Role of Plasticulture Technologies in Agriculture Production and Post-Harvest Management

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The Green Revolution with its emphasis on high yielding variety seeds, fertilizers, pesticides and better methods of farming, swept like a wave into the Indian countryside. It turned us from being deficient in food grains to being self-sufficient. But the increase in agricultural yield has to keep pace with the growing population. To remain self-sufficient in food grains, we need another green revolution, or rather, a greener, revolution. Innovative agro practices need be adopted towards transformation of Indian agriculture Plasticulture is one of the innovative application of plastics it is the combination of two words, plastics and agriculture. Per capita consumption of plastic (2015) in India is 9.7 kg/person which is far below world average of 45 kg/person. So the application of plastics in agriculture offers huge opportunity of modernizing Indian agriculture. It is defined as the use of plastics in plant and animal agriculture. Plasticulture is the use of plastics in agriculture, horticulture, water-management, food grains storage and related areas. A variety of plastics materials and end products are deployed in plasticulture applications - for water conservation, irrigation efficiency, crop and environment protection, as well as end product storage and transportation. Plasticulture applications are considered the most important indirect agriculture input which results in moisture conservation, water saving, reduction in fertilizer consumption, helps in precise application 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. Plastics can play a major role in energy conservation. They require minimum energy in production and conversion to finished products. Plastics have definite advantages over conventional materials because it has several properties: Higher strength / weight ratio, Superior electrical properties, Superior thermal insulation properties, Excellent Corrosion resistance, Superior flexibility, Impermeability to water and water, Resistance to chemicals, Less friction due to smoother surface.

Major plasticulture technologies applications areas are as follows:

Water management

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

Nursery Management:

1. Nursery bags, Pro-trays, Plastic plugs, Coco-pits, Hanging baskets, Trays etc
2. Surface cover cultivation :
3. Soil Solarisation
4. Plastics Mulching

Controlled environment agriculture:

1. Greenhouses
2. Shade net houses
3. Low tunnels
4. Plant Protection nets

Post-harvest Management:

1. Plastics crates, bins, boxes, leno bags, unit packaging products etc
2. Controlled Atmospheric Packaging(CAP) & Modified Atmospheric Packaging (MAP)

To harness or untap the potential of plastics in agriculture ICAR has started All India Coordinated Research Project on Plasticulture Engineering and Technologies (PET) become operational in 1988 during VII Plan period (known as AICRP on Application of Plastic in Agriculture). AICRP on PET takes research and extension activity pertaining to water management, protected farming, post-harvest produce management etc. In XII Plan period, the project became operative at fourteen Centres. The major thrust areas of the project are on surface covered cultivation and development of package of practices for better utilization of covered area, rainwater harvesting or water storage pond lining, efficient utilization techniques for stored water including pressurized irrigation, gravity fed micro-irrigation, farm machinery components using plastics as material for reducing weight and improving efficiency, and intensive fish culture devices and strategies. It has made significant contributions during the course of its execution in the field mentioned above. It includes development of polyhouse cultivation strategies and its participatory evaluation, plastic film lined ponds, shade net / insect net house designs, plastic body winnower-cum-grader for hilly regions, packaging strategies for fruits and fish, plastic mango ripening chamber, gadgets for intensive fish culture, etc AICRP on PET developed several plasticulture technologies which plays important role in agriculture production and post-harvest Management

Role of plasticulture technologies in agriculture production

1. Polyhouse, Shade net structures low tunnel and mulching technology :

Improved Polyhouse, shade net structure design and mulching techniques developed in this scheme have direct and indirect impact on overall agricultural production due to following advantages

- Intensive cropping on small land area – higher productivity per unit of natural resources used (land and water)
- Less input requirement - more input use efficiency labour and soil solarization.
- Environment friendly - Excessive uses of inputs (fertilizers and pesticides) are avoided.
- High quality produce - free of pesticide residues for human consumption.
- Easy to relocate and dismantled in case of low tunnel with low cost of operation
- Higher yield and better quality produce due to creation of optimum conditions such as climatic control, balanced plant nutrition and plant protection, which can never be achieved in the open field conditions.
- Some of the low cost technologies and design of Polyhouse reduce the cost of production and also increased production of crops
- Shade nets cuts down the light intensity and reduce the temperatures to some extent, making the climate congenial to grow many off-season crops where conventional farming is too difficult.
- In case of mulching Soil moisture control, temperature control in root zone, weed control, reduce damage to produce (Strawberry protected from contact to soil)
- Enhances photosynthesis by light reflected back to leaves, insect pest management (act as repellant or attractor for some insects

Major application of controlled environment structures:

1. Offseason cultivation of vegetables crops, flowers and high value crops
2. Nursery and seedling raising
3. In the area of aquaculture

Some of the studies carried out by AICRP on PET centres in the field of protected cultivation (greenhouse/ polyhouse and shade net structure) evident that use of plasticulture technologies have increased production of agriculture crops and also in above said applications.

Role of Polyhouse, shade net, low tunnel technology in agriculture production

ICAR-VPKAS Almora centre (2010) studied and found green onion yield under polyhouse conditions was 48.9 per cent higher than open field conditions (65.6 kg/100 m2). Lowest green onion yield was observed under control. In terms of net energy return, energy profitability, energy use efficiency and energy productivity; polyhouse conditions proved better than open conditions while in case of specific energy open conditions proved better. Palamapur centre (2010) studied nursery raising of different vegetable crops and found that Nursery grown outside the polyhouse took more days to germinate as compared to the nursery grown inside the polyhouse. Quality of nursery produced outside the poly house was very poor due to heavy showers of rain during rainy season. Palampur centre (2010) evaluated Capsicum-tomato-lettuce and Capsicum-tomato-broccoli for round-the-year utilization of the polyhouse and higher income generation. Yield of capsicum increased by 18 to 26% and yield of tomato increased by 47 to 53% in naturally ventilated polyhouse as compared to their yield in open condition. Yield of broccoli increased from 132 q/ha in open condition to 295 q/ha in the polyhouse recording an increase of 123% whereas yield of lettuce was recorded as 155 q/ha inside the polyhouse with an increase of 26% over the yield in open condition. Capsicum-tomato-lettuce fetched income of Rs 162.50 per m^2 whereas capsicum-tomato-broccoli fetched Rs. 172.20 per m^2 area. JAU Junagadh centre (2014) found in raising of papaya seedling that poly cum shade net and black shade net papaya are best for raising because it has shown maximum observations recorded seedling height (38.9 cm), collar diameter (5.05 mm), number of leaves per plant (14.75) and tap root length (20.42 cm). Junagadh centre (2014) studied and found Maximum yield

Table: Yield performance of different crops under protected cultivation

Crop	Average yield in open (t/ha)	Expected yield in poly-net-house (t/ha)	Remarks
Tomato	45-60	70-100	About 1.5 times higher yield compared to open field and about 20-30 % will be early yield
Capsicum	18-20	40-55	About 2 - 2.5 times higher yield compared to open field and about 40 % will be early yield
Chilli	25-30	30-50	About 1.2 - 1.5 times higher yield compared to open field
Bittergourd	20-25	30-40	About 1.5 times higher yield compared to open field
Cucumber	20-25	40-75	About 2.25 times higher yield compared to open field

of cumin (1267 kg/ha) in plastic film structure followed by PP nonwoven structure (1062 kg/ha). Minimum yield of cumin (758 kg/ha) was observed in control. Net profit in plastic film structure is estimated to be 75550 Rs/ha as compared with control.

Role of plasticulture technologies in Post-harvest management

Plasticulture technologies have major role in area of post-harvest management.

Plastics properties described earlier made them best contender in post-harvest management from filed to the consumer basket. Major areas of plasticulture technologies application in post-harvest management are drying, short term storage and long term storage, material handling and transportation of agricultural produce.

1. Drying of agriculture produce

Drying unit operation is simple method of preservation of agricultural produce. The plasticulture technology such as polyhouse multitier drier makes good use of modified microclimatic condition for drying of fruits and vegetable crops. High drying rates reduce time of dying and good quality that open sun drying are some advantages of this plasticulture technology.

SKUAST-K Srinagar centre developed multitier solar tunnel drier for drying of vegetables results revealed that The percentage weight loss in palak, fenugreek and okra were around 88%, 86% & 54%.During the drying of the samples inside the greenhouse dryer, the max/min temperature varied between 39.9 to -7.1 ^{0}C The final moisture content of palak & fenugreek was around 3.5% while it was 5% for okra.

2. Storage and Packaging, transportation of agriculture produce

Plasticulture technology play important role in storage, and transportation of agriculture produce. It helps in preservation of produce from short term storage to long term storage. Packaging provides produce itself microclimate which maintain its quality as well as extend the shelf life of produce. It offers several advantages such as ease in handling, flexibility in transport and storage with lower cost of operation. Reducing losses and maintain quality in storage of agriculture produce. Some of the popular plasticulture technologies are Plastics crates, bins, boxes, leno bags, unit packaging products, colored shade nets, Modified Atmospheric Packaging (MAP). Plastic packaging plays an important role in the fruit and vegetable distribution chain. According to Watkins and Nock (2012), it offers main function of packaging with ease: Containment. Containment is the basic requirement for movement of a product from one point to another. The package type and size will be a function of the product and market requirements. Protection and Preservation. Packages provide protection for the product against environmental factors such as dust and water, as well as impact and compression bruising, and friction injuries that can occur during handling and transport .Convenience. Products are packaged in sizes convenient for handlers and for the consumer. Consumer packages are often contained within larger containers for transport because of economies of scale Communication. In addition to advertising the type and source of the product, the package lists gross and net package weight, unit size of the product, and any additional information required by government regulations.

Some silent research findings of AICRP on PET centres in reduction of losses in perishables. Shadenet Based farm storage structure (Junagadh centre, 2011): Shelf life of tomato increased up to 4 days and for spinach it was increased by 2 days in the net house (75%) with less weight loss and decay. Plastics in handling, packaging and transportation of custard apples (Udaipur, 2011). The study was undertaken in participatory mode with farmers with help of an NGO. Fruits packed in foam sheet have minimum loss in mass (0.67%) and loss in hardness (3.02 %) while colour was same in all the treatments studied. The data were 0.82% and 3.47%, respectively for packed in bubble plastic sheets. The maximum loss in mass (2.95%) and loss in hardness (7.88%) was obtained for the control sample. Junagadh centre (2011) studied transportation study of fruits found that the quality parameters significantly highest in (fiber plastic board carton) FPBC and losses observed minimum in FPBC. Transportation losses of sapota fruit was minimized about 12% and 3% in FPBC as compared to gunny bag and plastic crate, respectively. Bhubaneswar centre (2009) evaluated PE, PP and laminated PP packaging materials for enhancing the keeping qualities. Laminated PP packaging materials were found to be most suitable for both vacuum packaging and MAP of fish processed product. Keeping quality of the product was found unaltered even after 3 months in frozen storage. Study of shrink packaging by ICAR-CIPHET Abohar centre illustrate performance of shrink packaging plasticulture technology in improving shelf life of fruits.

Commodity	Storage life			
	Ambient		Cold store	
	Shrink wrapped	Unwrapped	Shrink wrapped	Unwrapped
Kinnow	27	13	70	41
Tomato	19	10	39	23
Capsicum	25	4	46	21

Conclusion

Plasticulture has been proved effective for enhancing Agricultural production all over the world. In India, it is gaining importance in area of for improving agriculture production and post-harvest management in preventing transportation and storage loss. Still, the real benefits of the plasticulture are not being realized at farmer's level due to lack of information, standardized designs and package of practices, local level services, and availability of affordable technologies. AICRP on PET is striving to develop strategies for use, development and evaluation of efficient and economic plasticulture techniques for overall improvement of production scenario.

References

http://www.ncpahindia.com
http://ficci.in/spdocument/20396/Knowledge-Paper-ps.pdf
Workshop Coordinator reports of AICRP on PET (2011-12, 2012-13, 2015-16).