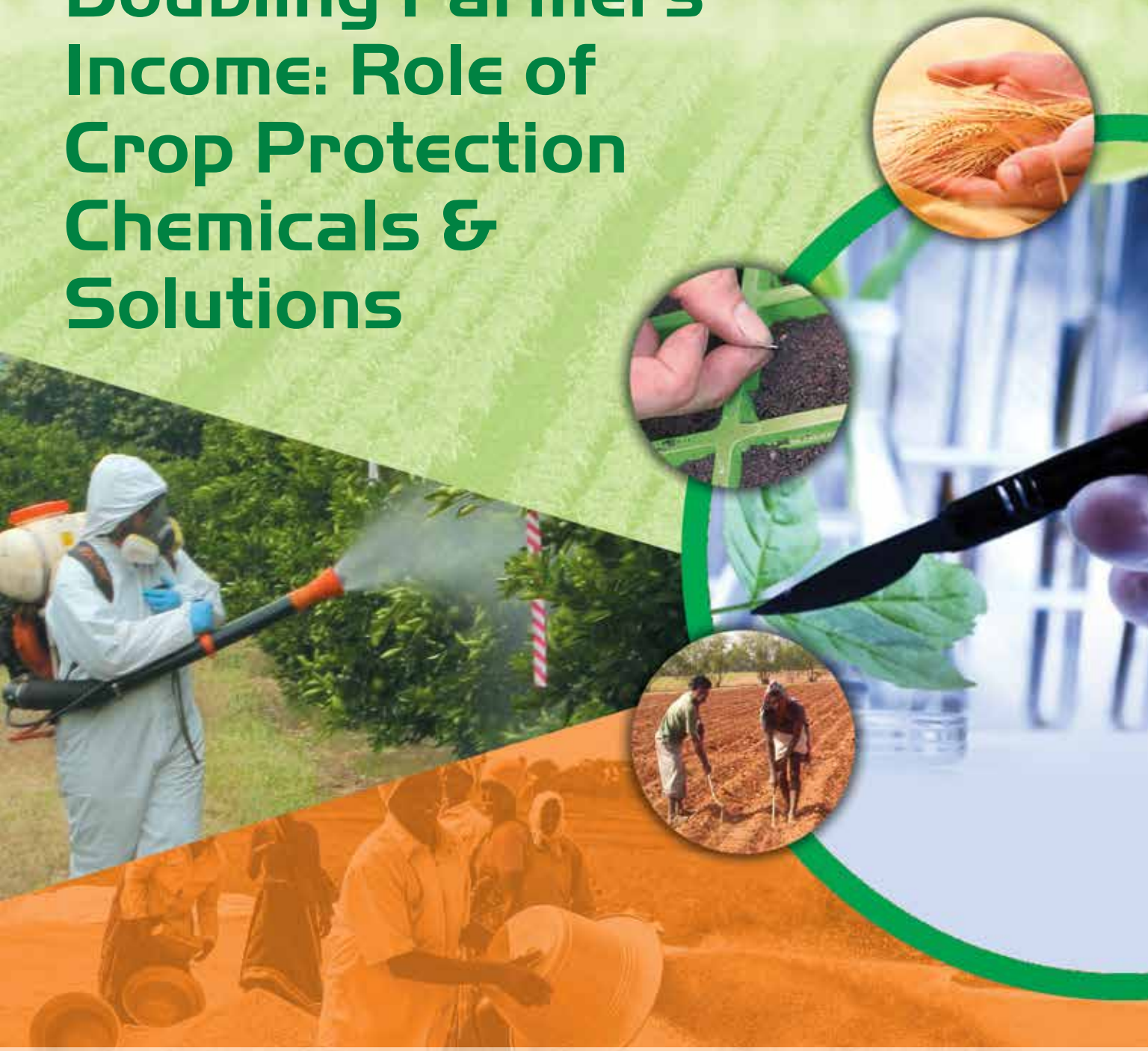
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Doubling Farmers' Income: Role of Crop Protection Chemicals & Solutions



A report on

Indian Agrochemical Industry

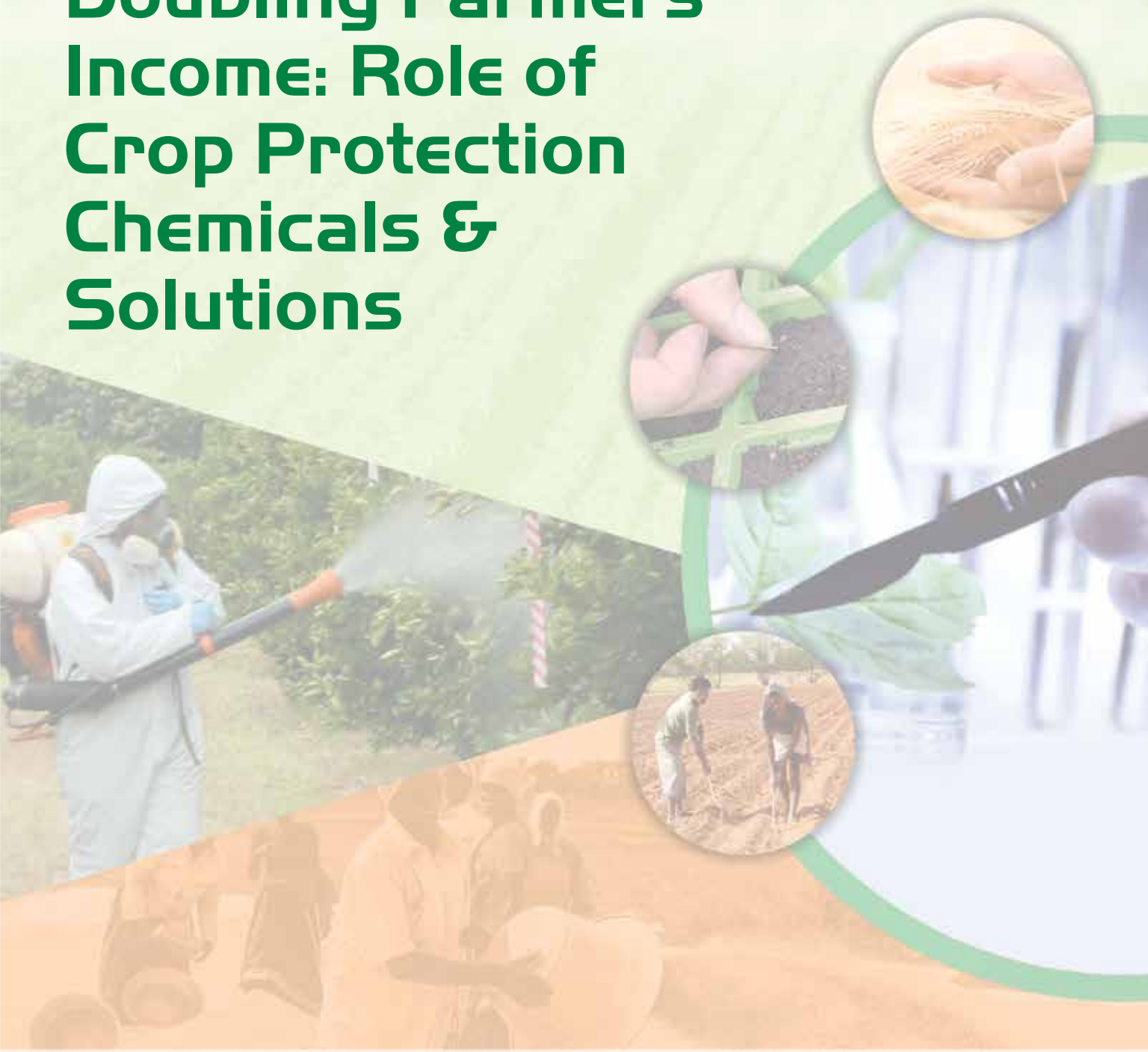
July 2018

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Doubling Farmers' Income: Role of Crop Protection Chemicals & Solutions



A report on

Indian Agrochemical Industry

July 2018

Mr.R G Agarwal

Chairman FICCI Sub Committee on Crop Protection Chemicals
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Message

As Chairman, FICCI Sub Committee on Crop Protection Chemicals, I'm thankful to the Department of Agriculture Cooperation & Farmers Welfare and the Department of Chemicals & Petrochemicals, Government of India for supporting and joining the 7th National Agrochemicals Conference on July 12, 2018.

The Crop Protection Chemicals & Solutions is a fast developing industry globally, which is open to innovation and are considered as the major tools to protect crops and increase the yields. The sector faces many challenges & solution to same can lead to India becoming a global manufacturing hub of Crop Protection Chemicals .This necessitates, the judicious use of crop protection chemicals within the confines of a regulatory framework of the country.

Indian farmers have an important role to play to ensure that Indian agriculture not only meets the needs of an exploding population of India, but also caters to the global need for nutrition thus ensuring environmentally safe "crop protection & crop health solutions". The 7th National Agrochemicals Conference 2018, which gives specials focus to Doubling the Farmers Income –Role of Crop Protection Chemicals & Solutions, will give a big boost to this important segment of Indian Industry.

I wish the event, all the success.

New Delhi
10th July,2018

R G Agarwal

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Message

Agriculture has the potential to bring all-round socio-economic development to the country. **The vision of Shri Narendra Modi, Hon'ble Prime Minister of India of Doubling Farmers' Income by 2022**, the Crop Protection Chemicals plays very major role. In fact their role in ensuring food and nutrition security of the nation is of paramount importance.

The Agrochemicals sector has huge unrealized potential for growth, given the presently very low level of application as compared to global norms. It is estimated that annual crop losses could double without the use of crop protection products, thus focusing correct and judicious use of Crop Protection Chemicals.

The need of the hour is to make our agricultural systems sustainable since there will not be any increase in agricultural land. I am sure the deliberations in the 7th National Conference on Agrochemicals 2018 will facilitate growth of this important segment of national economy.

I wish the conference all the success.

New Delhi
10th July,2018

Vinay Mathur

Vinay Mathur

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1. Preface



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This report provides an overview of Indian agriculture, highlights challenges faced by Indian agriculture and trends in farmers' incomes over the years and goes on to discuss the need and measures for doubling farmer's incomes by 2022. The report also offers insights into how use of crop protection solutions could be one of the ways to help achieve this target.

Farmers play a critical role in meeting the food requirements of a nation which has the second highest population in the world and is expected to surpass China sooner than later. If we can use technology and agricultural inputs in such a manner as to generate savings for the farmers it would result in a much higher rise in farmers' income, even more than the output itself.

One of the solutions to achieve this challenging task of doubling farmers' income is to help farmers cut down on crop losses especially occurring due to attacks by pests and diseases and improve productivity of their crops which will in turn help multiply their revenues.

To achieve higher yields, crop protection chemicals are expected to play a significant role. Simultaneously, it will also be critical to use them judiciously to maximize benefits and minimize the impact on non-targeted species. The report also highlights the importance of integrated pest management which is a targeted approach to pest management, and could play a critical play in improving farm productivity and in doubling farmers' incomes.

The report is a result of FICCI's objective to highlight the importance of Crop Protection Chemicals & Solutions in Doubling Farmers Income & business opportunities present in the sector. We are thankful to FICCI for providing us an opportunity to develop a report which can play a pivotal role in achieving this objective.

2

Executive summary



Agriculture is the backbone of the Indian economy, as it employs nearly half of India's workforce and contributes ~17% to the nation's GDP. The Green Revolution towards the beginning of 1970s had major economic effects in terms of the production and productivity. The Green Revolution led India from a food deficient country to a food surplus economy. It has not only helped increase exports of agricultural products but has also helped satisfy the demands of India's huge population.

Despite all its achievements, Indian agriculture is still grappling with challenges like high monsoon dependency, unpredictable weather patterns, reduction in arable land, low per hectare yield, increase in pest attacks, lower farmer incomes etc. Approximately 25% of the global crop output is lost due to attacks by pests, weeds and diseases and thus agrochemicals have an increasing role to play in enhancing crop productivity.

Even though India has doubled it's per hectare yield in the past decades it continues to be lower than the peer economies. Farmers in India continue to face challenges like lack of irrigation facilities, depleting water table levels, fragmentation of land, lack of scientific knowledge in farming, etc. However, one of the gravest problems faced by farmers is low level of income. The yearly average income earned by an Indian farmer is close to $ 1,800 as compared to USA's $ 119,880, UK's $ 50,365 and Japan's $5,000. There are several factors that have dented the farmer's income which includes small land holdings, lack of availability of irrigation facilities and over dependence on monsoon, low consumption of pesticides and scanty crop yield.

Farmers lose a significant part of their income as their crop and produce are attacked by pests and weeds. India's per hectare consumption of pesticides is significantly lower than countries with high yield. The per hectare consumption in India is 0.6 kg as compared to China's 17 kg, Japan's 12.5 kg, Germany's 3.7 kg, France's 3.7 kg and UK's 2.8 kg. Therefore, the crops get affected by pests at various stages in the farming value chain including pre-harvest and during harvest. As the productivity is directly hampered due to pests and weeds, it affects the income levels of farmers. It is essential to protect not only the crop but also the produce as on an average 25% of the yield is destroyed during storage and transportation.

Crop protection solutions play a vital role in two ways; protecting the crop and produce from pests and increasing the farm productivity. When judiciously applied, the damage of the crop is reduced and the output increases which directly impact the income generate per hectare. Hence, the crop protection industry will play a principal part in government's aspiration to double farmer's income by 2022.

After USA, Japan and China, India is the fourth largest producer of agrochemicals. It is valued at USD 4.1 billion and is expected to grow at 8.3% to reach USD 8.1 billion by FY25. Exports are expected to grow even faster at a rate of 8.6% and will contribute USD 4.2 billion by 2025. Insecticides dominate the Indian crop protection market and form almost 55% of the domestic crop protection chemicals market (~ USD 2.3 Bn). The major applications of pesticides in India are found in rice and cotton. Herbicides are, however, emerging as the fastest growing segment amongst the agrochemicals.

Integrated Pest Management (IPM) is one of the modern approaches to increase farmer income while protecting the environment. It provides a framework to undertake a step-by-step method in ensuring good crop health and higher productivity. IPM ensures reliable crop quality, decreased severity of pest infestations, reduced potential for problems of pest resistance or resurgence and increased consumer confidence leading to fair price of the yield.

Many organizations and start-ups in the agriculture domain are working towards addressing the issues faced by Indian agriculture. Government of India is proactively working towards addressing the unmet needs of the farmers across the Agri-value chain through multiple initiatives like National Agriculture Market (NAM), Soil Health card scheme, Paramparagat Krishi Vikas Yojana, National e-Governance Plan (NeGP), Pradhan Mantri Fasal Bima Yojana, etc.

3

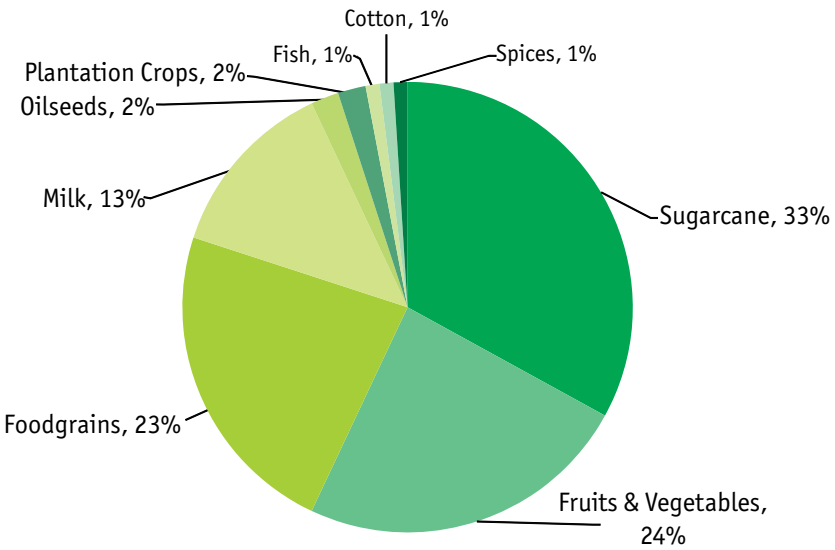
Introduction



Agriculture holds a prime importance in the socio-economic fabric of India. Agriculture and allied sectors remain the backbone of the Indian economy and account for ~17% of the country's GDP. India, with a second largest agricultural land in the world (157 Mn hectares), is also ranked 2nd globally in terms of agricultural output (USD 382 Bn) behind China (USD 1,005 Bn). Agriculture in India also employs more than 50% of India's working population.

Agricultural export constitutes 10 per cent of the country's exports and is the fourth-largest exported principal commodity. Agricultural exports from India reached US$ 28.09 billion during April 2017-January 2018 with exports of Basmati, Buffalo meat reaching US$ 6.19 billion and US$ 6.59 billion, respectively. India is also emerging as a global hub for exports of organic products. A split of major Agricultural produce in India (FY16) is provided in the graph below.

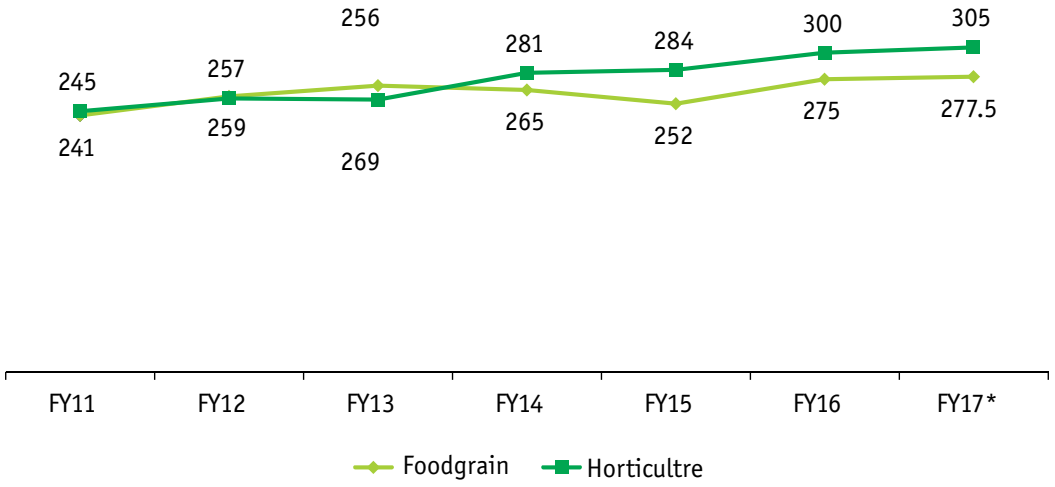
Figure 1: Structure of Indian Agriculture (FY16)



Source: IASRI, TATA Strategic Research

As India's diverse climate ensures production of all varieties of fresh fruits & vegetables, the trend has slowly shifted from production of food grains to horticulture, with production of horticulture consistently exceeding the production of food grains from FY13 to FY16 as more and more land came under irrigation (Ref: Figure 2). Of the total, fruits and vegetables together contribute to 91% of the total horticulture production in India.

Figure 2: Food grains and Horticulture trends in India (Mn of tons)

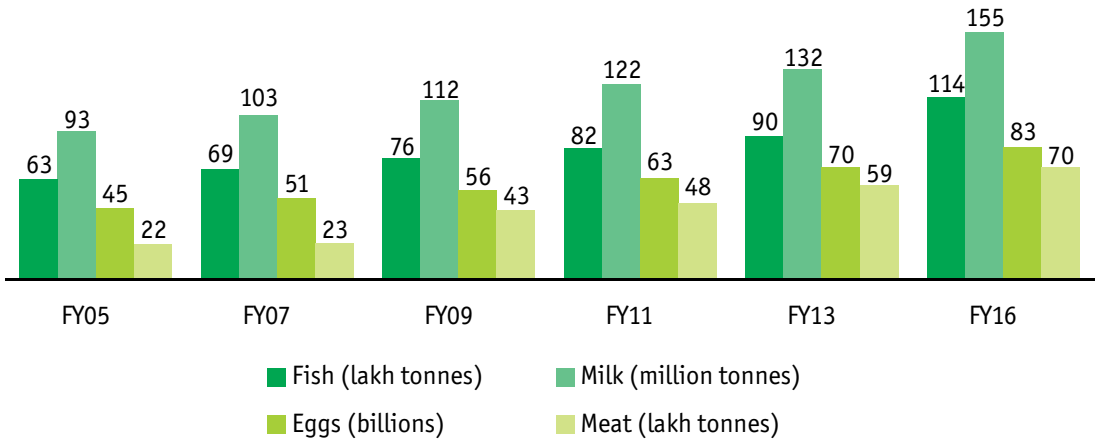


Source: ICAR, TATA Strategic Research

India is also among the leading exporters of agricultural products globally. The total agricultural exports from India have grown at 17% CAGR from USD 11.3 Bn in FY10 to USD 33.9 Bn in FY17. India has become a very important player on the global market, especially for rice, jute, cotton and sugar. In India, Uttar Pradesh, Tamil Nadu, Madhya Pradesh and Rajasthan lead in Fruits & Vegetables, Flowers, Aromatics & Medicinal crop and Spices production respectively. The major agricultural products exported from India include Rice, wheat, cotton, pulses, cereals, fruits and vegetables. India is also emerging as a global hub for exports of organic products.

In addition to horticulture, India has performed phenomenally well in fisheries production and livestock rearing too (refer fig.3). In the last five years, fish production has grown at healthy 6.2% per annum. Marine and freshwater catch fishing combined with aquaculture fish farming is a rapidly growing industry in India. Fish as food, both from fish farms and catch fisheries, offer India one of the easiest and fastest ways to address malnutrition and food security.

Figure 3: Fish, Milk, Eggs and Meat production India



Source: IASRI, Tata Strategic Research

Also, with our economy expected to become the 3rd largest economy in the world by 2030, accompanied by a rise in urbanization levels, there will be changes seen in the dietary patterns. With growing income levels, a large share of population below poverty line is expected to move out of it and spend more on food. This is expected to create a huge demand for Indian agriculture domestically.

Apart from increase in demand, the composition of the Indian food intake per thali is changing. Hence now we see less dependence on Cereals and more focus on Fruits & Vegetables, Milk and other forms of protein. This trend is expected to continue in the coming decades with growth of income levels and change in dietary patterns. This will create a diverse set of demand for Indian Agriculture. The estimated requirement of food grains in India in 2030 to meet the needs of an ever-increasing population is expected to reach 355 Million MT from the current 253 Million MT which necessitates a significant improvement in productivity.

4

Challenges faced by Indian Agriculture



In order to meet an increasing demand for Indian agriculture, there are certain challenges facing Indian agriculture which need to be tackled urgently

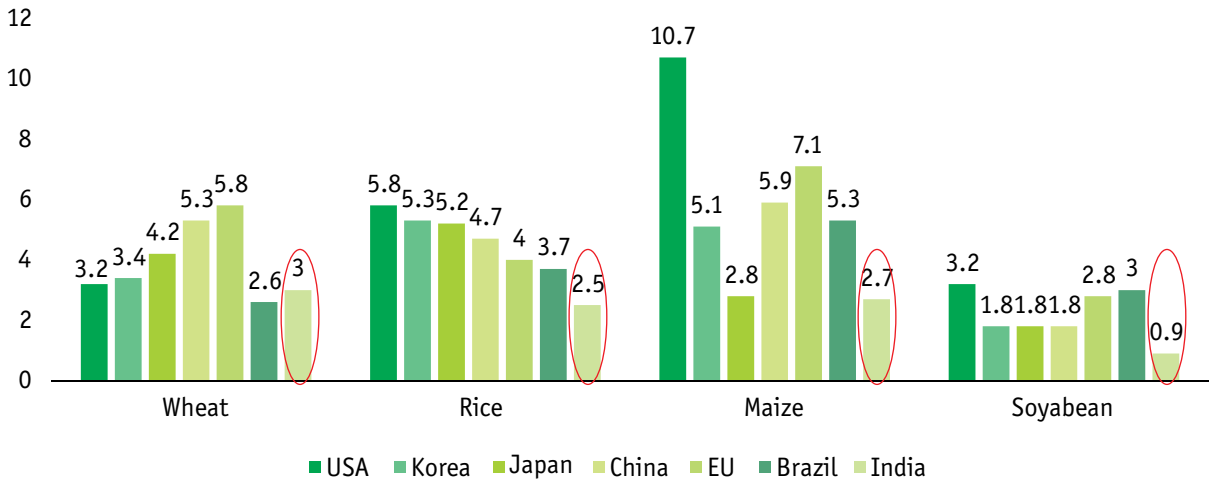
- **Reduction in arable land**

  The size of arable land in India has reduced by 62% from 0.34 hectares per person in 1951 to 0.13 hectares per person in 2011. There are two primary reasons to it; division of land among the newer generation and urbanization/industrialization.

- **Lower crop yields (Ref: Figure 3)**

  The following figure explains India's competence in yields of major crops as compared to major economies of the world:

Figure 4: Yields of major crops, 2017 (tons/hectare)



Source: OECD

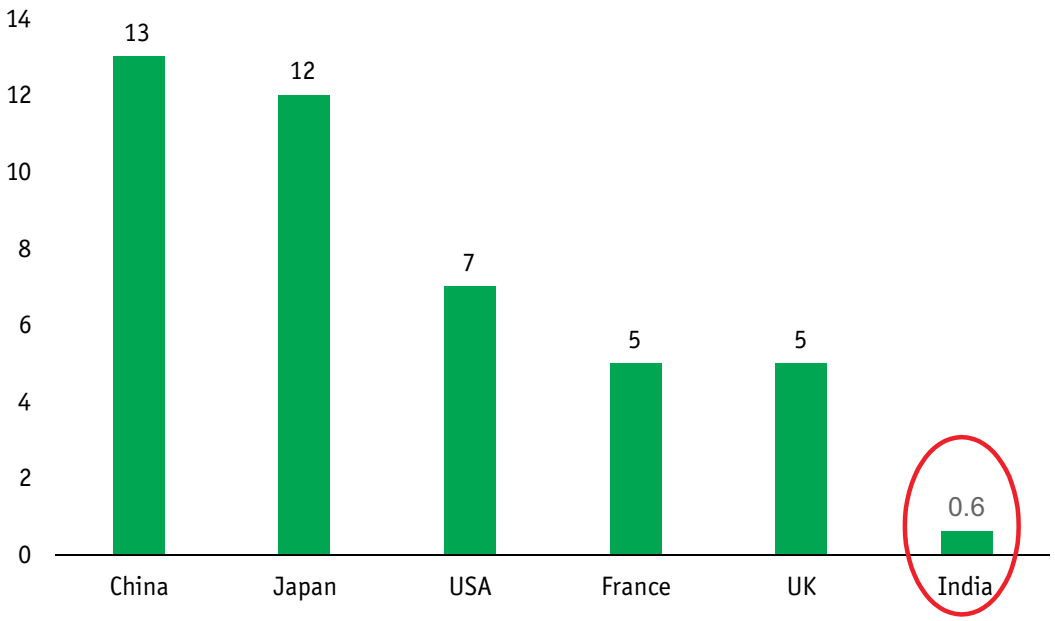
In three of the four major crops, India has significantly low yield mainly due to low quality seeds, improper usage of water and chemical fertilizer, lack of awareness of crop protection solution and degrading soil quality. Therefore, active participation of the public and private players with farmers is needed to educate them better about the role of crop protection chemicals.

- **Overdependence of monsoons and low irrigation coverage**

  About 46% of India's net sown area (land on which cultivation is done at least once a year) is irrigated. The balance 54% is un-irrigated and hence dependent on water that rains down from the clouds, mostly in the four monsoon months. The farmers owning this 54% land switch to utilizing groundwater to survive, depleting the groundwater table.

- **Low consumption of pesticides leading to increase in pest attack (Ref: Figure 4)**

Figure 5: Per capita consumption of pesticides (Kg/ha), 2016



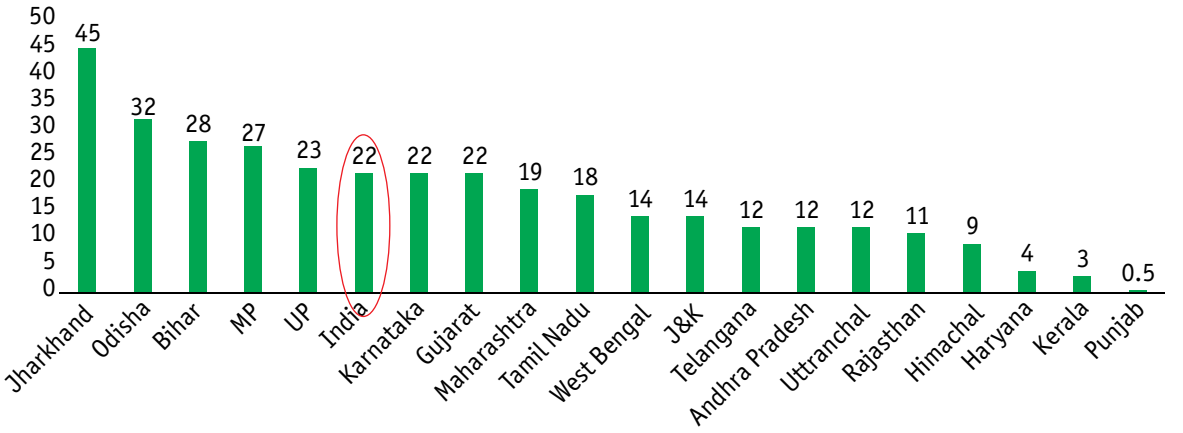
Source: TATA Strategic Estimates

One of the other reasons for lower productivity in India is the loss of crops caused by pest attacks. Every year in India pests and diseases eat away on an average 15-25% of food produced by the farmers. The increased damage to crops from pests and subsequent losses poses a serious threat to food security and further underscores the importance of agrochemicals. The most recent example is the large-scale whitefly infestation of Bt cotton crop in North India last year. Due to this, cotton area in Punjab & Haryana has declined by 27% to 7.56 lakh hectares in this year (FY 17 crop year) as farmers shifted to other crops after incurring huge losses owing to whitefly pest attack.

- **Low Farmers' income**

  The NSSO data on Consumption Expenditure Survey for year 2011-12 discloses that more than 20% of rural households with self-employment in agriculture as their principal occupation in India were having income less than the poverty line. The proportion of farm households suffering from poverty was quite high in some states (Fig 6). The highest incidence was observed in Jharkhand where 45.3 per cent of farm households were under poverty

Figure 6: Percentage of Farm Households Below Poverty Line



Source: NSSO & NITI Aayog

Small land holdings are the primary reason for low income. In India, over 65% of farm households have less than one hectare of land. Therefore, even if the farmer is producing crop at a higher productivity level, the overall income is low.

- **Spurious Crop Protection Chemicals**

  One of the key challenges faced by both farmers and agro-chemical industry is the presence of non-genuine / spurious pesticides. Such products not only pose danger to farmer's health but also have severe economic implications. Though available at a lower shelf price, the overall price paid by the farmer for these products in the entire season is more because of higher dosage requirement and more frequent application compared to a genuine product. The yield of the farm can reduce to more than half to nil. The farmer is oblivious to the reason of crop loss due to dependence of crops on environmental factors and vulnerability to human error. Since there no antidotes available, usage of non-genuine / spurious products can destroy the fields and harmful for users.

5

Need for doubling farmers income



Overview

Over the years, a lot of work has gone into increasing crop output and improve food security of the nation. This strategy mainly includes:

- Boost Crop productivity through better technology & increased use of quality seed, fertilizer and irrigation and crop-protection chemicals
- incentive structure in the form of remunerative prices of some crops and subsidies on farm inputs
- public investments in agriculture
- Building institutions

However, while India has achieved a lot in terms of agricultural output, farmers who are an integral and the most critical part of the entire agricultural value chain, continue to wallow in poverty. Realizing this need to pay special attention to the plight of farmers the Central government changed the name of the Ministry of Agriculture to Ministry of Agriculture and Farmers Welfare in 2015.

Although the government has undertaken various initiatives for the agriculture industry, it has focused very less on the income of farmer. It is essential that farmers' earnings from agriculture be relooked at in order to resolve the problems plaguing Indian agriculture and promote farmers welfare. The Government of India has also resolved to double farmers' income by 2022-23 to promote farmers' welfare, reduce agrarian distress and bring parity between income of farmers and those working in non-agricultural professions.

Farmer income trends

Based on estimates provided by Niti Aayog (Ref: Table X), which are updated to year 2015-16 and are presented at both nominal prices as well as in real terms. Farm income in real terms differs as compared

to the income at constant prices. During the past 22 years, between 1993-94 and 2015-16, farmers' income in nominal terms increased 9.18 times. Taking away the effect of inflation, real farm income has only doubled during past 22 years. The farm income per cultivator shows a slightly higher rise due to a in the number of cultivators post 2004-05.

Farm income has increased at different rates in different periods depending upon the growth rate in output, increase in wage bill, and changes in prices received by farmers relative to the changes in consumer price index for agricultural labour (CPIAL).

Figure 7: Trends in Farmers' incomes

Year	Total Farm Income of all Farmers (Rs. Crore)		Farm Income Per Cultivator (Rs.)	
	Market Price	Real Price	Current Price	Real Price
1993-94	177,954	303,814	12,365	21,110
1999-00	335,631	372,923	24,188	26,875
2004-05	434,160	434,160	26,146	26,146
2011-12	1,157,128	632,514	79,137	43,258
2012-13	1,312,730	596,695	91,416	41,553
2013-14	1,477,159	602,922	104,763	42,760
2014-15	1,558,223	597,020	112,507	43,106
2015-16	1,634,625	598,764	120,193	44,027

Source: Doubling Farmers' Income, NITI Aayog

The subsequent period till 2011-12 witnessed acceleration in total and per farmer income. Total income of all the farmers increased by 5.52% per year from 2004-05 to 2011-12. In a sharp contrast to the first decade of the reforms, the period 2004-05 to 2011-12 witnessed decline in the number of cultivators, which translated into much higher growth in per farmer income as compared to the growth rate in income of all farmers. The rate of growth was 7.46 per cent a year, which is a great step towards achieving goal of doubling farm income. The period 2004-05 to 2011-12 faced a very favorable combination of factors which constitute farm income. Growth rate in output was impressive, number of farmers to share farm income declined and prices received by farmers increased at a much higher rate than the increase in prices paid by rural consumers. Currently, the per cultivator income has been estimated at INR 1,20,193 at current market prices.

Broad level measures

Doubling real income of farmers till between FY16 and FY23 would require an annual growth of about 11% per cent in farmers' income. This implies that the on-going and previously achieved rate of growth in farm income has to be sharply accelerated. Therefore, strong measures will be needed to harness all possible sources of growth in farmers' income within as well as outside agriculture sector.

A quantitative framework for doubling farmer income has identified seven sources of growth. These are:

- increase in productivity of crops
- increase in production of livestock

- improvement in efficiency of input use (cost saving)
- increase in crop intensity
- diversification towards high value crops
- improved price realization by farmers
- shift of cultivators to non-farm jobs

There are two sources to increase in agricultural output viz. area and productivity. Due to rising demand for land for non-agricultural uses and already high share of arable land in total geographical area of the country, further expansion in area under cultivation is not feasible. Rather there is a decline of about 10 lakh hectares, as agricultural land has been diverted to non-agricultural uses since the year 2004-05. Therefore, agricultural output must be increased through improvement in productivity per unit of land.

Productivity of most of the crops in the country is low and there is considerable scope to raise it.

Except wheat, productivity of other crops in the country is below world average and much lower than agriculturally advance countries. Even, within the country there is large variation in yield across states. A large variation in yield across states is due to variation in access to irrigation but even for the states with similar irrigation coverage, productivity show significant variation.

Variation in productivity at same level of irrigation and lower yield in India compared to the world average are due to poor level or low adoption of improved technology. Enhancing access to irrigation and technological advancement are the most potent instruments to raise agricultural productivity and production in the country.

While there are several means of increasing productivity, viz irrigation, use of fertilizers, etc. One of the other ways of increasing crop productivity is through use of Crop-protection solutions. Crop protection solutions help cut down on crop losses because of pests & diseases that occur during multiple stages of crop growth, thus resulting in increased output and improvement in per hectare yield. The report further encapsulates the current status of Indian crop protection chemical industry, its growth drivers and how the Crop protection industry can improve productivity, and thus help in the Government's goal of doubling farmers' income.

6

Current status of India's Crop-protection Chemicals

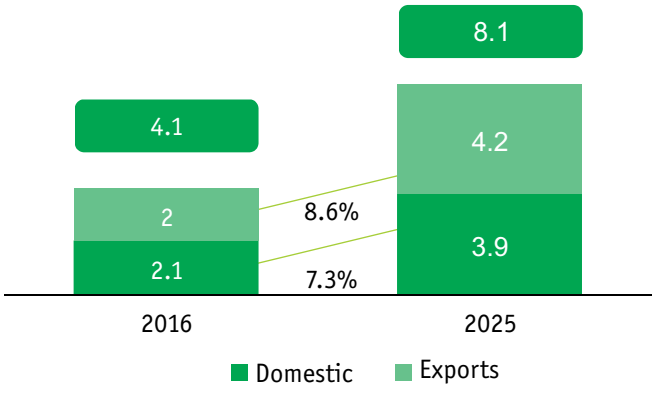


India is world's second largest nation with a population of 1.3 Bn which is approximately 18% of the Global population. The Global population is also expected to cross 9 billion by 2050. Rising population has led to a substantial increase in demand for food. To meet the food & nutrition needs of a growing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

The Indian Agrochemical industry is valued at USD 2.2 billion in FY16, having grown at a CAGR of around 3.5% from FY13 to FY16. It is further estimated to grow at a CAGR of 6.4% to reach USD 3.2 billion by FY22. Export market is expected to grow at 8.6%. India is the fourth largest producer of agrochemicals worldwide, after United States, Japan and China.

Crop protection chemicals also play a crucial role in India's exports generating a value of more than USD 2 Bn. India is the 4th largest global producer of agrochemicals after the US, Japan and China and has emerged as the 13th largest exporter of pesticides globally.

Figure 8: Indian Crop Protection Market

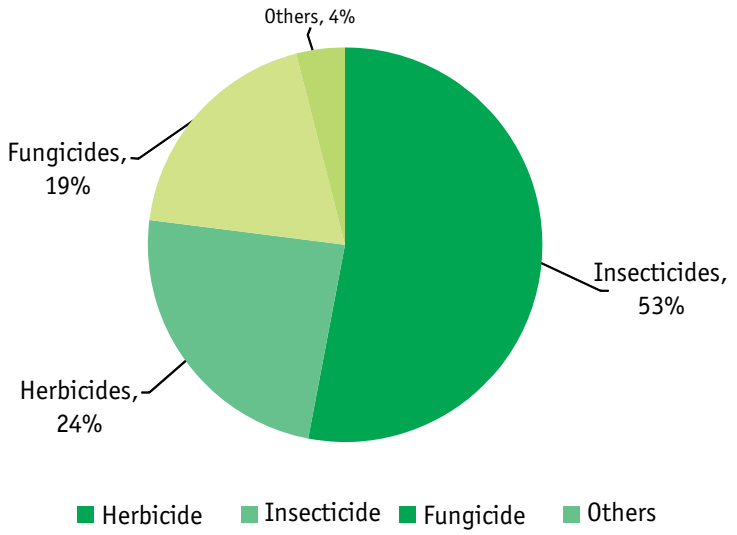


Source: TATA Strategic Research

Distribution of Agrochemicals by Product category

Insecticides dominate the Indian crop protection market and form almost 55% of the domestic crop protection chemicals market (~ USD 2.3 Bn). The major applications of pesticides in India are found in rice and cotton. Herbicides are, however, emerging as the fastest growing segment amongst the agrochemicals.

Figure 9: Domestic Market split by type of pesticides, FY16



Source: TATA Strategic Estimates

Proliferation of Spurious Crop Protection Chemicals and Companies

Over the years Indian Crop protection Industry has witnessed the proliferation of non-genuine / spurious pesticides. Illegal imports of technical grade chemicals having no C.I.B. and R.C. registration has led to the formulation of non-genuine / illegal pesticides locally. Apart from the counterfeit products of leading companies, a new practice has emerged by which counterfeiters are selling insecticides in the name of 'bio products' to avoid rigorous registration procedure. Market is filled with products having a low percentage of Active ingredients as compared to what they are registered for, hence are substandard and ineffective.

This indeed calls for a serious intervention from government and regulatory authorities to further arrest the proliferation of both non-genuine products and companies.

7

Opportunities & Key Growth Drivers for Indian Crop Protection Market



- **Export Opportunities:** In addition to exports to top 8 countries namely USA, Brazil, France, Japan, Australia, Belgium, China and Netherlands which contribute to ~50% of total agrochemical exports, manufacturers could also explore countries in South east Asia, Latin America and select countries in Middle East and Africa. For complete list of Indian agrochemicals exports by countries, please refer to the Annexure. Having a well-planned geographic expansion strategy in place could act as a key growth lever for Indian manufacturers and further help in increasing exports from India. The countries to focus on will depend on individual company's strengths, capabilities, and risk appetite.

- **Off Patent Molecules:** Between 2017 to 2022, patents of 26 pesticides (Ref: Figure 6) are expected to expire which includes 13 herbicides, 4 insecticides, 8 fungicides and 1 safener. This provides significant export opportunities for Indian companies and in addition to the existing products, Indian companies could focus on these products going forward.

Figure 10: List of Active ingredients going off-patent (2017-22)

Active Ingredient	Inventor company	Category
Aminopyralid	Dow Agrosciences	Herbicide
Amisulbrom	Nissan chemical industries	Fungicide
Chlorantriniliprole	DuPont	Insecticide
Cyrposulfamide	Bayer CropScience	Safener
Fenpyrazamine	Sumitomo chemical	Fungicide
Flubendiamide	Nihon Nohyaku	Insecticide
Flucetosulfuron	LG Chem investment	Herbicide
Fluopicolide	Bayer CropScience	Fungicide
Isotianil	Bayer CropScience	Fungicide
Mandipropamid	Syngenta	Fungicide
Metamifop	Dongbu Hannong chemicals	Herbicide

Active Ingredient	Inventor company	Category
Metofluthrin	Sumitomo chemical	Insecticide
Metrafenone	BASF	Fungicide
Orthosulfamuron	Isagro	Herbicide
Penflufen	Bayer CropScience	Fungicide
Pinoxaden	Syngenta	Herbicide
Pyrasulfotole	Bayer CropScience	Herbicide
Pyrifluquinazon	Nihon Nohyaku	Insecticide
Pyrimsulfan	Ihara Chemical Industry	Herbicide
Pyroxasulfone	Kumiai Chemical Industry	Herbicide
Pyroxsulam	Dow AgroSciences	Herbicide
Saflufenacil	BASF	Herbicide
Tembotrione	Bayer CropScience	Herbicide
Thiencarbazone	Bayer CropScience	Herbicide
Topramezone	BASF	Herbicide
Valifenalate	Isagro	Fungicide

Source: Agropages website

- **Growth in herbicides and fungicides:** The growth in exports of herbicides, on the other hand, has been remarkable with an increase of 31% in FY16 over FY14 and that of fungicides at 18% from FY14 to FY16.

The other major growth drivers for agrochemicals are-

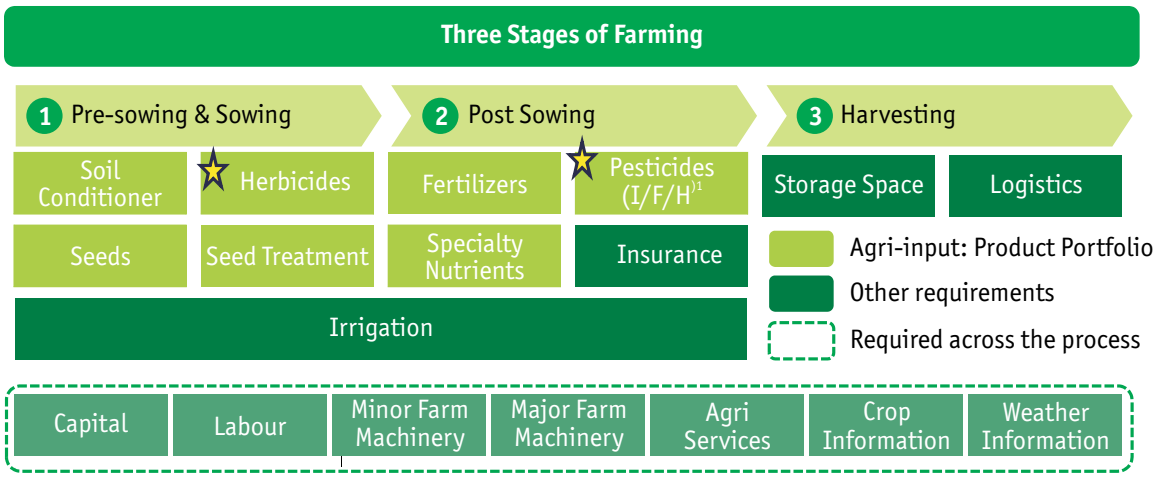
- Formation of Farmer Producer Organizations (FPOs) to counter the difficulties faced due to land fragmentation.
- Availability and dissemination of appropriate technologies that depend on quality of research and extent of skill development.
- Plan expenditure on agriculture and in infrastructure which together with policy must aim to improve functioning of markets and more efficient use of natural resources.
- Governance in terms of institutions that make possible better delivery of services like credit, animal health and of quality inputs like seeds, fertilizers, pesticides and farm machinery.

8

Increasing farmer income: Role of Crop Protection Solutions



Figure 11: Stages of Farming



Source: TSMG research

Note: ★ Application of Crop Protection Chemicals

Crop protection chemicals are used during both the pre-sowing & sowing, post sowing stages of farming. To multiply their savings, it is essential that farmers use crop protection chemicals judiciously across both these steps. Use of crop-protection chemicals across the value chain can increase the overall yield of crops, not only resulting in rise in incomes for the farmers but also boosting their profitability with significant cut-down in crop losses.

The importance of crop protection solutions for is enormous because they are considered as one of the major tools to protect crops and increase the yield. The crop protection products sector is a fast developing industry globally, which is open to innovation. The opportunity lies in developing and

executing innovative farming solutions that address the needs of the Indian farmer with very low landholding size, resources and knowhow available to him. This necessitates the use of pesticides or crop protection chemicals in a judicious manner within the confines of a regulatory framework of the country

Crop protection products are designed to protect crops from insects, diseases and weeds. They do so by controlling pests that infect, consume or damage crops. Uncontrolled pests significantly reduce the quantity and quality of food production. It is estimated that annual crop losses could double without the use of crop protection products. Food crops must compete with 30,000 species of weeds, 3,000 species of nematodes and 10,000 species of plant-eating insects. We know that despite the use of modern crop protection products 20-40% of potential food production is still lost every year to pests. These losses can occur while the crop is growing in the field when it is in storage and in the home. In short, an adequate, reliable food supply cannot be guaranteed without the use of crop protection products.

Modern chemical crop protection products have unique modes of action, based on the latest advances in science, and are designed to target noxious pests and weeds with minimal or no adverse effects to human health or non-target species.

A further benefit of crop protection is that it enables as little land as possible to be used to produce the food we need. This is hugely important from a climate perspective as bringing new land into agricultural production produces large quantities of greenhouse gases such as CO2 and nitrous oxide and allows more land to be available for environmental and amenity use.

Integrated Pest Management

To increase crop yields, continuous improvement of agricultural technologies is required to minimize crop losses. The challenge is to do it while protecting the environment.

IPM is a big part of the solution. Increasingly it is being adopted in both developed and developing countries for long-term, sustainable agriculture that achieves adequate, safe and quality food production, improves farmer livelihoods and conserves non-renewable energy.

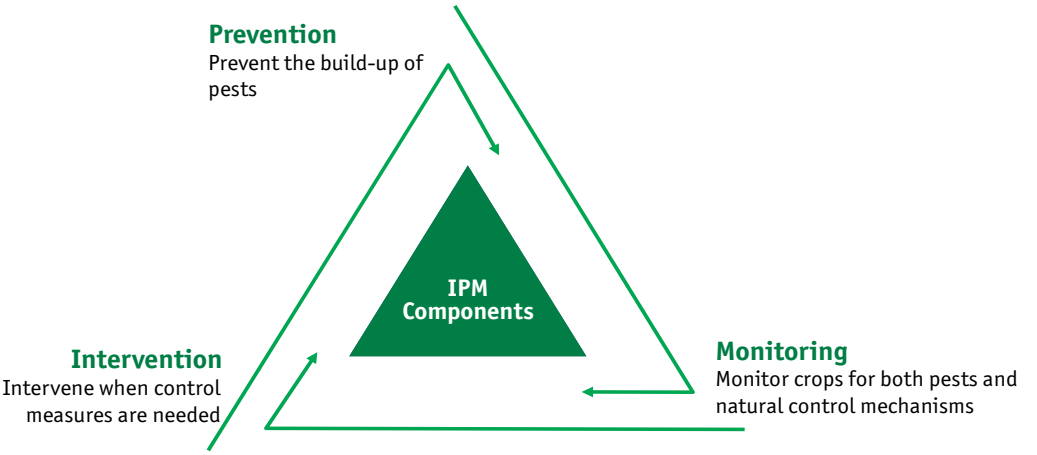
Benefits of Integrated Pest Management

- Improved crop profitability owing to better pest control measures & appropriate use of crop protection solutions
- Stable, reliable and good quality crop yields
- Fall in intensity of pest infestations
- Reduced potential for problems of pest resistance or resurgence

Decreased resistance of pests to crop protection products and GM crops

IPM Components

Figure 12: IPM Components



Source: TATA Strategic research

Prevention

Several crop management features are designed to prevent outbreak of insects, diseases or weeds. Multiple strategies (outlined below) can be combined and optimized for an IPM program. The goal is to prevent pest populations from building up to economically damaging levels.

- **Location for Crops**

  Growing crops in locations where they are best suited to climate, soil and topography provides them with optimal conditions from the start. Appropriate land preparation builds on these conditions.

- **Selection of Crop variety**

  Choosing beneficial crop varieties, like those with disease and pest resistance, is the main feature of IPM. These varieties can be derived from traditional cross-breeding or modern biotechnology: pest-resistant and herbicide-tolerant varieties, for example, may reduce the need for other crop protection measures. GM crops can also facilitate reduced or no-till practices, thus maintaining soil health and preventing erosion.

- **Crop Planting & Rotation**

  Planting similar crops alongside each other can substantially increase pests and should be avoided if possible. Traditionally, some farmers sow different crops in alternate rows or under sow a crop like maize with a legume such as cowpea to help improve soil fertility and reduce weeds. Such systems can help reduce pests.

- **Soil Management**

  Mechanical, physical and cultural crop protection methods prevent or minimize pests as well as reduce their build-up and carryover from one crop to another.

- **Water management**

  Supplying water to crops is essential to plant health but it can greatly influence pest incidence and impact. Irrigation may be required, especially in dry areas or with crops that require a lot of moisture.

  But while flood irrigating some crops, such as lowland rice, can control weeds, it is wasteful of water and can adversely affect beneficial soil organisms. Methods to combat these risks and conserve water include drip irrigation or growing crops on ridges or raised beds.

Monitoring

Management of any crop requires routine inspections to assess how well plants are growing and what actions need to be taken from seeding to harvest. Walking through a field involves scouting for pests and distinguishing them from non-pests and beneficial insects. Tools like pheromone traps, diagnostics and forecasting systems can assist with such monitoring in a timely and accurate way. IPM often requires collaborative decisions within a specific geography to provide effective control of pests. Some of these decisions need to be taken by national governments in relation to quarantine regulations and legislation, provision and training of advisory services and strategies for control of highly mobile pests like locusts. Geographic information systems and remote-sensing techniques can also assist in area-wide management.

Intervention

Reducing economically damaging pests to acceptable levels may involve cultural, physical, biological and chemical control measures individually or in combination. Costs, benefits, timing, labor force and equipment as well as economic, environmental and social impacts all must be taken into consideration.

- **Cultural and physical methods**

  These techniques, such as weed control by tractor cultivation or disease control by removing infected plant debris, should be assessed for their impact on plant roots and yields as well as their requirements for labor and energy Also, the possibility of integrating cultural techniques with the careful use of crop protection products should be explored.

  For example, instead of replacing manual weeding entirely with herbicides, hoeing may be used in conjunction with them.

- **Biological control**

  Research on nature's own methods of pest control is yielding new products and methods that can be used in IPM programs. Many of these require similar technical expertise as crop protection products in relation to formulation, field application and resistance management. Research on nature's own methods of pest control is yielding new products and methods that

can be used in IPM programs. Using beneficial insects to control pests works best when crops are grown in controlled environments like greenhouses and plastic tunnels. There are cases when control techniques with living organisms are successful in open field conditions, such as using predatory mites against spider mites.

However, biological control products are usually only efficient at low pest intensities and other interventions are often required.

Bacteria, fungi, nematodes or viruses have also been mass produced to control some pests. The most common and successful is Bacillus thuringiensis (Bt), a naturally occurring bacterium, which has been used to control several important pests (e.g., caterpillar pests in vegetables, vineyards and orchards). With modern biotechnology, crops like corn and cotton can now express the insect toxin produced by this natural control agent, delivering it more effectively.

Finally, the development and availability of insect sex pheromones and other behavior-modifying chemicals offer farmers the possibility of:

- Selective trapping techniques to monitor the movement of pests or changes in their populations during the season
- "Lure and kill" strategies to attract the pest to insecticide deposits and reduce the need for overall crop spraying
- Mating disruption that slows population build-up to delay or reduce the need for control treatments

Biotechnology also has considerable potential to contribute to IPM. One focus of research has been on mass production of micro-organisms that cause disease in insect pests and weeds or compete with plant disease-causing organisms. The second and most rapidly expanding area of biotechnology for pest control has been the development of crop varieties resistant to pests and diseases and/or tolerant to herbicides. These varieties incorporate insect or disease resistance within the plant for accurate and timely delivery of an active ingredient.

- **Chemical control**

Chemical crop protection products (pesticides) are biologically active chemicals that control a range of insect and vertebrate pests, diseases and weeds. They are often the most cost-effective way of controlling infestations as part of an IPM strategy. Today's crop protection products are the result of more than 50 years of research, development and field experience around the world by the plant science industry.

Before crop protection products are released in the market, they are thoroughly tested for their safety, usefulness and effectiveness. When sold, they are labeled with explicit use instructions.

To get the most out of these products, they must be applied correctly. Responsible use and good handling practices limit potential pesticide residues in crops and the environment as well as help avoid pest resurgence and resistance.

Improved application techniques and equipment, such as reduced drift nozzles and spot spraying, help farmers protect untreated refuges (e.g., hedgerows and field margins) and natural habitats for wildlife and pest enemies. The timing of treatment (season and time of day) as well as the types of products used is also critical factors.

In a nutshell, application of an Integrated Pest Management program offers following long-term benefits:

- ✓ A reduced amount of broad-spectrum pesticide used in the environment
- ✓ A reduced chance of pests developing resistance towards a specific pesticide
- ✓ A reduced health risk to humans
- ✓ A reduced health risk to pests and organisms that are not the target
- ✓ Less harmful to the environment

9

Government of India initiatives



GoI has taken several measures and identified seven key areas of farmer's income. It includes increasing crop and livestock productivity, increase in crop intensity, diversification towards high value crops, etc. Along with several key areas, the government has launched various schemes to create measurable impact on a mass level. The achievements of some of the major schemes have been listed below:

1. Pradhan Mantri Fasal Bima Yojana:

About 309 lakh farmers of 23 states had been covered under Fasal Beema during previous Kharif Season 2015 in which 294 lakh farmers were lonee and 15 lakh farmers were non-lonee. During Kharif 2016, however, 366.64 lakh farmers have been covered out of which 264.04 lakh farmers are lonee and 102.60 lakh farmers are non-lonee. Pradhan Mantri Fasal Beema Yojana has been implemented by 21 states during Kharif 2016.

2. Soil Health Card Scheme:

As on 27.12.2016, against a target of 2.53 crore soil samples collection up to March 2017, 2.33 crore soil samples have been collected till 27.12.2016, from which 12.82 crore soil health cards are being made. Out of these, 4.31 crore soil health cards have been printed and 4.25 crore soil health cards have been distributed to the farmers and remaining is under process. During 2016-17, 0.20 crore samples are to be collected from which 1.10 crore soil heath cards will be prepared. During 2014-17, 460 Soil Testing Laboratories have been sanctioned while during 2013-14 only 15 Soil Testing Laboratories were sanctioned. In addition to 460 Soil Testing Labs, 4000 mini labs have also been sanctioned to the States.

3. National Agriculture Market (NAM):

Under this scheme, 250 mandis of 10 states have been integrated with e-NAM Portal. In principal approval has been to integrate 399 mandis with e NAM for which an amount of Rs. 93 crores have been

released. As on 27.12.2016, 35,04,371.13 tons of agriculture produce worth Rs. 7,131.21 crores have been transacted on e-NAM platform. As on 27.12.2016, 9,49,112 Farmers, 59,742 Traders and 31,317 Commission Agents have been registered on the e-NAM platform.

The biggest market reform relates to APMC Act. This include institutional reforms (Table 6.3, 1.1 to 1.7), special treatment to fruits and vegetables and application and use of IT and e-commerce in agricultural marketing at the first point.

Figure 13: List of various types of reforms in agriculture sector

1	**Institutional reforms: make provisions for 1.1 to 1.7**	
	1.1	Private mandi
	1.2	Direct marketing
	1.3	Contract farming
	1.4	e-Trading
	1.5	Single point levy
	1.6	Direct sale to consumers by farmers
	1.7	Single traders license
2	Special treatment to fruits and vegetables: Denotify from APMC	
3	Participation in E-NAM	

Source: NITI Aayog

4. Neem Coated Urea:

Within a year, Modi Government has made available 100% neem coated area in the country. Due to this diversion of unauthorized use of urea by Chemical Factories has been stopped. Now farmers are getting urea in adequate quantity. Besides this, the cost of production is being reduced by 10-15% with the use of neem coated urea. Productivity will also increase with the use of Neem Coated Urea.

5. Farmer First:

The Farmer FIRST aims at enriching Farmers –Scientist interface, technology assemblage, application and feedback, partnership and institutional building and content mobilization. It will provide a platform to farmers and scientists for creating linkages, capacity building, technology adaptation and application, on-site input management, feedback and institution building. The scientists from 100 ICAR Institutes/ Universities are proposed to work with one lakh farmers directly.

6. Government Initiatives for IPM

Department of Agriculture, Co-Operation & Farmers Welfare (DAC&FW) emphasizes Integrated Pest Management (IPM) which promotes biological, cultural and mechanical methods of pest and advocates need based, judicious use of pesticides. DAC&FW implement a scheme "Strengthening and Modernization of Pest Management Approach in India" to promote Integrated Pest Management (IPM) which is an environment friendly broad ecological approach for managing pest problems. It encompasses pest control techniques such as cultural, mechanical and biological with minimum dependence on chemical pesticides.

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Way forward



Indian farmers have a critical role to play to ensure that Indian agriculture not only meets the needs of an exploding population in India, but also caters to the global need for nutrition. However, much needs to be done to empower farmers, and one of the ways of empowering them is to turn the poverty-ridden farmers into self-sufficient ones.

Figure 14: Key Imperatives for Government, Farmers and Industry

Key Imperatives for Government

- Investment in irrigation infrastructure as 54% of land under cultivation is still dependent on rainwater.
- Linking farmers with e-NAM and other such digital platforms to ensure better prices for output and prevent farmer exploitation.
- To pass the pesticide management bill 2017 and strictly enforce regulations for manufacturing, inspection, testing and distribution of pesticides and also establish system of licensing.
- Government can formulate single anti-counterfeiting committee / body to arrest the spread of non-genuine pesticides.
- Micro loans for farmers to invest in pesticides, fertilizers, seeds and other focus areas like poultry and animal husbandry which serve as alternative sources of income .

Key Imperatives for Farmers

- Scientific usage of pesticides viz. implementation of IPM to ensure efficient crop protection.
- Using new varieties of crop with better resistance to diseases and better productivity.
- Implement technology based solutions to reduce labor at farms & utilize mobile applications for knowing market prices, weather conditions, fertilizer and pesticide information, etc.
- Effective use of water resources to increase and maintain soil nutrients for greater crop productivity.

Key Imperatives for Government

- Producing high quality crop protection chemicals to avoid harmful effects on crop by reducing their residual content.
- Educating farmers to distinguishing between certified and spurious crop protection chemicals available in the market.

Source: TATA Strategic research

Rising farmers' income will help them in more ways than one:

- Farmers will no longer need to lead a hand-to-mouth existence, and can also spend on their families and children's education
- They will no longer be exploited by the loan sharks as they can use their savings for day-to-day existence
- Farmers' propensity to spend on critical agricultural inputs like fertilizers and pesticides for their crops will increase
- Doubling of farmers' income would curb the continual decline in number of cultivators which is evident in Indian agricultural for the last few decades
- It will also make mechanization and technology affordable to farmers, which will also help Indian agriculture in the long term
- A rise in incomes would offer farmers an incentive to increase the land under agriculture and enable crop rotation

The benefits of empowering farmers by multiplying their incomes are thus multifold and continuous efforts in that direction need to be taken if we are to meet the food requirements of a burgeoning population in future.

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Annexure



Figure 15: Country-wise Import Trend

Country	Value (INR Cr, FY15)	% of Total (FY 15)	Value (INR Cr, FY16)	% of Total (FY 16)	Value (INR Cr, FY17)	% of Total (FY 17)
CHINA P RP	2,500	42.3%	2,158	39.6%	3,388	48.5%
U S A	912	15.4%	782	14.3%	848	12.1%
GERMANY	461	7.8%	602	11.0%	793	11.3%
JAPAN	509	8.6%	564	10.3%	515	7.4%
ISRAEL	298	5.0%	412	7.6%	374	5.4%
SWITZERLAND	154	2.6%	191	3.5%	262	3.7%
U K	154	2.6%	131	2.4%	208	3.0%
KOREA RP	40	0.7%	69	1.3%	136	1.9%
TAIWAN	155	2.6%	88	1.6%	98	1.4%
THAILAND	76	1.3%	83	1.5%	77	1.1%
OTHERS	649	11%	368	6.8%	290	4.2%
TOTAL	5,908	100%	5,447	100%	6,988	100%

Source: DGFT

Note: Values are sorted in descending order for the year 2017

Figure 16: Country Wise Export Trends

Country	Value (INR Cr, FY15)	% of Total (FY 15)	Value (INR Cr, FY16)	% of Total (FY 16)	Value (INR Cr, FY17)	% of Total (FY 17)
U S A	1,937	16.4%	2,202	17.2%	2,457	17.2%
BRAZIL	1,747	14.8%	1,680	13.1%	2,437	17.1%
JAPAN	330	2.8%	493	3.8%	702	4.9%
FRANCE	606	5.1%	579	4.5%	525	3.7%
BELGIUM	471	4.0%	433	3.4%	418	2.9%
CHINA P RP	285	2.4%	393	3.1%	390	2.7%
AUSTRALIA	261	2.2%	433	3.4%	375	2.6%
BANGLADESH	287	2.4%	325	2.5%	374	2.6%
VIETNAM	236	2.0%	315	2.5%	353	2.5%
INDONESIA	279	2.4%	287	2.2%	341	2.4%
NETHERLAND	343	2.9%	389	3.0%	323	2.3%
THAILAND	223	1.9%	244	1.9%	274	1.9%
PUERTO RICO	120	1.0%	214	1.7%	265	1.9%
COLOMBIA	182	1.5%	229	1.8%	251	1.8%
GERMANY	403	3.4%	355	2.8%	233	1.6%
MEXICO	177	1.5%	200	1.6%	230	1.6%
IRAN	213	1.8%	140	1.1%	222	1.6%
SOUTH AFRICA	167	1.4%	212	1.7%	207	1.5%
ISRAEL	193	1.6%	224	1.7%	200	1.4%
ARGENTINA	143	1.2%	196	1.5%	199	1.4%
ITALY	159	1.3%	167	1.3%	187	1.3%
TURKEY	122	1.0%	126	1.0%	180	1.3%
SINGAPORE	210	1.8%	213	1.7%	154	1.1%
NIGERIA	142	1.2%	91	0.7%	143	1.0%
U K	292	2.5%	175	1.4%	143	1.0%
OTHERS	2,289	19.4%	2,514	19.6%	269	18.8%
TOTAL	11,821	100%	12,832	100%	14,271	100%

Source: DGFT

Note: Values are sorted in descending order for the year 2017

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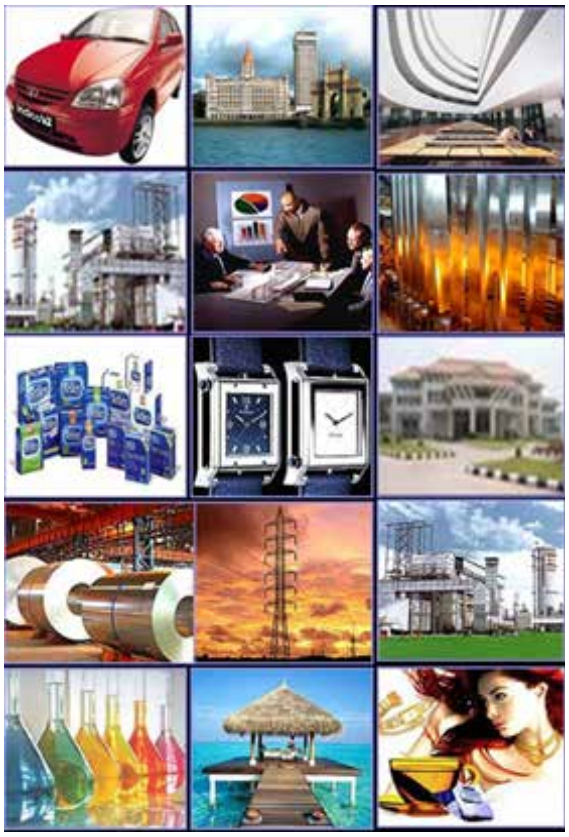
About Tata Strategic



Founded in 1991 as a division of Tata Industries Ltd, Tata Strategic Management Group is the largest Indian own management consulting firm. 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.

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- Lead Time

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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.

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Notes



Industry's Voice for Policy Change