Knowledge Paper on
Potential of Plastic Industry in Northern India
with focus to Plasticulture & Packaging
April, 2017
National Conference on
Potential of Plastic Industry in
NORTHERN INDIA
with focus to
‘PLASTICULTURE AND PACKAGING’

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Northern India has huge unrealized potential of consumption as also manufacture for the Plastics industry given the presently very low levels of consumption compared to the global levels.

I am sure, deliberations at this conference will bring out good results. I wish all the success to this conference.

Vinay Mathur
Message

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I am sure this conference will debate all these issues and I wish it all the success.

PRABH DAS
Chairman-FICCI National Petrochemicals Committee
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This report provides an overview of the Indian plastic industry, its past growth, challenges faced, emerging applications and its future growth prospects. The focus of the report is on agriculture (Plasticulture) and Packaging plastic applications. It also highlights the role northern states of India are expected to play as the demand for plastics is expected to double by 2020.

The Indian Plastic Industry gained momentum in the early 1990’s. Further impetus was added with investments in raw material production from mid 1990’s onwards, which fueled investments in plastic processing industry as well as downstream machinery sector.

In the last decade, a number of emerging applications of plastics have been developed in many industries, such as Automotive, Packaging, Agriculture and Infrastructure, which have positively impacted the day to day lives of the people. The industry has produced better and improved quality of plastics with the help of new technologies, especially in the packaging industry, leading to replacement of several materials such as wood, metals and glass. Agriculture is not far behind with plastics being extensively considered for a variety of applications. However, the per capita consumption of plastics is still very low as against other major economies which highlights that there is tremendous scope for growth in coming years.

Despite the fact that North India plays an important role in meeting the agricultural needs of the country, the penetration of plastics in agriculture has been lower, but expected to grow at a much faster pace as it seeks measures to save its depleting groundwater reserves, improve productivity and achieve better post-harvest security of food grains. North India is also home to a large number of industry clusters. As industries continue to grow and consumption further goes up in this region, North India will be one of the key drivers of plastics going forward.
The Indian Plastic industry has made significant contributions to the growth and development of various key sectors in the country such as: Automotive, Construction, Electronics, Healthcare, Textiles, FMCG, and Agriculture etc. It has expanded at 8% CAGR over the last four years to reach 12.1 MnTPA in FY16. The lower growth rate of 8%, which has been below expectations, is mainly attributed to economic slowdown and a depreciating rupee.

India observes significant regional diversity in consumption of plastics with Western India accounting for 47%, Northern India for 23%, South India 21%, and the eastern part of the country making up for the remaining 9% Majority of plastic consumption in North India can be contributed to end use industries like Automobiles, packaging (including bulk packaging), plasticulture applications, electronic appliances etc. which are concentrated mostly in UP Delhi-NCR, Himachal Pradesh (>50%). However, plastic processing in other parts like Rajasthan, Punjab, Haryana, Uttarakhand, and J&K are also expected to grow in the coming years, based on increased availability of feedstock and higher focus on manufacturing.

While the Packaging industry in India has witnessed strong penetration of plastics comparable to global standards, the agriculture sector, unfortunately, has not been able to explore their potential to the fullest. Global average for plastics demand in agriculture is 8% while in case of India, it is substantially lower at only 2%, thereby
leaving a lot of room for growth. The Government and industry need to work in tandem to help promote use of plastics in Indian Agriculture

Commodity plastics are being majorly used in India currently. However, going forward, growth in Demand for Engineering plastics (14%) is expected to exceed that of commodity plastics (9.6%).

North India offers good opportunities for the plastic industry in both plasticulture & packaging applications. As North India, along with other parts of the country, looks to overcome high dependence on monsoon and depleting ground water reserves, it will need to adopt plasticulture with both hands. Also, with increasing incomes, shifts in eating habits, shift towards online retailing and preferences for better packaging, demand for plastics in packaging is also expected to increase in North India. Significant capacity additions in commodity plastics have taken place in the Northern and north eastern parts of the country, which will ensure that regional demand is adequately met.

However, at the same time Indian Plastic industry continues to face challenges like disposal of waste plastics, dated technology and irrational customs duties. Disposal of waste plastics is a major problem in India, considering that of the 15,000 MT of plastic wastes that gets generated in India every day about 6,000 MT remains littered and uncollected. The Government and recycling industry both have an important role to play in tackling these challenges, as the plastics industry seeks sustainable solutions. Going ahead, recycling & reuse of plastics could be a foremost step towards fostering innovation and sustainability. While the industry needs to spend more on Research and Development and technological innovations to ensure recycling & reuse of wastes, the government should incentivize manufacturers focusing on waste reduction.

The demand for plastics in India is expected to grow by 10% over the next 5 years, and is likely to reach 19.5 MMTPA by FY21. Agriculture and Packaging industry are expected to lead the way with their huge growth potential.
Since independence, the plastic industry in India has been playing a predominant role in shaping our lives. The plastic industry in India has made significant achievements since its beginning by commencing production of polystyrene in 1957. In the last decade, with the advent of new and improved products, the industry has gained greater importance with the production of better and improved quality of plastic products.

As described in Figure 1, the entire chain in the Plastic industry can be classified into:

(A) Upstream sector: Manufacturing of polymers and

(B) Downstream sector: Conversion of polymers into plastic articles

**Figure 1: Plastics industry in India**

Source: Secondary Research
The upstream polymer manufacturers have commissioned globally competitive size plants with imported state-of-art technology from the world leaders. The upstream petrochemical industries have also witnessed consolidation to remain globally competitive.

The downstream plastic processing industry is highly fragmented and consists of micro, small and medium units. There are over 30,000 registered plastic processing units of which about 75% are in the small-scale sector. The small-scale sector, however, accounts for only about 25% of polymer consumption. The industry also consumes recycled plastic, which constitutes about 30% of total consumption.

The plastic industry is a major driver for India’s petrochemicals industry. Since plastic products permeate the entire spectrum of daily use items and cover almost every sphere of life like clothing, housing, construction, furniture, automobiles, household items, agriculture, horticulture, irrigation, packaging, medical appliances, electronics and electrical etc., the current low per capita consumption level of plastic products in India as compared to developed countries (Refer Figure 2) indicates that India has not yet realized it full potential and, therefore, offers a huge opportunity over the long term.

![Figure 2: Plastic consumption (per capita)](image)

<table>
<thead>
<tr>
<th>Country</th>
<th>Per capita plastics consumption (Kg/person, 2016)</th>
</tr>
</thead>
<tbody>
<tr>
<td>US</td>
<td>109</td>
</tr>
<tr>
<td>Europe</td>
<td>65</td>
</tr>
<tr>
<td>China</td>
<td>45</td>
</tr>
<tr>
<td>Brazil</td>
<td>35</td>
</tr>
<tr>
<td>India</td>
<td>12</td>
</tr>
<tr>
<td>World avg</td>
<td>27</td>
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Note: Per capita consumption for India is based on the assumption that 25% of plastics is recycled
Source: TATA Strategic Research

Packaging industry in India has seen a strong penetration of plastics as compared to global standards. However, agriculture sector still hasn’t explored the benefits of plastics to a large extent. Global average for plastics demand in agriculture is 8% while India is substantially lower at only 2%. However, significant investments planned in sectors such as water & sanitation management, irrigation, power, transport etc. will result in India becoming a hub for plastics production in future.
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<td>45</td>
</tr>
<tr>
<td>Brazil</td>
<td>35</td>
</tr>
<tr>
<td>India</td>
<td>8</td>
</tr>
<tr>
<td>World avg</td>
<td>15</td>
</tr>
</tbody>
</table>

Note: Per capita consumption for India is based on the assumption that 25% of plastics is recycled

Source: TATA Strategic Research

Figure 3: Polymer utilization by application (2015)

<table>
<thead>
<tr>
<th>Application</th>
<th>Global average</th>
<th>India</th>
</tr>
</thead>
<tbody>
<tr>
<td>Packaging</td>
<td>43%</td>
<td>35%</td>
</tr>
<tr>
<td>Infrastructure</td>
<td>25%</td>
<td>21%</td>
</tr>
<tr>
<td>Auto</td>
<td>17%</td>
<td>16%</td>
</tr>
<tr>
<td>Others</td>
<td>15%</td>
<td>18%</td>
</tr>
<tr>
<td>Agriculture</td>
<td>2%</td>
<td>8%</td>
</tr>
</tbody>
</table>

Substantially lower consumption in India

Source: Analyst Reports, TATA Strategic Research
Despite being a highly populated country, India still lags behind leading economies like U.S., China, Europe and even Brazil in consumption of plastics. Gujarat is the leading plastics processing hub, accounting for the largest number of plastics manufacturers. In the last four years demand for plastics has grown at a CAGR of 8% owing to economic slowdown and depreciating rupee. However, the low level of per capita plastics consumption in India (12 kg v/s world’s average of 27 kg) is indicative of the strong growth potential available in the plastic industry.

A variety of plastic raw materials are produced in India to meet requirements of different sectors. The polymeric materials are categorized into commodity, engineering and specialty plastics. Commodity plastics comprise of Polyethylene (PE), Polypropylene (PP), Polyvinyl Chloride (PVC) and Polystyrene while engineering exhibit superior mechanical and thermal properties, and include styrene derivatives (PS/EPS & SAN/ABS), polycarbonate, Poly methyl methacrylate, etc. Major plastic materials like PE & PP are derived from ethylene and propylene respectively while other PVC, PS & Acrylonitrile Butadiene Styrene (ABS) and PC are produced from benzene, butadiene and other feedstocks.

**Demand overview**

Demand for commodity plastics (PE, PP, PVC and PS) has grown at a CAGR of 8%, while the demand for engineering & specialty plastics has growth at a faster rate of 10% over the last 5 years.
Despite being a highly populated country, India still lags behind leading economies like U.S., China, Europe and even Brazil in consumption of plastics. Gujarat is the leading plastics processing hub, accounting for the largest number of plastics manufacturers. In the last four years demand for plastics has grown at a CAGR of 8% owing to economic slowdown and depreciating rupee. However, the low level of per capita plastics consumption in India (12 kg v/s world's average of 27 kg) is indicative of the strong growth potential available in the plastic industry.

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### Figure 4: Plastics Demand in India

<table>
<thead>
<tr>
<th>Year</th>
<th>PE</th>
<th>PP</th>
<th>PVC</th>
<th>PS</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>FY12</td>
<td>8.9</td>
<td>2.8</td>
<td>1.98</td>
<td>0.26</td>
<td>0.5</td>
</tr>
<tr>
<td>FY16</td>
<td>12.1</td>
<td>4.7</td>
<td>2.7</td>
<td>0.26</td>
<td>0.74</td>
</tr>
</tbody>
</table>

**Notes**: 1) Not including recycled plastics

**Source**: Chemicals & Petrochemicals manufacturers’ association

Polyethylene (PE) is the most largely used plastic raw-material by Indian industry. Its demand has grown at 6% per annum in last 4 years to reach 4.2 MMTPA in FY16. Polypropylene is the second largest with the consumption growing from 2.8 MMTPA in FY12 to 4.7 MMTPA in FY16 at growth rate of 11% p.a. Polyvinyl chloride (PVC) demand has grown at 8% p.a from 1.98 MMTPA in FY12 to 2.7 MMTPA in FY16. Poly-Styrene (PS) has observed a growth rate of 1% p.a. to reach 0.26 MMTPA in FY16. The other plastics which include engineering & specialty plastics like Polycarbonates (PC), Acrylonitrile butadiene styrene (ABS), Styrene-acrylonitrile (SAN), Polyamides (PA) etc. have grown at 10% p.a. from 0.5 MMTPA in FY12 to 0.74 MMTPA in FY16 (Ref figure 4). The other plastics are primarily imported to meet their growing demand in India.

### Figure 5: Plastics Demand by type

- **PP**: 35%
- **PVC**: 22%
- **LDPE**: 13%
- **LLDPE**: 13%
- **HDPE**: 17%
- **PS**: 2%
- **Others**: 6%

**Source**: Chemicals & Petrochemicals manufacturers’ association
Polyethylene (PE), which includes HDPE, LLDPE and LDPE (High Density PE, Low Density PE and Linear Low density PE), accounts for the largest share i.e., 36% of total consumption, while PP comes close accounting for 35% of total consumption. Within PE, HDPE has experienced a moderate growth and has a consumption share of 17%. LLDPE is expected to grow at higher pace due to its increased penetration in LLDPE applications. Others include EPS and PVC compounds

To manufacture finished products, polymers are processed through various types of techniques namely extrusion, injection moulding and blow moulding.

Extrusion process is the most commonly used process in India and accounts for 64% of total consumption by downstream plastic processing industries. Injection molding is the second most popular process accounting for 32% of the consumption, while Blow molding accounts for the remaining 4%.

**Region wise break of plastic demand**

At present the total consumption of the major plastic (PE, PP, PVC, PS, EPS & PVC Compounds) plastics in India is 11.4 MMTPA. Western India has traditionally been the largest consumer of plastics accounting for almost 47% of the total consumption. The region wise distribution of consumption is given in Fig 6.
Western region comprise of Maharashtra, Gujarat, the union territories of Daman and Diu & Dadra and Nagar Haveli along with Madhya Pradesh and Chhattisgarh. Northern India accounts for 24%. For the purpose of this report, states considered under North India include J&K, Himachal Pradesh, Punjab, Haryana, Uttarakhand, Rajasthan, UP, Delhi and NCR region.

Bulk of the consumption in Northern India is from the end use industries like Auto, packaging (including bulk packaging), plasticulture applications, electronic appliances etc. Figure below reflects indicative list of some end use industries (Refer Figure 7) in Northern India.

The Polymer industry in India is currently heavily concentrated in the west owing to proximity of ports. Reliance, the largest petrochemical player in India has all its cracking units in West which has facilitated the growth of downstream plastic processing industry in Western region. However, with commissioning of IOCL Panipat cracker , HMEL Bhatinda PP plant and recent capacity additions in North India (like GAIL in UP & BCPL in Assam in FY16), downstream plastic processing units are expected to flourish in the Northern and North-eastern regions of the country.

In North India, IOCL, GAIL & HMEL are the three plastic producers with plastic production capacities of 1,250 KTPA (PE and PP), 860 KTPA (PE), and 440 KTPA (PP) respectively taking the total capacity of plastics to 2,550 KTPA.
The demand for plastics in India is expected to grow by 10% to reach 19.5 KT by FY21, with demand for engineering plastics expected to go up by 14%, while that for commodity plastics expected to increase by 9.6%.

Figure 8: Future outlook for Plastics in India

Plastics in India: Future outlook (MMTPA, FY16-FY21)

Notes: 1) Not including recycled plastics
Source: TATA Strategic estimates
The demand for plastics in India is expected to grow by 10% to reach 19.5 KT by FY21, with demand for engineering plastics expected to go up by 14%, while that for commodity plastics expected to increase by 9.6%.

A favorable cost to benefit ratio and a versatile range of applications will continue to encourage the growth of plastics. The properties of these materials can be customized to meet specific demands by varying the chemical properties like molecular weight & side chain branching or by making copolymers and polymer blends.

Major reasons for the growth of the plastic processing industry are growth in the end use segments and higher penetration of plastics in various industry segments. The following figure illustrates major growth drivers for various industries-

Figure 9: End use industries

- **Agriculture**
  - Advanced Agricultural technology
  - Distribution channels
  - Refrigerated storage
- **Infrastructure**
  - Building & Construction
  - Public utilities services
  - Mega highway projects
- **Packaging Industry**
  - Food/Processed food
  - FMCG items
  - Packaged & fast food industry
- **Other growth areas**
  - Industrial/rigid packaging
  - Automotive/Appliances
  - Medical/personal care

The Packaging & Agriculture sectors are expected to be major growth drivers for the Plastics industry in India along with other major applications like Automotive, construction and infrastructure. With rising incomes and more & more women entering the workforce, demand for convenience & packaged foods will continue to increase driving the demand for plastics in packaging. As Indian agriculture increasingly focusses on water management and increasing yields, use of plastics in Agriculture is expected to grow significantly.

Additionally, rising thrust on 100 smart cities will further propel the growth of plastic industry. Considering the critical elements of any smart cities such as water management, infrastructure, waste management, etc. the usage of plastics can bring efficiency in all such fields and can therefore, make the smart cities more sustainable and cost effective.
New investments are also expected in the plastic sector with 180,000 machines planned to be deployed in India by 2020 in comparison to the current 130,000.

The exports of plastic goods are also set to double to USD 15 Bn in the next 5 years from the current USD 7.9 Bn.

Driven by the increased focus on the Make in India campaign, the Ministry of Chemicals & Fertilizers and the Central Institute of Plastics Engineering & Technology (CIPET) will also actively contribute towards growth of plastic industry in India.
The Indian Agricultural GDP has increased in the last 10 years from Rs. 5,654 Bn in 2004-05 to Rs. 8,085 Bn in 2015-16 (based on constant 2004-05 prices, refer fig.1). Contribution of agriculture to world GDP (6%) and for other developing countries such as China (9%) is much lower than that of India’s 12%. Thus Agriculture remains a strong contributor to Indian economy. Also, agriculture has a multiplier effect on the economy, where in it leads to overall development by being an important raw material source to the non-agriculture sectors of the economy.

India is also among the leading exporters of agricultural products globally. Total agricultural exports from India have grown at 21% per annum from Rs. 111,019 Cr in FY11 to reach Rs. 239,453 Cr in FY15.

A. Plasticulture

India supports nearly 16% of world’s population with 2.4% land resource and 4% water resource, and lately the dwindling quality and the vagaries of the availability of these resources are raising serious questions on the sustainability of agricultural practices. To counter these problems, efforts need to be redirected to improve the productivity of the land, employ measures for water management, and also reduce the carbon footprint as a result of agricultural practice.

Plasticulture, which is use of plastic in agricultural practice, is an answer to this rallying cry. Plasticulture is a scientific way of carrying out agriculture, which not only improves the productivity, but optimizes the input resources as well, thereby reducing the cost.
Plasticulture applications offer a multitude of benefits and are considered most important indirect agricultural inputs which result in moisture conservation, water saving, reduction in fertilizer consumption, help in precise application of water & nutrients, controlled environment agriculture is economically viable, plant protection through the use of nets and use of innovative packaging solutions help in increasing shelf-life and during collection, storage & transportation of fruits and vegetables.

Plasticulture refers to the application of plastics in agriculture and horticulture. Plasticulture provides variety of applications in modern agriculture and has the potential to transform Indian agriculture and bring in a 'second Green Revolution' in India. 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:

1. Water management:
   - Lining of canals, ponds & reservoirs with plastics film
   - Drip & Sprinkler Irrigation
   - PVC & HDPE pipes used for water conveyance
   - Sub-surface Drainage

2. Nursery Management:
   - Nursery bags, Pro-trays, Plastic plugs, Coco-pits, Hanging baskets, Trays etc

3. Surface cover cultivation:
   - Soil Solarisation
   - Plastics Mulching

4. Controlled environment agriculture:
   - Greenhouses
   - Shade net houses
   - Low tunnels
   - Plant Protection nets

5. Innovative Packaging:
   - Plastics crates, bins, boxes, leno bags, unit packaging products etc
- CAP Covers, Controlled Atmospheric Packaging (CAP) & Modified Atmospheric
- Packaging (MAP)

India currently has a limited plasticulture usage with a per capita consumption of plastics in Agriculture of 1 Kg against a global average of 32 Kg (and about 100 Kg in the United States). It is, therefore, essential that farmers are made aware of plasticulture techniques, the subsidies available, relevance and applicability. The industry also needs to take efforts towards bringing down the capital cost, and work on creating an environment such that plasticulture becomes a norm rather than an exception.

Plastics which are most widely used in agriculture, water management and related applications include PE, (LLDPE, LDPE and HDPE), PP and PVC.(Refer : Figure 10)

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<thead>
<tr>
<th>S. No</th>
<th>Applications</th>
<th>PVC</th>
<th>LDPE</th>
<th>LLDPE</th>
<th>HDPE</th>
<th>PP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Drip Irrigation</td>
<td>Main/sub main lines</td>
<td>-</td>
<td>Laterals/emitting pipes</td>
<td>Screen filter</td>
<td>Dippers/emitters</td>
</tr>
<tr>
<td></td>
<td>Control valves</td>
<td>-</td>
<td>Micro tubes</td>
<td>Disc filter</td>
<td>Fittings</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Sprinkler irrigation</td>
<td>Main/sub main lines</td>
<td>Connecting line</td>
<td>-</td>
<td>Main/sub main lines</td>
<td>Fittings</td>
</tr>
<tr>
<td></td>
<td>Control valves</td>
<td>-</td>
<td>-</td>
<td>Nozzles</td>
<td>Nozzles</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Greenhouse</td>
<td>Main/sub main lines</td>
<td>UV films</td>
<td>UV films</td>
<td>Main sub main lines</td>
<td>Ropes</td>
</tr>
<tr>
<td>4</td>
<td>Low Tunnel</td>
<td>-</td>
<td>UV films</td>
<td>-</td>
<td>Hoops</td>
<td>Ropes</td>
</tr>
<tr>
<td>5</td>
<td>Mulching</td>
<td>-</td>
<td>UV films</td>
<td>-</td>
<td>-</td>
<td>Non-Woven</td>
</tr>
<tr>
<td>6</td>
<td>Piped Conveyance</td>
<td>Main/Sub main lines</td>
<td>Main/Sub main lines</td>
<td>Main/Sub main lines</td>
<td>Envelope material</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Sub surface drainage</td>
<td>Main/Sub main lines</td>
<td>Main/Sub main lines</td>
<td>Shade nets</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Shade house</td>
<td>Main/Sub main lines</td>
<td>Main/Sub main lines</td>
<td>Shade nets</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Plant protection nets</td>
<td>Main/Sub main lines</td>
<td>Main/Sub main lines</td>
<td>Shade nets</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Soil Solarisation</td>
<td>Main/Sub main lines</td>
<td>Main/Sub main lines</td>
<td>Shade nets</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Lining</td>
<td>Film</td>
<td>Film</td>
<td>Film</td>
<td>Non-woven</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Banana/Fruit covers</td>
<td>Non-woven</td>
<td>Non-woven</td>
<td>Non-woven</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Unit packaging</td>
<td>Thin wall containers</td>
<td>Leno/ crates</td>
<td>Punnet/ crate</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: NCPAH
Plasticulture Potential

India is a vast nation, with every region having its own specific characteristics and problems. These area specific problems can be tackled with innovative and scientific use of Plasticulture techniques. This would not only maximize the output of farms but also optimizes the input factors. Table 4 shows the region specific constraints in agriculture. For example, in Western Himalayan region the productivity is low because of constraints like severe soil erosion, degradation due to heavy rainfall/floods and deforestation and inadequate market delivery infrastructure.

<table>
<thead>
<tr>
<th>States/Parts of States</th>
<th>Region Specific Constraints</th>
</tr>
</thead>
<tbody>
<tr>
<td>J&amp;K, HP, Uttarakhand</td>
<td>Severe soil erosion, Land Degradation, Poor market delivery infrastructure</td>
</tr>
<tr>
<td>Bihar, Eastern UP, West Bengal</td>
<td>Flood/Water logging, improper drainage, salinity, contamination</td>
</tr>
<tr>
<td>Western UP, Punjab, Haryana</td>
<td>Groundwater depletion, micro-nutrient deficiency, decreasing productivity</td>
</tr>
<tr>
<td>Assam, NE States, Sikkim</td>
<td>Aluminum toxicity and soil acidity, soil erosion and floods, shifting agriculture</td>
</tr>
<tr>
<td>Orissa, Jharkhand, Chhattisgarh</td>
<td>Moisture stress, drought, soil acidity, iron toxicity, poor infrastructure.</td>
</tr>
</tbody>
</table>

Source: National committee on Plasticulture Application in Agriculture

The application of Plasticulture can substantially decrease the costs and therefore can lead to high productivity with a better quality of crops. Table 5 shows the potential benefits from Plasticulture applications in terms water saving, water use efficiency and fertilizer use efficiency. Each application can drastically save water by about 30 to 100%. In case of farm pond lined with Plastic film the total loss by seepage of water can be minimized to zero which is highly beneficial. Also efficient use of fertilizers can bring the costs down which again is beneficial for the famers.
Advantages of Plasticulture

The unique advantages of plastic over conventional materials are:

- Higher strength/weight ratio
- Superior thermal insulation properties
- Excellent corrosion resistance
- Superior flexibility
- Resistance to most of the chemicals
- Excellent moisture barrier properties
- Favourable gas permeability.
- Smooth surface – resulting in reduction in friction losses
- Excellent light transmissibility
- Helps to enhance shelf-life of the produces
- Better visibility of the produce

Opportunity with Plasticulture

Following are the opportunities that the agriculture sector has with enhanced usage of Plasticulture applications

<table>
<thead>
<tr>
<th>Plasticulture Application</th>
<th>Water Savings (%)</th>
<th>Fertilizer Use Efficiency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drip Irrigation</td>
<td>40 – 70</td>
<td>20 – 40</td>
</tr>
<tr>
<td>Sprinkler Irrigation</td>
<td>30 – 50</td>
<td>30 – 40</td>
</tr>
<tr>
<td>Plastic Mulching</td>
<td>40 – 60</td>
<td>20 – 25</td>
</tr>
<tr>
<td>Greenhouse</td>
<td>60 – 85</td>
<td>30 – 35</td>
</tr>
<tr>
<td>Shade Nets</td>
<td>30 – 40</td>
<td>Not Available</td>
</tr>
<tr>
<td>Poly/Low Tunnel</td>
<td>40 – 50</td>
<td>Not Available</td>
</tr>
<tr>
<td>Farm Pond Lined with Plastic Film</td>
<td>100</td>
<td>Not Available</td>
</tr>
</tbody>
</table>

Source: National committee on Plasticulture Application in Agriculture
To sum up, plasticulture can offer following opportunities:

- Yield improvement upto 50-60%
- Water savings upto 60-70%
- Prevention of weeds growth
- Soil conservation
- Protection against adverse climatic conditions
- Fertilizer savings upto 30-40%
- Reduction in post-harvest losses
- Conversion – cold desert/wasteland for productive use

The greater use of plastic in agriculture can also help to a great extent to achieve up to fifty percent of the intended targets in Agriculture (as shown in the figure 13). The wider use of Plasticulture can reduce the loss of harvest and can increase the efficiency thus contributing more to the GDP. It is estimated that the agriculture output can be increased by ~INR 68,000 Cr by using proper Plasticulture applications like drip irrigation, mulching etc. Also, using innovative plastic packaging and handling techniques can promote proper harvest management which will in turn contribute towards the Agriculture-GDP.

**Plasticulture: A success story**

Farmers in several parts of Gujarat have reaped benefits of plasticulture by saving crucial natural resource, i.e. water and reducing the use of pesticides.

Use of plastics in agriculture in the form of pond lining, drip irrigation, sprinkler irrigation, mulching, greenhouses among others has brought down the usage of water by about 40%, fertilizers by 30-40% and the electricity consumption at the farms. Resultantly, farmers taking crops such as spices, vegetables and other cash crops like banana, cotton, groundnut and castor have witnessed their overall incomes rising by 2-3 times.

Use of drip irrigation has helping these farmers reduce the use of water. Also, plastic mulching helped them reduce weeds and pest attacks in crops like cotton. The weed management methods helped reduce use of insecticides by half and resulted in increase in the yield. The costs, as a result, have gone down and profits have increased.
Farmers growing other cash crops such as banana, watermelon have also started using fruit cover, PP non-woven fabric to keep the fruit from insects and weather extremities.

This is thanks to the efforts taken by Reliance Industries Limited (RIL)’s Plasticulture Development Centre (PDC) near Vadodara which provides training and demonstration to the farmers from across the state to adopt best practices by using plasticulture.

In order to encourage farmers to take up modern techniques in the farming and conserve natural resources, PDC has teamed up with states and central government agencies to help farmers avail subsidies and make the most of them.

Every year, PDC and the Reliance Foundation Information Services (RFIS) trains around 15,000 farmers across the country to adopt plasticulture applications such as greenhouses, low tunnel, nursery bags, plant protection nets and many more for optimum use of water, fertilizer, electricity, labor etc, and increase productivity for better value addition.

**B. Water Management and Micro-irrigation**

Groundwater levels in India are continually falling, with India’s groundwater extraction rate (251 Cu. Km) much more than China’s & USA, which come a close second (112 Cu. Km). More than nine-tenths of groundwater is extracted for irrigation, underscoring India’s dependence on groundwater for irrigation. Over the last 40 years, around 85% of the total addition to the net irrigated area has come from groundwater. In fact, a few areas in Punjab, Haryana and Rajasthan face the prospect of having no groundwater left for irrigation by 2025. Plastic based solutions can help North India in tackling its water scarcity issues.

**Handling water scarcity through plastic based solution**

Water storage for surplus rainfall – Polythene lined tanks can be used to collect excess rainfall especially in the states of Jammu& Kashmir, Himachal Pradesh and Uttarakhand. These tanks situated on the terraces supply water under gravity and can be connected to low head drips and micro-sprinklers and do not need any additional energy. Bucket or drum kit based plastic drip systems, cisterns, plastic lined trenches, etc. can also be used to directly harvest the rain water.

Canal commands linkages with plastic lined tanks (Diggis) – This solution is more relevant in arid states such as Rajasthan where ground water is saline, canal supply is uncertain & erratic and large part of water get wasted due to highly sandy and
undulating soils. In such situation water can be stored in plastic lined diggis and apply to the farms as per need through plastic pipes and sprinkler/ drip systems.

Plastic based resource recovery and reuse model – Plastic can be used for the safe disposal and use of wastewater which has become a huge problem after provision of household sanitation in rural areas. Wastewater can be collected in plastic lined tanks and safely used for agriculture after primary treatment.

The plastics based innovative solutions, besides the traditional interventions already well known, could synergise the growth of agriculture and plastics industry and also enhance the incomes and livelihoods of those engaged in the production systems.

Micro Irrigation

Conceptually micro irrigation, refers to low pressure irrigation system that either drips or sprinkles water needed by the plant for its optimum growth. Considering the need to increase productivity with minimum possible use of water, micro-irrigation can play a crucial role in the future of Indian agriculture. Currently, however, the micro-irrigation scenario in the country cuts a very sorry figure. While the total potential for micro-irrigation in India is estimated at 69.5 Million hectares, only about 7.73 Million hectares is currently under micro-irrigation. The six states of Rajasthan, Maharashtra, Andhra Pradesh, Karnataka, Gujarat and Haryana account for 82% of India's micro-irrigation coverage. This means there's immense potential not only for states in North India, but for other states in India to adopt micro-irrigation measures. The Government needs to increase the budgetary allocation (from INR 1,075 Cr. In FY16), and promote the implementation of micro irrigation technologies by providing financial assistance under the centrally sponsored schemes. Modern techniques such as drip/sprinkle irrigation can be utilized to conserve water and bring in efficiency in crop production.

Plastic application in Micro Irrigation

Plastics have found efficient usage in these micro irrigation systems in the form of PVC pipe fittings, LDPE tubes, plastic mulches etc and have proven to have many advantages as shown below (Figure 13)
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**Figure 13: Plasticulture benefits in Micro irrigation**

1. Soil erosion is eliminated
2. Helps to increase yield and reduces soil compaction.
3. Suitable for uneven/ undulating land
4. Control weed growth and diseases
5. Improves quality and ensures early maturity of crops.
6. Increase in Production & Productivity

Source: National committee on Plasticulture Application in Agriculture

**Water management and Micro Irrigation: A success story**

The Marathwada region in Maharashtra is one of the major drought prone areas in India, receiving an average annual rainfall of 683 mm, about 30% lower than the country as a whole. Between 1870 and 2015, the region has faced 22 droughts, the most recent ones being in 2014 and 2015, wherein the region had a rainfall deficit of about 40%. Water availability was a major issue then with more than 750 tankers carrying about 24,000 litres of water to the 2.7 Mn people residing in the region.

With a more than normal monsoon in 2016 (21% surplus rainfall) water availability is not a problem this year. However, the fact that only about 20% of Marathwada's land is irrigated poses a major problem. To add to it, Micro irrigation (drip or sprinkler irrigation) which is more efficient than surface irrigation is even rarer in the region. In Beed, for instance, a little above 6% of agricultural lands have micro-irrigation facilities.

The government, however, if playing an active role in ensuring successful implementation of irrigation facilities in Marathwada. More and more lands are now being brought under irrigation due to a state government programme launched in 2014 to make Maharashtra drought-free in 5 years. Since 2014, Beed has spent about INR 150 Crore on widening of existing storages like streams and farm ponds and creating new ones to conserve water under the programme which are being used to irrigate fields.
This led to a very good harvest of tur dal (pigeon pea) causing a glut in the market, and a fall in prices, and resulted in the Government procuring more than planned.

C. Post-harvest management

Plastics are found to be effective not only in maintaining the quality of produce but also in handling, disposal, storage and packaging of produce.

<table>
<thead>
<tr>
<th>Applications</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plastic Sacks</td>
<td>Used for packaging rice, grains and other materials. It can be generally recycled for packing fresh produce.</td>
</tr>
<tr>
<td></td>
<td>Key advantages are ready availability and cost effectiveness.</td>
</tr>
<tr>
<td>Storage structures</td>
<td>PVC based food grain storage structures are increasingly being used for storage of agricultural produce as they are easy to be handled and installed, and also reduce the need for closed storage systems</td>
</tr>
<tr>
<td>Plastic bags</td>
<td>Made from polyethylene films.</td>
</tr>
<tr>
<td></td>
<td>Commonly used for transporting highland vegetables such as lettuce, broccoli, cauliflower, cabbage, carrots, etc. to wholesale markets in urban centers</td>
</tr>
<tr>
<td></td>
<td>They are relatively inexpensive, readily available and have a low weight to volume ratio.</td>
</tr>
<tr>
<td>Plastic Crate</td>
<td>High quality plastic crates, with proper venting, which are stackable, nest-able, easy to clean and reusable are used extensively for storage, post-harvest, handling and transportation</td>
</tr>
<tr>
<td>Containers</td>
<td>Reusable plastic containers protect the produce from mechanical injury, and contamination during marketing.</td>
</tr>
<tr>
<td>Plastic films</td>
<td>Help in reduction of moisture loss from the product, which is a principal requirement of limited permeability packaging materials.</td>
</tr>
<tr>
<td>Plastic Cushioning</td>
<td>Commonly used cushioning materials are moulded plastic trays, foam Materials plastic sheet, plastic bubble pads, plastic film liners or bags</td>
</tr>
<tr>
<td></td>
<td>Prevent commodities from mixing, when there is a vibration or impact.</td>
</tr>
<tr>
<td>Plastic Sheets</td>
<td>Plastic sheets are spread below the tree being harvested to collect the nuts / fruits.</td>
</tr>
<tr>
<td>Plastic Pallets</td>
<td>Plastic pallets are widely used in moving the loads of cartons.</td>
</tr>
</tbody>
</table>

Source: NCPAH, TATA Strategic analysis
Status of Plastics in Indian Agriculture

As indicated in figure 3 earlier, penetration of plastics in Indian agriculture at 2% is much lower than the global average of 8%. Some of the major reasons for lower penetration of plasticulture in India are:

- Lack of water conservation measures as part of mainstream agriculture practice
- Lack of capital for investments into drip irrigation, sprinkler irrigation and other measures
- Low awareness about Government schemes amongst farmers
- Low awareness about benefits of plasticulture
- Quality of PVC pipes due to poor add ons sometimes used in Indian Agriculture

The National committee on Plasticulture Applications in Horticulture (NCPAH), constituted by Ministry of Agriculture, Government of India, has been working actively towards popularizing adoption of plasticulture applications in horticulture and overall development of plasticulture applications in India.

The Government has also initiated development centres like PFDC (Precision farming Development Centres) and schemes like NMMI (National Mission on Micro irrigation) to enhance usage of plastics in Indian Agriculture.

Some of the measures already taken by NCPAH include:

- Announcement of subsidies in plasticulture through centrally sponsored schemes on micro irrigation, green house, shade net house, insect net house, etc
- Demonstration of various plasticulture applications at state owned farms, KGK/ KVK, ICAR institutes in different states and farmers' yield
- Participated in the international & national events related to agriculture/horticulture in India to promote adoption of plasticulture applications under GoI schemes & provides growth to Plasticulture in India.
- Prepared guidelines, monitored scheme progress & interacted with MI industry for helping Micro Irrigation scheme to become a mission.

While these measures have certainly led to a rise in usage of plastics in Indian farming, agriculture in India has not been able to reap the benefits of Plasticulture
fully. Some of the measures that need to be taken in future by both the Government and industry include:

- Creating awareness about subsidies available, and ensure these subsidies reach the farmer for investments into plasticulture
- An increased awareness about possible benefits and subsidies available can further boost adoption of plastics in Agriculture
- Government also needs to build a culture of innovation in Indian agriculture by allocating a share of budget to Research & Development and technological innovations
- Continual technology advancements which bring down capital costs need to be promoted
- The Government needs to lay down strict norms regarding quality of PVC pipes to be used in irrigation, and ensure that the industry adheres to these guidelines
- The industry needs to build credibility by providing services for post-installation management & repairs
Packaging industry in India

The packaging industry in India is one of the fastest growing industries with influence on all industries, directly or indirectly. Indian packaging industry has registered a CAGR of 16% in the last five years (Ref: figure 16). The spending on packaged foods is increasing due to increase in per capita income, urbanization and a rise in number of women in workforce. There is a great growth potential since India's per capita consumption of packaging is only 4.3 kg whereas in case of neighbouring Asian countries like China and Taiwan, it is 6 kg and 19 kg respectively. This clearly indicates that the market is under penetrated and offers a great business opportunity for the Indian plastics packaging industry.

Plastics in Packaging

A large number of plastics, thanks to their versatility can be used in a myriad of applications. A list of plastics, along with the applications and the benefits they provide, is given in the table below:
Figure 15: Plastics & their Applications in packaging

<table>
<thead>
<tr>
<th>Plastic</th>
<th>Applications</th>
<th>Benefits</th>
</tr>
</thead>
</table>
| PET     | • Food jars for jelly, jam and pickles  
          • Plastic bottles for soft drinks, water, juice  
          • Ovenable film and microwavable food trays | ✓ Excellent resistance to most solvents  
✓ High impact capability and shatter resistance  
✓ Clear and optically smooth surfaces |
| HDPE    | • Cereal box liners  
          • Reusable shipping containers  
          • Bottles for non-food items, such as shampoo, liquid laundry detergent, household cleaners, motor oil etc. | ✓ Relatively stiff material with useful temperature capabilities  
✓ Higher tensile strength |
| PVC     | • Rigid packaging applications include blister packs and clamshells.  
          • Packaging, film and sheet, and loose-leaf binders.  
          • Flexible packaging uses include bags for bedding and medical | ✓ High impact strength  
✓ Brilliant clarity  
✓ Excellent processing performance |
| LDPE    | • Container lids  
          • Shrink wrap and stretch film.  
          • Squeezable bottles (e.g., honey and mustard). | ✓ Excellent resistance to acids, bases and vegetable oils  
Toughness, flexibility and relative transparency |
| PP      | • Medicine bottles  
          • Bottle caps and closures  
          • Bottles for catsup and syrup | ✓ Low moisture vapor transmission  
✓ Inertness toward acids, alkalis and most solvents |
| PS      | • Protective foam packaging for furniture, electronics and other delicate items.  
          • Packing compact disc cases and aspirin bottles | ✓ Low thermal conductivity and excellent insulation properties  
✓ Excellent moisture barrier for short shelf life products |

Source: Industry Reports, TATA Strategic Research

Growth drivers & Future outlook

Packaging in general is classified into two significant types i.e. Rigid Packaging and Flexible Packaging. As compared to rigid packaging, flexible packaging is one of the most dynamic and fastest growing markets in India. Flexible packaging anticipates a strong growth in future. There has been increasing shift from traditional rigid packaging to flexible packaging due to numerous advantages offered by flexible packaging such as convenience in handling and disposal, savings in transportation costs etc.

In the coming years Indian packaging industry is expected to grow at 18% p.a. wherein, the flexible packaging is expected to grow at 25% p.a. and rigid packaging to grow at 15% p.a.

The following factors are expected to play a vital role in the growth of the packaging industry in India

A. Retail Growth: Increased presence of global multinational companies has boosted the demand in the processed food, beverages, cosmetics, consumer products, toiletries and pharmaceutical space. The manufacturing units, especially the fast moving consumer goods (FMCG) manufacturers are exploring new markets continuously through newer retail models. This has widened the market and also increased the demand of packaging of the products.

B. Packaged food: Since packaged food is the fastest growing segment, it is expected to fuel the demand of plastic packaging in India. Spend on packaged foods is increasing (at inflexion point) due to Increase in per capita income, Urbanization and Increase in working woman population

C. Pharmaceuticals: Besides Food & Beverage, the pharmaceuticals segment is another major user of packaging. India’s domestic pharmaceutical market is
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C. **Pharmaceuticals**: Besides Food & Beverage, the pharmaceuticals segment is another major user of packaging. India’s domestic pharmaceutical market is
witnessing a double digit growth, and pharmaceutical packaging is now becoming a major part of the drug delivery system. Pharmaceutical companies rely more on packaging and labelling as media to protect and promote their products, increase patient compliance, and meet new regulations. Besides this, plastics have been gaining increasing importance in packaging of pharmaceutical goods due to properties such as barrier against moisture, high dimensional stability, high impact strength, resistance to strain, low water absorption, transparency, resistance to heat and flame etc.

D. Growth of Smaller Packaging: The current middle class population in India is approximately 30 Cr. which indicate that from affordability point of view, the demand for smaller packaging is huge. This population is rapidly growing and hence this will drive the growth for packaging industry. Smaller packaging caters to even the rural population and lower income groups.

E. Changing Lifestyle: Highly favourable demographic patterns in India like increasing working age population, growing disposable income, growth in middle class, ongoing urbanization and changing lifestyles etc. is expected to drive the growth of packaging industry in India. Globalization has ushered in significant cultural changes with people today buying more of branded products and thus packaging is playing an important role in creating and sustaining the brand equity. With a higher per capita income, the demand of personal hygiene products and convenience products has increased leading to increased demand for plastics.

Packaging in North India

As more and industries establish their base in areas in and around Delhi, Baddi (Himachal Pradesh), Sonepat (Haryana), Haridwar (Uttarakhand), Uttar Pradesh, Jammu & Kashmir, etc the demand for packaging industry has grown tremendously in North Indian states. Some of the major industries that have developed over the years in North India, and offer tremendous growth prospects for Packaging in North India include Agriculture & Agro-processing, Food & Beverages, Forest products, Cosmetics Consumer goods and Textiles. As these downstream industries continue to flourish, use of plastics in packaging will continue to rise. A rise in consumerism has also resulted in increasing demand for attractive & safe packaging.

The relative growth prospects for plastics in North India for packaging used in various segments have been highlighted in the figure below:
witnessing a double digit growth, and pharmaceutical packaging is now becoming a major part of the drug delivery system. Pharmaceutical companies rely more on packaging and labelling as media to protect and promote their products, increase patient compliance, and meet new regulations. Besides this, plastics have been gaining increasing importance in packaging of pharmaceutical goods due to properties such as barrier against moisture, high dimensional stability, high impact strength, resistance to strain, low water absorption, transparency, resistance to heat and flame etc.

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Highly favourable demographic patterns in India like increasing working age population, growing disposable income, growth in middle class, ongoing urbanization and changing lifestyles etc. is expected to drive the growth of packaging industry in India. Globalization has ushered in significant cultural changes with people today buying more of branded products and thus packaging is playing an important role in creating and sustaining the brand equity. With a higher per capita income, the demand of personal hygiene products and convenience products has increased leading to increased demand for plastics.

Packaging in North India

As more and industries establish their base in areas in and around Delhi, Baddi (Himachal Pradesh), Sonepat (Haryana), Haridwar (Uttarakhand), Uttar Pradesh, Jammu & Kashmir, etc. the demand for packaging industry has grown tremendously in North Indian states. Some of the major industries that have developed over the years in North India, and offer tremendous growth prospects for Packaging in North India include Agriculture & Agro-processing, Food & Beverages, Forest products, Cosmetics & Consumer goods and Textiles. As these downstream industries continue to flourish, use of plastics in packaging will continue to rise. A rise in consumerism has also resulted in increasing demand for attractive & safe packaging.

The relative growth prospects for plastics in North India for packaging used in various segments have been highlighted in the figure below:

![Figure 17: Relative growth of plastics in Packaging: North India](image)

### Key Industries in North India

<table>
<thead>
<tr>
<th>Industry</th>
<th>Relative presence in North India</th>
<th>Growth prospects for Plastics in packaging</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agro-processing</td>
<td><img src="image" alt="Icon" /></td>
<td><img src="image" alt="Icon" /></td>
</tr>
<tr>
<td>Food &amp; Beverages</td>
<td><img src="image" alt="Icon" /></td>
<td><img src="image" alt="Icon" /></td>
</tr>
<tr>
<td>Pharmaceuticals</td>
<td><img src="image" alt="Icon" /></td>
<td><img src="image" alt="Icon" /></td>
</tr>
<tr>
<td>Cosmetics &amp; Consumer goods</td>
<td><img src="image" alt="Icon" /></td>
<td><img src="image" alt="Icon" /></td>
</tr>
<tr>
<td>Auto spare parts</td>
<td><img src="image" alt="Icon" /></td>
<td><img src="image" alt="Icon" /></td>
</tr>
</tbody>
</table>

Source: TATA Strategic Estimates

### Emerging trends in packaging industry

Plastics have replaced many traditionally used packaging materials thereby transforming the packaging industry. Flexible packaging is a sub segment of packaging industry and it is producing revolutionary products. These products, as shown in Figure 7, focus on enhancing the shelf life of products by keeping intact the nutritional value of the enclosed product. For example, modified atmospheric packaging (MAP) has also reduced the cost of old style packaging considerably.

![Figure 18: Emerging trends in packaging industry](image)

- Saves storage space
- Ease of handling
- Toughest packaging bags widely used to pack materials for grain, milling and sugar industry
- Enhanced storage life
- Saves storage space
- Ease of handling
- Disposable
- Laminated jars have replaced glass containers
- Cost effective solution lesser packaging & transportation costs
- PE laminated pouch provides barrier properties during products shelf life
- Maintains freshness by simultaneous respiration & permeation
- Equilibrium packaging atmosphere is created with appropriate % oxygen and carbon dioxide
- Multilayered 5-7 layer films are used
- Lack of oxygen eliminates use of pesticides/fumigation
- Shelf life of almost 3-4 years

Source: Industry reports, Tata Strategic analysis
Challenges for Plastic industry

**Sustainability**

One of the major problems for plastics in India is the disposal of plastic wastes, and the effect it has on the environment if not recycled appropriately. Plastic recycling is a sustainable way of handling this problem. It not only solves the problem of plastic waste menace, but also provides a wide range of business opportunities. Currently in India, of the 15,000 MT of plastic waste that gets generated every day, about 6,000 MT remains littered and uncollected. If plastics can be collected & disposed of or recycled as per laid down rules & guidelines, the issue of public waste & pollution caused by plastics can be efficiently addressed. It is essential to ensure that the informal sector, which has a dominant share in plastics processing, also adhere to these guidelines. Going ahead, recycling and reuse of plastics is a foremost step towards fostering a culture of innovation & sustainability.

The industry has to adopt a sustainable approach to manufacturing and handling end-of-the-life plastic products. The recycling industry need to focus on research & development and innovations for growth. Manufacturers need to focus on building up scale and upgrade their technology to enhance competitiveness. The Government, on its part, should incentivize manufacturers investing heavily in offering sustainable solutions to disposal of plastics.

North India could also follow the examples of Mumbai & Chennai, where municipal authorities now plan to use plastic wastes in construction of roads. The Government of India has also announced recently that roads having plastics as one
Challenges for Plastic industry

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North India could also follow the examples of Mumbai & Chennai, where municipal authorities now plan to use plastic wastes in construction of roads. The Government of India has also announced recently that roads having plastics as one of the components would be default mode of construction for most city streets in the country.

Technology Upgradation

Technology needs are not particularly pertinent only to Northern India; they are a common need across India. The Indian Plastic processing industry has seen a shift from low output/low technology machines to high output, high technology machines. However, focus on developing a state-of-the-art R&D is dying down with more focus on increasing the capacity utilization. Domestic machinery is manufactured as per the current technology to improve productivity and energy efficiency, in order to enable the processors to compete globally. Key machineries are imported from Europe, the U.S. and Japan which invite a 7.5% customs duty resulting in huge losses. India’s technical needs are acute in areas like high production and automatic blow moulding machines, multilayer blow moulding, stretch/blow moulding machines, specific projects involving high capital expenditure like PVC calendaring; multilayer film plants for barrier films, multilayer cast lines, BOPP and non-woven depend exclusively on imported technology/machinery.

High Fragmentation

The downstream plastic processing industry is highly fragmented and consists of micro, small and medium units. There are over 30,000 registered plastic processing units of which about 75% are in the small-scale sector. The small-scale sector, however, accounts for only about 25% of polymer consumption. The industry also consumes recycled plastic, which constitutes about 30% of total consumption. The domestic downstream industry comprises three broad segments: injection molding, blow molding and extrusion. It caters to the requirements of a wide array of applications such as packaging, automobile, electrical accessories, laboratory and medical surgical ware, consumer durables, and healthcare. A consolidation would help create large entities in the Indian plastic processing industry, improve economies of scale and help the Indian plastic processing industry to compete on a global level.

Need for upstream capacities

The increasing demand for downstream plastics is expected to result in an increase in plastics processing in India. As consumption of plastics increases from 12.1 MMTPA in FY16 to 19.5 MMTPA in FY21, India is expected to deploy 180,000 machines by 2020 as compared to current 113,000. However, upstream capacity
additions may not be able to match this increase in demand which would result in India becoming more and more import dependent. This is especially true in case of PVC where the Government needs to rationalize customs duty in order to enable capacity additions in Indian PVC industry. The import duty on PVC in India, which stands at 7.5%, is far lower than that prevailing in other comparable economies. This results in poor margins for domestic manufacturers, and has resulted in lack of capacity additions in Indian PVC industry. The last greenfield PVC plant setup in India was way back in 2009. The domestic demand-supply gap keeps widening on a year-to-year basis, and in the next 5-10 years may widen to such an extent that meeting the needs through imports would also not be possible. It is therefore imperative that customs duty be rationalized so as to have more greenfield investments in Indian PVC industry.
Opportunities in North India

Major capacities were added for PE and PP in the North and North east India in FY16. GAIL expanded its PE & PP capacities at its Uttar Pradesh based plant, while BCPL expanded its plastics capacity at its Assam plant. IOCL is also planning a capacity expansion at its Odisha plant in FY18. This is expected to make the feedstock scenario more promising in Northern India, and will lead to increased investments in downstream plastic processing.

With Government’s current 'Make in India' campaign which has a special focus on the chemical industry and aims to turn the country into a global manufacturing hub, a tremendous growth in the plastic processing sector is expected especially in downstream industries. India’s increased focus on manufacturing is likely to provide a major boost to downstream plastic processing industries, especially in north Indian states of Bihar and Jharkhand, where the lack of plastic processing industries presents a huge unmet opportunity.

Increasing urbanization, changing lifestyle and demographic dividend, greater consumer spending for items that require plastics—from packaged goods to mobile phones and automobiles etc. are some of the other factors promoting the demand for downstream plastics. The regions of north and north-east India are in a growing phase and experiencing a significant shifts in lifestyle driving the growth of domestic end use industries.
Government initiatives like 'Swaccha Bharat', and selection of a few towns from North-Indian states like UP, MP, Punjab, Rajasthan and Odisha for developing into smart cities would further drive the Plastics industry in North & North-east India.

With some of the major crop producing states like Haryana, Punjab, Uttar Pradesh, Madhya Pradesh and West Bengal, demand for plastics in plasticulture applications is expected to receive a major boost. Moreover, National Committee on Plasticulture Applications in Horticulture (NCPAH) has the mandate to promote and develop the use of plastics in agriculture, horticulture, water management and other allied areas.

On the recommendation of NCPAH, the Government has also established 22 Precision Farming Development Centres (PFDCs) all over the country to promote various plasticulture applications in horticulture by undertaking trials, seminars, workshops etc. These PFDCs are located in State Agricultural Universities (SAUs, ICAR Institutes such as IARI, New Delhi; CIAE, Bhopal & CISH, Lucknow and IIT, Kharagpur, with 22 PFDCs currently in operation.

There are, therefore, good opportunities for Plastics in India with Agricultural and Packaging industry expected to lead the way. Plasticulture, which is in its infancy in India, can significantly benefit agriculture with its applications in multiple areas of farming. It can be used to tackle specific problems faced by North Indian agriculture. Applications of plastics in micro irrigation and post-harvest management provide new dimensions to the application of plastics in agriculture.

Application of plastics in food processing industry is also poised to grow at a significant rate. With changes in lifestyle, increasing income levels and aspirations, the growth in the food processing sectors, cosmetics and consumer goods are expected to be high. As plastics are majorly used for packaging fast moving consumer goods, their demand is expected to grow significantly. North India is already a hub for agro & food processing companies, cosmetics & consumer goods companies with major international players having established their presence, this region will continue to drive the demand of plastics in coming years.

As per the conclusion reached in the 2015 United Nations World Water Development Report, "Water for a Sustainable World", which was launched on 20 March 2015, the planet (earth) is facing a 40% shortfall in water supply by 2030, unless we dramatically improve the management of this precious resource.

Judicious usage of water is becoming increasingly important for the reason that India currently supports nearly 17.85% of the world's population, with 2.4% land and 4% of water resources. Coming to Rajasthan, which is the focus my thoughts presently, the state while holding 10.5% of the area of the country and 5.5% of the population, is holding only 1% of the water resources of the country. The state falls under extremely water scarce zone. Almost 70% area in the state depends on wells & tube-wells for irrigation and only 27% is irrigated through canals. This further puts pressure on long term sustainability of availability/usage of ground water. One of the main reason for same is incentivation of usage of groundwater by providing subsidies for irrigation equipment and cheap electricity leading to unbridled pumping out of groundwater for irrigation. The same is coupled with the cropping patterns (viz: water intensive crops in water challenged areas, e.g; sugar cane plantations in Marathawada region).

Water is a critical input into agriculture in nearly all its aspects. How much, at what time and how plants are watered has determining effect on the eventual yield. Good seeds and fertilizer fail to achieve their full potential if plants are not optimally watered. Indeed it was rightly mentioned by Leonardo da Vinci that "Water is the driving force of all nature."
Per Drop More Crop - Plasticulture shows the Way

**By: Mr. Vinay Mathur**  
Deputy Secretary General  
FICCI

While addressing a gathering of agriculture scientists at the Foundation Day of Indian Council for Agriculture Research, Sh. Narendra Modi, Hon'ble PM of India pitched for efficient use of water and said, "per drop more crop should be our mantra for better productivity from each drop of water". The message indeed is very timely, given the emerging water scenario.

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As per International Water Management Institute, during the past decade, groundwater in various parts of the country, esp. beneath the northern Indian
states of Punjab, Haryana, Rajasthan & western UP has fallen at an alarming level. This will impact the food security of the nation as the region also happens to be its food bowl. The given map shows the groundwater withdrawals as a percentage of groundwater recharge. The situation is indeed challenging.

As per the World Resources Institute 54% of India faces high to extremely high water stress. Irrigation using ground water increased ever since the green revolution started in the country. The UN World Water Development Report 2015 estimates that between 1960 and 2000 India's mechanised tube wells, used in irrigation, increased dramatically from one million to 19 million. Today just the state of Punjab has that many (above 1 million). The map below indicates that the groundwater is being over-exploited in the state of Rajasthan.

**GROUND WATER STRESSED BLOCKS OF INDIA**

1: Andhra Pradesh, 2: Gujarat, 3: Karnataka, 4: Maharastra, 5: Madhya Pradesh, 6: Rajasthan and 7: Tamil Nadu

(Source: IWMI)
At the same time, monsoons are also becoming erratic in recent years. The resultant is alarming fall in ground water levels placing at risk, the national food security mission. At present, irrigation consumes about 84 per cent of total available water in the country. As per Economic survey of India which was released in February 2016, although water is one of India’s most scarce natural resources, India uses 2 to 4 times more water to produce a unit of major food crop than does China and Brazil. **Hence, it is imperative that the country focus on improving the efficiency of water use in agriculture.**

**Unleashing the potential of Plasticulture is the Need of the Hour.** Plasticulture (viz: the use of plastics in agriculture, horticulture, water-management, food grains storage and related areas) is a good answer to this challenge. It can play an important role in facilitating judicious usage of water. **It is estimated that appropriate applications of micro-irrigation technologies can result in water saving up to 50-70%**. The resulting improvement in net farm incomes is substantial. The table below provides benefits of plasticulture applications.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Plasticulture Applications</th>
<th>Water Saving (%)</th>
<th>Water Use Efficiency (%)</th>
<th>Fertilizer Use Efficiency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Drip Irrigation System</td>
<td>40-70</td>
<td>30-70</td>
<td>20-40</td>
</tr>
<tr>
<td>2</td>
<td>Sprinkle Irrigation System</td>
<td>30-50</td>
<td>35-60</td>
<td>30-40</td>
</tr>
<tr>
<td>3</td>
<td>Plastic Mulching</td>
<td>40-60</td>
<td>15-20</td>
<td>20-25</td>
</tr>
<tr>
<td>4</td>
<td>Greenhouse</td>
<td>60-85</td>
<td>20-25</td>
<td>30-35</td>
</tr>
<tr>
<td>5</td>
<td>Shade nets</td>
<td>30-40</td>
<td>30-50</td>
<td>Under Trial</td>
</tr>
<tr>
<td>6</td>
<td>Plastic Tunnel</td>
<td>40-50</td>
<td>20-30</td>
<td>-do-</td>
</tr>
<tr>
<td>7</td>
<td>Farm Pond Lined with Plastic Film</td>
<td>100</td>
<td>40-60</td>
<td>Not Applicable</td>
</tr>
</tbody>
</table>

**Source: NCPAH**

A promising way forward, to increase productivity while conserving water, is to adopt micro irrigation methods. Compared to flood irrigation which involves flooding of the fields resulting in high consumption of water, micro irrigation is a more efficient method of water usage. In drip irrigation for example, perforated pipes are placed either above or slightly below ground and drip water on the roots and stems of plants, directing water more precisely to crops that need it. An efficient drip irrigation system reduces consumption of fertiliser (through fertigation) and water of the plant and hence there is less wastage. Yields of crops also go up - up to 45 per cent in wheat, 20 per cent in gram and 40 per cent in...
soybean. The resulting improvement in net farm incomes is substantial. Until now micro-irrigation techniques, owing to high fixed costs of adoption, have mostly been used for high value crops. However, recent research has shown its feasibility even in wheat and rice.

Benefits of Plasticulture Applications - Same can help the country to meet both food and nutrition needs at a time when population growth is @ +1% per annum with depleting natural resources such as land & water. The paucity of water, lower productivity and inefficient use of fertilizer leading to higher carbon footprint could all be taken care by efficient use of Plasticulture. As the figure below explains, Rajasthan indeed is doing good work in the sector. However far more waits to be done, given the peculiar geologically challenged situation in which the state is placed.
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**Flood Irrigation scene**

**Micro irrigation scene**

**Benefits of Plasticulture Applications**

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<table>
<thead>
<tr>
<th>State</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haryana</td>
<td>8%</td>
</tr>
<tr>
<td>Madhya Pradesh</td>
<td>5%</td>
</tr>
<tr>
<td>Chattishgarh</td>
<td>4%</td>
</tr>
<tr>
<td>Rajasthan</td>
<td>23%</td>
</tr>
<tr>
<td>Karnataka</td>
<td>11%</td>
</tr>
<tr>
<td>Gujrat</td>
<td>12%</td>
</tr>
<tr>
<td>Andhra Pradesh</td>
<td>16%</td>
</tr>
<tr>
<td>Maharashtra</td>
<td>17%</td>
</tr>
</tbody>
</table>

**CONCLUSION**

- We need to have a holistic view of the issue, which requires actions both at macro and micro levels. Cropping patterns linked to water availability with a view to long terms sustainability need to be encouraged.

- It is a fact that the plasticulture applications hold huge importance because of their relationship to water conservation and national food security. A very focused campaign to create awareness about benefits of its usage (thru demonstration centres) in which farmers are partners as also about the subsidies available will be helpful. At the same time, water harvesting for recharging the ground water is also important.

- Protective cultivation also holds very good potential and we have a long way to go. Presently, China is the world leader in cultivating horticultural crops and area under protected cultivation has reached around 3.5 million ha and out of this area nearly 96 percent is only being used for cultivation of commercial fresh vegetables and for hybrid seed production of vegetables. This compares to about 65000 hectares for India.

- There is also need to ensure availability of quality products based on good standards by industry. Literature on the subject in regional languages, which
may also include case studies will be helpful. These steps will go a very long way in promoting the idea of plasticulture in India.

- With a systematic industry approach supported by policies and government, it indeed is possible to double the income of the farmers and ensuring national food security and also ensure optimum usage of the precious commodity of water.

- Let us work together for this mission.
Present status, Challenges and options in Protected Cultivation in India

By: Dr. Balraj Singh
Vice Chancellor
Agriculture University-Jodhpur

With time it has been proved that protected cultivation is a better technology to enhance productivity and quality of the crops by providing a logical and technical solution to manage the major biotic and abiotic stresses encountered under open field cultivation of those crops. The effectiveness of the technology has been observed world over. In the last two decades, the area under protected cultivation in various parts of the world has increased exponentially in countries in and around Mediterranean sea and in China for adoption of various protected cultivation technologies in different forms like mulching, use of temporary plastic walls in open fields, plastic low tunnels, plastic covered walk-in-tunnels, high tunnels, temporary and permanent insect proof net houses, shade net houses and different kinds of greenhouses etc. Presently, China is the world leader in cultivating horticultural crops under different protected conditions and area under protected cultivation has reached around 3.5 million ha and out of this area nearly 96 percent is only being used for cultivation of commercial fresh vegetables and for hybrid seed production of vegetables.

Although, a simultaneous growth like China has also been observed in the developing countries of Indian and African sub-continent for adoption of protected cultivation technologies, but the success rate varied significantly because of poor correlation between the designs of various protected structures and prevailing agro-climatic conditions of the regions. The experience of greenhouse production or protected cultivation which emerged in Northern Europe, stimulated its development in other areas including the Mediterranean region, North America, Oceania, Asia and Africa, with various rates and degrees of success. It has been clearly established and proven that mere transportation or adoption of technology as such from Northern Europe to other parts of the World, irrespective of prevailing agro-climatic conditions was not a valid decision and step. Each region and area actually requires further research, development, extension, training and new norms, procedures and methods of application of the technology to meet the region specific requirements for protected cultivation of horticultural crops.
India being a country with diverse climatic regions have shown an overall growth of around 65,000 ha area under protected cultivation in different forms in the last two decades. The success rate of these technologies varied significantly depending upon the climatic conditions under various regions. In plains of Northern India, these technologies faced high challenges for making them successful against the harsh climatic conditions. Whereas, in the mild climatic areas like that of Bangalore and Pune the success rate achieved has been high. Basically the growth of protected cultivation technology in the country happened mainly due to government policies providing handsome subsidies under various schemes launched by government of India under MIDH (NHM), TM, NHB, RKVY etc., but merely due to the technical beauty of the technology. The technical knowhow for adoption of protected cultivation technology under Indian conditions was not to the level at the time of inception, with time research and development work carried out by various public sector institutions in collaboration with developed countries gradually reflected that for various Indian climatic conditions the technical designs of different protected structures needs modification suitable to the region specific needs of prevailing climatic conditions.

But it is sure that promotion of protected cultivation technology will not only going to help for creation of huge self-employment for unemployed educated youths, but it will also increase the national economy by sale of high quality produce in domestic and international markets. Under the new era of FDI (Foreign Direct Investment) in retail, these kinds of models posses' high potential for enhancing the income of farmers opting for quality and offseason vegetables and cut flowers cultivation through the use of various protected cultivation technologies. On one hand, production of vegetable and cut flower crops under protected conditions provides high water and nutrient use efficiency under varied agro-climatic conditions of the country. On the other hand, this technology has very good potential especially in peri-urban areas adjoining to the major cities which is a fast growing market for fresh quality food of the country, since it can be profitably used for growing high value vegetable crops like, tomato, cherry tomato, colored peppers, parthenocarpic cucumber & brinjal, cut flowers like roses, gerbera, carnation, chrysanthemum etc. and virus free seedlings in agri-entrepreneurial models. But protected cultivation technologies requires careful planning, attention and details about timing of production and moreover, harvest time to coincide with high market prices, choice of varieties adopted to the off season environments, and able to produce economical yields of high quality produce etc. Even though the
application of chemicals for controlling biotic stresses is also low under protected structures which gives a high quality safe vegetables for human consumption. By using protected structures, it is also possible to raise offseason and long duration vegetable crops with high yield (3-5 folds as compared to open field cultivation) and quality. Vegetables and cut flowers farming in agri-entrepreneurial models targeting various niche markets of the big cities is inviting regular attention of the vegetable and flower growers for diversification from traditional ways of crop cultivation to the modern methods like protected cultivation of horticultural crops.

The basis behind the successful implementation of protected cultivation technology lies on selection of suitable protected structures with suitable designs, crops, cultivation models and selection of cultivars for protected cultivation are the fundamental variables that may significantly affect the success and economic return of the entire production system. The success of protected cultivation technology entirely depends upon four basic concepts viz., what to produce, when to produce, how to produce and where to sell the high quality produce. The protected growers must know the two other basic options i.e., choice of crop or variety for its high economic potential/return and to develop the most suitable production system. Crop should be selected based on the existing structures, wide consumption and good adoption to unsteady climatic conditions and suitable for long cultivation cycles. While adopting the protected cultivation technology the following most important points viz., market requirement of the produce, distance from the market for the fresh produce, climatic conditions of the area, soil characteristics and quality of water, economic convenience, crop requirement, labour and skilled manpower requirement should be well considered in advance.

**Major Challenges for Protected cultivation in India**

- Non-availability of region specific designs of protected structures like green houses and insect proof net houses for varied agro-climatic conditions.

- Fabrication of protected structure has come up as a big business, taking an opportunity small industries are sacrificing with the quality of material to be used to gain more profit and also lack of understanding of the designs of the protected structures for different regions and quality of basic steel and cladding material used for fabrication of structures.

- Lack of trained skilled and professional manpower for designing, fabrication of protected structures and thereafter, maintenance of the structures and for protected cultivation of various high value crops.
- Lack of practical training institutions and advisory services in the area of protected cultivation of horticultural crops.
- Lack of availability of the suitable crop varieties and planting material specific to protected cultivation specifically with public sector institutions, its management practices etc. as the planting material/seeds, cladding material, water soluble fertilizers, etc. available with private sector companies and are too costly.
- Lack of demand driven cultivation without proper marketing strategies several times creates problem for proper disposal of the quality produce and sometime farmers are even not getting reasonable price of the produce.
- Increasing threat of soil born problems like root knot nematodes and Fusarium for protected cultivation of horticultural crops and more specifically vegetable crops.
- Non-availability of virus free healthy planting material in vegetables fruits and ornamental crops.
- Power supply for drip irrigation is the major challenge for protected cultivation.

**Potential and Major strategies for adoption of protected cultivation technologies under varied agro-climatic conditions in India:**

Protected cultivation technology for horticultural crops has tremendous potential for adoption over and across the country under varied agro-climatic conditions. The most potential areas where high scale interventions are required to be promoted are as under:

1) Use of plug tray nursery technology on commercial scale for raising healthy vegetable and flower seedlings as a model of agro-business.

2) Large scale use of insect proof net houses with different designs for vegetable cultivation and also for hybrid seed production of vegetable crops.

3) Use of modified naturally ventilated greenhouses equipped with mini sprinklers on the roof area and zero energy consuming exhausts on gutters for continuous removal of greenhouse hot air for cultivation of vegetable and flower crops cultivation under harsh conditions of arid and semi-arid regions of the country.
4) Use of naturally ventilated green house for hybrid seed production in vegetables for increasing the overall profitability of the farmers.

5) Large scale use of plastic mulches for commercial vegetable cultivation under open fields and also under green houses and even under insect proof net houses under varied agro-climatic conditions.

6) Large scale use of micro-grafting technology for developing resistant plant material against soil borne problems.

7) To promote cultivation of fruit crops like papaya, pomegranate under insect proof net houses for protection against biotic and abiotic stresses.

8) Large scale application of low pressure drip irrigation system for managing an area of 1000-2000 sq. mts. area for cultivation of different horticultural crops.

9) Commercial scale use of open roof type high tunnels in northern parts of the country and even under temperate conditions can be more rewarding.

10) Large scale skill development of youth manpower in two ways following the Chinese model i.e., designing, fabrication and maintenance of protected structures and secondly the production management of crops under protected conditions

11) Application of GAP procedures and standards for protected cultivation of crops like vegetables will help to catch international trade.

12) Government support should be extended for self-fabrication mode of temporary low cost structures like insect proof net houses, shade net houses, walk-in-tunnels and plastic low tunnels for the cultivation of suitable vegetable and flower crops.

13) Government should support and promote protected cultivation technology for its sustainability in cluster approach especially in peri-urban areas of the country.

14) Government should also promote to develop input hubs for protected cultivation in multi-locations in PPP mode.

15) Use of solar energy for running drip system and up to some extent for running heating and cooling devices of the protected structures should also be promoted.
16) All the protected cultivation clusters must be mandatorily clubbed with rain water harvesting infrastructure facilities.

17) Suggest most suitable crop sequences for different protected structures and seasons based on research data.

18) Promotion of large scale mechanization in vegetable and flower cultivation by using raised bed makers, plastic laying machines, plastic low tunnel making machines, pipe bending machines for making walk-in-tunnels, drip lateral laying and binding machines

19) To establish convergence and synergy among various on-going and planned government programmes in the field of protected cultivation development.

20) To ensure adequate, appropriate, time bound and concurrent attention to all links in production under protected conditions, post production on farm value addition, processing and consumption chains.

21) Cluster approach for taking up protected cultivation as a whole is required and may be clubbed with processing industries.

The future of protected cultivation technology in India is very vast but highly depending upon the technicality and recommendation of the technology implementation. It is believed that protected cultivation technology has to play a significant role under varied agro climatic conditions of the country as a means for sustainable crop diversification, intensification, and for vertical growth of productivity of horticultural crops leading to optimization of water and fertilizer use efficiency in an environment of water scarcity in addition to better control of product quality and safety, in line with the market demands, standards and regulations. In the near future, the first and most important requirement for the use of protected cultivation technology is for its large scale use for raising disease and virus free healthy planting material in all kinds of horticultural crops and secondly to use the technology for hybrid seed production of vegetables and thirdly production of fresh food for better economic viability in the country and mostly in cluster approach. Further, for sustainability of the technology it is utmost important to develop a huge skilled manpower in form of rural youths in two sets, one set for designing, fabrication/installation and maintenance of the protected structures and the other set for crop production systems and management under protected conditions.
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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. It has a 50 member strong consulting team supported by a panel of domain experts. Tata Strategic has undertaken 500+ engagements, with over 100 clients, across countries and sectors.

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Drive Implementation & Change to derive Benefits

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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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