

SEEDING INDIA'S FUTURE

An outlook on how seeds have
influenced Indian agriculture

Seeds represent the starting point of crop production. So when the projections and forecast predict an enormous food demand in the future, the onus directly falls upon the seeds. Seeds thus become the conduit of research and innovations to not only further the food production but to address other major challenges in crop production. Right from yield increments to varietal improvements, crop protection to crop production, climate change to sustainability, seeds dictate the character and nature of agriculture production. Thus seed sector becomes a crucial element in today's agriculture.

Seed Industry Outlook – World and India

Seed sector is an industry which constantly represents an upswing in terms of present growth and prospective growth. This probably can be explained by the enormous stress on the production of improved seeds. The phenomenon is not exclusive to India but globally.

The global seeds market reached a value of more than US\$ 62.1 Billion in 2017, exhibiting a CAGR of around 7% during 2010 – 2017. One of the major trends which has influenced the seeds market is the significant shift in farming practices worldwide. Nowadays, an increasing number of farmers buy commercially produced enhanced seed varieties as opposed to using seeds from the last harvest.

This has been a result of the various advantages offered by enhanced varieties of seeds such as high yield, improved nutritional quality, reduced crop damage, disease resistance, etc. Moreover, the increasing global population and the consequent rise in demand for food, coupled with the expanding biofuel production have also stimulated the demand for enhanced seed varieties worldwide. Owing to these factors, the global seeds market is further expected to grow at a CAGR of more than 6% during 2018 – 2023, reaching a value of more than US\$ 86 Billion by 2023. Currently, grain seeds represent the largest seed type accounting for nearly half of the total global production. North America represents the largest producer accounting for around a third of the total market share.

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Billion in 2017, exhibiting a CAGR of around 17% during 2010-2017. The Indian seeds market is further expected to grow at a CAGR of 14.3% during 2018-2023, reaching a value of more than US\$ 8 Billion by 2023.

The Indian seeds market has witnessed a major restructuring as a result of the implementation of some progressive policies by the government. Seed Development, 1988 and National Seed Policy, 2002 have helped in strengthening the Indian seed industry in the areas of R&D, product development, supply chain management and quality assurance. Owing to this, India has emerged as the fifth largest seed market across the globe. The active participation of both, public and private sectors has also played a vital role in laying a strong foundation of the industry. Growth in income levels, commercialization of agriculture, patent protection systems and intellectual rights over plant varieties, have given a great push to the market. In the Indian segment too, grain seeds represent the largest seed type, accounting for more than a half of the total seed production. Other major seed types include oil, vegetable and fruit seeds. Amongst the different states, Uttar Pradesh represents the largest producer, accounting for around

12% of the total market share.

Cotton holds the maximum share of revenue when the market is segmented by row crop. The large-scale adoption of Bt cotton seed in India has been the driving force behind this large share. Vegetables and maize are also crops with high hybridization and seed replacement rates, and hence have high shares among all the



crops. Bt cotton remains the only transgenic crop that is approved and that is being cultivated in the country. In a period of 14 years, the Bt cotton cultivating area has increased accounting for about 95% of the total cotton acreage, and has led to a surge in the Indian cotton production. Although there have been incidences of resistance in Bt cotton to pink bollworm in the recent years, the adoption rate of Bt cotton is expected to sustain.

The seed replacement rates for almost all the crops in India have

considerably improved in the recent times. Over a ten-year period, from 2002 to 2012, the seed replacement rates of key cereal crops have more than doubled, with that of rice experiencing a 111% jump, wheat increasing by 154%, and maize 238%. Increasing seed replacement rates are a result of increased farmer extension and marketing activities of seed companies, as well as the general perception among farmers about yield improvements that can be achieved through replacement of seeds every year.

The Access to Seeds Foundation has released in its first Access to Seeds Index which has reported that at the global level, seed companies are active in most countries with the exception of western African region. The report found that Colombia, Kenya, India, and Thailand have the highest concentration of global seed companies. Bejo, DuPont Pioneer, and East-West Seed have the largest footprint, operating in more than 30 countries across the four study regions.

Quite recently the international seed sector has witnessed acquisitions and mergers. The DowDuPont merger in 2015, the ChemChina's acquisition of Syngenta in 2017 and Bayer's acquisition of Monsanto in 2018, were some of the major events that happened



in the global seed sector. Monsanto continues to occupy the prime position globally. In 2017, backed by its GMO advantages, Monsanto's field crop sales reached \$10.098 billion, 9.9% up year on year. After the Dow DuPont merger, its new agricultural brand that shows up in the name of CortevaAgriscience has also emerged as a prominent player. Syngenta is also a significant player. Limagrain, Bayer, KWS (Germany), Sakata Seed, DLF (Denmark), Long Ping High-Tech (China) and RijkZwaan (Nederland) are

other important players globally.

India has emerged as a major seed hub in Asia as 18 companies out of 24 leading firms have invested in breeding and production activities in the country, according to a latest study. Both global and regional seed industry players have invested in a big way to boost crop yields of smallholder farmers in India. According to the Index's first ever ranking, four Indian seed companies -- Advanta, AcsenHyVeg, Namdhari Seeds and Nuziveedu Seeds -- have made it to the top 10 seed

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companies in South and Southeast Asia on their efforts to support smallholder farmer productivity. The list was topped by the Thailand-based East-West Seed. In addition, 83 per cent of the companies present in India provide some form of extension service. One of the many examples of capacity building in India, comes from Nuziveedu Seeds, which has signed a memorandum of understanding with the Uttar Pradesh government to carry out collaborative extension work on rice and maize production with 40,000 farmers in 25 districts. Namdhari Seeds' business arm, Namdhari Fresh, is a leading example of how a company can connect smallholder farmers to domestic and international export markets.

The leading Breed of seeds

India's gamble with food production in yester years have made high yielding varieties an integral part of agriculture. Our staples such as rice and wheat changed the agricultural fortunes of the country through improved varieties. Another crop that received considerable mettle with the introduction of high yielding varieties was cotton. So were many vegetables, fruits, plantation crops and spice crops.

While the high yielding varieties are still the favourite of the farmers, hybrids

emerged a notch higher in terms of rendering uniform quality in the yields, notwithstanding higher yields and better quality attributes. However, unlike the farm saved seeds, hybrids entailed recurrent purchases. Despite this marked departure from Indian farmers' conventional farming wisdom, hybrids gained major foot hold in Indian agricultural scene.

Although the adoption of hybrids have not been uniform across all crop categories, the deepest impact was left on the cotton production segment. India became a pioneer country for commercial cultivation of cotton hybrids, which covered more than 50% of the cotton area. Cotton hybrids gave fifty percent higher productivity than conventional varieties. Their wider adaptability, high degree of resistance to biotic and abiotic stresses and better fibre quality made them a favourite of the Indian farmers. The first intra-hirsutum hybrid cotton Hybrid - 4(H-4) was released in 1970 from Main Cotton Research Station, Surat of G.A.U. by Dr. C.T. Patel. This was followed by the development of world's first inter-specific hybrid Varalaxmi in 1972 from U.A.S., Dharwad by Dr. B.H. Katarki. India has the distinction of being the first country to have developed and grown hybrid cotton commercially.



India was also the first country to develop hybrids in pearl millet (bajra) which resulted in an increase in production from 2.84 million tonnes in 1950 to nearly 8.72 million tonnes in 1995. The newly developed hybrids were predominantly suitable for drought prone areas of Rajasthan. The crop, however, suffers from a serious downy mildew disease. Good progress has been made in developing extra early heterotic mildew resistant hybrids and composites to mitigate the losses caused by this disease.

Vegetables and fruits were also benefactors of hybrid technology. Development of high yielding varieties and hybrid fruits and vegetables have contributed to a phenomenal growth of 11.2% and 5.6% respectively during 1991-96 period. India is the largest producer of mango, banana, sapota and acid lime. In grapes India has recorded the highest productivity per unit area in the world. Among the vegetables India occupies the first position in cauliflower and second position in onion and third in cabbage. A singular achievement has been the development of dwarf and regular bearing hybrids in mango through extensive breeding work carried out at IARI, New Delhi and IIHR, Bangalore. These hybrids can be planted in close spacing in high density orchards, accommodating 1600 plants/ha, which yield more than ten times per unit area than the conventional varieties.

Coconut palms are also the crops that



SEED INDUSTRY SEEKS POLICY SUPPORT

Rajendra Barwale, Chairman Mahyco Grow

Our Farming community is awaiting the breakout of Kharif 2019 with optimism as always, and equally awaited is the result of national election in the last week of May 2019 when the new Government would takeover reigns of policy direction of the country for the next five years.

As is well-known, Indian agriculture holds enormous potential given that our productivity is less than half of global averages for most crops. A set of prudent policies to encourage agricultural productivity improvement would reduce cost of our agriculture production, enabling improvement in competitiveness in the global market. This in turn can help improve our exports, expanding markets for our farm produce, and increasing the income of our farmers.

Some of the key areas of focus for crop productivity improvement would be Seed technology, Irrigation, low cost automation, and better soil nutrition. In addition, improved market access to farm produce will help to minimize the systemic inefficiencies to improve farmers share in consumer rupee. While we have made progress in all of these areas in the past, there exists an opportunity to speed up the policy thrust in areas like seed technology to enable access to globally competitive innovations for our farmers. During the last few years, Indian seed Industry is encumbered with policy imbroglio related to IP protection and regulatory processes, resulting in fast diminishing investments in Seed research by the Industry. In the longterm interest of our farmers, this aberration needs correction through novel policy direction from the new Government.





have found relief in the hybridization technique. The first coconut hybrid in the world was developed in India in 1930s with West Coast Tall (WCT) as female parent and Chowghat Green Dwarf (CGD) as male parent. The hybrids yielded better with favourable crop characteristics. The popular hybrids reigning south India are Chandra Sankara, KeraSankara, Chandra Laksha, Laksha Ganga, Kera Ganga. Ananda Ganga, KeraSree, KeraSowbhagya, VHC-1, VHC-2 and Godavari Ganga. Some hybrids such as Chandra Sankara and KeraSankara can yield more than 210 nuts per palm in a year. They yield high quality copra with oil content exceeding 68 per cent. The other hybrids, which yield between 116 to 186 nuts per palm in a year, are Chandra Laksha, Laksha Ganga, KeraSree and KeraSowbhagya, and they are also released for commercial cultivation in Kerala. They also produced high quality copra with oil content ranging between 65 to 68 per cent. Ananda Ganga and Kera Ganga are two hybrids with average yields hovering between 95 to 100 nuts per palm in a year. VHC-1 is a hybrid released for cultivation in Tamil Nadu. It yields about 98 nuts per palm in a year, and it produces good quality copra with an oil content of 70 per cent.

VHC-2 is another hybrid suitable for cultivation in Tamil Nadu. This hybrid with a potential to yield 107 nuts per palm in a year, also produces high quality copra with 69 per cent oil content. Godavari Ganga is the hybrid developed for growing in Andhra Pradesh, and it has a potential to yield 140 nuts per palm in a year. It produces good quality copra with an oil content of 68 per cent.

Biotechnology has also swept agriculture world wide. Micropropagation has gained immense popularity in India especially in high value crops which demands uniformity in

quality and consistency in yield. In India, there are about 100 commercial plant tissue culture units with a minimum production capacity of about 1 million plants per year from each of the units. Among these, at least 20 of the units have larger production capacities, with 5 to 10 million plants/year. In addition, there are more than a dozen smaller units with 0.2 to 0.5 million plant production capacities where single crops are being produced. The Government of India has identified micropropagation industry as a priority area for further research, development and commercialization. The growth in demand for tissue culture banana has increased at a high rate of 25-30%. In sugarcane also micropropagation has been widely explored. To overcome the problem of 'seed' quality, micropropagation technology has been developed to produce nearly 78000 plantlets (in vitro) from a single explant in less than six months. There is growing awareness of superiority of tissue cultured plants, and demand for crops like banana, grapes, papaya, ginger, turmeric, cardamom, vanilla, potato, Jatropha is increasing.

Genetically engineered crops also became an important part in Indian agriculture. Bt cotton cultivation began in 2002, and its acreage shot up from 0.29 million





hectares in 2002 to 9.4 million hectares in 2011-12. By this time, the Bt variety accounted for 90% of cotton acreage. Cotton yield rose to 362 kg per hectare in 2005-06, and then increased further with fluctuations to 510 kg per hectare in 2010-11. In 2001, India was a large importer of cotton. But within seven years of Bollgard's introduction, India became the world's second-largest producer and exporter of cotton. Today, India's share of world cotton production is up 68%, and exports are at an all-time high.

Despite the introduction of Bt cotton which revolutionized India's cotton production scenario, transgenics has never caught hold of any other crop category. After the introduction of the I and II series of Bt cotton, the much awaited III in line is yet to be introduced in India. There is also a long wait for the Herbicide Tolerant series as well. Bt Brinjal came close to execution, but it was widely opposed on the grounds of safety of transgenics in food crops. Although the transgenic varieties have never been proved unsafe scientifically, the public chose caution to science.

Conserving Varieties

With the obligation of catering to the

agricultural community there came the immense responsibility of protecting the rights of the stakeholders involved. The entry of private segments and with the entry and exit of the planting materials from and to India, it became all the more pertinent to protect the biodiversity and breeders' rights.

India, signatory to World Trade Organization (WTO) was required to introduce an "effective system" for the protection of plant varieties. In compliance to the TRIPS Agreement, India established Protection of Plant Varieties and Farmers Rights (PPV&FR) Authority, under the Protection of Plant Varieties and Farmers Rights Act, 2001. PPV & FR Authority became operational from 11th November, 2005. The Authority favours establishment of an effective system for protection of plant varieties, the rights of farmers and plant breeders and to encourage development of new varieties of plants. The authority strives to accord recognition and protection of the rights of farmers in respect to their contribution in conserving, improving and making the available plant genetic resources for the development of new plant varieties. It also has the potential to accelerated agricultural development in the country

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by stimulation of investment for research and development both in public and private sector, and facilitate growth of seed industry to ensure the availability of quality seeds and planting material to the farmers.

Under this act, farmers who have developed or bred a new variety shall be entitled for registration as a breeder of a variety. They are also permitted to save, use, sow, re-sow, exchange, share or sell his farm produce including seed of a variety protected under this Act in the same manner as he was entitled before coming into force of this Act.

Farmer who is engaged in the conservation of genetic resources of land races and wild relatives of economic plants and their improvement and preservation shall be entitled to recognition and reward from the Gene Fund provided the material so selected and preserved has been used as a donor of genes in varieties registered under the PPV & FR Act. Any person or group of persons (whether actively engaged in farming or not) or any other Governmental or Non-governmental organization may stake a claim on behalf of the village or local community.

Navigating Challenges

India obviously has emerged as an important seed industry. Counted as the fifth in the world, India's seed market has emerged as one of the strongest pillars on which Indian agriculture rests. But the

growth and development has not been comprehensive and inclusive.

Post the introduction of seed policy of 1988, many private players entered the seed market. This raised the bar of seed production and the seed sector expanded. But the private seed sector has only been interested in multiplying high value seeds. On the other hand, the public sector is inundated with the massive task of supplying high volume low cost seeds across the nation with their intention to mainly secure food security of the country. Having said that it is mainly concentrated on major food crops. Considering the obvious limitations of the public sector, this is a huge task sometimes increasing the gap between the supply and demand. Apart from this India is facing a huge deficit in fodder requirements. Fodder cultivation is not where it is needed and one of the reasons is the lack of availability of quality seeds. Similarly traditional millets and pulses are neglected. India religiously imports a good amount of pulses to meet its protein requirements. To effectively navigate through India's diversified needs, the country should also focus on other crops which have been left out considering its lesser economic value.

Another significant factor that has affected India's productivity is seed replacement. Use of good quality seeds can increase India's agricultural productivity by 15-20%. So all the attempts to turn

'IMPROVED SEEDS ADDRESSING THE ENVIRONMENT ARE THE NEED OF THE HOUR'



Avesthagen Limited, an integrated systems biology platform company headquartered in Bangalore, India, was founded in 1998 by Viloo Morawala-Patell. In an interview with Agriculture Today, Dr. Viloo Morawala-Patell, Chairman & Managing Director, Avesthagen Limited discusses the current trends and challenges faced by the Indian seed sector.

What is the market share of Avesthagen in Indian seeds market?

Avesthagen has carved out its Agri R&D portfolio in a subsidiary AVA Seeds Pvt. Ltd. The company's Environment Adjusted Crops TM technology would be addressing a significant portion of the Indian seed market once the technology is embedded into seed varieties through partnerships and co-development with Indian and International seed companies.

How important is improved seeds in addressing the current challenges such as climate change, drought, flooding etc., faced by agriculture?

Improved seeds addressing the environment challenges are the need of the hour. Ava Seeds is one of the most advanced technologies today and we believe that we have a significant roles to play.

How has the quest for quality attributes influenced the research and development in seeds?

Well, it depends on what you are looking for in Quality. In my opinion, both go hand in hand. You can have high Quality and new traits in the same seed bundled together.

Among breeding for productivity, biotic and abiotic stress, which segment according to you would have tremendous scope in the future? How poised is the seed sector to take advantage of this?

I believe both biotic and abiotic stress need to be addressed. However, after my years of research

and development experience, they have different paths. To achieve biotic stress tolerance, one needs Biomarker Aided selection and for abiotic stress, it is bio-engineering with identification of the gene and splicing it in using any of the modern genetic tools like CRISPER- cas. We have some way to go to incorporating these technologies with common sense and logic and less emotion. It will have to be done.

Are you satisfied with the current seed replacement rate in India?

We need to think big, smart and integrating technologies, and I don't think there is any will at the moment. Its slow.

What are the challenges associated with seed industry?

Challenges are many, small holdings, inclement, unpredictable weather patterns,.....it goes on. We need to move on collectively by integrating multidisciplinary technologies and bringing the farmer into the technology and also bringing processing and storage to the village.

How can global cooperation in seed segment improve the prospects of Indian agriculture?

Global cooperation through shared data and open source. The time has come to end the control over Intellectual property. In my opinion there are very few people in the world capable of converting IP into Product. So open the doors.

around India's productivity is positively dependent on higher seed replacement rate of better varieties and hybrids. Unfortunately, seed replacement rates are below the optimal levels. So is the case of varietal replacements. Newer varieties are constantly appearing in the market, but the rate at which newer varieties are replaced is quite low. There are many reasons for the low varietal replacement as it is difficult to convince the farmers of the apparent benefits of a new variety when they are already satisfied by their existing varieties. Field demonstration involves time and money both of which may not be easily forthcoming. However, varietal replacement is important for the health of the agriculture system as quite often the cultivated varieties become less productive and more prone to newer threats like epidemics, droughts or other forms of stresses, Timely updation with varieties can save them from these losses.

India ranks first in the areas under rainfed irrigation. The rainfed agriculture accounts for 56.0 per cent of total cropped area, 48.0 per cent of the area under food crops and 68.0 per cent of that under non-food crops. But ironically, we are interested in developing varieties that are high yielding and hence requiring more water and fertilizers, a total antithesis of rainfed requirements. India needs to focus on research that would positively focus on raising yields of the rainfed regions. This will also help in raising the income of small and marginal farmers who are the largest benefactors of rainfed agriculture.

Climate change is yet another threat to modern day agriculture. Climate changes have already been noticed and agriculture is coping with last 2 back to back droughts. The recent heat waves are also indications of the same. As agriculture is deeply dependent

on climate, our production systems must be geared to face the challenges arising out of climate change. We need to invest more on research catering to development of climate resilient seeds. In years to come, we will be in more need of drought tolerant, salinity tolerant and submergence tolerant varieties. Not only research but seed production of these varieties of adequate quantities are essential. The Indian crop improvement programme has released a number of varieties which are tolerant to various abiotic stresses and the real impact of

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these varieties will be realized only if their seeds are made available to the farming community.

Seed enhancement is a very promising area that has been neglected in the Indian context. Seed quality enhancement involves the elevation or improvement of one or more aspects of seed performance (e.g. germination, emergence) above the level set by inheritance and achievable under natural conditions. It encompasses not only physiological treatments and conditioning (e.g. priming), but also improvements or alterations in physical seed properties that enhance plant ability and facilitate achievement of optimal stand geometry (e.g. coatings, hulling), and chemical/biological treatments that protect seeds in the soil and regulate

germination (e.g. fungicides, plant growth regulators). Presently, in the name of seed enhancement technologies only seed treatment with fungicides and/or pesticides are being used by public sector seed supply system, while highly sophisticated technologies i.e. seed coating, seed pelleting and solid matrix priming etc. are applied by the private seed sector in case of hybrids, vegetables and flower seeds. During the past three decades, the global seed industry has made tremendous progress in terms of technology marketing and regulation. India should invest more in these technologies.

India should also make its policy on GM technology clear. A consensus must be arrived upon by removing all the ambiguities existing in the regulatory mechanism for GM and should promote research in this promising area. GM technology is a promising area and India should not evade its farmers of this useful technology.

In the past, public - private collaborations have often worked well - India's public research system is typically credited with producing the upstream research on hybrid parent line development that has led to a vibrant private sector-led market in hybrid seed for pearl millet, sorghum and cotton. Yet, despite increasing public expenditure on agricultural research in recent years in India, the public sector's contribution to crop improvement remains constrained by factors including top-heavy organization and management structures, and a lack of incentives to encourage public researchers to rapidly release viable technology products or collaborate with the private sector. Greater policy attention must be given to improving management systems and innovation incentives in India's vast public research system, and to strengthening the public-private interface in the areas of crop improvement.