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**Review Article**

# Plasticulture –A Key Step to Second Green Revolution

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**A B S T R A C T**

The green revolution within India commenced in the early 1960's that led to an increase in food grain production, especially in Punjab, Haryana and Uttar Pradesh due to adoption of modern methods and technology such as the use of high yielding varieties, tractors, irrigation facilities, pesticides and fertilizers. To remain self-sufficient in food grains, we need another green revolution or rather a greener revolution. Innovative agro practices need to be adapted towards transformation of Indian agriculture to precision farming practices, which will result in stretching our agro input resources manifold to increase agricultural productivity in both quantity and quality. Plasticulture applications are one of the most useful indirect agricultural input, which hold the promise to transform Indian agriculture and bring the "Second Green Revolution". Plasticulture is defined as the use of plastics in agriculture, horticulture, water management, food grain storage etc. Plasticulture includes all kinds of plant or soil coverings ranging from mulch films, row coverings, low tunnels to greenhouses. A variety of plastic materials and products are deployed in plasticulture applications for water conservation, irrigation efficiency, crop and environment protection as well as end product storage and transportation. Plastic mulches enhance the productivity in hills. Black plastic mulch (double coated) recorded the highest soil moisture retention, lowest weed density, highest no. of fruits with maximum fruit weight and total fruit yield.

**Keywords**

Plasticulture, Green revolution, Soil, Precision farming and productivity

## Introduction

When the green revolution came into existence in the world, it sure increased the productivity in our agricultural field but it had various hazardous impacts on our environment due to the excessive use of chemical fertilizers that led to health problems and deteriorated our land to the greater extent. The soil fertility reduced drastically. So to overcome these increasing problems, there was a need to introduce second green revolution. Second green revolution will help in triggering higher agricultural growth in India, it is a high end initiative. The second green revolution focus on the entire farming system: livestock, water, soil, crops and income opportunities from agriculture. It will help us in reducing the blind usage of chemical fertilizers and

pesticides. It will predominantly focus on using biotechnology and use of various other innovations that include Soil Health Management, Resource Recovery and Reuse, Sustainable agriculture water management, multiple stress tolerant/Improved crop varieties, multiple water use based Integrated farming systems and Climate resilient/smart practices.

With the advent of second green revolution, the concept of using polymeric material called plastic got introduced. The use of plastics in our agriculture is called plasticulture. Plasticulture applications are one of the most useful indirect agricultural inputs, which hold the promise to transform Indian agriculture and bring in the "Second Green Revolution" (Fig. 1 and Table 1–6).

## What is green revolution?

Norman Borlaug, an American scientist, is credited with the birth of this revolution as he produced crop varieties, which are disease-resistant, and this largely increased the yield of wheat industry in Mexico. The improved strains of wheat together with the new mechanized agriculture practiced in Mexico enable them to meet the food demands. The green revolution started in early 1940s. The change in agricultural practices in the late forties in Mexico was credited to Green Revolution. It efficiently multiplied crop yields in the country and was finally used globally in the fifties and sixties.

Green revolution is defined as an increase in crop production because of the use of new varieties of seeds, the use of pesticides and new agricultural techniques. It was a period when the productivity of global agriculture increased drastically as a result of new advances. Green Revolution is also known as Seed-Water-Fertilizers-Pesticides-Technology (Hardin *et al.*,2008).

## Benefits of green revolution

### Increase in agricultural production

The introduction of Green Revolution in 1967-68 has resulted in phenomenal increase in the production of agricultural crops especially in food-grains. From 1967 onwards, the Green Revolution aimed at bringing about a Grain Revolution. Among the food grains too, it is the wheat crop, which drew maximum benefit from Green Revolution. The production of wheat increased by more than three times between 1967-68 and 2003-04 while the overall increase in the production of cereals was only two times. On account of this reason, it is said that the Green Revolution in India is largely the Wheat Revolution.

### Prosperity of farmers

With the increase in farm production, the earnings of the farmers also increased and they became prosperous. This has, especially, been the case with big farmers having more than 10 hectares of land.

### Reduction in import of food-grains

The main benefit of Green Revolution was the increase in the production of food-grains, because of which there was a drastic reduction in their imports. We are now self-sufficient in food-grains and have sufficient stock in the central pool. Sometimes we are in a position to export food-grains also. The per capita net availability of food-grains has also increased from 395 grams per day in early 1950s to the level of 436 grams in 2003, this in spite of the rapid increase in population. In the words of Dantwala, Green Revolution has given a breathing time. As a result, there will be relief from anxiety of food shortage and the planners will concentrate more on Indian planning.

## Capitalistic farming

Big farmers having more than 10 hectares of land have tended to get the maximum benefit from Green Revolution technology by investing large amount of money in various inputs like High Yielding varieties(HYV) seeds, fertilizers, machines, etc. This has encouraged capitalistic farming.

## Ploughing back of profit

The introduction of Green Revolution helped the farmers in raising their level of income. Wiser farmers ploughed back their surplus income for improving agricultural productivity. This led to further improvement in agriculture.

## Industrial growth

Green Revolution brought about large-scale farm mechanization, which created demand for different types of machines like tractors, harvesters, threshers, combines, diesel engines, electric motors, pumping sets, etc. Besides, demand for chemical fertilizers, pesticides, insecticides, weedicides, etc. also increased considerably. Consequently, industries producing these items progressed by leaps and bounds. Moreover, several agricultural products are used as raw materials in various industries. These industries are known as agro based industries. Textile, sugar, Vanaspati, etc. are some outstanding examples of agro based industries.

## Rural employment

While on one hand, large scale unemployment was feared due to mechanization of farming with the introduction of Green Revolution technology in India, there was an appreciable increase in the demand for labor force due to multiple cropping and use of fertilizers.

## Change in the attitude of farmers

The Indian farmer had remained illiterate, backward and traditional and had been using conventional methods of cultivation since the early times. But Green Revolution has brought about a basic change in his attitude towards farming. The way he has readily adopted the Green Revolution technology has exploded the myth that the Indian farmer is basically tradition bound and does not use new methods and techniques (PujaMondal, 2018).

## Issues of green revolution

Pollution and erosion of soil

Pollution of water

Unemployment among uneducated farmers

Deadly diseases

Introduction of chemical toxins into food chain

Over exploitation of land

Loss of biodiversity

Toxicity and deficiency of certain mineral nutrients into the soil

## Second green revolution

## Definition

An integrated approach based on the entire farming system: crops, livestock, water, soil and income opportunities from agriculture focusing on matching soil to seed and product to market.

## Need

India needed Second Green Revolution to bring food security to its billion plus

population, to remove distress of farming community and to make its agriculture globally competitive.

High productivity and better value addition by agro-processing are its key parameters.

Improving global market opportunities.

Developing technology to conserve water and energy.

Generating rural employment.

Improving rural infrastructure.

## Objectives

To raise agricultural productivity to promote food security.

More emphasis on biotechnology.

To promote sustainable agriculture.

To become self-sufficient in staple food, pulses, oilseeds and industrial raw material.

To increase the per capita income of the farmers.

Improve irrigation, roads and power for rural areas (ICARDA, 2013).

## Schemes Launched by GOI for Implementation of Second Green Revolution

### National Horticulture Mission (2005)

A centrally sponsored scheme to promote holistic growth of the horticulture through area based regionally differentiated integrated approach of water management, protected cultivation, nutrition and pest management, post-harvest, processing and marketing.

### Rashtriya Krishi Vikas Yojana (2007)

It was launched by Dr. Manmohan Singh, the main of this scheme was to achieve 4% annual growth rate in agriculture through development

### National Food Security Mission (2007)

It was also launched by Dr. Manmohan Singh for five years to increase production and productivity of wheat, rice and pulses on sustainable basis to ensure food security of country. In 2012, NFSM raise food grains output by 25 million tons. The main aim of this scheme was to bridge the yield gap in respect of these crops through dissemination of improved technologies and farm management practices.

### Mission for Integrated Development of Horticulture (2014-15)

A Centrally sponsored scheme for the holistic growth of the horticulture sector covering fruits, vegetables, root and tuber crops, mushrooms etc. The main activities of MIDH are use of plastics, setting up of nurseries, tissue culture units, rejuvenation of unproductive, old and senile orchards, organic farming and certification, protected cultivation, integrated pest management, integrated nutrient management etc.

### Pradhan Mantri Krishi Sinchayee Yojana (2015)

It was launched by Narendra Modi with the motto of "HarKhetKoPaani" i.e. per drop more crop. This scheme is being implemented to expand cultivated area with assured irrigation, reduce wastage of water and improve water use efficiency. It also focuses on creating protective irrigation by harnessing rainwater at micro level through "JalSanchay" and "JalSinchan".

### Neeranchal watershed development (2016-17)

The scheme was implemented across 9 states including Andhra Pradesh, Madhya Pradesh, Maharashtra, Gujarat etc.

The main aim of this scheme is to fulfill the watershed component of PMKSY to reduce surface runoff of rainwater, increasing recharge of ground water and better availability of water in rainfed areas resulting in incremental rainfed agricultural productivity, enhancing milk yield and increased cropping intensity through better convergence.

### National adaptation for climate change (2015-16)

The main aim of this scheme is to support the concrete adaptation activities which mitigate the adverse effects of climate change.

### Soil health card to every farmer (2015)

This scheme was launched by Shri Radha Mohan Singh. Its main aim was to provide soil health card to every farmer, which will carry crop wise recommendations of nutrients and fertilizers and also the needed soil amendments to maintain soil health in the long run(NCPAH,2010).

### Challenges of second green revolution

Second Green Revolution may take a long time to show its effect.

Use of chemical fertilizers and pesticides would not stop at one go.

Farmers might not adopt technology for farming implementation challenge.

Indigenous pest control methods are not full proof.

### Technologies and innovations

Soil Health Management

Resource Recovery and Reuse

Sustainable agriculture water management

Multiple stress tolerant/Improved crop varieties

Multiple water use based Integrated farming systems

Climate resilient/smart practices

Plasticulture (Sikka,2016).

### Plasticulture

Plasticulture represents use of applications of plastics in agriculture, horticulture, water management and related areas. Plasticulture applications offer a multitude of benefits and are considered most important indirect agricultural inputs which results moisture conservation, water saving, reduction in fertilizer consumption, helps in precise application of water and 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 and transportation of fruits and vegetables. Plasticulture applications are one of the most useful indirect agricultural inputs which hold the promise to transform Indian agriculture and bring in the “Second Green Revolution”.

### Plastic and its categories

Packaging industry in India has seen a strong penetration of plastics as compared to global standards. Agriculture sector still has not explored the benefits of plastics to a large extent.

India offers strong opportunity for manufacturing of petro chemicals in future with its plan to increase the share of manufacturing in GDP from 16% -25% by 2022. The increase in demographic dividend, urbanization, growing income levels all support a strong case of increase in both demand and supply of petro chemicals in India. Plastics are the major product that account for bulk of the Indian petro chemical industry. A wide variety of plastic raw materials are produced to meet the material needs of different sectors of the economy. These polymeric materials are broadly categorized as:

## Commodity plastics

These account for bulk of the plastics and in turn for petro chemical industry. These include:

Polyethylene (PE): [ (Low Density PE (LDPE), High Density PE (HDPE), Linear Low Density PE (LLDPE)]

Polypropylene (PP)

Polyvinyl Chloride (PVC)

Polystyrene

While Engineering and Specialty plastics are plastics that exhibit superior mechanical and thermal properties in a wide range of conditions over and above more commonly used commodity plastics and are used for specific purpose these include:

Styrene derivatives (PS/ EPS and SAN/ABS)

Polycarbonate

Polymethyl methacrylate

Poly oxy methylene plastics.

## Why plasticulture?

Higher strength/weight ratio.

Resistance to chemicals.

Superior electrical properties

Impermeability to water, gas, etc.

Superior thermal insulation properties.

Superior flexibility.

Excellent Corrosion resistance.

## Significance of plasticulture in agriculture efferent types

Broad Classification of plasticulture applications are as follows:

### Water management

Lining of canals, ponds & reservoirs with plastics film.

Drip & Sprinkler Irrigation.

PVC & HDPE pipes used for water conveyance.

Sub-surface Drainage

### Nursery Management

Nursery bags, Pro-trays, Plastic plugs, Coco-pits, Hanging baskets, Trays etc

### Surface cover cultivation

Soil Solarisation

Plastics Mulching

### Controlled environment agriculture

Greenhouses

Shade net houses

Low tunnels

Plant Protection nets

**Innovative packaging**

Plastics crates, bins, boxes, leno bags, unit packaging products etc

CAP Covers, Controlled Atmospheric Packaging(CAP) & Modified Atmospheric Packaging (MAP)

Organic farming

HDPE Vermibed

**Plasticulture application**

Plastic mulch

Drip irrigation

Sprinkler irrigation

Pond and Reservoir (Farm ponds with plastic films)

Green houses

Shade nets

Tunnels (low tunnel)

Soil solarization

**Plastic mulch**

In this technique, crops grow through the holes in the thin plastic sheets. This used in conjunction of drip irrigation is used mainly to conserve water and suppress weeds. Certain mulches act as barrier to keep Methyl bromide, a powerful fumigant & ozone depleting agent, in the soil. Disposal of plastic mulch is a concern; however, technologies exist to recycle mulch into reusable resins.

**Benefits**

Early planting and faster growth: Dark and clear mulches intercept direct sunlight thereby reducing soil temperature, hence facilitating early faster growth.

Soil moisture retention: Plastic mulches reduce the water loss due to evaporation which means there is less water requirement for irrigation and even distribution of moisture reducing plant stress.

Weed management: Plastic mulch prevents weed growth by preventing the sunlight from reaching the soil & by blocking the pathway for the weeds to grow.

Optimizing fertilizer usage: Drip irrigation with plastic mulch reduce the leaching of fertilizers below root zone thereby ensuring that the nitrogen and other nutrients are applied only to the root zone as needed. This greatly reduces the fertilizer requirement as compared to broadcast fertilization with flood & furrow irrigation.

Crop quality: Plastic mulches reduce contact of fruits and vegetables with soil thereby reducing fruit rot and keeping the produce clean.

Better Soil aeration: Plastic mulch reduces crusting effect of rain and sunlight and quantity of weed resulting in better soil aeration and aiding microbial activity.

Root damage reduction: Reduction in weed eliminates the need of cultivation ensuring lesser root damages and improving overall growth of plant.

## Disadvantages

Cost: plastic mulch comes at a much higher cost as compared to bare soil planting. The cost components include equipment, plastic film, trans-planters for plastic beds and additional labor for installation and removal of films.

Environmental concern: Conventional plastic, used as mulch film tend to accumulate in soil as the disposal of these are economically and technically difficult. Biodegradable plastics are a good substitute as they get eventually degraded by microbial community.

The influence of plastic and organic mulching on productivity, growth and weed density in chilli was conducted at experimental farm, division of vegetable science Skuast –K, Shalimar during 2013-15 by Narayan *et al.,* using three levels of organic mulch paddy straw as 6.0,9.0 and 12.0 t/ha and three forms of inorganic mulch as black double coated, white double coated and black single coated polythene of 30 micron thickness. The data was recorded on soil moisture, weed density, number of fruits, fruit length, fruit width, fruit weight and fruit yield. The result showed that the black plastic mulch (double coated) recorded the highest soil moisture retention (16.74%), lowest weed density (74.81 g/plot dry weight), highest number of fruits (140/plant) with maximum fruit weight (9.99g) and total fruit yield (463.08 q/ha). Mulching with double coated black polythene recorded highest B:C ratio.

## Types of plastic mulches

### Black mulches

The black plastic film does not allow sunlight to pass through on to the soil. Thus, photosynthesis does not take place in soil in absence of sunlight below the black film. Hence, it arrests weed growth completely. It is helpful in conserving moisture, controlling weed growth and increases the soil temperature. The black film has proved to be effective in plains to keep crop cool during summer.

### Clear or transparent mulches

The transparent film will allow sunlight to pass through and the weeds will grow. However, by using herbicide coating on the inner side of film weed growth can be checked. This application is quite successful in nursery raising by solarising the beds before sowing seeds for nursery raising, which gives near 100% seed germination and disease free nursery. It is effective in hilly areas for raising soil temperature in cold climatic conditions during winter.

### Two side colour mulches

These films enable growers to control different plant properties such as leaf and fruit size, colour, root development, yield, branching, plant height, strength plant stems, time of flowering and aid in disease control by keeping insects away.

YELLOW/ BLACK: Attract certain insects and thus acts as a trap for them, which prevent diseases.

WHITE/ BLACK: Cools the soil

SILVER/ BLACK: Cools the soil though not to the extent of white black film and repels some aphids and thrips. RED/ BLACK: Partially translucent allowing radiation to pass through and warm soil but also reflects radiation back into plant canopy changing ratio of R:FR light, which results in changes in plant vegetable, flower development and metabolism to early fruiting and increased yields in some fruit and vegetable crops.

### Degradable mulches

### Photodegradable

This type of plastic mulch film gets disintegrated under sunlight over the designated mulching period.

### Bio degradable

This type of plastic mulch film gets disintegrated under natural environmental conditions and gets mixed in soil after mulching period.

### Drip irrigation

Drip irrigation drips water slowly to the roots of the plant, either through the soil surface or directly on the root zone. A narrow tube delivers water directly to the plant base.

### Advantages

### Reduced labour

Labour cost is very less compared to conventional irrigation and is further reduced as activities like field leveling is no longer necessary in drip irrigation.

### Better water utilization

Water application efficiency is very high with flexibility of using recycled non-potable water, while providing a uniform water distribution and maintenance of moisture within the root zone at field capacity.

### Reduced cost

Reduced leaching results in better utilization of fertilizers and operating generally at lower pressure results in energy saving too. As foliage around plants is dry, it reduces the risk of plant diseases too.

### Disadvantages

### High installation cost

There is high initial cost of installation and if the water high salinity/ alkalinity, the field soil might become unsuitable due to salinity and poor infiltration of the soil.

### Requires proper maintenance

The sun affects the tube and associated systems and equipment, if not properly maintained, might result in clogging.

**Table.1** Increase in yield of vegetable crops through plastic mulching

| CROP | YIELD (t/ha) | | INCREASE IN YIELD (%) |
|---|---|---|---|
| | UNMULCHED | MULCHED | |
| CABBAGE | 14.30 | 19.90 | 39.16 |
| CAULIFLOWER | 18.58 | 25.02 | 34.66 |
| TOMATO | 69.10 | 94.85 | 37.26 |
| CHILLI | 16.79 | 19.71 | 17.39 |
| OKRA | 6.91 | 8.56 | 23.88 |
| BITTER GOURD | 20.12 | 25.63 | 27.39 |
| BRINJAL | 36.73 | 47.06 | 28.12 |
| BROCCOLI | 15.64 | 25.14 | 60.74 |

(Bhattacharya *et al*., 2018)

**Table.2** Effect of mulch on soil moisture, weed density and yield parameters in chilli (*Capsicum annuum* L)

| TREATMENTS | Soil moisture content (%) | Weed density (g/plot dry wt) | No. of fruits | Fruit length (cm) | Fruit width (cm) | Fruit wt(g) | Green fruit yield (kg/plant) | Green fruit yield (q/ha) | B:C ratio |
|---|---|---|---|---|---|---|---|---|---|
| No mulch | 10.10 | 418.41 | 55 | 12.50 | 1.97 | 7.81 | 0.433 | 144.6 | 1.63 |
| Organic mulch (6t/ha) | 12.92 | 373.97 | 68 | 11.87 | 1.67 | 6.17 | 0.419 | 139.85 | 1.52 |
| Organic mulch (9t/ha) | 13.32 | 366.08 | 60 | 12.60 | 1.33 | 5.39 | 0.504 | 167.99 | 1.48 |
| Organic mulch (12t/ha) | 14.78 | 352.82 | 71 | 12.43 | 2.03 | 8.48 | 0.278 | 198.79 | 1.62 |
| Black polythene (double coated 30micron) | 16.74 | 75.37 | 140 | 14.06 | 2.07 | 9.99 | 1.39 | 463.88 | 3.49 |
| white polythene (double coated 30 micron) | 15.22 | 82.82 | 80 | 14.02 | 1.83 | 8.86 | 0.718 | 239.12 | 1.77 |
| Black polythene (single coated 30 micron) | 15.00 | 108.92 | 120 | 14.03 | 1.73 | 7.79 | 0.945 | 314.94 | 2.91 |
| CD (P≤0.05) | 0.22 | 20.90 | 10.5 | 0.37 | 0.23 | 0.28 | 1.52 | 31.70 | |

**Table.3** Conventional Vs Drip Irrigation

| | **Yield (kg/acre)** | **Yield (kg/acre)** | |
|---|---|---|---|
| **Crop** | **Conventional method** | **Drip method** | **% increase** |
| **Tomato** | **576** | **894** | **55** |
| **Bitter gourd** | **2560** | **420** | **54** |
| **Chilli** | **1280** | **1600** | **25** |
| **Cauliflower** | **300** | **405** | **35** |
| **Potato** | **600** | **800** | **33** |

(kumar,2013)

**Table.4** Performance of tomato varieties under polyhouse and open field conditions in NEH Region (Barapani)

| Varieties | Polyhouse yield (q/ha) | Open field yield (q/ha) |
|---|---|---|
| BT-117-5-3-1 | 342.00 | 115.00 |
| KT-10 | 283.60 | 117.40 |
| BT-10 | 294.00 | 111.65 |
| ArkaAlok | 260.00 | 57.90 |
| BT-12 | 302.40 | 101.00 |

(Sanwal*et al.*, 2004)

**Table.5** Comparison of Growth and Yield of Cabbage Hybrid under Low Tunnel and Open Field Conditions

| Character | Location-1 | | Location-2 | | Location-3 | | Average | |
|---|---|---|---|---|---|---|---|---|
| | Low Tunnel | Open Field | Low Tunnel | Open Field | Low Tunnel | Open Field | Low Tunnel | Open Field |
| Germination (%) | 90 | 72 | 96 | 84 | 87 | 70 | 91* | 75.3 |
| Days To Maturity Of Seedlings | 46 | 52 | 48 | 54 | 46 | 51 | 46.6* | 53.0 |
| Transplantation Survival(%) | 98 | 81 | 98 | 75 | 94 | 73 | 96.6* | 76.3 |
| Days To Head Maturity | 72 | 88 | 70 | 86 | 75 | 82 | 72.3* | 85.3 |
| No. Of Head Formed Plant (%) | 96 | 91 | 98 | 90 | 95 | 88 | 96.3* | 89.6 |
| Average Head Weight (Kg) | 0.86 | 1.01 | 0.96 | 0.98 | 0.81 | 0.82 | 0.87 | 0.93 |
| Yield(Q/Ha) | 555.79 | 652.56 | 633.34 | 587.88 | 518.02 | 562.32 | 569.0 | 600.9 |
| Yield Of Super Heads (Q/Ha) | 278.58 | 191.55 | 301.92 | 186.76 | 280.30 | 180.43 | 290.2* | 186.2 |

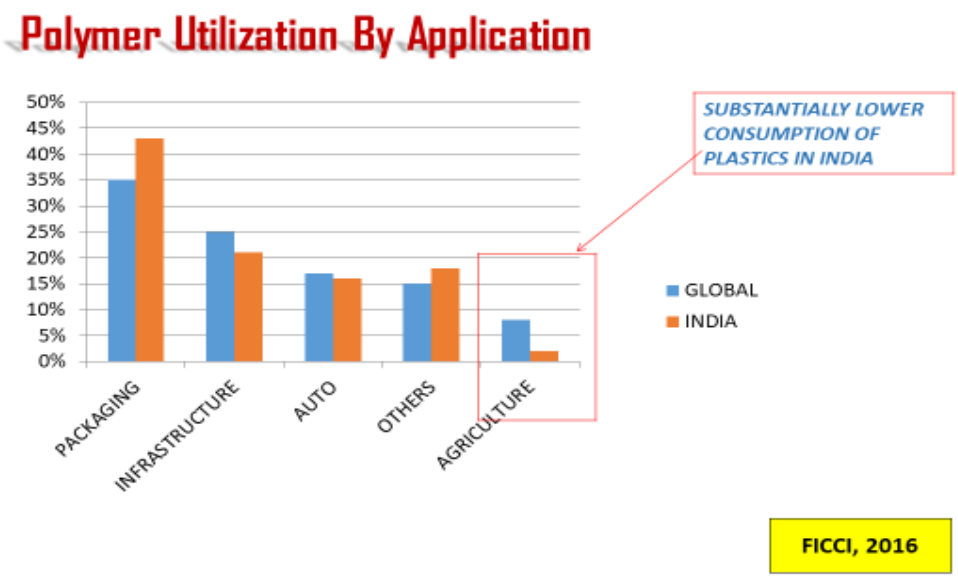
(Saleem et al., 2014)

**Table.6**

| S.NO. | Plasticulture application | Area covered (‘000 ha) | Potential area (‘000 ha) | Penetration Level (%) |
|---|---|---|---|---|
| 1 | Drip irrigation | 2,076 | 34,915 | 6% |
| 2 | Sprinkler irrigation | 2.169 | 45,790 | 5% |
| 3 | Green house and plastic tunnel | 20 | 700 | 2.8% |
| 4 | Shade net | 30 | 1,000 | 3% |
| 5 | Plastic mulching | 30 | 1,000 | 3% |
| 6 | Plant protection nets | 20 | 1,203 | 1.6% |

(NCPAH, NMMI Report)

**Fig.1**




Global average for plastics demand in agriculture is ~8% while India is substantially lower at only 2%.

## Sprinkler irrigation

Sprinkler irrigation is a method of applying the irrigation water by spraying it in the air through sprinklers so as to break it up into small drops before falling to the ground.

The pump system, sprinkler and operating parameters must be designed for uniform application(Haidula,2016).

## Advantages

Protects crops against frost

Saves crops from insects & pests

Irrigation is possible on undulating terrains

## Disadvantages

High installation costs

High operation costs

## Farm Pond with plastic film

Rainfall in drought prone areas is highly erratic, which makes storage of water an integral part of rainwater harvesting system. The water seepage and evaporation are major challenges in these areas due to which drop in depth per day of ponded water is high. To escape this depletion of stored water, pond sealing is done by installing it with conventional plastic lining. It reduces the seepage in effective and cost economic way. Different lining materials are available in the market, which includes concrete, HDPE (high density polyethylene), PVC (polyvinyl chloride) and polyethylene.

## Advantages

Conserves water for supplementary irrigation

Suitable for low rainfall areas

**Disadvantages**

Most of the liners are not flexible.

Cracking of liners may occur

**Greenhouse**

Greenhouse is essentially a structure built using transparent materials, such as plastic or glass, in which regulated climatic conditions are simulated to help crops grow. The climatic simulation is aided by equipment such as screening installations, heating, cooling and lighting. Typical plastics used for greenhouses are polyethylene film, polycarbonates and Poly methyl methacrylate acrylic glass.

**Advantages**

Quality of the produce is of superior standards

Provides better control on pests and diseases

Crop maturity is early, making room for more crops

**Disadvantages**

Cost is more for small scale farmers.

**Shade nets**

Shade nets are a framed structure made of materials such as bamboo, wood, iron, etc. Structurally being similar to greenhouses, it is covered with plastic nets having different shade percentages. Each plant has its distinct requirement for sunlight and shade under which it grows best. Simulating the optimum growth conditions requires selection of the correct percentage of shade factor. Round the year cultivation is made possible by partially controlling atmosphere and environment by reducing light intensity and effective heat during daytime.

**Advantages**

Better yields during summers

Reduces evaporation losses

Cuts down the sunlight intensity to protect plant saplings

**Disadvantages**

High cost and maintenance

Slow growth and development of some plants.

**Low tunnels**

Low tunnels enable crop production in the cold climates, plains and during rains. Being similar to greenhouse, polyethylene films have proved to be highly economical and effective in controlling conditions to support plant growth.

**Advantages**

Improved quality and quantity of produce.

Reduction in the incidence of disease and pests.

Faster growth and maturity of crops due to controlled conditions.
Use of water is optimized and there is a reduction of 40-50%

**Disadvantages**

Requires careful handling

Soils become too dry.

The comparative study on cultivation of

cabbage hybrid S-92"Mitra" was conducted during 2006 to 2008 at three locations in the Kargil district under low tunnel and open field conditions.

The result showed that low tunnel technology increased seed germination from 75.3-91.0 % and seedling survival on transplanting from 76.3-96.6%.

The time taken for production of marketable seedling as well as attaining marketable cabbage heads reduced from 53 to 46.6 days and 85.3 to 75.3 days respectively.

The total cabbage yield was significantly higher under low tunnels as compared to open field conditions.

Higher net returns per unit area were realized under low tunnel cultivation of cabbage than open cultivation due to early maturity, early market entry of produce and evading market glut.

## Soil solarisation

Soil Solarisation is a technique of using solar energy to control weed growth and soil borne pests such as plant pathogens including bacteria, insects & mites.

This is done by mulching the soil with a transparent polyethylene cover to trap the solar energy. Soil is decontaminated using solar power as a pre-planting soil treatment. Solarisation induces biological, chemical and physical changes in the soil inducing increased growth response & long-term effects on biological control.

## Advantages

Kills insects and soil borne pests

Controls weed growth

Controls nematodes

## Disadvantages

It is climate dependent.

The beneficial microorganisms also get killed due to high temperature.

## Vermi bed – organic farming

The product is chemically treated; UV stabilised and completely stitch-less having ability to withstand extra environmental stress.

Dimension of the bed 12' x 4' x 2' (L x W x H) & Mass 340 gms /sq- m (minimum), having fourteen support pockets (40mm X 120mm) for inserting pegs to keep the bed erect.

Three net windows on both sides for ventilation purpose to maintain required humidity to enhanced life span of the earthworms. An reinforced bottom outlets in corner is used for draining vermiwash with drain cover.

Requires less space, can be installed anywhere (allows shifting of structure) with proper ventilation.

Bed produces annually 100 liters of Vermiwash.

## Raising nursery beds using plastics

## Polythene bags nursery

The seeds are sown under protected structure to raise seedlings and provide protection to them from various natural hazards. For most of the cucurbits seed propagation and in situ sowing is practiced. These polybags are generally used for raising early nurseries of

cucurbits. The seedlings are ready for transplanting after 21-25 days at 2-3 true leaf stage. By using these polybags there is considerable saving in seed quality nearly 50-60%.

## Plug tray or pro-tray nursery

Low cost protected structure using shade nets have started vegetable seedling production in pro-trays by using sterilizing coco- peat as growing medium. The pro trays reduce the root damage in seedlings and decrease excess water retention at base. The media which is light in weight would promote excellent germination and growth (Narayan., 2012)

## Plastic application in post harvesting

India is a country with a large population with huge food requirements. Unfortunately, about 20-30% of the fruits and vegetables produced in the country are lost due to mismanagement, wastage and value destruction. So, a sizable chunk of the harvested product is lost before reaching its end-consumer. There is a huge potential to save this sizable fraction and improve the system.

Lack of sorting facilities, inappropriate packaging, slow transport systems and inadequate storage facilities are some of the key factors behind this loss of perishable goods. Plastics have the potential to play a significant role in preservation of quality and longevity of harvested produce. Plastics are easy to handle, cheap, durable over its substitutes such as paper, cloth, etc.

## Potential of plasticulture

Input optimization & Output maximization

Water saving (> 20%)

Time saving

Labor saving (7.5% - 18.75%)

Fertilizer saving (~ 28%)

Higher production (~42%)

Proper utilization of land

Improved Quality

Early fruiting (7-21 days)

## Limitations of plasticulture

High capital cost

Lack of technical knowledge

Lack of awareness regarding subsidies

Perception that the system is not required or the system is not economical, therefore not required for the cropping pattern adopted by them. Some farmers also reported that though they applied for the subsidy grant but are yet to receive the sanction.

## Measures to tackle the challenges

### Scheme related

Schemes should be made available as per the requisite condition of the field and environment. A uniform standardized subsidy policy fails to address the respective issues for specific segments.

The implementation is carried out by parallel departments, who do not pay adequate attention to the crops of other departments. The best implementation strategy is emulation of the Special Purpose vehicle (SPV) implemented in Gujarat and AP.

## Technology related

Central testing facility must be established to deal with the design, development & testing of equipment. Government should conduct regular random audit with at least 2% of the beneficiaries within first year of installation, to ensure that suppliers supply good quality installations.

Warranty & After-sales services ought to be monitored by implementing agencies and balance of payment on basis of satisfaction of the beneficiary should be considered and evaluated.

Standardization of components must happen as availability of fungible spare part is an issue.

## Awareness and capability building

Current extension network is not making significant impact in creating awareness. Involving system manufacturers would increase the existing quality of the existing network.

System manufacturers must carry out frequent demonstration at strategic locations for creating awareness and be involved in providing agronomic packages to encourage adoption.

System suppliers are as effective as Word of Mouth in creating awareness so they must be involved in demonstration to potential beneficiaries. Technical and operational aspects should be mandatory part of training by system suppliers.

It is understood that the field officials involved in GOI scheme have inadequate knowledge. Refresher course and exposure visits are required to enable them to deliver the implementation.

## Follow up action

The potential of these practices are yet to be mapped in the states. If the potential is mapped, targets for the same could be fixed and project management efficiency and efficacy could be tracked.

High initial cost of installation for Micro irrigation is one of the major reasons for disinclination of farmers to adopt the technology. 1% of the MI outlay must be earmarked for R&D and the existing low cost technologies must be popularized for scale up and adoption.

Plasticulture is a viable solution for India, to launch Second Green Revolution

The usage of plastics not only maximize output of farmers but also optimise the input factors

Leading to high productivity of crops along with efficiencies in time and cost involved.

## References

Bhattacharya, S., Das, S and Saha,T. 2018. Application of Plasticulure in horticulture. *The Pharma Innovation Journal.*7(3): 584-585.

Haidula,S. 2016. Irrigation water use and vegetable production efficiency assessment between sprinkler and drip irrigation systems at North Central Namibia. *Hedmark University of Applied Sciences.*

Hardin and Lowell,S.2008. The Green Revolution.*Nature:470-471.*

International Centre for Agriculture Research in Dry Areas (ICARDA). 2013. *Science for Resilient livelihoods in Dry Areas.*

Kumar, L. 2013. To study the promotion of

Micro Drip irrigation system and its impact on Horticultural crop production in Ranchi District of Jharkhand.

Mondal,P.2018. Eight Major Economical Impact of Green Revolution in India.

Narayan, R.2012. Vegetable Nursery Raising Techniques. *Krishi Vigyan Kendra, Indian Council of Agriculture Research Complex for Goa.*

Narayan, S., Makhdoomi, M.I., Malik, A., Nabi, A., Hussain, K and Khan, F.A. 2017. Influence of Plastic and organic mulching on productivity, growth and weed density in chilli (*Capsicum annuum* L.). *Journal of Pharmacognosy and Phyto-chemistry. 6(6):1733-1735.*

National Committee on Plasticulture Applications in Horticulture (NCPAH).2010.

National Committee on Plasticulture applications in Horticulture 2014. Protected Cultivation.

Potential of Plastics Industry in Northern India with Special focus on Plasticulture and Food Processing. 2014. *Federation of Indian Chambers of Commerce and Industry.*

Role of Plasticulture in next Generation Agriculture, 2016. A Report on Potential of Plasticulture in India. *Federation of Indian Chambers of Commerce and industry*.

Saleem, T., Mehdi, M., Hakeem, A.H., Trumboo, M.S and Ganai,N.A.2014. Comparative study on cultivation of cabbage under low tunnel and open field conditions in cold arid Ladakh region. *Journal of Krishivigyan. 2(2):19-21.*

Sanwal, S.K., Patel, K.K and Yadav, D.S. 2004.Vegetable production under protected conditions in NEH region:Problems and Prospects. *Himalayan Ecology 12(2).*

Sikka, A.K. 2016. Powering Second Green Revolution Through Emerging Technology. *IWMI Representative – India and Principal Researcher International Water Management Institutue New Delhi.*