the key growth areas for the domestic industry & export markets? What are your suggestions to the Govt.?
   - Uniform regulatory norms should be followed throughout the country. Policy for research of new hybrids/varieties should be redefined throughout the country. Govt. Interferance should be minimum. Farmers interest should be safeguarded while import and export of agriculture produce.

6. What are the challenges for the farmers today to make more income per acre? What steps do you suggest to make him move upwards in income status?
   - Economic land holding size is bottleneck. Small size farmers are not having adequate infrastructure and cannot adopt good practices. Corporate farming to be encouraged. Selection of crop, adoption of best possible cultivation practices, use of quality seeds and usage of latest available technologies and digital connect for market information are few steps for ..... upward in Income Status.

7. Is India on par with global industry in technology and R&D? Any suggestions to Government to promote and incentivize domestic seed industry to make India as the global seed production hub ?

- If not in the present, in the next 10 years, India surely has a potential to be amongst the leaders in R&D in agricultural sector. Initiatives to promote domestic seed industry have become necessary. There is a need to review and make amends to existing policies for the seed sector so that India sets its pace towards being a global seed production hub

8. Prime Minister Modi has given a call for "More crop per drop", What are your company's plan to breed and develop seeds for sustainable productivity?

- Being situated in the heart of the region heavily dependent on monsoons for agriculture, the concept of "More crop per drop" is indeed a valuable concept to us. We are working on a number of projects in Paddy, Cotton and Vegetables to generate water and nutrient use efficient lines using modern genomics tools as well as the transgenic approach. A number of such products are already in the pipeline.

9. What policy you would suggest for growth of Agriculture and Seed Sector.

- Agriculture should be granted industrial status. For R & D purposes govt. should not impose any ceiling on acquisition of agricultural land in any state. For infrastructure development in R & D more incentives should be given.

YES BANK, India's fourth largest private sector Bank, is the outcome of the professional & entrepreneurial commitment, vision & strategy of its Founder Rana Kapoor and his top management team, to establish a high quality, customer centric, service driven, private Indian Bank catering to the Future Businesses of India.

YES BANK has adopted international best practices, the highest standards of service quality and operational excellence, and offers comprehensive banking and financial solutions to all its valued customers. YES BANK has a knowledge driven approach to banking, and a superior customer experience for its retail, corporate and emerging corporate banking clients. YES BANK is steadily evolving its organizational character as the Professionals' Bank of India with the uncompromising Vision of "Building the Best Quality Bank of the World in India by 2020!"

National Seed Association of India (NSAI), as the apex body representing the seed industry, engages, partners and assists various Government, regulatory and scientific entities in enabling a favourable policy environment for the growth of the seed industry in India. NSAI has been actively engaging with various State Governments in India on the matters pertinent to the seed industry and furthering the stakeholders' interest.

The vision of NSAI is to create 'A dynamic, innovative, internationally competitive, research based industry producing high performance, high quality seeds and planting materials which benefit farmers and significantly contribute to the sustainable growth of Indian Agriculture'. The Association is also working towards the responsible use of biotechnology for modernizing Indian agriculture and enhancing the livelihood of Indian farmers. Increasing general awareness about crop biotechnology amongst the many stakeholders, technology up gradation and engaging in a continuous dialogue with regulators for the establishment of a transparent, fair and equitable regulatory system, among others, are the activities of NSAI.

The mission of NSAI is to encourage investment in state of art Research & Development to bring to Indian farmers superior genetics and technologies, which are high performance and adopted to a wide range of agro-climatic zones. It actively contributes to seed industry policy development, with the concerned government, to ensure that the policies and regulation create an enabling environment, including public acceptance, so that the industry is globally competitive.

NOTES


nsa
National Seed
Association of India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