CHAPTER I
INTRODUCTION

India has high population pressure on land and other resources to meet its food and development needs. The natural resource base of land, water and bio-diversity is under severe pressure. The massive increase in population (despite the slowing down of the rate of growth) and substantial income growth, demand an extra about 2.5 metric ton of food-grains annually, besides significant increases needed in the supply of livestock, fish and horticultural products. The demand for food-grains (including feed, seed, wastage and export) is projected in the year 2020 at the level of 280 metric ton. Future increases in the production of cereals and non-cereal agricultural commodities will have to be essentially achieved through increases in productivity, as the possibilities of expansion of area and livestock population are minimal. Productivity from the land can be increased by using high yielding seeds (Anon., 2017a).

1.1 OVERVIEW OF THE INDIAN ECONOMY

The Indian economy has been one of the fastest growing economies in the world. India’s economic growth is backed by strong economic fundamentals that have helped maintain a high growth trajectory with gross domestic product (GDP) growth averaging over 6.50 per cent over the five years between FY09-FY14. However, in recent years the Indian economy has been adversely affected by some spill-over effects of the global economic slowdown, coupled with domestic pressures. During FY14, the Indian economy registered a growth rate of 4.7 per cent as against 4.5 per cent during FY13 (Anon., 2017a).

A survey forecasts growth rate of 6.75 to 7.5 per cent for FY18, as compared to the expected growth rate of 6.5 per cent in FY17. Over the medium run, the implementation of the Goods and Services Tax (GST), follow-up to demonetization, and enacting other structural reforms should take the economy towards its potential real GDP growth of 8 per cent to 10 per cent (Anon., 2017b).

After China, India has the second largest population in the world and it is the third largest producer of grains in the world after China and U.S. The agriculture and allied sectors accounted for 14 per cent of India’s GDP in FY14. While the contribution of the agriculture sector to India’s GDP has steadily declined due to the high growth in
manufacturing and services sector, it still plays a significant role for the Indian economy because approximately 55 per cent of the population is dependent upon the agriculture sector (Anon., 2017b).

1.2 OVERVIEW OF GLOBAL AGRICULTURE

According to U.S. Department of Agriculture (USDA) estimates, global grain stock-to-use ratio is expected to be 20.8 per cent in FY15, which is relatively in-line with the 15-year historical average levels of 21.1 per cent. The world grain demand grew at a compounded annual growth rate (CAGR) of 1.86 per cent during FY01-15 on account of increasing population, rising per capita income in developing countries and use of grains for industrial purpose. Despite marginal increase in acreage (0.37 per cent), global grain supply also grew at a CAGR of 1.86 per cent during FY01-15 and this was due to significant improvement in yield (from 2.83 metric tons per hectare (MT/ha) in FY97-98 to 3.53 MT/ha in FY14-15) caused by increased use of better agriculture inputs and improved farm practices. While the use of agricultural inputs like seeds, nutrients (fertilizer, manures, micronutrients), water, pesticides (insecticides and fungicides), herbicides and farm machinery, has increased the global productivity of agriculture. Seeds are the basic and most critical input for sustainable agriculture. To a large extent, a crop response to all other agricultural inputs will depend on the quality of seeds. It is estimated that the direct contribution of the quality of the seed alone to total crop production is about 15 to 20 per cent (depending upon the type of crop) and this contribution can be raised to up to 45 per cent with efficient management of other agricultural inputs. According to USDA estimates, global cotton stock-to-use ratio is expected to reach a record 93.7 per cent in FY15, well above the 15-year average of 58.3 per cent. This is on account of a sharp improvement in cotton productivity on the back of higher adoption of Bt. cotton by the major producing countries and a slowdown in demand in the key consuming regions (such as China and Brazil) due to weakening global economy. Over the medium-term, cotton prices are expected to be supported by expectation of partial recovery in consumption, particularly from major importing countries in FY16. According to the International Cotton Advisory Committee, it is expected that higher Chinese imports (27 per cent year on year) will increase the world cotton trade by 4 per cent year on year to 7.9 MT in FY16 (Anon., 2017b).
1.3 OVERVIEW OF GLOBAL SEED INDUSTRY

Developments in seed technology have increased the momentum of the industry’s growth, and the introduction of genetically modified crops has further boosted the seed market. The value of global seed market has tripled since 2000 and reached approximately U.S. $ 50 billion in 2014. Globally, North America occupies the largest market share and together with Europe it constitutes more than 50 per cent of the global seed market. Currently, the market is highly competitive and to increase the share in the seed market, top companies are adopting strategies such as mergers and acquisitions. The global seed market is expected to grow at a CAGR of 6.8 per cent during the forecast period 2017-2022. The market, estimated, is projected to reach a value of U.S. $ 78219.35 million by 2022. The seed market is segmented by crop type into - oilseeds, cereals/grains, fruits and vegetables, and other seeds; by type into - non genetically modified seeds (hybrid seeds), genetically modified seeds, varietal seeds, and by geography into - Asia-Pacific, North America, Europe, South America, and Africa. Considering that the seed industry is concentrated in the more industrialized and developed countries, North America and Europe constitute nearly half of the global seed market. America dominates the genetically modified crop market, followed by Asia. Non genetically modified seeds/hybrids constitute the largest share of 22 per cent, followed by genetically modified seeds. At the same time, rising adoption of organically grown food products results in a steady growth of hybrids. Varietal seeds segment is expected to grow at a CAGR of 8.8 per cent during the forecast period. Regarding the crop type, vegetable seeds segment is projected to be the fastest-growing during the forecast period, at a CAGR of 8.5 per cent, followed by oilseed crops. Vegetable seeds are further segmented into solanaceae, cucurbit, root and bulbs, brassica, and others. Tomato, from solanaceae, is a major crop witnessing the fastest growth. Oilseeds constitute soybean, sunflower, cotton, and rapeseed as the major crops. Cereals and grains, such as rice, wheat, maize, and sorghum, constitute the largest share of 48 per cent of the global seed market and play a crucial role in meeting the global food demand. The global seed market is segmented into North America, Europe, Asia-Pacific, South America, and Africa by geography. Asia-Pacific is seen as the fastest growing segment during the forecast period, with a CAGR of 7.9 per cent, followed by South America. China is the second biggest seed market in the world, right behind the United States. With a market value of U.S. $ 10654.8 million in 2016, the China seed market is growing at an
estimated CAGR of 6.5 per cent, and is expected to reach U.S. $ 15377.5 million by 2022 (Anon., 2017c).

1.4 OVERVIEW OF INDIAN AGRICULTURE

According to Food Agriculture Organization (FAO), 11 per cent of world’s arable land is in India which makes it the country with the second largest amount of arable land, the U.S. has the largest amount of arable land. However, India’s arable land accounts for only 4.0 per cent of the world’s agricultural area on account of low cropping intensity. On a global scale, despite the fact that India has been a small net exporter of agricultural products, it maintains its standing in the global agricultural market because it caters for the domestic demand from its large population (Table1.1).

**Table1.1 India’s agriculture position in global market for key crops**

<table>
<thead>
<tr>
<th>Crop</th>
<th>Area(mha)</th>
<th>Yield (Mt/Ha)-FY-15</th>
<th>Demand (Mt)</th>
<th>Export FY-15</th>
<th>Stock-to-use</th>
<th>India’s Position</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>World</td>
<td>India</td>
<td>India</td>
<td>World</td>
<td>Per cent of global trade</td>
<td>FY-15</td>
</tr>
<tr>
<td>Rice</td>
<td>43.5</td>
<td>3.52</td>
<td>4.41</td>
<td>102</td>
<td>99</td>
<td>20.4</td>
</tr>
<tr>
<td>Wheat</td>
<td>30.6</td>
<td>3.13</td>
<td>3.25</td>
<td>95.9</td>
<td>94</td>
<td>2.2</td>
</tr>
<tr>
<td>Cotton</td>
<td>12.7</td>
<td>0.52</td>
<td>0.76</td>
<td>30.5</td>
<td>24</td>
<td>13.8</td>
</tr>
<tr>
<td>Soybean</td>
<td>11</td>
<td>0.95</td>
<td>2.66</td>
<td>10.5</td>
<td>10.3</td>
<td>0.1</td>
</tr>
<tr>
<td>Corn</td>
<td>9</td>
<td>2.44</td>
<td>5.56</td>
<td>22</td>
<td>20</td>
<td>2.2</td>
</tr>
<tr>
<td>Millet</td>
<td>8.8</td>
<td>1.08</td>
<td>0.87</td>
<td>9.5</td>
<td>9.7</td>
<td>0</td>
</tr>
<tr>
<td>Sorghum</td>
<td>5.5</td>
<td>0.91</td>
<td>1.56</td>
<td>5</td>
<td>49</td>
<td>0.5</td>
</tr>
</tbody>
</table>
Despite a marginal decline in acreage (0.26 per cent), Indian grain output rose at a CAGR of 1.43 per cent during FY00-15 on account of improving agriculture productivity (Fig. 1.1.). However, India’s agriculture productivity is significantly below that of the other major worldwide grain producing regions due to lower consumption of high quality seeds, fertilizers, pesticides, lower farm mechanization, weak credit facilities, shortage of water and energy and certain other factors (CARE, 2015).

Fig. 1.1  Indian grain output rose 1.4 per cent per year over FY15 (CARE, 2015)

Fig. 1.2  Yield (in million metric ton/ha) in major grain producing regions – FY15 (CARE, 2015)
1.5 OVERVIEW OF INDIAN SEED INDUSTRY

The Indian seed industry has total Seed Industry which worth about 8000 – 9000 crores which is less than 2 per cent of the global seed business of U.S. $ 25 billion. Private sector accounts for 70 per cent turnover in seed. Almost one third companies have a global technology/financial partner. Private seed companies are spending 10 – 12 per cent of their turnover in research and development (R& D). R & D budget of medium sized companies is growing at the rate of 20 per cent per annum. At present the number of seed companies engaged in seed production or seed trade is about 500 number. Key Players in Indian market is Mahyco, Monsanto, HLL Unilever, Proagro, Aventi, Ankur, Namdhari, Advanta, Advanta & ITC and Syngenta. Seed export from India is very minuscule at around 500 crore rupees accounting for just 1 per cent of total global seed export in which horticultural crops, 31 per cent maize, 15 per cent herbage crops, 12 per cent beet, 8 per cent potato, 11 per cent wheat, 2 per cent other agri crops, 21 per cent (Anon., 2017d).

The developments in the seed industry in India, particularly in 30 years, are very significant. A major re-structuring of the seed industry by the government of India through National Seed Project Phase-1 (NSPP) (1977-78), Phase-2 (1978-79) and phase-3 (1990-1991). New seed development policy (NSDP) (1988-1989) was yet another milestone in the Indian seed industry, which transformed the very character of seed industry. The policy give access to Indian farmers of the best of seed and planting material available anywhere on the world. The policy stimulated appreciable investments by private individuals. Protection of Plant Varieties and Farmers’ Rights Authority (PPV&FR) enacted in 2001. Varieties of crops can have proprietary or Intellectual Property Rights (IPRs) on them through either patent or plant variety protection or a combination of both. The PPV&FR Authority registers plant varieties to protect plant breeder’s rights, thereby stimulating R&D investment in development of new plant varieties. New Policy on Seed Development (NPSD), 1988 was formulated with a view to provide the best planting material available abroad to Indian farmers. Import of seeds under various categories such as coarse cereals, pulses, seeds of vegetables, flowers, etc. to improve agricultural production and productivity. The policy permits an initial import of small quantity of cereals, oilseeds, pulses, etc. for in-house trial by importer and multi location testing under All India Coordinated Trials (AICT) of ICAR. The objective of the Organization for Economic Cooperation and Development (OECD) seeds scheme is to encourage use of seeds of consistently high quality in participating countries. India’s
participation in the OECD Seed Scheme was accepted by the OECD in 2008 in respect of five seed schemes viz. grasses and legumes, cereals, crucifers and other oil and fiber species, maize, sorghum and vegetables. Production and consumption of Seeds in India and year production of Breeder seeds (in thousand quintals) Production of Foundation seeds (in lakh qtls) Distribution of certified /quality seeds (in lakh qtls) 1991-92 (3.75 34.9 57.5), 1995-99 (4.76 43.36 69.9), 2001-01 (5.91 42.69 86.27), 2005-06 (7.4 68.64 126.75), 2009-10 (10.5 105 257.11) and 2010-11 (17.53 119.21 277.3). All India Position of requirement & availability of quality Seed (2010) is briefed in next line. Year Requirements (in lakh quintal), availability (in lakh quintal) and surplus (in lakh quintal) . In 2006-07 (128.76, 148.18, +19.42), 2007-08 (180.74, 194.31, 13.57), 2008-09 (207.28, 250.35, 43.07), 2009-10 (249.12, 279.72, 30.60), 2010-11 (290.76, 321.36, 30.60), and 2011-12 (330.41, 353.62, 23.21) respectively. The policy aims at enhancing food production targets achievable by enhancing, the Seed Replacement Rates (SRR). The policy aims at creating an enabling climate for growth of a competitive and vibrant seed industry, encouraging import of useful germplasm and boosting exports. The thrust areas are varietal development and plant variety protection, seed production, quality assurance, creation of infrastructure for seeds, transgenics, import of planting material, export of seeds and promotion of domestic seed industry. The Seeds Bill, 2004 aims to regulate the quality of seeds and planting material of all agricultural, horticultural and plantation crops to ensure availability of true to type seeds to Indian farmers by curb the sale of spurious, poor quality seeds, protect the rights of farmers, increase private participation in seed production, distribution and seed testing, and liberalize import of seeds and planting materials. There is a mismatch between the seed multiplication ratio from breeder seed to foundation seed and from foundation seed to certified seed. Comprehensive and authentic databases on seed production and trade need to be built up. The seed chain and the norms for quality control to be followed without any compromises or shortcuts. For horticulture crops which have a long gestation period, it is imperative to ensure that only such varieties are imported that are suited to Indian conditions. A genetically diverse portfolio of improved crop varieties needed. Timely delivery to farmers of high-yielding varieties requires big improvements in the system that connects plant germplasm collections, plant breeding and seed delivery. Improving policies and legislation for variety development and release as well as seed supply is enactment of flexible variety release legislation, strengthening capacity by creating a new generation of skilled practitioners to support enhanced breeding, working with farmers to explore the ways in which crops and
varieties contribute to successful intensification and revitalizing the public sector and expanding its role in developing new crop varieties. With one sixth of the world population and the second largest cultivable land, the Indian seed industry presents a poor picture. There are many factors which influence the trends. Cultivation in India is more self-oriented than market oriented. The average farmers tries to grow as many commodities as possible on his land, regardless of the economies of production. The farmer prefers to grow more than variety of even the main crop as a risk aversion measure. Catering to these varied needs in different parts of the country is definitely a daunting task for the seed industry, though it also holds great promise. With world trade expected to reach US $75 billion by 2020 (Anon., 2017e).

1.6 OPPORTUNITIES IN INDIAN SEED INDUSTRY

The Indian seed industry is eighth largest in the world with an estimated value of INR 49 billion (USD 1.06 Billion) and with an annual growth rate of 12 per cent to 13 per cent. Despite of only production and marketing of seed now it is developing by acquiring technological strength to cater to the varietal needs of tomorrow. 70 per cent of production capacity of India's seeds' come from farmer bred seeds, 26 per cent from those bred in publicly financed institutions, and only 4 per cent from research hybrids. The domestic hybrid seed market is around at U.S. $4.9 billion and is annually growing at 10 per cent a year, against 5 per cent global growth rate. The domestic market works out to be about 3.7 per cent of the global market. India is among the few countries where the seed sector is already reasonably advanced (Anon., 2017f).

1.7 SEED

Seeds are a critical and basic input for enhancing agricultural production and productivity in different agro-climatic regions. It can also be defined as any propagative part of plant.

1.7.1 Types of seeds:-

1.7.1.1 Open Pollinated Variety (OPV) - In this pollination is carried out by wind, insects or other naturally occurring agents. Seeds saved from this can be saved for use in subsequent years.

1.7.1.2 Hybrid seeds- It is the result of pollination of one genetically uniform variety with pollen from another specific genetically uniform variety. It is done in controlled
environment so that all the plants grown will be the result of desired cross and genetically identical.

1.7.1.3 Genetically Modified (GM) seeds- seeds containing genes from unrelated species that were artificially inserted by genetic engineering techniques. These can be hybrids or OPV.

Table 1.2 Difference between public bred variety and hybrid seeds

<table>
<thead>
<tr>
<th>Public-Bred Variety Seeds</th>
<th>Hybrid Seeds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Available for cereals</td>
<td>Available for vegetables, cotton and maize</td>
</tr>
<tr>
<td>Certified seeds</td>
<td>Truthful seeds</td>
</tr>
<tr>
<td>Low Value-High Volume Seeds</td>
<td>High Value-Low Volume Seeds</td>
</tr>
<tr>
<td>High seed requirement</td>
<td>Low seed requirement</td>
</tr>
<tr>
<td>Can be reused for upto 3 yrs</td>
<td>Needs to be replaced every year</td>
</tr>
<tr>
<td>Low yield</td>
<td>High yield</td>
</tr>
<tr>
<td>Nucleus and Foundation seed produced by State Agricultural Universities, IARI</td>
<td>Nucleus and Foundation seed produced by the Seed Companies</td>
</tr>
<tr>
<td>Can be easily procured in seed form</td>
<td>Can be procured as germplasm from parent company</td>
</tr>
<tr>
<td>No royalty is paid</td>
<td>Royalty is paid (for each seed bag produced)</td>
</tr>
<tr>
<td>Short shelf life</td>
<td>Longer shelf life</td>
</tr>
</tbody>
</table>

1.7.2 Classes of seeds:-

1.7.2.1 Nucleus seeds-

It is the initial amount of pure seed of an improved variety available with plant breeder who has evolved it. The nucleus seed is cent per cent pure genetically as well as physically and is very limited in quantity.
1.7.2.2 Breeder seeds-

It is the seed obtained from the progeny of nucleus seed. It is directly supervised by a breeder concerned with the crop. Its genetic purity is 100 per cent. After passing the seed lot, breeder seed tags in buff colour or Golden Yellow are signed by the concerned breeder. Breeder seed can be produced by original breeder, sponsored breeder on Agricultural University farms and rarely on government farm. Breeder seed plots are subjected to joint inspection by a team consisting of crop breeder from other Agricultural Universities in the State, representative of All India Coordinated Research Projects of the crop, National Seeds Corporation, State Seeds Corporation and Divisional Seed Certification Officer. Breeder seed produced should meet all prescribed standards viz. genetic purity (99.9 per cent or more), physical purity (98 per cent). Germination (as per crop) moisture content (less than 12 per cent).

1.7.2.3 Foundation seeds-

It is seed obtained from nucleus or breeder’s seed. It is produced on seed multiplication farm of a state government or agriculture Universities. Foundation seed plots are jointly inspected by the SCA (seed certification agency), it is not as pure as the nucleus and breeder’s seeds are. The bags are sealed with white colour label. Foundation seed plots are required to be registered for certification with state seed certification agency.

1.7.2.4 Certified seeds-

It is the progeny of foundation seed. Plots of certified seed are offered for certification with seed certification agency which inspects the plots during crop growth and at harvesting. After processing seed samples are drawn by seed certification officer and sent to STL (seed testing laboratories) for seed testing. When seed lot meets certification standards prescribed for the crop, then it is processed, bagged, tagged with blue colour tag and label together and sealed by using lead seal.

1.7.2.5 Truthful seeds-

It is the category of seed produced by cultivators, private seed companies and is sold under truthful labels. But field standard and seed standard should maintain as per seed act and certified seed stage. Under the seed act, the seed producer and seed seller are responsible for the seed.
# 1.8 Benefits of Quality Seeds

- **Yield enhancement:** According to the Ministry of Agriculture, seed quality is estimated to account for 20-25 per cent of productivity. It is, therefore, important that quality seeds are made available to farmers.

- **Savings from lower pesticide consumption:** GM seeds with resistance to biotic stresses (insects and diseases) are available with different traits such as insecticide and disease resistance or both, which enables reduction in pesticide consumption. For example, according to ISAAA, cotton insecticides as a percentage of the total insecticides consumed in India has fallen from 46 per cent in 2001 to 26 per cent in 2006 and then further declined to 20 per cent in 2011 due to increased adoption of Bt cotton seeds. In addition to biotic stresses like insect resistance, certain traits which confer tolerance to herbicides make the GM plant survive in the field while all other weeds are eliminated. Therefore, plants which have tolerance to herbicides will have less competition from weeds for natural resources as herbicides can be used without harming crop yields. Farmers can also make savings and benefit from using seeds which have been genetically modified to have more than one trait, for example, insect resistance and herbicide tolerance.

- **Others traits:** Varieties and hybrids are also available with traits like abiotic stress tolerance (such as tolerance of drought and salinity stress), post-harvest traits (softness or hardness, increased shelf life and delayed ripening), and improved protein and vitamin content. However, since Fiscal 2002 GM cotton hybrid seeds with the *Bacillus thuringiensis* (Bt) traits have been introduced in India and in Fiscal 2013, 93.0 per cent of India’s cotton acreage was based on GM cotton hybrid seeds with the Bt-1 trait or its advanced versions. At present, cotton is the only commercialized GM crop in India (Seed Certification Standard, 2005).

# 1.9 Seed Production and Marketing Process

Seed production can be formal and informal. In the informal system, the farmers produce the seeds and store it for use in the next season or they get the seeds from friends, family or relative. The seeds used in such a system are low value and open pollinated type i.e. they can be used generation after generation without losing their characteristics. These kinds of variety are not ideal as their yield decrease because of
inbreeding depression and they need to be replaced after at most 3 years or 3 generations. In the formal system, seed is produced by seed companies or SAUs or by farmers under contact for them. This is done for distribution on a larger scale as compared to informal system.

Seed production process starts with identification of site and progressive farmer (for contract farming). In this first step, farmer or farm community with minimum 5 acre land is selected. The operation can be on cooperative basis or individual basis. The farmer or cooperative or farmer village selected should have technical knowledge of the production process. The site is also important aspect of selection process as the soil condition is one of the factors affecting the quality of seeds. Also, the location helps the farmer in maintaining the parameters like, isolation distance in maintaining seed quality. The concept of farmer village is progressive from farmers’ view point as it enables them in getting better rates and other facilities. This concept also helps in reducing risk liability on a single person and farmers can share their technical knowledge to get a better production.

The next important step in seed production process is the source of seed. The source of seed is the most important parameter attributing to the quality of seed. If the seed procured for further multiplication is of good quality, it increases the production and profit of farmers. If the seed is procured from a trustable and good source (like IARI, SAUs), then the farmer is liable to claim compensation in case of low production or low quality of seeds, provided the package and practices were followed. Availability of other agricultural inputs like fertilizers, pesticides and irrigation is also important. Government has introduced many schemes in this direction. Prime Minister Irrigation Scheme-“Per Drop More Crop” is one such scheme that promotes better irrigation facilities.

The most important point to consider in seed production business is the assurance of marketing. If the seed produced is of good quality and the production is good too and there is no one to buy the good quality seeds then it will demotivate the farmer. Private seed companies, IARI and SAUs provide assured markets to their farmers. Private seed companies, IARI and SAUs buy back the seed produced by the famers. Price provided by IARI is mandi price of the week in which seed is delivered 20-30 per cent incentive (only for seeds).
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The next step in seed production process or the steps after production is processing. Processing of seed entails gravitational separation, size sorting and colour sorting (especially in pulses). In gravitational separation, other inert material is removed, in size sorter seeds are sorted by size and under-sized and over-sized seeds are rejected. Color sorting is done generally in pulses. Private seed companies use palliative coating to get a uniform color of the seeds.

Marketing of seed can be done through C&F, Distributor, Dealer or seed can be distributed directly to farmer. Private seed companies generally distribute through distributor and dealer and can have their own retail centres. IARI distribute seed directly to the farmer.

1. Seed company → C&F → Distributor → Dealer → Retailer → Farmer
2. Seed company → Dealer → Retailer → Farmer
3. Seed company → Retailer → Farmer
4. Seed company → Farmer

Certification is third party quality assurance and is voluntary. Certification increases the cost and thereby price of seed but also provides assurance of quality to the consumer. Certified seeds are tagged with blue coloured tag. The seed label also mentions that the seed is certified along with the kind, variety, date of packaging, quantity and price. Expiry of seeds is not mentioned on the label as it is calculated as 9 months after date of packaging. Seeds can be revalidated for another 6 months by following due process i.e. their shelf life can be increased by 6 months. Seed companies (private and public) also provide technical assistance to the farmers under contract and undertake inspections at sowing, flowering, harvesting and rest at an interval of 15 to 20 days. Seed companies act as facilitator in providing financial assistance to the farmers. Financial assistance is through banks or Co-operatives only. Seed production and processing requires funds at every stage, but the financing is generally required for infrastructure development for processing, storage, packing or for value addition, seed quality assurance, nursery raising.

In hybrid seed production, the company has rights of production and selling the variety it produces. It can allow other companies to replicate or further develop the variety on payment of an agreed upon royalty. The hybrid seed germplasm is provided in an insulated cylinder which is surrounded by another cylinder of liquid nitrogen (-275°C).
Methodologies of hybridisation include cross hybridisation, air hybridisation (female is so placed that it is in the direction of wind, as it carries pollen), bee pollination (bee pollinate female flower). In hybridisation, isolation distance need to be maintained to ensure that pollination takes place in between the desired male and female plants only and contamination doesn’t take place (Ramanjeneyulu, 2014).

1.10 KEY CONSIDERATIONS FOR DEVELOPMENT OF SEED INDUSTRY

- **Role of R&D and intellectual property rights:** Increasing investment in R&D, introduction of IPR in plant breeding and biotechnology were major drivers of structural change in the global seed industry. The seed industry involves significant R&D for development of seeds with improved genetic traits, which are developed over generations before being commercially released. Accordingly, companies are required to invest heavily in R&D in order to produce seeds with improved traits and remain competitive. Both seed companies with end to end capabilities from R&D to commercial production to marketing and distribution, and companies which only perform a single function such as trading, marketing or distribution exist in India. R&D spending in the seed industry can be broadly categorized in two types a) development of superior variety or a hybrid through plant breeding and b) technology development for delivery of traits. Generally, international players (such as Bayer, Syngenta, Monsanto, BASF, Dupont and Dow) are involved in development of technologies for delivery of new traits as it requires heavy spending on R&D and involves long gestation periods. However, both domestic and international seed producers are involved in large scale plant breeding programs on proprietary germplasm to develop improved hybrids (such as hybrids which lead to improvement in product yields and quality and may also be resistant to pests, and have drought tolerance) and varieties. For example, in India, Bt. cotton trait was initially developed by Monsanto and was then licensed to more than 40 domestic seed companies until FY13. Domestic seed companies have developed superior cotton hybrids through plant breeding with plants which have the Bt. gene licensed from Monsanto. Domestic companies have used their R&D on plant breeding to release more than 1,000 varieties of improved Bt. cotton hybrids over the last 12 years. According to industry sources, it typically takes approximately 72 to 84 months from the time of collection and evaluation of the germplasm to the launch of a new seed product (hybrid or open pollinated varieties) in the market.
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- **Product life cycle (PLC)**: The typical life cycle of a seed product is, approximately, a 10-15 year cycle. This breaks down into (i) four years to develop test and commercialize the product, (ii) three years of ramp up, (iii) four years of the product’s growth phase, during which the seed products supply high volumes and margins, and (iv) two-three years of maturity, during which crop volumes stabilize and decline, however, margins remain high.

- **Long production period**: Seeds are grown through agricultural operations rather than manufactured. Given that each processing stage requires a growing season, seed production requires long lead times. Hence, correct estimation of future seed demand is important as it will enable producers to accurately plan their supply.

- **Barriers to entry and key success factors**: In order to develop products in the seed industry, companies need access to a diverse germplasm bank and adequate capital to develop products over long periods of time. The development of a diverse germplasm bank requires the accumulation of hereditary materials over a period of years both by collection from various sources and also by internally generating genetic diversity.

- **Working capital**: In contrast, sales typically take place a few weeks before the sowing season. Consequently, a seed producer needs to have good storage facilities so as to meet demand during the peak season period, which may lead to a requirement of higher working capital. Long production periods and the extremely short sales periods expose companies to liquidity management problems if sales do not take place as projected and may lead to higher inventories.

- **Contract farming**: Seed firms with a marketable seed product typically contract out the production and multiplication processes to independent farmers, farmers’ associations, and private firms. The duration of contract farming arrangements usually spans for one crop season (Rabi or Kharif).

- **Seed conditioning**: Once harvested, the seeds are conditioned for sale to farmers. The conditioning process typically includes drying, cleaning and sorting, treating with insecticides and fungicides, and packaging. Such processes are generally performed at centralized processing facilities.

- **Quality control**: Seed quality assurance is a critical component of the supply chain of the seed business. Production of improved seeds of highest genetic and physical purity of both varieties and hybrids is a prerequisite for meeting the need of the growing consumer demand for quality seed products. Seeds are subject to inspection
under various government programmes to ensure that the final product meets certain quality standards. This inspection may include tests for purity, germination, presence of noxious weed seeds and moisture content. Seed certification is a legally sanctioned system in India for quality control of seed multiplication and production. Agencies which are notified under section 8 of the Seeds Act are authorized to certify seeds.

Under the Seeds Act, seed certification is voluntary and most of large seed companies prefer to self-certify. Where a company has certified its own seeds, such seeds will be labelled as “truthfully labelled” and are perceived to be of higher quality because the company will have had to meet certain standards of quality control and assurance mechanisms before self-certifying.

- **Marketing and distribution**: Private seed companies generally rely on dealers or will sell directly to farmers. Apart from dealers or self-selling points, both private and public seed corporations supply seeds to farmers through many channels such as cooperatives and societies such as KRIBHCO, IFFCO. Marketing and distribution channels are generally localized. Local distribution is typically run by independent agents, such as farmer-dealers, farmers’ associations, company salesmen and private wholesalers and retailers. Many companies also license or outsource marketing and distribution to private firms and individuals in order to improve access to local markets. Different distribution channels are used in different regions and markets and marketing and distribution typically accounts for approximately 6-8 per cent of the total cost of production.

### 1.11 RISK IN SEED PRODUCTION AND THEIR MITIGANTS

Although the seed industry has an enormous growth potential, it carries some unique risk factors that need to be considered from a credit perspective.

#### 1.11.1 Over-dependence on cotton

Cotton is one of the few crops, which gives both volumes and better realizations and more than one-fourth of the industry’s turnover comes from cotton hybrids. This high dependence exposes the companies to the risk of lower demand due to (i) change in area under cotton cultivation, which, in turn, depends on the prevailing and expected prices of cotton and (ii) competitors coming out with better hybrids and hampering the prospects of other players.
Mitigants- By having a wide product portfolio so that even if there is a drop in demand for one crop, the top line is protected to a certain extent and farmers too are retained within the company’s fold.

1.11.2 Research & Development- R&D is the first and most critical endeavour of a seed company. It typically takes rs. 50 to rs. 100 million over a period of seven to eight 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 the form of retaining the purity of the hybrid season after season, which requires proper maintenance breeding of the parent variety.

Mitigants- The R&D efforts need to be market oriented also to take into account the needs of the end user so that when the variety is launched after incurring so much expenditure, it is accepted by the market. R&D is a key differentiator in this industry and companies with good R&D facilities are better placed to succeed than others.

1.11.3 Life cycle Risk- On an average, the life cycle of a hybrid is eight to ten years after which, newer and better varieties typically outperform older ones. Hence, even though a particular hybrid variety might achieve high sales and better margins in the introductory period, these may not be sustainable for long.

Mitigants - To remain ahead of the market, the company has to keep churning out better varieties at least once every four years. In the long run, then, only those seed companies with adequate R&D infrastructure and where the management is committed to developing better varieties have a higher chance of survival.

1.11.4 Long production periods- Hybrid seed production takes place in two stages (preparation of foundation seeds and production of hybrid seeds) by crossing two varieties. As each stage is seasonal, production has to be planned two seasons ahead, which, in case of crops like cotton, can be as long as two years. Hence, no changes in seed production can be carried out based on the current demand estimates as the actual production has begun much earlier. In contrast with the long production period, a sale typically takes place within a few weeks prior to the sowing season. This increases the companies’ vulnerability to fluctuations in demand. The inflexibility on the production side and extremely short sales period exposes companies to a sudden inventory pile-up if sales do not take place as projected, which could lead to liquidity
problems. It also increases costs in terms of storage and the consequent risk of damage unless the company has good storage facility.

Mitigants- Having better forecasting abilities, better working capital management and the financial strength to withstand shocks in demand patterns.

1.1.5 Risks in contract farming- In India, hybrid seed production from the basic foundation seeds is outsourced to thousands of contract farmers, most of whom have miniscule land holdings. Many such farmers do contract production for more than one seed company besides growing their normal varieties. This enhances the possibility of unintended cross-pollination, resulting in poor hybrid quality. In such a scenario, quality testing is must which can be done through grow out test (GOT) etc., which takes months. Any lapse in quality front can spell disaster to both farmers (due to poor yields) and the seed company.

Mitigants- Making strong term relationships with contract farmers and geographical diversity in contract farming (CRISIL, 2016).

1.12 CORIANDER

Coriander (Scientifically known as Coriandrum sativum) is an indespensible spice in Indian and other Cuisines. It is believed to be a native of southern Europe. Although it is now widely cultivated all over the world for its green leaves, seed production is largely concentrated in India. Coriander is commonly known as “Dhaniya” in India. India is the largest producer of coriander with a production share of more than 70 per cent (496240 tons) of the total world output. Other major producers are Bulgaria, Romania, Russia, Iran, Morocco, Canada and Australia. In India Rajasthan is major producer of coriander with 117084 tons. Gujarat comes on number fourth in production with 117084 tons.

India is the largest producer and consumer of coriander seed. Coriander production has increased significantly in the past decade and currently hovering around 5 lakh tonnes. The rise in output was primarily on account of rise in yields. However, coriander production has moderated in 2012-13 due to adverse weather conditions. India is the major Exporter, producer and consumer of Coriander in the world. The export data from the reliable sources also evidences that India being the world largest producer of coriander dominates in the world market with major export markets at Malaysia, Pakistan, UAE, Saudi Arabia, US, Yemen and other Asian countries.
Coriander is used in various cuisines. It is used in pickling and in making sausages. Other health benefits are use of coriander helps in reducing skin inflammation, it can help keep our arteries clean of bad cholesterol, Keeps our liver healthy, it can help in reducing our blood pressure and Strengthen the immune system (Spice board, 2016).

1.13 COMPANY INTRODUCTION

Akshay Seed Pvt. Ltd was established in 1992 by Shri Natubhai G. Makadia, the Managing Director of the company. Initially, company has commenced research and development work in collaboration with an Israeli seed company Hazera Ltd. with prime objective to develop superior high yielding and insect-pest & disease resistant genotypes (varieties) of cotton and vegetables with better quality. Akshay Seed Pvt. Ltd. company is pioneer in the Indian seed industry who brought seed film coating technology from Netherland based multinational company Incotec Ltd. Now, it has become popular among all seed companies due to realization of its beneficial effects and wide acceptance by Indian farmers. Since from its beginning company has developed nearly 75 products in 18 crop species including cotton, vegetables, oilseeds, cereals, pulses and spices with the application of various most advanced plant breeding methods. By exploiting the use of Plant Biotechnology, company has developed Bt (Bollgard) hybrid cotton varieties i.e., Akhsay-102 (PRCH-102 Bt), Shree Maha Rakshak (Rudra Bt) and Shree Rakshak (PRCH-31 Bt) in collaboration with Pravardhan Seeds Pvt. Ltd., Hyderabad which are suitable for cultivation in irrigated as well as rain fed areas. Company has also forayed into other sectors like dairy industry, cotton seed ginning & pressing and textiles while remaining committed to the healthy growth of its core business “SEEDS”.

1.14 MAJOR ACTIVITIES OF AKSHAY SEEDS

1.14.1 Research Infrastructure

With strong emphasis on research, company has established three research farms in Gujarat state. Our main research farm is located at Junagadh with well equipped laboratory and R and D facilities. This farm occupies 40 acres area with deep black highly fertile soil. It has full irrigation facilities with check dams, electricity, communication and highly skilled man power including technical and non technical. Research activities are conducted by highly efficient crop specific plant breeders, agronomist and entomologist with commitment to develop superior crop varieties by using modern scientific and biotechnological tools and techniques.
Another two subsidiary farms are located at Mahundra, Ahmedabad on Delhi NH-8 and at Bhayavadar, Taluka, Upleta, which facilitate evaluation of newly developed hybrids/varieties under wide range environment as well as multiplication of elite genotypes and parent foundation under required isolation.

It has Collaboration with national and international institute/companies ICRISAT, Hyderabad Getting technical assistance for the improvement in some specific characters of groundnut like stem rot resistance, aflarot and collar rot resistance, bold kernel size and high oil content, BARC, Trombay for development of bunch and semi spreading varieties of groundnut with supernumerary pod bearing capacity and fodder of best quality, NRCG, Junagadh Coordinates trials, Pravardhan Seeds Pvt. Ltd., Hyderabad (development of transgenic crop varieties particularly for the improvement of those traits that have limited chance of success through conventional breeding INCOTEC India ltd. for seed film coating technology. Collaboration with SAUs and other semi government organization Junagadh agricultural university, junagadh, Anand Agricultural university, Anand, SK Nagar Dantiwada Agricultural University, Banaskatha, Navsari Agricultural University, Navsari. for large scale trials, Hybrid evaluation trials, transfer of technology and breeder seed for the improvement in various crop species like cotton, castor, bajra, wheat, maize, groundnut, sesame and vegetable crops. Lokbharti, Sanosara (Bhavnagar) sourcing and evaluation of germplasm.

1.14.2 Research Achievements

- Company has carried out the research work on quality seed production with employing well qualified personalas. Company has implemented high tech research projects for the development of superior varieties in different crops viz., cotton, groundnut, sesame, castor, pulses, cereals and vegetables and as a result few superior genotype are developed and seed released for farmers.

- Groundnut : In order to develop high yielding soil borne disease resistant and export quality groundnut variety, they have under taken collaborative research programme with ICRISAT, BARC and state agricultural universities and good quality groundnut varieties viz., Akshay Amber, Akshay-99, Akshay Sweta have been developed and seed released for farming.

- Sesame : It is an export oriented crop and at present farmers required high yielding disease resistant white and bold seeded variety of sesame. For that company has put more concentration on high-tech research for isolating superior genotype as per
present need and two best sesame varieties, Akshay-111 and Akshay Rupa are released for cultivation.

- Castor: It is important oilseed crop of Gujarat. Three high yielding hybrid castor varieties viz., Akshay Sona, Akshay-21 and Akshay Raj are developed, which are resistant to wilt disease and exhibit least sex reversion.

- Pulses: The present genotype growing at state and national level are inheritably low yielder, therefore breeding research is accelerated to develop high yielding varieties of mung, urd, cowpea and pigeon pea. As a result the mung variety Akshay Bold, Urd variety, Akshay Blackbold, Pigionpea varieties viz., Akshay Hazari, Akshay Varsha and Akshay-1515 and cowpea variety Akshay-102 are evolved and released.

- Vegetables: Superior vegetables crop varieties such as Akshay Komal and Akshay Hira of ladies finger, Akshay-7 of cluster bean crop and Akshay-102 of cowpea with yellow Vein Mosaic disease resistance and best fruit quality have been developed and released for vegetable farmers.

- Bt Cotton: Hybrid cotton varieties i.e., Akshay-102 (PRCH-102 Bt), Shree Maha Rakshak (Rudra Bt) and Shree Rakshak (PRCH-31Bt) in collaboration with pravardhan Seeds Pvt. Ltd., Hyderabad which are suitable for cultivation in irrigated as well as rain fed areas.

1.14.3 Quality control

The company never compromise in quality of the seed. Every lot is throughly scrutinized for germination, physical and genetic purity, moisture content and vigour before packaging and supplying it to marketing centres. simultaneously our quality control department also performs GOT in field conditions to ensure that all the seed lots are of highest genetic purity. All the seed samples at our laboratory are tested to meet the ISTA standards.

1.14.4 Extension

In this department 50 diploma workers for giving demonstration to the farmers in different village and they provide information to the farmers related to new ideas and technology in 7 states of the country i.e. Punjab, Haryana, Madhya Pradesh, Rajasthan, Gujarat, Maharastra and Andhra pradesh.

1.14.5 Marketing
In this department 112 employees are working. Crop wise distributions is there, so there are 2 marketing managers and 2 employees are provided to each manager. There are 150 distributors and 1500 dealers in Gujarat state. The multi level marketing channel has adopted by this company (Company-Distributor-Dealer-Retailer-Consumer).

1.15 PRACTICAL UTILITY OF THE RESEARCH STUDY

This study was helpful for the company to let them know about how place, age, literacy, annual income etc... affect the livelihood of coriander farmers in Junagadh and its nearby taluka. They knew that how to keep the stock efficiently and effectively to fulfill their future demand, when to maintain adequate or less stock and how to manage them and they came to know that whether they are gaining loss or gain over recent years. Crop diversification and disposal pattern gave them idea about which type of seed they should grow more according to the region, climatic condition, demand and various other factors.

1.16 OBJECTIVES OF THE STUDY

Through out the project work, secondary and primary data had been collected to justify following objectives.

1. To study the socio-economic profile of coriander farmers
2. To find out the change in cropping pattern of coriander farmers
3. To estimate inventory cost through economic order quantity model
4. To analyse selling trend of Akshay seeds
5. To study the disposal pattern of Akshay seeds

1.17 LIMITATION

1. This survey was conducted in Junagadh district only
2. Total number of surveyed farmers was hundred
3. Two year data was collected to analyse sells pattern
4. Five year data was taken to study crop diversification
5. Price of seed packet was kept constant
Introduction