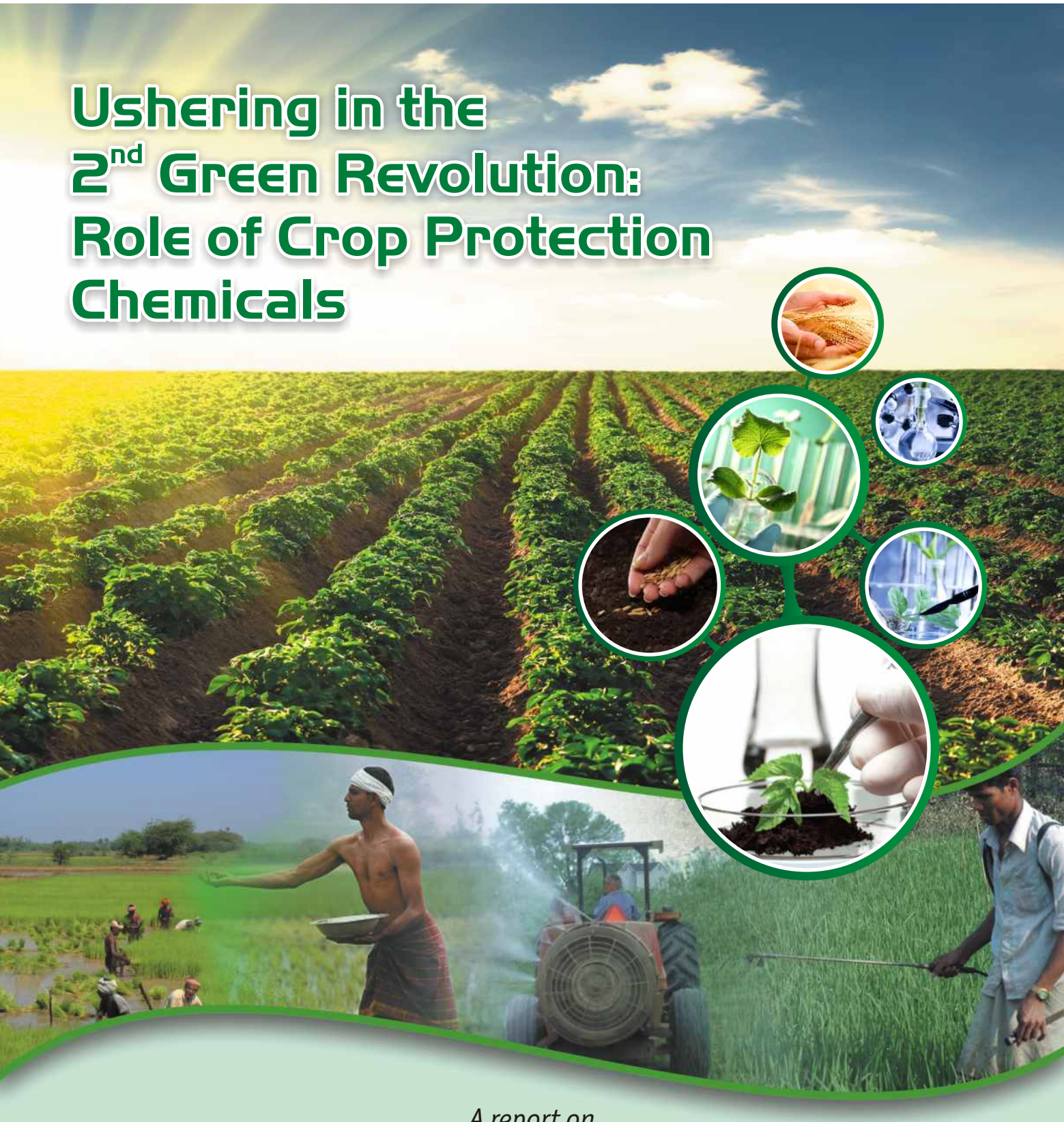
Knowledge and Strategic Partner

TATA STRATEGIC MANAGEMENT GROUP

FICCI

Ushering in the 2nd Green Revolution: Role of Crop Protection Chemicals



A report on

Indian Agrochemical Industry

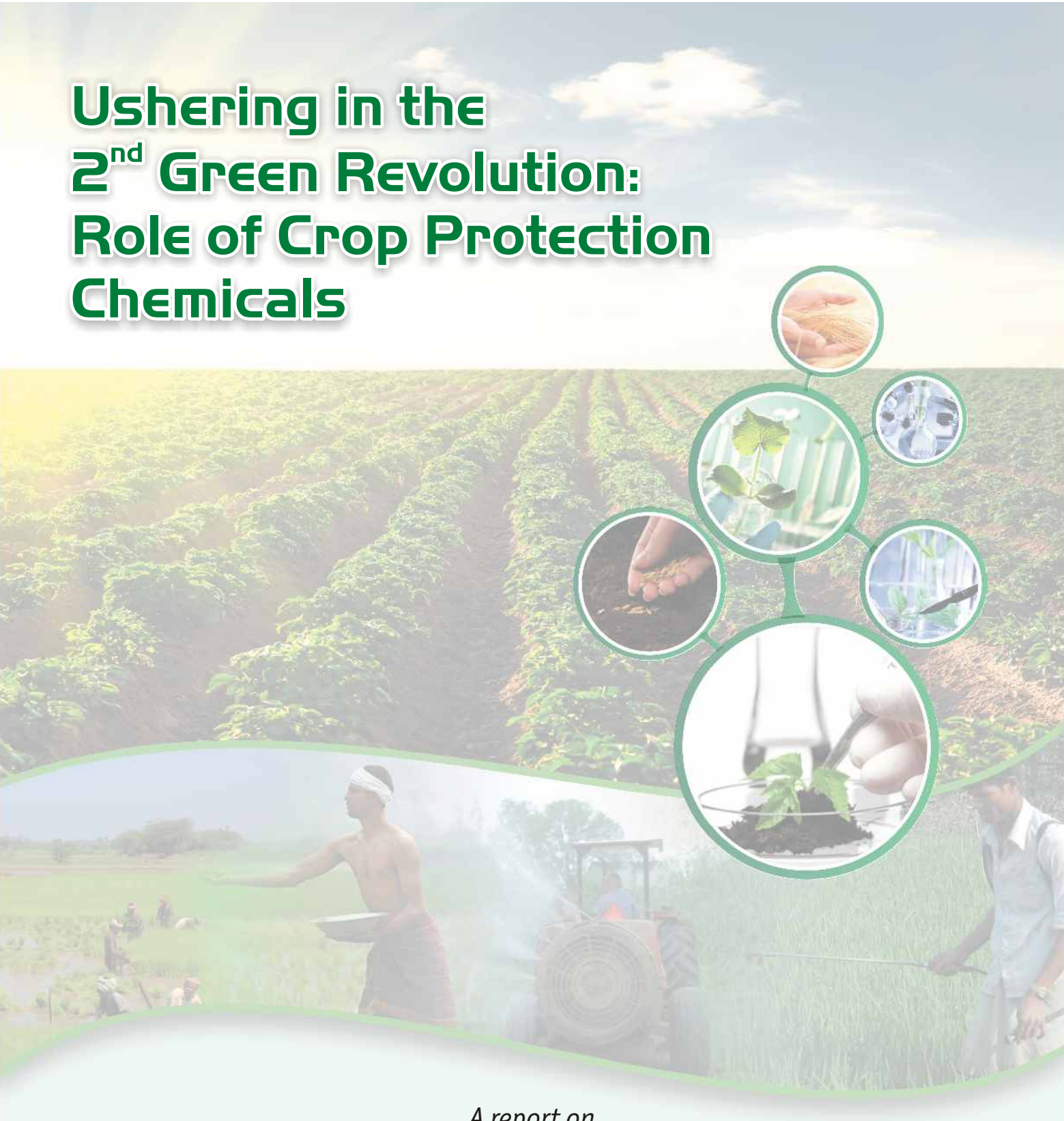
November 2015

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Ushering in the 2nd Green Revolution: Role of Crop Protection Chemicals



A report on

Indian Agrochemical Industry

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Indian Chambers
of Commerce and Industry

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MESSAGE

Crop Protection Chemicals are recognized as an essential input for increasing agricultural production and preventing crop loss before and after harvesting. Indian Crop Protection Chemicals industry has contributed significantly towards increased agriculture output and improved public health. Thus they are playing a very important role in facilitating national food security. Besides catering to domestic requirements, the sector is also export oriented and makes substantial exports even to the developed countries. This segment of the chemical industry has good potential for further growth.

To bring focus to the important sector of chemical industry and deliberate on the issues, FICCI jointly with Dept. C&PC has been organising annual conference. I am happy to note, that now the **Fifth National Agrochemicals Conference – 2015 is being organised** on 18th November, 2015 by FICCI jointly with the Department of Agriculture Cooperation and Farmers Welfare and Department of Chemicals & Petrochemicals, Government of India, to discuss issues of the sector and thus facilitate it.

I wish the conference all the success.

With best regards,

Deepak C. Mehta

Place : Vadodara
Date : 06-11-2015

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Dr. A. Didar Singh
Secretary General



Message

The Indian population currently stands at 1.2 billion and is expected to reach 1.6 billion by 2050. Keeping in pace with these growing numbers, the country will not only have to raise its agriculture production but also the productivity as land availability will not increase. Crop Protection Chemicals or Agro-chemicals are an important input for facilitating pre & post-harvest management. The Agrochemicals sector has huge unrealized potential for growth, given the presently very low level of application as compared to global norms. The sector faces many challenges & solution to same can lead to India becoming a global manufacturing hub of quality Crop Protection chemicals.

I am happy to note that FICCI jointly with Department of Agriculture Cooperation & Farmers Welfare and Department of Chemicals & Petrochemicals, Government of India is organizing the Fifth National conference on Agrochemicals on 18th November 2015 at New Delhi. The Theme of the conference is:"Ushering in the Second Green Revolution-Crop Protection Chemicals", which I feel is very timely.

I am sure it will be found useful by all stakeholders.

A. Didar Singh

New Delhi
05th, November, 2015

Dr. Ram K Mudholkar
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Business Director, Dupont Crop Protection (South Asia)

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Message

I want to congratulate Department of Agriculture Cooperation & Framers Welfare, the Department of Chemicals and Petrochemicals, Government of India and FICCI for the initiative to organize the 5th National Conference on Agrochemicals.

The world's population currently stands at 7 billion and is estimated to rise to 9.3 billion by 2050. This will require global food production to increase by 70% over the same time period in order to meet the increased demand. To add to the problem, 25% to 40% of world crop output is lost due to the attack of pests, weeds and diseases. To minimize these losses, and to enhance yield, it is essential to use crop protection chemicals responsibly.

Correct and judicious use of Crop protection chemicals support sustainable farm management and delivers significant socio-economic benefits to meet the challenges of feeding an ever growing population.

I am sure the deliberations in the conference will facilitate growth of this important segment of national economy.

New Delhi
09th, November, 2015

Ram K Mudholkar

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1. Preface



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The report on "Ushering in the 2nd Green Revolution – Role of Crop Protection chemicals" is a part of Federation of Indian Chambers of Commerce & Industry (FICC) and TATA Strategic Management Group (TSMG) Chemical Practice's endeavor to highlight the need and importance of adopting a Second Green Revolution in the country. The same covers the aspect as to how the Crop Protection chemicals sector will play a critical role in it, in order to bring further prosperity to the Indian agricultural sector. FICCI & TSMG have been regularly tracking the trends in agrochemical and associated industries.

The rising population in India accompanied by rising affluence is seeing a shift in the consumption patterns. There is a need to not just increase production to meet demand but also to ensure that the nutritional needs of an increasingly affluent population are met. Shrinking arable land and loss of crops due to pests lead to wastage posing a critical challenge to ensuring food and nutritional security. India wastes nearly 40 per cent of its total production in terms of value. The agricultural workforce in India is expected to reduce to nearly 50% in 2020s, a trend which will be observed in other developing countries as well. It is further expected to be on a consistent decline due to better remuneration and growth opportunities in the alternate sectors. These growing challenges indicate that the focus should not only be on raising the agricultural production but also on enhancing the productivity. Therefore, there is an increasing pressure on agricultural sector to usher in the Second Green Revolution, thereby ensuring high output both in terms of quality and quantity as also a wider geographical spread (compared to the First Green Revolution) with the objective of ensuring the food and nutrition security of the nation.

A significant outcome of the prospective Second Green Revolution would be the focus on crop protection chemicals (agrochemicals); as they will become increasingly important in achieving higher yields and increasing productivity.

In combination with Pest Management and Plasticulture techniques, Crop Protection chemicals shall thus play a critical role in achieving the two objectives, viz. enhancing productivity and protecting the produce during and post-harvest period. The need for increased use of Crop Protection chemicals has been underscored by historically lower per hectare yields and pesticide consumption in India, when compared to other countries.

Through this report we have highlighted the various challenges faced by Indian Agriculture and Agrochemical sector, focused on the role that Crop Protection Chemials can play in the phase of Second Green Revolution and indicated the way forward for increasing the penetration of agrochemicals thereby endeavoring to achieve the objective of food and nutrition security for the country.

We are grateful to the inputs provided by industry leaders who agreed to interact with us. Their knowledge and guidance helped us shape the report.

The report is a result of FICCI's & TSMG's objective to highlight the importance of agrochemicals in national economy and business opportunities present in the sector. We hope the report meets its objectives.



2 Executive Summary

At 1.2 billion, India is the second most populous country after China in the world. According to United Nations statistics, India will surpass China to become the world's most populous country by 2022. With the economic growth, India is likely to become the 3rd largest economy in the world by 2030 accompanied by a rise in urbanization levels which will lead to a change in dietary needs. To sustain the growing population's food and nutrition needs, India will have to adopt the sustainable measures in agriculture sector. Although yield per hectare has doubled in the past years due to increased use of hybrid seeds, fertilizer, crop protection chemical, etc. major challenges to increase our productivity still exists. These include mainly the risk of land degradation, fall in the per capita arable land and increasing water scarcity.

These critical challenges call for ushering in a Second Green Revolution which can chart a path of sustainability for the agricultural sector such that it can meet the changing needs of the country. The First Green Revolution in India, which was witnessed in 1970s, led to expansion of farming areas, double-cropping in the existing farmland and using seeds with improved genetics etc. But it had limitations as it focused on limited cultivable area in India with a thrust on only the major crops. This clearly depicts that the concept of high-yield value seeds has not yet been extended to all crops or all regions. In terms of crops it has largely remained confined to food grains only and not all kinds of agricultural produce. In terms of regions, the cultivable lands of Punjab and Haryana showed the best results with West Bengal showing reasonably good results but the results in the rest of the part of the country were not as impressive.

There is now a need for the agriculture sector to undergo technological transformation and adopt modern methods which reduce the dependency on monsoons and ensure more productive use of the available resources and thereby serve the nation efficaciously.

These factors therefore highlight the importance of agrochemicals for enhancing food and nutrition security for the nation. Moreover, low per hectare yield as compared to global average and increasing pest attacks further strengthen the need for crop protection via use of agrochemicals.

The Indian crop protection industry is estimated to be ~ INR 27,000 Cr (~ USD 4.25 Billion) in FY'14 and is expected to grow at a CAGR of 12% to reach ~ INR 47,000 Cr (~ USD 7.5 Billion) by FY '19. Out of this, the domestic market is ~ INR 14,000 Cr. (~ USD 2.25 Billion) in FY '14.

Insecticides are largest sub-segment of agrochemicals with 60% market share whereas herbicides with 16% market share are the fastest growing segment in India. Going ahead, opportunities for Indian crop protection industry will come in the form of exports, growth in generic products, product portfolio expansion, and growth in herbicides and fungicides. However, the Industry faces a number of challenges. Some of the key challenges are stringent environment regulations across the world, low focus on R&D due to high costs, long gestation period for new products and rising sale of non-genuine products. Non-genuine products are not only a challenge to agrochemical industry but also to the overall Indian economy, resulting in loss of revenues for farmers, agrochemical companies and Government.

In order to withstand the industrial challenges agrochemical companies can use some of the possible levers such as; adopting product innovation strategies, providing end to end comprehensive service offerings to the farmer, developing effective marketing and distribution strategies and leveraging on the existing IT and telecommunication infrastructure, which can help them to expand their presence amongst the end users and promote use of agrochemicals.

In order that the crop protection industry achieve its objectives, government support on various levels is extremely critical. Continued infrastructural support from the government is necessary for companies to improve their speed to market. Policy initiatives by the government should also provide implementation support in terms of stricter punitive measures and supervision to contain the menace of non-genuine products. Adequate support is also required for encouraging the industry to invest in R&D activities and develop innovative solutions.

Thus to harness the potential of agrochemicals by cultivating outlined opportunities, a collaborative and comprehensive approach from the various stakeholders- the Industry, the Government and the regulatory bodies is essential. This concerted and collaborative approach can help overcome the demand-supply constraints and provide the much needed thrust to a Second Green Revolution that can lead to a surplus and self-sufficient agricultural sector in the country.



3 Introduction

The global population currently stands at 7.2 billion, and is expected to rise to 9.3 billion by 2050. This will lead to an increased demand for food. The dietary needs in emerging countries will change as economy grows. 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/agro industry collectively so that the changing needs of the society are met. Around 25% of the global crop output is lost due to attacks by pests, weeds and diseases which doesn't augur well for farming given the critical challenges ahead and thus agrochemicals have an increasing role to play.

The scenario in India, even considering that we have different climatic conditions and cropping patterns is also underscored with similar macro trends. With the boom in population, it is estimated that by 2022, India will surpass China as the world's most populous country. Demand supply imbalances which have arisen on account of various challenges discussed briefly in the executive summary and which shall be covered in great detail further in the report need to be addressed expediently.

The first green revolution was fairly successful in putting the country on a path to self-sufficiency of food grains. However it had certain limitations in that it could not help achieve absolute sustainability in agriculture.

The Second Green Revolution would strive to correct in full or partial measure the shortcomings of the First Green Revolution. This would require a holistic approach to farming in India which would include adopting measures on various fronts. These would namely include:

1. Reducing dependency on monsoons with better irrigation/water harvesting methods
2. Developing high yields variants of other crops besides food grains
3. Educating the farmer education on right agricultural practices

4. Integrated pest management techniques

5. Bringing in technology & mechanization to consolidate fragmented farmlands;

6. Developing measures such as crop insurance and generating alternate sources of livelihood to mitigate risk to protect farmers

Crop protection chemicals will also play a major role in the new phase of Second Green Revolution. The role of crop protection chemicals is not limited to protection; they help in yield enhancement as well. Use of crop protection chemicals can increase crop productivity by 25-50%, by mitigating crop loss due to pest attacks. It is estimated that almost 25% of world's agricultural production is lost due to post-harvest 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.

The crop protection chemicals can be broadly classified into five types:

1.1. **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

1.2. **Fungicides:** 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

1.3. **Herbicides:** Herbicides also called as weedicides are used to kill undesirable plants. They can be of two types - selective and non-selective

1.4. **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

1.5. **Others (Fumigants, Rodenticides, Plant growth regulators etc.):** 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

The following sections of the report provide an overview on the challenges faced by the Indian agriculture sector, need for Second Green Revolution, holistic approach needed to make farming in India more sustainable, role of crop protection chemicals in overcoming the limitations of First Green Revolution, the Indian crop protection market, underlying challenges and opportunities and the way ahead for agrochemical industry.



4 Farming in India: Caught in a Time Warp

At 180 million hectares, India holds the second largest agricultural land holdings in the world. Agricultural GDP has increased at a rate of 3% between 1980 & 2012 which makes India the third largest agricultural producer by value right behind China & the United States. With more than half the population dependent on agriculture as the chief source of income, the agricultural sector is yet to realize its full potential in terms of bringing in efficiencies along the value chain- increasing yields, processing & exports. The contribution of the agricultural sector to the GDP is a mere 13.9 % India relies on old methods for farming such as supplanting mechanization with manual labor and farm animals- the levels of mechanization stand at 40-45% as opposed to levels as high as 95% in the US. Indian agriculture is still heavily dependent on monsoons which are becoming erratic and high unpredictable over the years rather than develop water harvesting and irrigation techniques.

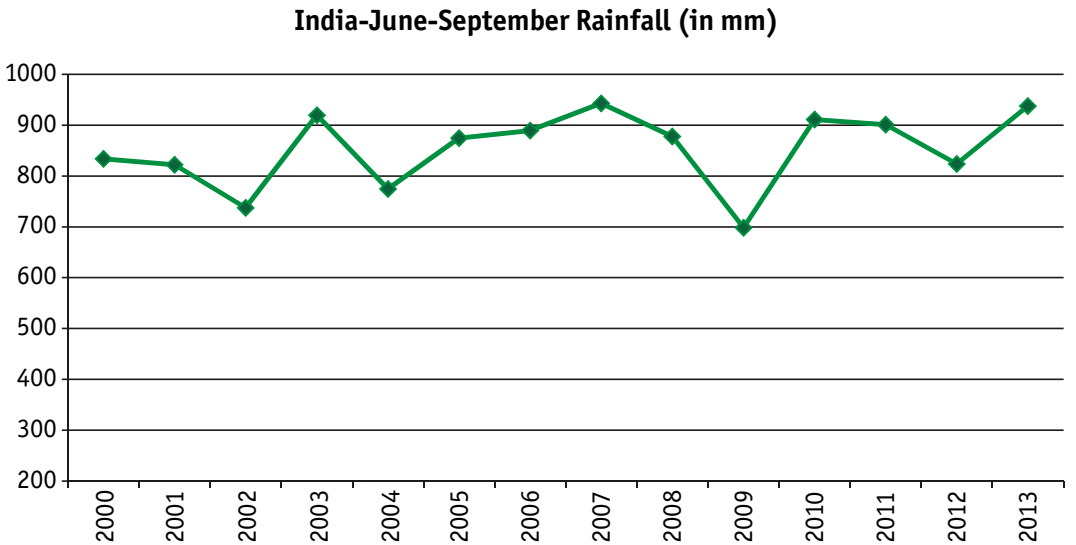
Land degradation to the tune of ~ 50% stands to threaten the food & water security and jeopardize livelihood of those engaged in the occupation. The overgrazing of land and changing climatic patterns are further exacerbating the situation. As more and more land becomes unsuitable for cultivation, it only adds to the danger to food security of the Indian population. This is one of the many critical challenges that are hampering the productivity.

Being the second most populous country in the world, India faces a critical challenge of ensuring adequate food availability for its burgeoning population. The recent GHI (Global Hunger Index) rating of 2014 puts India at 55th position amongst the 76 developing nations covered. Over the past decade, though significant strides have been made in ensuring that we produce enough to feed our people; overcoming structural barriers that still continue to hamper the sector has become essential in order that we remain self-reliant in the coming years, and more become an agricultural powerhouse.

Critical Challenges faced by Indian Agriculture

- **High Monsoon Dependency:** 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. Its availability or scarcity determines a successful harvest or diminution in yield, or even total failure of a crop with farmers suffering from huge economic damages the most. Over the past few years the average rainfall received in the country has declined and the variability has increased. Heavy reliance on rainfall, underscored by dim prospects will continue to hamper productivity and disrupt yields.

Figure 1: Indian Rainfall Statistics



Source: India Meteorological Department, Analysis by Tata Strategic

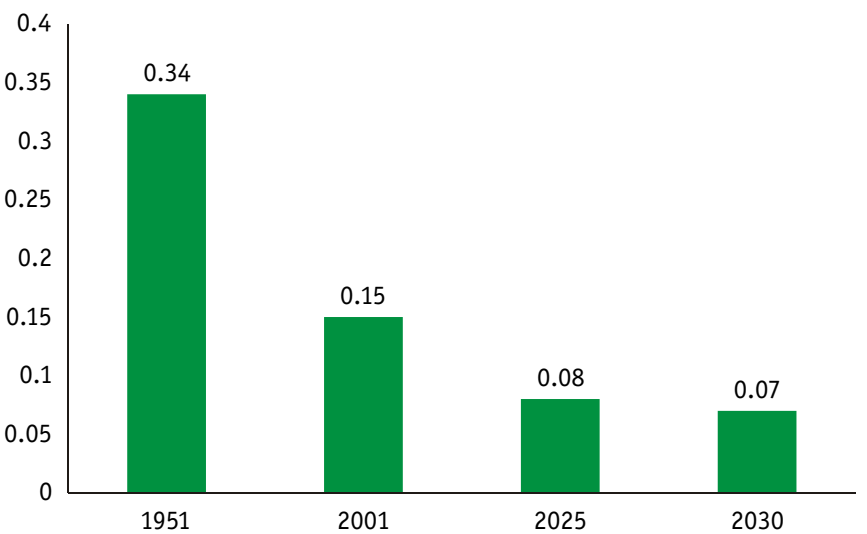
In India the June – September rainfall provides three quarters of the total rainfall in the country (averaging ~ 89 cm) and in four out of ten years it proves to be erratic. Climate change along with rising pollution will further exacerbate this situation by giving rise to increasing downpours which are patchy – not arriving at the right time, in the right place or with the right intensity. There is a need to invest in mechanisms that can harvest the water and mitigate the consequences of a drought

- **Low Levels of Mechanization:** The current levels of mechanization in farming in India stands at roughly 40-45%. These levels are far lower than those observed in other countries such as the USA (95%), Western Europe (95%), Russia (80%), Brazil (75%) and China (57%). The average farm

power availability in India is still at a lower level when compared to other Asian countries such as China, Korea & Japan. Mechanization in India faces critical challenges pertaining to machinery & equipment, technology, operations, policy and other related areas. Smaller land holdings which require flexible machinery that in turn requires serious effort and commitment towards developing such flexible solutions is a key impediment to adopting mechanization in India. The other critical factors which determine the level of mechanization in the country include cropping patterns, availability and cost of alternatives such as labor which is often more abundant and much cheaper than machinery and equipment, fragmented land holdings, high costs and inadequate access to finance to support these investments.

- **Reduction in arable land:** The amount of per capita arable land in India has consistently declined from ~0.34 ha in 1950s to ~0.15 ha in 2000s. With rising population it is further expected to reduce to ~ 0.07 ha by 2030. India had 16,000 sq. km of total cropped area during 10 years from 2000-01 to 2010-11. During the same period land under urban use increased by 24,000 sq. km, at the expense of arable land. This has put immense pressure on the current available arable land for the food and nutritional needs of the population.

Figure 2: Per capita arable land (ha)

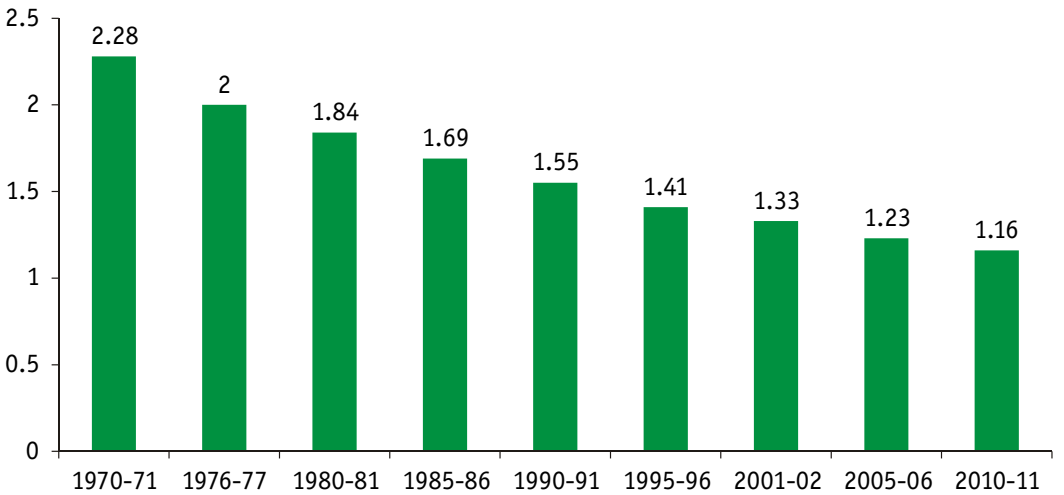


Source: Industry Analysis by Tata Strategic

- **Decreasing farm sizes:** The average size of operational holding in India ha s declined from 1.23 ha in 2005-06 to 1.16 ha in 2010-11. Small and marginal holdings constituted 85 per cent of total holdings in 2010-11 compared to 83 per cent in 2005- 06. The 2011 Census of India indicates that 68% of farms are less than two acres in size and 95% are less than five acres in terms of owned holdings. While the average size of landholding is decreasing (also fragmenting) the number of operational holdings is increasing leading to poor harvest and low incomes for the farmers.

Figure 3: Average size of landholdings (ha)

Average size of operational holdings as per different agriculture census. All India (ha)

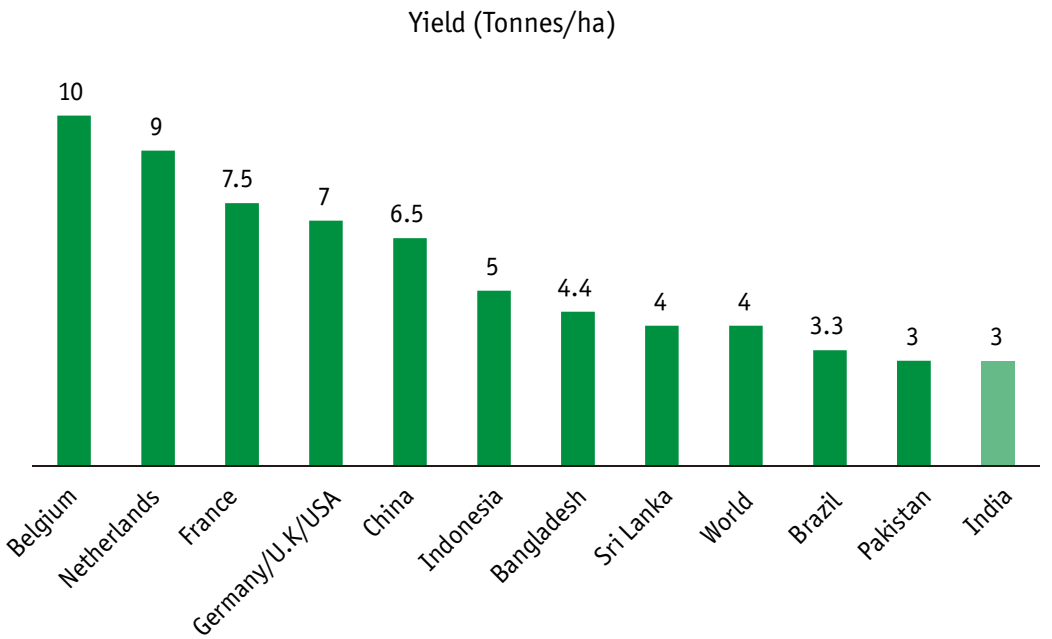


Source: Agricultural Census, Analysis by Tata Strategic

An increase in the number of fragmented landholdings has led to more landholdings but a decrease in the operating size of farms. This also creates issue in terms of adopting modern farming practices which can only be applied in larger land holdings. Irrigation difficulties and restrictions in crop variety due to small size impact the productivity

- **Per hectare yield in India lower than the rest of the world:** 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, UK, France and Germany are able to achieve higher per hectare yields than India due to better farming practices. As workforce in agriculture in India reduces, we need to look at increasing yields to be able to meet growing demand which will require better farming practices as already discussed.

Figure 4: Yield comparison (Tons/ha)



Source: Agricultural Census, Analysis by Tata Strategic

- **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.

Figure 5: Crop wise pests

Crop	1940		At present	
	Total pests	Serious Pests	Total pests	Serious Pests
Rice	35	10	240	17
Wheat	20	2	100	19
Sugarcane	28	2	240	43
Groundnut	10	4	100	12
Mustard	10	4	38	12
Pulses	35	6	250	34

Source: Agricultural Census, Analysis by Tata Strategic

Inadequate Infrastructure and Ecosystem: Even though the agriculture in certain regions of India has prospered, and witnessed high productivity; there still exists certain support functions which are important and which need to be bolstered. An instance of this is agricultural marketing which still continues to suffer from informational disadvantages not allowing farmers to realize a better price for their products. A system with numerous middlemen tends to siphon off profits with the most vital stakeholder actually not partaking in the bulk of the profits. Another major constraint is storage facilities. For example cold storage facility is available for only 10 per cent of fruits and vegetables produced in India. A 1955 law that bans the storage of large quantities over ~ 90 commodities including wheat & onions in order to deter "hoarding" has resulted in discouraging traders and farmers from investing in cold storages and warehouses. Thus, the stockholding capacity has not kept pace with the increase in production and demand for a long time. Given the capacity constraints in warehousing and cold-storage, seasonal commodities may also add to the inflation risk.

Access to finance is (capital, crop insurance) another problem which go on to make the agricultural profession a rather difficult one to practice, is access to finance which farmers have to often grapple with.

Need For Second Green Revolution:

The challenges faced by the Agricultural sector go on to reflect that farming in India seems to be mired in a time warp and bold measures need to be undertaken by all stakeholders in order that agricultural productivity can keep pace with the growing population and thus the food and nutritional adequacy needs of the nation can be secured. A step in this direction would be to align the sector towards the Second Green Revolution, which should be aimed at capacity building within the available resources. The Second Green Revolution should build on the success of the First while overcoming the limitations of the First Green Revolution such as, inter-crop, regional and inter-personal disparities amongst the farmers, growing environmental problems, etc.



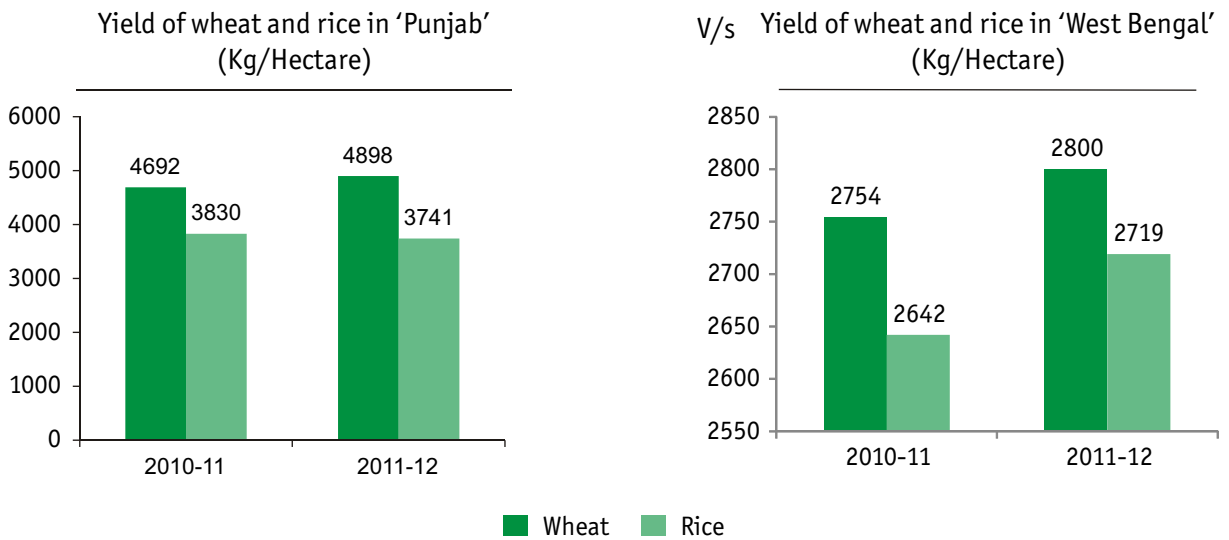
5 Overcoming the Limitations of First Green Revolution-Role of Agrochemicals

- **Inter-crop Imbalances:** During the First Green Revolution, though crops like wheat, rice, bajra and maize realized benefits, the focus was largely confined to wheat and rice. The two crops wrested area from coarse cereals, pulses and oilseed. The HYV (high yield variety) seeds for some of the crops have either not been developed so far or the results have not been guaranteed. The lack of guarantee on realizable benefits creates a hindrance to adoption by farmers who have to bear the risk of crop failure.

  What the 1st Green Revolution achieved was an increase in yield and surplus produce of crops that could address the per calorie requirement of the nation- which led to imbalances in the crop portfolio reflecting our need for food security. An example of this is pulses which is the main source of protein for the largely vegetarian population of India. At 641 kg/ha (FY12), the yield of pulses in India is extremely low as compared to other countries such as China (1431 kg/ha), Myanmar (1323 kg/ha), Canada (1892 kg/ha) and Brazil (1027 kg/ha) which are the major producers of pulses in the world. The 2nd Green Revolution should strive to secure the nutritional requirements of the country by building on a balanced crop portfolio.

- **Growing Regional disparities:** The First Green Revolution led to economic disparities at inter and intra- regional levels. Not all of India transitioned to the new agricultural technologies at the same time; as it only focused on the areas which were better from the cultivation and arability point of view such as northern regions including Punjab, Haryana, and Western Uttar Pradesh in the north and Andhra Pradesh and Tamil Nadu in the south. Whereas, the eastern region including Assam, Bihar, West Bengal and Orissa and arid and semi-arid areas of southern and western India were largely neglected

Figure 6: Yield in Punjab v/s Yield in West Bengal



Source: Agricultural Census, Analysis by Tata Strategic

Thus, India failed to extend the concept of high-yield value seeds to all crops or all regions, and therefore, even today, in certain regions, the agricultural output falls short of demand resulting in the country not achieving self-sufficiency across all crops and regions.

However, these problems can be addressed by ensuring the use of the region and crop specific agrochemicals. Varied number of chemicals can be used to encourage plant growth and higher crop production of different crops in different areas depending on suitability of the region to a specific crop/chemical. The increasing focus on development and use of indigenous technology such as pesticide formulation, seed coating, and use of hydrogels and soil conditioners can further help in enhancing the productivity of a wide variety of crops and broaden its reach in the overall region.

- **Inequalities amongst the Farmers:** The First Green Revolution, with all of its advantages, resulted in further exacerbating the inequities between the large, marginal and small farmers. Large farmers benefited immensely from the largesse of the First Green Revolution as they possessed the financial resources to purchase farm implements, better seeds and fertilizers. The conditions of the small and marginal farmers didn't improve and benefit from the impetus provided by the revolution as they had small land holdings and very few resources to purchase modified seeds, high cost fertilizers and pesticides.

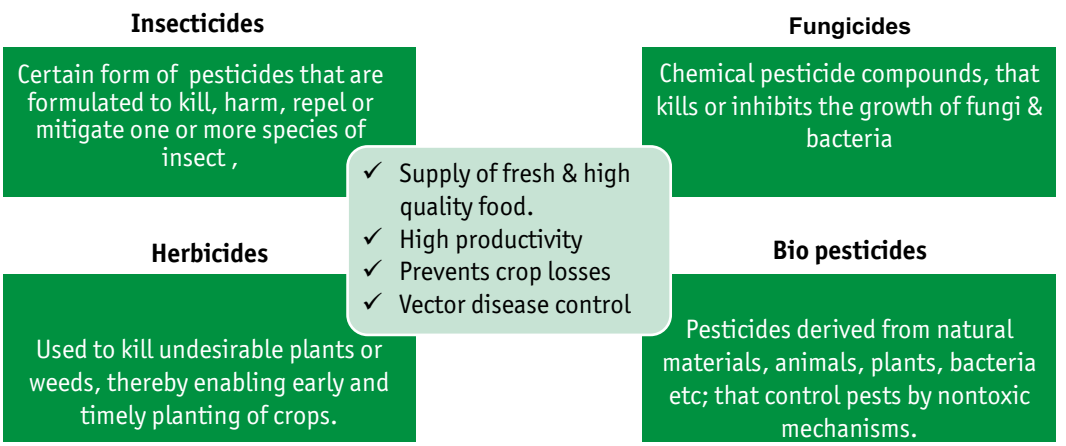
  Crop protection measures can help reduce the gaps and benefit wider audiences. First and foremost crop protection products offer a meaningful solution towards meeting the challenge of more food on less land thus helping the farmers improve agriculture productivity. Further, to

make access to crop protection products more affordable, government has extended its support by providing financial assistance for training farmers on balanced used of fertilizers, field demonstrations, schemes such as Capital Investment Subsidy Scheme (CISS) through NABARD for establishment of bio-fertilizers/bio-pesticides production units etc.

- **Challenge of Associated Environmental problems:** During the First Green Revolution, various environmental hazards were caused due to usage of agrochemicals. The use of agrochemicals does pose problems of ecological damage, genetic erosion and threat to human health. However these crop protection chemicals have and will continue to play a crucial role in meeting the food, feed and fiber needs of the mankind. And therefore to tame the inherent toxicity of pesticides and reap the advantages of these chemicals certain measures need to be implemented and strictly followed.

  Appropriate measures include manipulating the dosage parameters to an optimal level, ensuring appropriate application, complying with the environmental and ecological safety norms among others. The use of bio-pesticides/bio-regulators also needs to be developed and promoted, along with the development, formulation and promotion of region and crop specific use packages. Thus balanced and optimum dosages, proper and timely application of agrochemicals along with matching suitability of a specific chemical to the crop/land can help contain the associated, environmental problems to a large extent.

Figure 7: "Agrochemicals"- Beneficial to Protect the Agricultural Produce



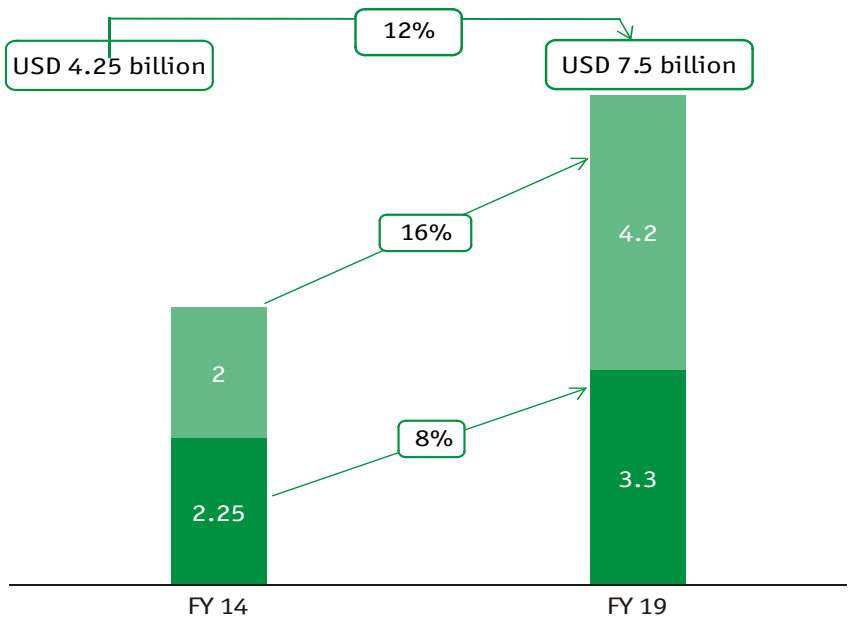
Source: Industry Analysis by Tata Strategic



6 Indian Agrochemical market Overview

The Indian crop protection industry is estimated to be USD 4.25 billion in FY14 and is expected to grow at a CAGR of 12% to reach USD 7.5 billion by FY19. Exports currently constitute almost 50% of Indian crop protection industry and are expected to grow at a CAGR of 16% to reach USD 4.2 billion by FY19, resulting in 60% share in Indian crop protection industry. Domestic market on the other hand would grow at 8% CAGR, as it is predominantly monsoon dependent, to reach USD 3.3 billion by FY19. Globally, India is fourth largest producer of crop protection chemicals, after United States, Japan and China. The crop protection companies in India can be categorized into three types –Multi-National, Indian including public sector companies and small sector units.

Figure 8: Indian Crop Protection Market (USD Billion)



Source: Industry Analysis by Tata Strategic

Knowledge and Strategic Partner

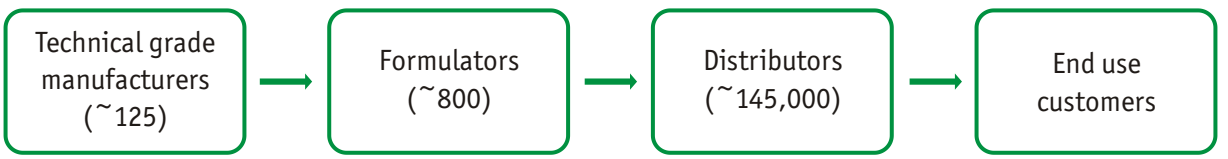
TATA STRATEGIC MANAGEMENT GROUP

Industry structure and Competitive landscape

The Indian crop protection industry is dominated by generic products with more than 80% of molecules being non-patented. This results in very low entry barriers for the industry. Hence, strong distribution network, appropriate pricing, brand recall and dealer margins are some of the critical factors for companies to succeed. Crop protection chemicals are manufactured as technical grades and converted into formulations for agricultural use.

The Indian Agrochemical value chain comprises of technical grade manufacturers, formulators producing the end products, distributors and end use customers. According to the Pesticide Monitoring Unit, GOI, there are about 125 technical grade manufacturers, including about 10 multinationals, more than 800 formulators and over 145,000 distributors in India. More than 60 technical grade pesticides are being manufactured indigenously.

Figure 9: Agrochemical Value Chain



Source: Industry Analysis by Tata Strategic

In India top ten companies control almost 75-80% of the market share (Refer Annexure-I for list of top agrochemical companies in India). The market share of large players depends primarily on product portfolio and introduction of new molecules. The market has seen a number of mergers and acquisitions with large players buying out small manufacturers. Companies are also looking for strategic alliances and partnerships in order to expand their market reach.

Figure 10: Key Industry Players in India

Presence of key industry participants across product segments				
Company	Insecticides	Herbicides	Fungicides	Others
BASF India	✓	-	✓	Seed treatment
Bayer Crop science Ltd	✓	✓	✓	Seed treatment, plant growth regulators
Dhanuka Agritech Limited	✓	✓	✓	PGRs, Surfactants
Dow AgroSciences India Pvt. Ltd.	✓	✓	✓	Plant Growth Regulator
DuPont	✓	✓	✓	Growth Enhancer
Excel Crop Care Limited	✓	✓	✓	Seed treatment, Home & Garden
Gharda Chemicals Ltd.	✓	✓	✓	Plant growth Regulator
Meghmani Organics Limited	✓	✓	✓	Pesticide Intermediates
Monsanto India Ltd.	-	✓	-	Maize seeds
Nagarjuna Agrichem Limited	✓	✓	✓	Fertilizers, Micro Nutrients, Liquid Fertilizers,
PI Industries Ltd	✓	✓	✓	Speciality Products
Rallis India	✓	✓	✓	Rodenticides, Seed treatment
Syngenta India	✓	✓	✓	Seed treatment
United Phosphorous Limited	✓	✓	✓	Fumigants, Rodenticides

Source: Industry Analysis by Tata Strategic

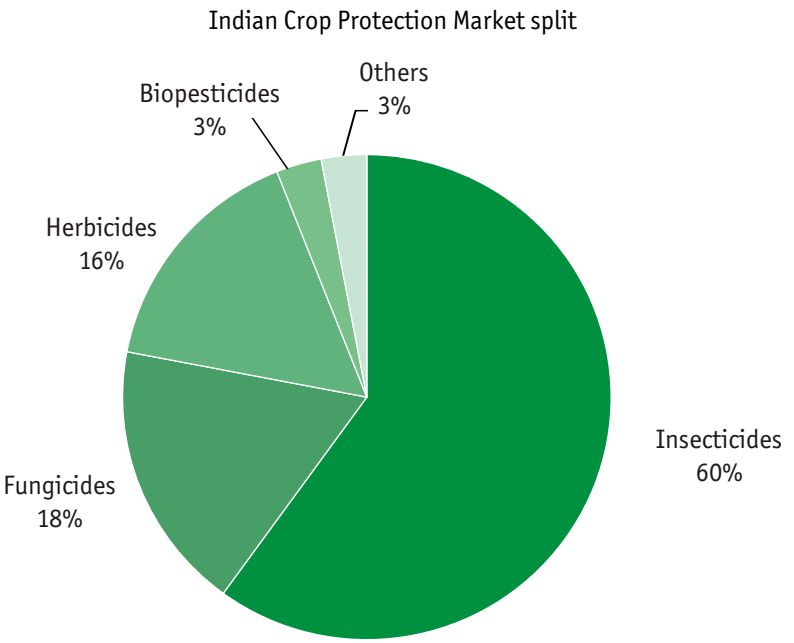
Indian market scenario

Distribution of domestic crop protection market by Product category

The Indian crop protection market is dominated by Insecticides, which form almost 60% 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% and 16% 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% 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.

Figure 11: Indian Crop Protection Market Split



Source: Industry reports, Analysis by Tata Strategic

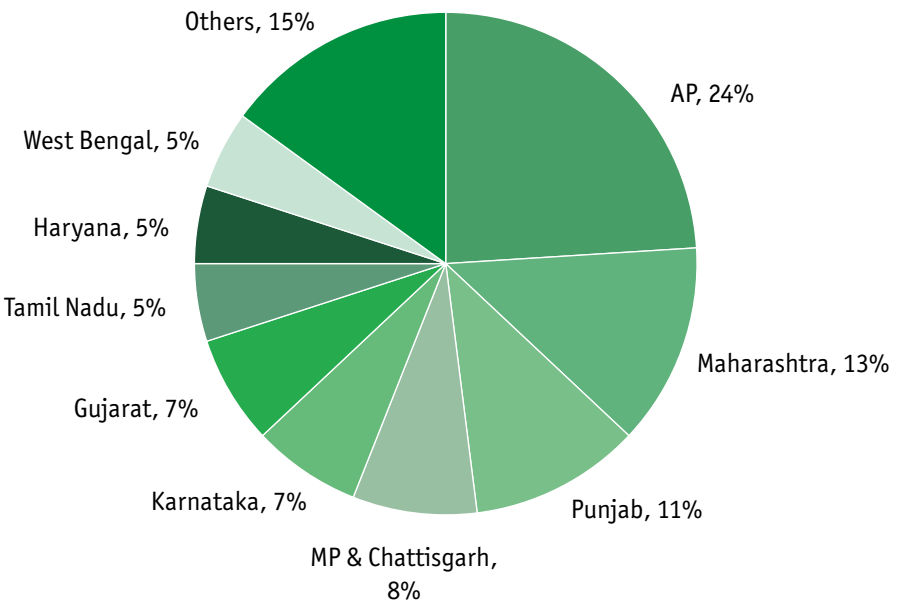
Figure 12: Major crop protection products

Segment	Major Products	Main Applications
Insecticides	Ace hate, Monocrotophos, Permethrin	Cotton, Rice
Fungicides	Mancozeb, Copper Oxychloride, Ziram	Fruits, Vegetables, Rice
Herbicides	Glyphosate, Isoproturan, 2,4-D, Pendimethalin	Rice, Wheat
Bio-pesticides	Spinosyns, neem based	Rice, Maize, Tobacco
Others	Zinc Phosphide, Aluminum Phosphide	Stored produce

Source: Industry Analysis by Tata Strategic

Erstwhile Andhra Pradesh (Seemandhra and Telangana), Maharashtra and Punjab are top three states contributing to 45% of pesticide consumption in India. Erstwhile Andhra Pradesh is the leading consumer with 21% share. The top seven states together account for more than 70% of crop protection chemicals usage in India.

Figure 13: State wise agrochemical consumption



Source: Industry reports, Analysis by Tata Strategic



7 Challenges faced by the Indian Crop Protection Chemical 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% of the pesticides sold in India in FY14. These products are inferior formulations which are unable to kill the pests or kill them efficiently. They also leave by-products which may significantly harm the soil and environment. The damage through such products is multifold. 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.

In association with FICCI, TATA Strategic has taken up a study focusing on this subject

- **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. It takes almost nine to ten years to bring a new product.

- **Low focus on R&D by domestic manufacturers due to high costs:** The industry is facing a serious challenge owing to the rising R&D costs. R&D associated with new product development amounts to ~ USD 250 million in costs. This prevents the companies from investing in R&D activities and they tend to focus more on the generic products which require low investments in research and development. In order to sustain in the long run, the industry needs to be committed to making long term investments and withstand longer gestation periods in order to bring to the market more innovative products.

- **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. Only 25-30% of farmers are aware of agrochemicals products and the usage, therefore; large numbers of farmers are unaware of the cost benefit that could be gained by using agrochemicals. However it is not easy to reach the farmers owing to infrastructure issues, 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 contact 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 makes a strong and efficient distribution network essential 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 post-harvest losses estimated at INR 45,000 crore every year. The lack of an efficient distribution system also makes it difficult for the agrochemical companies to reach the farmers to promote their products and educate them about their usage and benefits.

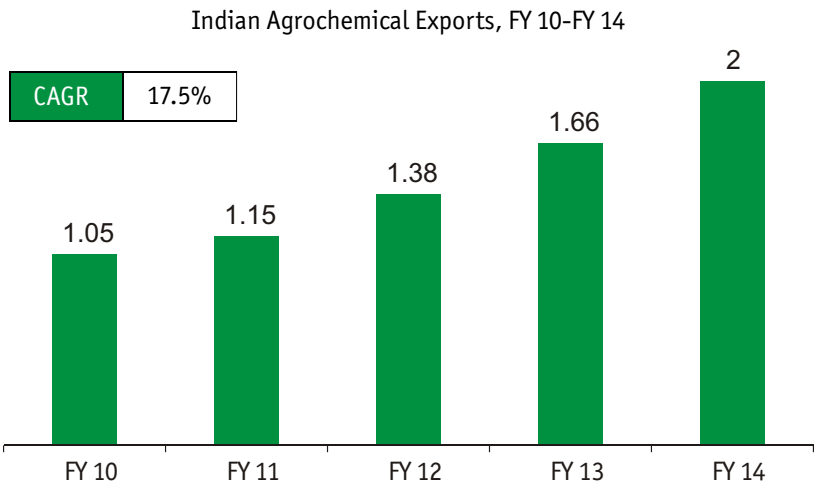
- **Long gestation period for new products:** It takes almost 10 years to bring a new molecule into the market. Even for the generic products, it can take up to 5 years to get the product registered. The regulatory bodies do not have adequate resources and infrastructure to execute timely registration of products. Sometimes the rules are not clearly defined creating interpretation challenges for the regulatory bodies, leading to confusion thereby adding to the complexities for the crop protection chemical companies.

Opportunities and Key Growth Drivers for Indian Crop Protection Market

- **Export Opportunities:** 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, overcapacity, better price realization globally and strong presence in generic pesticide manufacturing (India has process technologies for more than 60 generic molecules).

- Post tsunami Japanese companies are trying to build manufacturing capacities outside Japan to de-risk themselves. The Japanese companies are highly particular about confidentiality and intellectual property protection and some of them have seen opportunity in India and are now creating a base here. However, complex registration procedures pose a major challenge for the Indian crop protection chemicals export.

Figure 14: Indian Agrochemical Exports, FY11 - FY15

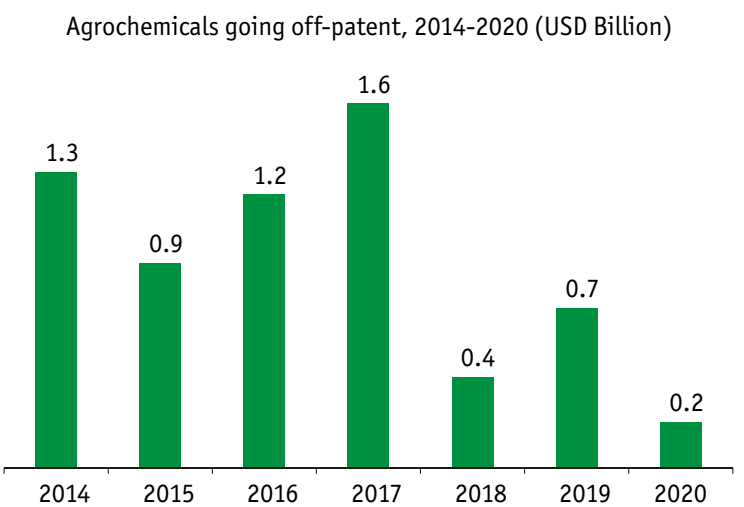


Source: Trademap Statistics, Tata Strategic Analysis

Agrochemicals worth USD 6.3 billion are expected to be taken off-patent list by 2020.

This provides significant export opportunities for Indian companies which have expertise in generic segment. Top 6 importing nations constitute only 44% of India's agrochemical exports. This also indicates export potential for Indian companies. In order to build a strong export base, companies should set up marketing offices in association with domestic players in export geographies. Companies can look for strategic alliances with local companies to expand their marketing and distribution reach. Companies can also explore merger and acquisition opportunities to increase their global presence.

Figure 15: Opportunities in generic products

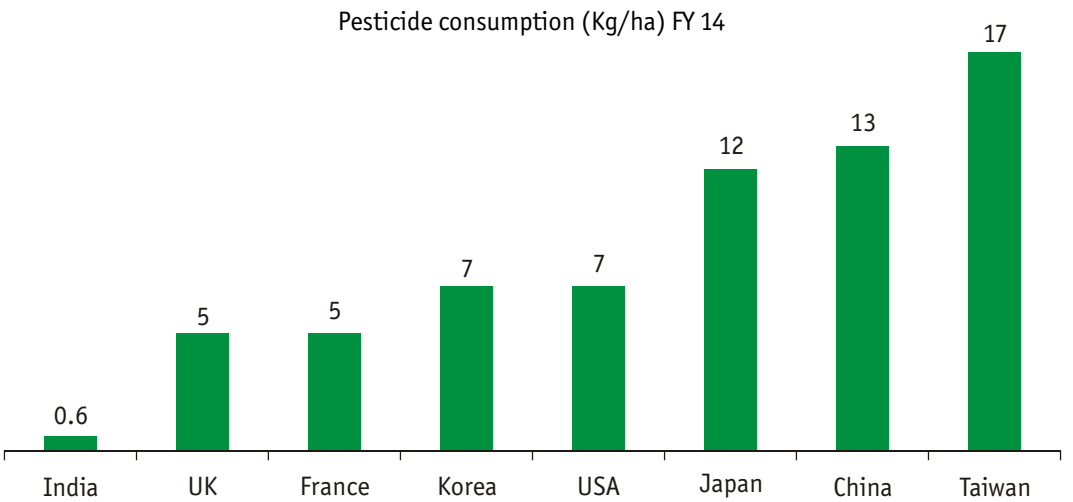


Source: Industry reports, Analysis by Tata Strategic

- **Growth in herbicides and fungicides:** Labor shortage, rising labor costs and growth in GM crops has led to growth in the use of herbicides. The herbicide consumption in India stands at 0.35 USD billion in FY14 and is expected to grow at a CAGR of 15% over the next five years to reach ~0.8 USD billion by FY19. 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% 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 20-30 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.

Figure 16: Pesticide consumption (Kg/ha) comparison



Source: Industry reports, Analysis by Tata Strategic

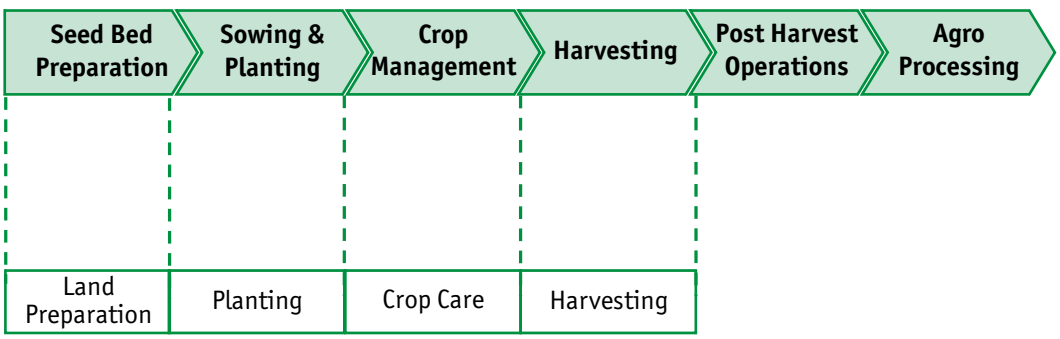


8 The Way Forward

Key imperatives for the Second Green Revolution

Increasing Mechanization: The focus of agricultural mechanization should be to bring about a sustainable increase in yields, productivity and cropping intensity. It should addressed the twin challenges of obtaining higher productivity from small and fragmented land holdings as well as achieving economies of scale. Increasing mechanization should address the needs of achieving it for all ccropping systems including rice and horticultural crops. The adaption should happen along all the activities along the farming process chain right from seed bed preparation to harvesting to post harvest operations. The process chain is mapped as under

Figure 17: Farming: Key Activities along the Process Chain



Source: Industry Analysis by Tata Strategic

The way forward for mechanization can work through three levers which would involve:

1. Identification: The key and unique requirements of farming in India such as for example: need for solutions that can be used for small farm holdings as opposed to solutions which have been developed for traditionally large land holdings. Appropriate technology requirements thus need to be identified

2. Adaptation: Solutions once identified, whether existing in a global capacity or developed domestically need to be adapted in order that they can target the exact need of the farmer. An example could be adapting a solution for optimal power requirement in land holdings that do not require high power requirement. A critical component of adaptation would involve increasing the level of indigenization in mechanization equipment in order to make the products cost competitive for the Indian farmer

3. Validation and feedback: The performance of developed solution needs to be validated and feedback generated should be incorporated in order to provide increasingly effective and improved solutions. The validated product needs to be further propoagted for large scale use by maximum farmers

In addition, there needs to be created an ecosystem which can ensure that the technology improvements are rapidly absorbed and adapted in Indian farmlands- some of these points would be covered later. But critical success factors for adoption of technology would include briefly extensive reach-outs to farmers, ensuring access to credit for purchase of the machinery, training on use of machinery among others.

Reducing Dependency on Monsoons: The key thrust areas here would be the development of variants of crops which are drought resistant and that give comparable yields to traditional varieties. Water harvesting techniques need to be developed in order to ensure that patchy rainfall which is being felt in increasingly heavy downpours is stored and efficiently used during lean periods. Low cost innovations which focus on more frugal use of water need to be developed and propagated for use in agriculture. The Second Green Revolution needs to focus on bringing more farmland under irrigation in order to boost crop productivity and reduce dependency on monsoons. These measures need to be undertaken in conjunction with increasing awareness of water saving innovations, educating the farmers regarding the various technologies available, easy credit facilities and so on.

Achieving Balanced Crop Portfolio: The First Green Revolution focused on ensuring that we become self-sufficient in food grains. The focus was more on achieving food security for a growing nation. The Second Green Revolution in addition to ensuring that food security becomes sustainable should focus on also ensuring nutritional security. Shifting dietary patterns demand a balanced crop portfolio. The focus should shift from developing high yield variants not only for food grains like wheat but also other sources of nutrition such as for example protein rich pulses. The nutritional needs of the nation needs to be identified, and high yield variants need to deployed in order to ensure that we are self sufficient across all crops.

Protecting the most vital stakeholder- the farmer: The Indian farmer has to bear tremendous economic losses on account of erratic monsoons and inefficiencies in the distribution chain. Economic losses in turn have in turn heightened insecurities regarding agriculture as a profession The Second Green Revolution in addition to adopting modern agricultural practices should also focus on the creation of a robust ecosystem that protects the farmer from the risks of the profession. It should ease the transition of the Indian farmer from the traditional ways of farming to adopting newer, modern methods. This would involve providing easy access to finance for procuring seeds, crop protection chemicals, machinery and equipment as also crop insurance in the event of crop failure. Extensive farmer education on all aspects of modern farming would ensure that these practices are rapidly assimilated. Creating efficiency and transparency in the distribution needs to be a key imperative in order that farmer can get a fair price for the produce. Thus risk mitigation for the farmer should be a key imperative for the Second Green Revolution.

Here the other stakeholders such as the Government, the financial institutions, the regulatory agencies, agro-experts and the farming solutions providers need to come together and work collaboratively to ensure that the most vital stakeholder- the farmer is well protected from the uncertainties of the profession. In brief certain instances/initiatives and policies have been illustrated as below:

HUL's INR 42 Cr. Initiative for water conservation in drought prone Maharashtra: The NREGA partnership in Jalna with HUL is a step in the direction of ensuring that dependency on monsoons can be reduced in drought prone regions. The government has extended wages for soil and water conservation under the scheme while HUL with its NGO partner the Watershed Organization Trust has extended technical and managerial inputs to the programme. The INR 42 Cr. Project spread over 76 villages has so far created a water potential of 100 billion litres across the country and it aims to reach 500 billion litres by 2020

Sub- Mission on Agricultural Mechanization: The Sub- Mission on Agricultural Mechanization as outlined by the Ministry of Agriculture as part of the 12th Five Year Plan envisages increasing farm mechanization to small and marginal farmers and to the regions where availability of farm power is low. The scheme will be implemented across all the states to promote mechanization and to increase the ratio of farm power to cultivable unit area upto 2kW/ha. The mission will in effect:

1. Promote farm mechanization among stake holders through on-field and off –field demonstrations
2. Conduct performance testing of various farm machineries and equipments at designated testing institute
3. Provide financial assistance to farmers for procurement of farm machinery & equipments as also financial assistance to small and marginal farmers for hiring machinery and implements in low mechanized regions
4. Establish custom hiring centers for location and crop specific farm machinery and implements

Key imperatives for Agrochemical Companies, Govt. and Regulatory bodies

Agrochemicals can play a crucial role in overcoming the challenges faced by Indian agriculture sector, thereby ensuring food and nutritional security for the nation. This can be achieved by developing innovative products, expanding the product/service offering and promoting the use of agrochemicals amongst the end users, i.e. the farmers. The low consumption levels provide a significant opportunity for agrochemical companies to increase their market penetration. Some of the key imperatives are:

Product innovation: Product innovation needs to capture emerging market trends and match international standards. India lags far behind in adoption of technology and new development, which results in high yield difference. For instance since the past few years China's percentage of Rice acreage under hybrids is about 57-60% whereas in India it is just 4-7%. Hence, GOI has been increasing the financial outlay on hybrid rice promotion to meet its objective of ~20% coverage in the present year. However it is also imperative for the Companies in agro-chemical space to focus on emerging trends and developments

In the forthcoming revolution, relying on generic agrochemicals won't suffice the ever increasing demand of the country. Hence it would become crucial for the companies to adopt innovation and developments such as GM (genetically modified) crops, hybrid seeds, seed coating etc. All this would result in better output and yield, disease resistance, enhanced nutritional value, and would reduce pesticides spraying, cost and labor intensity for farmers.

Companies need to undertake product developments which can improve the effectiveness of pesticide usage as well as reduce negative impact on the environment. With the advent of GM crops and increasing popularity of bio-pesticides, environment friendliness of the agro-chemicals could be a differentiating factor. Indian companies would need to increase focus on developing new active ingredients rather than just focusing on generics. Indian companies usually spend 1-2% of their turnover on R&D as compared to global companies which spend 10-12% of their turnover on R&D.

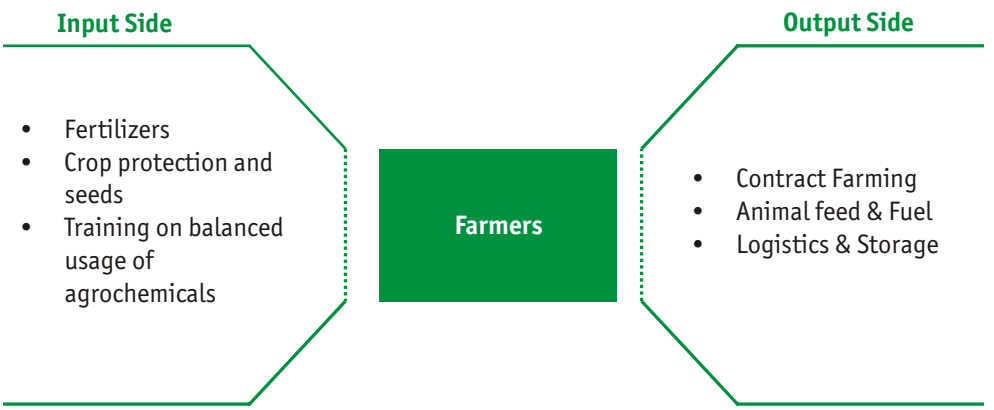
Another development in this area is the use of targeted pest protection products that are effective against a particular pest rather than a broad spectrum pesticide which is supposed to target a variety of pests. The thrust is welcome as focused/targeted pesticides are more effective rather than broad spectrum ones. Most crops have a particular strain of pest which is a major nuisance and thus targeted solutions are better than broad spectrum ones. More developments on these lines should follow with such product innovations being linked to the needs of the farmer and the pest related nuisances faced by them.

Indian companies can also look for strategic tie-ups/ alliance with large MNCs for contract manufacturing if they lack the ability to invest in developing new molecules.

In line with the global trend, Indian companies can look for opportunities to expand their presence in the value chain by incorporating seeds in their product portfolio. Globally it has been witnessed that EBITDA and PAT margins have increased as companies have integrated into seed manufacturing. This would help in increasing the reach amongst the farmers.

End to end farmer solution: Companies should look for opportunities to provide a comprehensive agro offering to the farmer. A one stop solution for the farmer ranging from agriculture and farm inputs to procurement, storage and distribution services on the output side would help companies develop sustainable business models. End to end solution not only creates a better reach with the farmers but also turns threats like genetically modified seeds, organic farming etc. into opportunities. Many companies are already following the integrated model. While it has helped the farmers improve their yield, get technical assistance and better vazlue for their produce, it has also helped companies strengthen their presence amongst the farmers.

Figure 18: Indicative end to end farmer solution



Source: Industry reports, Analysis by Tata Strategic

Effective Marketing and distribution: Effective marketing and distribution and increased reach to farmers is a key growth driver for the agrochemical companies. However, rising sales of non-genuine agrochemical products has impacted the industry image. Companies are already investing in marketing activities aimed at educating the farmers and increasing their customer base. Companies should also educate distributors and retailers who are often the key influencers and affect the purchase behavior of the farmers.

Hence it is not only critical for companies to promote their products amongst the retailers/distributors but also incentivize them to sell genuine products. Industry bodies also need to invest in overall "image improvement" of the industry. Companies should come together and develop strategies to promote the

use of genuine products amongst the end users. Joint efforts should be undertaken to educate farmers about pesticide use in a judicious and appropriate manner. Benefits of bio-pesticides also need to be promoted to encourage shift from the traditional products.

Leverage on IT and Telecommunications: Companies should leverage the existing IT and Telecommunication infrastructure to promote the use of their products. Apart from Television and Radio, companies can capitalize on SMS services to be in touch with distributors' retailers and farmers. IT services can be used to provide technical and operational guidance. Portals in regional languages can help build connect and enduring relationships with farmers.

Role of Government and Regulatory Bodies: Apart from Agrochemical companies, Government and Regulatory bodies have to play a critical role for achieving increased reach of agrochemicals amongst the farmers. Without their support it would be difficult to realize the true potential of agrochemicals.

The Government needs to continue to provide infrastructural support to the industry so as to develop effective marketing and distribution solutions. A repository of best practices and the development of a Centre of Excellence should be intensified by the Government. The Government should increase the frequency of various awareness camps/education programs organized in association with industry and academia to encourage farmers to use agrochemicals.

Fast track approvals and clearances should be provided by regulatory bodies to encourage companies to develop new products. Monetary support by Government to Industry and Academia for R&D activities can also provide an impetus for developing new products and techniques

Non-genuine pesticides are a critical challenge which not only impact the industry image but also hamper the crop productivity and soil fertility. Strict actions, regular crackdowns and punishments are therefore required to stop the menace and damage caused by non-genuine products. Agrochemical companies as also the regulatory bodies need to work in tandem in order to contain this menace.

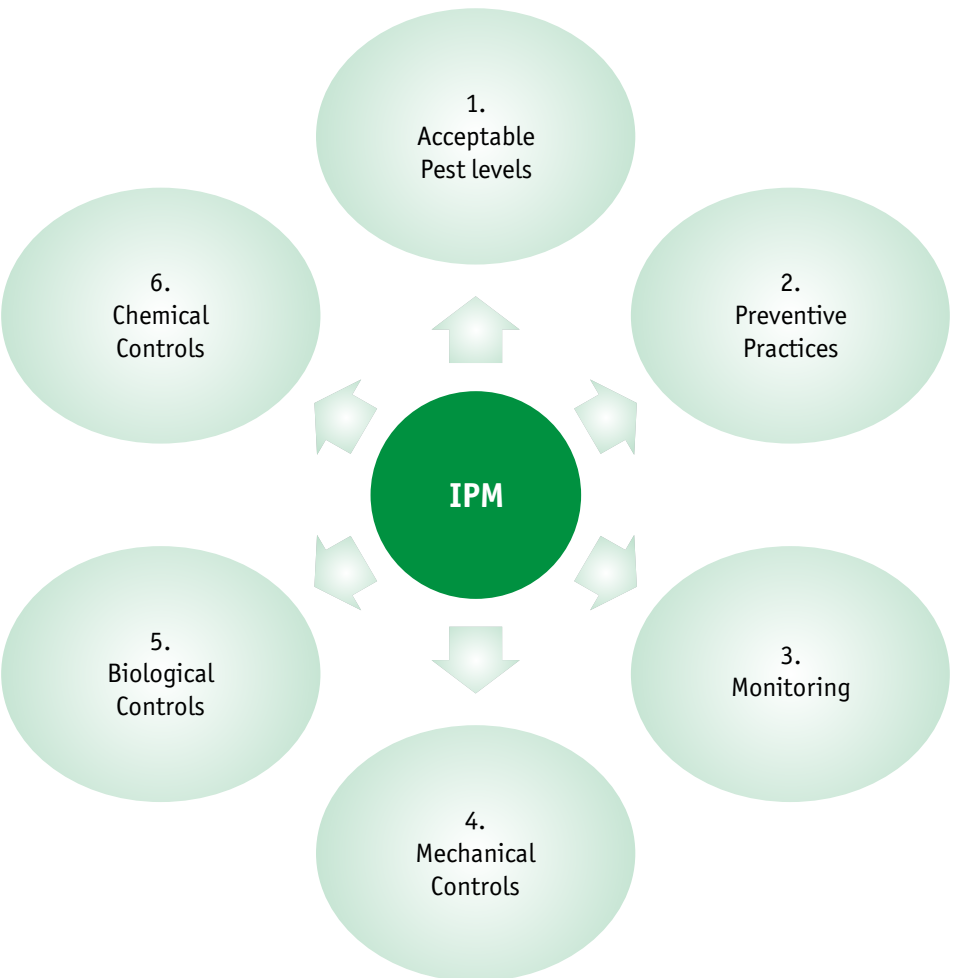
DuPont has introduced several unique solutions which can help identify genuine DuPont products from illegal/counterfeit pesticides. DuPont has introduced DuPont™ Izon®, which is a secure authentication technology - a visible 3D security system with a unique code that helps farmers identify DuPont crop protection brands. A web based verification system or an SMS based verification system allows the farmer to send an SMS to a phone number to validate the authenticity of the product. Another unique solution is DuPont™ Traceology® which is a cloud based product verification system that keeps track of products and provides critical product information such as batch, lot, and part number to verify products. The use of this technology helps prevent the use of counterfeit product and safeguards farmers' interest.

Integrated Pest Management: Integrated Pest Management (IPM) is a sustainable approach to pest management by combination of biological, mechanical, physical and chemical methods. These methods are performed in three stages: prevention, observation and intervention. It is an ecological approach

and strives for eliminating or significantly reducing the use of pesticides and at the same time containing pest growth at acceptable levels. There are six basic components of IPM which are employed to control pest growth.

Figure 19: Integrated Pest Management components

Basic Components of Integrated Pest Management



Source: Industry reports, Analysis by Tata Strategic

Apart from IPM, newer molecules with better efficacy are being developed. These molecules such as sulfonylurea and imidazolinone require lesser volume of chemicals per net treated area. Newer products such as biological pesticides, seed treatment chemicals, and semiochemicals are being introduced. Seed treatment chemicals require a very small volume of the chemical as compared to normal crop protection chemicals.

Although IPM is accepted in principle as one of the options for crop protection, its implementation at the end user (farmer) level is limited. While chemical pesticides cannot be avoided altogether, incorporating non-chemical methods in pest management would help in optimizing costs and would provide crop protection in an eco-friendly manner.

Plasticulture in Agriculture: Plasticulture refers to use of plastics in agriculture and horticulture. Plasticulture has a number of applications in modern agriculture and promise to transform Indian agriculture and bring in the "Second Green Revolution". Both the quality and the quantity of the crops and other farm products can be optimized using various techniques. Some of the major applications of Plasticulture are listed in the table below:

Figure 20: Plasticulture applications

Application	Comments
Drip Irrigation System	• Precise application of irrigation water and plant nutrients at low pressure and frequent intervals through drippers/emitters directly into the root zone of plant
Sprinkle Irrigation System	• Application of water under high pressure with the help of a pump. • Water is released through a small diameter nozzle placed in the pipes
Ponds and Reservoir Linings	• Plastics film lining to prevent against seepage in canals, ponds and reservoirs • Also avoids depletion of stored water used for drinking & irrigation purpose
Plastic Mulching	• Mulching is covering the soil around the plant with plastics film, straw, grass, hay, dry leaves, stones etc. • Prevents loss of moisture and acts as a barrier between the soil and atmosphere
Greenhouse	• Greenhouse is a framed structure covered with glass or plastics film • Acts as selective radiation filter, in which plants are grown under the controlled environment
Plastic Tunnel	• Plastics tunnel facilitates the entrapment of carbon dioxide, thereby enhancing the photosynthetic activities of the plant that help to increase yield

Source: Industry reports, Analysis by Tata Strategic

Plastics which are most widely used in agriculture, water management and related applications are PE, (LLDPE, LDPE and HDPE), PP and PVC.

The application of Plasticulture can substantially decrease the costs and therefore can lead to higher productivity with a better quality of crops. The table below shows the water saving, water use efficiency and fertilizer use efficiency by various plasticulture applications. Each application can drastically save water by about 30 to 100%.

Figure 21: Benefits of Plasticulture applications

Plasticulture Application	Water Saving (%)	Water Use Efficiency (%)	Fertilizer Use Efficiency (%)
Drip Irrigation	40-70	30-70	20-40
Sprinkler Irrigation	30-50	35-60	30-40
Plastic Mulching	40-60	15-20	20-25
Greenhouse	60-85	20-25	30-35
Shade Nets	30-40	30-50	Not Available
Tunnel	40-50	20-30	Not Available
Farm Pond Lined with Plastic Film	100	40-60	Not Applicable

Source: Industry reports, Analysis by Tata Strategic

Indian Agriculture sector needs a second green revolution to ensure food and nutritional security for the nation due to growing population, increasing urbanization at the expense of agricultural resources and loss of agricultural produce due to pest attacks. It therefore becomes imperative to implement measures not only for crop protection but also for enhancing the crop productivity and agrochemicals thus will continue to play a critical role in achieving food and nutritional security for the nation.



9 Industry Leaders Speak

DuPont:

Mr. Ram Mudholkar, *Business Director, DuPont*

On DuPont's commitment to addressing Global Food Security:

"DuPont is optimistic, as scientific innovations have already significantly enhanced the quality and quantity of food production. Our employees around the world are addressing food security with science-based innovations; collaborations with businesses, NGOs and governments; and work with local farmers and food producers. And, at the corporate level, we are transforming our business model and investing heavily in our agriculture and nutrition businesses to make food more nutritious, safer and available to people everywhere."

On Approach that the 2nd Green Revolution needs to adopt/Critical challenges:

"The 2nd Green Revolution needs to do much more than merely focussing on improving yields. The approach needs to be much more holistic and should encompass developing a more balanced portfolio of crops to ensure overall food as well as nutritional security of the country; building stronger, more direct linkages between farmers as producers and people as consuming customers ; food safety ; uniform , easy and affordable availability as well as developing a strong export base."

Excel Industries Limited:

Mr. Ashwin Shroff, *Chairman and Managing Director, Excel Industries Limited*

On Integration of Agrochemicals into 2nd Green Revolution:

"The agrochemical industry is cognizant of the environmental implications and the perceptual challenges that grapple it. Product innovation is key. Well-designed formulations effective in small dosages and extremely target specific will ensure that the intended purpose of effective pest management is realized while at the same time minimal damage is caused to the environment"

Rallis India Limited:

Mr. Veeramani Shankar, *Managing Director and CEO, Rallis India Limited*

Agrochemicals: Critical Challenges

"Intensified food and dietary requirements, shrinkage of the available land and growing threat of spurious products in the market creates an impetus for us to evolve into a new phase. The focus should predominantly be upon policy reinvention, productive utilization of available resources and education of farmers about the safer and judicious use of chemicals."

Agrochemicals: Developments

"The indigenous industry is coming up with effectively designed, safe and cost effective solutions. What it needs to do is ensure that the farmer get access to these solutions and understands how to use them. Overdosing will create problems in the food chain whereas under-dosing would only render the pest resistant to a perfectly good solution. What is needed is innovation supported by extensive farmer education"

Dhanuka Agritech Limited:

Mr R G Agarwal, *Chairman, Dhanuka Agritech Limited*

On Integration of Agrochemicals into 2nd Green Revolution:

With more than 6 lakhs villages and 12 crore farmers in the country strong government support is needed to back up a predominantly agrarian economy. Agrochemicals can play an instrumental role in managing the 2nd Green revolution; it is crucial to provide technology intensive training to the farmers, dealers and distributors, drive out the complexities within the system and bring in a change in people's perception on the use of agrochemicals. There is also a need to make initiatives such as the recently launched Kissan Channel more interesting and effective to encourage the farmers. Growth in agriculture won't be attainable without the judicious use of agrochemicals. Therefore efforts need to be undertaken to differentiate amongst the good and the spurious agrochemical manufacturers.

10 Promoting skill development in Indian Agriculture – A multifaceted and holistic approach

Agriculture represents India's most significant sector: accounting for 14% of India's Gross Domestic Product (GDP) and employing more than 55% of the Indian population. The challenge for Indian agriculture is to achieve higher productivity in a sustainable manner, despite constraints on availability of land, irrigation and labour. To achieve this, farmers need to be empowered with new farming technologies like irrigation systems and mechanisation, as well as modern input materials like high yielding seeds and crop protection products to increase productivity. However technology alone is not enough, its application requires a steep increase in knowledge, training and a proper advisory system. This is an enormous target considering India has an estimated 120 million farmers...

Bayer CropScience, a leading player in the crop sciences business globally and in India, shares some of its approaches towards education and training, capacity building and skill development initiatives implemented in the Indian market.

The relevance of farmers' capacity and skill building

While addressing agricultural scientists and experts at the Indian Council of Agricultural Research (ICAR) in July 2014; Indian Prime Minister, Narendra Modi, advocated a policy of, "Kam zameen, kam samay, zyaada upaj" (less land, shorter time, more productivity). "In order to produce more and earn more, farmers need to be empowered more. Therefore, we need to think of how to reach out to farmers," stressed Mr. Modi. His statement holds true in today's context as it highlights the need for local agricultural extension services through farmer trainings and also utilizing the advantages of modern communication tools and technologies.

At Bayer CropScience, this is done through a comprehensive set of capacity building activities for farmers, which are tailor made depending on crop, target group, educational backgrounds and the development stage of agriculture in a particular geography. Bayer's set of capacity building and training activities includes more than thousands of field demonstrations, on-farm training and field days, workshops, SMS & call advisory and most importantly: on-farm consultancy.

As a producer and supplier of high quality seeds and crop protection products based on chemical and biological modes of action, Bayer has firsthand expertise in farming agronomy, which is shared and demonstrated through suitable and advanced crop management practices and agricultural information. Across India, Bayer has a network of over 3,000 farm advisors. Bayer's farm level advisors, also known as "Field Officers" identify farmers who need support and provide them with timely and relevant advisory to carry out farming operations in a sustainable, safe and profitable manner.

For farmers, "Seeing is Believing." Therefore, we regularly conduct farmer field days where Bayer experts conduct field demonstrations to create awareness on a range of topics such as GAP (Good Agricultural Practices), high yielding hybrid seed technology, Integrated Crop and Pest management and safe handling of products. Further, Bayer CropScience provides farmers additional information and advisory on soil testing, seeds and weather forecasting.



For farmers, "Seeing is Believing", that's why Bayer conducts demonstrations to showcase the yield difference between farmer's own practice and the Bayer Labhsutra plots where Bayer products and solutions are used. On Harvest Days, Bayer's Field Officers and farmers compare the quantity and assess the quality of Rice yields.

Initiatives by Bayer CropScience in India

In 2013, Bayer CropScience launched an experiential marketing initiative in India, called **"Bayer Labhsutra"** the Mantra for Farmer Prosperity. The initiative aims to help farmers achieve better returns on investment by adopting modern agronomical practices from "Seed to Harvest". Under the program, the participating farmer's land is divided into two halves. On one half, Bayer's Seed & Crop Protection solutions are used; and on the other half of the land, the farmer follows his own practice. The plot is then used during the season for regular visits and trainings with around 30-50 neighboring farmers. Finally, on harvest day, the output from the two halves is compared.

In 2013, Bayer conducted 3,469 Bayer Labhsutra field demonstrations across India for Rice / Paddy, Cotton, Pulses, selected Vegetables and Fruits. These demonstrations resulted in a sizeable yield increase, which also brought 12 - 15% incremental profits for the farmer compared to his current practice (Source: Internal reports). Hence, the Bayer Labhsutra initiative educates farmers using a very practical approach, where the Labhsutra farmer usually develops the capacity to advise his fellow farmers with the help of Bayer farm advisors.

A testimonial from a Bayer Labhsutra farmer



"I used the Bayer Labhsutra package in 1 acre of my potato field and got a higher yield as compared to other fields in the region. I also got a higher value for potato in the market. In future, I plan to use the Bayer Labhsutra package in my entire farm."

- Satinder Pal Singh, Potato farmer, Killi Village, Jalandhar District, Punjab

Bayer experts distributing the Bayer Labhsutra kit to chilli farmers



In addition, Bayer CropScience has set up 237 “Bayer Solutions Stores” across the country with its distribution partners. The major idea is to offer not just products, but also expert advice to farmers at the point of sales. The Bayer Solutions Stores aims to satisfy farmers’ need for farming knowledge, while offering them the "Right Product with Right Advice". To achieve this, Bayer has placed special Farm Advisors in the Bayer Solutions Stores. These Farm Advisors also pay special attention to the education of the shop owner, who will then be equipped to provide better solutions to the visiting farmers. As a result, he can become the preferred supplier for the farmer, which will ultimately also lead to increased farmer footfalls in his outlet.



The Bayer Solutions Store aims to satisfy farmers’ need for farming knowledge, while offering them the "Right Product with Right Advice"

Educating and reaching millions of farmers with modern communication technologies

Reaching out and educating millions of farmers is a huge challenge for all stakeholders in Indian Agriculture. Hence leveraging communication technology can be an important way to address this challenge. Around 54% of mobile phone users in India are from rural areas (Source: India Mobile Landscape Report 2013). Leveraging this opportunity, Bayer CropScience introduced a national toll free helpline for Indian farmers in October 2014. The helpline provides free product-specific consultancy, crop related advice and general information on integrated crop protection solutions. All conversations and queries from the helpline are recorded and monitored by Bayer Agri-Experts to ensure that correct and quality information is provided to farmers on a real time basis. Farmers are also given the option to request for a Field Officer visit at their farms, in case the query cannot be resolved on the phone.



Apart from receiving inbound calls, the call center reaches out to farmers registered on Bayer CropScience India’s database on regular intervals with relevant recommendations. India has around 33 recognized languages and approximately 2,000 dialects. Therefore, a special emphasis is given to answering farmers’ queries

in their local languages/dialects. This is achieved by locating call centers in the heart of rural areas. Bayer does this in partnership with Rural Shores, a company specializing in providing employment to youth in rural areas. Hence our call centers also teach and train rural youth in addition to providing qualified service and expert advice to farmers.

Bayer CropScience's national farmer helpline provides free technical advisory, crop related advice and information on crop protection products and solutions to farmers across India

Educating the safe and responsible use of agrochemicals

In India, there are still major gaps in safe usage, application techniques and disposal of agrochemical containers. Hence, Bayer CropScience also carries out various stewardship and safety education initiatives to demonstrate responsible ways of managing crop protection products throughout their product lifecycle, from correct use to disposal. Farmers are educated on the principles of Integrated Crop and Pest Management, like for instance – the knowledge of pre-harvest intervals while using pesticides close to harvest, seed treatment and after care of treated seeds etc. Bayer has made these subjects an integrated part of all its farmer meetings and field demonstrations.

Creating shared value through partnerships

Bayer CropScience is convinced that partnerships can open up new ways to sustainably feed the growing world population. Bayer CropScience is therefore leveraging its position as a global leader in agri-inputs and services, to help connect all parts of the food value chain, through its "Food Chain Partnership" initiative. In India, Bayer CropScience currently runs 31 successful partnerships across 140 locations, covering more than 62,000 hectares and benefitting 79,000 farmers. A few good examples where Bayer has been able to drive and teach new farming technologies include its grape and potato Food Chain Partnership projects.

In these projects, Bayer often complements its expertise by teaming up with local partners. For example in 2013, Bayer CropScience joined hands with India's National Research Center for Grapes (NRCG) and Express Weather, a weather forecasting company, to create a weather advisory model for grape farmers. This innovative model supports grape growers with the knowledge of correct timing for spraying, in order to achieve a better crop.

In potato, Bayer CropScience has been working extensively with farmers under its Food Chain Partnership with PepsiCo. Under the program, training workshops are held for vendors and growers; with a focus on pest and disease management, safe use of crop protection products and application technologies. This is followed by field monitoring at the grower level. All these interventions have resulted in improved yield and higher returns for the growers and good quality potato availability for PepsiCo.



A potato farmer under Bayer CropScience's Food Chain Partnership demonstrating his healthy produce of potatoes to a Bayer expert

Using the power and reach of Public Private Partnerships

In 2008, Bayer CropScience India joined hands with the Confederation of Indian Textile Industry - Cotton Development & Research Association (CITI-CDRA), Rajasthan Textile Mills Association and the Rajasthan State Department of Agriculture. The objective of the partnership was to make a difference to the lives of small, marginal, tribal and women cotton farmers in south and central Rajasthan. Over the last six years, the various farmer education initiatives executed by the project team and Bayer experts has led to significant enhancement in the productivity and income of cotton farmers.



Bayer experts and the CITI-CDRA team during a visit to the project cotton field in Jodhpur, Rajasthan

Under this collaborative project, average cotton productivity has gone up by 80 - 105% with a return on investment of 1:2 from the basic level of 245 kg lint/ hectare in the tribal Banswara district of Rajasthan. In the adjoining districts of Bhilwara and Rajsamand, average cotton productivity went up by 33% with a return on investment of 1:1 to 1:1.4 from an average basic level of 455 kg lint/ hectare. In 2012, the project was extended to four new districts in south Rajasthan. The project provides good scope to link the project cotton farmers and an assurance to key stakeholders along the cotton value chain. It is also a good example of public-private-partnership for sustainable development of small and marginal cotton farmers.

Conclusion

Indian agriculture is highly diversified and operates in an environment faced with many variable and complex factors influencing the speed of adoption of new technologies. Reaching out to more than 100 million farmers requires a multifaceted approach in knowledge transfer. Bayer CropScience has developed a large number of targeted interventions for farmers' education and advisory. These include its large number of highly experienced field staff and Farm Advisors, a strong network of trade partners and Bayer Solutions Stores, Bayer Labhsutra on farm demonstrations, a dedicated National Helpline and Public Private Partnership projects. Technology and capacity building together will support a further sustainable increase of agricultural productivity, support the demand for food and improve the lives of farmers.

Authored by Joerg Rehbein, Head of Bayer CropScience, Indian Subcontinent

About the Author (Additional Information)



Joerg Rehbein is the Head of Bayer CropScience, Indian Subcontinent; a role he has been in since June 2011. Prior to this, Joerg has held several leadership positions at Bayer over the past 20 years, where he gained a wide range of experience by managing Bayer's agrochemical business in countries with varied agricultural, distribution and farming characteristics.

11 Crop Protection Chemicals industry-Imperatives of growth

By Mr. P S Singh

The future of Crop Protection Chemicals industry is bright. It is expected to grow at a CAGR of 12% between FY 14 and FY 19 to reach USD 7.5 Bn. In coming years, agrochemical industry should focus on developing new processes and products with sustainability as the core principle. This requires developing a collaborative platform in which the academia, government and regulatory bodies, farmers associations, manufacturers and farmers come together to promote safe and judicious usage of pesticides. Going ahead, opportunities for the Indian crop protection industry will come from exports, higher production of generic products, product portfolio expansion, and growth in herbicides and fungicides.

2. In coming years, the need for safe and effective use of crop protection chemicals will further increase to brace with larger climatic variations and emergence of new invasive insects, weeds and diseases. Hence, it is important for companies to invest today in science and practices which promote safe and judicious use of crop chemicals. Judicious use of pesticides implies using the right product, with correct dosage and with correct application methodology. When used judiciously, the products deliver maximum impact on the target species. Therefore, it is critical for both the government and for Crop Protection Chemicals manufacturers to work closely with the farmers and farmers associations to educate them on safe and judicious use of existing pesticides as well as advancements happening in products on a regular basis.

3 Internally, crop protection products manufacturers can also consider performing a process and environmental impact audit of their existing products and adopt green chemistry practices. To move to "green practices", in the short term, companies can implement zero discharge solutions, adopt COD reduction techniques and develop collaborative platforms. In the medium term, companies can implement solvent recovery practices, explore alternate green solvents, evaluate biocatalysts and microwave chemistry technology. Over the long term, companies may also focus on developing biopesticides, implement process innovation to achieve a better material balance and build symbiotic relationships with key stake holders. Embracing farmers to promote judicious usage of crop protection products will be an appropriate way to develop a long term sustainable business model in Crop Protection Chemicals.

4. For a sustainable growth it is imperative for crop protection chemicals manufacturers to adopt green chemistry processes, develop new products which are nearly 100% green and increase their focus on educating and training the farmers for proper usage of Crop Protection Chemicals. Focus on Green Chemistry will help the companies to design new products and processes with

sustainability as the core principle. Over the long term, this will help the companies to differentiate themselves and build competitive advantage. Government should also look to curb the menace of spurious pesticides.

5. However, the industry cannot implement the green chemistry practices in isolation. It is imperative to build a collaborative ecosystem in which the academia, industry, government and regulatory bodies come together and create opportunities for the industry, academia and the Entrepreneurs to test, scale-up and commercialize their ideas in the domain of green chemistry practices. Ideas or concepts with potential should be nurtured and adequate support should be provided for scale-up and commercialization. This would encourage creation of inventions and innovations 24

6. With Government's current campaign on ***'Make in India'*** which has a special focus on the chemical industry and aims to turn the country into a global manufacturing hub, good infrastructure and adoption of cluster approach(in which like minded industry shares common infrastructure and thus bringing down the over-all cost. Government could also consider giving same excise treatment to crop protection chemicals, as to fertilizers and seeds as all of them facilitate the agriculture sector.

7. The future indeed is bright for Indian Crop protection chemicals industry, as a facilitator of the Indian agriculture as also of national economy.

Annexure - I

Figure 22: Key Agrochemical Players in India



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13 About Tata Strategic

Founded in 1991 as a division of Tata Industries Ltd, Tata Strategic Management Group is the largest Indian own management consulting firm. It has a 50 member strong consulting team supported by a panel of domain experts. Tata Strategic has undertaken 1000+ engagements, with over 300 clients, across countries and sectors.

It has a growing client base outside India with increasing presence outside the Tata Group. A majority of revenues now come from outside the group and more than 20% revenues from clients outside India.

Tata Strategic offers a comprehensive range of solutions covering Direction Setting, Driving Strategic Initiatives and Implementation Support



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- Profit
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14 About FICCI (Federation of Indian Chamber of Commerce and Industry)

Established in 1927, FICCI is the largest and oldest apex business organisation in India. Its history is closely interwoven with India's struggle for independence, its industrialization, and its emergence as one of the most rapidly growing global economies.

A non-government, not-for-profit organisation, FICCI is the voice of India's business and industry. From influencing policy to encouraging debate, engaging with policy makers and civil society, FICCI articulates the views and concerns of industry. It serves its members from the Indian private and public corporate sectors and multinational companies, drawing its strength from diverse regional chambers of commerce and industry across states, reaching out to over 2,50,000 companies.

FICCI provides a platform for networking and consensus building within and across sectors and is the first port of call for Indian industry, policy makers and the international business community.

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