CHAPTER-I
INTRODUCTION

The practice of agriculture first began about 10,000 years ago in the fertile crescent of Mesopotamia (part of present day Iraq, Turkey, Syria and Jordan) where edible seeds were initially gathered by a population of hunter/gatherers. Cultivation of wheat, barley, peas, lentils, chickpeas, bitter vetch and flax then followed as the population became more settled and farming became the way of life. Similarly, in China rice and millet were domesticated, whilst about 7,500 years ago rice and sorghum were farmed in the Sahel region of Africa. Local crops were domesticated independently in West Africa and possibly in New Guinea and Ethiopia. Three regions of the Americas independently domesticated corn, squashes, potato and sunflowers.

It is clear that the farmed crops would suffer from pests and diseases causing a large loss in yield with the ever present possibility of famine for the population. Even today with advances in agricultural sciences losses due to pests and diseases range from 10-90 per cent, with an average of 35 to 40 per cent, for all potential food and fiber crops. There was thus a great incentive to find ways of overcoming the problems caused by pests and diseases.

1.1 HISTORY OF PESTICIDES

The first recorded use of insecticides is about 4500 years ago by Sumerians who used sulphur compounds to control insects and mites, whilst about 3200 years ago the Chinese were using mercury and arsenical compounds for controlling body lice. Writings from ancient Greece and Rome show that religion, folk magic and the use of what may be termed chemical methods were tried for the control of plant diseases, weeds, insects and animal pests. As there was no chemical industry, any products used had to be either of plant or animal derivation or, if of mineral nature, easily obtainable or available. Thus, for example, smokes are recorded as being used against mildew and blights. The principle was to burn some material such as straw, chaff, hedge clippings, crabs, fish, dung, ox or other animal horn to windward so that the smoke, preferably malodorous, would spread throughout the orchard, crop or vineyard. It was generally held that such smoke would dispel the blight or mildew. Smokes were also used against insects, as were various plant extracts such as bitter lupin or wild cucumber. Tar was
also used on tree trunks to trap crawling insects. Weeds were controlled mainly by hand weeding but various “chemical” methods are also described such as the use of salt or sea water. Pyrethrum, which is derived from the dried flowers of *Chrysanthemum cinerariaefolium* “Pyrethrum daisies”, has been used as an insecticide for over 2000 years. Persians used the powder to protect stored grain and later, Crusaders brought information back to Europe that dried round daisies controlled head lice. Many inorganic chemicals have been used since ancient times as pesticides, indeed Bordeaux mixture, based on copper sulphate and lime, is still used against various fungal diseases.

Up to until the 1940s inorganic substances, such as sodium chlorate and sulphuric acid, or organic chemicals derived from natural sources were still widely used in pest control. However, some pesticides were by-products of coal gas production or other industrial processes. Thus early organics such as Nitrophenols, Chlorophenols, Creosote, Naphthalene and petroleum oils were used for fungal and insect pests, whilst ammonium sulphate and sodium arsenate were used as herbicides. The drawback for many of these products was their high rates of application, lack of selectivity and phytotoxicity. The growth in synthetic pesticides accelerated in the 1940s with the discovery of Dichloro Diphenyl Trichloroethene (DDT), Benzene Hexachloride (BHC), Aldrin, Dieldrin, Dndrin, Chlordane, Parathion, Captan and 2,4-D. These products were effective and inexpensive with DDT being the most popular, because of its broad-spectrum activity. DDT was widely used, appeared to have low toxicity to mammals, and reduced insect-born diseases, like malaria, yellow fever and typhus; consequently, in 1949, Dr. Paul Muller won the Nobel Prize in medicine for discovering its insecticidal properties. However, in 1946 resistance to DDT by house flies was reported and, because of its widespread use, there were reports of harm to non-target plants and animals and problems with residues.

Throughout most of the 1950s, consumers and most policy makers were not overly concerned about the potential health risks in using pesticides. Food was cheaper because of the new chemical formulations and with the new pesticides there were no documented cases of people dying or being seriously hurt by their "normal" use. There were some cases of harm from misuse of the chemicals. But the new pesticides seemed rather safe, especially compared to the forms of arsenic that had killed people in the 1920s and 1930s. However, problems could arise through the indiscriminate use and in 1962 these were highlighted by Rachel Carson in her book Silent Spring. This brought
home the problems that could be associated with indiscriminate use of pesticides and paved the way for safer and more environmentally friendly products.

Research into pesticides continued and the 1970s and 1980s saw the introduction of the world’s greatest selling herbicide, Glyphosate, the low use rate sulfonylurea and Imidazolinone herbicides, as well as Dinitroanilines, Cyclohexanediones and Aryloxyphenoxy propionate families. For insecticides there was the synthesis of a 3rd generation of Pyrethroids, the introduction of Avermectins, Benzoylureas and Bt (Bacillus thuringiensis) as a spray treatment. This period also saw the introduction of the Triazole, Morpholine, Imidazole, Pyrimidine and Dicarboxamide families of fungicides. As many of the agrochemicals introduced at this time had a single mode of action, thus making them more selective, problems with resistance occurred and management strategies were introduced to combat this negative effect.

In the 1990s research activities concentrated on finding new members of existing families which have greater selectivity and better environmental and toxicological profiles. In addition new families of agrochemicals have been introduced to the market such as the Triazolopyrimidine, Triketone and Isoxazole herbicides, the Strobilurin and Azolone fungicides and Chloronicotinyl, Spinosyn, Fiprole and Diacylhydrazine insecticides. Many of the new agrochemicals can be used at grams rather than the kilograms per hectare.

New insecticide and fungicide chemistry has allowed better resistance management and improved selectivity. This period also saw the refinement of mature products in terms of use patterns with the introduction of newer and more user-friendly and environmentally safe formulations. Integrated pest management systems, which use all available pest control techniques in order to discourage the development of pest populations and reduce the use of pesticides and other interventions to levels that are economically justified, have also contributed to reducing pesticide use.

Today the pest management toolbox has expanded to include use of genetically engineered crops designed to produce their own insecticides or exhibit resistance to broad spectrum herbicide products or pests. These include herbicide tolerant crops like soybeans, corn, canola and cotton and varieties of corn and cotton resistant to corn borer and bollworm respectively. In addition the uses of Integrated Pest Management (IPM) systems which discourage the development of pest populations and reduce the use of
agrochemicals have also become more widespread. These changes have altered the nature of pest control and have the potential to reduce and/or change the nature of agrochemicals used (Anon. 2017).

1.2 PESTICIDE INDUSTRY IN INDIA

Agriculture holds a prime importance in the socio-economic fabric of India. The sector has remained backbone of the Indian economy and presently accounts for approximately 15 per cent of the country's Gross Domestic Product (GDP). Nearly 58 per cent of the rural households rely on agriculture as their principal means of livelihood.

Being a source of livelihood and food security of the nation, higher growth in agriculture assumes great importance and is matter of concern. Thus, to accelerate high growth and ensure sustainability, combined effort in terms of technology, policies and institutional support has to be adopted.

At present the sector is yet to realize its full potential in terms of bringing in efficiencies across all the stages in the value chain. The population of marginal cultivators is now seen to increase whereas the landholdings are decreasing thus making the agriculture profession unviable for marginal cultivators. Besides this, the sector is highly susceptible to vagaries of the nature. Difficulties in adopting modern farming technologies and lack of know how about modern farming processes and agri-inputs are creating immense pressure on the agriculture sector to undergo transformation.

Thus in the next generation agriculture practices, there is a need to do more with less and increase the yield by optimizing the available resources. Therefore it is essential to adopt modern methods to ensure more optimized and make productive usage of the resources to harness the growth potential of this sector.

The following sections of the report provide an overview on the challenges faced by the Indian agriculture sector, the Indian crop protection market, next generation crop protection and crop enhancement solutions and Government of India initiatives (Anon. 2016).
1.2.1 Critical Challenges Faced by India Agriculture

**High monsoon dependency:** Indian agriculture is heavily dependent on monsoon. Poor rains could potentially hurt the agricultural output and lead to food inflation. In India, rainfall is the primary source of water, three-fifths of land under cultivation is watered only by rainfall; therefore the agriculture in India is often held hostage to the vagaries of rainfall. Heavy reliance on rainfall, underscored by dim prospects will continue to hamper productivity and disrupt yields.

**Unpredictable weather patterns:** Across the globe, changing weather patterns are a major concern not only affecting crop productivity but also impacting lives of the farmers. India has also experienced delayed monsoon and severe drought like conditions in several regions of the country for the past two years which has resulted in low agricultural output in those regions. On the other hand, unseasonal rains in some parts of the country like in south India affect crop schedules or cause mass destruction and spoilage of crops. This has a negative impact on crops like rice, wheat and also horticultural produce.

**Reduction in arable land:** As per Indian agriculture census 2010-11, per capita arable land availability in India has consistently declined from approx 0.34 ha. in 1950s to approx 0.15 ha. in 2000s. With rising population it is further expected to reduce to approx 0.07 ha. by 2030.

**Decreasing farm sizes:** As per Indian agriculture census 2010-11, the average size of operational holding in India has declined from 1.23 ha. in 2005-06 to 1.16 ha. in 2010-11. The 2011 census of India indicates that 85 per cent of farms are less than two hectares in size. While the average size of landholding is decreasing the number of operational holdings is increasing leading to poor harvest and low incomes for the farmers.

**Low per hectare yield:** As per World Bank statistics for FY’14, per hectare yield in India is amongst the lowest in the world. Yields in India stand at 3 tons/ha compared to the global average of 4 tons/ha. Developed countries like USA (7), UK (7), France (7.5) and Germany (7) are able to achieve higher per hectare yields than India due to better farming practices.
Increasing pest attacks: The total number of pests attacking major crops has increased significantly from 1940s. For instance, the number of pests which are harmful for crops such as rice has increased from 10 to 17 whereas for wheat have increased from 2 to 19 respectively. The increased damage to crops from pests and subsequent losses poses a serious threat to food security and further underscores the importance of agrochemicals. The most recent example is the large scale whitefly infestation of Bacillus Thuringiensis (BT) cotton crop in North India last year. Due to this, cotton area in Punjab & Haryana has declined by 27 per cent to 7.56 lakh hectares in this year (FY’17 crop year) as farmers shifted to other crops after incurring huge losses owing to whitefly pest attack.

1.3 INDIAN CROP PROTECTION MARKET OVERVIEW

India is world’s second largest nation with a population of 1.3 billion which is approximately 18 per cent of the global population. The global population is expected to cross 9 billion by 2050. Rising population has led to increasing food demand. To meet the food & nutrition needs of a growing population requires a sustainable approach that puts thrust on increasing productivity against the background of lower yields & decreasing farm sizes. It requires a push from all stakeholders-the farmer, the government and the agrochemical industry collectively so that the changing needs of the nation are met. Approximately 25 per cent of the global crop output is lost due to attacks by pests, weeds and diseases which doesn't predict well for farming given the critical challenges ahead and thus agrochemicals have an increasing role to play.

Agrochemicals can play a major role in enhancing productivity and crop protection post-harvest. They are diluted in recommended doses and applied on seeds, soil, irrigation water and crops to prevent damage from pests, weeds and diseases. Insecticides are the largest sub-segment of agrochemicals with 60 per cent market share, whereas herbicides with 16 per cent market share are the fastest growing segment in India.

India is the fourth largest global producer of agrochemicals after the US, Japan and China. This segment generated a value of USD 4.4 billion in FY’15 and is expected to grow at 7.5 per cent per annum to reach USD 6.3 billion by FY’20. Approximately 50 per cent of the demand comes from domestic consumers while the rest goes towards exports. While the domestic demand is expected to grow at 6.5 per cent per annum, exports are estimated to grow at 9 per cent per annum during the same period.
Introduction

FY’15 has been a challenging year for crop protection chemicals market in India as well as throughout the world. As per economic survey of India, agriculture sector has grown by 1.1 per cent in FY’15. The country faced weak monsoons with rainfall falling 12 per cent short of expectations. A number of states were affected due to drought like conditions especially during the kharif season. FY’15 has been a stagnant year for Indian crop protection industry which experienced a marginal growth of 2 per cent.

On the global front, crop protection chemicals sales in almost all the regions declined in 2015, with the sharpest falls occurring in Europe and Latin America. Weakening herbicide prices, varying weather including the El Nino phenomenon and weak rainfalls caused a slump in sales. One of the worst droughts was encountered in parts of Brazil and USA. Moreover, commodity prices declined worldwide, making it imperative for farmers to moderate costs. Currencies weakened against the US Dollar in several countries. Crop protection chemical purchases were postponed or not done as a result of which companies had to grapple with high inventories. As a result, exports from India increased marginally by ~2.5 per cent in FY’15.

Monsoon in India is predicted to be better. This should help recover farm and related economic growth. El Nino effects are gradually fading in India and paving way for La Nina, which would be inductive to more rains and consequently increased farm production. This will translate into a better demand for crop protection chemicals. Input prices for crop protection chemical companies are likely to remain subdued in the near future which will impact selling prices for farmers. Due to this, while the market could grow in volume terms, but in value terms, growth would be moderate. The long term drivers like increasing population, current low capita consumption of pesticides, decreasing arable land, focus on productivity and increasing purchasing power would continue to remain intact and will drive the global crop protection market.
Every year in India pests and diseases eat away on an average 15-25 per cent of food produced by the farmers. Due to the rising population and decreasing arable land, demand for food grains is increasing at a faster pace when compared to its production. This, therefore, necessitates putting more thrust on crop productivity enhancement as well as crop protection methods. Use of crop protection chemicals can increase crop productivity by 25-50 per cent, by mitigating crop loss due to pest attacks. Thus, crop protection chemicals are also very essential to ensure food and nutritional security.

Traditionally, agrochemicals have been manufactured through chemical synthesis but lately biochemical processes are also gaining popularity. Usually, agrochemicals involve an active ingredient in a definite concentration along with adjuvants which enhance their performance, safety and usability. The agrochemicals are diluted in recommended doses and applied on seeds, soil, irrigation water and crops to prevent the damages from pests, weeds and diseases.

Therefore to improve crop performance, yield or to control pests, agrochemicals is the most relevant and reliable solution in the current context. Agrochemicals are substances that are manufacture through chemicals or bio-chemical processes. They contain active ingredient in a definite concentration along with other material which increases performance and enhance safety of crops. Compared to the past the environmental and toxicological property of these chemicals has increased.
Introduction

Research aims to improve chemicals that are not just potent but are specific for the required process while not affecting the environment in any other way.

The agrochemicals can be broadly classified into five types:

1. **Insecticides**: Insecticides provide protection to the crops from the insects by either killing them or by preventing their attack. They help in controlling the pest population below a desired threshold level. They can be further classified based on their mode of action:
   
   a. **Contact insecticides**: These kill insects on direct contact and leave no residual activity, hence causing minimal environmental damage. Examples include Carbaryl, Fipronil, Pyrethrins, Pyrethroids (Bifenthrin, Cyfluthrin, Cypermethrin, Deltamethrin, Lambda-cyhalothrin, Permethrin, Es-fenvalerate, Tefluthrin or Tralomethrin), and liquid Fipronil or Spinosad.
   
   b. **Systemic insecticides**: These are absorbed by the plant tissues and destroy insects when they feed on the plant. These are usually associated with long term residual activity. Examples include Imidacloprid, Terbufos, Thiamethoxam, Dimethoate and Dinotefuran.

2. **Fungicides**: Fungi are the most widespread causes of crop loss across the world. Fungicides protect the crops from the attack of fungi and can be of two types – protectants and eradicates. Protectants prevent or inhibit fungal growth and eradicates kill the pests on application. This in turn improves productivity, reduces blemishes on crop (thus enhancing market value of the crop) and improves storage life and quality of harvested crop.

3. **Herbicides**: Herbicides also called as weedicides are used to kill undesirable plants. They can be of two types - selective and non-selective. Selective herbicides kill specific plants, leaving the desired crop unharmed, while non-selective herbicides are used for widespread clearance of ground and are used to control weeds before crop planting.

4. **Bio-pesticides**: Bio-pesticides are new age crop protection products manufactured from natural substances like plants, animals, bacteria and certain minerals. They are eco-friendly, easy to use; require lower dosage amounts for same performance as compared to chemical based pesticides. The bio-pesticides
category currently is a small proportion of the market but has a huge growth potential considering its non-toxic nature.

5. **Others**: Fumigants and rodenticides are the chemicals which protect the crops from pest attacks during crop storage. Plant growth regulators help in controlling or modifying the plant growth process and are usually used in cotton, rice and fruits.

Source: Anon., (2016)

**Fig. 1.2 Indian Crop Protection Market for the year 2015**

The Indian crop protection market is dominated by Insecticides, which form almost 60 per cent of domestic crop protection chemicals market. The major applications are found in rice and cotton crops. Fungicides and Herbicides are the largest growing segments accounting for 18 per cent and 16 per cent respectively of total crop protection chemicals market respectively. As the weeds grow in damp and warm weather and die in cold seasons, the sale of herbicides is seasonal. Rice and wheat crops are the major application areas for herbicides. Increasing labor costs and labor shortage are key growth drivers for herbicides.

The fungicides find application in fruits, vegetables and rice. The key growth drivers for fungicides include a shift in agriculture from cash crops to fruits and
vegetables and government support for exports of fruits and vegetables. Bio-pesticides include all biological materials organisms, which can be used to control pests. Currently bio-pesticides constitute only 3 per cent of Indian crop protection market; however there are significant growth opportunities for this product segment due to increasing concerns of safety and toxicity of pesticides, stringent regulations and government support.

Source: Anon., (2016)

**Fig. 1.3 State-wise Crop Protection Market**

Andhra Pradesh, Maharashtra and Punjab are top three states contributing to 45 per cent of pesticide consumption in India. Andhra Pradesh is the leading consumer with 24 per cent share. The top seven states together account for more than 70 per cent of crop protection chemicals usage in India.
### Table 1.1 Major products across the crops protection chemicals segments

<table>
<thead>
<tr>
<th>Molecule</th>
<th>Type</th>
<th>Application</th>
<th>Crop</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acephate</td>
<td>Insecticide</td>
<td>Control of severe infestations of sucking &amp; chewing insects</td>
<td>Chillies, vegetables, fruits &amp; cereals, tobacco</td>
</tr>
<tr>
<td>Chlorpyrifos</td>
<td>Insecticide</td>
<td>Control of fruit borers, stem borers &amp; leaf eating caterpillars</td>
<td>Cotton, pulses, oilseeds, rice. Etc</td>
</tr>
<tr>
<td>Dinofuran</td>
<td>Insecticide</td>
<td>Control of Brown plat hoppers in rice</td>
<td>Rice</td>
</tr>
<tr>
<td>Fipronil</td>
<td>Insecticide</td>
<td>Control of rice stem borer, diamond moth</td>
<td>Cole crops, sugarcane, Chilly</td>
</tr>
<tr>
<td>Flonicamid</td>
<td>Insecticide</td>
<td>Control of all aphid species</td>
<td>Apples, peaches, wheat, potato, vegetables</td>
</tr>
<tr>
<td>Imidacloprid</td>
<td>Insecticide</td>
<td>Control of sucking pests-aphids, jassids, whitefly, brown plant hopper</td>
<td>Cotton, rice &amp; vegetable crops</td>
</tr>
<tr>
<td>Glyphosate</td>
<td>Herbicide</td>
<td>Control of weeds and grasses</td>
<td>Variety of crops</td>
</tr>
<tr>
<td>Quizalofop</td>
<td>Herbicide</td>
<td>Control of narrow leaf weeds</td>
<td>Broad leaf crops</td>
</tr>
<tr>
<td>Hexaconazole</td>
<td>Fungicide</td>
<td>Control of powdery mildews, rusts &amp; leaf spots</td>
<td>Cereals, Oil seeds, horticultural &amp; plantation crops</td>
</tr>
<tr>
<td>Tricyclazole</td>
<td>Fungicide</td>
<td>Control of leaf blast, node blast &amp; neck blast</td>
<td>Rice</td>
</tr>
</tbody>
</table>

Source: Anon., (2016)

### 1.3.1 Opportunities and Key Growth Drivers for Indian Crop Protection Market

The export of pesticides from India has seen a strong growth over the last few years. Globally, India is the thirteenth largest exporter of pesticides. Most of the exports are off-patent products. The major exports from India happen to Brazil, USA, France and Netherlands. The key growth drivers are India’s capability in low cost manufacturing, availability of technically trained manpower, seasonal domestic demand, over capacity, better price realization globally and strong presence in generic pesticide manufacturing (India has process technologies for more than 60 generic molecules). Due to the reasons mentioned above, India offers good scope for contract manufacturing as well.
Introduction

Post tsunami, Japanese companies are trying to build manufacturing capacities outside Japan to de-risk themselves. The Japanese companies are very particular about confidentiality and intellectual property protection and some of them have seen opportunity in India and are now creating a base here. The recent deal between Sumitomo and Excel Crop Care is a recent example. More such deals are possible in the coming years as it will give Indian companies the access to technology which they need and the global Multi National Company (MNC’s) a fast track entry into the country.

Agrochemicals worth USD 4.1 billion are expected to go off-patent by 2020. This provides significant export opportunities for Indian companies which have expertise in generic segment. Top six importing nations constitute only 44 per cent of India’s agrochemical exports. This also indicates export potential for Indian companies. In order to build a strong export base, companies could set up marketing offices in association with domestic players in export geographies. Companies could also look for strategic alliances with local companies to expand their marketing and distribution reach. Merger and acquisition opportunities could also be explored to increase their global presence.

Fig. 1.4 Opportunities in generic products

Source: Anon., (2016)
Introduction

**Growth in herbicides and fungicides:** Labor shortage, rising labor costs and growth in Genetically Modified (GM) crops has led to growth in the use of herbicides. The herbicide consumption in India stands at 0.4 USD billion in FY’15 and is expected to grow at a Compound Annual Growth Rate (CAGR) of 15 per cent over the next five years to reach ~ 0.8 USD billion by FY’20. On the other hand the fungicide industry in India has grown due to the growth in Indian horticulture industry, which has grown at a CAGR of 7.5 per cent over the last five years.

**Low consumption of pesticides in India:** The per hectare consumption of pesticides in India is amongst the lowest in the world and currently stands at 0.6 kg/ha against 5-7 kg/ha in the UK and at almost 20 times ~ 13 kg/ha in China. In order to increase yield and ensure food security for its enormous population agrochemicals penetration in India is bound to go up.

The other major growth drivers for agrochemicals are-

a. Formation of Farmer Producer Organizations (FPOs) to counter the difficulties faced due to land fragmentation.

b. Availability and dissemination of appropriate technologies that depend on quality of research and extent of skill development.

c. Plan expenditure on agriculture and in infrastructure which together with policy must aim to improve functioning of markets and more efficient use of natural resources.

d. Governance in terms of institutions that make possible better delivery of services like credit, animal health and of quality inputs like seeds, fertilizers, pesticides and farm machinery.
1.3.2 Challenges Faced by the Indian Crop Protection Industry

Non-genuine products: There is a significant share of non-genuine pesticides which include counterfeit, spurious, adulterated or sub-standard products. According to industry estimates the non-genuine pesticides could account for more than 40 per cent of the pesticides sold in India in FY’14. These products are inferior formulations which are unable to kill the pests or kill them efficiently. They also result in by-products which may significantly harm the soil and environment. Apart from crop loss and damage to soil fertility, use of non-genuine products leads to loss of revenue to farmers, agrochemical companies and government. Some of the key reasons for use of non-genuine products are lack of awareness amongst the farmers, difficulty in differentiating between genuine and non-genuine products, supply chain inefficiencies, law enforcement challenges and influencing power of distributors/retailers.

Stringent regulations: Stringent environmental regulations across the world are increasing the cost of developing new products and simultaneously delaying the introduction of new products in the market. For instance, in the European Union any agrochemical product if found to be mutagenic, carcinogenic or classified as an endocrine disruptor would not achieve registration or re-registration irrespective of the level of exposure generated.
Low focus on Research and Development (R&D) by domestic manufacturers: R&D for novel molecule discovery requires huge capital and manpower investments. Indian companies spend only 1-2 per cent of their revenues in Research and Development as against the global MNCs which invest about 8-10 per cent of their revenues. This makes Indian manufacturers uncompetitive globally in specialty molecules.

Lack of education and awareness among farmers: It is important to educate the farmers about the appropriate kind of pesticide, its dosage and quantity and application frequency. However it is not easy to reach the farmers owing to differences in regional languages and dialects and a general inertia towards adoption of newer products on account of possible risks of crop failure. The main point of exchange between the farmers and the manufacturers are the retailers who don't have adequate technical expertise and are thus unable to impart proper product understanding to the farmers. It is also very difficult for the farmers to convey their needs effectively to the manufacturers.

Need for efficient distribution systems: The large number of end users and the predominantly generic nature of the market make it essential to have a strong and efficient distribution network for the crop protection market. However, the industry has been plagued by problems arising out of supply chain inefficiencies and inadequate infrastructure which result in postharvest losses estimated at INR 45,000 crore every year. Lack of efficient distribution system also makes it difficult for agrochemical companies to reach out to the farmers and promote their products and educate them about their benefits.
1.4 COMPANY PROFILE

<table>
<thead>
<tr>
<th></th>
<th>“INDO FIL INDUSTRIES LIMITED”</th>
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<tbody>
<tr>
<td><strong>Company Name :</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Company Logo :</strong></td>
<td><img src="image" alt="Indofil Industries Logo" /></td>
</tr>
<tr>
<td><strong>Founded :</strong></td>
<td>1962</td>
</tr>
<tr>
<td><strong>Products Manufactured :</strong></td>
<td>Agriculture Chemicals</td>
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<tr>
<td><strong>Headquarter :</strong></td>
<td>Mumbai, Maharashtra, India.</td>
</tr>
<tr>
<td><strong>Founder &amp; key people :</strong></td>
<td>K. K. Modi Group</td>
</tr>
<tr>
<td><strong>Address :</strong></td>
<td>Near Vits Hotel, Kalpataru Square, 4th Floor, Kondivita Road, Off. Andheri Kurla Road, Andheri (E), Mumbai, Maharashtra 400059.</td>
</tr>
</tbody>
</table>

The journey of Indofil Industries Limited started in 1962 as a subsidiary of Rohm & Hass Co., USA. Indofil is a fungicide giant in Agricultural Chemical Industry – A name known for excellence in product quality and service.

Indofil industries limited is belongs to the renowned K. K. Modi group of companies. Indofil industries limited, established five decades ago, headquartered in Mumbai, a research-led and fully integrated chemical company has simple philosophy of retaining loyalty and enlarging the fold of satisfied customers. Indofil has a very strong domestic base and a well-recognized international presence. Both businesses viz, agricultural chemicals and specialty & performance chemicals are poised for much faster growth through partnerships and joint ventures for manufacturing, marketing and research and development activities with prospective companies across the world.

Agricultural business division – is based on the concept of crop district approach. Indofil has promoted “Crop Care Concept” throughout the crop districts in India by 1986, where the needs and problems of the crops are identified and an attempt is made to meet the same by existing solutions or procuring new/right solutions. The basic market potentials are worked out by a systematic approach called market potential system, which helps to determine market share on every important crop in the district.
Introduction

This also helps to identify new avenues and understand customer’s requirements better. The field staffs are in constant touch with the market and customers to achieve this objective.

Indofil has two multi-product, state-of-the-arts, Programmable Logic Control (PLC) based manufacturing facilities and multiple toll units across various locations in India. The facilities are ISO 9001 and ISO 14001 certified, and the processes are fully automated with advanced equipment and environmentally-compliant machines, ensuring faster throughput and safe working conditions. The first plant of Indofil at Thane, commissioned in 1962, continues to possess one of the most modern production facilities in the industry. It is one of the world’s largest Ethylenebis Dithiocarbamate (EBDC) fungicide plants, producing popular fungicides, including Mancozeb, Zineb, Maneb, Cymoxanil, Tricyclazole, Myclobutanil, Metalaxyl, Daldine and Propergite.

Indofil commenced commercial production at the recently commissioned plant at Special Economic Zone (SEZ), Dahej. The additional capacity expansion from 18,000 MT to 30,000 MT per annum of Mancozeb will help Indofil to meet the increased international demand. This plant is another landmark in company journey towards manufacturing excellence, quality and efficiency.

Indofil has a robust Information Technology (IT) system which efficiently facilitates the business processes and provides on-line information for all their internal and external customers. The entire business of Indofil runs on System Applications and Products in Data Processing (SAP). Company also understands the importance of the responsibility towards environment, health and safety management with the growth, profitability and long term success. Company has its own quality policy regarding customers’ satisfaction and value delivering process. Company has collaboration with several Non-Government Organizations (NGOs) to elevate the standard of living of the underprivileged communities. Company has achieved so many awards for their performance and developing new agrochemicals for welfare of the farmers through continuous efforts (Anon., 2017).
1.4.1 Mission of the Company

Company’s mission is to achieve leadership in growth rate.

They want to leverage their efficient Research & Development (R & D), registration, manufacturing and marketing competencies through their committed and proficient team. They will strive to make their customers successful, by providing high quality products, services and solutions in domestic and global markets. To expedite growth, they will use collaborations, acquisitions and manufacturing proximity to the market in the segments of crop care, specialty and performance chemicals.

1.4.2 Pesticides of Indofil Industries Limited

- **Fungicides** - Company manufactures various fungicides with the different combination of chemicals for the fungus affecting the different crops. Avatar, Sprint, Boon, M-45, Captra, Dhan, Sitara are the few brands of the fungicides of Indofil.

- **Acaricides** - A class of pesticides to kill the organisms belonging to Acari group (Ticks and Mites). Colonel-S and Share are the brand of the acaricides of Indofil.

- **Insecticides** - A class of pesticides to kill or prevent multiplication of insects and also increases farm yield considerably. Agent, Agent plus, Atom, Becon GR and Becon SP are some of the brands of insecticides of Indofil.

- **Herbicides** - A class of pesticides which kills unwanted plants and weeds without harming desired crops. Atrafil, Clean up, Offset, Oxygold, and Society are the brands of the herbicides of the Indofil.

- **Sufactants** – A kind of wetting agent to reduce interfacial tension between two liquids. It facilitates easier dispersion of sprayed material. Indtron AE and Filwet Premium are the brands of the surfactants of Indofil.

- **Plant Growth Regulators (PGR’s)** – PGR’s are basically regulates the hormones of the plants and controls the ripening process. Ethefol and Superfix are the PGR’s brands of Indofil.
1.4.3 **Certificates and Achievements of Indofil**

- GOTS (Global Organic Textile Standard) Certificate
- Certificate of Accreditation by National Accreditation Board for Testing & Calibration Laboratories (NABL)
- Export House: 2005
- 2016 – Indofil, Thane plant awarded certificate of merit for achieving zero accident frequency in the year by National Safety Council – Maharashtra.
- 2016- Indofil won a Silver award in the Coaching and Mentoring Category at the TISS – Leap Vault CLO Awards held during the 5th edition of Chief Learning Officers Summit in Mumbai.
- 2015-2016 – Indofil Dahej awarded the National Award for Manufacturing Competitiveness (NAMC) presented by International Research Institute for Manufacturing (IRIM) in the Gold category.
- 2016 – Indofil wins the FAST 50 award. This award is conceptualized by EI Sol Media to honor brand excellence amongst the best brands in the country.
- 2015-2016 – WCRC Award in the category of “100 Most Valuable Brands of the year 2015-16”.
- 2015 Indofil Thane Plant is the proud recipient of GEEENTECH Safety Award 2015 – Gold category, on July 24, 2015.
- 2015 Indofil Industries Limited recognized as the Industry’s Best with a 5th ranking and were also recognized as India’s Best companies to work for 2015-Top 100 list (71st rank) by Great Place to Work.
- 2011-12 Platinum Award from the League of American Communications Professionals, for excellence within its industry on the development of the organization’s Annual Report.
- 2011-12 Vision Award from the League of American Communications Professionals, for developing one of the Top 100 Annual Reports worldwide ranking at #19.
- Ms. Sonal Raj has been honored with the prestigious Award for Recruiting & Staffing- Best in Class Leadership Award from World HRD congress.
- Dr. Avinash V. Deolekar has been honored with the prestigious Award for Outstanding Contribution to Leadership Development by Forum for Emotional Intelligence Learning (FEIL) & Tata Institute of Social Science (TISS).
- Umbrella Pack for Token has won the National Award for Excellence in Packaging by Indiastar Awards.
- Cotton Research & Development Association’s Public Private Partnership Award was presented to Indofil Industries Limited in the Category of Pesticides Industry.
- Mr. R.K. Malhotra has been honored with the Lifetime Achievement Award by the Cotton Research & Development Association.
- Second Runner Up Award in the “Best Innovative Exporters 2011-12” by ECGC and Dun & Bratstreat.
- 2012 World HRD Congress awarded Indofil “BEST HR STRATEGY IN LINE WITH BUSINESS at IPE HR LEADERSHIP Award
- 2010-11 Vision Award from League of American Communications Professionals, for developing one of the Top 100 Annual Reports worldwide ranking at #12
- 2010-11 Platinum Awards from League of American Communications Professionals, for excellence within its industry on the development of the organization’s annual report
- 2009-10 One of Top 50 Annual Reports (AR) , season ranking at # 5
- 2009-10 “MOST CREATIVE” AR worldwide Platinum Award
- Platinum Award for excellence within the industry on development of the AR
- 2010, 2nd November, Indofil wins “Best Company from an Emerging Region” at AGROW AWARDS, London, UK.
• 2000 December 13: Best Export Performance Award for the year 1999-2000 in the Large Scale Sector at the 37th Annual General Meeting of Thane Manufacturers’ Association held at TMA House, Thane.


1.5 PRACTICAL UTILITY OF THE STUDY

Project work will be helpful in identifying the differentiations in the education, age, experience, annual income and land holding of the farmers in the Junagadh district. The study will be useful in identifying the expectation towards fungicides they are using; also the actual requirement of the farmers for the fungicides can be identified. The improvements required in the fungicides can be known from the study and scrutinized. The loop faults in the marketing can be identified and problems can be solved by the proper steps towards marketing. The factors which are influencing the purchase can be helpful in the marketing of the products and also can be helpful in the developments of the markets. More concentration can be given on those factors to satisfy the more customers. The study also helps in finding the reasons behind the brand switching. That will be helpful for needed improvements in the current brand and identifying the faults in the brand. It also helps in knowing the actual requirements of the farmers regarding the fungicides purchasing decision. The study will also be helpful in the identifying the competitive advantages of the product and constraints faced by the dealers in the marketing of the products. That will be helpful to the company to the various aspects of marketing and dealer level problems that can be scrutinized to healthy marketing channel and positive relationships. The competitive advantages can be used as the powerful factor and used in the marketing of the brands.

1.6 OBJECTIVE OF THE STUDY

1) To measure farmers’ level of satisfaction and expectation towards Sprint fungicide.
2) To identify the factors influencing the purchase of Sprint fungicide by farmers.
3) To study the reasons behind brand switching of farmers.
4) To identify competitive advantages and marketing constraints faced by dealers of Sprint.
1.7 LIMITATION OF THE STUDY

1) This survey was restricted to Junagadh district only.

2) The sample size was limited to 100 farmers and 20 dealers, which may not be representing the whole district.

3) The results were totally derived from the respondent’s answers. There might be a difference between the actual and projected results.

4) The information was filled in the questionnaire through personal experience and based on the memory of them.