

**STUDY ON DEVELOPING MEASURES TO PROMOTE THE USE OF
AGROTEXTILES IN INDIA UNDER THE TECHNOLOGY MISSION ON
TECHNICAL TEXTILES (TMTT)**

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सत्यमेव जयते

Office of the Textile Commissioner

Ministry of Textiles

Government of India

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MESSAGE

Agriculture forms the backbone of the Indian economy and one cannot disregard the significant role that agriculture plays in the Indian economy and in the daily lives of its citizens. Yet, food security continues to be a pressing issue in India. In light of this major challenge, Agrotexiles utilization has helped the agriculture community in attaining increased yield and enhanced quality in agricultural produce. Thus, to further promote the usage of Agrotexiles in India, I am pleased to release the report on **Study on Developing Measures to Promote the Use of Agrotexiles in India** conducted by the Ministry of Textiles as part of the Technology Mission on Technical Textiles.

Agrotexiles constitute an important and impactful sector that is very closely aligned with the needs of the agriculture community. Amongst its various benefits, Agrotexiles protect produce from harmful external elements and assist in better soil management. These benefits provide farmers with enhanced productivity and increased yields resulting in further socio-economic development of the stakeholders within the agriculture community. This report focuses on laying the foundation and setting the roadmap to accrue the economic and social benefits from the usage of Agrotexiles.

I am proud that the joint and tireless efforts of the stakeholders are being realized and hope that this study will provide the necessary information on the current usage of Agrotexiles along with detailed data on the key interventions required to increase the economic and environment benefits for the nation. I sincerely hope that this report leads to increased interactions in the entire Agrotexiles value chain and result in stronger partnerships amongst the various stakeholders.

I eagerly hope that this study proves beneficial to the industry & farmers for a better understanding of the Agrotexiles industry in India and its potential uses.

(K.S. RAO)

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Message

The growth of the Indian economy is significantly reliant on the success of the agriculture community. Traditional methods are limited in their ability to increase yields with the current constraints of restricted space and water supply. In this context, Agrotextiles have proved to be an effective alternative that delivers strong results despite the constraints. In our endeavour to increase the utilization and application of Agrotextiles in India, I am happy that the report on Study on Developing Measures to Promote the Use of Agrotextiles in India is being released.

The study ensures that the Indian Agrotextiles sector has been exhaustively analysed and appropriately benchmarked against the most relevant and widely recognized best practices from across the globe. Along with a comparative analysis of the Agrotextiles industry in India and abroad, the study also provides valuable insights into the various Agrotextiles products, their uses & applications as well as the associated socio-economic and environmental benefits. Further, the recommendations provide a well-defined direction for promoting the development of the Indian Agrotextiles industry.

The assessment of the Agrotextiles industry in India involved the support of various Government organizations, project teams and individuals associated in the ecosystem. I am proud of our efforts and hope that various stakeholders shall utilize this report and partner with us in our pursuit of accelerating the development of this significant sector.

Panabaaka Lakshmi
(Panabaaka Lakshmi)

New Delhi
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MESSAGE

Despite significant economic growth and improved living standards, the surge in population has continued to increase the demand for various agriculture products considerably. The decrease in cultivable land, unpredictability of the monsoons and imbalanced distribution of irrigation facilities necessitates improvement of India's agricultural yield to sustain its growing population and Agrotextiles is a sector that has exhibited successful outcomes across the globe in increasing the yield and quality of agriculture and horticulture produce.

Further progress in this field is possible with the application of new technologies, processes and products. The Ministry of Textiles has got a detailed study done to further the understanding of the Agrotextiles industry, its benefits & scope for application in India and to chart a strategic plan to accelerate the development of this sector. I take great pleasure in releasing the report of the **Study on Developing Measures to Promote the Use of Agrotextiles in India**.

The utilization of agrotextiles is a technique which has shown significant improvements in agricultural productivity; even in unfavourable conditions. Some of the benefits of the usage of agrotextiles are enhancing freshness in fruits and vegetables, prevent soil from drying, protection from harmful pesticides, yield increase etc. However, there are challenges such as lack of awareness of agrotextiles, cultivation complexities, affordability and high investment costs which act as deterrents for potential agrotextile entrepreneurs. This report points towards developing solutions to address these challenges and suggest the necessary steps required to overcome the identified impediments. I am sure it will prove to be a critical initial step towards obtaining a better comprehension of the agrotextiles sector and will contribute towards attaining further cooperation with all stakeholders in ensuring that efforts and objectives are jointly realized for achievement of the common goal of increased productivity in agriculture.

I congratulate the Joint Secretary, Shri Sujit Gulati and the team of officers which have taken this sector forward with great interest & devotion.


(Zohra Chatterji)

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We would also like to give our special thanks to individuals within and outside these organizations including honourable Shri Sujit Gulati (Joint Secretary, Ministry of Textiles), Shri A B Joshi (Textile Commissioner, Ministry of Textiles), Shri Ajay Pandit (Dy Director, Textile Commissioner's Office), Smt Shashi Singh (Executive Director, ITTA), Shri U K Gangopadhyay (Executive Directive, SASMIRA), Dr Manisha Mathur (Asst. Director, SASMIRA), Shri V Kannan (Vice President, Reliance) and Shri A R Venkatramanan, along with all persons interviewed (Annexure B). Their support and guidance along with key insights on the Agrotextile industry were crucial in authoring this report.

This assessment of Agrotextiles industry in India involved support from various Government officials, project teams and individuals associated in the ecosystem and importantly the study team of Accenture and Suvin Advisors. We express our thanks to all of them for their support during the study.

List of Abbreviations

ABINT	Brazilian Association of Nonwoven and Technical Textile Industries
AIC	Agriculture Insurance Co. of India
APEDA	Agricultural & Processed Food Products Export Development Authority
ARO	Agriculture Research Organization – Israel Ministry of Agriculture
ASTM	American Society for Testing and Materials
ATMA	Agricultural Technology Management Agency
BHU	Banaras Hindu University
BIS	Bureau of Indian Standards
CAGR	Compound Annual Growth Rate
CARDI	Cambodian Agricultural Research & Development Institute
CAU	Central Agricultural University
CCI	Corporate Catalyst India
CEN	European Committee for Standardization (EN Standards)
CIAE	Central Institute of Agricultural Engineering
CIDA	Canadian International Development Agency
CITH	Central Institute for Temperate Horticulture
COE	Centre of Excellence
CPRI	Central Potato Research Institute
DAO	District Agriculture Office
DIN	German Institute for Standardizations
ECPA	European Crop Protection Association
ECTT	Expert Committee on Technical Textiles
EDANA	European Disposable and Nonwovens Association
EU	European Union
EURATEX	The European Apparel and Textile Confederation
FAO	Food and Agriculture Organization of the UN
FDI	Foreign Direct Investment
FIBC	Flexible Intermediate Bulk Container
FIIS	Farm Income Insurance Scheme
GAIC	Gujarat Agro Industries Corporation
GAP	Good Agricultural Practices
GGRC	Gujarat Green Revolution Company
GIC	General Insurance Corporation of India
HACCP	Hazard Analysis & Critical Control Point
HDPE	High Density Polyethylene
HMNEH	Horticulture Mission for North East and Himalayan states
IARI	Indian Agricultural Research Institutes
ICAR	Indian Council of Agricultural Research
IICA	Inter-American Institute for Cooperation on Agriculture
INDA	Association of Nonwoven Fabrics Industry
IOC	Indian Oil Corporation Ltd
IPM	Integrated Pest Management
IRDA	Insurance Regulatory and Development Authority
IRR	Internal Rate of Return
ISO	International Organization for Standardization
ITC	Indian Tobacco Company

ITTA	Indian Technical Textile Association
LOI	Letter of Intent
MANTRA	Man-made Textile Research Association
MIS	Micro Irrigation System
MOAG	Ministry of Agriculture and Rural Development, Israel
MOFPI	Ministry of Food Processing Industries
MOT	Ministry of Textiles
NABARD	National Bank for Agriculture & Rural Development
NAIS	National Agriculture Insurance Scheme
NAU	Navsari Agricultural University
NGO	Non-Governmental Organization
NHB	National Horticulture Board
NHM	National Horticulture Mission
NMMI	National Mission on Micro Irrigation
NRC(O)	National research centre for Orchids
PG	Post Graduate
POC	Point of Contact
POS	Point of Sale
PP	Poly Propylene
PSU	Public Sector Undertaking
PTI	Press Trust of India
R&D	Research & Development
RFP	Request For Proposal
RKBY	Rashtriya Krishi Bima Yojana
ROI	Return on Investment
SAO	Superintendent Agriculture Office
SASMIRA	Synthetic & Art Silk Mills' Research Association
SCGDTT	Steering Committee on Growth and Development of Technical Textiles
SEBGS	Self-employed Bio Gas Supervisors
SEZ	Special Economic Zone
SHM	State Horticulture Missions
SITP	Scheme for Integrated Textile Parks
TAO	Taluka Agriculture Office
TMTT	Technology Mission on Technical Textiles
TUFS	Technology Upgradation Fund Scheme
UV	Ultra Violet
VoC	Voice of Customer
VPKAS	Vivekanand Parvatiya Krishi Anushandhan Sansthan

This report is a compilation of literature/data/photographs from various sources (including public sources including internet, manufacturers and sources cited in the annexures) as suggested by key stakeholders during the course of the assignment. This objective of the handbook is to promote the usage of agrotextiles in the country and should be used only for the promotion of this sector.

Executive Summary

Agrotextiles are a specific type of Technical Textiles which are applied for agricultural & horticultural uses covering livestock protection, shading, weed / insect control and agro produce packaging. Agrotextiles help to keep sufficient soil humidity and increase the soil temperature, protect produce from external elements such as pests, insects and hail, all of which help increase productivity.

In 2007-08 the size of the Indian Agrotextile industry stood at INR 487 crore with exports of INR 67 crore and imports of INR 12 crore, and was projected to grow to INR 709 crore by 2012-13 (*latest report is yet to be published*). A significant proportion of Agrotextile consumption comes from fishing nets – INR 564 crore or 80% in 2012-13 according to the same projections. In comparison, fishing nets contributed to 90% or INR 442 crore of the INR 487 crore agrotextiles market in 2007-08. This points to the significant growth of expected of other product categories such as shade nets, mulch mats, anti-bird and anti-hail nets in the last half decade viz-a-viz fishing nets.

This report attempts to study and provide guidance and recommendations to identify, promote and advance the use of Agrotextile materials across the country in all the categories. Based upon the deliverables and scope outlined in the RFP, the report has been segregated into four major thematic sections:

I. Agrotextile products, their usage, and the associated benefits

This section deals with basic information regarding the various Agrotextile products and their applications. This information is further expounded in a handbook for Agrotextile products which additionally discusses implementation instructions and product characteristics.

Also covered are seven Indian case studies highlighting solutions for field level problems that can be referred to guidance on Agrotextile usage.

Lastly, the economic benefits of using agrotextiles with the most potential – shade nets, anti-hail/bird nets and mulch mats, have been highlighted. The benefits can be accrued via three levers – (i) increase in yield, (ii) increase in average selling price, and (iii) reduction in cultivation costs from lower fertilizer use. These benefits are greatly varied depending on type of crop and accompanying techniques and practices used. For example:

- Yield increase was seen at 60-100% in shade net applications for vegetables like tomatoes and capsicum.
- For capsicum, compared to cases where fertilizers have extensively been used, yield with only shade nets and no fertilizers dropped by 25% but average selling price saw a threefold increase.
- Similarly with jute mulch mat use increase in yield of curry leaves was seen to be 64%.

- Anti-hail/bird nets use has shown increase in average selling price for apples was seen as 67%.
- Mulch mat use for mango cultivation showed a twofold benefit – an increase of yield of 33% and an increase in average selling price of 30%.

For details, please refer to Section 4 of the report.

II. Analysis of current usage of Agrotextiles in India

As a part of the primary research, stakeholders were classified into five major groups:

- a. Consumers
- b. Manufacturers
- c. Sales Channel
- d. Government Agencies and Bodies
- e. Subject Matter Experts

On the basis of the study and feedback from these stakeholders with regards to the key issues and impediments fall into three major categories – Awareness, Subsidies & Regulations, and Standards & Specifications published or in process of getting published by the BIS (Bureau of Indian Standards).

Consequently these areas were focused upon in subsequent research.

- a) At a holistic level, it can be summarised that the general awareness on the use of Agro Textiles is very low amongst the farmers. Majority of the end users (i.e. farmers) are illiterate and hence creating awareness /generating interest for using Agrotextile products is a challenge. It may be also mentioned that the benefits of using agrotextiles in Universities / Government has not perpetuated to the grass root levels.
- b) A review of Indian subsidies, procurement tenders, standards framework and awareness was carried out. Manufacturing feasibility study for various technologies has been carried out and summary of these has been presented in this report. Regulations & subsidies under NHM (National Horticulture Mission), NHB (National Horticulture Board), HMNEH (Horticulture Mission for North East and Himalayan states), APEDA (Agricultural & Processed Food Products Export Development Authority) has also been studied.

On the basis of the study, it has emerged that a tedious bank procedure for loan approval makes availability of subsidy difficult for end users/farmers. This leads to the most important impediment – lack of off-the-shelf subsidized Agrotextile (that are not project linked /one time benefits to farmers).

- c) The Standards currently in use in the industry and the gaps thereof for the key applications have also been identified. Knowledge of specifications coupled with lack of Standards is an area which needs to be addressed immediately.

III. Analysis of current usage of Agrotextiles globally

Global practices were studied with an objective to learn / use it as a template for gaps identified in India. Based upon the study and discussions with experts /stakeholders it emerged that there are very few Rules/Regulations / Subsidies specifically targeted for promotion of Agrotextiles.

For manufacturing of agrotextiles, most incentives were broad based for the entire textile industry, like the 11th Five Year Plan for the Textile Industry drafted by the Chinese government. Such measures are well represented in India as well, as can be seen by the various schemes discussed in the previous sections.

To spur demand foreign Government Departments / supporting organizations have relied largely on promoting awareness through guidelines and organizing training programs. Such measures have been taken in Australia and Cambodia respectively (refer section 6.2 for details). Another important measure taken to promote consumption of Agrotextiles (especially for anti-hail nets) has been observed in a few European countries where agriculture insurance premiums have been discounted up to 80% by Banks (in case the consumers use anti-hail nets to protect their agriculture produce).

The report has proposed Standards for common applications on the basis of study/analysis of the major test methods prescribed by the EDANA, INDA, ASTM and ISO (refer section 7.9).

IV. Recommendations

This report is based on a comprehensive analysis of the current usage of agrotextiles in India and the best practices across the globe. Based on this exercise, the recommendations have been discussed with various stakeholders. Also a handbook has been developed which details out the use of various Agrotextiles and the process of implementation of solutions.

This section of the report discusses various takeaways for various stakeholders:

- a) Policy maker/Government
 - i) **Updation/Restructuring of Subsidy:** Suggested inclusion of additional products in the subsidy schemes (refer section 7.5.1 to 7.5.4), i.e.:
 - (1) Mulch mats, Anti insect nets, Crop covers and Wind Shield nets in the key subsidy schemes by the NHM (National Horticulture Mission), NHB (National Horticulture Board), HMNEH (Horticulture Mission for North East and Himalayan states)

- (2) Leno Bags, Pallet Nets and Shade Nets by APEDA (Agricultural & Processed Food Products Export Development Authority)
- ii) **Direct Subsidy for Agrotextiles:** Establishment of direct subsidy for Agrotextiles leveraging Aadhaar (refer section 7.5.5). Demarcation of ₹500 crore towards this subsidy to be provided through the farm equipment distribution network similar to the subsidy mechanism for fertilizers. This subsidy can replace existing subsidies when the IT infrastructure for direct subsidy has been created.
- iii) **Mass Awareness & Capacity Building:** This area is important and plays a crucial role in the promotion of Agrotextiles in India via marketing and educational initiatives. This should involve radio, POS advertising, information dissemination via Kisaan call centres, and multi-lingual handbooks (refer section 7.5.4). It is also recommended that the benefits of Agrotextiles is included in the curriculum (refer section 7.8) of graduate courses (agriculture science).
- iv) **Formation of a Subsidy Facilitation Organization:** Appointment of a national level subsidy facilitation organization in direct conjunction with manufacturers, State level organizations / NGOs (similar to Gujarat Green Revolution Company). This organization may liaison with the nodal NHB/NHM offices at the State level for facilitation of disbursement of subsidies to farmers at field level. The ITTA could possibly be entrusted with this role (if amenable to all stakeholders) as they have well established relationships with both manufacturers and relevant Government Departments (refer section 7.5.7).
- b) Farmers/Institutional Users
- i) **Handbook:** Awareness and access to resources are the two most important aspects pertaining to greater uptake of Agrotextiles by farmers. A handbook has been created to help address the issue of awareness. This handbook needs to be published in various regional languages and distributed to farmers to educate them on Agrotextile products and their usage.
- ii) **Tender Template:** A tender template for procurement of agrotextiles has been provided so that institutional buyers may use it for drafting tenders (refer Annexures G & H).
- c) Manufacturers
- i) **Mulch Banks:** The concept of Mulch Banks or institutionalised bodies (consisting of manufacturers and local cooperatives/entrepreneurs) can increase the use of Mulch Mats by renting them out to farmers needs. This will help reduce the price advantage Mulch film has over Mulch Mats. However this advantage will be limited to the same kind of produce (refer section 7.3).

- ii) **Manufacturing Feasibility:** Summary of Project financials for Agrotextile manufacturing has been provided to generate awareness amongst potential investors. Based on the analysis it may be concluded that the investment attractiveness is moderate with an investment payback period ranging from 3-4 years to 6-7 years (refer section 5.2).
 - iii) **Manufacturer Accreditation:** It is proposed that Ministry of Textiles may initiate a manufacturer accreditation to ensure minimum level of quality of the products. This can be ensured if the subsidy for Agrotextile (under NHB, NHM, HMNEH etc.) is restricted to accredited manufacturers. Suitable agencies like SASMIRA may be entrusted with this responsibility (refer section 7.9.2).
 - iv) **Strategic Retail Tie-Ups:** Manufacturers to approach retailers having penetration in rural areas (like IOC with Kisan Sewa Kendras and ITC with e-Choupal) for strategic retail tie-ups. ITTA can play role of facilitator for these meetings (refer section 7.7).
- d) COEs/Associations
- i) **Demonstration Projects:** The ITTA (along with ATMA & SASMIRA) has volunteered to conduct 50 pilot studies and demo projects in conjunction with local and regional government bodies and NGOs. These “Demo projects” will be undertaken across the country in identified regions (refer section 7.2).
 - ii) **Standards & Quality Framework (refer Section 7.9):**
 - (1) This report also recommends Standards with accompanying test methods from BIS (wherever existing) or from the ISO, EDANA or ASTM for Shade Nets, Mulch Mats/Ground Covers, and Crop Covers/Anti-Frost Covers.
 - (2) BIS Specifications for Fishing Nets, Jute Sapling Bags, Jute Ground Covers, Bird Protection Nets, and Crop Covers already exist or are in the process of being published.
 - (3) For other products like Plant Nets, Harvesting Nets, Anti-Hail Nets, Turf Protection Nets, Pallet Net Covers and Anti-Insect Nets, standard product characteristics have been provided in the report.
 - iii) **Initiating Application Based Research:** During discussions with various stakeholders as well as research conducted certain areas were identified for further pilot studies and cost benefits analysis to ascertain future potential (refer section 7.10):
 - Polymer fibre balls as substitute for soil
 - Screening fabrics for sunlight management
 - Knitted hose
 - Superabsorbent polymer fibre mats for Water management in horticulture appl

- Use of water retention nets coated with Superabsorbent polymer resin
 - Composites of hemp or polypropylene for reducing soil pollutants
- iv) **Crop Insurance Premium Benefits:** Agriculture insurance schemes for farmers / consumers using agrotextiles (specifically for anti-hail nets) may be introduced which have lower premiums for crop insurance. This is a practice which is prevalent abroad especially in Europe. The Ministry of Textiles may initiate discussions with the Agriculture Insurance Company of India to initiate such measures in India as well. Subsequently this can be escalated to the IRDA for adoption by other insurance companies as well (refer section 7.5.8).

1 Background

1.1 Technical Textiles

The history of conventional textiles in our country has its own culture and heritage, but consumer textiles are becoming more and more competitive and facing tough competition. Many companies producing conventional textiles have to continuously struggle to survive in a highly competitive global market. Now is the time that traditional textile entrepreneurs should move into the lucrative field of technical textiles while retaining their traditional textile business.

Technical textiles are textile materials and products manufactured primarily for their technical performance and functionality rather than their aesthetic or decorative characteristics. They have been replacing conventional materials with innovative technology, low cost, better efficacy and many added features. They account for over one-fourth of all textile consumption in weight terms. The application of technical textiles can be in consumer as well as industrial products.

Technical Textile Segments

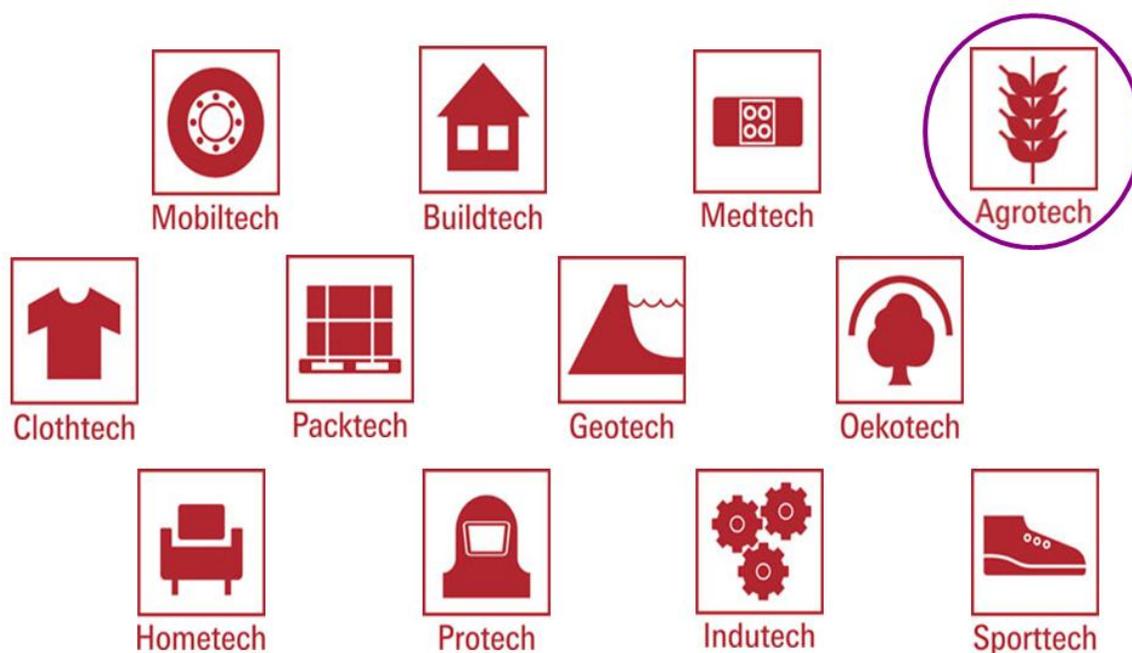


Figure 1.1: Technical Textile Industries

India currently consumes the products under all twelve categories. The percentage of indigenous production varies drastically across various products. India is a large producer of technical textiles

products in Packtech, Clothtech, Hometech and Sporttech segments, the products of which are primarily commodities. Technical textiles used in the agrotech segment are known as Agrotextiles.

Unlike the conventional textile industry in India which is highly export intensive, the technical textile industry is an import intensive industry. Many products like baby diapers, adult diapers, wipes, protective clothing, hoses, webbings for seat belts, etc. are imported to a very large extent. The technical textiles which are exported are those typical commodity products and not very R&D intensive and include products such as flexible intermediate bulk containers (FIBCs), tarpaulins, jute carpet backing, hessian, fishnets, surgical dressings, crop covers, etc.

There are a few multinational companies like Alstom, Johnson & Johnson, Du Pont, Procter & Gamble, etc., who are internationally very large players in technical textiles and have set up their units in India as well. There are some domestic players like SRF, Entremonde Polycoaters, Vardhman, etc., who are also some of the large players in this industry.

With a compounded annual growth rate of 11%, the technical textile market in India has grown to INR 57,000 crore in 2011-12 from INR 42,000 crore in 2007-08, and is expected to touch INR 1.58 lakh crore by 2016-17.¹

1.2 Agrotextiles

India is the 2nd largest producer of food in the world and holds the potential of being the biggest on global food and agriculture canvas, according to Corporate Catalyst India (CCI) survey. Food processing industry is one of the largest in India - ranking 5th in terms of production, consumption, export and expected growth.



a

¹ PTI - Press Trust of India. "Technical textile market to touch Rs 1.58 lakh crore by FY 2017". *The Economic Times*. August 3, 2012. Retrieved November 1, 2012, from http://articles.economictimes.indiatimes.com/2012-08-03/news/33020000_1_technical-textiles-textile-ministry-officials-office-of-textile-commissioner

Indian food industry is projected to reach US\$ 300 billion by 2015. Agriculture sector is vital for the nation and is the principal source of livelihood for more than 58% of the population. Growth of the agriculture and allied sectors is expected to be around 5.4 per cent during 2010-11, according to the Economic Survey 2010-11.

The word "Agrotextiles" now is used to classify the woven, nonwoven and knitted fabrics applied for agricultural & horticultural uses covering livestock protection, shading, weed and insect control, and extension of the growing season including agri-produce packaging. Hence Agrotextiles are termed as "Farm to Fork" products. Agrotextiles help to keep sufficient soil humidity and increase the soil temperature. Return ample gauze weaves; for example, protect the harvests of fruits against the damage caused by the hail.

The Agrotextiles sector is one of the forerunners in this growth within technical textiles. Agrotextiles are textiles used for their functional benefits in the agricultural field. With the continuous increase in population worldwide stress on agricultural crop production has increased. Hence it is necessary to increase the yield and quality of agro-products within the current space and water constraints prevalent today. But it is not possible to meet this increased demand completely with traditional methods such as use of pesticides and herbicides. The agriculture and horticulture industries have realized the need to pursue various technologies to get higher overall yield and better quality agro-products. The essential properties required in agrotextiles are strength, elongation, stiffness, resistance to sunlight and resistance to toxic environments. All these properties help with the growth and harvesting of crops and other foodstuffs. With growing diseases due to various chemicals in food, vegetables, etc. due emphasis is laid on organic foods today. These are best achieved with controlled regulation of water, sunlight, and composts, duly made effective by use of agrotextiles.

Preliminary studies have shown that by using woven of return gauze it is possible to increase the harvest of fruits in a 30% under favourable conditions of time and up to 50% under unfavourable conditions. The agro textiles are also used to prevent the growth of injurious weeds to agriculture.

Need of Agrotextiles

- They prevent the soil from drying out and thereby increase crop yield. Also it enhances freshness in fruits, vegetables and give farmers and consumers value for their money.
- They improve product quality
- Agro textiles protects farmer from harmful pesticides
- Thermal protection textiles are treated with ultraviolet ray stabilizers.
- The best-known products are shade netting and thermal screens, the use of which can save up to 40% on energy in heating greenhouses
- Their use improves the quality of fruit, prevents staining and improves uniformity of colour

1.3 Need for the Study

Upon observing the industry there are various factors in play that have provided the motivation behind conducting this benchmarking exercise and charting of a strategic plan to increase the use of Agrotextiles in India:

1. Agricultural yield percentage is insufficient for India's requirement

The primary benefits of Agrotextiles revolve around enhancing yield and quality of agricultural produce. In a country like India where the agricultural harvest is subject to great variance due to unpredictable rains and lack of irrigation facilities as well as extreme climactic conditions, it is important to maximise productivity of the sector to ensure sufficient food to feed the 1.25 billion people residing within its borders. This is doubly important when you consider the fact that the per capita availability of cultivable land has dropped from 0.36 hectare to 0.13 hectare.

2. Prevention of negative environmental effects

Quite a few agrotextile products help fight insects, weed growth, etc. that would normally be addressed by using insecticides and pesticides. This helps reduce use of these chemicals and helps prevent toxification of the soil and produce (in cases of overuse).

Within such alternative anti-insect/pest and anti-weed solutions, certain plastic films such as plastic mulch as well as greenhouses have gained a foothold with farmers and agriculturists. These broadly provide the same kind of benefits as comparable agrotextiles such as Mulch Mats and Shade Net Houses. In either case the removal of plastic material from the soil is a tedious and costly process which is required to prevent pollution of the soil. In India inorganic mulch materials like plastic mulch or mulch mats are often not removed from the soil. The case for using Agrotextile products viz-a-viz plastic film has a lot to do with plastic mulch film requiring frequent replacement, and non-removal means greater plastic material making the soil more toxic. Agrotextiles also have biodegradable varieties and those made from natural fibres such as jute/coir that can be used without the negative side effects.

The objective of this study is also to use it as a reference document to bridge the gap that exists between Ministry of Agriculture, Horticulture with Ministry of Textiles and elimination use of plastic bags/films where these contribute more damages to cattle, etc. and increase labour costs for removal of films scrap.

3. Realization of economic & social benefits

Apart from direct monetary benefits there are several indirect benefits of Agrotextiles such as reduction in water requirement for irrigation, export quality surplus produce that can add to the plus side of India's import-export ledger, etc. Such indirect economic and social benefits are crucial for the economy.

4. High cost of imports

Imported products are costly due to high duties but local manufacturers are unable to provide certain sophisticated Agrotextiles or those with low usage. Therefore such products are imported adding to the overall product costing. Imported products are around 22-25% costlier than locally manufactured products. Government provides subsidy on import duties on certain products but still the duties are around 20-25%.

Product	Domestic Price Structure	Imported Price Structure
Cost price/Unit cost (including VAT & Excise)	₹25/- (Per m ²)	\$ 0.80/- (Per m ²)
Import duty/custom	N.A	29.80%
Final Price	₹25/- (Per m ²)	₹65.50/- (Per m ²)

However prices for some other products (for e.g. Indian Nonwoven Needle punch geotextile of 300 gsm is 50-60 Rs (Including 12.36% of Excise duty), whereas the price of the reputed China company of same product is 37-42 Rs (Including 29.80% of all taxes).

Challenges

There are proven benefits of using Agrotextiles in various applications and are being used globally for the past few decades. Despite such a history of proven performance, uptake in India has been slow and lags significantly behind other countries. The major impediments to growth in the domestic market are as follows:

- Lack of awareness and hesitation in adopting globally proven cost effective technologies
- Absence of required standards to ensure product quality and implementation guidelines
- Absence of product specifications to define standard manufacturing properties
- Unorganized structure of cultivation compounds difficulty in penetrating the market
- Affordability for a majority of the broad target group for Agrotextiles
- Deterrents for entrepreneurs in setting up units for Agrotextiles due to:
 - Huge capital expenditure involved
 - Lack of skilled manpower and training facilities

These questions can logically be classified into the five following focus areas:

1. Are they Cost Effective?
2. Are there Skills & Awareness?
3. Is Financial Assistance Effective?
4. Is a Quality Framework in Place?

5. Are any Legal Interventions Applicable?

This study aims to address these issues and propose steps to overcome these impediments to the Agrotextiles industry.

2 Approach and Methodology

2.1 Approach of the Study

In this project an approach consisting of distinct yet tightly integrated phases for achieving the targeted outcomes was adopted. The approach contained six distinct phases namely:

- I. Project Inception
- II. Assessment
- III. Global Benchmarking
- IV. Analysis
- V. Recommendations
- VI. Stakeholder Discussions

These 6 phases with key activities have been pictorially depicted in the following illustration:

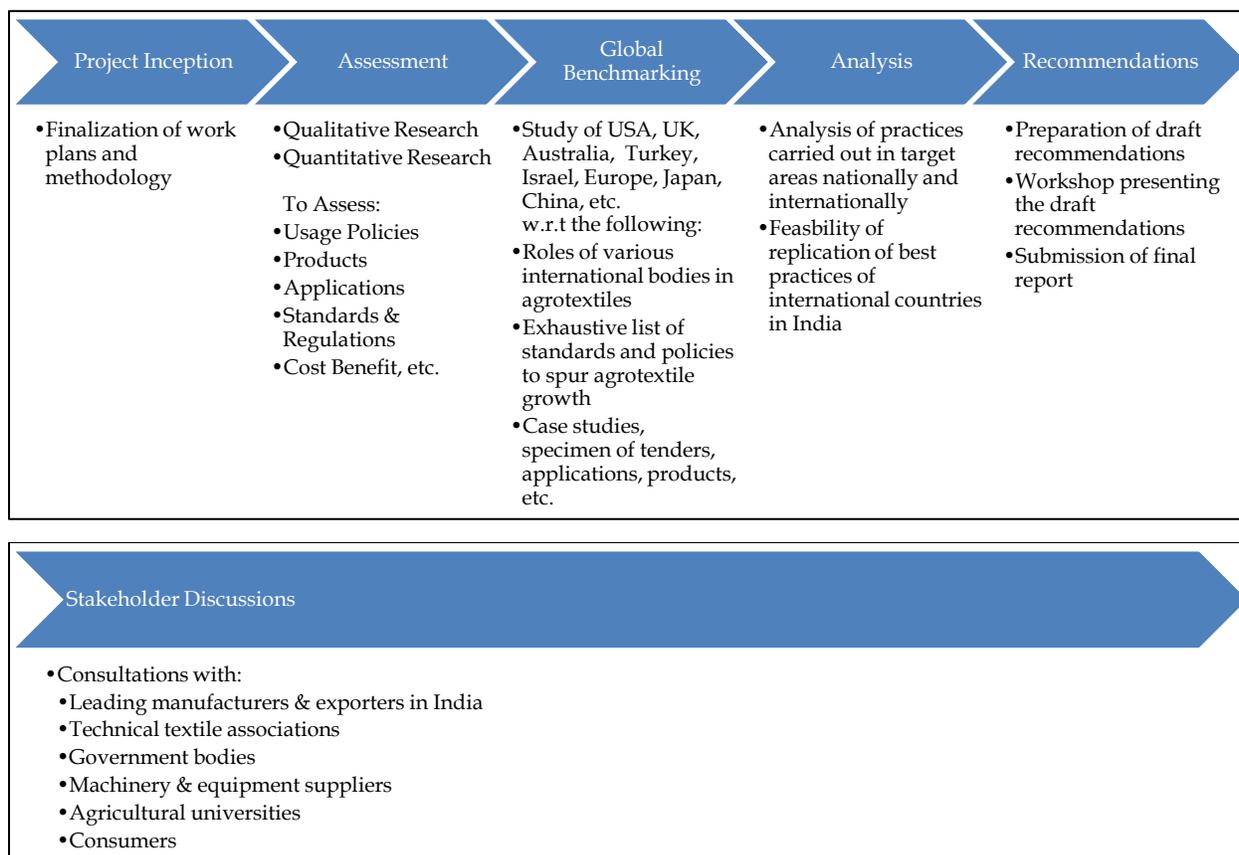
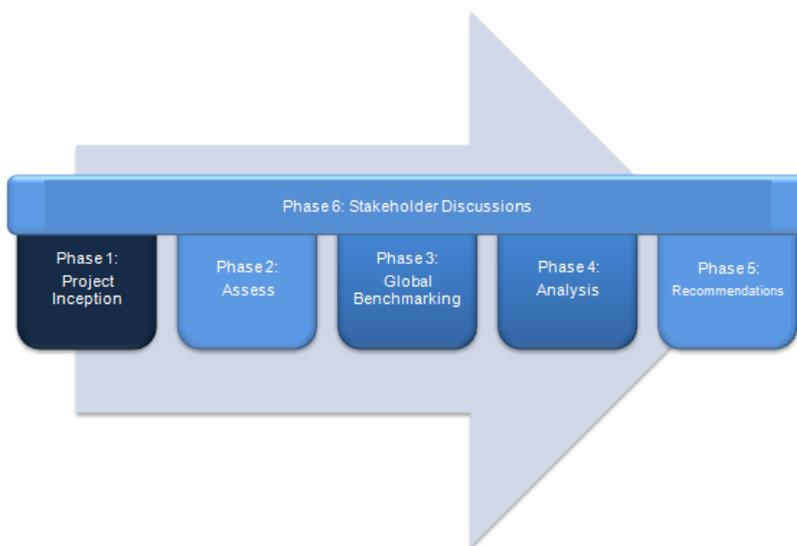


Figure 2.1: The Six Phases

Phase I: Project Inception

During Project Inception phase, the engagement roadmap with activities and timelines of the complete engagement were detailed. The following activities were included under this stage:

- Mobilization of the resources
- Preparation and finalization of a full and comprehensive plan for the engagement
- Determination of all necessary review considerations



It was important to draw a stakeholder map at this stage to help in understanding the position of each stakeholder with respect to the goals of the project. The following matrix depicts the centres of influence for this engagement:

		Importance of Stakeholder	
		Moderate	High
Influence of Stakeholder	Significant		<ul style="list-style-type: none"> • Centres of Excellence
	Moderate	<ul style="list-style-type: none"> • Technical Textile Associations • Leading Manufacturers 	<ul style="list-style-type: none"> • Consumers • Govt Bodies
	Low	<ul style="list-style-type: none"> • Engineering Universities 	

Figure 2.2: The Stakeholder Matrix

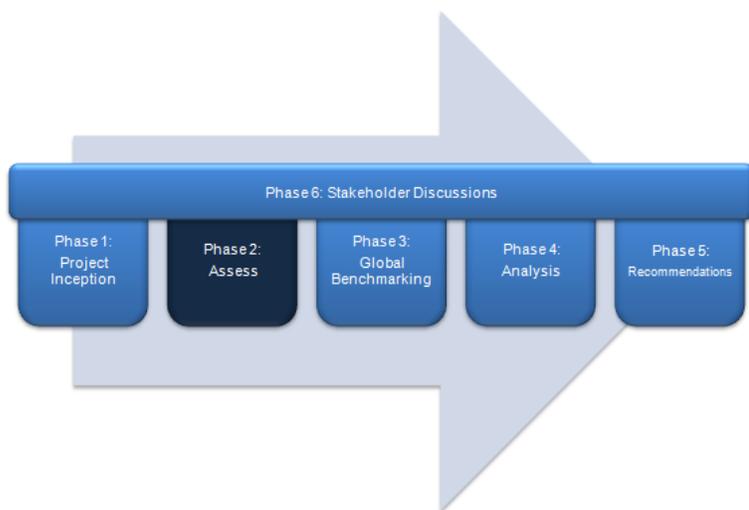
This matrix helped to refine the primary research strategy and prioritise stakeholders according to their importance and influence. Interactions were initiated with the consumers including farmers and agricultural universities, the COEs (Centre of Excellence) and leading manufacturers such as CTM Agrotextiles, Ambica Polymers, Rishi Packers, Garware Marine, Reliance Industries, etc. Also extremely important were interactions with the various government bodies and agencies implementing subsidies such as the NHM (National Horticulture Mission), NHB (National

Horticulture Board), Gujarat Green Revolution (Gujarat Agro), etc. Details of people met are included in Annexure B.

Phase II: Assessment

In the Assessment phase, the existing Agrotextiles ecosystem in India was studied in detail. The various components intrinsic to the Agrotextiles sector in India were studied, including:

- a) Current areas where agrotextiles are used
- b) The current guidelines/ procedures for various applications of agrotextiles
- c) Current specifications and performance standards for Agrotextile products
- d) The current level of subsidies as well as regulations/laws/rules affecting the agrotextile industry in place in India
- e) Need of standards and regulations for each product category and its impact on overall consumption
- f) Feedback of key institutional consumers in India for such type of products with regard to the issues of standards faced by them while sourcing such products either domestically or from overseas.
- g) Current status on NHM subsidies such as amount of subsidy, products included, implementing mechanism, etc.
- h) Current status on linkages of financial aids & subsidies with usage of agrotextiles to ensure better returns by Ministry of Agriculture, State Governments etc., if any.
- i) Current schemes for usage of agrotextiles at vulnerable areas/sensitive produces, if any
- j) Current agrotextile products in agriculture kits
- k) Any other areas of Agrotech.



In the Assessment phase, an exhaustive study and analysis was undertaken covering all the aspects of allied fields and cross-cutting applications of Agrotextile segment.

This phase also studied details of the regulatory & legal framework governing the Agrotextile sector in India. In this phase, the following activities were carried out:

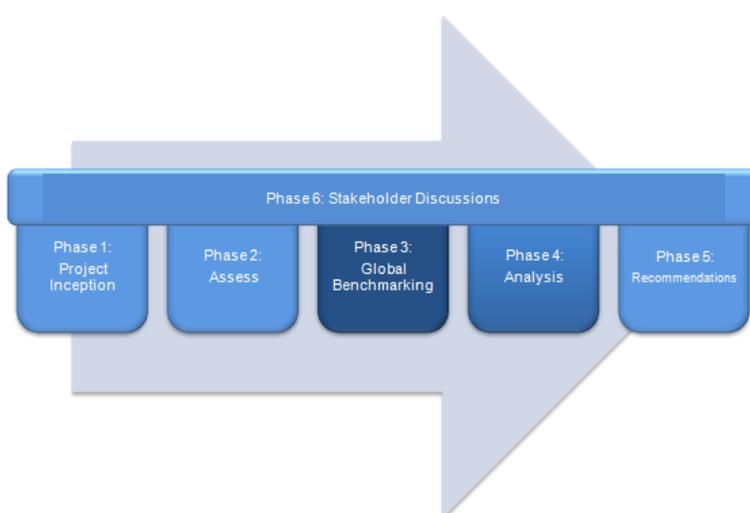
- Studied the Government policies, acts, rules, regulations & office orders governing the Agrotextile sector in India
- Gained high-level understanding of legal framework & the way it drives the Agrotextile sector in India
- Identified the key bottlenecks from a legal perspective for the Agrotextile industry in India.

In studying the legal & regulatory framework, the study captured the inputs of stakeholders & documented the available information only. Further, this report summarises the views and data provided by the stakeholders on legal and regulatory aspects.

Phase III: Global Benchmarking

In this phase, international markets were studied to identify areas of improvement in the Agrotextile sector in India. A Gap Analysis was carried out that involved determining the variance between stakeholder requirements and current capabilities. Gap analysis naturally flowed from benchmarking and other assessments.

This phase involved a study of global best practices in terms of conceptualization, implementation, key learnings, etc. The details covered in this phase include:



Study of regions with mature and well established markets including

- Turkey
- Israel
- USA
- UK
- Europe
- Japan
- China

List of various international bodies which are involved in developing measures to promote usage of Agrotextiles

Exhaustive list of standards available globally for products in the Agrotextiles segment

Summary of all relevant regulations/laws/rules that govern the usage of Agrotextiles in various applications

Case studies on usage of Agrotextiles in illustrative projects of reasonable scale

Specimen of tenders used for awarding contracts which have well defined specifications and guidelines for usage of Agrotextiles

Global (USA, UK, Turkey, China, Brazil and Israel) details on

- Applications of Agrotextiles used to improve quality and reduce cost
- Usage policy of Agrotextile products in various applications
- Agrotextile products used in different situations etc.

In this phase, the good practices implemented outside India with respect to the existing implementation of sector initiatives were studied. The key learnings from this research were identified and incorporated into the recommendations.

Phase IV: Analysis

On the basis of the as-is-analysis as well as the gap analysis with respect to international practices, areas of improvement in the Agrotextiles sector were identified and measures were devised to plug these gaps.

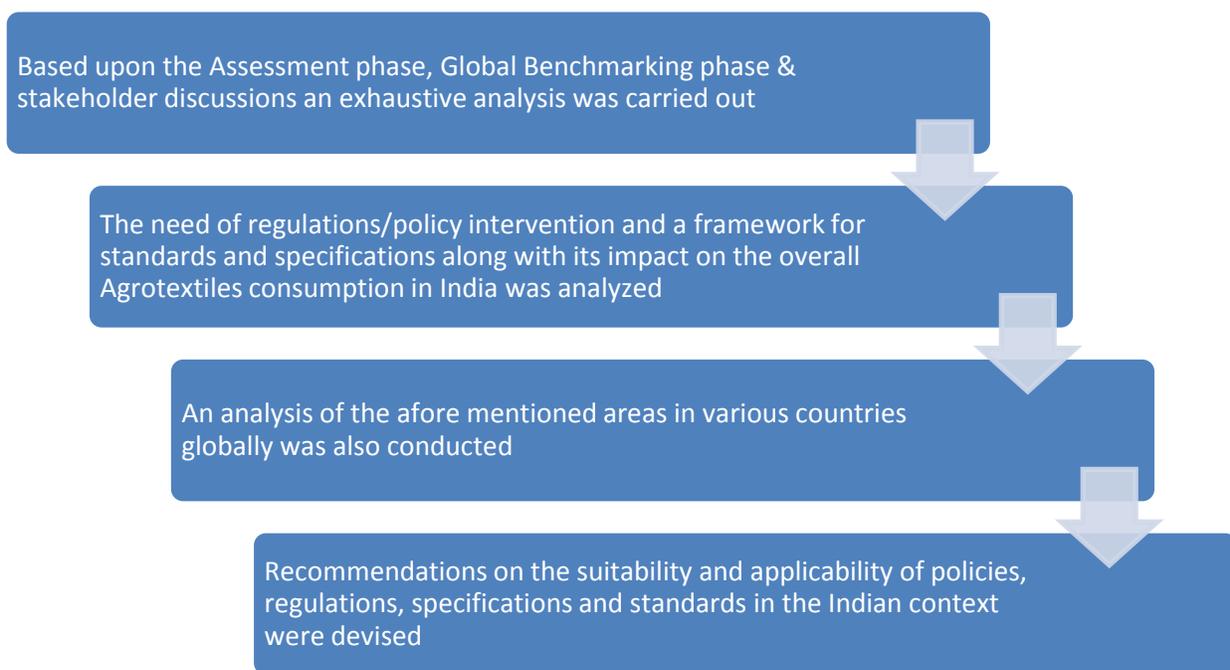
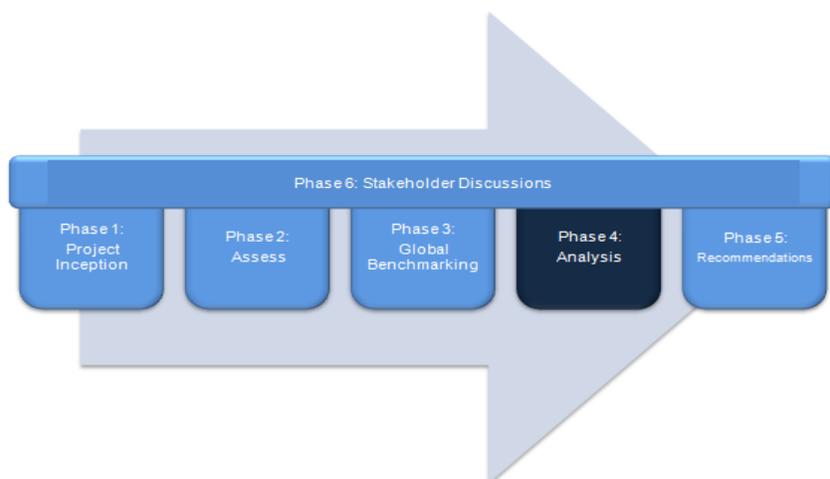
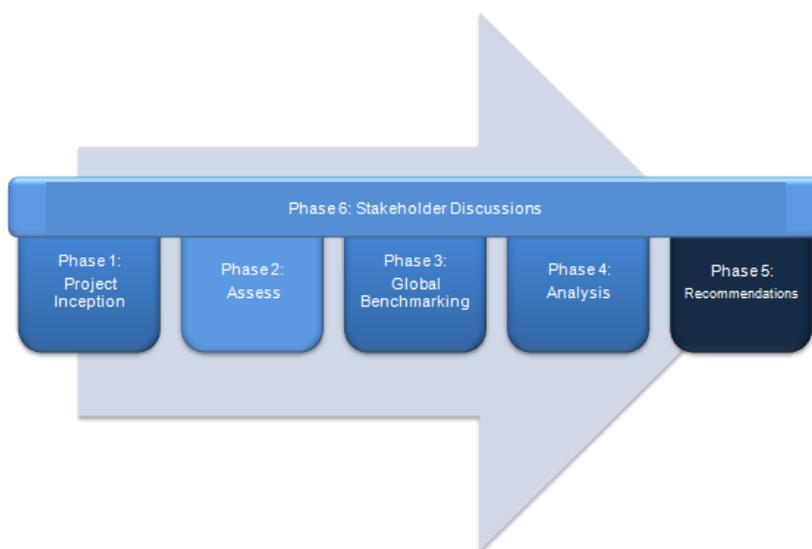


Figure 2.3: Key activities in the analysis phase

Based on this analysis and discussions with the key stakeholders the impediments that exist in growth of the Agrotextiles industry were identified and the steps that can be taken to overcome the same have also been identified

Phase V: Recommendations

The purpose of this phase is to first ascertain the gap between the current framework for the Agrotextiles sector and the envisaged way, and then dovetail it with the best practices to identify actionable measures to be undertaken for enhancing the Agrotextiles sector in India.



Activities involved:

On basis of previous stages, Accenture prepared the draft section-wise areas of improvement/modification for the Agrotextiles sector in India.

These recommendations have been discussed in meetings with key stakeholders.

Feedback was sought and has been incorporated suitably to finalise the deliverables.

Accenture continued to work with the client project team to arrive at acceptable and pragmatic outcomes. Some activities as part of these interactions included the following:

- Workshops with the key stakeholders to re-validate the issues and constraints based on which the recommendations were designed.
- An implementation plan that is feasible and could be achieved within the desired time frame of the client.
- Determined if the performance targets are appropriate and if they should be changed.
- Designed recommendations for improvements in institutional, procedural, infrastructural, technological, and personnel related areas.



Phase VI: Stakeholder Consultations

It was important to involve the key stakeholders during all the phases of the project. This was an overarching phase and activities under it were carried out throughout the project.

Voice of Customer (VoC)

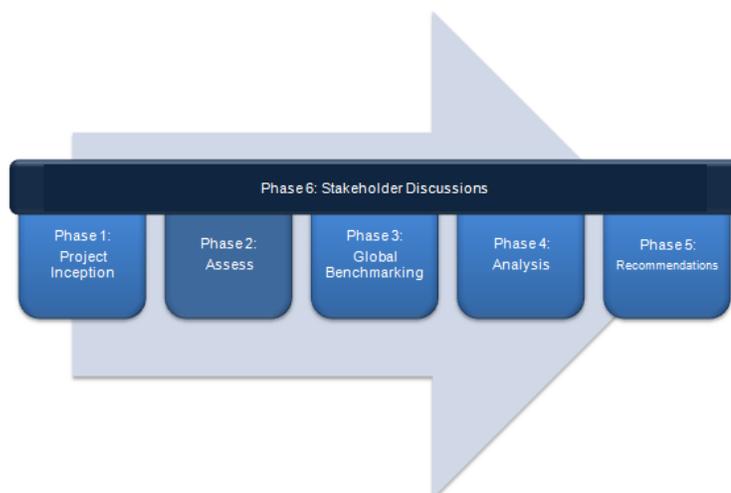
Key stakeholders were engaged and their perspective towards the project topics was understood.

The VoC was gathered through the following means:

1. Face to face interviews of key stakeholder personnel
2. Focus groups discussions with key stakeholders
3. Workshops / Brainstorming sessions

Questionnaires were prepared for understanding the requirements and needs of the stakeholders and their views towards the project. The key stakeholders include:

- Leading manufacturers & exporters in India like CTM Agrotextiles, Shri Ambica Polymers, Neo Corp International Ltd, Tuflex (or Netlon), Garware Wall Ropes, Kwality Net, Agro Shade Industries, Gayatri Plastic Corporation etc.
- Centres of Excellence, technical textile associations and agricultural universities such as SASMIRA, Indian Technical Textile Association (ITTA), ICAR (Indian Council of Agricultural Research), CAU (Central Agricultural University) Imphal, BHU (Banaras Hindu University) Varanasi, CIAE (Central Institute of Agricultural Engineering) Bhopal, etc.
- Government agricultural associations like state horticulture departments, the National Horticulture Mission (NHM), State Horticulture Missions, National Horticulture Board, State Agricultural Marketing Board, Coir Board, National Centre for Jute Diversification - Jute production Enchantment agency etc.
- Machinery and equipment suppliers like ATE Enterprises, Karl Mayer, etc.
- Consumers i.e. farmers, agricultural universities, horticulturists, nurseries, etc.



2.2 Methodology

We adopted a two-fold approach to our research in this engagement:

A. Quantitative Research

Quantitative research focused on statistical data gathering & analysis was undertaken. Tools such as information capturing templates, surveys and other equipment were used to collect numerical and measurable data.

Secondary research was initiated before the primary research was rolled out and encompassed information collected from the following sources.

- Trade associations
- Industry publications and databases
- Government databases
- International trade magazines
- Technical textile magazines
- Sector reports / publications on Agrotextiles
- Our corporate library

Need for secondary research

- It improved the focus of the primary research to be conducted
- It helped to frame questionnaire for primary research
- It gave a neutral and outside perspective

B. Qualitative Research

The primary aim of qualitative research is to provide complete, detailed descriptive information on current status of various components of Agrotextiles sector in India & abroad. The following data gathering strategies were used in this stage:

- 2) Study of various journals, websites, literature and directories for generating information on the Agrotextiles
- 3) In-depth structured and non-structured interviews of with key stakeholders
- 4) Focus group discussions & brainstorming sessions
- 5) Documentary analysis & archival research
- 6) Brainstorming sessions

Questionnaires were prepared - separate questionnaires for manufacturers, government bodies, consumers and subject matter experts. The following points were considered while preparation of the questionnaires:

- Short and to the point questions
- Simple and specific questionnaire
- Questions which can accommodate all possible answers
- Variety of questions like open-ended, closed-ended, likert-scale, multiple-choice, ordinal, categorical, numerical etc.
- Questionnaire of not more than two pages

The primary research was conducted in the following ways:

- Personal interview survey
- Telephone survey

First preference was always to personally meet the respondents but in cases where the respondent was not available, other methods of conducting the interview were adopted

Need for primary research:

- First-hand information of what is happening in the sector
- Addressing specific research issues which cannot be taken care by secondary research like actual implementation of standards, subsidy disbursement issues, etc.
- Higher level of control on the information collected

Through this phase of research, domestic and overseas industry stakeholders were contacted. The list of stakeholders can be seen in Annexure B. The breakup is as follows:

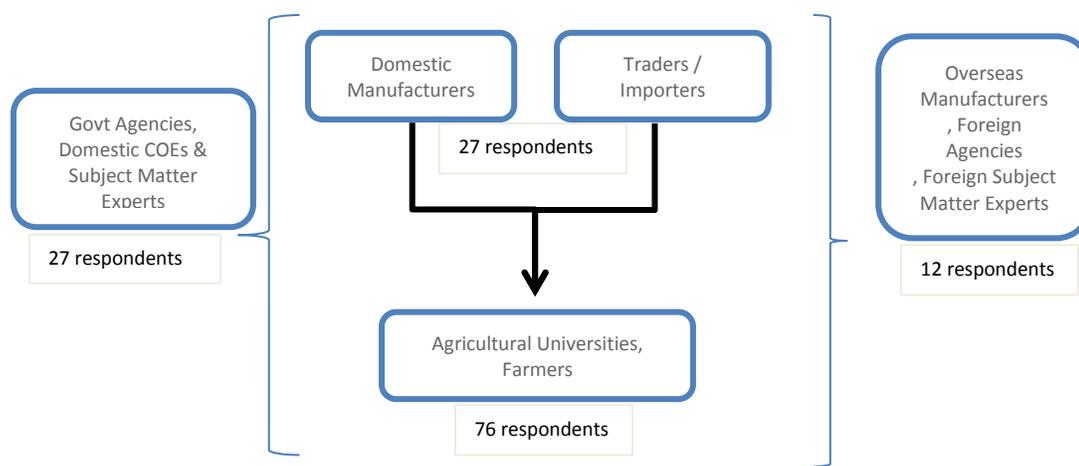


Figure 2.4: Stakeholders and Interviews Completed

A focus group discussion with various industry stakeholders was conducted on October 19, 2012. These sessions were used to address certain points of contention that had become apparent while conducting the primary research.

2.3 About the Report

The report has been structured as under:

Chapter 3 - Current usage of Agrotextiles (supplemented by Handbook enclosed as Annexure A)

1. Comprehensive list of Agrotech products with their applications and end-users to improve quality and reduce crop damage. (Stepwise pictorial representation of each process of using agrotextiles in each application)
2. Detailed guidelines for usage of each product of agrotextiles in India as per recent research carried out on these areas.

Chapter 4 - Cost Benefit & Economic Impact

3. Business case for usage of Agrotech for select applications

Chapter 5 - Analysis of Current Usage of Agrotextiles in India

4. Feasibility of indigenous manufacturing
5. Details of regulatory mechanism/laws/rules for these products

Chapter 6 - Analysis of Global Initiatives and Practices for Promoting Agrotextiles

6. Details of international bodies involved in developing measures to promote usage of Agrotextiles.
7. Standards and regulatory mechanism/laws/rules in place for the target products in place in countries like Europe, Australia, Israel, USA, etc.
8. Specimen of tenders used for awarding contracts which have well defined specifications and guidelines for usage of Agrotech.

Chapter 7 - Recommendations

9. Guidelines/proposal for Revision of NHM (National Horticulture Mission) subsidies/inclusion of products in NHM/Implementing mechanism for NHM with proper justification
10. Detailed guidelines for Linkages of various Financial aids & subsidies with usage of agrotextiles to ensure better returns
11. Detailed areas for application based research for cost economics of the products to be conducted with proper justification.
12. Details of proposed special schemes for usage of agrotextiles at vulnerable areas/sensitive produces with details of implementing agency, outlay, benefit, need etc.
13. Our views on areas for amending the existing Indian laws/rules/regulations & new regulations required to be brought for mandatory usage of Agrotextiles in Indian context.

14. Details of Agrotextile products to be included in the agriculture kits which are distributed to farmers on subsidized rates.
15. Applicable standards for each of the products in India, considering variations arising due to application segment and the end user type.
16. Performance standard for new Agrotextile products as per recent research carried out on these areas.
17. Comparative analysis of standardization and regulatory mechanism/laws/rules in developed countries. This will include a clear benchmarking and identification of gaps in terms of product standards and regulatory / policy interventions for Agrotech segments, between India and the countries where the market for particular products is mature and well established.
18. Suggestions on bridging the gap that exists between Ministry of Agriculture, Horticulture with Ministry of Textiles (including co-ordination with the States on laws on banning Plastic bags/films where these contribute more damages to cattle etc and intense labour costs for removal of films scrap).

3 An Overview of Agrotextile Products and Industry

3.1 Introduction

In 2007-08 the size of the Indian agrotextile industry not including plastic products such as films stood at ₹ 487 crore with exports of ₹ 67 crore and imports of ₹ 12 crore, and was projected to grow to ₹ 709 crore by 2012-13. A significant proportion of agrotextile consumption comes from fishing nets – ₹ 564 crore or 80% in 2012-13 according to the same projections. In comparison, fishing nets contributed to 90% or ₹ 442 crore of the ₹ 487 crore agrotextiles market in 2007-08². This points to the significant growth of expected of other product categories such as shade nets, mulch mats, anti-bird and anti-hail nets in the last half decade viz-a-viz fishing nets. Additionally, exports were projected to stand at ₹ 107 crore in 2012-13.

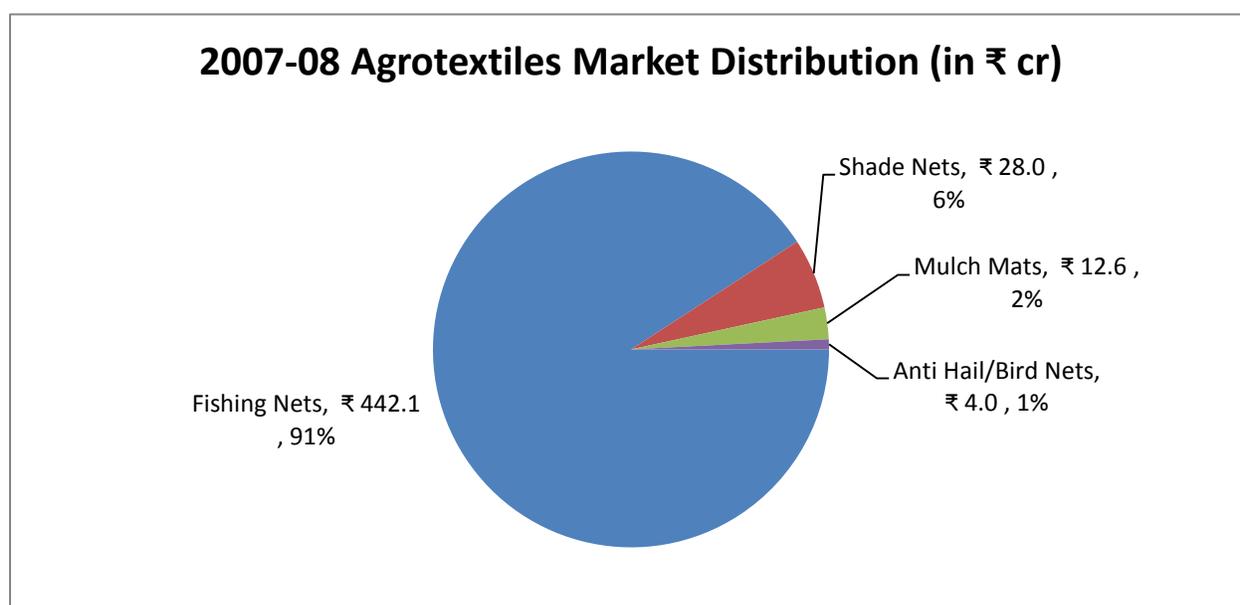


Figure 3.1: 2007-08 India Market Distribution (in Rupee crores)

² Gangopadhyay, U K. "Current Scenario of Agrotextiles & Recent Developments". SASMIRA. Sept 9, 2009.

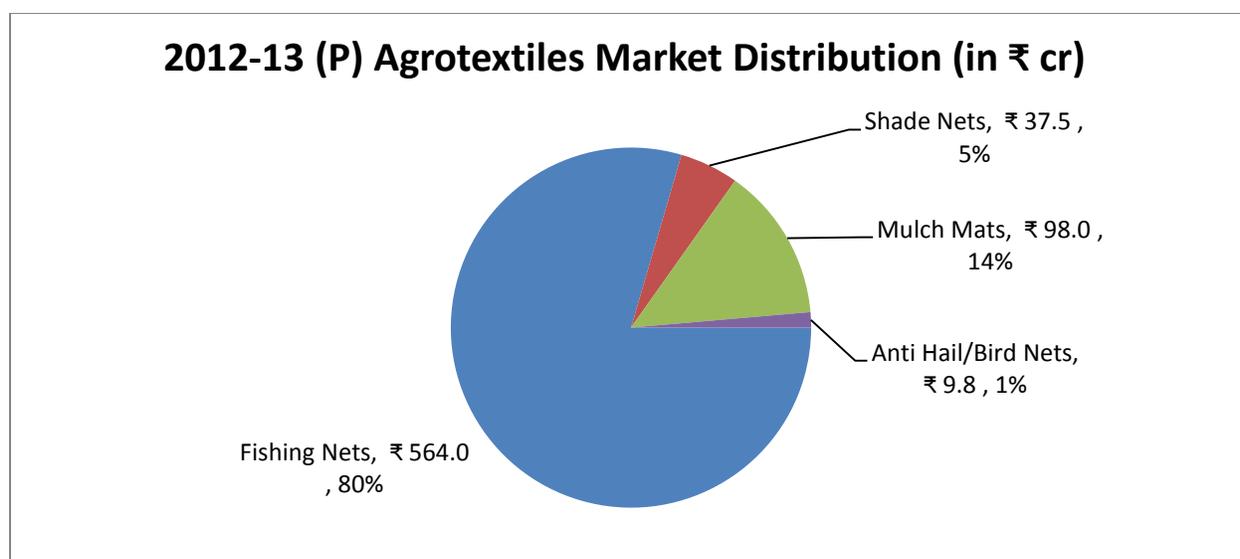


Figure 3.1: 2012-13 India Market Distribution (in Rupee crores)

The market actually outperformed these projections and in 2011-12 itself stood at ₹ 751 crore. This figure is further projected to rise to ₹ 1869 crore by 2016-17.³

3.2 Agrotextile Products and Application Areas

Wide varieties of agro textile products are available and the selection of suitable type of products depends on the protection required for the crop. Selection of the agrotextile is greatly influenced by the geographical location. In some locations, agrotextile is used to protect the plantation from excessive sunlight while at some places it is used to protect plants from cold temperatures. Therefore the selection of agrotextile is done as per the location and the desired protection from the external conditions. With the use of high quality agrotextiles, quality and yield of agro products can be enhanced.

The general characteristic requirements of Agrotextiles are:

- Weather Resistance - They must work effectively in various climatic conditions involving wide ranging temperatures, precipitation, etc.

³ Joshi, A B. "India's Approach to technical textiles". August 25, 2011. Textile Commissioner's Office. (Projection by sub-group on technical textiles for 12th five year plan with a growth rate of 20% year on year)

- Resistance to Microorganisms - They must be resistant to microorganisms to protect the produce and prevent diseases
- Stable Construction - The construction must be such that they can undergo a fair amount of wear and tear
- Light Weight - The weight of the fabric should be such that it can be borne by the plant

Agrotextiles have vast areas of application and accordingly their classification also varies. Agro textiles can be classified on following basis:

Classification of Agrotextiles on the basis of production technique:

- a) *Knitted* - Most agrotextile products, especially those with high use, are knitted products. Knitted netting is made with synthetic yarns similar to a textile process. It offers superior flexibility and movement without sacrificing tensile strength. With regards to Agrotextiles warp knitting technique is more widely used compared to weft knitting. Warp knitted agro nets are produced on Raschel machines and are produced in various construction or lapping types - which is the way in which individual yarn systems are converted into fabrics.
- b) *Woven* - These are manufactured by weaving yarns of drawn polymer. These yarns may be flat tape, mono-filament, multi-filament, and fibrillated (flat tape slit and twisted).
- a) *Non-woven* - While there are various varieties of non-woven manufacturing techniques, only two are employed to manufacture certain agrotextiles. These are:
 - *Needle-punched* - Needle-punching is a mechanical process which, rather than using heat, fixes the fibres relative to each other by entanglement. The manufacturing machines consist of reciprocating banks of barbed needles compact loose fibre into a labyrinth of interconnected fibres
 - *Spun-bonded* - Continuous filament fibres are extruded from spinnerets to form a swirling pattern of fibres across a web. This web then may or may not undergo needle-punching (as described) above, followed by thermal bonding in which the web passes through a pair of heated rollers or an oven where the fibres are bonded together to form a uni-planar Agrotextile.

Classification of Agrotextiles on the basis of areas of application:

- a) Agrotextiles for crop production.
- b) Agrotextiles for horticulture, floriculture and forestry.
- c) Agrotextiles for animal husbandry and aqua culture.
- d) Agrotextiles for agro engineering and packaging related applications.

The various types of Agrotextile products are:

1. Shade Nets
2. Windshield Nets
3. Bird Protection Nets
4. Crop Covers

5. Plant Nets
6. Root Ball Nets
7. Anti-Insect Meshes/Nets
8. Harvesting Nets
9. Mulch Mats/Ground Covers
10. Anti-Hail Nets
11. Fishing Nets
12. Turf Protection Nets
13. Pallet Net Covers
14. Woven Sacks/Bags
15. Leno Bags

Shade Nets

Shade Nets are nets made of Polyethylene or Polypropylene thread with specialized UV treatment having different shade percentages. These nets provide a partially controlled environment by primarily reducing light intensity and effective heat during day time to crops grown under it. This enables lengthening of the cultivation seasons and well as off-season cultivation depending on the conditions and type of crop.



Figure 3.3: Shade Net

Shade nets are typically used in structures known as shade net houses which are frame structures made of materials such as GI pipes, angle iron, wood or bamboo which are then covered with shade nets to provide the benefits listed above.

Anti-Bird Nets

Enormous fatalities are caused by birds in most of the crops. The crops like grapes, guava, and pomegranate are harshly infected by parrots. From time to time the parrots can wipe out the whole crop within hours. To keep away from such huge losses, bird protection nets are used.



Figure 3.4: Anti-Bird Net

Bird protection nets are produced from Polypropylene or High Density Polyethylene (HDPE) mono filament yarn. These yarns are ultra violet (UV) stabilized and knitted into a durable mesh fabric. Knitted monofilament nets offer effective passive protection to seeds, crops and fruit against damage caused by birds and a variety of pests. Open-mesh net fabrics are used as a means of protecting fruit plantation. The special open structure repels birds, provides

minimal shading and excellent air circulation - allowing plants to flourish, whilst avoiding the risk of dangerous mould developing on the fruit.

Windshield Nets

Wind Shield Nets are designed for the protection of crops, small trees and plants from strong winds as well as wind-chill. They are UV stabilized in order to ensure durability and they are easy to install. There is loop line provision so that a beanpole can be used to hold the net towards the wind.



Figure 3.5: Windshield Net



Figure 3.6: Root Ball Net

Root Ball Nets/Sapling Bags

It is extremely important for safe and speedy growing of young plants that root system is not damaged when they are dug up, transported or replanted. Normally root balls are wrapped in cloth, but elastic net tubes or Root Ball Nets are an alternative to this. When the plants are transplanted the nets on the outside do not have to be removed since the roots can protrude through the nets. Sapling Bags are a variation of this product where instead of a net a woven or non-woven bag is used.

Anti-Insect Nets

Various insects like whitefly, thrips, aphids, etc. attack some ornamental plants and vegetables frequently. Insect Nets are clear, woven polyethylene monofilament meshes that protect plants from insect attack (without the use of insecticides). Insect Nets can also be placed over the openings of greenhouses to prevent pollinating insects, such as bumblebees, from escaping.



Figure 3.7: Anti-Insect Net

Mulch Mats/Ground Covers

Mulch mats are used to suppress weed growth in horticulture applications. They cover the soil around the plant or tree and help in blocking off light and preventing the competitive weed growth around seed links. This also reduces the need for herbicides required for weed control. While plastic mulch films are popular and extensively used, woven and non-woven and spun bonded agrotextile mats are preferable for this application as they provide durability and better breathability. Bio-degradable types of mulch mats based on jute are also available. In India, straw, silage, sawdust, asphalt paper, mulch film, etc. is conventionally used for mulching.

However, adoption of technical textiles for mulching is yet to gain momentum, especially due to presence of cheaper mulch films



Fig 3.8: Sheets of mulch fabric (coir here) have a long lifespan & are very effective on very weedy sites



Fig 3.9: Individual mats suppress weeds very successfully round the base of trees and give a neat appearance to the site

Crop Covers

Generally, the crop covers are ultra-violet treated fabrics of polypropylene manufactured using the spun bond technique. The fabric is very tough, with a high degree of UV stabilization (to protect against breakdown in sunlight), and the suppleness makes it very easy to handle. The cover creates a micro-climate (without hindering ventilation) which gives protection against adverse weather conditions - improving both quality and yields. Crop-covers generate an outstanding micro atmosphere for seed germination and seedling growth. A crop-cover is positioned over a huge area (a number of rows) of a harvest. In cooler atmosphere, crop-covers are often positioned over direct seeded rows or newly removed crops to create a warmer, more humid micro environment to assist quick plant establishment of warm season crops. Rope covers also offer crop shelter from pesticide.



Figure 3.10: Crop Cover

Plant Nets

These are the made from polyolefin type of fibre. It is mainly used for the tomato type of plant. The gsm of the nets are 30-40. Fruits, which grow close to the ground, can be kept away from the damp soil by allowing them to grow through vertical or tiered nets in order to keep the amount of decayed fruit to minimum

Harvesting Nets

Harvesting nets are used to collect the fruits falling from a tree. This helps to keep the cost of cultivation low by eliminating additional labour associated with harvesting. Harvesting nets are predominantly grip structures which can be developed using warp knitting technology.



Figure 3.11: Harvesting Net



Figure 3.12: Anti Hail Net

Anti-Hail Nets

Hail protection fabrics help shield vines from the fruit damage and defoliation associated with hail yet still let through plenty of sunlight. The lightweight netting is tough, rip resistant, and highly UV stabilized and has the additional benefit of protecting vines from wind and birds.

Fishing Nets

Fishing Nets are technical textiles utilized in fishing industry. Fishing nets are knitted fabrics used for marine and inland fishing by fisherman, fishing trawlers and boats. The characteristics and specifications of fishnets vary on the basis of method adopted for fishing. Fishnets are manufactured using nylon chips as well as HDPE. The average life of fishing nets is 2 - 3 years. Some fishermen use it after repair.

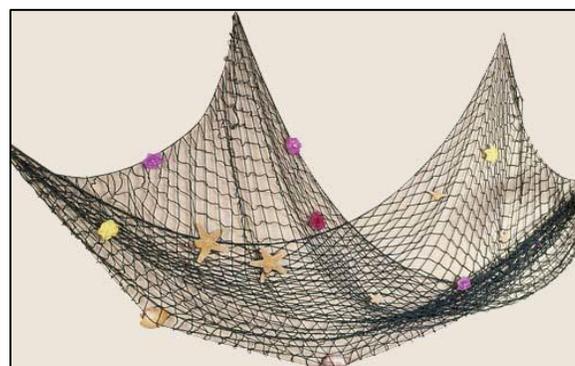


Figure 3.13: Fishing Net

Turf Protection Nets

A Turf Reinforcement Net is an extruded plastic mesh designed to help grass seedlings germinate and grow in a uniformly strong structure. The roots intertwine with the durable mesh and prevent separation from the soil when rolled. This allows turf producers to harvest a crop in half the time, providing the opportunity for a second planting during their season. Such nets also provide soil stabilization to make green areas available for pedestrian and vehicular use.



Fig 3.14: Turf Nets are laid on the ground just after seeding to encourage the growth and reinforcement of turf grass

Pallet Net Covers

For safe transportation of fruits and vegetables to the market individual boxes are collected into larger units and these boxes are covered with wide, large mesh nets on pallets to stop the boxes being turned upside down or squashing each other. This prevents damage to goods during transportation. Nets used for this purpose generally have high tensile strength and are made from high tenacity Polypropylene in a diamond mesh pattern and an elastic cord on the surrounding edges.



Figure 3.15: Pallet Net

Woven Sacks/Bags

Woven polypropylene bags or simply woven PP bags are considered to be the toughest packaging bags, widely used to pack materials for grain, milling and sugar industry. Additionally, these bags also find wide application in fodder industry, chemicals and fertilizers industry besides cement industry and other applications like sand, metal parts and concrete etc.

Leno Bags

PP Leno bags are widely used for packing onions, potatoes, corn, cabbages, seafood and citrus products, etc.



4 Key Case Studies and Cost Benefit Analysis

The Indian scenario when it comes to agrotextiles is in a nascent stage where uptake of most products is extremely low. Various factors contribute to this such as lack of awareness, affordability for bottom of the pyramid farmer consumers, as well as suspect quality materials that have led to inconsistent results when used. These factors have been studied in detail later in the report based upon in depth discussions with various stakeholders of the agrotextile industry ecosystem.

Citing the nascent stage of the industry, various stakeholders such as the COEs and manufacturers as well as end users felt that there is a need to focus on 3-4 proven products/applications that can address a large share of the market and provide economic benefits. Certain key case studies that indicated increased yields and improved quality of produce can be seen below.

4.1 Key Case Studies Displaying Increased Yield and Produce Quality

Case studies documenting use of Agrotextiles and extolling their qualitative benefits have been largely carried out by various agricultural agencies and universities. This report takes this opportunity to collate and present some of the representative case studies that showcase the advantages of using Agrotextiles.

4.1.1. Case Study 1: NAIP Mass Media Sub-Project on Shade Nets and Mass Media Mobilization, DKMA with inputs from IIHR, Bangalore

Quality seedlings are essential for good growth and performance of vegetable crops. Hence, the practice of seedling production is emerging as a professional and commercial activity. During the past, as most of the vegetable varieties were open pollinated, farmers produced the seedlings at a relatively low cost by preparing their own nursery beds. However, due to increase in demand for seeds of hybrid varieties which cost much more than the open pollinated varieties, many progressive farmers and agriculture entrepreneurs have taken up the production of quality seedlings using seedling trays as a commercial activity.

One such enterprising farmer was cultivating finger millets, paddy, marigold and vegetables on 2.5 acres of ancestral land. His crops were plagued with diseases and low yield. Then, he approached Indian Institute of Horticultural Research, Bangalore to find out the solution to his problems and overcome the poverty of his family.

A low cost protected structure using shade nets was set up and vegetable seedling production was started in portrays using sterilized coco-peat as growing media. The shade nets prevented virus causing pests to enter the structure, the portray reduced the root damages in seedlings and decreased excess water retention at base, and the media with its light weight promoted excellent germination and growth. As expected, the farmer got quality seedlings which were very much in demand. He started to grow seedlings in the ancestral land and today the full 2 ½ acre is under quality vegetable seedling production.



Figure 4.1: Quality seedling cultivation

The farmer has achieved protection of the seedlings during rains in the net house which is simple, cheap and easy to use. He has also developed an iron structure for ease and to prevent loss during transportation.

Seedlings grown include tomato, cabbage, cauliflower, brinjal, capsicum, chilli, knoll-khol, ridge gourd, cucumber and other vegetable seedlings. The capacity of the nursery has increased and today produces 40 lakh seedlings per annum, with a monthly profit of over ₹1,00,000.



Figure 4.2: raising of seedling under Shade Net

Farm Area	Cultivation	Agrotextile Used	Benefit
2.5 acres	Tomato, cabbage, cauliflower, brinjal, capsicum, chilli, knoll-khol, ridge gourd, cucumber and other vegetable seedlings	Shade Nets	Capacity of 40 lakh seedlings per annum with a monthly profit >₹1,00,000

4.1.2. Case Study 2: Evaluation of insect net for insect dynamics and microclimate inside net house for vegetable production by Central Institute of Post-Harvest Engineering & Technology (CIPHET)

Four Net-houses of 25, 40, 50 and 60 mesh size of with double doors have been constructed. Two big springs have fitted in each gate, which work as auto door closure to avoid entry of the tiny insect through gate when workers or visitors open the gate.



Figure 4.1: Shade Net Houses with various Insect Mesh

Objectives:

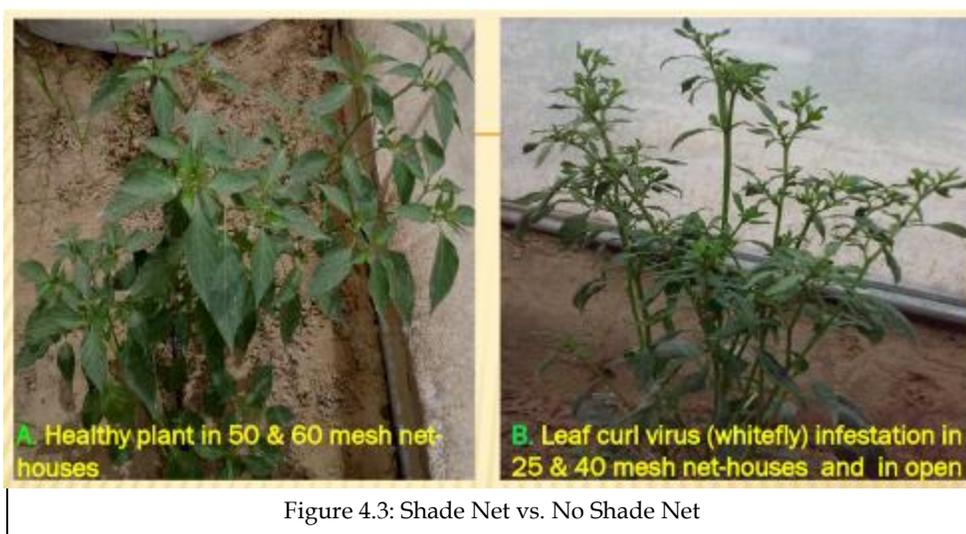
1. Standardization of specific mesh size of net to prevent entry of the tiny insect pests
2. Optimization of microclimate inside net house for growth and yield of the crop



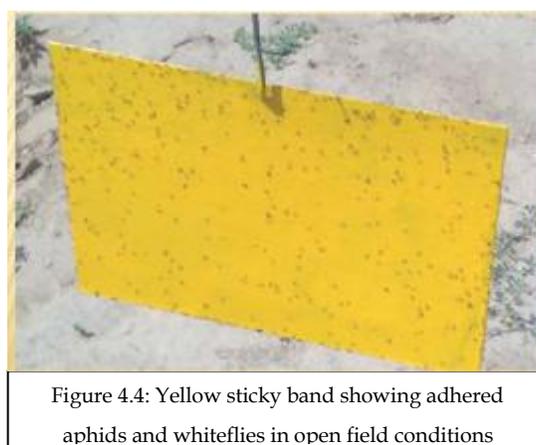
Figure 4.2: Tracking insects inside Net House

Three rows of tomato, capsicum (shimla mirch) and two rows of chilli (deshi mirch) were transplanted with 50 x 50cm spacing on 15 Jan 2011. Drip irrigation was arranged for need based irrigation and fertigation and to avoid the contamination of tiny insects, adult, eggs and larvae. Entire net-house structures were protected to prevent the insect entry through secondary sources.

Observations:

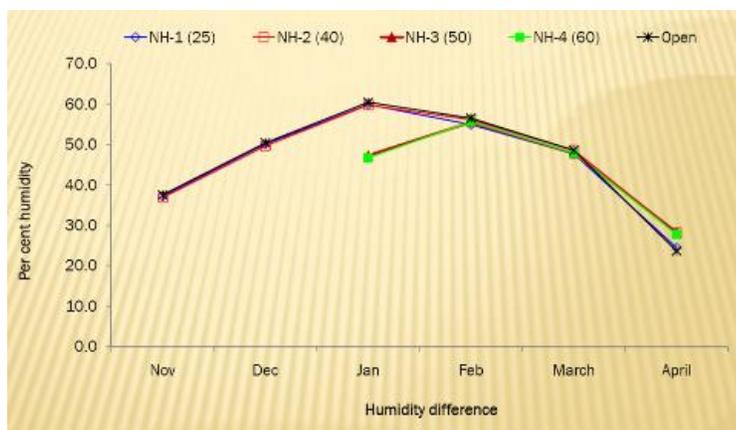
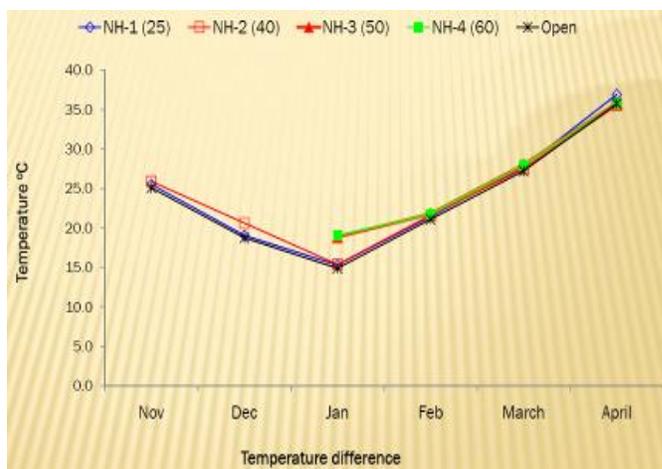


1. No infestation of aphid and whitefly has been found in tomato. Whereas, infestation of whitefly i.e. leaf curling was recorded in capsicum under 25 and 40 mesh size net houses. It indicates that the whiteflies were able to penetrate inside in 25 and 40 houses mesh size nets. Thus, net of 50 and 60 mesh size may be recommended to prevent the entry of harmful tiny insects in the net-houses
2. No any aphid was found inside 50 and 60 mesh size net-houses. Whereas, 5-8 aphids were observed inside the 25 mesh net house. In open field conditions 450-600 aphid counts were recorded on a single yellow sticky band.



Microclimate results:

During winter there was marginal difference of 2-3 degrees C more in winter temperature recorded inside the net houses as compared to the open field conditions. But among the net-houses no significant variations in temperature were found.

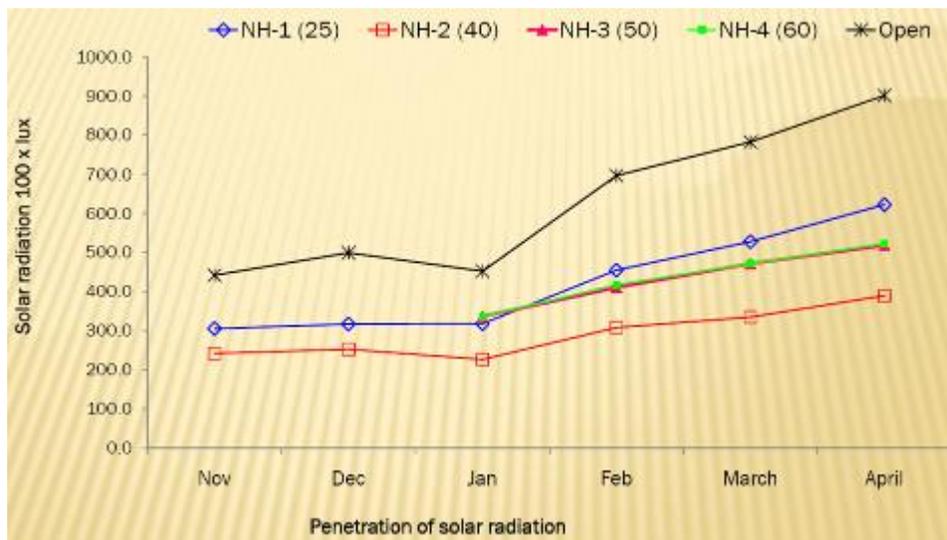


Humidity:

The difference in humidity was also negligible when comparing conditions inside and outside the net-houses as well as amongst the four different net-houses.

Solar radiation:

Comparatively significant reduction of solar radiation was recorded inside net-houses i.e. less solar radiation was found inside the net-houses as compared to open field conditions.



Yield and quality of the produce:

Net houses	Tomato					Capsicum	
	Fruit weight (g)	Yield (Kg/p)	TSS%	Vit. C	Acidity	Fruit weight (g)	Yield (Kg/p)
NH-1	54.0	3.62	5.8	32.76	0.78	45.7	2.7
NH-2	57.9	3.83	6.3	34.02	0.78	57.4	2.5
NH-3	48.8	3.97	6.1	34.74	0.92	77.6	2.6
NH-4	45.6	3.71	7.0	36.18	1.03	62.5	2.7
Open field	42.0	2.17	5.6	32.72	0.72	35.8	1.3

Snapshot of Benefits:

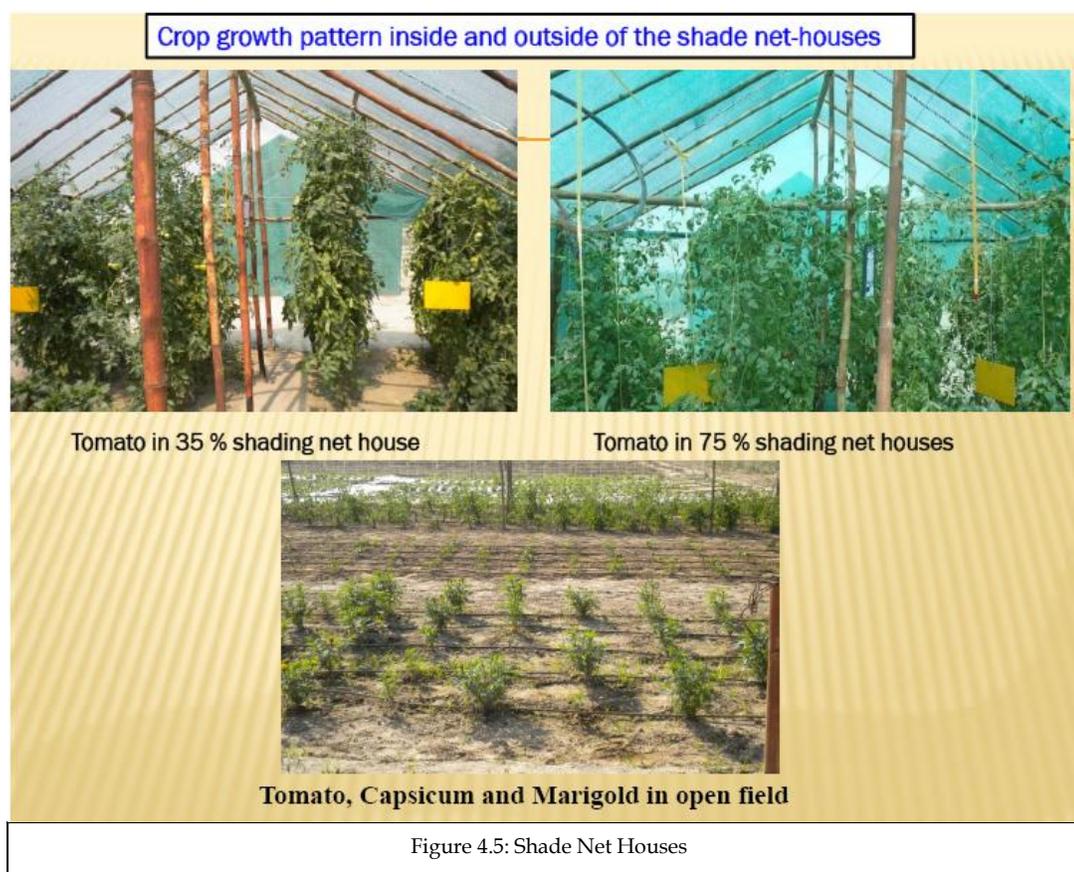
Area	Cultivation	Agrotextile Used	Benefit
Shade net houses of 18-20 m ² each	Tomato and Capsicum	Shade Nets, Anti-Insect Nets	Increase in tomato yield of 67-83% Increase in capsicum yield of 92-108%

4.1.3. Case Study 3: Optimization of shade net design to create a suitable climate for cultivation of vegetable, cut flowers in semi-arid region by Central Institute of Post-Harvest Engineering & Technology (CIPHET)

Nine bamboo framed shade net-houses of three different heights (2.5, 3, 3.5 m) and three shading percentage (35, 50 and 75 %) were constructed. Tomato (Cv Naveen), Capsicum (Cv California wonder) and marigold were transplanted in nine shade net-houses and open field.

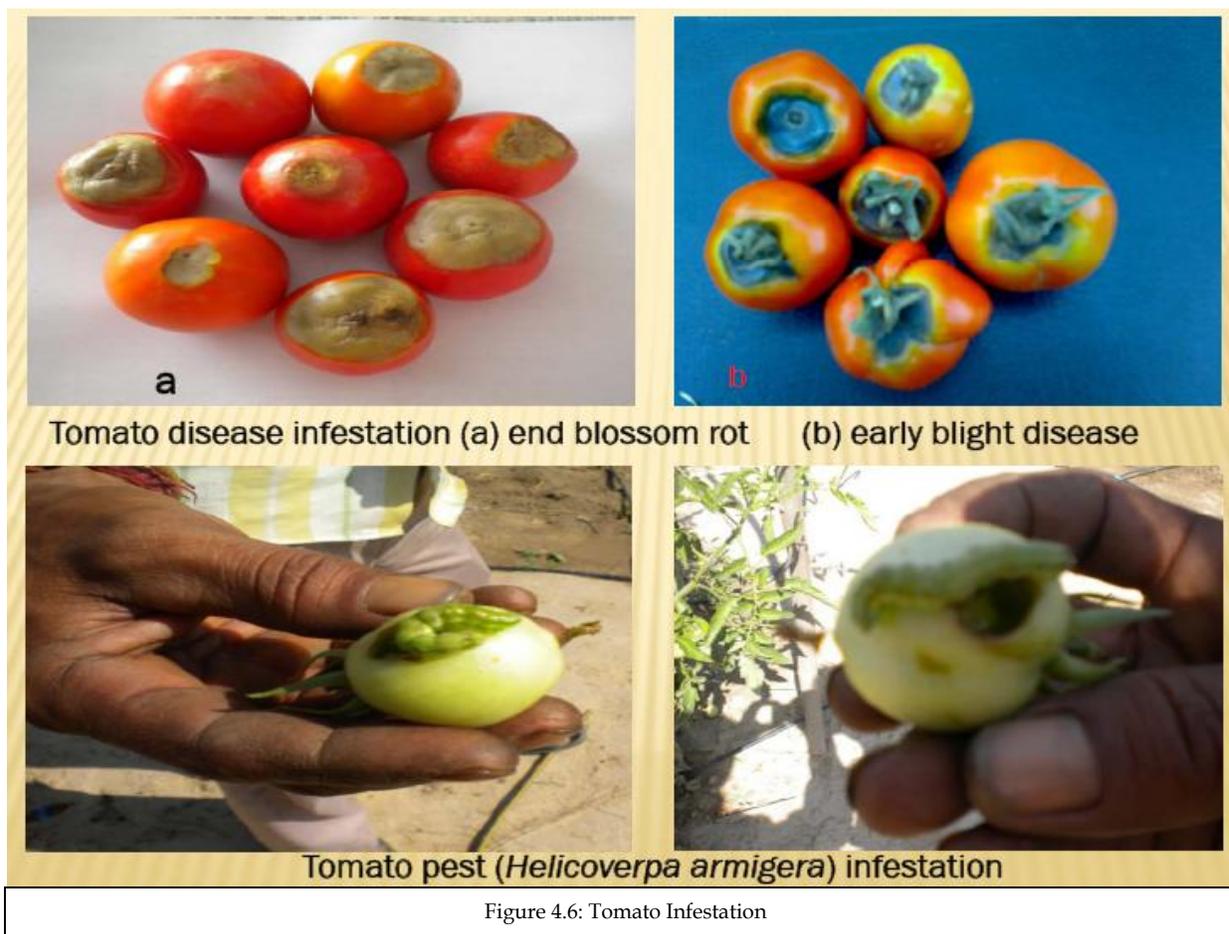


Figure 4.5: Shade Net Houses



Tomato

- Early and more flowering and fruiting was observed in open field and 35% shading g nets as compared to the 50 and 75 % shadings.
- Contrary to the previous example, more tomato yield 3.27 kg/plant was found in open field conditions followed by 2.90, 0.84, 0.72 kg/plant in 35, 50 and 75% shading net, respectively. But as can be see in the next point, there was significant attach of pests to crop in open field there affecting usable yield. Thus only 35% shade net can be recommended for tomato cultivation, which also increased the crop period of tomato.
- No pest and disease infestation was found in produce of the shade net-houses. Whereas in open field, a significant attack of pest (*Helicoverpa armigera*) and diseases (early blight *Altenaria solani*) was observed.
- No significant differences were observed in TSS, acidity and ascorbic acid among the all shade nets produce. But more ascorbic acid content was found as compared to open field.



Capsicum

- In capsicum highest aphid and whitefly infestation was found in open field conditions i.e. 58.2 aphids plant were observed on three apical leaves. However, almost negligible number of aphids was found in shade net-houses.
- More yields were observed under 35% shade nets as compared to 50, 75% and open field. This may be due to reduced penetration of solar radiation inside 50 and 75% shade nets.
- Highest average fruit weight and yield was found in 35% shade nets, which was significantly higher than 50 and 75 % shade nets and open field conditions.

Marigold

- The average total yield of flowers was found to be 517.8 g/plant in 35% shade, which was significantly more than the other net-houses and open field.
- The average flower weight was found to be 32.67 g under 35% shade net, followed by open field (21.60 g). Similarly it was 17.39 and 6.53 g under 50% and 75% shade net-houses respectively



Figure 4.7: Shade Net Houses

Snapshot of Benefits:

Area	Cultivation	Agrotextile Used	Benefit
Shade net houses of 18-20 m ² each	Tomato, Capsicum and Marigold	Shade Nets cum Anti-Insect Nets	<ul style="list-style-type: none"> • Longer cultivation season for tomato and higher usable yield due to no infestation • Increase in capsicum yield by using 35% shade net • Marigold flower weight increase of 51%, and significant increase in yield per plant at 518 g/plant

4.1.4. Case Study 4: Comparison of Different Weed Control Techniques

Curry leaf cultivation was chosen to compare various weed control methods. The control of weeds was carried out by four main techniques:

- Using non-woven jute mulch
- Manual weed control
- Chemical weed control
- No weed control

This experiment involved comparing each method and observing subsequent effect on weed control and yield.

Using Non-Woven Jute Mulch

Mulching blocks the sunlight and thereby prevents the germination of the weed. But this no way effects the growth of the plant since mulching is done only after the plant grows to certain extent.



Figure 4.8: Conventional cultivation of curry leaves



Figure 4.9: Cultivation through fibre mulching

Advantages:

1. Reduces maintenance costs whilst plants are establishing.
2. Discourages weeds and unwanted grass.
3. Improves water retention due to uneven surfaces.
4. Reduces soil erosion on sloping ground whilst roots develop.

Manual Weed Control Technique

- This involves manually pulling out weeds.
- In certain cases simple tools are used to pullout the weeds.
- Weeds should be removed right from the root to avoid weeds growing again from the ruins.
- The crop matures within three months. Weeds have to be removed once in 20 days.
- It takes a day and a half for ten men to pull out weeds from one acre of plantation.

Chemical Weed Control Technique

Chemicals used in Curry leaves include:

- Gramaxzone
 - Required amount is approximately one litter per one acre.
 - It is mixed in a proportion of hundred ml in ten liters of water.
 - Mixed solution is applied to the field through a spray motor, which requires ten to fourteen liters per tank.
 - One acre consumes about ten to fifteen tanks of mixed solution.
 - Weeds will start to die after one month of applying.
 - Chemicals will remain effective for about two to three months or until toiling.

No weed control Technique

- Here no care is taken to this plot. The plot is irrigated like other plots.
- Usually weeds grow like a bush here and cover the overall area.
- This plot needs more amount of water. The seeds from these weeds fall over the land and spoil the fertility of the soil.

Results

Weed count in the various weed control techniques:

Week no.	Weed Count			
	No weed control	Manual weed control	Chemical weed control	Mulch weed control
1	3	1	2	0
2	3	3	2	0
3	5	4	3	0
4	6	0	1	0
5	5	2	1	0
6	10	2	5	0
7	21	4	2	0
8	21	0	2	0
9	24	4	2	1
10	27	6	2	1
11	30	9	4	1
12	30	0	2	1

Yield comparison in various techniques:

Plot	No weed control	Manual weed control	Chemical weed control	Mulch weed control
Yield in kg/Acre	1600	2408	2357	2617

Mulch weed control is most effective and has highest yield.

Snapshot of Benefits:

Cultivation	Agrotexile Used	Benefit
Curry Leaves	Jute Mulch Mat	<ul style="list-style-type: none"> • 64% increase in yield over no weed control • 97% decreases in weeds after 12 weeks

4.1.5. Case Study 5: Construction of Farm Ponds in Andhra Pradesh under State Horticulture Mission

Farm ponds are manmade tanks constructed for holding the water which could be used during scarce season for the uninterrupted physiological activities of the crops. It is constructed by excavating the soil, by depositing the soil on the bunds and by laying a Geo-Membrane HDPE sheet in the excavated tank for preventing the infiltration and seepage. The water from bore wells, canals during the rainy seasons can be stored in these ponds and which can be used during scarce season.

Significant progress has been achieved in this component during 2009-10. Overwhelming response was received from 7 districts i.e., Kadapa, Ananthapur, Kurnool, Chittoor, Prakasam, Nalgonda and Mahabubnagar where the availability of water is not continuous throughout the year and the yield of water depletes during summer months.

500 Farm Ponds of five standard sizes - 10 (14 x 14 x 4m), 20 (21 x 21 x 4m), 30 (27 x 27 x 4m), 40 (31 x 31 x 4 m) & 50 (35 x 35 x 4m) lakh litres for irrigating 1, 2, 3, 4 & 5 hecatres of crops respectively were constructed to provide water facility for crops like Mango, Sweet Orange during crucial period and also to facilitate raising of irrigated dry crops.

Sri. A. Indrasena Reddy, Uppunuthala Mandal, Mahabubnagar Dist.
Pond Size 21 x 21 x 4 Mtrs.



Sri. Ramchandraiah, Veldanda Mandal, Mahabubnagar Dist.
Pond Size 21 x 21 x 4 Mtrs.





FARMPOND OF SRI.NARAYANA-(ST FARMER) AMMARIVARI PETA, BOKKA RAYA SAMUDRAM

Name of the Beneficiaries: T.Saidulu goud/Thandu Sridevi and others

Village: Cheruvupalli

Mandal: Thipparthi

District: Nalgonda

Farmpond capacity: 50 lakhs litres

Before construction of farm pond: Ground water depletion and inadequate water availability led to drying up of Citrus plants.

After construction of farmpond: The farmpond has been stored with 50 lakhs litres of water to provide critical irrigation during April- May months. This is a case where quantifiable benefit is hard to pin point, but the overall benefits - both direct (such as any savings in water procurement cost, increased yield due to proper irrigation, etc.) and indirect are crucial and significant.

4.1.6. Case Study 6: Comparison of Mulch Mats vs. Mulch Films

There is great substitution in place where Mulch Mats are concerned as Mulch Films are seen to provide similar benefit at a cheaper cost. The properties of each can be seen below:

Textile Mulches (Woven and Non-Woven)

Property	Sample 1 (NW Needle Punch)	Sample 2 (NW Spun Bonded)	Sample 3 (NW Spun Bonded)	Sample 4 (Woven)
Polymer	Jute	PP	PP	PP
GSM	1241	124.4	109.9	100
Thickness (mm)	7.86	0.55	0.53	1.0
Tensile Strength (Kgf)	14.4 x 10.1	19.1 12.3	18.2 x 8.9	113 x 70
Tear strength (Kgf)	-	16.5 x 8.8	17.4 x 6	28 x 19.2
Water Permeability (lt/sq-m/sec)	42.6	16.3	36.8	39
Water vapour permeability g/sq.m./day	504	1041.7	1037.5	742
Loss in strength after 500 hours UV exposure	42 %	38 %	30 %	8 %

HDPE Mulch Films

Property	Sample 1	Sample 2
Thickness (μ)	16	50
Tensile Strength (Kg/cm²)		
Direction-I	190.00	267.00
Direction-II	137.00	200.00
Tear Strength (lbs)		
Direction-I	0.30	1.90
Direction-II	0.80	2.30
Water vapour permeability g/sq m/day	11.3	9.6

The qualitative advantages and disadvantages of each are as follows:

Conventional Mulch films

- Use HDPE sheets and help prevent weed growth
- Help raise temperature
- However, do not provide controlled microclimate for crop growth

- Cheaper cost, but life is short as it tears easily due to winds

Nonwoven Mulch Fabric like Spun-bond polypropylene nonwovens

- Multilayer construction of mulch mats consisting of needle punched nonwoven, support scrim and monoporouss laminate
- Advantages
 - o Controlled soil microclimate for both temperature and humidity
 - o Appropriate soil and water management
 - o Prevention of weed growth
 - o Longer life and easier to remove
 - o Biodegradable mats also available which do not toxify the soil

Woven Mulch Fabrics

The key features are as follows:

- Can be made available in different colours
- Increases soil temperature as required by plants
- Black mulch fabric provides good weed control
- Micro holes in fabric provide good aeration and maintain soil temperature stable giving good growth to plants
- Can be rolled back and reused again-savings for farmers in terms of money, time and labour
- UV stabilised hence can be used for minimum of 2 yrs also. No change color on sunlight exposure
- Biodegradable mats also available which do not toxify the soil
- It prevents fertiliser leaching saving money for farmers-no frequent fertiliser feeds to plants
- Soil remains moist and retains moisture for a longer time; this helps root branching easily and water savings for the farmer

From benefits displayed in the five cases above, the following applications were chosen to highlight the cost-benefit associated with these products as they are the most widely used products and have already been incorporated into some of the government incentive schemes, further augmenting the monetary benefit.

4.1.7. Case Study 7: Cultivation of Tomato, Capsicum & Chillies under All-In-One Greenhouse in Mizoram by ARGOS (Agri Products) Ltd Israel

Although growing in a greenhouse is much more expensive than growing outdoors, one can grow virtually anything and at any time of the year. Harvesting in a greenhouse carries on for up to 10 months in a year when using the right kind of seeds. The obvious reason one would grow in covered agriculture is to supply the market during the off - seasons of crops etc. so as to fetch higher prices.

You are able to control the temperature, Pests, control humidity, protect your plants from adverse weather, and produce quality with longer shelf life.

Mizoram project: In 1 sq. meter of space we are able to produce up to 20 kgs of tomatoes in a cycle. Some crops may have 2 cycles a year.

Not every farmer can afford Covered agriculture, however with the right economics worked out it is profitable. Growing in soilless media (coco peat) is even more effective for the plants. Helps reduce threat of pests and disease. No standardized Greenhouse material can give the desired results. One must always study the location of the greenhouse (crop to be grown, climate, soil, and other important factors) and then decide as to the quality, strength etc required in the material used for setting up a greenhouse. The following gives an insight in to what must be calculated while designing a Greenhouse:

Polyethylene (Cover & Curtains)

Must have the right thickness tolerance, mechanical properties (tensile strength at break, transverse direction, machine direction etc. Optical properties for total light transmission/diffusion. Palrig Agri - side - Cloth weight, UV stability, light transmission, breaking strength, light diffusion properties etc.

Insect net

A new concept in plant protection – controls the activity of insects by a double mechanism. This innovative net causes insects such as whiteflies, leaf miners, aphids and red spider mites to become disoriented and lose their ability to attack plants.

Characteristics of net

- Made of high tensile strength round monofilaments
- UV Stabilized for many years use
- Transparent
- Lightweight and easy to install
- Strong tucked-in selvages

Advantages

- Optimal ventilation
- Reduced expenditure on pesticides and chemicals
- Improved plant yield and quality
- More organic product
- Reduced labor and production costs
- Fast and easy installation
- Protection against climatic damages

Ground Cover

A woven polypropylene cloth with combined colors (outer white (85%) and inside black (85%)) is strong, flexible and blocks the light transmission. The white side is used uppermost in order to reflect sun rays onto the plant foliage and thereby improve its growth. The black side is used as groundcover to prevent weed growth in the paths of gardens and plant nurseries. It is used for the growth of plants in soilless medium and other applications, where there is a need for porous cloth which blocks the light.

Black shade nets

Low density net system, fixed on wires inside the nursery, manually operated.

Drainage and growth bag systems

- Black color, made of polypropylene
- Thickness: 700 micron

Approximate Production & Revenue Costs

	Total Area of Production	Cost per kg (Wholesale)	Production from 1 cycle	Total Sales	Total Operating Costs	Net Profit
Tomato	770 m ²	Rs. 35	16,000 kg	Rs. 5,60,000	Rs. 82,720	Rs. 4,77,280
Capsicum (Coloured)	770 m ²	Rs. 80	9,000 kg	Rs. 7,20,000	Rs. 80,190	Rs. 6,39,810
Mexican Habanera Chillies	770 m ²	Rs. 100	6,000 kg	Rs. 6,00,000	Rs. 80,630	Rs. 5,19,370
Total	2,310 m ²		31,000 kg	Rs. 18,80,000	Rs. 2,43,540	Rs. 16,36,460

4.2 Cases Displaying Cost Benefit Analysis of Key Products

Interactions with stakeholder during the course of this project have led to information and cases regarding the cost benefit of using Agrotextiles in various applications. Certain such studies carried out and documented by these stakeholders have been given in Annexure L.

The analyses conducted below are based upon **real world feedback** from users.

4.2.1 Shade Net House

The cost benefit analysis for capsicum over an area of 1000 sq m is given below.

Production Cost:

Particular Required	Units	With Shade net (organic)	Without Shade net
Organic fertilizer			
Cowdung fertilizer	Rupees	32,000	32,000
Vermi cost	Rupees	6,000	6,000
Plant	Rupees	7,000	7,000
Fertilizers			
191919,05232,0050 & calcium calcate	Rupees	Not required	15,000
Insecticides	Rupees	Not required	35,000
Harvesting & Transport	Rupees	55,000	55,000
Production	Tons	15	20
Rate sale in market	Rupees	60	20
Total cost of production	Rupees	1,00,000	1,50,000
Sales	Rupees	9,00,000	4,00,000
Profit /year.	Rupees	8,00,000	2,50,000
Total cost of shade net structure	Rupees	1,80,000	Not Applicable
Pay back year for shade net	Year	1	Not applicable

Conclusion:

From the above table, we can conclude that the farmers are gaining more profit in organic farming (with shade net) and the payback year is in 1 year. Since the life of the Shade Net can conservatively be assumed to be 2 years, the investment of ₹1,80,000 gives additional profit of ₹11,00,000 over two years. Hence the calculated ROI (Return on Investment) is 511%.

The production cost is more for the farmer who produced capsicum w/o shade net thereby affecting the profits and market rate of crop is less due to harmful fertilizers used for farming.

4.2.2 Anti-Hail/Bird Net

Anti-Hail/Bird Nets were identified as another product with the potential for swift growth as manufacturing processes are complimentary to anti-bird nets and shade nets, on top of which anti-hail/bird nets are already under the purview of the various national and state subsidies in effect. The cost benefit analysis for apple produced in 1 hectare with Anti-Hail Nets/Bird Nets is detailed below.

Production of Apples in Kgs/ha/year = 27000..... (I)

Production Cost:

			(Per Acre)
Sr. No.	Component		Proposed Expenditure (Rs.)
1.	Cultivation Expenses		
	(i)	Cost of planting material	2500
	(ii)	Manures & fertilizers	7700
	(iii)	Insecticides & pesticides	3000
	(iv)	Land Preparation	4200
	(v)	Others, if any, (Power)	3600

		Sub Total	21000
2.	Irrigation		
	(i)	Borewell	25000
	(ii)	SIP & Electrical Installation	25000
	(iii)	Others, if any	-
		Sub Total	50000
3.	Cost of Drip/Sprinkler		20000
4.	Infrastructure		
	(i)	Store & Pump House	20000
	(ii)	Labour room	5000
	(iii)	Agriculture Equipments	10000
	(iii)	Others, if any, please specify	
		Sub Total	35000
5.	Land Development		
	(i)	Soil levelling	4000
	(ii)	Digging	-
	(iii)	Fencing	20000
	(iv)	Others, if any, please specify	-
		Sub Total	24000
	Grand Total		1,50,000.00

Total expenditure required for producing apples in 1 hectare = Rs 1,50,000 × 2.47
= Rs 3,70,500(II)

Cost of Installation and maintenance of Anti-Hail/Bird Nets = 10,000 sq m × Rs 20 per sq m
= Rs 2,00,000(III)

Average Selling price of Apples produced by using Anti-Hail/Bird Nets = Rs 50/kg

Therefore,
Earnings in 1 year per hectare = (27000 × 50) - 370500 - 200000..... (from I, II & III)
= **Rs 7,79,500** (IV)

Average Selling price of Apples produced by without using Anti-Hail/Bird Nets = Rs 30/kg

Therefore,
Earnings in 1 year per hectare = (27000 × 30) - 370500
= **Rs 4,39,500** (V)

Total benefit by using Anti-Hail/Bird nets = 779500 - 439500 (from IV & VII)
= **Rs 3,40,000**

As can be seen from above the use of anti-hail/bird nets leads to an increase in price fetched by apples from Rs 30 to Rs 50, an increase of 66.7%. The total additional benefit over a hectare is ₹6.8 lakh from an investment of ₹2 Lakh, resulting in an ROI (Return on Investment) of 240%.

4.2.3 Mulch Mats

Mulch Mats are similarly an area of potential rapid growth within agrotextiles. The biggest hindrance is the uptake of mulch films which are a cheaper substitute for mulch mats, but there are additional benefits to mulch mats such as permittivity and breathability as well as life that should make them the more preferable option.

The cost benefit analysis for mangoes produced in one hectare using mulch mats in 5 years is detailed below.

Production Cost:

Spacing: 10m x 10m

Plant population: 100..... (I)

Sr. No.	Particulars	Year					Total
		1	2	3	4	5	
1	Planting material	2200	--	--	--	--	2200
2	Manures & Fertilisers	3000	1100	1100	1400	1400	8000
3	Plant protection	1100	600	600	700	700	3700
4	Sprayer & implements	1500	--	--	--	--	1500
5	Fencing	2500	--	--	--	--	2500
6	Irrigation	1800	500	500	500	500	3800
7	Labour	3200	1200	1200	1500	1500	8600
8	Intercropping	1500	--	--	--	--	1500
9	Miscellaneous	600	500	500	500	500	2600
	Total	17400	3900	3900	4600	4600	34400

(Source: <http://www.nabard.org>)

Total cost of production for 5 years = Rs 34,400 (II)

Cost of Installation and maintenance of Mulch Mat (approx.) twice in 5 years =
500 x Rs 30 per sq mtr x 2 = Rs 30000 (III)

Average Selling price of Mangoes per dozen produced by using Mulch Mats =
Rs 130/Dozen (IV)

No of mangoes per tree = 400..... (V)

Total dozens of mangoes in 1 hectare = 333.33 ~ 330..... (From I & V), (VI)

Therefore,
Earning in 5 years per hectare = (330 x 130 x 5) - 34400 - 30000..... (from II, III & IV)
= **Rs 1,50,100**(VII)

Average Selling price of Mangoes per dozen without using Mulch Mats = Rs 100/Dozen

No of mangoes per tree without use of Mulch Mats = 300..... (VIII)

Total dozens of mangoes in 1 hectare = 250

Therefore,

Earnings in 5 years per hectare w/o Mulch Mats = $(250 \times 100 \times 5) - 34400$... (from VIII, IX & XI)
= **Rs 90,600** (XII)

Total benefit by using mulch mats = $150100 - 90600$ (from VII & XII)
= **Rs 59,500**

As can be seen from above the use of mulch mats has a two dimensional effect on mango cultivation. First, the average selling price of mangoes has increased by 30% from Rs 100 per dozen to Rs 130 per dozen. Secondly, yield has increased from 300 mangoes per tree to 400 mangoes per tree, a growth of 33%. The resulting ROI (Return on Investment) is 98%.

4.3 Summarising key benefits

Based on the study of demonstrated benefits, the return on investments of using Agrotextiles is summarised in below table:

Application	Product	Benefit	ROI (2 yr life)
Capsicum cultivation	Shade Net cum Anti-Insect Net	<ul style="list-style-type: none"> • Decrease in the cost of production by 30-35% (reduction in insecticide & fertilizers) & Increase in yield by 92-108% • Additional profit of Rs 11 lakh over 2 yrs from Rs 1.8 lakh investment in shade nets per hectare 	<ul style="list-style-type: none"> • 511%
Apples	Anti-Hail/ Bird Nets	<ul style="list-style-type: none"> • Increase in avg. selling price of 60-65%; • Return of an added Rs. 6.8 lakhs on additional cost of Rs. 2 lakhs in one hectare 	<ul style="list-style-type: none"> • 240%
Mangoes	Mulch Mat	<ul style="list-style-type: none"> • Increase in yield of 33% & Increase in avg. selling price of 30% • Return of Rs. 23,800 lakhs on additional cost of Rs. 12,000 per hectare (2 yrs) 	<ul style="list-style-type: none"> • 98%
Tomato cultivation	Shade Net cum Anti-Insect Net	<ul style="list-style-type: none"> • Increase in yield of 67-83% • No significant increase in savings 	<ul style="list-style-type: none"> • 19%
Curry Leaves	Jute Mulch Mat	<ul style="list-style-type: none"> • Increase in yield of 64% • No significant increase in savings 	<ul style="list-style-type: none"> • 15%

5 Analysis of Current Usage of Agrotextiles in India

5.1 Stakeholder Analysis

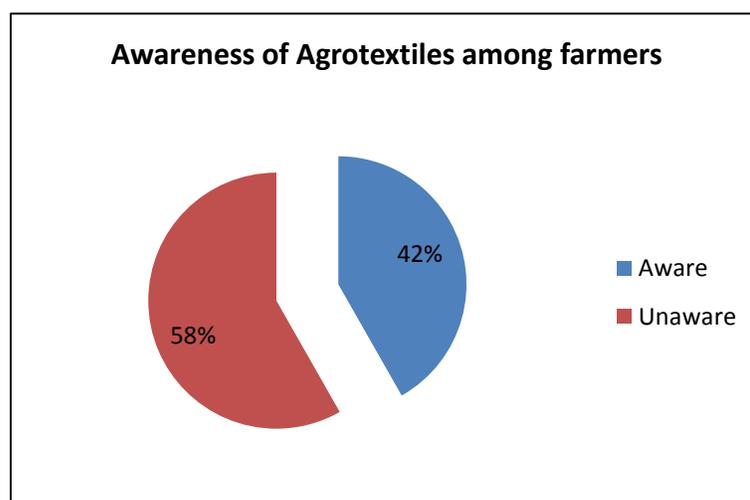
As mentioned at the beginning of this report, the Agrotextile industry has four broad groups of stakeholders - Manufacturers/Traders, End Users, Government Agencies, and Subject Matter Experts/ Centres of Excellence/ Research Bodies who play a crucial role for industry stimulus.

After identifying key stakeholders and devising the approach and methodology to achieve the objectives of this engagement, extensive interviews were conducted with the stakeholders. A summary of the stakeholder issues can be seen within the following sections.

The Agrotextile industry is purely demand driven with onus lying upon the manufacturers to educate and convince end users about the benefits of using agrotextiles, with peripheral involvement by the government.

5.1.1 Customers

As mentioned above, this stakeholder group is the most important part of the industry ecosystem as demand is generated from the users. The end users include farmers, agricultural universities, agricultural parks, etc. While agricultural universities and parks are well advanced in their knowledge and awareness of the various Agrotextiles and subsidies, these make up a small percentage of the overall consumer group. The primary drivers of growth of the agrotextile industry going forward will be the farmers and hence it makes sense to focus on the issue faced by this group of stakeholders.



As can be seen above, awareness of Agrotextile products and their benefits is lower than expected amongst end users at 42%. This forms part of our broader key takeaways from our interactions with this group:

- i. *Awareness* – There is a lack of awareness with respect to specific Agrotextile products. Detailed in-depth knowledge about Agrotextile products is missing as most end users only know about shade nets.
- ii. *Subsidy* - End users, typically farmers, are facing difficulties in availing the subsidies due to long, complex and time consuming procedures along with tedious paper work including a mandatory bank loan and lack of guidance for availing the subsidy.
- iii. *Standards & Specifications* – Lack of common industry standards and specifications has led to confusion regarding quality required during procurement and with regards to product durability.

To address the issues highlighted by this group certain initiatives regarding increasing awareness and the subsidy implementation mechanism will be studied in detail and the pain points highlighted accordingly.

It should be noted that the objective of these surveys was to get qualitative inputs; hence the sample size of respondents was not relevant. This survey helps to provide an indepth assessment of reasons behind the lack of growth of the industry.

Usage amongst the various Agricultural Universities and Government Institutions

As mentioned at the beginning of the section, awareness and use is high amongst agricultural universities and government parks around the country. To highlight this, the various tenders for agrotextiles issued recently in various newspapers and other such media were collected to observe which organizations are actively using agrotextiles. The list of these organisations is as follows:

1. District Horticulture Officer – Murshidabad
2. Department of Horticulture – (All States and UT's)
3. Gujarat state seed corporation Ltd (Dept of Horticulture)
4. Agriculture and corporation department – Gujarat
5. Centre for Environment science and climate resilient agriculture, New Delhi
6. Indian Agriculture research institute, New Delhi
7. Gram Panchayat, Hingna, Maharashtra
8. Chennai Port trust, Chennai, Tamil Nadu
9. Urban improvement trust, Bhilwara, Rajasthan
10. Office of the city development trust, Rajasthan
11. Punjab state grains procurement corporation, Chandigarh
12. CSIR - National Institute Of Oceanography, Goa, Goa
13. Indira Gandhi Institute Of Medical Sciences, Patna, Bihar
14. Jharkhand Silk, Textile And Handicraft Development Corporation Limited, Ranchi, Jharkhand
15. Central Inland Fisheries Research Institute, Barrackpore, West Bengal
16. Agriculture Directorate, Department of Agriculture, Tamil Nadu

17. Indian Council of Agricultural Research, New Delhi
18. National Agri-food biotechnology institute
19. University Of Rajasthan, Jaipur, Rajasthan
20. Directorate Of Agriculture - (All States)

One observation here was the fact that a lot of the usage is still cantered around shade nets, with anti-hail/bird/insect nets showing fledgling use. Some institutions such as the CIAE are carrying out further pilot studies in areas such as Low Tunnels, Bird Nets, Ground Covers, Mulching and Agro-produce packaging. These pilot projects should be leveraged to spread awareness, and impetus should be given by the Textile Commissioner's Office to further expand pilot studies to applications such as agricultural produce storage/packaging, bio-degradable textiles and smart agro-textiles.

5.1.2 Manufacturers

This group consists of the various manufacturers of agrotextile products. This group has obvious significant vested interest in seeing the sector grow and are responsible for carrying out various promotional and awareness activities to drive sales. As is analysed later in this report, the investments required to set up manufacturing in this sector are fairly high, and so the manufacturer's perspective on issues hindering growth of the segment is very important in analyzing target improvement areas.

The following are the key takeaways from these discussions:

- i. *Standards & Specifications* - Lack of standards has led to lack of a level playing field as low customer awareness and affordability has led to cheaper and low quality products that do not perform as expected; thereby hindering the growth of the industry.
- ii. *Cheaper alternatives* - Cheaper alternatives for agrotextile products such as mulch films and greenhouses are available in the market thereby restricting the growth of agrotextile products which are knitted or woven/nonwoven.
- iii. *High Investment Costs* - High production cost and extensive marketing and distribution requirement, coupled with low pricing due to low quality material being sold by competitors is placing pressure on existing manufacturers and dissuading new manufacturers from entering the market.
- iv. *Testing* - The cost of testing is not conducive to testing per consignment thereby leading to uncertainty of the quality of the product.

Also a point highlighted in speaking with various stakeholders is that through subsidy schemes like TUFs and initial efforts of the MOT as well as COEs supply side capacity has increased significantly in the last 5 years. In comparison, demand is lagging and so it was suggested that focus of report be on increasing awareness and penetration of Agrotextiles so that manufacturers can utilize their capacity and achieve their break-even point earlier.

5.1.3 Sales Channel

Feedback from manufacturers indicated that a significant portion of sales is driven through sales agents and distributors for agricultural inputs. These are the entities that have direct interactions with consumers and hence understand the true obstacles in uptake of agrotextiles.

The following are the key takeaways from these discussions:

- i. *Awareness* – Four of the five distributors for agrotextiles related to crop production stated that awareness was an issue with farmers and that the dealers themselves had to push sales. Awareness is basically limited to shade nets, and even if plastic film products are taken into account then only greenhouses are known.
- ii. *Quality Standards & Specifications* – Products in this domain are currently sold with minimal specifications - Shading percentage, UV resistance percentage, mesh size, colour and the product size itself. But none of the strength properties such as tensile strength, bursting strength, air/water permeability, etc. are used apart from in Shade Nets and Mulch Mats (Ground Covers). Instead the crucial product differentiator is the life of product, something which is unscientific and cannot be ascertained while the product is being purchased by the farmers. This is exacerbated by the fact that dealers themselves are unaware of any existing formal product specifications or standards that are issued by the BIS, ISO, etc.

Interactions with the various dealers serve to reinforce some of the issue faced by end users. Additionally, it was observed that these stakeholders do not have any involvement in the subsidy implementation mechanism even though they have a vested interest in spreading awareness about these financial incentives as this will only serve to provide an impetus to their sales.

5.1.4 Government Agencies and Bodies

Government agencies have recognised the importance and usefulness of agrotextiles and have devised certain schemes for granting funds for procurement and using of these products such as the NHM (National Horticulture Mission), NHB (National Horticulture Board), Horticulture Mission for Northeast and Himalayan States and the Gujarat Green Revolution. Government agencies conduct seminars, lectures to create awareness among the end users regarding the usage of these products and to give information of various schemes devised by them. Their over-riding mandate is to promote their sectors and industries and devise measure to provide said impetus. The following are the key takeaways from discussions with these stakeholders:

- i. *Policy focus* – Holistic focus on agrotextile products is missing. Subsidies are granted to specific agrotextile products and not on all the agrotextile products. This leads to low usage of these products. Only products covered are shade nets and anti-hail/bird nets.
- ii. *Awareness and Expertise* – A lack of awareness and expertise on the part of consumer's results in fewer applications for subsidy. A tedious bank procedure for loan approval

- makes availability of subsidy difficult for end users/farmers. Majority of the end users which are farmers are illiterate, creating awareness and generating their interest in using agro textile products is difficult.
- iii. *Standards & Specifications* – Subsidies approved to the farmers do not have any quality stipulations and hence there is no systemic incentive for manufacturers to provide material adhering to the standards and no mechanism for end users to demand the same are not monitored as this generates a loophole for end users to use cheap low quality products against the standard products for which the subsidy is approved.
 - iv. *Policy* – Subsidy for specific agrotextile products say Mulch mat can be incorporated under drip irrigation scheme as mulch mat helps to retain moisture. This will indirectly improve the usage of such products.

The primary focus with government agencies is to update the various subsidy programs in effect to ensure all agrotextiles products are included which will ensure greater uptake and hence greater benefit to the economy through increased productivity. The ancillary focus is to increase coordination with other programs whose objectives can be met through use of agrotextiles.

5.1.5 Subject Matter Experts

This group of stakeholders include subject matter experts, centres of excellence and research bodies.

The following are the key takeaways from discussions with this group:

- i. *Standards & Specifications* – Coordination with the BIS and implementation of India specific standards is a tedious process, further compounded by variation and general absence in standards and specifications followed by manufacturers. The BIS currently only has standards for shade nets and mulch mats.
- ii. *Manufacturer Accreditation* – Some form of manufacturer accreditation for specifically agrotextiles will help ensure quality on the supply side, something which is lacking at this point. This is rather necessary due to consumer tendency not to stipulate material quality or certification.
- iii. *Limited scope for development* – Due to cheaper alternatives (like mulch film, reflective strip, greenhouses, etc.) available in the market, it becomes difficult to create awareness for agrotextile products (like mulch mat, shade net houses, bird protection net etc.)
- iv. *Schemes to Promote Agrotextiles* – There are difficulties in measuring performance of existing schemes and identifying target areas for new schemes.

5.2 Analysis of Financial Viability of Manufacturing

Several techniques of fabric production can be used to produce Agrotextiles, with each method offering specific advantages for each particular product. The manufacturing feasibility depends upon which technology is being employed. Three of these are knitted, woven and non-woven Agrotextiles. Most agrotextile products are nets that are manufactured using knitted technology – warp knitting and weft knitting, of which warp knitting is the more popular. A table showing agrotextiles products and their manufacturing techniques can be seen below:

Products	Woven	Knitted	Nonwoven
Shade Net		√	
Windshield Net	√	√	
Bird Protection Net		√	
Crop Cover	√	√	√
Plant Net		√	
Root Ball Net		√	
Harvesting Net		√	
Mulch Mat/ Ground Cover	√		√
Anti-Hail nets		√	
Fishing Net		√	
Turf Protection Net		√	
Pallet Net Cover		√	
Anti-Insect Net/Mesh	√	√	√

5.2.1 Manufacturing Feasibility for Warp Knitted Facility

As mentioned above Warp knitting technology offers a wide range of possibilities for producing nets which no other technology can match, and hence is the most widely employed technology to manufacture agrotextile. Agrotextile products manufactured using this can be seen in the table above.

Features:

- Warp-knitted fabrics are elastic and dimensionally stable
- They can have open or dense constructions with fine or coarse structures
- They can be produced as flat, tubular or three-dimensional textiles in widths of upto 6 metres and above
- The design of the nets can also be varied extensively; depending upon the knitting process used
- The construction warp knitting technology enables the individual products to adapt the specific end-use requirements.
- All the machines can produce single or multiple webs, and it is no longer necessary to carry out costly making-up processes

To aid entrepreneurs entering this segment an indicative project feasibility snapshot has been prepared by the project team based upon real life bankable project reports that give an idea of the various assumptions and cost factors to consider while planning such a project. These assumptions can be seen in Annexure C.

Along with the assumptions in Annexure C, the feasibility snapshot below assumes purchase of new machines and not used machines. It is also assumed that the unit will operate at maximum utilization from the 3rd year onwards.

PROJECT AT A GLANCE - WARP KNITTED TEXTILES			
*	<u>Production Capacity</u>		
	Fabric For Sale - Domestic (Mtrs/Day)		23,180
*	<u>Basis For Planning</u>		
	Working Days Per Annum		312
	Shifts/Day		3
	Hours Per Shift		8
*	<u>Means Of Finance</u>		
	Total Project Cost	Rs. Lakh	674
	Promoters Contribution	Rs. Lakh	236
	Total Equity	Rs. Lakh	236
	Rupee Term Loan	Rs. Lakh	438
*	<u>Financial Results</u>		
	Sales Realisation	Rs. Lakh	1,275
	Other Income	Rs. Lakh	0
	Cost Of Production	Rs. Lakh	936
	Gross Operating Profit	= 26.6% Rs. Lakh	339
	Net Profit	= 11.6% Rs. Lakh	147
	Break Even Point		54.08%
	Cash Break Even Point		40.08%
	Average D.S.C.R.		2.83
	I.R.R.		37%
	Return On Investment		46.87%
	Pay Back Period	Years	3 - 4

Table 6.2: Key Numbers - Woven Textile Facility

The advantage of setting up a knitted facility is that the market for knitted products is well established within the agrotextile domain and hence if focus is solely within sector then this technology is the best to deploy. Secondly, the up-front capital investment at ₹6.74 crore including other set up costs is significantly lower as compared to minimum scale setups for woven and nonwoven manufacturing technology. The payback period is 3-4 years with gross profit margins of 25-30%.

5.2.2 Manufacturing Feasibility for Woven Facility

Woven products are produced by using weaving machines especially Sulzer projectile weaving machines. The range of light to heavy and wide width fabric production is possible with Sulzer projectile weaving machine. Other systems of woven fabric production such as air jet and rapier weaving machines are not preferred for the manufacture of such fabrics, as they do not have required weaving width. Assumptions for setting up a manufacturing facility for woven Agrotextiles are listed in Annexure C.

Along with the listed assumptions the feasibility snapshot below assumes purchase of new machines and not used machines. It is also assumed that the unit will operate at maximum utilization from the 3rd year onwards.

PROJECT AT A GLANCE - WOVEN AGROTEXTILE			
*	<u>Installed Capacity</u>		
	Woven Technical Textiles	No Of Looms	24
*	<u>Basis For Planning</u>		
	Working Days Per Annum		
	Fabric Processing	350	Days (3 Shifts)
	Hours Per Shift		8
*	<u>Project Cost</u>	Rs. Lakhs	0
	Total		9782
*	<u>Means Of Finance</u>		
	Promoters Contribution	Rs. Lakhs	2935
	Public Issue / Mutual Funds	Rs. Lakhs	0
	Total Equity	Rs. Lakhs	2935
	Foreign Currency Loan	Rs. Lakhs	0
	Rupee Loan	Rs. Lakhs	6848
	Total	Rs. Lakhs	9782
*	<u>Financial Results</u>		
	Sales Realisation	Rs. Lakhs	12166
	Other Income	Rs. Lakhs	0
	Cost Of Production	Rs. Lakhs	8132

	Gross Operating Profit	Rs. Lakhs	2240
	Net Profit	Rs. Lakhs	377
	Break Even Point		55.79%
	Cash Break Even Point		37.65%
	I.R.R.		15%
	Return On Investment		20.00%
	Payback Period		5-6 Years

Table 6.2: Key Numbers – Woven Textile Facility

Woven technology is the next most used technology applicable to manufacture of agrotextile products – with primary products being mulch mats and crop covers. The large ticket size at ₹98 crore and the limited products that use woven technology, coupled with nascent market size for mulch mats (and the corresponding substitution by mulch films) makes relying upon only agrotextile products to drive sales is not advisable. Products catering to allied fields such as geotech, packtech and medtech should also be incorporated within the project plan to make woven manufacturing ventures feasible.

5.2.3 Manufacturing feasibility for Non-Woven Facility

As mentioned earlier, there are many techniques to produce Nonwoven fabrics, but within agrotextiles only Needle-Punching and Spun Bonding are utilized for manufacture of agrotextiles, specifically certain types of crop covers, mulch mats and anti-insect nets. Assumptions for calculating manufacturing feasibility non-woven Agrotextiles are listed in Annexure C.

Along with the listed assumptions the feasibility snapshot below assumes purchase of new machines and not used machines. It is also assumed that the unit will operate at maximum utilization from the 3rd year onwards.

PROJECT AT A GLANCE - NONWOVEN AGROTEXTILE			
*	<u>Installed Capacity</u>		
	Needlepunch Products	Tons/Day	13
*	<u>Basis For Planning</u>		
	Working Days Per Annum	350	Days (3 Shifts)
	Hours Per Shift		8
*	<u>Project Cost</u>	Rs. Lakhs	7685
*	<u>Means Of Finance</u>		
	Promoters Contribution	Rs. Lakhs	1760
	TUFS or State Subsidy	Rs. Lakhs	745
	Total Equity	Rs. Lakhs	2505
	Rupee Loan	Rs. Lakhs	5149

	Total	Rs. Lakhs	7685
*	<u>Financial Results</u>		
	Sales Realization	Rs. Lakhs	8363
	Cost Of Production	Rs. Lakhs	7044
	Gross Operating Profit	Rs. Lakhs	1319
	Net Profit	Rs. Lakhs	779
	Break Even Point		52.04%
	Cash Break Even Point		28.05%
	Average D.S.C.R.		1.99
	I.R.R.		20%
	Return On Investment		24.93%
	Payback Period		6-7 Years

Table 6.4: Key Numbers – Non-Woven Facility

Like woven technology, the large ticket size at ₹77 crore and the limited products that use nonwoven technology, coupled with the fact that this is not the primary manufacturing technology for any agrotextile product makes relying upon only agrotextile products to drive sales unadvisable. Products catering to allied fields such as geotech, packtech and medtech should also be incorporated within the project plan as primary sales drivers to make nonwoven manufacturing ventures feasible.

5.3 Policy/Schemes and their Impact

The Government of India has recognized the need to provide an impetus to the technical textile industries and has taken certain steps towards promoting these industries. Some of the prominent initiatives are:

- Constitution of Expert Committee on Technical Textiles (ECTT)
- Setting up of a Steering Committee on Growth and Development of Technical Textiles (SCGDTT)
- Launching of the Technology Mission on Technical Textiles (TMTT)
- Coverage of technical textiles under Technology Upgradation Fund Scheme (TUFS)
- Basic Custom Duty for major machineries on technical textiles reduced from 10 to 5 %
- 10 % Capital Subsidy for new projects
- 5 % Interest Subsidy on loans under TUFS
- 14 Special Economic Zones to attract FDI and duty free imports and domestic procurement for 100 % exports
- Gujarat and Maharashtra are providing 10 % investment subsidy on technical textile projects

- The Ministry of Textiles is promoting technical textiles by incentivising to the extent of Rs 40 crores of the total project cost, Textile Parks specifically dedicated to Technical Textiles under the Scheme for Integrated Textile Parks (SITPs). Five such parks, namely, the Pallavada Technical Textile Park in Tamil Nadu, Baramati Hi-Tech Park in Maharashtra, Eco Textile Park in Gujarat, Jaipur Tex Weaving Park in Rajasthan and the Technical Textile and Machinery Mega project in Karnataka are under various stages of completion.

While these initiatives have been taken predominantly by the Ministry of Textiles, there has not been much in the way of specific policy changes on behalf of the government in areas such as:

- Incentives for certification / accreditation to international standards
- Incentives for substitution of traditional textiles by technical textiles

Before analyzing schemes like the NHM (National Horticulture Mission), NHB (National Horticulture Board), HMNEH (Horticulture Mission for Northeast and Himalayan States) certain other schemes were studied for synergies in product as well as execution. One such particular scheme was by the Seed Corporation of India. It was observed that the Seed Corporation of India subsidy scheme deals mostly with seed processing plants and storage where the scope of inclusion of Agrotextiles is negligible. More can be learned from the subsidy implementation mechanism where while the process of disbursement is common in it being back ended credit linked, the practice of disbursing 50% of subsidy upfront is something to be studied. Another scheme where synergies have been explored is the APEDA (Agricultural & Processed Food Products Export Development Authority) which focuses is on post production and export Details of some of the premier subsidies and incentives to drive agrotextile use in India such as the NHM (National Horticulture Mission), NHB (National Horticulture Board), HMNEH (Horticulture Mission for Northeast and Himalayan States) have been described in the following sections.

5.3.1 National Horticulture Board (NHB) Subsidies

Some of the key incentives to promote the agrotextile industry in India have been authored and implemented by the NHB. Details of this scheme are given in Annexure D.

Key highlights of the NHB scheme pertaining to agrotextiles include:

- For *Primary Processing and Post-Harvest Management related projects* subsidy of 50% as per prescribed norms is available for crates and nets (shade and anti-hail only) in integration with commercial horticulture projects (for production as one time assistance). Subsidy for crates is processed only after its actual purchase which is be at stage of fruiting/harvesting.
- Above mentioned subsidy of 50% as per prescribed norms for shade nets and anti-hail nets is considered as one time assistance for credit linked project for the benefit of existing commercial horticulture projects (of fruit orchards qualifying area norm of above 4 Ha). Assistance in case of CFB Cartons, Aseptic Packaging, Punnets / Poly bags etc. shall be

available on merit for launching a new horticulture product during its first year and for introduction of horticulture products in a market as one time assistance.

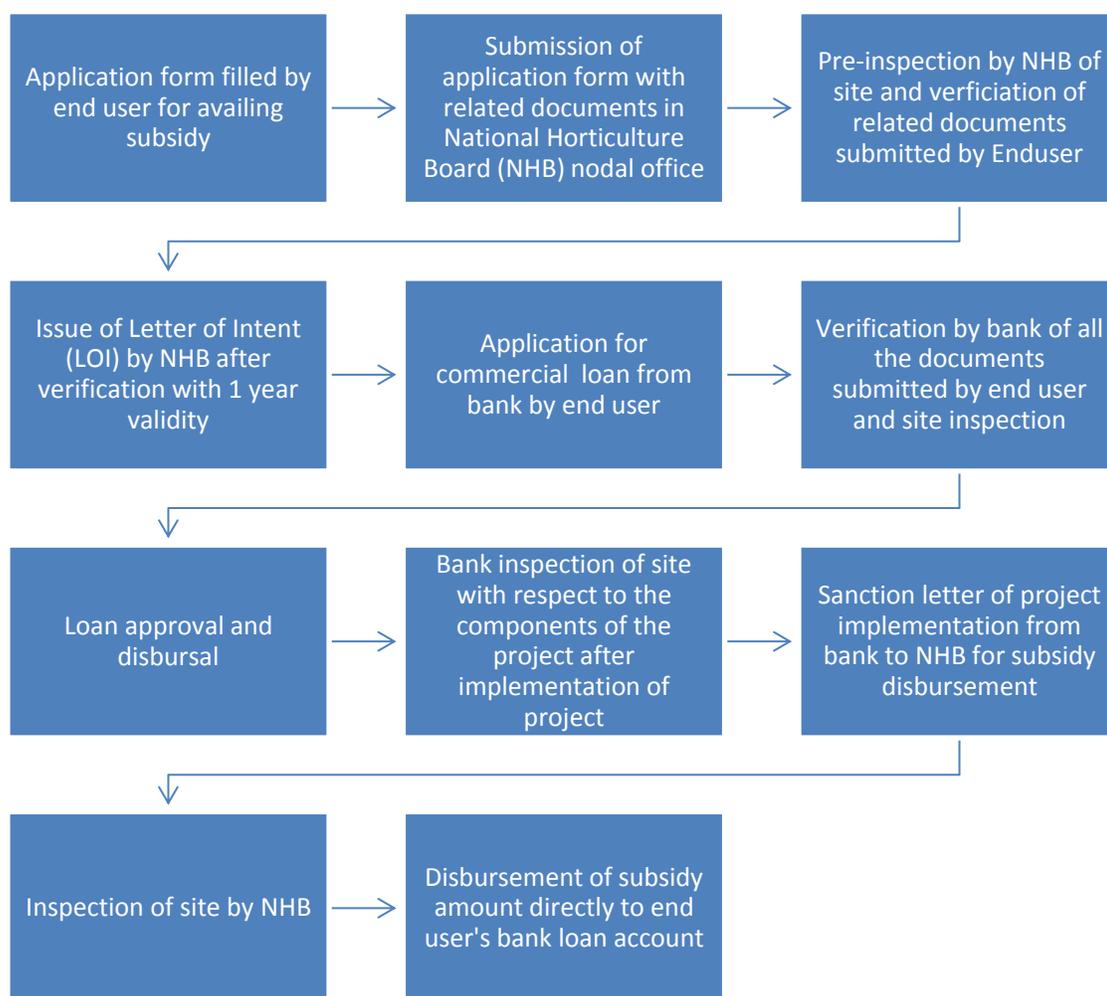
- For *Production Related - Hi-tech Commercial Production of Vegetables in Open Field* there is assistance for “Tunnel net/shade net for production of seedling etc.” in the form of Rs. 250/ per sq m, as per requirement, if undertaken on project land.

The amount of subsidies dispersed from 2007-11 under the NHB for “Development of Commercial Horticulture” has not grown and has infact decreased in this period.

Year	2007-08	2008-09	2009-10	2010-11
Development of Commercial Horticulture (Subsidy)	₹98.87	₹93.97	₹74.19	₹89.80

This is at odds with the disbursal under the NHM, which as you will see in the next section has increased subsidy disbursal in the same timespan. The one caveat here is the disbursement figures for the NHB are for all of their incentives under “Development of Commercial Horticulture” which includes Production Related Components (where Agrotextiles are included), Post-Harvest Management (PHM) and Primary Processing, as well as Hi-tech Production of Vegetables in Open Field (also includes agrotextiles), whereas for NHM the breakup has been given specifically for protected cultivation, which correlates directly with use of agrotextiles.

The NHB organizational structure is fairly straightforward; there are various NHB nodal offices around the country that implement the NHB schemes. The implementation process is as follows:



The process is fairly efficient and the fact that the subsidy amount is disbursed directly to the bank via mutual coordination is of great convenience to the end users. Feedback from NHB officials coupled with a review of the NHB initiatives leads to the following observations:

- Polyhouses (which use plastic film) and shade nets are the most popular products against which subsidies are claimed
- Only shade nets and anti-hail nets are covered under products for which subsidies can be availed
- There is ambiguity regarding shade nets and other varieties of agrotextile nets due to lack of awareness and product differentiation
- There is lack of acknowledgement of benefits of agrotextiles over plastic films for shade and mulching purposes which leads to them being clubbed together

Recommendations to address these shortcomings are discussed in Chapter 7.

Impact of the Scheme

Advantages	Disadvantages
<ul style="list-style-type: none"> • Efficient application processing • Bank as compulsory facilitator ensures transparent oversight and financial inclusion 	<ul style="list-style-type: none"> • Only shade nets, anti-hail nets and poly bags are included • Only for farm sizes above 4 Ha • Outreach underwhelming as limited nodal offices • Project linked so only a one time assistance pattern • Subsidy disbursement has been stagnant over the past 4 years despite growing market

5.3.2 National Horticulture Mission (NHM) Assistance Initiatives

The difference between the NHB and NHM is that the NHB is an independent body with the Agriculture Minister as its Chairman. It deals with large farms and corporate entities, whereas the NHM is a mission mode programme that works more with the state governments. So while there is some overlap, both organizations are largely complementary in nature.

The NHM is the other major incentive program offered to consumers to promote the uptake of agrotextiles in India. It is operated in all states and union territories of India except for Northeast States as well as Sikkim, Himachal Pradesh, Jammu & Kashmir and Uttarakhand for which the Horticulture Mission for North East and Himalayan States has been implemented. The NHM is a centrally sponsored scheme with 85% is funded by the Government of India and 15% is met by the State government. The NHM does coordinate moderately with the NHB by way of utilizing their technical prowess, and including certain Integrated Post Harvest Management schemes under the NHM.

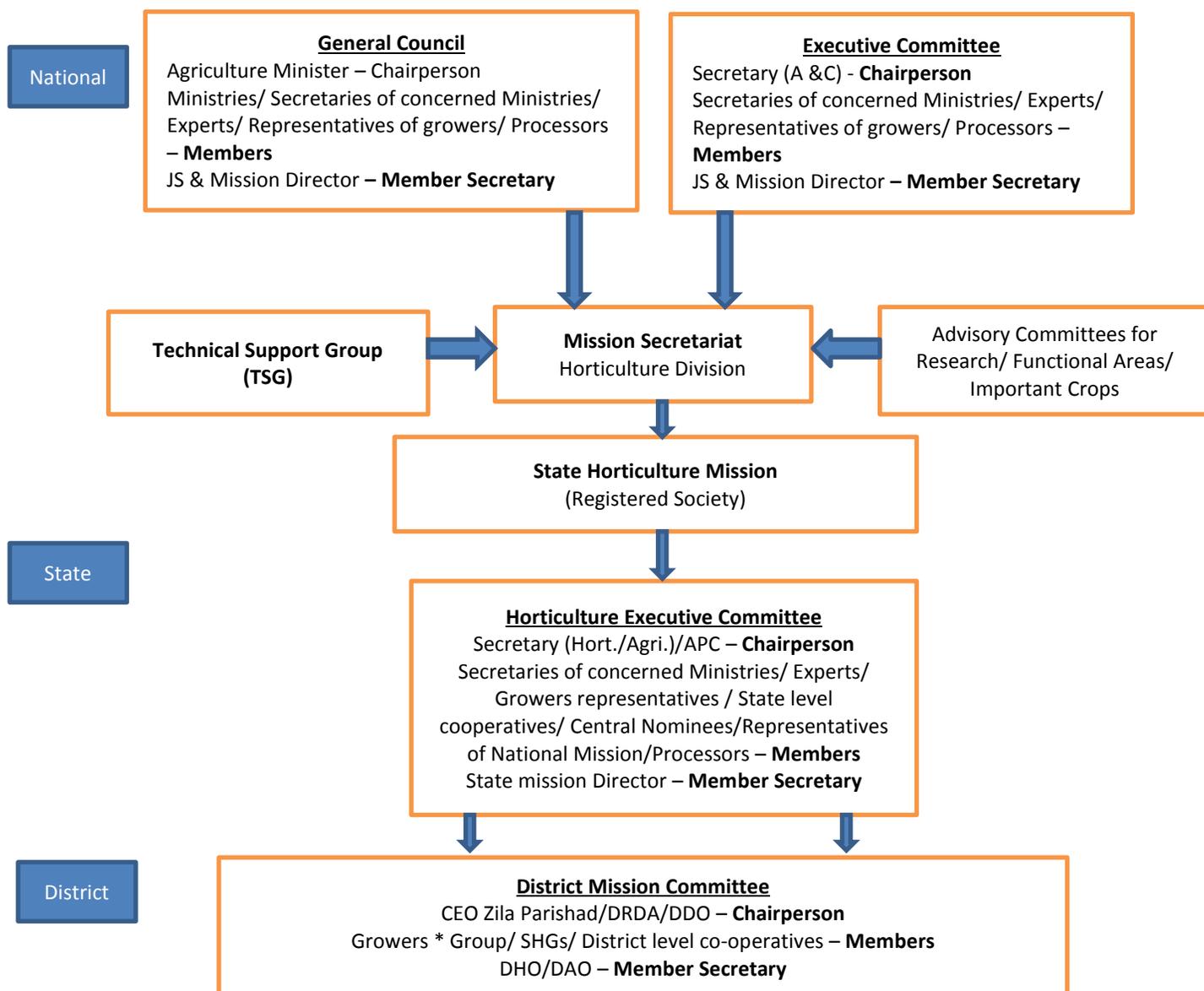
Key aspects of the NHM subsidies dealing with agrotextiles can be seen below:

Sr. No.	Item	Maximum permissible cost	Pattern of assistance
A	Green House structure		
1	Fan & Pad system	Rs. 1465/ m ²	50% of the cost limited to 4000 m ² per beneficiary.
2	Naturally ventilated system		

a	Tubular structure	Rs. 935/ m ²	50% of the cost limited to 4000 m ² per beneficiary.
b	Wooden structure	Rs. 515/ m ²	50% of the cost limited to 8 units (each unit not to exceed 500 m ² per beneficiary.
c	Bamboo structure	Rs. 375/ m ²	50% of the cost limited to 20 units (each unit not to exceed 200 m ²) per beneficiary.
B	Plastic Mulching	Rs. 20,000/ ha	50% of the total cost limited to 2 ha per beneficiary
C	Shade Net House		
1	Tubular structure	Rs. 600/ m ²	50% of cost limited to 4000 m ² per beneficiary
2	Wooden structure	Rs. 410/ m ²	50% of cost limited to 20 units (each unit not to exceed 200 m ²) per beneficiary
3	Bamboo structure	Rs. 300/ m ²	50% of cost limited to 20 units (each unit not to exceed 200 m ²) per beneficiary
D	Plastic Tunnels	Rs.30/ m ²	50% of cost limited 1000 m ² per beneficiary
E	Anti-Bird/Anti Hail Nets	Rs.20/ m ²	50% of cost limited to 5000 m ² per beneficiary
F	Cost of planting material of high value vegetables grown in poly house	Rs.105/ m ²	50% of cost limited to 500 m ² per beneficiary
G	Cost of planting material of flowers for poly house	Rs.500/ m ²	50% of cost limited to 500 m ² per beneficiary

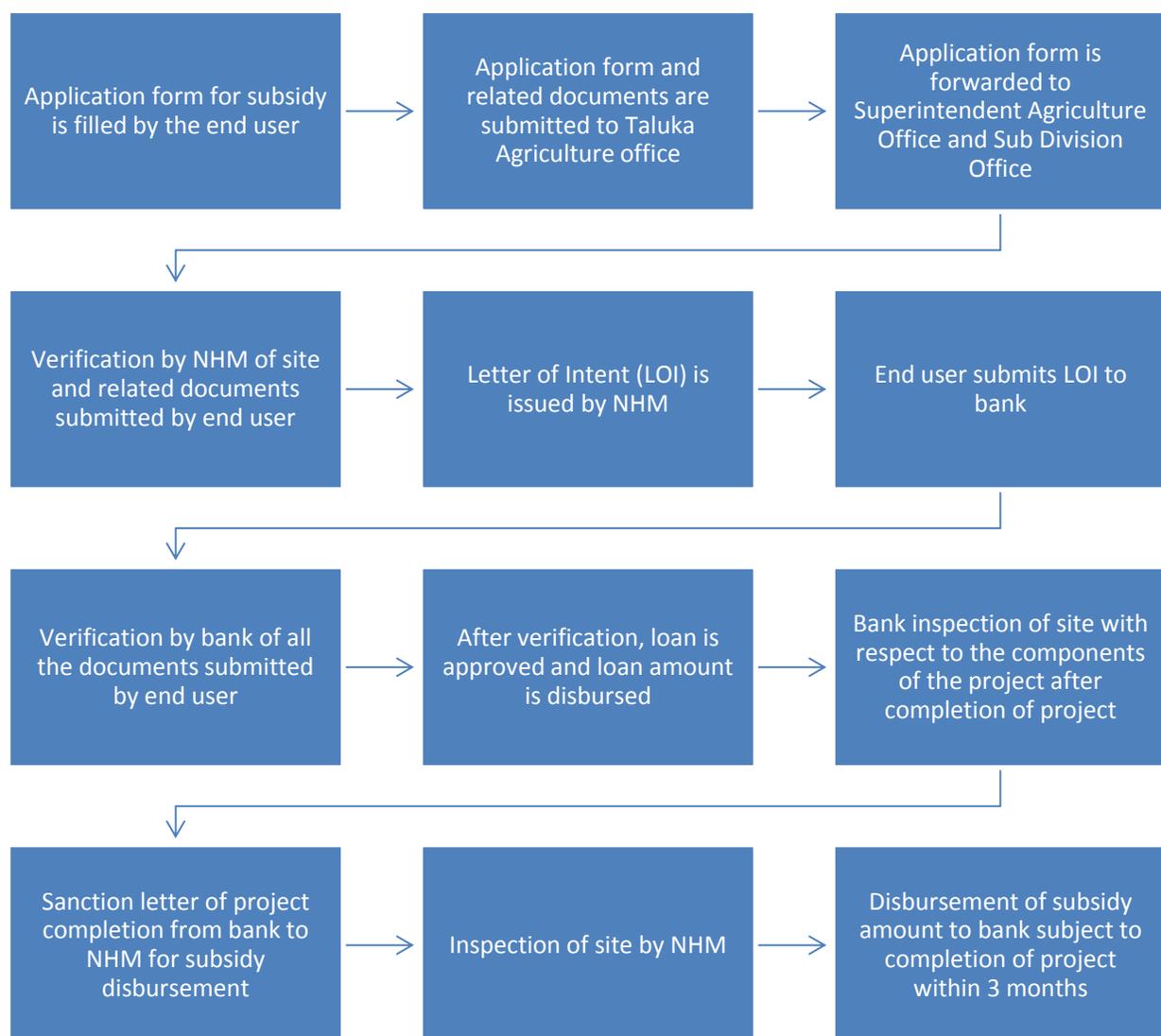
The NHM is governed and implemented at the state level by the various State Horticulture Missions (SHM), and further at the District Level by the District Agriculture Office (DAO) like the SAO (Superintendent Agriculture Office) and TAO (Taluka Agriculture Office). The organizational structure of the NHM can be seen in the diagram below:

Structure and Composition of NHM at the National , State and District Levels*



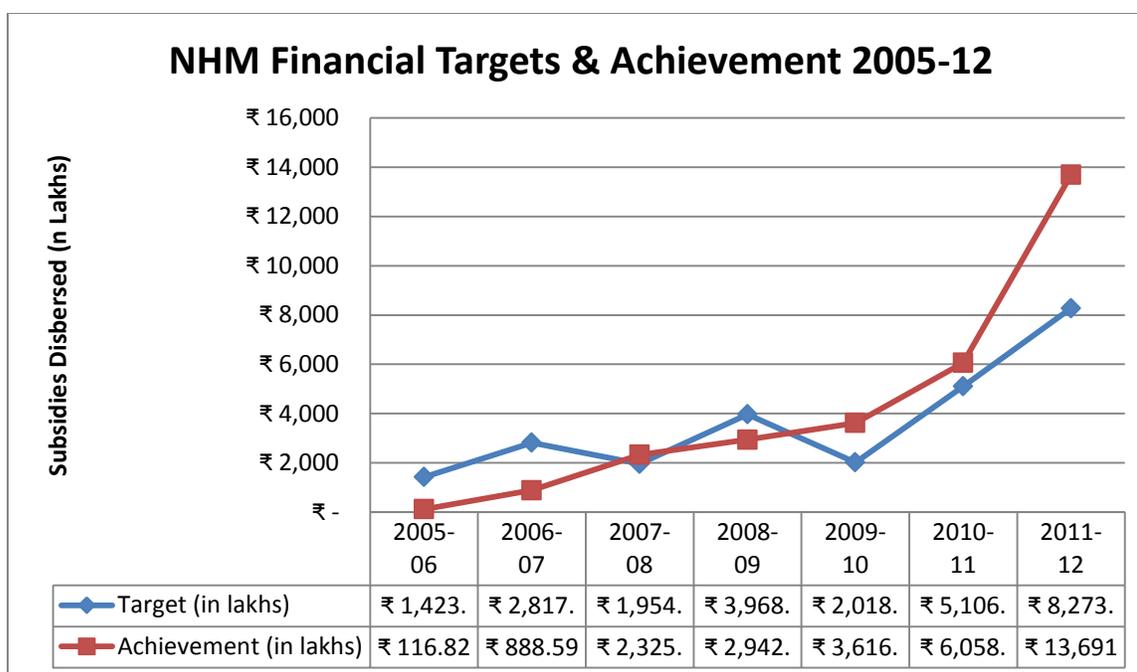
* The above structure is indicative. The institutional arrangement at the state level and below state level would be flexible and the state will have the flexibility to adopt appropriate model viz cooperative federations on the pattern of NDDB, incorporated companies (with cooperatives for procurement, joint sector for processing and corporate for marketing) or orient existing institutions to carry out the task of the mission.

The process of applying for subsidies with the NHM machinery is described as follows:



In the past 7 years the amount of NHM subsidy utilized for protected cultivation (that includes greenhouses, shade nets houses, anti-hail/bird nets, etc.) has increased significantly. While growth from 2005-09 was good to steady, the last two complete years, i.e. 2010-2012 have seen phenomenal growth with the market growing approximately 380% from ₹36.16 crore to ₹136.91 crore. In 2011-12, while the target for subsidy disbursal under protected cultivation was ₹82.7 crore, the budgetary allocation for the same was ₹155.99 crore. A chart showing these trends can be seen below.

This uptick in disbursement for subsidies under the NHM shows that the overall agrotextile market too is growing significantly, and that the NHM subsidies are having a positive impact on growth of the industry in India. Also of note is the fact that in the last three year the achievements have soundly crossed targets and budget set aside for protected cultivation subsidies.



Interactions with various officials within the NHM machinery along with farmers who have availed NHM subsidies led to the following observations:

- Shade Nets are included amongst subsidized products along with the type of structure opted for – tubular, wooden and bamboo
- Anti-Bird Nets and Anti-Hail Nets also included , the subsidy for both being the same
- Various states/districts have not updated the subsidies to the current NHM rates as a base template and adjusted the subsidy limits according to their local scenario
- The process for subsidy disbursement while similar to the NHB, is more tedious for the end users as they are required to coordinate between the bank and the SAO/TAO to ensure the subsidy amount is disbursed.

Impact of the Scheme

Positive Impact	Improvement areas
<ul style="list-style-type: none"> • Significant reach via DAOs (District Agri Offices), SAOs (Superintendent Agri Office) and TAOs (Taluka Agriculture Office) • Bank as compulsory facilitator ensures transparent oversight and financial inclusion • Subsidy disbursement has shown strong growth, especially in the past 2 years (380%) 	<ul style="list-style-type: none"> • Only shade nets and anti-bird/hail nets are covered • Plastic Mulching and Plastic Tunnels are included but are ambiguous as to whether they cover Mulch Mats and Plant/Tunnel Nets • Project linked so only a one time assistance pattern • The SHM (State Horticulture Mission) offices are not as efficient as the NHB nodal offices in coordinating with the bank to ensure certification and subsidy disbursement

5.3.3 Horticulture Mission for North East and Himalayan States (HMNEH)

As mentioned earlier the Northeast states including Sikkim as well as Jammu and Kashmir, Himachal Pradesh and Uttarakhand are not covered under the NHM (National Horticulture Mission) but are instead covered under the HMNEH. It is 100% funded by the Government of India and earlier used to be known as the Technology Mission for Integrated Development of Horticulture in North Eastern States, Himachal Pradesh, Jammu & Kashmir & Uttarakhand (TMNE)). It is the precursor to the NHM and hence is similar in all aspects apart from the funding percentage from the centre.

To provide impetus, the Union Minister for Commerce, Industry and Textiles Shri Anand Sharma on Thursday, Jan 17th 2013 announced a ₹55 crore scheme on usage of Agrotextiles to North-Eastern states of India to encourage Agrotextiles use in the region.

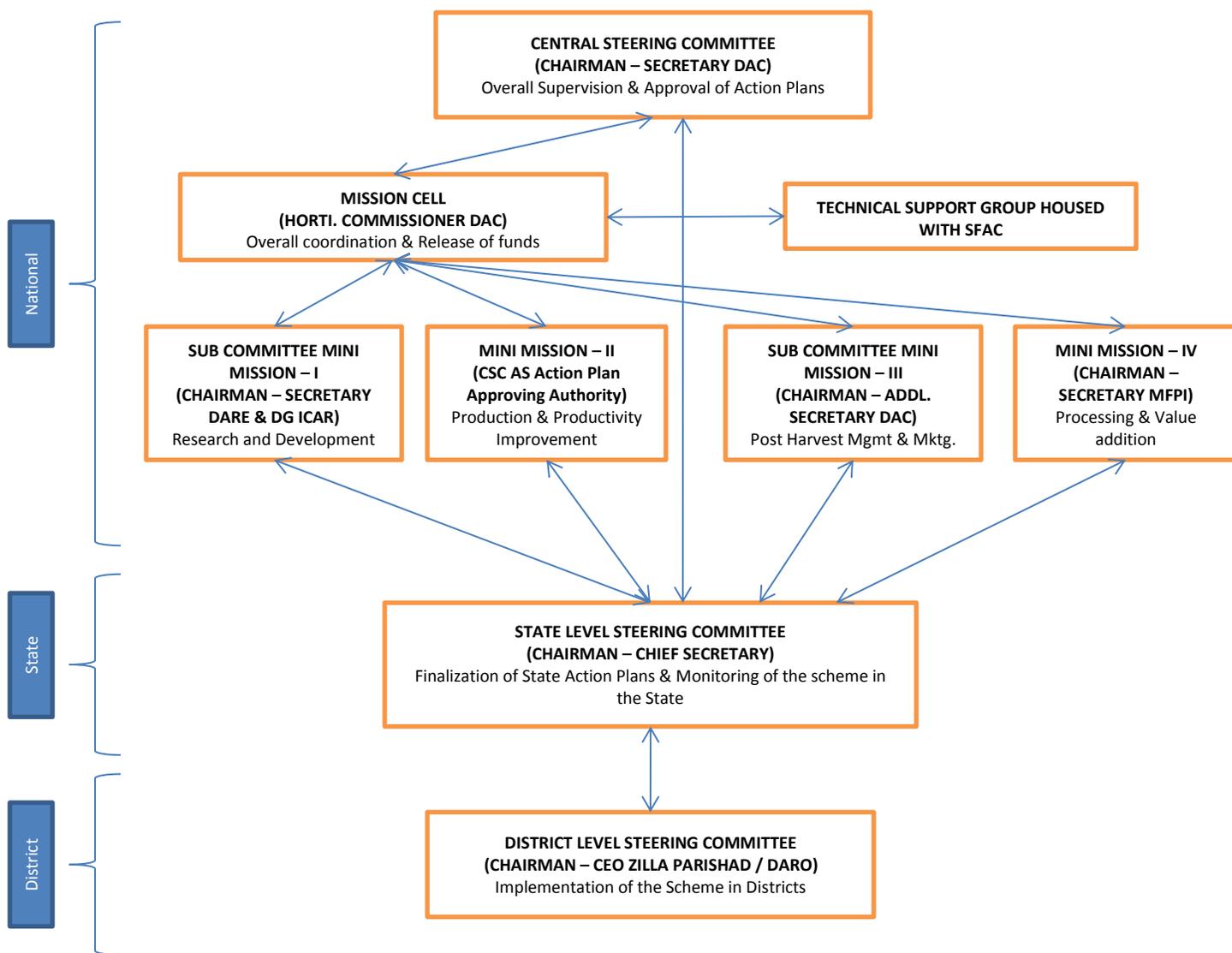
The various subsidies related to agrotextiles in the HMNEH are given below.

Sr. No.	Item	Maximum permissible cost	Pattern of assistance
A	Green House structure		
1	Fan & Pad system	Rs. 1465/ Sq.m	50% of the cost limited to 4000 Sq.m per beneficiary.
2	Naturally ventilated system		

Sr. No.	Item	Maximum permissible cost	Pattern of assistance
a	Tubular structure	Rs. 935/ m ²	50% of the cost limited to 4000 m ² per beneficiary.
b	Wooden structure	Rs. 515/ m ²	50% of the cost limited to 8 units (each unit not to exceed 500 m ² per beneficiary.
c	Bamboo structure	Rs. 375/ m ²	50% of the cost limited to 20 units (each unit not to exceed 200 m ²) per beneficiary.
B	Plastic Mulching	Rs. 20,000/ ha	50% of the total cost limited to 2 ha per beneficiary
C	Shade Net House		
1	Tubular structure	Rs. 600/ m ²	50% of cost limited to 4000 m ² per beneficiary
2	Wooden structure	Rs. 410/ m ²	50% of cost limited to 20 units (each unit not to exceed 200 m ²) per beneficiary
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D	Plastic Tunnels	Rs.30/ m ²	50% of cost limited 1000 m ² per beneficiary
E	Anti-Bird/Anti Hail Nets	Rs.20/ m ²	50% of cost limited to 5000 m ² per beneficiary
F	Cost of planting material of high value vegetables grown in poly house	Rs.105/ m ²	50% of cost limited to 500 m ² per beneficiary
G	Cost of planting material of flowers for poly house	Rs.500/ m ²	50% of cost limited to 500 m ² per beneficiary

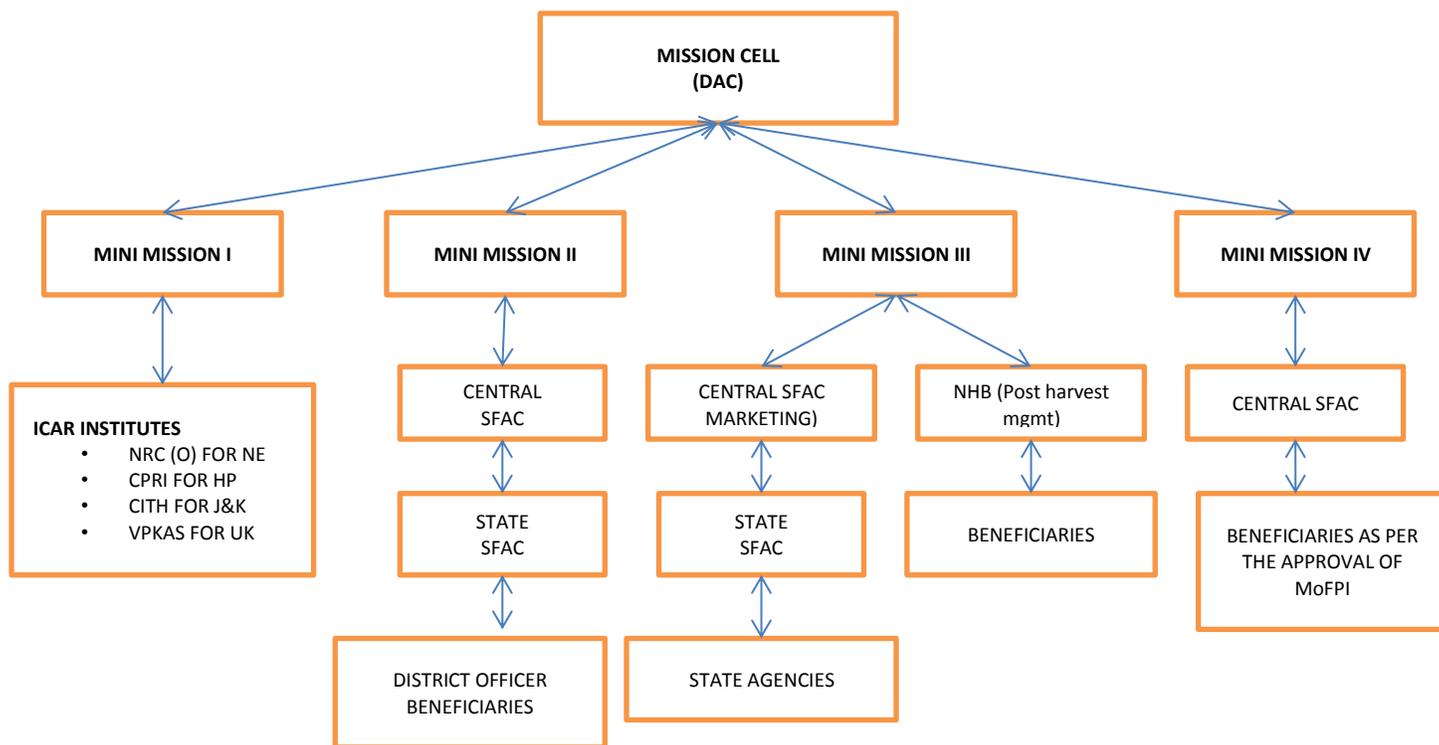
The HMNEH is implemented largely in coordination and cooperation with the NHB (National Horticulture Board) and its nodal offices in these various states. The structure of implementation can be seen in the diagrams given below. As can be noticed in the subsidies present above, similar to the other schemes the HMNEH only covers shade nets, and anti-bird/anti-hail nets for subsidies.

(5) STRUCTURE AND COMPOSITION OF HMNEH AT NATIONAL . STATE AND DISTRICT LEVEL



The funds are disbursed according to the following process:

FUNDS FLOW



Note: Funds to designated agencies like NHB, NBB for capacity building will be disbursed directly
NRC (O) – National research centre for Orchids, Sikkim
CPRI – Central Potato Research Institute, Shimla, Himachal Pradesh
CITH – Central Institute for Temperate Horticulture, Srinagar, J&K
VPKAS – Vivekanand Parvatiya Krishi Anushandhan Sansthan, Almore, Uttrakhand

HMNEH subsidies are similar to the NHM subsidies and hence have the same shortcomings – namely non-inclusion of various other agrotextile products for which subsidies can be availed.

Positive Impact	Improvement Areas
<ul style="list-style-type: none">• Significant reach via DAOs (District Agri Offices), SAOs (Superintendent Agri Office) and TAOs (Taluka Agriculture Office)• Bank as compulsory facilitator ensures transparent oversight and financial inclusion• Subsidy disbursement has shown strong growth, reinforced by the announcement of ₹55 crore for usage of Agrotextiles in the North East & Himalayan States.	<ul style="list-style-type: none">• Only shade nets and anti-bird/hail nets are covered• Plastic Mulching and Plastic Tunnels are included but are ambiguous as to whether they cover Mulch Mats and Plant/Tunnel Nets• Project linked so only a one time assistance pattern• The SHM (State Horticulture Mission) offices are not as efficient as the NHB nodal offices in coordinating with the bank to ensure certification and subsidy disbursement

5.3.4 Agricultural & Processed Food Products Export Development Authority (APEDA)

The Agricultural & Processed Food Products Export Development Authority (APEDA) is another national level scheme for incentivising advances in the agriculture industry. Incentives for manufacturers are divided into following categories:

1. Schemes for Market Development
2. Scheme for Infrastructure Development
3. Scheme for Quality Development
4. Scheme for Research and Development
5. Transport Assistance Schemes
6. Marketing and Export Promotion Schemes
7. Schemes for Creation and Management of Cold Chain Infrastructure

Out of the above, the scheme directly related to areas where agrotextiles are applicable is Infrastructure Development. This scheme offers financial assistance to farmers for storage, handling, mechanization of harvest, pack-houses/greenhouses, environmental control, etc. Since these financial incentives are geared towards producing export quality produce, introduction of agrotextiles within this scheme would align with the objectives of the scheme.

Another interesting scheme here is the one for Quality Development that provides incentives for quality management, quality assurance and quality control by adoption of ISO, HACCP, GAP, etc. This scheme can be leveraged by the COEs (Centre of Excellence) in India to ensure quality agrotextiles in the market if manufacturers can be brought under the coverage of the scheme.

Impact of the Scheme

Positive Impact	Improvement Areas
<ul style="list-style-type: none">• Under the auspices of the NHM and hence shares the advantages of outreach and available funds• Entities availing benefits under APEDA are generally more affluent and hence affordability is not a concern	<ul style="list-style-type: none">• Scope for Agrotextile growth is minimal with only storage and handling functions offering opportunities for shade net houses and leno bags

5.3.5 State Level Schemes

While studying the schemes deployed by the various states it was discovered that most States do not have their own schemes for promoting various agricultural and horticultural advancements. States like Gujarat and Maharashtra refer to national level schemes highlighted above. For example the Agriculture and Co-operation Department of the Government of Gujarat highlights the following programmes and schemes:

- MOFPI (Ministry of Food Processing Industries)
- APEDA (Agricultural & Processed Food Products Export Development Authority)
- NHB (National Horticulture Board)
- Biogas Subsidies
- Agri-implements Subsidies

Of these the NHB and APEDA have been discussed in the earlier sections and are the only schemes as such that are applicable to agrotextiles.

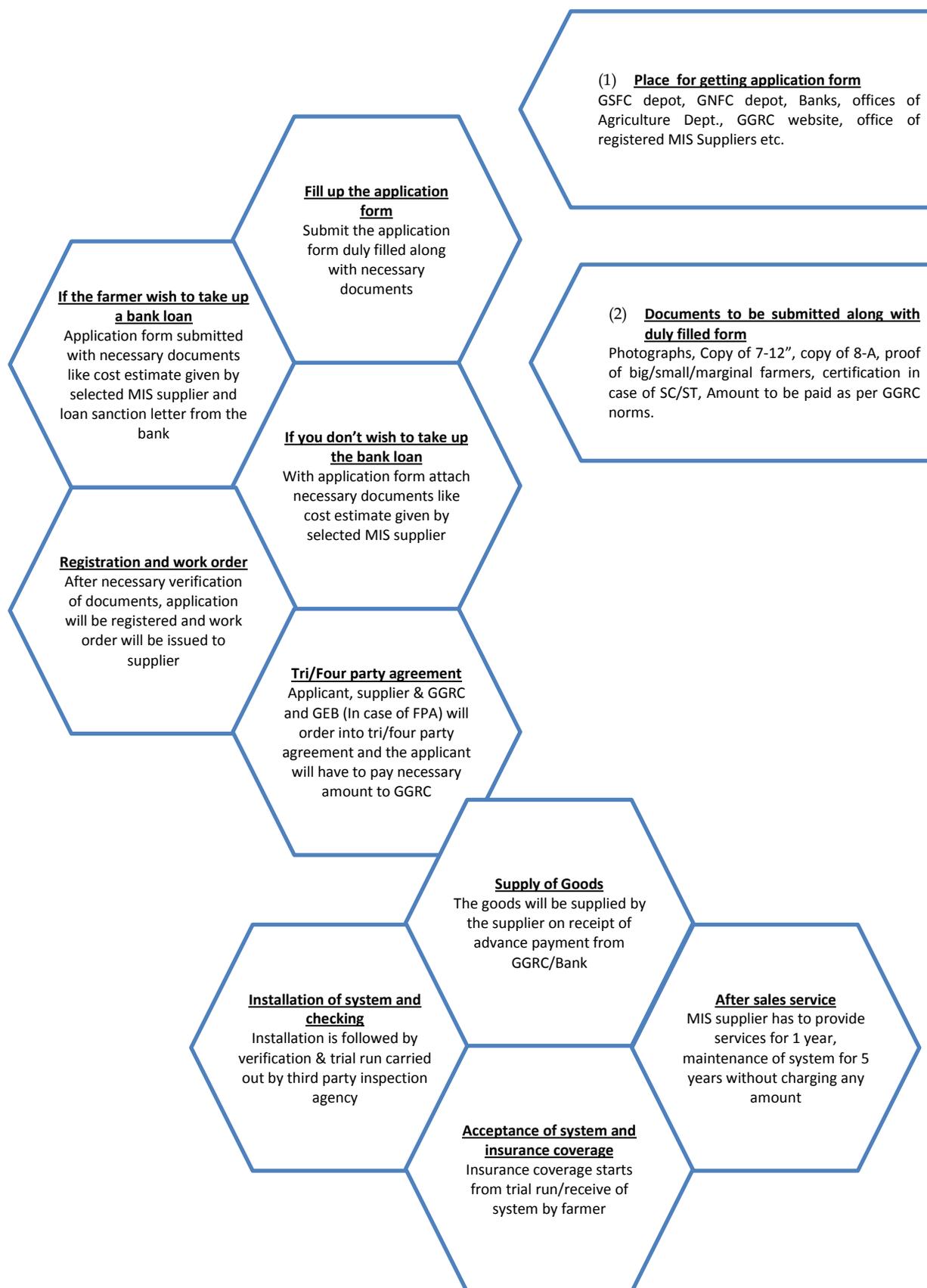
The GAIC (Gujarat Agro Industries Corporation) acts as the nodal agency for the Directorate of Agriculture for disbursing subsidies to the farmers under the above mentioned schemes. The GAIC also implements Bio-gas Programme through its field officers, SEBGS (Self-employed Bio Gas Supervisors) and Non-Government Organizations.

5.3.6 The Gujarat Green Revolution Company

The Gujarat Green Revolution Company was formed in 2005 to act as a nodal agency and implement uniform scheme for MIS (Micro Irrigation System) in the state on behalf on the Government of Gujarat. Details of the scheme are as follows:

- The subsidy is back ended 50% or Rs. 60,000 whichever is less, and is part of the central NMMI (National Mission on Micro Irrigation) scheme
- Tribal area farmers get 25% extra subsidy, i.e. 62.5% or Rs 75,000, whichever is lower
- The centre provides 80% of the funds of the scheme, while the state provides the remaining 20%
- GGRC does occasional promotional activities such as farmer meetings organized on district/village level in conjunction with manufacturers
- 46 Manufacturers for MIS are empaneled with the GGRC.
- Once the project is sanctioned the manufacturers typically implement micro irrigation system within 35-42 days
- Once project is sanctioned and work order issued project has to be implemented within 6 months else it expires

The exact implementation process can be seen in the diagram below:



Two observations are key here and salient features can be gleaned and applied to promote agrotextiles.

1. The implementation and especially the promotional mechanism employed by the GGRC is increasingly effective as the manufacturers have been brought on as partners in the implementation process and often help with the outreach for the program as they interact directly with the end users as well as handle the requisite paperwork and coordination with the GGRC to help farmers avail subsidies for micro irrigation setup.
2. As the objective of the GGRC scheme is promoting micro-irrigation, water conservation is obviously an important aspect of the program. Feasibility of incorporating agrotextiles use within the GGRC program and imparting subsidies against use of these products should be studied.

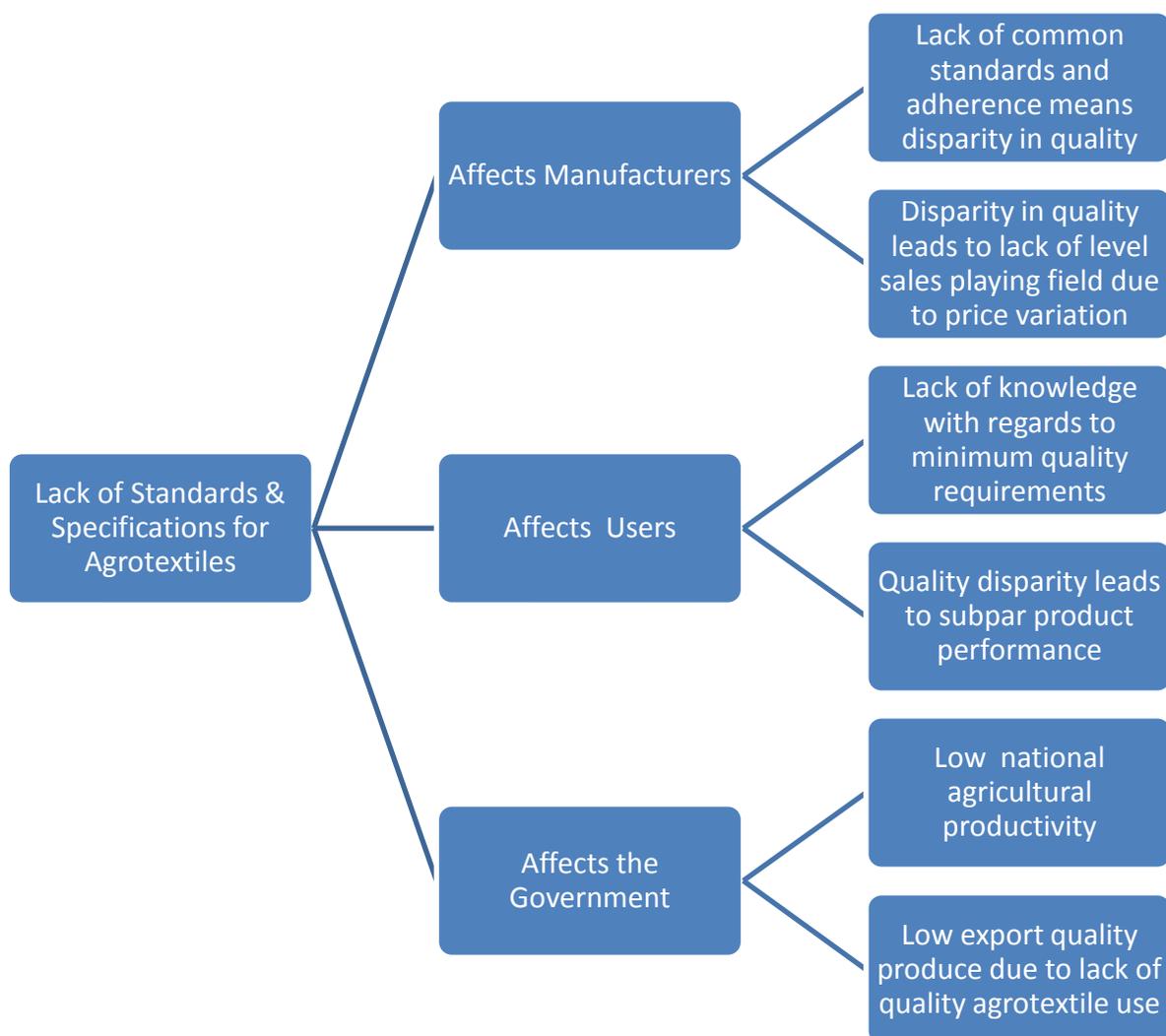
Impact of the Scheme

Positive Impact	Improvement areas
<ul style="list-style-type: none">• Established network and relationships with 46 manufacturers• Defined role as facilitator and coordinator with the various state level organizations such as the SHM• Takes the onus of marketing and coordination between users and the NMMI in conjunction with the manufacturers	<ul style="list-style-type: none">• From the point of view on Agrotextiles not much scope except positioning Mulch mats as a complementary product to micro irrigation systems

5.4 Lack of Standards and its Impact on the Industry

Standards and specifications stipulating certain product properties and performance are omnipresent for mostly all products encountered on a daily bases – from food to consumer goods to appliances and beyond. Similarly standards and specifications are important in the area of Agrotextile. Maturity of standards and specifications in this domain is still in a nascent stage and hence the focus of our study was to provide standards from various standard setting organizations abroad and recommend these as benchmarks for the BIS and the industry.

The key stakeholders with directly discernible incentives to establish and adapt a framework for standards and specifications are – Consumers and Manufacturers. Consumers in the Agrotextiles industry can be either farmers, universities or nurseries and floriculturists. But before embarking upon research into globally prevalent standards it was imperative to understand the dynamics of the Agrotextile industry ecosystem in India and articulate well defined reasons for the need for standards and specifications in India.



Summarizing the above listed feedback results in the following key takeaways:

- Product specifications and standards empower consumers to procure a minimum level of quality and ensure satisfactory product/application performance
- Product specifications and standards specified in guidelines for specific applications and schemes help overcome lack of knowledge and awareness for consumers
- Product specifications and standards create a level playing field for manufacturers from a sales perspective

The Bureau of Indian Standards (BIS) has devised certain standards in conjunction with the COEs (Centre of Excellence) such as SASMIRA and is continuously developing standards along the lines of the International Organization for Standardization (ISO) and test methods from the American Society for Testing and Materials (ASTM). It is important that the Textile Commissioner's office in conjunction with SASMIRA continues interaction with the BIS with regards to ensuring standards under development are finalized and approved swiftly. Below is a list of active specification standards that have already been or are being developed by the BIS. These specifications define the minimum properties acceptable for such products such as Tensile Strength, Bursting Strength, Weight per Square Metre (gsm), etc.

Specifications

Sr. No	BIS Standard No.	Description
STANDARDS PUBLISHED		
1	IS 15351:2008	Textiles- Laminated high density polyethylene (HDPE) woven fabric (Geo-membrane) for water proof lining (First revision)
2	IS 15907:2010	Agro textiles - High Density Polyethylene (HDPE) Woven Beds for Vermiculture - Specification
3	IS 16008:2012	Agro-Textiles - Shade nets for agriculture and horticulture purposes-Specification
4	IS 7533:2003	Polyamide monofilament line for fishing
5	IS 14287:1995	PP Multifilament netting twine
6	IS 6347:2003	PE Monofilament twine for fishing
7	IS 4401:2006	Textiles-Twisted nylon fishnet twines (fifth revision)
FINALISED DRAFTS UNDER PRINT		
8	DOC.TXD 35(981)	Jute Agro-textile - Sapling bags for growth of seedling /sapling - Specification
DRAFT STANDARDS COMPLETED WIDE CIRCULATION		
9	DOC.TXD 35(980)	Jute Agro-textiles for growth of plants and suppression of weeds-Specification
DRAFT STANDARDS APPROVED FOR WIDE CIRCULATION		

10	DOC.TXD 35(1089)	Textiles - 100 gsm woven ground covers for horticulture application-Specification
11		Glossary of Agrotexiles
DRAFT STANDARDS FORMULATED		
12	DOC.TXD 35(1128)	Textiles – Polypropylene spun bonded non-woven crop cover fabric for agricultural and horticultural applications - Specification
NEW ITEM		
13	DOC.TXD 35(1127)	Textiles-Specification for bird protection nets

For Fishing Nets the following BIS test methods are in place:

Description	IS
Fishing nets -- Description and designation of knotted netting	IS 4641:2005
Fishing nets - Cutting netting to shape	IS 6920:1993
Fishing nets -- Designation of netting yarns in the Tex System	IS 4640:1993
Fishing nets -- Netting -- Basic terms and definitions	IS 4402:2005
Fishing nets -- Cutting knotted netting to shape ("tapering")	IS 6920:1993
Fishing nets -- Determination of breaking force and knot breaking force of netting yarns	IS 5815(Part 4):1993
Fishing nets -- Determination of mesh breaking force of netting	IS 5815(Part 5):2005
Fishing nets -- Mounting and joining of netting -- Terms and illustrations	IS 8746:1993
Fishing nets -- Determination of elongation of netting yarns	IS 5815(Part 7):1993
Netting yarns - Determination of change in length after immersion in water (first revision)	IS 5815(Part 6):1993
Basic terms for hanging of netting	IS 6348:1971
Fishing nets - Method for determination of taper ratio and cutting rate (first revision)	IS 9945:1999
Fishing nets - Method of test for determination of mesh size - Opening of mesh	IS 15788:2008
Fishing nets - Method of test for determination of mesh size - Length of mesh	IS 15789:2008
Guides for fishing gears	IS 5508 (Parts 1 to 24)

Studying the available standards, an analysis was done to assess gaps in specifications by the BIS (Bureau of Indian Standards) and conduct the benchmarking with specifications available globally or to develop a working draft for new specifications.

Products	BIS Standard
Shade Net	√
Windshield Net	√
Bird Protection Net	√
Crop Cover	√
Plant Net	
Root Ball Net/Sapling Bag	√
Harvesting Net	
Mulch Mat/ Ground Cover	√
Anti-Hail nets	
Fishing Net	√
Turf Protection Net	
Pallet Net Cover	
Anti-Insect Net/Mesh	

5.5 Plastic Films vs. Agrotextiles

The uptake of Agrotextiles in India has been significantly impeded by the substitution effects of plastic products such as mulch films, greenhouse films, etc. But there are some significant qualitative advantages associated with the use of Agrotextiles that need to be propagated. These are as follows:

Products	Mulch Films	Mulch Mats
Weed Control	√	√
Helps Raise Temperature Significantly	√	
Controlled Microclimate w.r.t Temperature		√
Controlled Microclimate w.r.t Humidity		√
Cheaper Cost	√	
High Durability		√
Longer Life		√
Soil & Water Management		√
Biodegradability		√ (Jute)
Easy to Remove		√
UV Stabilized		√
Prevents Fertilizer Leaching		√
Ease of Availability	√	

As can be seen above, plastic films have a few advantages, chiefly the significantly cheaper cost and ease of availability. There are also certain applications/produces where use of films is more appropriate. But holistically Mulch Mats and similarly Agrotextiles have a significant advantage over films - particularly their comparative environmental benefits as degradation is limited and removal is easier. (To this end certain recommendations have been presented in section 7.5.9).

6 Analysis of Global Initiatives and Practices for Promoting Agrotextiles

6.1 International Bodies Involved in the Promotion of Agrotextiles

Through discussions with various global stakeholders one of the objectives was to identify Global bodies involved with promoting Agrotextiles. It was found that while there are organizations promoting either improving agricultural efficiency, or technical textiles as a whole, there were no real global organizations promoting Agrotextiles specifically. Hence the international bodies that play an important role in promoting Agrotextiles industry, fall under three distinct categories:

1. *Organizations promoting improvements in agricultural productivity* – There are various organizations round the world that are focused upon improving agricultural productivity by up-skilling farmers and imparting knowledge to improve agricultural practices. A few of these organizations are as follows:

Standard	Organization Name	Geography	Description
FAO	Food and Agriculture Organization of the UN	Global Body	FAO help developing countries and countries in transition to modernize and improve agriculture, forestry and fisheries practices and ensure good nutrition for all.
MOAG	Ministry of Agriculture and Rural Development, Israel	Israel	Steadfastly been promoting the use of greenhouses and net houses to counter the extreme climatic conditions.

2. *Organizations focused on Integrated Pest Management & Crop Protection* – These organizations are focused upon improving agricultural productivity by reducing the damage caused by pests and climatic conditions. A few of these organizations are as follows:

Standard	Organization Name	Geography	Description
ARO	Agriculture Research Organization – Israel Ministry of Agriculture	Israel	An organization focused on increasing Israel’s agricultural output and conducting research in various aspects of plant & animal sciences, plant protection, soil, water and environmental sciences, agri-engineering and post-harvest and food sciences.
ECPA	European Crop Protection Association	Europe	ECPA acts as the ambassador of the crop protection industry in Europe and represents the industry's European regional network while promoting modern agricultural technology.
CARDI	Cambodian Agricultural Research & Development Institute	Cambodia	Provides paid training to participants in areas pertaining to agrotextiles such as Integrated Nutrient Management, Post-Harvest Technology and Integrated Pest Management.

3. *Industry bodies and organizations that help promote awareness and lobby on behalf of the industry* – While there are numerous such organizations and associations globally, a few of the popular and active ones include:

Standard	Organization Name	Geography
INDA	Association of Nonwoven Fabric Industry	USA
EDANA	European Disposable and Nonwovens Association	Europe
EURATEX	The European Apparel and Textile Confederation	Europe
ABINT	Brazilian Association of Nonwoven and Technical Textile Industries	Brazil

4. *Standards setting organizations that devise standard product specifications and corresponding test methods* – These organizations are similar to the role the BIS (Bureau of Indian Standards) fulfils in India. Examples include:

Standard	Organization Name	Geography	Description
ISO	International Organization for Standardization	Global Body	International standard setting body composed of representatives from various national standards organizations
ASTM	American Society for Testing and Materials International	Global Body	A global organization involved in creating specifications, test methods and guidelines, but not involved in any sort of certification or enforcement
DIN	German Institute for Standardizations	Germany	German representative in ISO
EN	European Committee for Standardization (CEN)	European Union	Officially recognized as the European standards body by the EU. Signed Vienna Agreement with ISO to avoid duplicity in standards

6.2 Analysis of Global Scenario and Benchmarking of Key Policy Interventions

Understanding what foreign government agencies have done to promote agrotextiles from a policy perspective is important. During this phase of the project, feedback was sought from various government agencies and manufacturers around the world on policies and incentives that are implemented to promote the use of agrotextiles and broadly technical textiles.

Interactions with various stakeholders such as government departments, manufacturers and subject matter experts in countries such as Israel, Turkey, Australia, UK, Netherlands, Taiwan, etc. (details of personnel interviewed included in Annexure B) the general feedback was that there are not many assistant measures in the way of policies or financial assistance schemes to drive demand. The certain schemes we were able to glean information on are discussed below.

Initiatives to support the supply side of the ecosystem are generally broad based and often come under the broad based initiatives for the textile or technical textile industries. An example of this was China, details of whose programs have been listed below:

- In 2007 the Chinese government devised the *11th Five Year Plan for the Textile Industry* which was fairly comprehensive and contained the following initiatives:
 - To provide lump sum direct grants to projects of technology innovation, development and industrialization of core technologies and equipment, establishment of innovation services platforms, and brand development and promotion.
 - To provide loan interest subsidies for the construction of overseas textile industrial parks.
 - To subsidize the provision of land, manufacturing facilities, infrastructure and services in overseas textile industrial parks.
 - To subsidize the expenses of Chinese textile companies incurred in early stages of “going global” that may involve R&D, consulting services, feasibility study and project evaluation, and intellectual property rights protection.
 - To subsidize the expenses of Chinese textile companies in the establishment of distribution channels in overseas markets.
 - To create a fund for trade promotions and technology service platforms with grants up to RMB 2 million per project related to these technology service platforms.
 - To create a special fund for brand development that subsidizes branding expenses upto RMB 200,00 or 50% of actual expenses.
 - To introduce tax breaks on advertising expenses exceeding 8% of revenue and upto 150% of R&D expenses, custom duties and import VAT exemptions for the import of key spare parts and raw materials.
 - Many local governments provide monetary incentives to boost textiles and apparel exports and encourage brand building.
 - Another major type of incentive offered to the textiles and apparel industry at the provincial and local level is loan interest subsidies for technology renovation.
 - To provide reduced energy costs, preferential land prices, and tax incentives by provincial and local governments at their textile industrial parks.
- Feedback from the Ministry of Agriculture, Forestry & Fisheries (MAFF) of Japan, the Ministry of Economy, Trade & Industry (METI) of Japan, Ministry of Industry, Trade & Labour of Israel, Weisman-Friedman Industry Development Ltd in Israel, as well as manufacturers in the UK, US, Europe and Australia, revealed that there were no special initiatives to promote agro textiles or technical textiles by the government. According to the respondents in these countries the market for technical textiles was mature enough to allow market dynamics to dictate its course.

Incentives and Practices to Promote Demand Generation

There is a lack of financial initiatives globally to assist in demand generation for the agrotextile industry. Most government initiatives are centred around promotional and technical assistance for agrotextiles applications. Certain such initiatives are listed below:

Israel

- Israel is a leader in the area of protected cultivation which is a product of greater awareness and promotion but leading government organizations such as the Ministry of Agriculture and Rural Development (MOAG) as well as the Agriculture Research Organization (ARO). These organizations have steadfastly been promoting the use of greenhouses and net houses to counter the extreme climatic conditions. What is interesting to note is that Greenhouses (using plastic covering) are quite more popular than Shade Net houses.
- The total area covered with greenhouses, shade-houses and walk-in tunnels increased from 900 ha in the 1980s to about 13,000 ha in 2012 at a CAGR of 4-6%
- Of this 8,000 ha is for vegetables and 5,000 ha is for floriculture, and another 2,500-2,900 ha is for fruit trees (mainly covered with nets)
- Plastic is in wide use – 7000 tons per year for protected cultivation structures. Israeli standard for such plastic covering material also developed in 2011
- The main Integrated Pest Management (IPM) tool that is used in Greenhouses and Shade Net Houses is Insect Nets – 50 mesh insect proof net is most common
- Coloured Shade Nets show significant benefits when used with fruit trees such as apple, nectarine, peach, citrus, and various ornamental cut leaves as well as other high value crops such as orchards, bananas, grapes and pomegranate. The new coloured shade nets are found to promote earliness, improve quality, produce higher yields and provide other benefits.
 - Tomatoes - average of 400 tons per Ha, four times open field yield
 - Sweet peppers – 85-100 tons per Ha per season
 - Short cucumbers – 280 tons per Ha
 - The yield at a net house reaches 8 tons, 90% of which is slated for export
- Some innovations with regards to Agrotextile use in Israel include:
 - “Eco Seal” net houses that can be converted to greenhouses and vice versa, which eliminates the need for separate constructions, reducing non-degradable plastic requirement and extending the growing season.
 - Misting/Fogging systems that help reduce shade structure temperature during the day and increase temperature by night using shower systems
 - Computerized greenhouses that automatically control water and fertilizer levels

- Strict regulations on plastic after use; the state subsidizes machinery for plastic collection aimed at recycle and reuse.

Cambodia

- The Cambodian Agricultural Research and Development Institute (CARDI) provides consultancy services for various projects to private sector consumers. It also provides consulting services to project partners for projects that have been established in conjunction with another institute or organization.
- CARDI also provides paid training to participants in areas pertaining to agrotextiles such as Integrated Nutrient Management, Post-Harvest Technology and Integrated Pest Management.

New South Wales, Australia

- The Australia Government's Bureau of Rural Sciences - Department of Agriculture, Fisheries and Forestry has a handbook on "Managing Bird Damage to Fruit and other Horticultural Crops" that has a dedicated chapter on "Exclusion" that covers the use of various anti-bird nets. Such legislations exist in India too with the Ministry of Environment and Forests under the various Wildlife Acts, Bills, Rules and Notifications, but enforcement in this domain is severely lacking in India and energies towards implementing these will not have proportionate effect.
- Certain legislations help in promoting the use of agrotextiles such as bird nets or insect nets in cases where use of chemicals/insecticides/pesticides is restricted and hence there is no alternative option for protection against birds and insects.
 - In the case of protection of crops against birds, the use of certain chemicals (like polybutene) is illegal under the Prevention of Cruelty to Animals Act 1985 (Published in the South Australian Government Gazette 11 July 1996 p. 113; sub-regulation 2 b: 'gel for bird feet prohibited').
 - The use of illegal toxins is a concern on environmental, occupational health and safety and animal welfare grounds. Illegal poisoning may kill non-target animals and contaminate crops and the environment. Landholders employing such techniques are liable to prosecution under various state laws; for example in the Australian Capital Territory no permits are issued for native birds, even if they are considered to be causing damage to agriculture or the environment under the *Nature Conservation Act of 1980*.

Europe (Italy, Spain, Israel, Turkey, Slovenia, UK, Germany, France)

- The banking sector in Slovenia has systemically incorporated incentives for farmers that deploy various crop protection technologies. For example, the Triglav Bank promotes active defence against insurable and uninsurable risks. This is achieved by the use of anti-hail nets,

greenhouses, tunnels, sprinkler systems against spring frost and irrigation systems. Insured persons who invest in active protection enjoy premium policy incentives so that at the same insurance guarantee level cover they are given up to an 80% discount compared to premiums for insurance of the same crop grown outdoors. The Group provides relevant training and information in this area to its existing and potential clients. They are made aware of the increased likelihood that extreme loss events and natural disasters will occur (hailstorms, windstorms, floods, frosts, droughts, etc.), which may as a result require them to gradually discontinue certain crops in more exposed or vulnerable those areas which are more exposed or vulnerable.

- Similarly, in other European countries such as Spain and Italy the premiums for insurance against hail are significantly lower with use of anti-hail nets than without. Italy even has insurance for damage to greenhouse/shade net house structures as well as anti-hail nets under “Structures Combined Risks”.
- Turkey used a 25% subsidy during the 1990-95 period on protected cultivation material such as plastic greenhouse films, low and high tunnels. This has resulted in significant adoption on greenhouses. 76.7% of the greenhouses are covered with plastic film, with the balance being glass. And herein lays an indicator of how agrotextiles such as shade nets are not specifically promoted.
- In Turkey a regulation called “controlled production in protected cultivation” was issued on December 27, 2003 by the Ministry of Agriculture and Rural Affairs to accelerate farmers’ transition to GAP (Good Agricultural Practices), a certified production system. By registering farmers and familiarising them with production related record keeping it would help in this transition. Another regulation on September 8, 2004 took into consideration other countries’ implementation of EUREPGAP so that all elements of the production chain can be controlled and certified (carried out by independent bodies).
- No particular Government regulations, subsidies, or instructional material on Agrotextiles could be located for some other premier European countries such as UK, Germany and France.

6.3 Comparison of Relevant Terms & Conditions

It has been discussed extensively how throughout the industry, especially in India, there is a lack of established product specifications for various agrotextile products. This becomes an obstacle to ensure quality products are being introduced and sold in the market to various consumers. Unlike certain other technical textile industries like Geotech where infrastructure is governed by government departments and hence quality is mandated in their policies, the Agrotech industry is completely market driven with the onus on the consumers to demand products adhering to specific quality standards.

In this regard tenders issued by Indian institutional customers such as agricultural universities and government institutions is lacking in the level of detail required to ensure quality products are provided. This is displayed in Annexure E which shows a tender issued by the Rajasthan Horticulture Development Board for polypropylene low tunnels (miniature greenhouse tunnels or shade net tunnels) which only stipulates the weight per unit area (gsm) and the colour. This trend is more acutely displayed in the tender specimen in Annexure F issued by the Manjra Farm Centre in Latur, Maharashtra for skirting bags (a variation of crop cover typically used in banana cultivation) which simply requests the quantity.

Studying tenders abroad one could see a greater level of detail in defining the product properties in the tender itself that would ensure quality required as per the application. While reference specifications by the ISO/ASTM for all products have not been established, these sample tenders at least provide the detailed properties including this like water

Annexure G contains a tender specimen for greenhouse construction in Jamaica issued by the IICA (Inter-American Institute for Cooperation on Agriculture) under the CIDA (Canadian International Development Agency). Of specific interest is the procurement of plastic film and shade nets as part of this tender. The specifications required for this material can be seen as part of the tender specimen in Annexure G. There is also a tender from Armenia for Anti-Hail Nets that can be seen in Annexure H.

6.4 Standards Adhered to Globally

As described earlier, the various standards organizations generally devise two distinct types of standards - product *Specifications* and reference *Test Methods* to check the properties in the specifications. While specifications available with various global organizations are not well established, the reference methods are more widely applicable and hence are well developed. The test methods applicable to agrotextile are as follows:

EST	EDANA	INDA	ASTM	ISO
Tensile Strength	ERT 20.2-89	IST 110.4-95	D 5035-95	ISO 9073-3:1989
Thickness	ERT 30.5-99	IST 120.1	---	ISO 9073-2: 1995(E)
Weight	ERT 40.3-90	IST 130.1	D 3776-96	ISO 9073-1: 1989
Tear Strength	ERT 70.4-99	IST 100.2-95	D 5733-95	ISO 9073-4: 1997
Air Permeability	ERT 140.1-99	IST 70.1	D 737-96	ISO 9237:1995
Liquid Strike Through	ERT 150.4-99	IST 70.3-98	----	ISO 9073-8: 1995

The BIS is similarly well advanced in the area of reference test methods, and these test methods are referred to in the various product specifications discussed in Section 5.4. Available product specifications followed by various manufacturers and users have been consolidated in Section 7.9.1.

6.5 International Case Studies

6.5.1 Using Photosensitive Shade Netting for Improving Sweet Pepper Productivity - Israel

In recent years, numerous crops have been found to improve their productivity and fruit quality when grown under coloured (photo-selective) shade nets. The coloured shade nets have been developed during the past decade to filter selected regions of the spectrum of sunlight, concomitantly with inducing light scattering. They are designed specifically to modify the incident radiation (spectrum, scattering and thermal components). Depending on the pigmentation of the plastic threads and the knitting design, these nets provide varying mixtures of natural, unmodified light, together with spectrally modified scattered light. They are aimed at optimizing desirable physiological responses, in addition to providing physical protection to the crop.

In 2008, red pepper (*Capsicum annuum* L.) cultivars, cv. 'Vergasa' and cv. 'Romans' were grown at the B'sor Experimental Station in south-west Israel, using commercial cultivation practices, under four different coloured shade-nets, as follows: pearl, red, yellow, black with 35% relative shading. Fruit was harvested weekly, at a stage of maturity of 80-85% red, using a sharp clipper, without the calyx. The cumulative total and export-quality fruit yield were evaluated from the beginning of September until the beginning of December. Export-quality fruit was designated as fruit above 130 g each (medium size and above), without blemishes or defects.

The influence of coloured shade nets on postharvest quality was evaluated four times during the growing season for export-quality fruit. The fruit quality parameter of decay incidence, was evaluated immediately after each harvest, and at the end of 14 days of storage at 7°C and a relative humidity (RH) of ~94%, plus 3 days at 20°C.

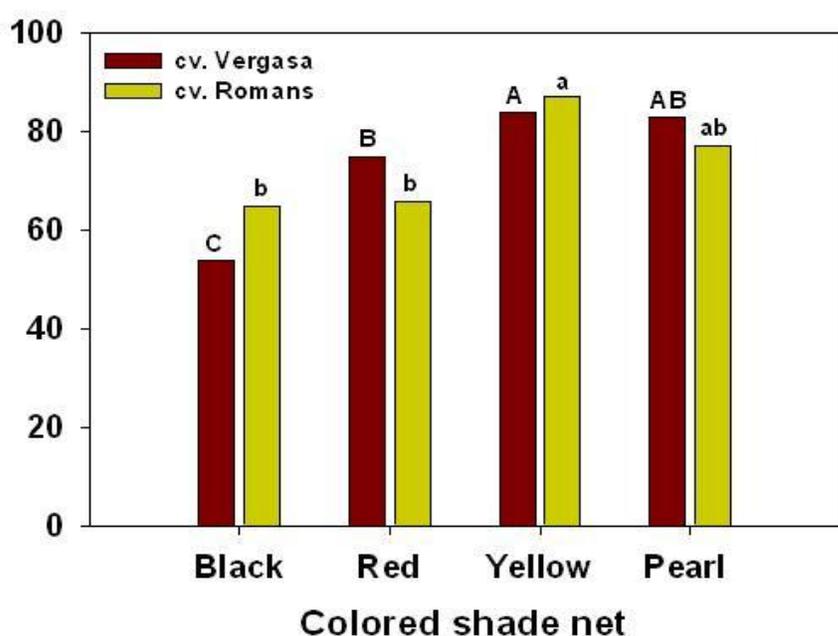


Figure 6.1: The influence of different coloured shade nets on the total fruit yield and the export-quality fruit yield, in tons per hectare of red pepper cv. Vergasa (A) and Romans (B). Means with different upper-case letters are significantly different for total yield, while means with different lower-case letters are significantly different for export-quality yield ($P = 0.05$).

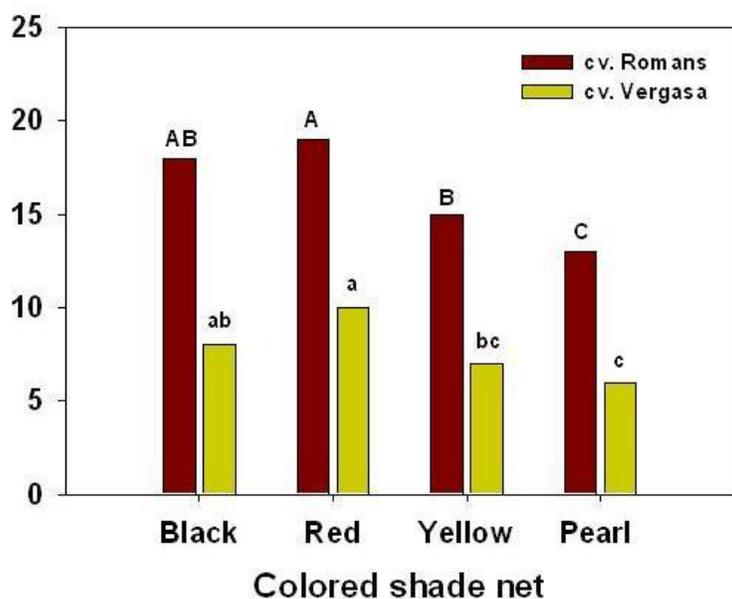


Figure 6.2: The influence of different coloured shade nets on decay incidence in red pepper cultivars; cv. Romans and cv. Vergasa, after 14 days at 7°C + 3 days at 20°C. Means of 4 harvests from September to December. Means with different upper-case letters are significantly different for cv. Romans, while means with different lower-case letters are significantly different for cv. Vergasa (P = 0.05).

Field yield and export-quality yield

The results showed a significant increase in the total fruit yield under the photo-selective shading. In cv. Vergasa, the red, yellow and pearl shade nets increased the yield by 30, 32 and 34%, respectively, relative to the commercial black shade net (Fig. 6.1), while in cv. Romans, the red, yellow and pearl nets increased the yield by 6, 16 and 14%, respectively, compared with the commercial black shade net (Fig. 6.1). The export-quality yield was affected to a larger extent. In this case the relative increase by the red, yellow and pearl was 39, 56 and 56%, respectively, in cv. Vergasa (Fig. 6.1), and in cv. Romans, the export-quality yield increased by 2, 34 and 18%, under the red, yellow and pearl shade net, respectively.

Postharvest quality

In preliminary experiments conducted in 2007, results have shown that fruit harvested from yellow



Figure 6.3: Pepper plants after 6 weeks



Figure 6.4: Pepper plants after 4 months

and red coloured shade nets had significant less decay incidence after prolonged storage (Fallik et al., 2009). In 2008, after 14 days of storage at 7°C plus 3 days at 20°C, the decay incidence was affected significantly by the shade nets (Fig. 6.2). At the end of storability and shelf-life simulation, fruit grown and harvested under the pearl shade net, had a significantly lower decay incidence compared with fruit harvested under the commercial black shade net. Fruit harvested under yellow shade nets also had a relatively low decay incidence compared with the commercial black shade net. The main decay-causing-agent isolated from decayed pericarp and calyx was *Botrytis cinerea*. No significant differences were found in fruit firmness or sugar content, as evaluated by total soluble solids under the different shade nets.

Conclusions

Demonstrated here is the potential use of pearl and yellow coloured shade nets to improve pepper productivity, relative to the traditional black shade nets, and to maintain better fruit quality after prolonged storage and shelf-life. The more pronounced effect on the export-quality yield, especially by the yellow and pearl nets, is probably related to the reduction of aphid-borne viral disease by the yellow and pearl nets. The significantly lower decay incidence at the end of storability and shelf-life simulation is a most interesting result. How does the stored fruit "remember" its light conditions during growth? There are a few alternative explanations for the effects of light-quality during plant growth, which, at this stage, are all hypothetical: (i). The quality of light might directly affect the pathogen propagation in the field, to be later expressed during post-harvest; (ii) photosensitive effects on fruit traits related to the infectibility of the fungal pathogen, such as sink, or cuticle morphology, or defence processes; (iii) an indirect photosensitive effect on the plant host susceptibility, which will affect storability and shelf-life.

6.5.2 Natural Coir Growbags for Tomato Crop

The main agro -technology adopted for tomato growing worldwide is with growbags. 3 plants per 100 cm growbag, 2 branches, mostly grafted material. Cherry tomatoes sometimes go for 4 plants per growbag. The plot layout (1 or 2 rows per bed and distance between rows) is variable. The number of plants per square meter is the most common factor and varies from 2.2 plants to 2.5. In cold climate conditions and multi water cycles (10 cycles and more) the growers adopted the 18 litre growbag (100x15x12 cm), crush material (section C).

Hot climate condition requires water buffer and therefore the common growbag is the 29 litre (100x18x16 x cm) , PLF material and even 3/4 of inch double sieved (section B). Such material should not be watered frequently. The ideal number of water cycles per day is around 3-6. All growbags are supplied with UV resistant plastic guaranteed for 3 years/seasons. As a matter of fact, some growers were able to use the growbags for longer time, up to 5-6 years/seasons.

Other advantages for growing with this range of coir is: the highest buffering capacity, with good abilities to compensate and protect the plant during "stress", fast reaction to water and fertilizer

adjustments, longer periods of use than a one crop season if needed, fast and easy replacement and site preparation - gives the professional growers the first step to success.

The worldwide demand for coir products is increasing every year, especially for hydroponics use. This factor demands serious attention to top quality control process and new production technologies, in order to keep the right balance between the quality and demand - this will be the only way to make proper use of this natural resource.

Section A: Mainly used for seed beds, propagation, growing cubes and small pots nurseries.

These coir products fractions include small particles from 1/6" up to 1/4" grades. These types of coir can be used in their pure forms or as part of a blend with peat or other substrates such as perlite, vermiculite, etc. These types of coir consist of small particles distribution with very short and thin fibres; in some of the fractions in this section there are no fibres at all or in a very low percentage.



The buffering of the coir for nursery use (a cation exchange protocol) is essential. The final result of the buffering is a reasonable lowering of the EC and a stable pH (around 5.8-6.0).

Section B: Mainly for hydroponics/soilless culture -for various flowers, roses, flowering bulbs crops [the flower and the bulb itself], also for indoor and outdoor plants as house plants and gardening plants.

This type of coir is also recommended as a growing media for pots, large volume trays or other types of containers including planting bags, High Open Top bag for fruit trees, olives, citrus and ornamental trees.

This fraction type includes medium sized coir particles and fibres starting from 3/4" to 1" grade. The products are ideal for hydroponics uses such as grow bags or container systems; for hot climates/ high levels of radiation during the crop development period - where better water holding capacity is needed in order to increase the coir's ability to avoid stress. The optimal air content at full water capacity of these products is not less than 23-25%. The drainage management is easier under various irrigation regimes.



Section C: This is premium long fibres and the multi drain line of products and has a wide range of

mixtures of fibres and Crush husk sizes.

The coir in this range is developed for hydroponics use in growbags or container systems, and is mainly used in cold climates / low radiation, and for multi cycle irrigation regimes. These products give almost unlimited options to the grower for optimum water management.

Other uses: used as potting soil in the media blending industry, as a growing media in its pure form, or as part of a blend contributing to air holding and buffer capacity.

These products combines' different grades of coir from both of the above sections, plus coir husk chips in different sizes or pure Crush husk with different grades of particles. The air content at full water capacity with these types of products reaches 35-50%-depending on the combination of the basic fractions and the husk particle sizes.

Actually, the full segmentation technology range of types of coir makes the grower's decision much easier and less complicated for choosing the right product for his crop.

The grower's decision takes into consideration the various factors which have an impact on the development of the crop in coir. Below are several illustrative examples:

1. For the multi cycle water regime, as in the northern hemisphere, crush coir is recommended while in cases of 2-4 water cycles per day (as in the Mediterranean area) the 3/4 inch double sieved coir is recommended.
2. In cases of water sources with elevated chlorine content, the farmer is obliged to run a large quantity of drip water in order to avoid the accumulation of the chlorine in the full medium profile. Thus, a regime of few, but long water cycles should be adopted using a fine fraction of coir such as the 3/4 inch double sieved.
3. For small, and numerous tray holes, use the fine fraction 1/2 coir inch not sieved.
4. For orchids with a combination of top water quality and the typical root system, the crush or even the chip fractions of coir are recommended.

6.5.3 Coloured Shade Nets for Improved Apple Quality and Yield

Research Questions

- A. What is the effect of net covering compared with an uncovered orchard?
- B. Is the type of net important?
- C. What is the effect of selective filtration of solar radiation?
- D. Which net properties integrate the most advantages with one covering?

Method

Nets were spread horizontally above the trees in Kibbutz Baram's apple orchards, in the north of Israel, forming a high and well-ventilated net house.

Varieties: Golden and Starking Delicious

The following nets were studied for five consecutive seasons, in two cycles of 700 m² for each net: Pearl, Red, Blue, Grey, and Black, with a shading level of 30%, and White with a shading level of 15%.

Control: an uncovered orchard in the same plot



Results

Many advantages were found in covering the apple orchard with net:

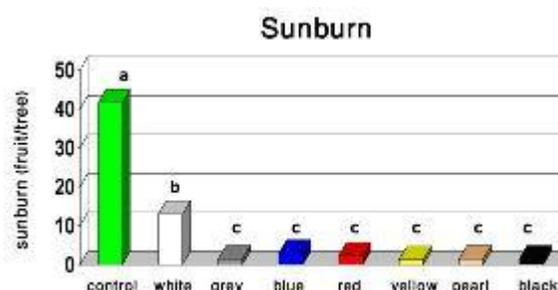
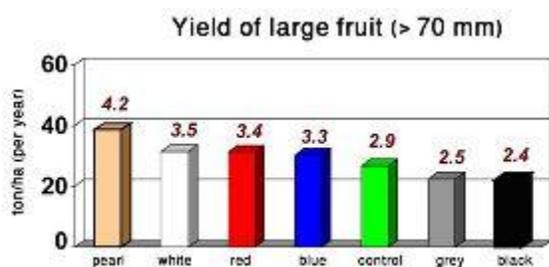
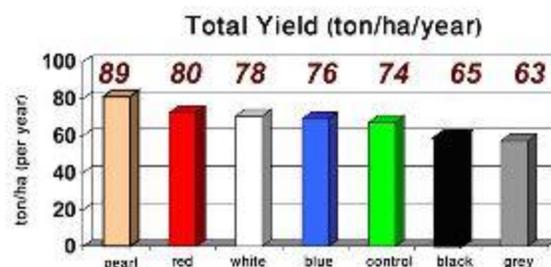
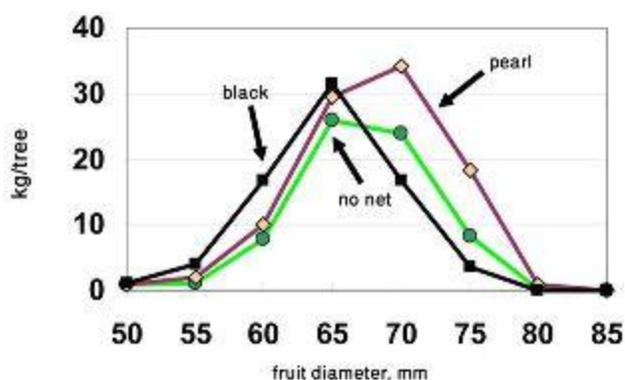
- Protection against natural damage, such as hail and heat waves
- Creation of a favorable microclimate for deciduous trees: less wind, cooler temperatures and slightly higher humidity

The result: improved assimilation (despite the shading) and reduced water consumption

Distinct differences were found in the effect of the different nets:

- Pearl: Results indicated significantly higher protection against water stress, larger fruit, higher yield and enhanced quality compared with the other nets. Trees under Pearl net produced an additional 20 tons per hectare of Golden Delicious per year in general yield, with large and high-quality fruit, compared with the uncovered control plot.
- Red and White: These nets produced second best results in productivity, yield and size for Golden Delicious.
- Black and Grey: These nets produced the poorest results. Fruit grown under these nets were smaller and yields were lower.
- All the 30% shade nets provided excellent protection against sunburn, for both varieties, irrespective of the type of net. The 15% shade net provided partial protection.
- Disadvantages (in some of the varieties): Growth is more vigorous in trees covered by net.
- There were no negative effects in respect of plant protection or pollinating bees.

Distribution of fruit size; Golden, 2005



Conclusion

- Covering apple orchards with suitable nets produces a range of advantages with economic value:
- Enhanced fruit size and quality, larger high-quality yield, protection against sunburn, effective water consumption and protection against natural and environmental damage.
- The net properties and selective filtration of solar radiation are extremely important.
- Nets that diffuse light and are enriched with red spectrum compared with blue and UV (pearl, red and white nets) produce improved results.
- Nets that do not diffuse light (black and grey nets) produce poorer results.
- Commercial implementation of the research results is already underway.
- Directions for further R&D: continued improvement of net properties, adaptation of the technology to other varieties and cultivars, adaptation of irrigation and pruning management to net house conditions, improved plant protection using nets, reduced chemical use

6.6 Inclusion of Agrotextiles in Academic Curriculums Globally

Most stakeholders in the area of Agrotextiles feel that adoption of Agrotextiles in India will be via top-down mechanism where large and educated farmers need the exposure and instruction

- **Iowa State University (Ames, Iowa, USA)** - Iowa State University is a top 10 university for Agriculture & Forestry in the US and is a pioneer in Agrotech instruction. Agrotextiles is a

part of an Agricultural Studies degree undergraduate course titled “Crop Growth, Productivity & Management” which is a required (3rd semester) 2nd year course.

- **University of Reading (UK)** - University of Reading is ranked #11 globally for Agriculture & Forestry. Agrotextiles is a part of BSc Agriculture undergraduate program course titled “Crop Protection” which is an optional 2nd year course.
- **The University of Queensland (Australia)** - The University of Queensland is the top rated university for Agricultural Sciences in Australia. Agrotextiles is a part of the Bachelor of Agricultural Science undergraduate program course code PLNT3009 titled “Plant Protection” which is an optional 2nd year course.
- **Kyoto University (Japan)** - The Kyoto University is ranked 17 globally for Agriculture & Forestry. While there is no specific course for plant protection as is common in other leading agriculture universities, Agrotextiles is a part of the Graduate School of Agriculture courses “Plant Propagation in Horticulture” and “Advanced Course in Weed Management” under the Division of Agronomy and Horticulture Science.

6.7 Comparative Analysis - Implications of International Benchmarking for India

The various sections above have served to provide international benchmarks and best practices which can be adapted for India.

Country/Region	Europe	SE Asia	US	Australia	India
Manufacturer Incentives for Textile Industry / Capital subsidy	No	Yes	No	Yes	Yes
Crop Insurance Discount from use of Agrotextiles	Yes (Spain, Slovenia, Italy)	No	Yes	No	No
Centralized Training Programs and Consulting Services for Agrotextiles	No	Yes (Cambodia)	No	No	No
Subsidized Agrotextile Products	No	No	No	No	Yes

Based upon the current usage in India and abroad the following focus areas have been identified to classify the issues and base our recommendations on:

- Policy interventions centred around financial incentives
- Standards & Specifications to ensure quality

- Awareness initiatives and pilot studies

Within these three focus areas international benchmarks and best practices have been used to form a basis of some of the recommendations. These are

Policy/Incentives

One of the primary mandates of the engagement was to study current subsidies and financial incentives being offered by the government through the various instruments including the NHM (National Horticulture Mission), NHB (National Horticulture Board), HMNEH (Horticulture Mission for North East and Himalayan states), etc. To arrive at updates to these policies certain focus areas have been identified in section 5.3. Policies applicable globally were also studied in section 6.2, though there are not many countries have assistance programs geared specifically towards agrotextiles.

Standards & Specifications

Another area where global practices were closely studied is the standards and specifications framework prevalent. There is a lack of established specification standards globally and infact a lot of agrotextile products are sold with life (durability in years) being one of the features specified. This is an ambiguous measure and for this study there has been an attempt to reinforce this measure with a quantifiable logic. Standards for test methods are merely methods of testing the critical properties as outlined in specifications and are fairly similar globally. Hence both standards and specifications used as benchmarks were transferrable to India.

Awareness

One of the motivations behind this engagement is ensuring our use of Agrotextiles is at par with the use globally so that India can avail or the economic and social benefits as well. Hence globally prevalent material for promotion of usage has been referred to in drafting the handbook in Annexure A. This philosophy has also been used in identifying applications for research in section 7.10 which were based upon primary research conducted.

Tendering Process

It was observed that countries abroad have Agrotextile use and specifications built into tenders issued for procurement. While exact language has not been used, a similar format has been prescribed for inclusion in tenders issued in India.

Keeping these factors in mind certain interventions have been identified in chapter 7.

7 Recommendations

7.1 Regulatory and Policy Changes

Based on the Global benchmarking study detailed out in section 6, it has emerged that no regulatory changes are required to be mandate for promoting the use of Agrotextiles. Moreover the justification of use and promotion is based upon financial benefits accruing to the farmer.

In India also, the benefits accrue for a variety of produce as per the analysis below.

Sr	Application	Product	Benefit
1	Capsicum cultivation	Shade Net cum Anti-Insect Net	<ul style="list-style-type: none"> • Decrease in the cost of production by 30-35% (reduction in insecticide & fertilizers) • Increase in yield by 92-108% • Additional profit of Rs 11 lakh from Rs 1.8 lakh investment in shade nets per hectare (over 2 yrs)
2	Apples	Anti-Hail/ Bird Nets	<ul style="list-style-type: none"> • Increase in avg. selling price of 60-65%; • Return of Rs. 6.8 lakhs on additional cost of Rs. 2 lakhs in one hectare (over 2 yrs)
3	Mangoes	Mulch Mat	<ul style="list-style-type: none"> • Increase in yield of 33% & Increase in avg. selling price of 30% • Return of Rs. 23,800 on additional cost of Rs. 12,000 per hectare (2 yrs)
4	Tomato cultivation	Shade Net cum Anti-Insect Net	<ul style="list-style-type: none"> • Increase in yield of 67-83% • No significant increase in savings
5	Curry Leaves	Jute Mulch Mat	<ul style="list-style-type: none"> • Increase in yield of 64% • No significant increase in savings

As can be gleaned from applications 1, 2 & 3, for Capsicum, Apples and Mangoes there was a significant benefits with return of investment ranging up to 500%. On the other hand for produce such as Tomatoes and Curry Leaves the benefit was more or less equal to the costs resulting in negligible savings.

This is indicative of a broader trend where the benefits of Agrotextiles are distinctly apparent in high value produce and not so much for low value common produce. This also helped identified areas where interventions in the form of subsidies could help increase yield of low value produce while at the same time ensuring profitability. These areas are highlighted in section 7.5.6.

7.2 Undertake “Demo Projects” across the country

During the study, it emerged that the scale /rate of adoption of agrotextiles by farmers increases significantly wherever there is a live demonstration in the vicinity and establishing the benefits. No other form of awareness generates this level of conviction amongst farmers.

During the meeting held on 9th May 2013, the possibility of taking up “demonstration projects” across the country was explored. Given the benefits envisaged from this initiative such demonstration projects across the country in partnership with local Non-Government Organizations, manufacturers, associations etc. Organizations that should be roped in for this initiative include ATMA, ITTA and SASMIRA.

The table below suggests the States where these demonstration projects can be taken up. The States have been identified on the basis of production data (2011-12) with an objective to:

1. Establish the benefits in maximum number of States covering at least 50 projects, spread across the country
2. Cover all the key agrotextiles
3. Cover the fruits & vegetables where there is significant volumes

	Agrotextile	Potential States for Demonstrations
1	<u>Shade net</u>	
	Capsicum	TN, Karnataka, Himachal Pradesh
	Tomato	AP, Karnataka, Odisha
	Cabbage	West Bengal, Odisha, Bihar
	Flowers	Maharashtra
2	<u>Mulch mats⁴</u>	
	Cauliflower	West Bengal, Bihar
	Chilli	AP, Karnataka
	Potato	UP, West Bengal, Bihar
3	<u>Windshield nets</u>	
	Coffee	Karnataka, Kerala, Tamil Nadu

⁴ Seeing that Mulch Mats are an important thrust area for growth, a detailed breakdown of Produce and States to focus on can be seen in Annexure I

	Tea	Assam, West Bengal, Tamil Nadu
	Spices	AP, Gujarat, Rajasthan
4	<u>Bird Protection net</u>	
	Pomegranates	Maharashtra, Karnataka, Gujarat
	Grapes	Maharashtra, Karnataka
	Guava	Maharashtra, MP, Uttar Pradesh
5	<u>Crop Covers</u>	
	Cabbage	West Bengal, Odisha, Bihar, Assam, Jharkhand
	Cucumber	AP, Karnataka, J&K, Assam
	Radish	West Bengal, Haryana, Bihar
	Beans	AP, Jharkhand, Maharashtra
	Strawberry	Himachal Pradesh
	Melons	UP, Karnataka, West Bengal, Odisha
6	<u>Harvesting nets</u>	
	Mango	UP, AP, Karnataka, Bihar
7	<u>Anti-Hail Nets</u>	
	Apple	J&K, Himachal Pradesh, Uttarakhand
	Litchi	Bihar, West Bengal, Jharkhand
	Grapes	Maharashtra
8	<u>Woven/Non-woven Bags</u>	
	Grapes	Maharashtra
	Bananas	Maharashtra, Gujarat

7.3 Promote the concept of “Mulch Banks”

Mulch Mats (woven/non-woven mulch fabrics) are one category of products which are easily replaceable by plastic films. However the comparison between mulch mats and plastic films are as follows:

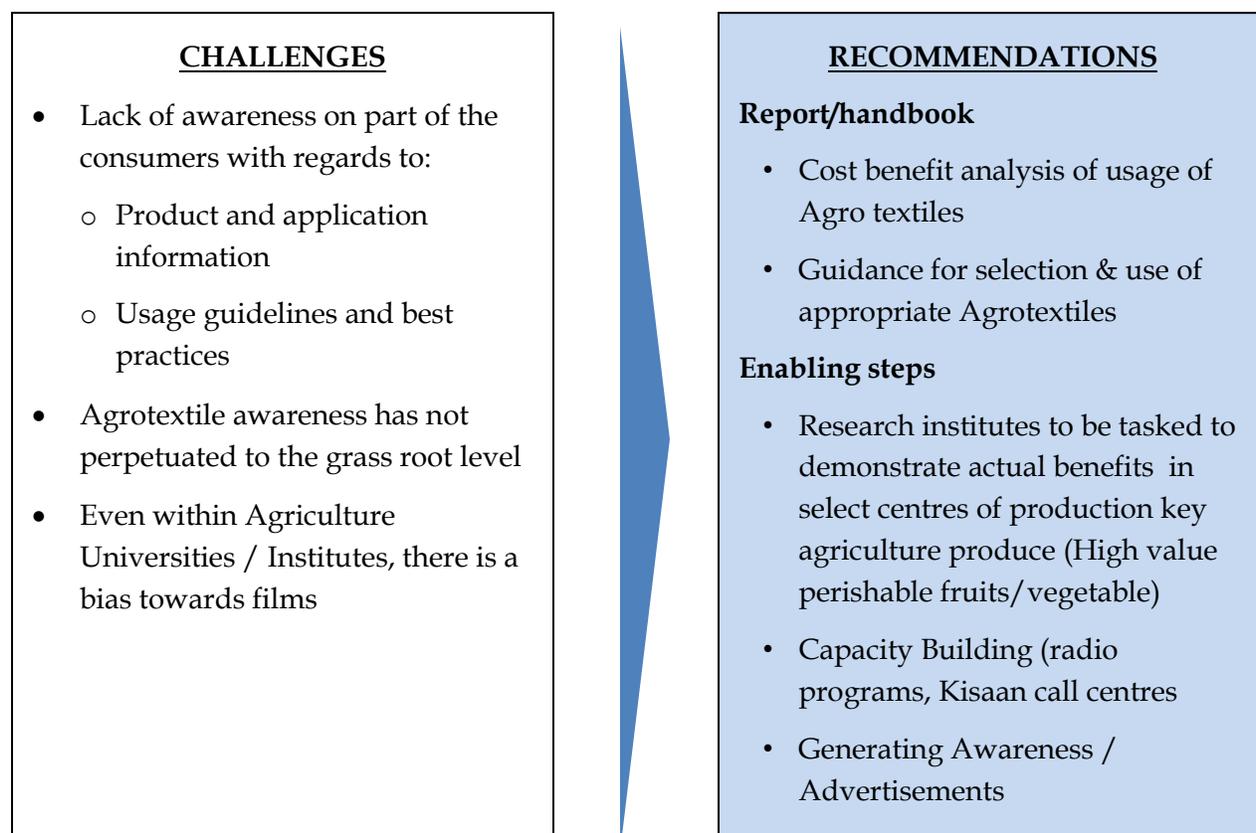
- Plastic films can be used only once whereas Mulch mats can be used 3-5 times
- Price varies from Rs. 15-20 per m², whereas the prices of mulch mats varies between Rs. 30-35 per square metres
- Plastic films are environmental hazard and may even cause choking to cattle

However inspite of the abovementioned benefits, plastic films are very commonly used as the farmers have to spare lesser cash up front.

In the above circumstances, it is suggested that the manufacturers should institutionalise “Mulch Banks” in partnerships with Co-operatives, local entrepreneurs etc., where the Mulch Mats can be procured by these partners and can be rented out to the farmers for each season. The payback period of such investment is 2 years. It may be noted that the mulch mats reusability will be limited to the same crop and it will not be interchangeable with other produces.

7.4 Promote Mass Awareness and Capacity Building

Some of the major impediments & recommendations to growth of the Agrotextiles industry are:



The various strategies to mitigate the lack of awareness and capacity building with regards to Agrotextiles are as follows:

- a) Educational outreach programs and consulting services by local agricultural institutes and universities mirroring those carried out by CARDI in Cambodia
- b) Radio programs in rural areas / radio jingles promoting agrotextiles

- c) Kisaan Call Centres to be equipped with information and answers with regards to Agrotextiles
- d) Advertising efforts such as posters and promotional schemes to be carried out at agricultural items POS (Point of Sale) of shops selling agricultural equipment
- e) Distribution of the Handbook on Agrotextiles (Annexure A) accompanying this report in various languages via local agriculture offices
- f) There should be some short movies in various languages / regional and ethnic dialect to generate awareness on use of agrotextiles. It may be noted that already some of the manufacturers already have developed short movies/documentaries, for which permissions may be taken to make minor edits & converting them in various ethnic languages.

It is proposed that an amount of **₹5 crore** can be budgeted for these activities by the Ministry of Textiles and/or the Ministry of Agriculture, and an organization like the ATMA (Agriculture Technology Management Agency) can be entrusted with the responsibility to oversee some of these initiatives.

7.5 Restructuring Financial Incentives & Subsidies

As mentioned in section 5.3 the policy framework in India that directly or indirectly deals with agrotextiles mostly revolves around the various incentive and financial subsidy programmes built around providing a boost to various technologies and techniques that can help boost agricultural productivity. These can also be referred to as “agriculture kits”. Details regarding the NHM and NHB subsidies and their implementation mechanism have been described in detail in Section 5.3 of this report. The various gaps or shortcomings of these initiatives have also been highlighted.

To address the non-inclusion of many of the Agrotextile products in the market this report has proposed their inclusion as well as the maximum amount of subsidy per unit measurement. These products and their price ceilings have been arrived at after discussion with various stakeholders. Similar exercise was carried out for items currently included. Our recommendations for modifying each as well as additional initiatives than can be implemented are as follows.

7.5.1 National Horticulture Board (NHB) schemes

As highlighted in section 5.3.1, the NHB only covers agrotextiles in the following subsidies:

- For *Primary Processing and Post-Harvest Management related projects* subsidy of 50% as per prescribed norms is available for crates and nets (shade and anti-hail only) in integration with commercial horticulture projects of production as one time assistance. Subsidy for crates is released only after its actual purchase at appropriate stage, which is at stage of

fruiting/harvesting. Accordingly, release of subsidy for crates is made separately at a stage later.

- Above mentioned subsidy of 50% as per prescribed norms for shade nets and anti-hail nets is considered as one time assistance for credit linked project for the benefit of existing commercial horticulture projects of fruit orchards qualifying area norm of above 4 Ha. Assistance in case of CFB Cartons, Aseptic Packaging, Punnets / Poly bags etc. is available on merit for launching a new horticulture product during its first year and for introduction of horticulture products in a market as one time assistance.
- For *Production Related - Hi-tech Commercial Production of Vegetables in Open Field* there is assistance for "Tunnel net/shade net for production of seedling etc." in the form of Rs. 250 per square metre, as per requirement, if undertaken on project land.

As per the feedback received during this study and our analysis, it is proposed to increase the list of agrotextile products which will make the subsidy more relevant as per the market realities. Taking this into account, we propose the following subsidies inclusive of agrotextile products which are currently not present in the NHB subsidies.

Sr. No.	Item	Maximum permissible cost	Pattern of assistance
A	Plastic Mulching	Rs. 20,000/ ha	50% of the total cost
*B	Mulch Mats (70 gsm black/white, life 5 yrs)	Rs. 25/ m ²	50% of cost
*C	Mulch Mats (100 gsm, black/white, life 5 yrs)	Rs. 35/ m ²	50% of cost
*D	Jute Mulch Mat	Rs. 30/ m ²	50% of cost
E	Shade Net House		
1	Tubular structure	Rs. 600/ m ²	50% of cost
2	Wooden structure	Rs. 410/ m ²	50% of cost
3	Bamboo structure	Rs. 300/ m ²	50% of cost
F	Plastic Tunnels	Rs.30/ m ²	50% of cost
G	Anti-Bird/Anti Hail Nets	Rs.20/ m ²	50% of cost
*H	Insect Mesh/Nets	Rs. 29/ m ²	50% of cost
*I	Windshield Net	Rs. 28/ m ²	50% of cost
*J	Crop Covers (30 gsm)#	Rs. 150/ kg OR Rs. 10/ m ²	50% of cost
*K	Harvesting Net	Rs. 18/ m ²	50% of cost limited to 4000 m ² per beneficiary
L	Tunnel net/shade net for production of seedling etc.		@ Rs. 250/ m ² for <i>Production Related - Hi-tech Commercial Production of Vegetables in Open Field</i>

***New Items Proposed**

#Crop covers are generally sold in per kg terms as per manufacturer feedback

As mentioned above, the products added here are a result of consultations with stakeholders in the industry. Reasons highlighted were as follows:

- Shade Nets and Hail Nets are already included in the NHM and are proven products with high awareness, hence they should be included under the NHB with stipulated maximum permissible cost.
- Mulch Mats, Insect Meshes/Nets, Windshield Nets, Crop Covers and Harvesting Nets are considered to have considerable untapped potential which is being inhibited by lack of inclusion in the NHB.
- The products are being manufactured in India and the technology does not require significant additional investments.
- Customer understanding of these products is fairly evolved with minimal to moderate instruction required in imparting knowledge of use and benefits.

While making these additions the follows aspects were kept in consideration:

- The “pattern of subsidy” was kept consistent with other products already included within the subsidies, and the “maximum permissible cost” arrived upon after consultations with manufacturers with regards to market prices.
- Current prices of products already present were cross checked to ensure the subsidy was in line with market realities.

It is suggested to include Mulch Mats, Insect Meshes/Nets, Windshield Nets, Crop Covers and Harvesting Nets in the NHB list of subsidized products

Enabling steps

- Approach the NHB for inclusion of new items proposed in table.

7.5.2 National Horticulture Mission (NHM) schemes

As mentioned in section 5.3.2, analysis of the NHM scheme as well as feedback from various stakeholders led to the following observations:

- Shade Nets are included amongst subsidized products along with the type of structure opted for – tubular, wooden and bamboo
- Anti-Bird Nets and Anti-Hail Nets also included , the subsidy for both being the same

- Various states/ districts have not updated the subsidies to the current NHM rates as a base template and adjusted the subsidy limits according to their local scenario
- The process for subsidy disbursement while similar to the NHB, is more tedious for the end users as they are required to coordinate between the bank and the SAO/TAO to ensure the subsidy amount is disbursed

Taking these points into account, we propose the following updated subsidies inclusive of agrotextile products that are currently not present in the list of subsidised products.

Sr. No.	Item	Maximum permissible cost	Pattern of assistance
A	Plastic Mulching	Rs. 20,000/ ha	50% of the total cost
*B	Mulch Mats (70 gsm black/white, life 5 yrs)	Rs. 25/ m ²	50% of cost
*C	Mulch Mats (100 gsm, black/white, life 5 yrs)	Rs. 35/ m ²	50% of cost
*D	Jute Mulch Mat	Rs. 30/ m ²	50% of cost
E	Shade Net House		
1	Tubular structure	Rs. 600/ m ²	50% of cost
2	Wooden structure	Rs. 410/ m ²	50% of cost
3	Bamboo structure	Rs. 300/ m ²	50% of cost
F	Plastic Tunnels	Rs.30/ m ²	50% of cost
G	Anti-Bird/Anti Hail Nets	Rs.20/ m ²	50% of cost
*H	Insect Mesh/Nets	Rs. 29/ m ²	50% of cost
*I	Windshield Net	Rs. 28/ m ²	50% of cost
*J	Crop Covers (30 gsm)#	Rs. 150/ kg OR Rs. 10/ m	50% of cost
*K	Harvesting Net	Rs. 18/ m ²	50% of cost limited to 4000 sq m per beneficiary
K	Tunnel net/shade net for production of seedling etc.		@ Rs. 250/ per m ² for <i>Production Related - Hi-tech Commercial Production of Vegetables in Open Field</i>
*New Items Proposed			
#Crop Covers are generally sold in per kg terms as per manufacturer feedback			

The reasons for proposing this is the same as for NHB, i.e. products added here are a result of consultations with stakeholders in the industry. Reasons highlighted are as follows:

- Mulch Mats, Insect Meshes/Nets, Windshield Nets, Crop Covers and Harvesting Nets are considered to have considerable untapped potential which is being inhibited by lack of inclusion in the NHB.
- The products are being manufactured in India and the technology does not require significant additional investments.
- Customer understanding of these products is fairly evolved with minimal to moderate instruction required in imparting knowledge of use and benefits.

While making these additions the follows aspects were kept in consideration:

- The “pattern of subsidy” was kept consistent with other products already included within the subsidies, and the “maximum permissible cost” arrived upon after consultations with manufacturers with regards to market prices.
- Current prices of products already present were cross checked to ensure the subsidy was in line with market realities.

We also propose the various SHMs (State Horticulture Mission) be requested to update their subsidy rates according to most recent published NHM subsidies.

Feedback should also be given to the SHMs to follow the NHB nodal office process for disbursement of the subsidy by coordinating directly with the banks so the farmer is not unnecessarily burdened.

It is proposed that Mulch Mats, Insect Meshes/Nets, Windshield Nets, Crop Covers and Harvesting Nets should be included in the NHM list of subsidized products

Enabling steps

- Approach the NHM for inclusion of new items proposed in table.

7.5.3 Horticulture Mission for the Northeast and Himalayan States (HMNEH)

As has been observed in section 5.3.3 the shortcomings of the HMNEH are the same as the NHM upon which it is based. Hence the recommendations are also similar. The proposed subsidies should include other agrotextiles as follows:

Sr. No.	Item	Maximum permissible cost	Pattern of assistance
A	Plastic Mulching	Rs. 20,000/ ha	50% of the total cost
*B	Mulch Mats (70 gsm black/white, life 5 yrs)	Rs. 25/ m ²	50% of cost
*C	Mulch Mats (100 gsm, black/white, life 5 yrs)	Rs. 35/ m ²	50% of cost
*D	Jute Mulch Mat	Rs. 30/ m ²	50% of cost
E	Shade Net House		
1	Tubular structure	Rs. 600/ m ²	50% of cost
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3	Bamboo structure	Rs. 300/ m ²	50% of cost
F	Plastic Tunnels	Rs.30/ m ²	50% of cost
G	Anti-Bird/Anti Hail Nets	Rs.20/ m ²	50% of cost
*H	Insect Mesh/Nets	Rs. 29/ m ²	50% of cost
*I	Windshield Net	Rs. 28/ m ²	50% of cost
*J	Crop Covers (30 gsm)#	Rs. 150/ kg OR Rs. 10/ m	50% of cost
*K	Harvesting Net	Rs. 18/ m ²	50% of cost limited to 4000 m ² per beneficiary
K	Tunnel net/shade net for production of seedling etc.		@ Rs. 250/ m ² for <i>Production Related - Hi-tech Commercial Production of Vegetables in Open Field</i>

*New Items Proposed
#Crop covers are generally sold in per kg terms as per manufacturer feedback

The products added here are a result of consultations with stakeholders in the industry. Reasons highlighted were as follows:

- Mulch Mats, Insect Meshes/Nets, Windshield Nets, Crop Covers and Harvesting Nets are considered to have considerable untapped potential which is being inhibited by lack of inclusion in the NHB.
- The products are being manufactured in India and the technology does not require significant additional investments.

- Customer understanding of these products is fairly evolved with minimal to moderate instruction required in imparting knowledge of use and benefits.

While making these additions the follows aspects were kept in consideration:

- The “pattern of subsidy” was kept consistent with other products already included within the subsidies, and the “maximum permissible cost” arrived upon after consultations with manufacturers with regards to market prices.
- Current prices of products already present were cross checked to ensure the subsidy was in line with market realities.

It is proposed that Mulch Mats, Insect Meshes/Nets, Windshield Nets, Crop Covers and Harvesting Nets should be included in the HMNEH list of subsidized products

Enabling steps

- Approach the *HMNEH* for inclusion of new items proposed in table.

7.5.4 Agricultural & Processed Food Products Export Development Authority (APEDA) schemes

The APEDA schemes are different from the other schemes highlighted above as they focus more upon post harvesting and storage and handling operations, as well as export promotions, etc. These steps are further down the value chain than cultivation of produce and hence scope of the subsidies should also reflect this difference.

Under the “Infrastructure Development” schemes the following subsidies are present:

Components	Pattern of Assistance
Setting up of integrated post-harvest handling system (pack houses / green houses with any two or more of the above facilities)	25% of the cost subject to a ceiling of Rs.25.00 lakh per beneficiary

Within these subsidies agrotextile products such as shade nets and insect meshes can be included as they will help achieve the intended objectives, along with core products such as Leno Bags and Pallet Nets. Preference is to be given to usage of Agrotextiles so that expenses involved in exports are reduced and farmers get direct advantage of subsidy without any hassles of site visits by inspectors. Credit benefits can also be made available from banks when certified by such government agencies on use of Agrotextile products. Government’s benefit is on getting good quality produce at low cost for better exports abroad.

APEDA has limited scope in providing a fillip to Agrotextiles, but it can help in boosting sales for Leno Bags, Pallet Nets and Shade Nets provided those products are included in the “components” section.

Enabling Steps

Co-ordinate with Ministry of Commerce & Industry to issue advisory/guidance to promote use of Leno Bags and Pallet Nets for post-harvest handling and storage.

7.5.5 Proposed Direct Subsidy for Agrotextiles based on Aadhaar

Post our discussions with various stakeholders, especially agricultural universities and industry experts; the glaring lack of direct subsidies from the Government was consistently highlighted. Other products that increase yield such as fertilizers receive direct subsidies from the government from the Ministry of Finance via the line ministry (Ministry of Chemicals and Fertilizers in this case) and its various departments. The lack of inclusion of Agrotextiles in such a subsidized disbursement program is the biggest impediment to the mass adoption.

It is important to understand how fertilizer subsidies in India work as the objectives of fertilizers are the same as those of Agrotextiles. Fertilizers in India are produced or imported by entities in both the private and public sector and are distributed through a massive supply-chain of private wholesalers and retailers. The prices of such products are also administered, and the fertilizer subsidy is transferred to the manufacturers from the Department of Fertilizers, Government of India. The farmer thus purchases subsidized fertilizers at an affordable price.

However the efficiency of this mode of subsidy disbursal has been found to be inadequate as it leaves too few players controlling a lot of the funds involved and hence open to misuse. Another option considered was disbursing subsidies to aggregators along the lines of GGRC. But since such organizations are not prevalent in all states this cannot be a national roll-out model and hence such a subsidy implementation mechanism was not considered. Hence “Direct Subsidies” are considered to be the most effective and the long term solution.

It is suggested that the Ministry of Textiles should explore the feasibility of transferring the subsidy directly to the beneficiaries rather than to the manufacturers. This will involve coordination with the Ministry of Finance as well as the State Government departments. Quantum of subsidies should be similar to those offered by the NHB/NHM.

The proposed future flow of direct subsidies for Agrotextiles can be seen in Figure 7.1. Figure 7.2 illustrates how the direct subsidy will tangibly be implemented and how the various stakeholders will interact with each other.

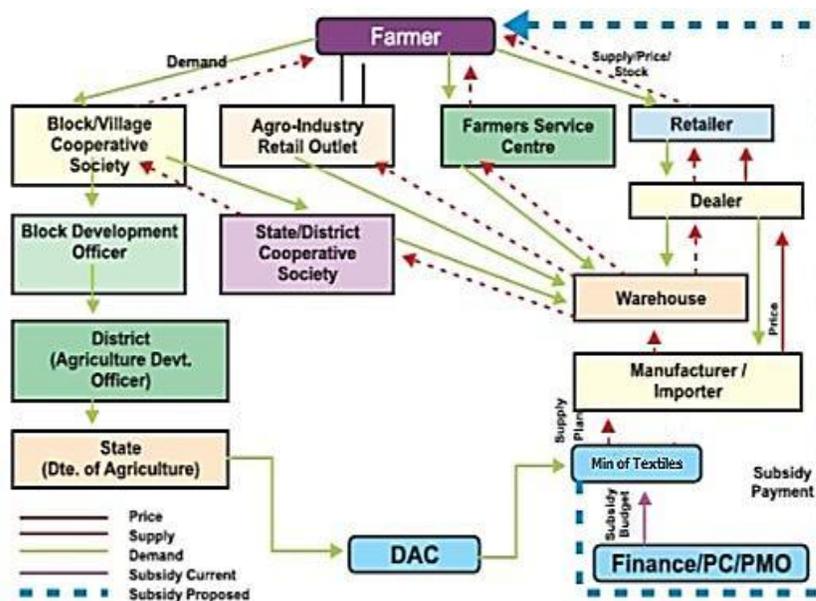


Fig 7.1: Phase wise flow of future subsidy

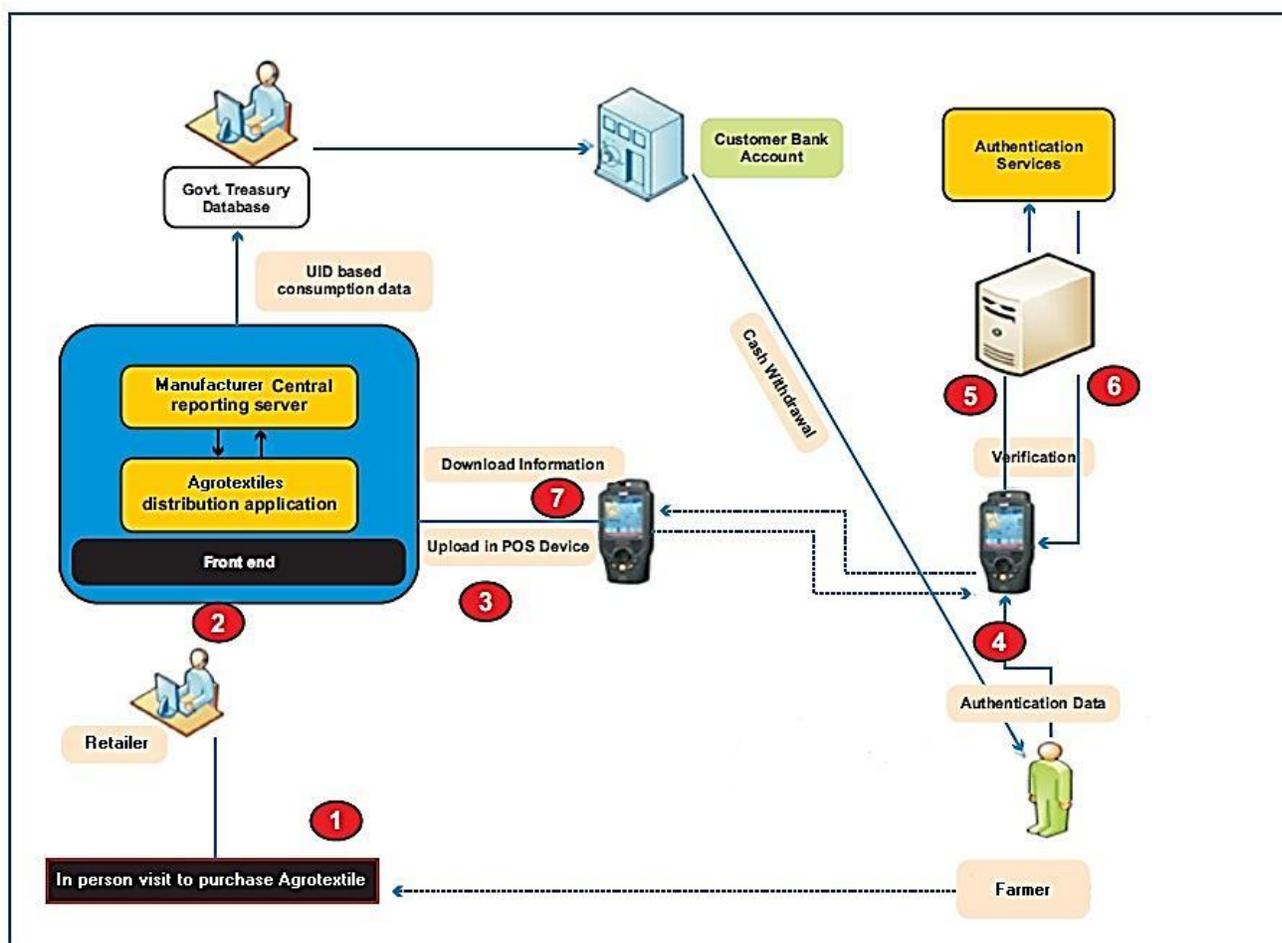


Fig 7.2: Direct subsidy implementation illustration

There glaring lack of subsidies specifically for Agrotextiles is the biggest impediment to the growth of the industry. The direct subsidy mechanism may be emulated for providing agrotextile subsidy.

Enabling steps

- Coordination between Ministry of Finance, Ministry of Textiles and State Governments to initiate subsidies by Govt. for agrotextiles

7.5.6 Special Schemes by Ministry of Textiles for Agrotextiles including Vulnerable Areas/Sensitive Produces

From the observations made in section 7.1 of this report, subsidy assistance will go a long way in providing a fillip to use of Agrotextiles for *increasing yield of low value produce* where without subsidy savings are negligible and hence use of Agrotextiles is stagnant. Low value produce would refer to items like tomatoes, cabbage, cauliflower and chilli. From a subsidy disbursal perspective it would not be possible to segregate beneficiaries based upon produce and hence low value produce cannot specifically be targeted, but to help focus initiatives production quantity and productivity for various vegetables and fruits have been mapped in Annexure J. A summary is as follows based on the combination of the two:

Vegetables	Focus States
Cabbage	Andhra Pradesh, Assam, Bihar, Chhatisgarh, Gujarat, Haryana, Jharkhand, Karnataka, Madhya Pradesh, Maharashtra
Cauliflower	Assam, Bihar, Chhatisgarh, Gujarat, Jharkhand, Madhya Pradesh, Maharashtra, Odisha, Punjab
Tomato	Andhra Pradesh, Bihar, Chhatisgarh, Gujarat, Madhya Pradesh, Maharashtra, Odisha, Punjab, Uttarakhand, West Bengal
Chillies	Andhra Pradesh, Gujarat, Karnataka, Madhya Pradesh, Odisha, West Bengal

Fruits	Focus States
Banana	Andhra Pradesh, Assam, Bihar, Chhatisgarh, Karnataka, Kerala, Maharashtra, Mizoram, Nagaland, Odisha, Tamil Nadu, Tripura, Uttar Pradesh, West Bengal
Grapes	Karnataka, Maharashtra
Guava	Andhra Pradesh, Bihar, Chhatisgarh, Gujarat, Haryana, Jharkhand, Madhya Pradesh, Maharashtra, Odisha, Uttar Pradesh, West Bengal
Mango	Andhra Pradesh, Bihar, Gujarat, Maharashtra, Odisha, Tamil Nadu, West Bengal

A crucial area of focus is also sensitive areas due to social or climatic conditions that require Agrotextile to improve agricultural productivity and would truly benefit from financial assistance. Already climatically vulnerable areas like NE & Himalayan States are covered. However Naxal affected States – like Chhattisgarh, Jharkhand, West Bengal, Andhra Pradesh and Odisha can be extended subsidy on the lines of NE & Himalayan States with the leftover budget being used to fund this initiative.

To achieve the above mentioned objectives regional offices of the NHM and NHB should be used to disburse subsidy to qualifying participants and ascertain whether projects are for above produce.

There should be focus on providing subsidies for Agrotextile to promote use in low value produce where cost benefit is otherwise negligible. Sensitive areas such as naxalite zones as well as hilly regions where geographical factors prevail should also be focused upon.

Enabling steps

- Ministry of Textiles should coordinate with NHM and NHB to enforce special subsidy within identified regions for sensitive produce via their regional offices.
- The schemes should be back ended and credit linked.
- The leftover NHM and NHB budgets can help fund the additional expense.

7.5.7 Formation of Agrotextile Subsidy Facilitation Organization

The Agrotextile COEs (Centres of Excellence) such as the SASMIRA should be deemed facilitator for the various agrotextile subsidies available under the NHM, NB, HMNEH, etc. similar to the role the GGRC (Gujarat Green Revolution Company) plays in implementation of micro-irrigation schemes. For this the COE would have to partner with the various manufacturers and create a parallel subsidy disbursement process flow to leverage the distribution network of the manufacturers. Key highlights of such a program would be:

- Dealers would help spread awareness of the subsidies to their customers of agricultural inputs
- These dealers would accept applications and along with manufacturers coordinate with the COE to have subsidy disbursed
- The current NHB/NHM subsidy mechanisms are based on entire projects and require establishment of a loan account to avail benefits. Since agrotextile products are continuously required, such a parallel mechanism would avail farmers to regularly purchase agrotextiles under subsidy
- If manufacturer accreditation is accomplished then through such a mechanism the COE can ensure adherence to the conditions for agrotextile supply under subsidy

The effectiveness of national programs such as the NHB and NHM can be significantly amplified if state or private organizations play the role of facilitator and help in promotion of Agrotextiles and availability of subsidies. This is similar to what the GGRC has been able to do in Gujarat with micro-irrigation systems.

Enabling Steps

- Strengthen institutional mechanism in leading 7-8 States for awareness and outreach similar to the function GAIC performs in Gujarat.
- Industry body like the ITTA/ATMA to act as subsidy facilitator where it partners with manufacturers and utilizes their outreach to promote and increase uptake of subsidy.

7.5.8 Premium Benefits to Anti-Hail Net Users

As mentioned in Section 6.2, various banks in the Europe offer premium savings of up to 80% in crop insurance schemes covering hail damage if the consumer farms have anti-hail nets installed. These savings are significant and such insurance policies can be crucial in the Indian perspective where there are great variations in climate and irrigation facilities. Uptake of agricultural insurance has been slow in India, especially due to affordability concerns of most farmers.

1. AIC (Agriculture Insurance Company) of India - AIC offers yield-based and weather-based agricultural insurance for crops in almost 500 districts of India. The plan provides comprehensive risk insurance for yield losses due to natural fire and lightning, storms, hailstorms, cyclone, typhoon, tempest, hurricane, tornado flood, inundation, landslide, drought, dry spells, pests/diseases, etc. In FY2011-12 the AIC of India, the primary crop insurance company in India, had gross premiums earned of ₹1320 crore covering only 2.5 crore farmers covering 3.43 crore hectares of land. In a country with 70% population depending on agriculture for their livelihood, with majority held hostage to the whims of the weather conditions, there is significant scope for improvement.
2. FIIS (Farm Income Insurance Scheme) - The central government formulated this scheme in 2003-04 to cover only wheat and rice crop to protect farmers by making up any shortfall to the minimum guaranteed income (avg yield x minimum support price) via the AIC of India. This scheme is compulsory for farmers availing crop loans.
3. NAIS (National Agriculture Insurance Scheme) or RKBY (Rashtriya Krishi Bima Yojana) - coverage of all food crops (cereals and pulses), oilseeds, horticultural and commercial crops. It covers all farmers, both loanees and non-loanees, under the scheme. The premium rates vary from 1.5 percent to 3.5 percent of sum assured for food crops. In the case of horticultural and commercial crops, actuarial rates are charged. Small and marginal farmers are entitled to a subsidy of 50 percent of the premium charged- the subsidy is shared equally between the Government of India and the States. The subsidy is to be phased out over a period of 5 years. NAIS operates on the basis of
 - a. Area approach- defined areas for each notified crop for widespread calamities.
 - b. On individual basis- for localized calamities such as hailstorms, landslides, cyclones and floods.

Under the scheme, each state is required to reach the level Gram Panchayat as the unit of insurance in a maximum period of 3 years.

While these are helpful, penetration of agri-insurance is woefully low. Crucially, certain agrotextiles exist which help in reducing crop damage due to external factors. As in some European countries it is recommended that new insurance policies may be designed that give discounts in premium offered to farmers using protective agrotextile products. The following products have been

identified where the Ministry of Textiles and insurance companies can collaborate to introduce insurance schemes

- Anti-Hail Nets
- Crop Covers
- Insect Nets
- Windshield Nets

These measures can provide impetus to agricultural insurance as well as Agrotextiles and the proliferation of these industries will be a boon to farmers. It is recommended that the Ministry of Textiles approach the AIC (Agriculture Insurance Company) of India via its Chairman cum MD as well as the GIC (General Insurance Corporation) of India to add such riders in the crop insurance schemes and partner with them for promotion of use of such agrotextile products. Alternately, the PSU insurance companies such as Oriental Insurance, United India Insurance Co., New India Assurance, National Insurance, and NABARD (National Bank for Agriculture & Rural Development) can be approached to initiate programs in Agricultural Insurance that will incorporate afore mentioned Agrotextiles. Such a step would be mutually beneficial. It may be noted that interest from the private insurance sector is limited.

Insurance companies in certain European countries such as Spain, Italy and Slovenia offer premium discounts on crop insurance for use of Anti-Hail Nets. Such incentives in India could achieve the dual objective of promoting agrotextiles as well as crop insurance which has till now been a failure.

Enabling Steps

Coordinate with AIC & GIC of India for Insurance premium benefits of up to 80% to farmers and consumers using agrotextiles such as anti-hail nets may be introduced. (This is a practice which is prevalent abroad especially in Europe). Also approach PSU insurance to introduce agricultural insurance

7.5.9 Promoting Environment Friendliness through Agrotextiles

There has been considerable debate on whether certain Agrotextiles such as Shade Nets, Mulch Mats, Crop Covers, etc. justify the higher cost when compared to performance of their plastic film counterparts. Justifying the preference of Agrotextiles over films on the basis of performance and results while feasible in many cases, performance varies greatly depending on the conditions prevalent, the type of soil, and the type of produce. In some case films offer sufficient performance and hence does not incentivise adoption of Agrotextiles. These differences have been highlighted in section 5.5.

Additionally, the amount of subsidy on plastic film is the same as that on Agrotextiles. With plastic film being cheaper on average than the corresponding Agrotextiles, this provides additional reasons for slow uptake of Agrotextiles.

But the crucial advantage of using Agrotextiles is the fact that Agrotextiles are recyclable (into non Agrotextile products) as compared to Plastic Film. Films are generally prone to wear and tear and hence harder to remove from the field, which results in the plastic mixing with the soil. This not only pollutes the soil but is also a danger to animals who end up consuming these materials.

With all these factors taken into consideration, it is hereby recommended that the subsidy on plastic film products be reduced by half from current levels (mostly 50%) to around 25% so that subsidy is lower than that of Agrotextiles. This will serve the dual purpose of:

1. Protecting the environment by reducing the harmful use of plastic films
2. Increase the use of environmentally friendlier Agrotextiles

Concurrently, awareness initiatives for the removal of plastic film and/or Agrotextiles after use need to be implemented for the benefit of the environment and our planet.

7.5.10 Benefits and Costs to the Government from Subsidies Proposed

In the aforementioned sections various updated or new government subsidies have been proposed, namely:

1. Proposed New Special scheme by the Ministry of Textiles to subsidize Agrotextile including Vulnerable Areas/Sensitive Produce

The scheme highlighted in section 7.5.5 proposed subsidies specifically for Agrotextiles that will significantly benefit the agricultural economy of India. It is proposed that an outlay of ₹500 crore towards this initiative will result in an additional horticulture produce

As discussed previously that while this subsidy may not have significant cost savings for some of the produce (as mentioned in section 7.1), there would have a significant economic impact due to avoidance of value losses and increase in the productivity. To exemplify, this subsidy will improve the yield of low value crops such a tomatoes by 1,50,000 metric tonnes! This provides the justification for this subsidy.

However it may be noted that this only represents less than 1% of the approximately 1.7 crore metric tonnes tomato output in India and it is not possible to cover the entire production. However this would help in raising awareness and subsequently will ensure its usage even without the subsidy.

Further, it is suggested that the hilly States & States having extremist issues may be allocated a higher amount of the subsidy (for e.g. J&K, Uttarakhand, North Eastern States, Odisha, Chhattisgarh)

2. Proposed updations in the existing NHM Schemes to subsidize Agrotextile (including Vulnerable Areas/Sensitive Produce)

The NHM is responsible for funding schemes mentioned below and has a combined budget of over ₹1200 crore which covers the following schemes

- a. NHM (National Horticulture Mission) subsidies
- b. NHB (National Horticulture Board) subsidies
- c. HMNEH (Horticulture Mission for North East and Himalayan States) subsidies
- d. Agricultural & Processed Food Products Export Development Authority (APEDA) schemes

For the central program (i.e. point “a.” above) in 2011-12 the NHM had budgeted ₹155.99 crore of which ₹19 crore was unutilized. As the recommendations suggest addition of four Agrotextile products in sections 7.5.1-4 which are not mass use products, it is recommended that this leftover budget should be sufficient to cover subsidies for the added products and should only be updated upwards based upon the industry growth rate.

While financial budgets, targets and expenditure are not completely available for the NHB, HMNEH and the APEDA, the opinion is that the performance and outlook is similar to that of NHMs central program and hence no increase is proposed for these schemes.

Enabling steps

- Advisory/ Request to Ministry of Agriculture to issue advisories to NHM, NHB and HMNEH for better representation of Agrotextile products
- Focus in States having high horticulture production (Gujarat, Maharashtra, MP, TN, UP, AP and Karnataka) for these subsidies

7.6 Focused Marketing and Sales

Various agrotextile products have different usage. Based on the sales potential of the agrotextiles, States have been identified for focused marketing. The activities for focused marketing include the recommendations already detailed put in previous sections:

- Demonstration projects
- Streamlining of subsidies
- Mass communication/awareness

At the same time penetration of products has been charted after polling various manufacturers as to where they are seeing repeat sales. It should be noted that this does not automatically mean potential in these states is high. Potential is based upon the variety of crops grown and the productivity; the lower the productivity of the particular product in the state, the higher the potential to increase sales of appropriate Agrotextiles in the region. This state wise productivity can be seen in the tables below:

Based upon the focus areas identified in the tables above, potential was ascertained. This was followed by primary research to ascertain current state wise penetration. This helped us perform a gap analysis on where marketing and sales efforts as well as earlier awareness campaigns should be focused. The results can be seen below.

Key	
	Low Potential
	Medium Potential
	Considerable Potential
	High Potential
	Negligible Potential

	States	Shade Nets		Mulch Mats		Windshield Nets		Bird Protection Nets	
		Penetration	Potential	Penetration	Potential	Penetration	Potential	Penetration	Potential
1	Tamil Nadu	✓				✓		✓	
2	Karnataka	✓							
3	Himachal Pradesh								
4	Andhra Pradesh							✓	
5	Odisha								
6	Madhya Pradesh								
7	Bihar								
8	West Bengal			✓					
9	Uttar Pradesh								
10	Kerala	✓							
11	Gujarat							✓	
12	Rajasthan								
13	Maharashtra	✓		✓				✓	
14	Assam								
15	Haryana								
16	Jharkhand								
17	Jammu & Kashmir								
18	Uttarakhand								

	States	Crop Covers		Harvesting Nets		Anti-Hail Nets	
		Penetration	Potential	Penetration	Potential	Penetration	Potential
1	Tamil Nadu	✓	●				
2	Karnataka		◐		◐		
3	Himachal Pradesh		◑			✓	◐
4	Andhra Pradesh		●		◑		
5	Odisha		◑				
6	Madhya Pradesh	✓	◐				
7	Bihar	✓	◐		◐		◑
8	West Bengal		●				◐
9	Uttar Pradesh		◑		●		
10	Kerala						
11	Gujarat	✓	◑				
12	Rajasthan	✓	◐				
13	Maharashtra	✓	◐				
14	Assam	✓	◐				
15	Haryana		◐				
16	Jharkhand		◑				◐
17	Jammu & Kashmir	✓	◐			✓	◑
18	Uttarakhand	✓	◐				◐

It may be noted that the potential of agrotextile in decreasing order is as follows:

1. Shade Net
2. Crop Cover
3. Mulch Mats
4. Windshield Net
5. Bird Net

This chart should be used as a blueprint by respective stakeholders for planning the various marketing and awareness efforts proposed in this report.

7.7 Strategic Retail Tie-Ups

In talking to the various stakeholders, especially farmers and manufacturers, last mile availability was cited as an area of huge potential for providing stimulus to Agrotextile sales. During the various brainstorming sessions the Kisan Seva Kendras were identified as a retail network that could be leveraged.

The IOC (Indian Oil Corporation) set up the Kisan Seva Kendras to add to the IOCs outreach for selling fuel and pioneered the cross selling of non-fuel supplies such as pesticides, vegetables, banking products and stationery items. The IOC has tied up with Indo-Gulf for fertilisers, National Seeds Corporation for marketing seeds and agricultural inputs as well as alliances with NABARD, Oriental Bank of Commerce and Bank of Baroda for banking products. The manufacturers should follow the example of the Seed Corporation of India and tap into this retail network by partnering with the IOC Kisan Seva Kendra's to sell Agrotextiles.

Another tool that can be studied is ITC's e-Choupal network which was devised to improve supply chain efficiency and provide farmers with better access to buyers at fair prices. A byproduct of the initiative was again the retail push via cross selling and ties ups with various manufacturers. Again manufacturers should utilize this sales channel to improve outreach of agrotextiles and provide impetus to sales.

7.8 Inclusion of Agrotextiles in Curriculum of Educational Institutions

The Ministry of Textiles as well as COEs such as NAU and SASMIRA approach various autonomous universities to facilitate the incorporation of Agrotextiles within the Agricultural university curriculums along with offering of elective courses if not already available. The curriculum can cover basic information from the handbook in Annexure H. This would contain chapters on:

- Products - A list of the 14 Agrotextile products
- Functions - A description of the functions the various Agrotextiles perform
- Applications - Common applications where Agrotextiles are used, showing the functionality, the products in use and the recipient products/crops
- Advantages - A brief idea of the benefits associated with using Agrotextiles including cost benefit analysis

Leading universities/colleges in India that can lead research and develop courses for agrotextiles have been identified after discussions with industry stakeholders based upon their faculty as well as research conducted in this area. The list is as follows:

- **Indian Agricultural Research Institutes (IARI)** – Centre for Protected Cultivation & Tech handles demos and research that includes Agrotextiles. Agrotextiles should be incorporated in following classes (these are PG courses):
 - HORT 256 – Protected Cultivation of Horticulture Crops
 - HORT 201 – Fundamentals of Fruit Production
 - HORT 310 – Export Oriented Horticulture
- **Punjab Agricultural University** – Vegetable Research Farm handles demos and research that includes Agrotextiles.
- **Tamil Nadu Agricultural University, Coimbatore** – “Greenhouse Cultivation” contains information on using shade nets, but no mention of nettings in “Crop Protection” section. Agrotextiles should be incorporated in following classes:
 - SAC 401 – Nutrient Management and Fertilizer Technology
 - AEN 401 – Pests of Horticultural Crops and their Management
 - HOR 311 – Production Technology of Vegetables and Spice crops
 - HOR 211 – Production Technology of Fruits and Plantation Crops
 - AGR 201 – Weed Management
- **Ch. Charan Singh Haryana Agricultural University, Hisar** – Agrotextiles should be incorporated in following BSc Agriculture classes, especially Elective Module VII (Plant Protection):
 - PFE 304 – Protected Cultivation & Post Harvest Technology
 - FOR 401 - Nursery Technology for Commercial Forest Trees
 - HORT 401 – Commercial Floriculture
 - HORT 402 – Commercial Fruit Production
 - HORT 403 – Nursery Management of Horticulture Crops
 - HORT 405/VSC 404 - Protected Cultivation of Horticultural Crops
 - ENT 401 - Integrated Pest and Disease Management
 - ENT 405 – Pesticides & Plant Protection Equipment
- **GB Pant University of Agriculture & Tech, Pantnagar** – Plant protection is a thrust area within courses but not offered as a separate course; net houses present for research. Agrotextiles should be incorporated in following BSc & MSc Agriculture & Horticulture classes:
 - APH-511 – Plant Propagation & Nursery Husbandry

- APH-311 – Fundamentals of Horticulture
- APH-315 – Fruit and Plantation Crops

This will be in addition to the extensive efforts of the Navsari Agricultural University and other such institutes already engaged in promotion efforts (listed in Annexure B).

The various industry stakeholders have also highlighted the dearth of instructors and academicians with detailed knowledge of Agrotextiles who can aid in improving knowledge and awareness of Agrotextiles. For this, manufacturers can be invited as guest speakers to conduct sessions on Agrotextile that will help mitigate any tutorial shortcomings on the subject of Agrotextiles. The recipients of this information will mostly be people from established farming backgrounds and institutional consumers though, and will not be the common farmers that make up majority of India's agricultural landscape.

7.9 Standards & Quality Framework

It has been highlighted in earlier sections that there is a great deal of variance regarding the various product specifications in place for agrotextiles, both in India and abroad. This is in addition to the fact that the standards and specifications are underdeveloped globally to begin with. Specifications that do not exist with the BIS are:

- Plant Net
- Harvesting Net
- Anti-Hail Net
- Turf Protection Net
- Pallet Net Cover
- Anti-Insect Net/Mesh
- Windshield Net

From the consumer standpoint it is a significant challenge to differentiate products from one another as there are no standard specifications that make the differences between products apparent. Since user awareness is low and stated requirements basic, evolution of the specifications available for most agrotextile products has been slow. The follows measures have been highlighted to address concerns regarding product quality.

7.9.1 Standards and Specifications

On the basis of our analysis, interactions with experts, the Agrotextile product specifications have been drafted below to be used as a template moving forward.

Shade Nets (as per IS 16008 : 2012)

Sr. No	Characteristic(s)	Requirements			Test Method
		Type 1 50% shading	Type 2 75% shading	Type 3 90% shading	
1	Weight/square meter (g/sqm)	Min. 100	Min. 120	Min. 140	IS 1964, ISO 7211/6
2	Avg breaking strength (raveled strip method, 325mm x 70mm [#] , (N):				IS 1969 (part 1), ISO 13934
	a) Warp way	Min. 200	Min. 250	Min. 290	
	b) Weft way	Min. 200	Min. 250	Min. 290	
3	Retention of breaking strength after UV exposure, N	Min. 85 percent of original actual value (fabric)			Annex B and IS 1969 (part 1)
4	Bursting pressure, (kg/cm ²)	Min. 5	Min. 6.0	Min. 9.0	IS 1966 - 1975
5	Haze %	Min. 15%	Min. 18%	Min. 22%	Annex C
6	Colour fastness to artificial light ^{###}	Min. 4	Min. 4	Min. 4	IS 2454 – 2008
	[#] Width after ravelling = 50 mm, Gauge length = 200 mm				
	^{###} Applicable for coloured shade nets only.				

Mulch Mat

- Specifications for 100 gsm Woven Ground Covers from Polypropylene/Polyethylene (*In process – BIS Doc.Txd 35-1089*):

Sr. No	Characteristic(s)	Requirements	Methods of Tests
1	Weight/square meter, g	100	IS 1964, ISO 7211/6
2	Thickness, mm	0.28	IS 7702, ISO 9863-1&2
3	Tensile Strength (Grab), Kgf		ISO 13934, IS 1969
	Warp way	65	
	Weft way	35	
4	Tear strength woven, kgf		IS 13937 – 1 & 2
	Warp way	30	
	Weft way	20	
5	Air Permeability, cft/ft ² /s	20	IS 11056, ISO 9237
6	Puncture Resistance, kgf Index	30	ISO 12236
7	UV Accelerated exposure testing, % strength retained	70	IS 1969
8	Water permeability lt/sq.m/sec	7	IS 14324, ISO/CD 10776, 11058
9	Water vapor permeability, g/m ² /day	730	ISO 11092

- Specifications for 50 gsm Nonwoven Ground Covers:

Sr. No	Fabric Quality	Unit	Test Results	Test Method
1	Basic Weight	GSM	50	ERT 40.3-90 (DIN 53854)
2	Thickness	DTEX	3.0	ERT
3	Tensile Strength - MD	N/5 CM	100	ERT 20.2-89 (DIN 53857)
4	Tensile Strength - CD	N/5 CM	70	ERT 20.2-89 (DIN 53857)
5	Elongation - MD/CD	%	65-100	ERT 27.2-89 (DIN 53857)
6	Air Permeability	CU M/SQR M/MIN	350-375	ERT 140.1-81 (DIN 53857)
7	UV (With % dosage for high tropical exposure conditions)	-	Compliant	UV - A tester (CEN method - European Committee for standardization)

Crop Cover/Anti-Frost Cover (In process – BIS Doc.Txd 35-1128)

- The crop covers are light in weight (generally 17-21 grams per square meter) so that the plants are not crushed under their weight.
- Upto 3.2 metres, generally 3.0 metres. With length of 400-500 m.

Sr. No	Characteristic(s)	Requirements			Test Method
		17 gsm	18 gsm	19 gsm	
1	Weight/square meter (gsm)	17	18	19	ERT 40.3-90 (DIN 53854)
2	Thickness (DTEX)	3.0	3.0	3.0	ERT 20.2-89 (DIN 53857)
3	Tensile Strength – MD (N/5cm)	28	30	32	ERT 20.2-89 (DIN 53857)
4	Tensile Strength – CD (N/5cm)	18	20	22	ERT 27.2-89 (DIN 53857)
5	UV Resistance %	< 2 %	< 2 %	< 2 %	UV-A tester (CEN method)
6	Elongation – MD/CD (%)	65-100	65-100	65-100	ERT 27.2-89 (DIN 53857)
7	Air Permeability (m ³ /m ² /min)	350-375	350-375	350-375	ERT 140.1-81 (DIN 53857)

Products lacking well defined specifications

Certain products do not have well defined product specifications globally, and there is great variation in critical properties like tensile strength, bursting strength, tear strength, elongation, etc. However the basis of our discussions with the experts, a set of characteristic properties has been proposed which will help in standardization of products for the customers and sellers.

Anti-Hail Nets

- These fabrics are made up of UV stabilized polyethylene monofilaments both woven and knitted form.
- The GSM (gram per square meter) of these nets varies from 60 to 100.

Anti-Insect Nets

- Weave: Linen
- Material: Polyethylene Mono Filament Yarns.
- Yarn diameter: 0.25mm

- Cloth density: 24epcm*11ppcm

Windshield fabrics

- Filament used: Poly Propylene Monofilament / Tape Yarns
- Weight g/sq. metre: 40-90
- Mesh size: As per the required wind blocking
- Technology used: Warp knitting

Bird Protection Net (In process - BIS New Item TXD35 – 1127)

- Bird protection nets are generally ultra-light fabrics around 25 to 40 GSM in weight. 40 to 80 GSM fabrics are also used.
- These nets are tough, durable, tear resistant and light weight.
- The regular sizes of nets available are 1, 2, 3 & 6 meters in width and 10, 20, 50 and 100 meters in length. Mesh size is 2-3cm.
- These nets are generally green, blue or white in color
- The shade percentage, which indicates the degree of shade provided by the nets, is around 20%.

Harvesting nets

- Raw material used for the harvesting nets are polypropylene monofilament / Polyethylene Tape yarns
- Harvesting nets are Warp knitted
- Flat nets of square or triangular construction, of mesh size 8 – 12 mm
- Weight is generally 40 – 90 g/sq.m.
- Woven structures of lighter weight are also used.

Fishing Nets

- Fishnets are made from Nylon or HDPE twines which could be used in mono filament form or single twines twisted together for multi filament form.
- The basic characteristics for fishnets are transparency and invisibility in water.
- The variable mesh size from 10 mm to 2,000 mm makes it ideal for its use in different areas.
- The fish net has various types of knots like single, double and U-knots.
- In case of multifilament nets, the number plies in the yarn varies from 2 to 36.
- The length and width size of the fishnets are primarily driven by customer terms & conditions. These types of nets are obtainable in 100 m, 250 m, 500 m, 600 m and 1000 m of spools.

As can be seen, Shade Nets standards have already been issued by the BIS, while Mulch Mats and Crop Covers/Anti-Frost Covers are in process. These should be expedited to completion. Additionally, development of specifications for Anti-Hail Nets, Insect Nets and Bird Protection

Nets should be taken up on priority based upon characteristics outlined in this section and expert inputs.

By and large specifications are missing for most of the non-common Agrotextile products in both India and abroad. Specifications wherever available have been consolidated, and if not available then product characteristics have been provided.

Enabling steps

- Request BIS to finalize Standard Specifications for Mulch Mats and Crop Covers/Anti-Frost Covers on priority.
- SASMIRA to study development of standards for other products, specifically Anti-Hail and Insect Nets as well as Bird Protection Nets and forward to the BIS.

7.9.2 Procurement of Agrotextiles under Subsidy to Be Limited to Standard Products or Accredited Manufacturers

Chapter 8.7 of the NHM (National Horticulture Mission) guidelines stipulates the following:

Planting material for NHM will be procured from accredited nurseries. Only when adequate planting materials not available with accredited nurseries should it be procured from other sources after fully satisfying that planting material conforms to requisite quality parameters. SHM will, however, ensure that all nurseries set up under NHM will be accredited within period of one year through designated agencies like National Horticulture Board, State Agricultural Universities, ICAR institutes etc.

A similar stipulation needs to be introduced for procurement of Agrotextiles under the various subsidy programs such as NHM, NHB, etc. The COEs like SASMIRA should carry out or take onus of manufacturer process audits and provide certification of quality compliance. The mechanism used in Turkey could be emulated for the manufacturer certification process. Subsequently material subsidised material should only be allowed to be procured from such accredited manufacturers.

Conversely, the subsidy guidelines should specify the specifications and test methods that the agrotextile products being procured should adhere to. Section 7.9.1 discusses the various standards and specifications that should or already have been adopted.

Enabling steps

- Gradual upgradation of COE to an institute covering manufacturer accreditation only after which can subsidies be availed on products from such manufacturers.
- Initially facilities are at SASMIRA and hence SASMIRA can be a starting point but in due course it can be a self-supporting body.
- Appoint a committee of experts to chart a roadmap for the same.

7.9.3 Proposed Tender Format

As highlighted in section 6.3 as well as Annexure E, F, G & H, a tender for procuring an agrotextile product should contain detailed specifications. Additionally it would be beneficial to have the test methods expected for validating the product specifications being requested. Using the international tenders cited as a template and also by talking to various manufacturers and users a sample format for specifications of agrotextile materials to be procured has been devised and can be seen below.

A sample of the specifications format/details we require is as below (this is for shade nets):

Sr. No	Characteristic(s)	Requirements	Test Method (ASTM/BIS/ISO standard number)
1	Shading %		
2	Weight/square meter (gsm)		
3	Tensile Strength (N)		
4	Bursting strength, (kg/cm ²)		
5	UV Accelerated exposure testing		
6	Light shading percentage		
7	Colour fastness to light		

It should be noted that the objective of this format is to ensure quality products are procured by focusing on these standard properties. Scope and purpose are not standard and hence not included in this template as these requirements will vary.

7.10 Initiating Application Based Research and Leveraging Cross Cutting Applications

It has been observed that typically the machinery and equipment to manufacture Agrotextiles can be used for various cross cutting applications. Consequently most Agrotextile manufacturers offer products that are not limited to the Agrotextile industry but also belong to various other technical textile industries such as Geotech, Packtech, Sporttech, Indutech, etc. Some of the most popular cross cutting products/applications are:

- Geotextiles for slope stabilization and road reinforcement
- Indutech Fabrics for Seed Processing Plants
- Protective textiles such as scaffolding and netting for construction and site maintenance
- Geomembranes for drainage applications
- Turf for sporting applications such as golf

During the study, several areas were also identified which need to be researched and cost-benefit needs to be established to stay with future market trends. These products/applications are as follows:

Polymer fibre balls as substitute for soil

A substitute for soil has been developed by DuPont. The growth medium comprises polymer fibre balls, each of which consists of randomly arranged crimped polymer fibres having a length of 0.5-60 mm. Depending on the type of polymer used, the balls may or may not be biodegradable but in any case they offer good water retention with excellent drainage, oxygenation and thermal insulation. Such fibre balls may also be used for precision sowing of seeds and application of nutrients and pesticides.

In the conventional cultivation of plants, naturally produced soil has been the medium for storing and supplying the nutrients, air and moisture necessary for raising plants. Artificial media such as peat moss, vermiculite, perlite, wood bark, sawdust, certain types of fly ash, pumice, plastic articles, glass wool and certain foams are commonly used either alone or in admixtures with each other and/or soil. However these media do not provide an optimal balance between water and the gases that can significantly influence root and total plant growth. The plants growing in such commonly used media suffer from lack of oxygen, chlorosis, slow growth, pale colour and death.

The synthetic cultivation medium provides a method of supporting plant growth which eliminates or minimizes the plant growth problems mentioned above. It also provides a plant growth medium that upon the addition of water and appropriate nutrients can be used for the germination of seeds and growth of seedlings, the vegetative propagation and growth of other plant material and the growth of plants to maturity or some other stage of growth and development. This helps in replacing all or a substantial amount of conventional materials such as normal soils, soil mixtures, clay, vermiculite, perlite, peat moss, bark wood shavings or clips, and the like, thus substantially improving water holding ability and maintaining a more optimal balance between solids, water and gases.

Screening fabrics for sunlight management

Many crops are also extremely light sensitive. Sunlight management is the process of manipulating the sunlight quality and quantity to which plants are exposed. A new generation of agrotextiles can be developed to address this problem. They would allow the grower to choose both the duration of light as well as the particular wavelength that will produce the desired effect from the plants at all stages of development.

The proposed project at SAMIRA aims to develop wide range of agrotextile screens which will reflect light and thus ripen all plants uniformly protecting them from extreme climatic conditions. SASMIRA will develop woven reflective agro ground covers with suitable reflective coatings leading to desired results. The fabrics is constructed by elastic weft and metallized polyester warp which helps to control level of sunlight, air circulation, humidity and carbon dioxide concentration for the vegetation.

Knitted hose

The hose for agricultural applications is produced on warp knitting machine based on Kemafil Technology. It helps in storing and transporting water near to plant roots for irrigation. It also helps in transporting fertilizers and other chemicals. The polyester fabric is coated with various chemicals like neoprene, Hypalon, Viton etc. The properties of these fabrics include improved temperature resistance, flame resistant, highly flexible, excellent chemical resistance, UV- and ozone-resistant, extreme compressibility, vibration proof etc.

Superabsorbent polymer fibre mats for Water management in horticulture applications

Superabsorbent polymer in the form nonwoven fibre mats help to enhance retain water, suitable for horticulture in drought-prone areas. This helps to promote emergence and growth in the plants. The advantages of these types of material include substantive and compact textile materials design, ease of handling and installation, wide range of fabric formats suitable for short and long periods of time, reduced re-watering periods and enhanced establishment times. Super absorbents are not appropriate for all applications. Where there is ample rainfall or the area receives adequate, uniform irrigation the use of super absorbents may not be justified.

Use of water retention nets coated with Superabsorbent polymer resin

Textile structures coated with SAP resin enhance water retention property to support plant growth. These types of structures are used in ground covers which help in suitable growth of the plants.

Composites of hemp or polypropylene for reducing soil pollutants

Composite of Hemp or Polypropylene nonwoven fabrics and aluminium silicate are found to be useful in protection of soil from chemical pollutants

8 Approach Recommending Future Course of Action by Various Stakeholders

Sr	Activity/ Recommendation	Responsibility	Reference Section
<u>Polymakers/Government</u>			
1	Restructuring of existing project based subsidies	Ministry of Textiles to contact NHM (National Horticulture Mission), NHB (National Horticulture Board), HMNEH (Horticulture Mission for the North East and Himalayan States) and APEDA (Agricultural and Processed Food Products Export Development Authority) and initiate process to add the following products under their subsidy schemes: <ul style="list-style-type: none"> • Mulch Mats • Anti-Insect Nets • Crop Covers • Jute Mulch Mats • Windshield Nets • Harvesting Nets 	7.5.1 7.5.2 7.5.3 7.5.4
2	Formulation of direct subsidy for Agrotextiles	Ministry of Textiles to initiate the process of implementing direct subsidy for Agrotextile by requesting funds from the Ministry of Finance. The first step could be subsidizing retailers until Aadhaar/UID is fully adopted by majority of the population upon which subsidies can be transferred directly to end users.	7.5.5
3	Special Schemes for Agrotextiles including Vulnerable Areas/ Sensitive Produces	Ministry of Textiles to initiate the process with direct subsidies for the fruits and regions identified in section 7.5.6 in the initial phase before enacting direct subsidies pan India.	7.5.6
4	Mass Awareness and Capacity Building	The Ministry of Textiles to set up marketing committee for Agrotextiles that would organize radio programs and Agrotextile POS (Point of Sale) advertising, along with other steps outlined in action item #14	7.4
5	Formation of a subsidy facilitation organization	The Ministry of Textiles should appoint the ITTA (Indian Technical Textile Association) or ATMA (Agricultural Technology Management Agency) as national subsidy facilitator seeing their existing relationships with manufacturers and the manufacturers' ability to reach out to consumers. The role of the selected organization would be to spread awareness about subsidies and to assist farmers in applying for said subsidies.	7.5.7
6	Promoting environmental friendliness through Agrotextiles	The Ministry of Textiles should approach the NHB/NHM to pitch for reduction of subsidies on plastic products such as greenhouse films and mulch films by half to make Agrotextiles more attractive. The aid of the Ministry of Environment and Forests (MOEF) can be enlisted for this initiative.	7.5.9
<u>Consumer (Farmers/Institutional Users)</u>			
1	Handbook	The Ministry of Textiles should publish the provided handbook and translate to various regional languages. Distribution should be entrusted to SASMIRA which would then leverage the NHM and NHB nodal offices. Cooperation of Ministry of Agriculture to be sought.	Annex A
2	Tender Template	Institutional users to be given tender template by the SASMIRA as well as the ATMA after review so that they can ensure procurement of quality Agrotextiles.	7.9.3

3	Standards & Quality Framework	Consumers should demand products adhering to certain standards and specifications to ensure quality products are procured. For this awareness regarding quality standards will have to be disseminated by the COEs and industry bodies.	7.9.1
Manufacturers			
1	Demonstration Projects	Manufacturers/ ATMA/ITTA/SASMIRA to sponsor and carry out demo projects.	7.2
2	Mulch Banks	Manufacturers to ascertain feasibility of Mulch Banks with local NGOs and cooperatives.	7.3
3	Manufacturing Feasibility	Project snapshots created should be distributed via Ministry of Textiles as well as ITTA to be given to prospective technical textile entrepreneurs.	5.2
4	Manufacturer Accreditation and Standards Adoption	SASMIRA to initiate manufacturer accreditation program and develop resources for facility inspection, as well as protocol for product testing. Products should adhere to standards laid out by the BIS (Bureau of Indian Standards) or global standards if BIS standard not available.	7.9.2
5	Focused Marketing and Sales	Manufacturers to target areas and produce highlighted in section 7.6. This will be encouraged by initiatives by the Ministry of Textiles such as targeted subsidies.	7.6
6	Strategic Retail Tie-Ups	Manufacturers to approach IOC/ITC and propose tie-ups to sell Agrotextiles via Kisan Seva Kendras and e-Choupal outlets. ITTA can play an assistant role in facilitating the same.	7.7
COEs/Associations			
1	Demonstration Projects	<ul style="list-style-type: none"> • ITTA to identify the 50 products/produce/ regions where pilot programs are to be conducted in the first phase which will span 2 months. • Subsequently the pilot projects shall be carried out over the next 6 months as per a predefined schedule 	7.2
2	Standards and Quality Framework	SASMIRA to follow up with the BIS in ensuring specifications standards under development are expedited and missing standards are developed as per available international specifications provided. These standards have to be included in all promotional and educational material to spread awareness amongst end users.	7.9.1
3	Initiating Application Based Research	<p>NAU (Navsari Agricultural University) to coordinate with universities and research associations for pilot studies in the identified areas that are important for future growth and parity with advanced user countries in this area</p> <ul style="list-style-type: none"> • Polymer fibre balls as substitute for soil • Screening fabrics for sunlight management • Knitted hose • Superabsorbent polymer fibre mats for Water management in horticulture applications • Use of water retention nets coated with Superabsorbent polymer resin • Composites of hemp or polypropylene for reducing soil pollutants 	7.10
4	Agricultural Insurance Premium Benefits	SASMIRA to approach the AIC (Agricultural Insurance Corporation of India) and coordinate with them to offer 80% insurance premium discount if farmers are using Anti-Hail Nets.	7.5.8
5	Mass Awareness and	<ul style="list-style-type: none"> • SASMIRA to coordinate with manufacturers, consultants and 	7.4

	Capacity Building	<p>NABARD-agridivision, and ITTA for dissemination of information regarding Agrotextiles to farmers via the Kisaan Call Centres.</p> <ul style="list-style-type: none"> • NAU (Navsari Agricultural University) and IIT-Delhi to conceive educational outreach programs and consulting services by local agricultural institutes and universities mirroring those carried out by CARDI in Cambodia • MANTRA to initiate radio programs in rural areas /radio jingles promoting agrotextiles • MANTRA to initiate advertising effort consisting of posters and promotional schemes at agricultural equipment POS (Points of Sale). • SASMIRA to assume responsibility for distribution of the Handbook on Agrotextiles (Annexure A) accompanying this report in various languages via local agriculture offices • SASMIRA to initiate development of short movies in various languages / regional and ethnic dialect to generate awareness on use of agrotextiles. It may be noted that already some of the manufacturers already have developed short movies/ documentaries, for which permissions may be taken to make minor edits & converting them in various ethnic languages. 	
6	Mulch Banks	ITTA and SASMIRA to take lead on getting buy in from manufacturers to initiate these Mulch Banks with local NGOs and cooperatives. Pilot projects can be trialled to ascertain feasibility.	7.3
7	Formation of a subsidy facilitation organization	The ITTA or ATMA should chart a strategy to leverage manufacturers' distribution networks for disbursing knowledge about NHM/NHB subsidies and resources to enable farmers to avail them.	7.5.7
8	Inclusion of Agrotextiles in Curriculum of Educational Institutions	NAU (Navsari Agricultural University) and IIT-Delhi to approach identified universities to ensure inclusion of Agrotextiles in academic curriculum and research programs along the lines of inclusion in international institutions.	6.6 7.8

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Annexure A - Handbook

Provided as an accompanying book.

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Annexure B – List of Stakeholders Interviewed & Brainstorming Sessions Conducted

S No	Activity	Date
1	Initial meeting and POC established with MANTRA	13 th June 2012
2	Initial meeting and POC established with Navsari Agricultural University for Agrotextiles	14 th June 2012
3	Meeting with Hind Fab, J. B. Packaging, C. T. M. Technical Textiles	20 th June 2012
4	Meeting with Rajvi Plastotech Pvt. Ltd., Fortune Agro Net, Flora Agrotech, Vyankatesh Agrotech	22 nd June 2012
5	Contacted Dept of Agriculture & Rural Development, UK	28 th June 2012
6	Meeting with A.T.E. Enterprises	3 rd July 2012
7	Interview with Gromax – UK Agrotextile manufacturer	5 th July 2012
8	Interview with Capatex – UK technical textile manufacturer	6 th July 2012
9	Meeting with SASMIRA	10 th July 2012
10	Meeting with Everest International	12 th July 2012
11	Meeting with machinery supplier, Marfatia	12 th July 2012
12	Meeting with Mr V Kannan (VP) and Mr Akchaya Sinha (Sr Manager), Reliance Industries	13 th July 2012
13	Meeting with Garware	16 th July 2012
14	Telephonic interview with Shree Ambica Polymer	16 th July 2012
15	Meeting with Dept. of Horticulture, Pune	17 th July 2012
16	Meeting with Reliance, Pune	17 th July 2012
17	Meeting with Raviraj Enterprises	17 th July 2012
18	Meeting with Nets & Screens	20 th July 2012
19	Interview with Tex Delta, Spain	17 th July 2012
20	Meeting with Mr Sable – who is setting up cold storage in Nagpur and has an MOU with 1500+ farmers for supply of fruits and vegetables. He shared his extensive knowledge on prevalent cultivation practices.	26 th July 2012
21	Meeting with Mr Mohan Khandwekar – a food consultant who has worked with various food processing companies for procurement	26 th July 2012
22	Meeting with 15 farmers in and around Nagpur cultivating crops such as brinjal, capsicum, etc.	27 th July 2012
23	Meeting with College of Agriculture, Pune	2 nd August 2012
24	Meeting with Mr Devender Kumar, Dir Finance, ICAR	7 th August 2012
25	Meeting with Mr Nagre – Head & Principal of Horticulture, Panjabrao Deshmukh Krishi Vidyapeeth (PDKV), Akola	17 th September 2012
26	Meeting with Mr Kale – Associate Prof. , Horticulture, (PDKV), Akola	17 th September 2012
27	Meeting with Mr Pardesi – Prof., Engineering, (PDKV), Akola	17 th September 2012
28	Meeting with Ms Suchita Gupta – Ph.d student, Akola	17 th September 2012
29	Meeting with Mr G.U.Satpute – Associate Prof., Dept of Soil & Water Conservation Engineering, Akola	17 th September 2012
30	Meeting with Dr S.N.Deshmukh –Chief Scientist, Akola	18 th September 2012
31	Meeting with Dr Sameer Kade – Junior Research Assistant, Akola	18 th September 2012
32	Meeting with Dr Amit Deshmukh – Nagaarjun Medicinal Plants, Akola	18 th September 2012
33	Meeting with Mr M.P. Meshram – Pulses famer, Akola	18 th September 2012

34	Meeting with Mr B.R. Patil – Principal Scientist, Cotton, Akola	18 th September 2012
	Meeting with Dr Dudhare - Prof., Botany, Akola	18 th September 2012
35	Meeting with Mr Gaurkar, Farmer, Nagpur	19 th September 2012
36	Meeting with Dr S.K. Pandey – Principal Scientist, Jawaharlal Nehru Krishi Vishwavidyalaya (JNKV), Jabalpur	21 st September 2012
37	Meeting with Dr S. B. Agarwal - (JNKV), Jabalpur	21 st September 2012
38	Meeting with Dr (Smt.) S. Rao – Professor & Head, (JNKV), Jabalpur	21 st September 2012
39	Meeting with Dr P.K. Jain – Professor & Head, (JKNV), Jabalpur	21 st September 2012
40	Meeting with Dr H.C. Patel - Head & associate professor, Anand Agriculture University (AAU), Gujarat	28 th September 2012
41	Meeting with Dr A.C.Sadhu - Professor, Agronomy, AAU	28 th September 2012
42	Meeting with Dr H. R. Kher – Research Scientist, Vegetable, AAU	28 th September 2012
43	Meeting with Dr M. V. Patel, AAU	28 th September 2012
44	Meeting with Dr L.R. Verma – Prof., Head & Dean, Horticulture, Sardarkrushinagar Dantiwada Agricultural University (SDAU), Palanpur	3 rd October 2012
45	Meeting with Dr R. R. Patel – Directorate Research Head, SDAU	3 rd October 2012
46	Meeting with Dr Piyush Verma – Associate Prof., Horticulture SDAU	3 rd October 2012
47	Meeting with Dr Patel - Associate Prof. SDAU	3 rd October 2012
48	Meeting with Mr Sarkar – Director, Horticulture, Tripura	8 th October 2012
49	Meeting with Mr K R Das – Deputy Director, Horticulture, Tripura	8 th October 2012
50	Meeting with Dr R.S. Patil – Dean, Horticulture, Mahatma Phule Krishi Vidyapeeth (MPKV), Rahuri	12 th October 2012
51	Meeting with Dr Ranpise – Head, Horticulture, MPKV	12 th October 2012
52	Meeting with Dr A.D. Tumbhare – Agronomy, MPKV	12 th October 2012
53	Meeting with Mr Amol Shirsagar – Junior Research Assistant, MPKV	12 th October 2012
54	Meeting with Ms Manisha Khair - Assistant PGI Farm, MPKV	12 th October 2012
55	Meeting with Dr Bhalekar – Senior Vegetable Breeder, MPKV	12 th October 2012
56	Meeting with Dr Narendra Firke – Principal Investigator of Precision Farm, MPKV	12 th October 2012
57	Meeting with Dr Ravi P. Anhdade – Doctor of Philosophy, Agronomy, MPKV	12 th October 2012
58	Meeting with Yogesh Khare, Manager of Badve Engineering Ltd. Pune	13 th October 2012
59	Meeting with ITTA and ITTA members, Mumbai	19 th October 2012
60	Meeting with Dr P.B. Kale, Director, MGIRI, Wardha	22 nd October 2012
61	Meeting with Mr U. R. Khobragade, Asst. Principal, PKV, Nagpur	22 nd October 2012
62	Meeting with Mr S.N. Katkar, Head, Taluka Agriculture Office (TAO), Nagpur	23 rd October 2012
63	Meeting with Mr R.S. Surmare, Agriculture Officer, Taluka Agriculture Office (TAO), Nagpur	23 rd October 2012
64	Meeting with Mr Sandeep Kute, Asst. Agriculture Officer, Taluka Agriculture Office (TAO), Nagpur	23 rd October 2012
65	Meeting with Mr Girish Dod, Farmer, Nagpur	23 rd October 2012
66	Meeting with Mr N.V. Gaukar, Asst. Agriculture Officer, Taluka Agriculture Office (TAO), Saoner	23 rd October 2012
67	Meeting with Dr R.A. Kaushik Head & Professor of horticulture, Maharana Pratap University of Agriculture & Technology (MPAUT), Udaipur	1 st November 2012

68	Meeting with Mr Sanjay Acharya PHD. Student, MPAUT, Udaipur	1 st November 2012
69	Meeting with 30 Farmers during their training in MPAUT, Udaipur	1 st November 2012
70	Meeting with Mr Narendra Kumar Agriculture Programmer Officer, Bhartiya Agro Industries Foundation (BAIF), Chittaurgarh	1 st November 2012
71	Meeting with Ms Seema Bammi, Secretary to Principal, Horticulture, ICAR, Delhi	5 th November 2012
72	Meeting with Mr Udai Gosain, Sr. Manger - CEO Office, Head – Sustainability Initiatives & Business Excellence, Gurgaon	6 th & 7 th November 2012
73	Meeting with Dr Vishwas, Senior Scientist, ICAR, Delhi	8 th November 2012
74	Meeting with Dr A.K. Sharma, Head & Professor, Centre for Agri Tech, Indian Agricultural Research Institute (IARI), Delhi	8 th November 2012
75	Meeting with Dr Pritam Kalia, Head & Professor, Vegetable Breeding, IARI, Delhi	8 th November 2012
76	Meeting with Dr Raj kumar, Principal scientist & In charge, Centre of Protected Cultivation Technology, IARI, Delhi	9 th November 2012
77	Meeting with .Dr S. S. Sindhu, Scientist, Floriculture, IARI, Delhi	9 th November 2012
78	Meeting with Dr A. K. Singh, Senior Scientist, IARI, Delhi	9 th November 2012
79	Meeting with Dr Shiv Prasad, Senior Scientist, Environment Sciences, Delhi	9 th November 2012
80	Meeting with Mr A R Venkatramanan, Consultant	9 th November 2012 1 st February 2013 3 rd February 2013 9 th February 2013 2 nd May 2013
81	Meeting with Mr Tarse, Technical Agriculture Officer, SAO, Nagpur	16 th November 2012
82	Meeting with Mr Bagde Junior Asst in Horticulture, SAO, Nagpur	16 th November 2012
83	Meeting with Mr Bala Virudkar Area Advisor, SAO, Nagpur	16 th November 2012
84	Meeting with Mr Lahod, Technical Officer, SAO, Nagpur	16 th November 2012
85	Interview with Prof Dr Bulent Ozipek, Coordinator of Textile Development and Marketing Program, Istanbul Technical University, Turkey	20 th December 2012
86	Meeting with Dr Manisha Mathur, Assistant Director, SASMIRA	24 th December 2012
87	Interview with Mr Shaligram Ganpatrao Chafle, Farmer, Rehaki, Wardha	26 th December 2012
88	Interview with Mr Rajendra Dhudhane, Farmer, Wardha,	26 th December 2012
89	Interview With Mr Rajeev Jagtap, Filberts Industries Ltd, Nagpur	26 th December 2012
90	Interview with Mr J K Gupta, Scientist C, Textiles, Bureau of Indian Standards, Delhi	28 th December 2012 25 th November 2013
91	Meeting with Dr Pitam Chandra, Director, CIAE Bhopal	29 th December 2012
92	Meeting with Mr Subodh Shah, Marketing Manager, Gujarat Agro Industries Corporation, Ahmedabad	2 nd January 2013
93	Interview with Mr Hemesh Patel, Officer (Field Coordination), Gujarat Green Revolution Company Ltd, Vadodara	3 rd January 2013
94	Interview with Mr Anil Kumar, SHB Nashik	3 rd January 2013
95	Interview with Mr Hanmante, Horticulture SAO, Nagpur	3 rd January 2013
96	Interview with Mr Anand Zambare, Vice president, Essen Multi Pack Ltd Rajkot	7 th January 2013

97	Interview with Mr Yeshwant Gharpode, Director, Flora Agro Importers, Pune	8 th January 2013 24 th January 2013
98	Interview with Mr Amit, Jvishwas Enterprises, Pune	8 th January 2013
99	Interview with Mr Rajeeb Roy, Agri Plastech, Bengaluru	8 th January 2013
100	Meeting with Mr Borade, NHM, Thane	8 th January 2013
101	Interview with Mr Rajesh Gupta, Baldev Traders, Chandigarh	24 th January 2013
102	Interview with Mr S.A. Manikandaraja, Dhanya Traders, Tamil Nadu	24 th January 2013
103	Interview with Mr Mangesh, Panchanathan Sons, Tamil Nadu.	24 th January 2013
104	Meeting with 9 farmers in and around Nasik cultivating crops such as grapes, tomato, etc.	30 th June 2013
105	Mr Yoram Kapulnik, Researcher, Plant Sciences, ARO Israel	17 th July 2012
106	Olga Tarnopolski, Dy Director, Kidum-R&D, ARO Israel	2 nd August 2012
107	Yoshie Osumi, Ministry of Economy, Trade & Industry (METI), Japan	12 th July 2012
108	The Textile Institute, UK	3 rd July 2012
109	Dvora Tsarsati, Ministry of Industry, Trade & Labour, Israel	13 th August 2012
110	David Ashkenazy, BD Head, ARGOS (Agri Products) Israel	22 nd November 2013
Brainstorming Sessions		
(i)	Mr M K Talukdar, Dr Desai, Mr V Kannan, Mrs Deepa Raisinghani,	28 th August 2012
(ii)	Professors & Scientists of Panjabrao Deshmukh Krishi Vidyapeeth (PDKV), Akola	17 th September 2012
(iii)	Professors & Scientists of Jawaharlal Nehru Krishi Vishwavidyalaya (JNKV), Jabalpur	21 st September 2012
(iv)	Professors & Scientists of Anand Agriculture University (AAU), Gujarat	28 th September 2012
(v)	Professors & Scientists of Sardarkrushinagar Dantiwada Agricultural University (SDAU)	3 rd October 2012
(vi)	Professors & Scientists of Mahatma Phule Krishi Vidyapeeth (MPKV), Rahuri	12 th October 2012
(vii)	Meeting with ITTA and 10-15 of its members	19 th October 2012
(viii)	Officers of Taluka Agriculture Office (TAO), Nagpur	23 rd October 2012
(ix)	Professors & Scientists of Maharana Pratap University of Agriculture & Technology (MPAUT), Udaipur	1 st November 2012
(x)	Professors & Scientists of Indian Agricultural Research Institute (IARI), Delhi	9 th November 2012
(xi)	Meeting with the TXC and committee members	9 th May 2013
(xii)	Meeting with the TXC and committee members	15 th November 2013

Annexure C - Assumptions for Manufacturing Feasibility

ASSUMPTIONS - WARP KNITTED TEXTILES		
1	No. of Working Days / Annum	312
	Shifts/day	3
	No. of Working Hours / Shift - Spinning, weaving & Processing	12
2	Capacity Utilisation	
	Ist Year	65%
	IInd Year	75%
	IIIrd Year	80%
3	Cost of Power from S. E. B. - Rs per Unit	7.0
	*Cost of Water - Rs. per m ³	25.0
4	Power Load Factor	0.65
5	Cost of Land in Rs. Lakh Per Acre	70
	Land Developing Cost in Rs. Lakh Per Acre	-
6	Consumable Stores and Spares	
	Sizing chemical cost/kg	-
	Cost in INR per loom per shift	-
7	Fuel For Boiler (Coal) Rs./Ton	-
8	Packing & Transport	
	Packing & Transport Cost for Export Fabric in Rs. Per Meter	0.50
	Packing & Transport Cost for Domestic Fabric in Rs. Per Meter	1.00
9	Labour Wages - Rs per Month	
	Labour Wages - Rs per Month	7,000
	Fringe Benefits	10%
10	Fringe Benefits For Staff and Supervisors	10%
11	Repairs and Maintenance	

	% of machinery cost	2.0%
	-% Of Building Cost	1.0%
	- % Of Utilities Cost	1.0%
12	Administrative Expenses	
	% of Sales Turnover	2%
13	Interest on Term Loan -	
	- Rupee Loan @	13.00%
	Interest on Working Capital @	13.50%
14	Interest during construction period in No. of months	-
15	Guarantee Commission	0.5%
16	L.C. Charges @ foreign exchange	1%
17	Insurance During Construction Period	0.1%
18	Selling Expenses - Rs/ sq. meter	2
19	Stock requirements in Days	
	Raw Materials	30
	Consumable Stores & Spares	30
	Packing Material	15
	Finished Goods	7
	Work In Progress	15
	Creditors	30
	Debtors	60
	Factory Overheads (Wages, Salaries & Utilities)	30
20	Exchange Rates as on 16.05.12	
	Exchange Rates	
	1 US \$	55.0
	1 Euro	68.0
	1 Pound	85.0
	1 CHF	55.0
	1 JPY	0.71
21	Selling Market	
	Fabric - Domestic%	100%

	Fabric - Export%	0%
21	Selling Prices in INR per Sq. meter	
	Fabric - Sort 1	22
	Fabric - Sort 2	-
	Waste	
	Hard Waste Rs./Kg	15
22	Raw Material cost Rs/Kg	
	HDPE granuals	110
	Master batch	324
	UV	365
	Calcium carbonate	40
23	Imported Machines	
	Import Duty (EPCG)	22.50%
	CIF Charges	3.0%
	Clearing, Forwarding, Local Transport, Insurance & Erection	2.0%
24	Indigenous Machines	
	Excise Duty (EPCG)	12.36%
	CST/VAT	2.0%
	Transport, Insurance, Erection, Etc.	1.0%
25	MFA imported	
	Import Duty (EPCG)	22.50%
	CIF Charges	3.0%
	Clearing, Forwarding, Local Transport, Insurance & Erection	2.0%
26	MFA indigenous	
	Excise Duty	12.36%
	CST/VAT	2.0%
	Transport, Insurance, Erection, Etc.	1.0%
27	Corporate Tax	30.9%
28	Minimum Alternative Tax (MAT)	19.0%

29	Contingencies on	
	Non-firm Cost	5.0%
	foreign exchange fluctuations	5.0%
30	Water for Human Consumption (Liters/Person/Day)	35
31	Rate of Depreciation - SLM Method (As per companies act)	in %
	Factory Buildings	3.3
	Non-Factory Buildings	1.6
	plants and equipments	10.3
	Other Misc. Fixed Assets	10.3
	Furniture and Fixtures	6.3
	Cars and Vehicles	9.5
32	Rate of Depreciation (WDV) As per IT Act	
	Factory Buildings	10.0
	plants and equipments	15.0
	Other Misc. Fixed Assets	15.0
	Furniture and Fixtures	10.0
	Cars and Vehicles	15.0
33	Moratorium Period (in Quarters)	8
	Installment Period (in Quarters)	28
34	Equity %	35%
	Debt %	65%

ASSUMPTIONS - WOVEN AGROTEXTILE		
1	Shift/ day	3
	No. of Working Days / Annum	350
	No. of Working Hours / Shift	8
2	Capacity Utilisation	
	Ist Year	50%
	IInd Year	60%
	IIIrd Year	75%
3	Cost of Power	6
	Cost of Coal - Rs per Ton	6000
	Cost of Water - Rs.per m3	15
4	Consumable Stores and Spares	
	- % of Machinery Cost	1%
5	Packing & Transport	
	Packing Cost Rs per Kg	4
	Transport Cost Rs per Kg	10
6	Labour Wages - Rs per Day	
	Skilled	240
	Semi Skilled	220
	Un-Skilled	200
	Fringe Benefits - For first 3 Years	36%
	From fourth year onwards	40%
7	Repairs and Maintenance	
	- % Of Machine Cost	2%
	- % Of Building Cost & Utilities	2%
8	Administrative Expenses	
	% of Sales Turnover.	2.0%
9	Interest on Term Loan -	
	- Rupee Loan (Government Bond) @	13.5%
	-Interest on Working Capital @	13.5%
10	Selling Expenses as % of Sales Turnover	
	Selling Expenses	3.0%
	Selling Commission	5.0%
11	Product Development & Sampling	5.0%

12	Exchange Rates - as on 11/10/12	
	1 US \$	52.75
	1 Euro	67.95
	1 Pound	84.49
	1 CHF	56.26

ASSUMPTIONS - NONWOVEN AGROTEXTILE		
1	No. of Working Days / Annum	
	3 Shifts/Day	350
	No. of Working Hours / Shift = 8 Hours	
2	Capacity Utilisation	
	Ist Year	70%
	IInd Year	80%
	IIIrd Year	90%
3	Cost of Power	6
	Cost of Coal - Rs per Ton	6000
	Cost of Water - Rs.per m3	15
4	Consumable Stores and Spares	
	- % of Machinery Cost	1%
5	Packing & Transport	
	Packing Cost Rs per Kg	4
	Transport Cost Rs per Kg	10
6	Labour Wages - Rs per Day	
	Skilled	240
	Semi Skilled	220
	Un-Skilled	200
	Fringe Benefits - For first 3 Years	36%
	From fourth year onwards	40%
7	Repairs and Maintenance	
	- % Of Machine Cost	2%
	- % Of Building Cost & Utilities	2%
8	Administrative Expenses	
	% of Sales Turnover.	2.0%

9	Interest on Term Loan -	
	- Rupee Loan @	13.5%
	-Interest on Working Capital @	13.5%
10	Selling Expenses as % of Sales Turnover	
	Selling Expenses	3.0%
	Selling Commission	5.0%
11	Product Development & Sampling	5.0%
12	Exchange Rates - as on 12/10/2012	
	1 US \$	52.75
	1 Euro	67.95
	1 Pound	84.49
	1 CHF	56.26

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Annexure D - National Horticulture Board (NHB) Incentives

Scheme: Development of Commercial Horticulture through Production and Post-Harvest Management of Horticulture Crops

Description of Components

- I. Production related components** - Credit linked projects relating to establishment of hi-tech commercial production units involving any of the following items are eligible for assistance under this component:
- i. High quality commercial horticulture crops
 - ii. Indigenous crops / produce, herbs, spices
 - iii. Aromatic and medicinal plants
 - iv. Seed and nursery
 - v. Bio-Technology, micro-biology, bio-chemistry, bio-diversity and tissue culture
 - vi. Protected cultivators
 - vii. Bio-pesticides
 - viii. Organic fertilizers, organic foods, bio-dynamic farming and vermi-compost
 - ix. Establishment of horticulture health clinics / laboratories
 - x. Hydroponics and aeroponics
 - xi. Beekeeping and its products
 - xii. Mushrooms and its products
 - xiii. Nuts and its products

Pattern of Assistance

Credit linked back-ended subsidy @ 20% of the total project cost limited to Rs 25 lakh per project in general area and Rs 30 lakh in NE Region, Hilly and Scheduled areas. However, for capital intensive and high value crops under protected cultivation and open air cultivation of date palm, olive and saffron subsidy will be @ 25% of project cost with ceiling of Rs 50 lakh (33% of project cost with ceiling of Rs 60 lakh for scheduled and hilly areas).

General Conditions

- i. The above assistance shall be available for projects covering area above four hectares (above 10 acres) in case of open cultivation, and more than 1000 sq. meter in case of protected cultivation.
- ii. Credit component as means of finance of the project should be term loan from banking or non-banking financial institutions and should be at least 15 % more than the admissible rate of subsidy.
- iii. Projects relating to setting up of new production units shall be appraised to ensure and enable entrepreneur to incorporate essential hi-tech components in the form of planting material, plantation, irrigation, fertigation, precision farming, on farm PHM/ primary

processing related infrastructure, GAP etc.; and to that extent, the project shall be integrated in nature.

iv. Normative cost of various components shall be prescribed by NHB.

II. Post-Harvest Management (PHM)/Primary Processing (PP) related components - Credit linked projects involving the following items are eligible for assistance under this component:

- i. Washing, drying, sorting, grading, waxing, packing, palletizing, freezing units etc.
- ii. Pre-cooling units / Cool Stores
- iii. Reefer Van / Containers
- iv. Specialized Transport Vehicle
- v. Retail outlets
- vi. Auction platform
- vii. Ripening / curing chamber
- viii. Market yards / rope ways
- ix. Irradiation / Vapour Heat Treatment unit
- x. Primary processing of products (fermentation, extraction, distillation, juice vending, pulping, dressing, cutting, chopping, dehydration etc.)
- xi. Natural colour and dyes extraction
- xii. Essential oils, perfumery and cosmetics out of horticulture products
- xiii. Products out of horticulture waste
- xiv. Horticulture ancillary industry for promoting indigenous manufacturing of horticulture related farm tools & machinery, equipment, plastic containers, packaging etc.
- xv. Adoption of Quality Assurance Systems (HACCP, TQM, ISO, Euro-GAP etc.)
- xvi. Plastic crates and bins, cartons, aseptic packaging and nets

Pattern of Assistance

Credit linked back-ended subsidy @ 40% of the total project cost limited to Rs 50 lakh per project in general area and @ 55% of project cost limited to Rs 60.00 lakh in Hilly and Scheduled areas. Pattern of assistance for plastic crates will be 50% of the total cost.

General conditions for PHM/PP projects

- i. Primary Processing and Post-Harvest Management related projects shall be implemented either as on-farm projects linked with individual projects of area expansion of commercial horticulture or as a common facility for cluster of new projects of commercial horticulture and existing orchards / farms. Projects relating to introduction of new plant/ machinery/ equipment to effect automation, introduction of latest processing technology etc. in existing PHM infrastructure may also be considered; however, components covered by regular repairs & maintenance and replacement of old plant & machineries on attaining near zero book value is not to be incorporated. PHM components such as pack-house will be eligible

- for enhanced rate of subsidy only when infrastructure is as per prescribed level of technology, if any.
- ii. Subsidy @ 50% as per prescribed norms will be available for crates and nets (shade and anti-hail only) in integration with commercial horticulture projects of production as one time assistance. Subsidy for crates shall be released only after its actual purchase at appropriate stage, which shall be at stage of fruiting / harvesting. Accordingly, release of subsidy for crates shall be made separately at appropriate stage later.
 - iii. As financial assistance for plastic crates / bins is given at producers' end itself and it is aimed to increase producer's share in consumer-end price of horticulture produce; assistance for plastic crates / bins shall be considered along with a new, credit-linked project of pack-house / ripening or curing chamber / cold storage unit/ primary processing unit or their suitable combination when Producers' Company / Registered Growers Association / PSU is the promoter of such projects. The proposal shall be considered on merit in view of business model of the project, stocking & stacking system and actual need. But for this, the crates must be integral part of fixed capital investment under such credit linked projects and should be appraised by the lending Bank accordingly. Committee of NHB shall formulate formula for assessing admissible number of crates / bins in respect of any such project.
 - iv. Shade nets and anti-hail nets shall be considered as one time assistance for credit linked project for the benefit of existing commercial horticulture projects of fruit orchards qualifying area norm of above 4 Ha. Assistance in case of CFB Cartons, Aseptic Packaging, Punnets / Poly bags etc. shall be available on merit for launching a new horticulture product during its first year and for introduction of horticulture products in a market as one time assistance.
 - v. Benefit of exclusive components of cold storage scheme shall also be available to the promoters over and above the assistance that will be provided under Commercial Horticulture Scheme to set up integrated projects for production and PHM components.
 - vi. Selection of units for promotion of indigenous manufacturing of items covered by item II (xiv) shall be decided on merits by a Committee of NHB.
 - vii. Credit component as means of finance of the project should be term loan from banking or non-banking financial institutions and should be at least 15 % more than the admissible rate of subsidy.
 - viii. Projects relating to setting up of new production units shall be technically and financially appraised to ensure and enable entrepreneur to incorporate latest available technology to take care of quality of produce, economy in cost of production, energy saving, safety and environmental concerns.

- ix. Projects under this scheme component may be integrated as part of new Production Related projects or in integration with existing Production Related projects set up with or without assistance under NHB schemes and falling under category of Production related Components; certain components may be on-farm and other may be off-farm; in addition, such projects may be set up by a service provider/ trader / processors with proper backward linkage with production of fresh horticulture produce.
- x. Normative cost for various components shall be prescribed by NHB from time to time.

Production Related - Hi-tech Commercial Production of Vegetables in Open Field

Component	Pattern of Assistance
Tunnel net/shade net for production of seedling etc.	@ Rs. 250/ per sq m, as per requirement, if undertaken on project land

Annexure E – Rajasthan Horticulture Development Society Tender for PP Nonwovens for Low Tunnels

**Rajasthan Horticulture Development Society
Directorate of Horticulture, Pant Krishi Bhawan, Jaipur (Rajasthan)**

F.21() DH/NHM/Plastic Tunnel/2010-11/

Dated:

Expression of Interest for empanelment to supply of polyethylene plastic sheet & poly propylene non woven sheets for making low tunnels/ plastic tunnels/ walk in tunnels under NHM/RKVY during 2010-11 & 2011-12

The Rajasthan Horticulture Development Society invites EOI/ proposals for empanelment to supply of Polyethylene plastic sheet & poly propylene non woven sheets for making low tunnels/ plastic tunnels/ walk in tunnels from reputed Manufacturer/ Companies/ Firms/ Authorized Dealers of companies under NHM/RKVY 2010-11 & 2011-12.

Applications for Empanelment of the interested firms/manufacturers/ authorized dealers may be obtained by paying Rs. 100 in favour of "Mission Director, Rajasthan Horticulture Development Society, Jaipur (Rajasthan)" through cash or DD. The document may be downloaded for the website www.rajasthankrishi.gov.in and may be submitted with a bank draft of Rs. 100/- . The EOI can be submitted within office time of working day.

Applications for Empanelment in envelope duly super-scribed "Application for Empanelment for supply of plastic sheets" under NHM/RKVY addressed to the Mission Director, Rajasthan Horticulture Development Society, Jaipur should be submitted in Room No. 302, Directorate of Horticulture, Pant Krishi Bhwan, jaipur.

**Mission Director
Rajasthan, Jaipur**

**Rajasthan Horticulture Development Society,
Horticulture Directorate, Pant Krishi Bhawan, Jaipur**

**APPLICATION FORM FOR EMPANELMENT OF FIRMS/ MANUFACTURERS/
AUTHORIZED DEALERS FOR SUPPLY OF POLYTHEEN PLASTIC SHEET & POLY
PROPYLENE NON WOVEN SHEETS FOR MAKING LOW TUNNELS/ PLASTIC
TUNNELS/WAL IN TUNNELS FOR THE YEAR 2010-11 & 2011-12 UNDER NHM/RKVY.**

1.	Name & address of the Company											
2.	Address for the correspondence											
3.	Address of factory											
4.	Local address & telephone of concerned person & e-mail											
5.	RST/CST registration & date											
6.	Income Tax Pan No.											
7.	District wise authorized agent network (If available)											
8.	Detailed Product Specification	Type of sheet	Polyethylene plastic sheet					Polypropylene non woven sheet				
		GSM	30	40	50	70	100	20	25	30	50	
		Size (L x W)										
		Micron										
		Colour										
		Made Up of Nos.										
		Rate Per Sq. Mtr. for FOR supply to District Head Quarter										

11. Details of fees deposited

S.No.	Particulars	DD No.	Date	Validity	Bank	Remarks
1.	Reg. Fees (Rs. 5000/-) Non-refundable					
2.	Bank Guarantee (Rs. 50,000/- up to 31.03.2012)					

Certified that above said informations are true to best of our knowledge.

Place
Date

Signature of competent authority
Name/Designation

Expression of Interest for empanelment to supply of polyethylene plastic sheet & poly propylene non woven sheets for making low tunnels/ plastic tunnels/ walk in tunnels under NHM/RKVY during 2010-11 & 2011-12

- **Application fee:-**

Rs. 100/- (Rs. One hundred only) by cash or DD in favour of Mission Director, Rajasthan Horticulture Development Society, Jaipur.

- **Registration fee:- (Non Refundable)**

Rs. 5000/- (Rs. Five Thousand only) by DD in favour of Mission Director, Rajasthan Horticulture Development Society, Jaipur.

- **Bank Guarantee :- Rs. 50000/- (Rs. Fifty Thousand only)**

Validity of Bank guarantee = 31/03/2012 (Performa enclosed) in the name of Mission Director, Rajasthan Horticulture Development Society, Jaipur.

- **Last date of submission of offers:- Upto 31-03-2011**

- **Specifications:-**

GSM	-	Polyethylene plastic sheet- 30, 40, 50, 70, 100
	-	Polypropylene non-woven sheet- 20, 25, 30, 50
Color	-	White
Type	-	Polyethylene plastic sheet - Transparent U.V. Stabilizer
	-	Polypropylene non-woven sheet - Translucent U.V. Stabilizer
Size	-	As per company manufacture detail

- **Supply is to be made at Districts Headquarter.**

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Annexure F - Manjra Farm Centre Tender for Skirting Bags

तातुम्ब्यातील मुपटा येथील विवाहितेस आत्महत्या करण्यास प्रवृत्त केल्याप्रकरणी नवव्यास सह सामू सास-बा विरुद्ध अजिंठा पोलिस ठाण्यात गुन्हा दाखल करण्यात आला आहे.

सिद्धोड तातुम्ब्यातील खुपटा येथील मिनबाई वित्तास कुन्हाडे (२८) ही विवाहिता १. मार्चला जवळी होती. तिला उपचारासाठी औरंगाबाद येथील आश्विन हॉस्पिटल येथे दाखल करण्यात आले असता उपचारादरम्यान सोमवारी दुपारी २ वाजेच्या सुमारास तिची प्राणज्योत मालवली.

at KVK, Latur. The details can be downloaded from www.kvklatur.com and submit on or before 26.03.2012

Sd/-
Programme Co. ordinator
Krishi Vigyan Kendra, Latur
Addli. MIDC Plot No. 160, Vilasnagar, Latur
Tq. Dist. Latur - 413 531

मांजरा कृषि विज्ञान केंद्र, लातूर

आत्मा अंतर्गत केळीमध्ये स्कर्टिंग बॅगचा वापर करणे या प्रयोगासाठी नामांकित संस्थेकडून स्कर्टिंग बॅगचा पुरवठा करण्यासाठी निविदा मागविण्यात येत आहेत. सदरील निविदा दिनांक : २६.०३.२०१२ पर्यंत प्राप्त होणे बंधनकारक राहिल.

स्वाक्षरित/-
कार्यक्रम समन्वयक,
मांजरा कृषि विज्ञान केंद्र, लातूर
प्लॉट नं. पी-१६०, अतिरिक्त एमआयडीसी.,
विलासनगर, लातूर ४१३५३१

50k pcs
50% subsidy

परिचयः
२. वस्तुनूत आहारात्मक दुग्धदायीवाक्याच्या सौी आहारात्मिक कृपाण अ
३. ऑनलाईन अर्ज
४. जेकेमधील परीक्षा रूत
५. आयुगाच्या वेब
नुंबरः
दिनांक : २१ मार्च, २०१२

अ. क्र.	
१	गाहिरात क्रमांक : १
२	गाहिरात क्रमांक : २
३	गाहिरात क्रमांक : ३ (अभियांत्रिकी), गट अ/महा संशोधन, अ
४	गाहिरात क्रमांक : ४
५	गाहिरात क्रमांक : ५ प इतर परे, गट अ.
६	गाहिरात क्रमांक : ६
७	गाहिरात क्रमांक : ७ अद्ययावत (विधी), ग
८	गाहिरात क्रमांक : ८
९	गाहिरात क्रमांक : ९ गट अ

(१) आयुगाच्या कार्यालयक इलेक्ट्रॉनिक साधने आयुगा

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Annexure G - Jamaica Greenhouse Tender Specimen

ANEXE II:

NETS DESCRIPTION

JAMAICAN GREENHOUSES DESIGNS

IICA

NET 10 x 16

TYPE > PROTECTIVE > 10 X 16
PRIMARY MATERIAL > PTAD
COLOR > CRISTAL / BLACK
DIAMETER OF THREAD > 281.1 MICRONS
VARIATION COEFFICIENT > 3.60%
WEIGHT > 137.9 GRAMS
LIGHT TRANSMISSION OF WHITE COLOR > 80%
LIGHT TRANSMISSION OF BLACK COLOR > 45%
SHADE NET - WHITE THREAD > 20%
SHADE NET - BLACK THREAD > 55%
GUARANTEE > 5 YEARS SOUTHWEST SPAIN
POROSITY > 36.60%
PASAJE O FAIR > 48.50%
REDUCTION > 51.50%
SHAPE OF PORE > RECTANGLE
DIAMETER OF PORE > 311 MICRONS
VARIATION COEFFICIENT > 6%
AREA OF PORE > 0.212 MM2
WIDTH > 309.9 MICRONS
LENGTH > 685.7 MICRONS
PARALLELOGRAMS > 5.50%
TRAPEZIUMS > 20.60%
TRAPEZOIDS > 73.90%
THREAD TENSILE STRENGTH / KG > 1
WARP > 1.810 KG.
WEFT > 1.041 KG.
WIDTHS > 1-1.5-2-2.5-3-3.5-4-5 M. (OTHER MEASUREMENTS MADE TO ORDER)
LENGTHS > 100 M. (OTHER MEASUREMENTS MADE TO ORDER)
MARGIN OF ERROR IN MEASUREMENTS > 3%

JAMAICAN GREENHOUSES DESIGNS

I I C A

NET 6 x 6

TYPE > PROTECTIVE > 6 X 6
PRIMARY MATERIAL > PTAD
COLOR > WHITE/BLACK GREEN
DIAMETER OF THREAD > 297.6 MICRONS
VARIATION COEFFICIENT > 4.50%
WEIGHT > 73.2 GRAMS/M ²
LIGHT TRANSMISSION OF WHITE COLOR > 90%
LIGHT TRANSMISSION OF BLACK COLOR > 70%
SHADE NET – WHITE THREAD > 10.00%
SHADE NET – BLACK THREAD > 30%
GUARANTEE > 5 YEARS SOUTHWEST SPAIN
POROSITY > 69.30%
PASAJE O FAIR > 86%
REDUCTION < 14%
SHAPE OF PORE > SQUARE
DIAMETER OF PORE > 1444.5 MICRONS
VARIATION COEFFICIENT > 1.50%
AREA OF PORE > 2.167 MM ²
WIDTH > 1.470,5 MICRONS
LENGTH > 1.474 MICRONS
PARALLELOGRAMS > 2.80%
TRAPEZIUMS > 11.10%
TRAPEZOIDS > 86.10%
THREAD TENSILE STRENGTH / KG > 1.3
WARP > 746 KG.
WEFT > 746 KG.
WIDTHS > 1-1.5-2-2.5-3-3.5-4-5 M. (OTHER MEASUREMENTS MADE TO ORDER)
LENGTHS > 100 M. (OTHER MEASUREMENTS MADE TO ORDER)
MARGIN OF ERROR IN MEASUREMENTS > 3%

MSC FÁBRICAS AGRÍCOLAS, S.L.

JAMAICAN GREENHOUSES DESIGNS

IICA

NET 10 x 20

TYPE > PROTECTIVE > 10 X 20
PRIMARY MATERIAL > PTAD
COLOR > CRISTAL / BLACK
DIAMETER OF THREAD > 252 MICRONS
VARIATION COEFFICIENT > 3.30%
WEIGHT > 140 GRAMS
LIGHT TRANSMISSION OF WHITE COLOR > 76%
LIGHT TRANSMISSION OF BLACK COLOR > 28.50%
SHADE NET – WHITE THREAD > 24%
SHADE NET – BLACK THREAD > 61.50%
GUARANTEE > 5 YEARS SOUTHWEST SPAIN
POROSITY > 37.90%
PASAJE O FAIR > 41.8 5
REDUCTION < 58.20%
SHAPE OF PORE > RECTANGLE
DIAMETER OF PORE > 255.8 MICRONS
VARIATION COEFFICIENT > 7%
AREA OF PORE > 0.199 MM2
WIDTH > 253.9 MICRONS
LENGTH > 784.3 MICRONS
PARALLELOGRAMS > 9.20%
TRAPEZIUMS > 54.40%
TRAPEZOIDS > 36.40%
THREAD TENSILE STRENGTH / KG > 1.3
WARP > 2562 KG.
WEFT > 1261 KG.
WIDTHS > 1-1.5-2-2.5-3-3.5-4-5 M. (OTHER MEASUREMENTS MADE TO ORDER)
LENGTHS > 100 M. (OTHER MEASUREMENTS MADE TO ORDER)
MARGIN OF ERROR IN MEASUREMENTS > 3%

MSC FÁBRICAS AGRÍCOLAS, S.L.

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Annexure H - Armenia Anti-Hail Net Specification

UNDP Armenia: E-Procurement - <http://operations.undp.am>



REQUEST FOR QUOTATION (RFQ) 113

NAME & ADDRESS OF FIRM: (please write company's name here)	DATE: REFERENCE: Anti-Hail nets (vineyard)
---	--

Dear Sir / Madam:
 UNDP Armenia is soliciting quotations for the items listed below.
 You can submit your signed and sealed price quotation in a closed envelope, marked RFQ - 113 to the UN security guards office at the following address, 14 Petros Adamyan street, 0010, Yerevan no later than Friday, November 18, 2011, 18:00 local time or you can apply online through UNDP website.
 For clarifications please contact to Procurement unit +374 10 566073 ext. 126 or 119.

Price quotation

#	Description	Q-ty	Supplier Offer (please provide exact model and detailed specification)	Unit Price (Currency)	Price (Currency)
1	Anti-Hail nets (vineyard) Woven Material: Virgin HDPE+ UV stab. Or High Density Polyethylene HDPE Construction: English row_ Hole dimens: 4 x 7 mm Weight: 46 gr/m2-55 gr/m2 Color: black Shade average: black color : 14% - neutral 8% Standard windth: 100cm_ 520 cm	3000			

REQUEST FOR QUOTATION (RFQ) - 113
 Anti-Hail nets (vineyard)

UNDP Armenia: E-Procurement - <http://operations.undp.am>

	Rolls: 100, 500 m Packaging: Rolls PE film wrapped Durability: 8-15 years Inflammability: inflammable at 340 °C			
	Accessories 2 Hook to fasten/fix the anti hail net (MSC)(@N: 4;O ?@8:@5?:5=8O A5B8)	2000		
	Structure having fixing options 3 Structure having fixing options in the beginning and at the end of the set (IB@C:BC@0 :>B>@00 45@68B A5BL 2 =0G0;5 8 2 .:>=F5 ;8=88)	20		
	Special equipment 4 Special equipment for lift device (1>@C4>20=85 4;O ?>4L5<0 A5B8)	50		
	Training 5 Construction Training for farmers - 2 hours	2		
Total				

CONDITIONS

Validity of Quotation	60
Delivery Duration	30
Warrant Period	12
Partial Bids	Not Allowed
Documentation Language	English
Delivery Term & Place	DDU, 14 P. Adamyan str, Yerevan, Armenia
VAT	0 % VAT applied

REQUEST FOR QUOTATION (RFQ) - 113
Anti-Hail nets (vineyard)

Annexure I - Mulch Mats: Focus Produce and Regions

STATE	AGRIPRODUCE	AGROTEXTILE RECOMMENDED
MAHARASHTRA	POMEGRANATE	MULCH MATS WOVEN AND NON WOVEN
	ORANGES	MULCH MATS WOVEN AND NON WOVEN
	BRINJALS	MULCH MATS WOVEN AND NON WOVEN
	GRAPES	MULCH MATS WOVEN AND NON WOVEN
	STRAWBERRIES	MULCH MATS-WOVEN
	GOOSEBERRIES	MULCH MATS
	BANANAS	MULCH MATS-WOVEN
GUJARAT	POTATOES	MULCH MATS-WOVEN
	PEANUTS	MULCH MATS-WOVEN/NON WOVEN
	BANANAS	MULCH MATS-WOVEN
BIHAR	LITCHI	MULCH MATS-WOVEN,
	BRINJALS	MULCH MATS-WOVEN,
	BITTER GOURDS	MULCH MATS-WOVEN,
	CUCUMBER	MULCH MATS-WOVEN,

Annexure K - Project Deliverable Compliance

Sr #	Deliverable	Report Section	Remarks
1	Comprehensive list of Agrotech products with their applications and end-users to improve quality and reduce crop damage. (Stepwise pictorial representation of each process of using agrotexiles in each application)	3.2 & Handbook	Complied - Handbook has flowcharts to illustrate process as well
2	Detailed guidelines for usage of each product of agrotexiles in India as per recent research carried out on these areas.	Handbook	Complied - Flowcharts to illustrate use also included
3	Business case for usage of Agrotech for select applications	4	Complied
4	Presentation to technical textile manufacturers to study the feasibility of indigenous manufacturing at an affordable cost.	5.2	Complied - The manufacturing feasibility snapshots have been incorporated in the report based on feedback from manufacturers
5	Details of regulatory mechanism/laws/rules for these products in India, if any.	5.3	Complied
6	Details of international bodies involved in developing measures to promote usage of Agrotexiles.	6.1	Complied
7	Specimen of tenders used for awarding contracts which have well defined specifications and guidelines for usage of Agrotech.	7.9.3	Complied
8	Standards and regulatory mechanism/laws/rules in place for the target products in place in countries like Israel, USA, Germany, Japan, UK, etc. Relevant section of such acts / rules / regulations should be cited in separate annexure to the report.	6.2 6.4	Complied
9	Comparative analysis of standardization and regulatory mechanism/laws/rules in developed countries. This will include a clear benchmarking and identification of gaps in terms of product standards and regulatory / policy interventions for Agrotech segments, between India and the countries where the market for particular products is mature and well established.	6.4 6.5	Complied
10	Guidelines/proposal for Revision of NHM (National Horticulture Mission) subsidies/inclusion of products in NHM/Implementing mechanism for NHM with proper justification	7.5.1 7.5.2 7.5.3	Complied
11	Detailed guidelines for Linkages of various Financial aids & subsidies with usage of agrotexiles to ensure better returns	7.5	Complied
12	Detailed areas for application based research for cost economics of the products to be conducted with proper justification.	7.10	Complied
13	Details of proposed special schemes for usage of agrotexiles at vulnerable areas/sensitive produces with details of implementing agency, outlay, benefit, need etc.	7.5.5	Complied
14	Areas for amending the existing Indian laws/rules/ regulations & new regulations required to be brought for mandatory usage of Agrotexiles in Indian context.	7.1	Complied
15	Details of agrotexile products to be included in the agriculture kits which are distributed to farmers on subsidized rates. Justification for inclusion should also be provided.	7.5	Complied - During meeting "kit" was deemed to mean financial incentive schemes
16	Applicable standards for each of the products in India, considering variations arising due to application segment and the end user type.	5.4 6.4 7.9.1	Complied
17	Performance standard for new Agrotexile products as per recent research carried out on these areas.	7.9.1	Complied
18	Report should also cover all the aspects of allied fields and cross-cutting applications of Agrotech segment.	7.10	Complied
19	Approach to be followed for facilitating the identified regulatory and policy changes	8	Complied
20	Benefits and cost involved for such Regulatory Measures	7.5.10	Completed

Study on Developing Measures to Promote the Use of Agrotexiles in India

21	Comments from an “advisory panel” comprising of lawyers specialized in respective areas and legal drafting of the proposed legislative changes.		Complied - Not required as no regulatory changes proposed
22	Report finalization and submission to Ministry of Textiles to take it to next level.		Complied
23	Convening series of brain storming sessions and compilation of the recommendations.	Annex B Annex K	Details of people interacted with in Annexure B and Recommendations and resolutions in Annexure K
24	Discussions with the ultimate end users & out come	Annex B	Details of people interacted with in Annexure B
25	Presentation to user Ministries, State Govt. agencies and agencies involved in decision making for enacting those recommended regulations.		Completed – Refer Annexure B for stakeholders met and meetings conducted

Responsibilities

Analysis of prevalent scenario with respect to the target areas

Sr #	Deliverable	Report Section	Remarks
The engaged Consultant will be required to conduct as “As-Is Analysis” on the above target areas for all types of products under the Agrotech sub-segment. This will essentially cover:			
1.	Current areas where agrotexiles are used	3.2 Handbook	Complied
2.	The current guidelines/procedures for various applications of agrotexiles	Handbook	Complied
3.	Current Performance standard Agrotexile products, if any	5.4	Complied
4.	The current level of standardization and regulatory mechanism/laws/rules in place in India.	5.3 5.4	Complied
5.	Need of standards and regulations for each product category and its impact on overall consumption	5.4	Complied
6.	Feedback of key institutional consumers in India for such type of products with regard to the issues of standards faced by them while sourcing such products either domestically or from overseas.	5.1	Complied
7.	Current status on NHM subsidies such as amount of subsidy, products include, implementing mechanism etc.	5.3	Complied
8.	Current status on Linkages of Financial aids & subsidies with usage of agrotexiles to ensure better returns by Ministry of Agriculture, State Governments etc., if any	5.3	Complied
9.	Current schemes for usage of agrotexiles at vulnerable areas/sensitive produces, if any	5.3	Complied
10.	Current agrotexile products in agriculture kits	5.3	Complied - Agriculture kits were deemed by SASMIRA and ITTA to be financial assistance packages, which are covered in 5.3
11.	Any other areas of Agrotech	5	Feedback on the sales channel, manufacturing feasibility, state level schemes, has also been discussed

Analysis of global scenario with respect to the target areas

Sr #	Deliverable	Report Section	Remarks
The engaged Consultant will have to present a detailed knowledge base on the above target areas globally. The countries to be covered will primarily be the markets where the market for particular products is mature and well established e.g. Israel, USA, UK, Germany, France, Japan, China etc.			

Study on Developing Measures to Promote the Use of Agrotexiles in India

1.	The Consultant will identify various international bodies which are involved in developing measures to promote usage of Agrotexiles	6.1	Complied
2.	The Consultant will also present an analysis of practices carried out on the target areas in different countries. This will lay the founding stone for development in India.		
	<ul style="list-style-type: none"> ○ This analysis will include an exhaustive list of standards available globally for products in the Agrotech segment 	6.4	Complied
	<ul style="list-style-type: none"> ○ Summary of all relevant regulations/laws/rules that mandate the usage of Agrotech segment in various applications 	6.2	Complied
	<ul style="list-style-type: none"> ○ Case studies on usage of Agrotech in illustrative projects of reasonable scale 	6.4 4.1	Complied
	<ul style="list-style-type: none"> ○ Specimen of tenders used for awarding contracts which have well defined specifications and guidelines for usage of Agrotech 	6.3 Annex G Annex H	Complied
3.	The Consultant will then provide comments on suitability and applicability of replicating the international standards and regulations in India, and finally recommend the standards, regulations and policy changes required which are suitable for Agrotech segments.	6.5 7	Complied
4.	The consultant will also provide global (USA, UK, Germany, France, Japan, China and particularly Israel) details on areas where agrotexiles used to improve quality and reduce crop damage, guidelines for usage of agrotexiles, Performance standard for new Agrotexile products, Special schemes for usage of agrotexiles	6.2 6.4 Handbook 7.5.6 7.9.1	Complied

Discussion with Stakeholders

Sr #	Deliverable	Report Section	Remarks
The engaged Consultant will have to discuss all the recommended guidelines/ suggestions/ schemes/ policy/ performance standards/ schemes/ regulatory changes with relevant stakeholders			
1.	For example, suggested policy changes for mandating use of Agrotech have to be done in consultation with key stakeholders and nodal agencies such as NHM, Ministry of Agriculture, Agriculture Universities etc. and fine tune the same. As a result of this consultation with stakeholders and nodal agencies, the consultant has to design an approach paper highlighting key policy / regulatory changes required to promote the usage of the Agrotech in India, and an approach towards facilitating the identified regulatory and policy changes	Annex B 8	Complied
2.	The consultant also has to prepare a business case for usage of Agrotech for select applications, including a clear cost benefit analysis	4.2 4.3	Complied
3.	Discussion with manufacturers to study the feasibility of indigenous manufacturing at an affordable cost	5.2	Complied

Annexure L - Case 1

Phone : 0431-2618104/2618106
Fax : 0431-2618115
E-mail: directornrcb@gmail.com

National Research Centre For Banana
(Indian Council of Agril. Research)
Thogamalai Road, Thayanur Post
Trichy - 620 102(Tamil Nadu)

F.No.9(89)/2011-Estt/ 3900

Dated: 16.04.2013

To

BY SPEED POST

M/s.Reliance Industries Limited,
AI Towers, 5th Floor,
No.89, Dr. Radhakrishnan Salai,
Mylapore,
Chennai - 600 004.☎

Sub: Report on the "Testing of Suitability/Performance of "Repol" a Polypropylene based Non Woven Fabric as bunch sleeves on bunch characteristic & fruit quality Banana".

Ref: This Office letter no.F.9(89)/2011/Estt./3537 dated 02.11.2013.

Sir,

I am directed to forward the final report of the Contract Research "Testing of Suitability/Performance of "Repol" a Polypropylene based Non Woven Fabric as bunch sleeves on bunch characteristic & fruit quality in Banana" by Dr.V. Kumar, Senior Scientist, National Research Centre for Banana during 2012-13 as per the Memorandum of Understanding entered with M/s.Reliance Industries Limited.

Kindly acknowledge the receipt.

Yours faithfully,



Administrative Officer

Encl: as stated above.

PROJECT REPORT

on

“Performance of ‘Repol’, a polypropylene based non-woven fabric as bunch sleeves on bunch characteristics and fruit quality in banana”

PROJECT FUNDED BY

M/s Reliance Industries Limited, Chennai

National Research Centre for Banana (ICAR),

Thogamalai Road, Thayanur Post, Tiruchirappalli - 620 102

TAMIL NADU

PROJECT REPORT

PROJECT TITLE : “Performance of ‘Repol’, a polypropylene based non woven fabric as bunch sleeves on bunch characteristics and fruit quality in banana”

OBJECTIVE : To study the effect of ‘Repol’, a polypropylene based non -woven fabric as bunch sleeves on bunch characteristics and fruit quality in the summer and winter crops of banana

INSTITUTE : National Research Centre for Banana, Tiruchirappalli, Tamil Nadu

PROJECT WORKERS:

- 1). **Dr. V. Kumar**
Senior Scientist (Horticulture)

- 2). **Dr. K.N. Shiva**
Senior Scientist (Post Harvest Technology)

- 3). **Dr. M.M. Mustaffa**
Director, NRC for Banana

“Performance of ‘Repol’, a polypropylene based non woven fabric as bunch sleeves on bunch characteristics and fruit quality in banana”

An agreement was signed between the Director, National Research Centre for Banana (ICAR), Tiruchirappalli, Tamil Nadu and M/s Reliance Industries Limited, Chennai to study the ‘Performance of ‘Repol’, a polypropylene based non woven fabric as bunch sleeves on bunch characteristics and fruit quality in banana”.

The trial was funded by M/s Reliance Industries Limited; Chennai who is the manufacturer and supplied the ‘Repol’, a polypropylene based non woven fabric to be used as bunch sleeves in the summer and winter emerged bunches of certain commercial cultivars of banana. The main objective of the experiment was study the effect of poly polypropylene based non woven fabric ‘Repol’ as bunch sleeves on bunch characteristics and fruit quality of banana.

The trial was conducted for two seasons in farmers’ fields and the summer crop (February-June, 2012) study in Ney Poovan (AB) and Rasthali (AAB) bananas was conducted in Thottiam, Tiruchirappalli and in cv. Grand Naine (AAA) in Chinnamanur, Theni, Tamil Nadu. The study on the rainy/winter crop (August-December, 2012) was conducted in Grand Naine (AAA) and Ney Poovan (AB) bananas at Chinnamanur taluk, Theni district in Tamil Nadu. Uniform bunches emerged within a gap of three to five days were selected for the study and the treatments were imposed. The details of the trials are as follows:

TREATMENT DETAILS:

T1- White polypropylene sleeves T2- Blue polypropylene sleeves
T3- Polythene sleeves with 6% ventilation T4- Control- No bunch sleeves

VARIETIES: Grand Naine (AAA), Ney Poovan (AB) and Rasthali (AAB)

Design: RBD **Number of Replications:** Five **No. of plants/unit:** Six

LOCATION:

- A) Farmer’s field, Chinnamanur, Tamil Nadu- **Grand Naine (AAA) and Ney Poovan (AB)**
- B) Farmer’s Field in Thottiam, Trichy, T N – **Ney Poovan (AB) and Rasthali (AAB)**

OBSERVATIONS RECORDED:

Days taken from flowering to harvest, bunch weight, weight of the finger, finger length, finger girth, shelf life of fruits, Pulp: peel ratio, TSS, Acidity, starch and total sugars. In addition, data on micro-climate i.e., temperature and RH inside the bunch covers were also recorded. Fruits from the second hand of the bunch were selected for various biometric and biochemical analyses.

RESULTS:

The data collected from the summer crop of Grand Naine (AAA), Ney Poovan (AB) and Rasthali (AAB) bananas and the rainy season/winter crop of cvs. Grand Naine, Ney Poovan were statistically analyzed and the results are presented in Tables 1 and 2.

In the summer crop of cv. Grand Naine, significant differences were recorded among various treatments. The time interval between bunch emergence and harvest of bunch was significantly reduced in all the bunches covered with sleeves and the fruit maturity was advanced by 7.1 days in the bunch covered with blue polypropylene sleeves (108.7 days) as against 115.8 days recorded in uncovered control (T4).

In addition, the bunches covered with blue polypropylene sleeves (T2) recorded the highest bunch weight (35.68 kg), fruit weight (221.7g) followed by white polypropylene bunch sleeves which recorded a bunch weight of 34.5 kg whereas, the uncovered bunch recorded the least bunch weight (32.88 kg) with average finger weight of 198.5 g. Other finger characteristics and fruit quality parameters like pulp: peel ratio (3.08) and fruit TSS (27.8° Brix) were the highest in bunches from treatment T2.

Similarly, in the summer crop of Ney Poovan and Rasthali bananas, polypropylene bunch sleeves resulted in early fruit maturity (111.4 days and 104.9 days respectively), also enhanced the bunch weight (16.3 kg and 18.5 kg respectively) and finger weight (89.9 g and 205.4g respectively). There was significant delay in fruit maturity (120.3 and 114.2 days) and the lowest bunch weight (14.2 kg and 16.9 kg) were recorded in Ney Poovan and Rasthali bananas respectively. In addition, both the blue (T2) and white polypropylene bunch sleeves (T1) recorded significantly the highest fruit length, fruit girth, pulp: peel ratio, TSS and total sugars as compared to the control (T4).

The results pertaining to the rainy season/winter crop of Grand Naine and Ney Poovan bananas revealed that the bunch sleeves produced more encouraging results with significantly highest values for almost all the parameters including early maturity of fruits. In Grand Naine banana, the maturity was advanced by 8.7 days and 6.2 days combined with a significant increase in bunch weight by 2.8 kg and 1.3 kg in blue (T2) and white polypropylene sleeves (T1) respectively as compared to the control (T4).

In addition, the banana fingers were blemish free and with attractive green colour. The other finger characteristics and fruit quality parameters were also favourably enhanced in bunches covered polypropylene sleeves.

In cv. Ney Poovan, similar results were obtained with early fruit maturity in both blue (107.3 days) and white polypropylene sleeves (111.7 days) as against delayed fruit maturity of 116.1 days as recorded in control treatment without bunch covers (T1). The highest bunch weight (16.96 kg), finger weight (94.2g), finger length (12.9 cm), girth (21.1 cm) with high pulp peel ratio (7.03), TSS (26.3° B) as well as total sugars (24.7 %) were recorded in blue polypropylene sleeves. The bunch weight in blue polypropylene sleeves (T2) was increased by 2.1 kg over the control without bunch sleeves (T4).

However, no significant differences were observed with regard to shelf-life of fruits in terms of both green life as well as yellow life of fruits and the fruits under all the treatments had about five days of yellow life.

Phytotoxicity:

In general, no symptom of fruit abnormality or sun scorching of fruits was recorded in any of the varieties. However, in both seasons of trial, due to poor visibility of bunch and owing to comparatively early fruit maturity, there were instances of pre-harvest fruit ripening. Hence, the farmers are to be advised to be more watchful in monitoring of bunches and harvesting the matured bunches in time to avoid occurrences of pre-harvest ripening of fruits with polypropylene bunch sleeves.

Effect of bunch sleeves on micro climate:

In the summer crop, bunch covers reduced the temperature inside the bunch sleeves. Compared to the outside temperature (36.8° C), the temperature was reduced to 32.7° C and 32.2° C inside the white and blue polypropylene sleeves respectively. Covering of bunches with polypropylene sleeves has increased the relative humidity by 2% and 3% inside the white and blue polypropylene sleeves respectively depending on the weather conditions.

Similarly, in the rainy season experiment there was a reduction in temperature from an outside temperature of 32.1 °C to inside temperature of 28.9 and 28.1 °C in white and blue polypropylene sleeves respectively. The reduction in temperature and increase in the RH inside the bunch sleeves has favoured the growth of the fruits resulting in early maturity of the fruits.

Benefit: Cost Ratio:

The analysis of the cost economics revealed that use of blue polypropylene bunch sleeves in the summer season recorded a benefit cost ratio of 2.26, 3.50 and 2.00 in Grand Naine, Ney Poovan and Rasthali bananas respectively. The rainy season crops of Grand Naine and Ney Poovan bananas registered a BC ratio of 2.28 and 3.46 respectively.

The economics has clearly indicated that the use of blue polypropylene bunch sleeves has increased the yield thereby the profitability is increased by the use of polypropylene bunch sleeves in all the three banana varieties.

Conclusion:

From the trials conducted and the results obtained it can be concluded that:

- Use of both blue and white polypropylene bunch sleeves had significantly advanced the fruit maturity by a minimum of 4.4 days to a maximum of 9.3 days depending on the varieties grown and season on application of bunch covers.
- Bunch covering also increased the bunch weight by 2.8 kg in Grand Naine (AAA), 2.1 kg in Ney Poovan (AB) and 1.6 kg in Rasthali (Silk-AAB) bananas over the control.
- In addition, blue and white polypropylene bunch covers proved to be better for improving most of the physico-chemical parameters such as finger weight, finger length, finger girth, pulp: peel ratio, total sugars, TSS, and starch when compared to control (with no bunch covers) in all the three banana cultivars studied.
- Use of blue polypropylene bunch sleeves recorded a benefit cost ratio in the range of 2.00 to 3.50 in the summer season and 2.28 to 3.46 in the rainy season crops while the white polypropylene sleeves recorded in the range of 1.08 to 1.97. The highest BC ratio was recorded in Ney Poovan banana followed by Grand Naine.

- Overall, the bunches grown by covering with blue and white polypropylene bunch sleeves was fully blemish free without any mechanical injuries caused by insects and the fruits developed attractive green colour thereby, fetched about 10-15 per cent higher price as compared to control bunches without bunch sleeves. The control fruits with out bunch sleeves had blemishes and injuries on the fruit surface and also recorded less fruit weight and yield which has reduced the profitability of the farmers.



(V. Kumar) 11/4/12

Senior Scientist (Horticulture)



(K.N. Shiva) 11/04/2012

Senior Scientist (Post Harvest Technology)



(M.M. Mustaffa) 11/4/13

Director, NRC for Banana

Table 1: Effect of bunch sleeves on fruit maturity, bunch weight and fruit characteristics of banana (summer crop)

Treatments	GRAND NAINIE (AAA)										
	Days taken for maturity	Bunch weight (kg)	Fruit weight (g)	Fruit length (cm)	Fruit girth (cm)	Pulp: peel ratio	TSS (°B)	Acidity (%)	Starch (%)	Total sugars (%)	
T1- White Polypropylene sleeves	110.5	34.50	216.1	22.0	13.6	2.63	27.3	0.28	1.61	18.67	
T2- Blue Polypropylene sleeves	108.7	35.68	221.7	22.6	14.1	3.08	27.3	0.30	2.13	17.03	
T3- Polythene with 6% Ventilation	110.4	34.20	212.4	22.2	13.7	2.84	27.0	0.32	1.68	17.22	
T4- Control without sleeves	115.8	32.88	198.5	20.3	13.1	2.49	26.5	0.27	1.33	17.66	
S. Ed.	1.809	0.665	5.577	0.462	0.391	0.067	0.261	0.013	0.065	0.281	
C.D.	5.526**	2.033**	17.036**	1.410**	NS	0.204**	0.569*	0.028*	0.142**	0.860**	
NEY POOVAN (AB)											
T1- White Polypropylene sleeves	115.5	15.38	81.3	11.5	10.94	6.75	27.26	0.27	1.76	24.40	
T2- Blue Polypropylene sleeves	111.4	16.30	89.9	13.1	11.64	7.06	27.34	0.30	1.55	25.34	
T3- Polythene with 6% Ventilation	115.6	14.90	96.2	13.3	11.60	6.52	27.06	0.31	1.74	24.16	
T4- Control without sleeves	120.3	14.20	79.6	10.8	10.14	5.83	25.90	0.28	1.96	23.30	
S. Ed.	0.976	0.447	4.314	0.369	0.326	0.103	0.580	0.011	0.113	0.423	
C.D.	2.981**	1.366**	9.399*	1.127**	0.711**	0.314**	1.162**	0.034**	0.246*	1.291**	
RASTHALI (AAB)											
T1- White Polypropylene sleeves	108.3	17.7	195.0	19.7	15.4	4.23	22.70	0.23	2.17	20.24	
T2- Blue Polypropylene sleeves	104.9	18.5	203.4	20.3	15.8	4.45	21.60	0.28	2.20	22.70	
T3- Polythene with 6% Ventilation	107.9	17.3	207.7	19.5	15.6	4.34	22.30	0.24	2.06	20.66	
T4- Control without sleeves	114.2	16.9	183.7	18.1	14.3	4.03	23.12	0.22	2.01	21.30	
S. Ed.	1.859	0.351	3.004	0.429	0.325	0.115	0.349	0.013	0.079	0.517	
C.D.	5.680**	1.201*	9.175**	1.309**	0.992**	0.251*	1.065**	0.039**	NS	1.580**	

* Significance at p=0.05 ** Significance at p= 0.01

Table 2: Effect of bunch sleeves on fruit maturity, bunch weight and fruit characteristics of banana (Rainy season/winter crop)

Treatments	GRAND NAINNE (A.A.A)										
	Days taken for maturity	Bunch weight (kg)	Fruit weight (g)	Fruit length (cm)	Fruit girth (cm)	Pulp: peel ratio	TSS (°B)	Acidity (%)	Starch (%)	Total sugars (%)	
T1- White Polypropylene sleeves	103.1	35.76	243.3	21.8	14.3	2.22	22.10	0.33	1.07	15.28	
T2- Blue Polypropylene sleeves	100.6	37.30	248.4	23.5	14.5	2.38	21.84	0.34	1.50	14.14	
T3- Polythene with 6% Ventilation	102.5	36.22	245.2	22.0	14.1	2.29	21.74	0.32	1.92	14.10	
T4- Control without sleeves	109.3	34.46	234.2	20.7	13.7	2.29	20.90	0.32	1.41	14.61	
S. Ed.	1.269	0894	2.339	0.425	0.393	0.037	0.339	0.013	0.075	0.116	
C.D.	3.879**	2.732**	7.147**	0.926**	0.856*	0.114**	0.739*	NS	0.228**	0.355**	
NEY POOVAN (AIB)											
T1- White Polypropylene sleeves	111.7	15.68	86.5	12.1	11.4	6.64	26.1	0.30	1.82	22.3	
T2- Blue Polypropylene sleeves	107.3	16.96	94.2	12.9	12.1	7.03	26.3	0.29	1.54	24.7	
T3- Polythene with 6% Ventilation	112.1	15.80	92.8	12.8	11.8	6.31	26.0	0.31	1.67	23.8	
T4- Control without sleeves	116.1	14.88	82.5	11.2	10.6	5.94	24.9	0.28	1.91	21.2	
S. Ed.	1.684	0.518	2.588	0.398	0.282	0.095	0.263	0.015	0.063	0.566	
C.D.	5.147**	1.583**	7.907**	1.216**	0.860**	0.289**	0.803**	NS	0.193**	1.729**	

* Significance at p=0.05

** Significance at p= 0.01

Annexure L - Case 2

PROJECT REPORT

On

Effect of grape bunches covered with Repol Polypropylene based Non-woven fabric on yield and quality of grapes.

Trial Sponsored By

M/s Reliance Industries Ltd., Mumbai.

2011-12

Trial Conducted By

राष्ट्रीय अंगूर अनुसंधान केन्द्र

(भारतीय कृषि अनुसंधान परिषद)

**NATIONAL RESEARCH CENTRE FOR GRAPES
(INDIAN COUNCIL OF AGRICULTURAL RESEARCH)
P.B. NO. 3, MANJRI FARM POST, SOLAPUR ROAD, PUNE - 412 307,
INDIA**



PROJECT REPORT

- Project Title** : **Effect of grape bunches covered with Repol Polypropylene based Non-woven fabric on yield and quality of grapes.**
- Objective** : **To study the effect of grape bunches covered with Repol Polypropylene based Non-woven fabric on yield and quality of grapes.**
- Conducted by** : **National Research Centre for Grapes**
- Project Workers** : **1. Dr. P.G. Adsule**
Director, NRC for Grape
- 2. Dr. S.D. Ramteke**
Sr. Scientist (Plant Physiology)

Effect of grape bunches covered with Repol Polypropylene based Non-woven fabric on yield and quality of grapes.

An agreement was signed between M/s Reliance Industries Ltd., (RIL) Mumbai, India and the Director, NRC for Grapes; Pune to study the effect of grape bunches covered with Repol polypropylene based Non-woven fabric on yield and quality of grapes.

Repol Polypropylene based non-woven fabric/ bags to cover the bunches, which may play a role in control of pink berries in Thompson Seedless grapes and to increase the export proportion of grapes.

This trial was sponsored by Reliance Industries. Ltd., Mumbai.

Materials and Methods

The trial was conducted at NRCG, Research Farm; Pune to study the effect of grape bunches covered with Repol Polypropylene based Non-woven fabric on yield and quality of grapes during the year 2011-12. The non-woven fabric bags were used for covering of bunches of 10 years old Thompson Seedless variety grafted on Dogridge rootstock.

Pruning was done on 28th October 2011 and treatments were imposed at various growth stages. The details of the treatments are as follows.

Treatment Details

- T1 : Reliance cover, 75 DAP
- T2 : Reliance cover, 85 DAP
- T3 : Reliance cover, 95 DAP
- T4 : Paper covers, 75 DAP
- T5 : Paper covers, 85 DAP
- T6 : Paper covers, 95 DAP
- T7 : Reliance bags fully covered, 75 DAP
- T8 : Control, non covered

II. Observations Recorded:

- Pink Berry percentage
- No of pink berries in bunch
- Anthocyanin Content
- Powdery mildew infection on bunch
- Mealy bug infection on bunch

- Dry matter content
- Micro climate i.e. Temperature and RH inside cover.
- Bunch weight
- 50 Berry weight
- Berry Diameter
- Berry Length
- Pedicel thickness
- Skin thickness
- TSS
- Acidity
- Shelf life
- Yield

Skin thickness was measured with micrometer, Temperature and RH inside cover was measured with hand held

II. Shelf life

The harvested grapes were packed in 5 kg corrugated boxes and kept for pre-cooling at 0°C temperature and 95% relative humidity for 10-12 hours. After pre-cooling the boxes were shifted to cold storage and stored for a period of 30 days at 0°C temperature and relative humidity of 85-95 %. After taking out these boxes from cold storage, the observations on PLW was recorded for 7 days at room temperature. The replicated grape samples in shelf were weighed and observation was recorded as W_0 . Subsequently on 1st, 2nd7th day the samples were weighed and the physiological loss in weight (PLW) was calculated on all the days (1st ... 7th) by using following formula:

$$PLW = \frac{W_0 - W_n}{W_0} \times 100$$

Where, W_0 → initial weight in shelf

W_n → corresponding weight on 1st...7th day.

Results

The data was analysed and presented as below (Table 1 and 2). The significant differences were observed in covered and non-covered bunches regarding all parameters studied.

The pink berry percentage (%) & number of pink berries in a bunch were affected significantly due to coverings. The least pink berry percentage (%) was recorded with treatment (T6) bunch covered with newspaper at 95 DAP followed by (T4) bunch covered with newspaper at 75 DAP and (T1) bunch covered with lower side open Non-woven fabric of RIL at 75 DAP. The number of pink berries in a bunch was recorded with treatment (T4) bunch covered with newspaper at 75 DAP followed by (T1) bunch covered with lower side open Non-woven fabric of RIL at 75 DAP. This indicates that to avoid the pink berry formation, bunches should be covered before or at 85 DAP.

Anthocyanin content in berry was also significantly affected by coverings. The least anthocyanin content was recorded with (T7) bunch fully covered with Non-woven fabric of RIL at 75 DAP followed by treatment (T4) bunch covered with newspaper at 75 DAP and treatment (T1) bunch covered with lower side open Non-woven fabric of RIL at 75 DAP.

Bunch weight was not significantly affected by coverings. All treatments recorded at par readings. 50 berry weights were significantly affected by coverings. Both Bunch weight and 50 berry weight was recorded highest in bunch covered with newspaper at 75 DAP.

Berry size in terms of berry length and berry diameter also recorded significant differences. The highest berry length was recorded with (T4) bunch covered with newspaper at 75 DAP while highest berry diameter was recorded with (T1) bunch covered with lower side open Non-woven fabric of RIL at 75 DAP followed by (T4) bunch covered with newspaper at 75 DAP.

The pedicel thickness was recorded significantly higher in (T3) bunch covered with lower side open Non-woven fabrics of RIL at 95 DAP. While no significant differences were found in case of skin thickness and acidity of grape berries.

Total soluble solids (TSS) was recorded highest in control followed by (T5) bunch covered with newspaper at 85 DAP. The microclimate i.e. Temperature and RH inside cover results were not significant. There are no much more differences in different treatments. The highest temperature was recorded in bunches covered with newspapers at 85 DAP. Relative humidity was highest in bunch covered with newspaper at 75 DAP while lowest was measured in control.

There was no uniformity in color and size of bunches. The control bunches were full of pink berries while (T4) bunch covered with newspaper at 75 DAP retained green colour as compared to other.

There was no disease like powdery mildew infection in any of the treatment but treatment (T4 and T5) had some infection of mealy bug. Treatment (T1) bunch covered with lower side open Non-woven fabrics of RIL at 75 DAP has also some infection of mealy bug.

The bunches covered with (T1) lower side open Non-woven fabrics of RIL at 75 DAP had minimized duration for ripening. The least days from flowering to harvest and ripening to harvest was observed with this treatment.

The higher yield was recorded in (T4) bunch covered with newspaper at 75 DAP. The highest yield per hectare recorded was found 19.04 t/ha.

There was less loss in physiological weight in cold conditions than that of room temperature. The least physiological loss in weight in cold conditions was recorded in (T5) bunch covered with newspaper at 85 DAP while the least physiological loss in weight in room temperature conditions was recorded in (T1) lower side open Non-woven fabrics of RIL at 75 DAP upto 7 days.

Phytotoxicity:

No symptoms of any abnormality, toxicity were found either on berries in bunches with covering of bunches with lower side open Non-woven fabric of RIL at different days of pruning.

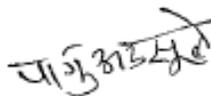
Inferences

From the above finding, it can be concluded that:

1. Repol based Polypropylene non-woven fabric bags have potential of decreasing pink berry formation.
2. It decreased the pink bunches and pink berries in a bunch.
3. It increased the shelf life in grapes.



(S.D. RAMTEKE)
Sr. Scientist (Plant Physiology)



(P.G. ADSULE)
Director



NATIONAL RESEARCH CENTRE FOR GRAPES
(INDIAN COUNCIL OF AGRICULTURAL RESEARCH)
P.B. NO. 3, MANJRI FARM POST, SOLAPUR ROAD, PUNE - 412 307, INDIA



File no. IRGS/CR(15)/2011-12

Date: 1.10.2012

To
M/s. Mr. Satyajeet Bhonsle, DGM
Reliance Industries Ltd. (RIL)
Pune

Sub: Effect of grape bunches covered with Repol polypropylene based Non-woven fabric supplied by Reliance Industries Ltd. (RIL) on yield and quality of grapes

Sir

Kindly find enclosed herewith the Final Report of Contract research trial on "Effect of grape bunches covered with Repol polypropylene based Non-woven fabric supplied by Reliance Industries Ltd. (RIL) on yield and quality of grapes". Two copies of the Certificate of Acceptance for the reports are also enclosed. You are requested to return one copy after signing. In case no reply is received within one month of release of the final report, it will be considered that the report has been accepted and we will not accept any comment or suggestions that may arise in future on account of any review of the report by you or third party.

You may also kindly convey your consent for publication of result in suitable journal by the concerned research workers.

Yours faithfully

A handwritten signature in black ink, appearing to read 'S. D. Ramteke'.

(S. D. Ramteke)
Sr. Scientist & I/c IRGS

Annexure L - Case 3

IMPACT OF “REPOL POLYPROPYLENE (RELIANCE INDUSTRIES LIMITED) NON- WOVEN FABRIC COVER ON WINTER TOMATO”

INTRODUCTION :

The tomato, a member of the family solanaceous and the genus lycopersicon, which is a herbaceous annual to perennial, prostrate and sexually propagated plant with bisexual flowers. Tomato is one of the most important protective food crop of India. The major tomato producing states are Orissa, Karnataka, Maharashtra, Uttar Pradesh, Andhra Pradesh, Bihar, Madhya Pradesh and West Bengal. In Uttar Pradesh it is grown in Sitapur, Unnao, Faizabad, Varanasi, Barabanki, Sonbhadra, Kanpur Nagar, Kanpur Dehat, Lalitpur and Jhansi district. Tomato is used as fresh vegetable and is also very important for processing purposes like soup, pickles ketchups, sauces containing concentrates, purees, juice etc. Tomato is also known as poor man's apple. One hundred gram ripe tomato fruit contains 94% moisture, 3.6 g carbohydrate, 0.9 g protein, 0.2 g fat, 585 I.U. vitamin-A, 26 mg vitamin - C, Vitamin -B (Thiamin 0.12 mg and riboflavin 0.06 mg), 15-30 mg. ascorbic acid and other minerals.

Tomato being most important to growers, consumers and to the processing industry, there is pressing need to increase the productivity to fulfill the increasing demand. This is possible through adoption of improved techniques.

AGRO- ECOLOGY :

Tomato, a warm season vegetable, is grown extensively in cool season also. The crop can not withstands severe frost. The optimum temperature required for its cultivation is 15^oC – 27^oC. Temperature and light intensity affects the fruit set, pigmentation and nutritive value of the fruits. At low temperature, there is poor plant growth, flower drop, poor fruit set, yield and quality of fruits is also reduced. A winter crop of tomato faces many unfavourable conditions like frost, severe cold, rainfall, wind, diseases, pest, flower drop etc. Some variables like rainfall, winds etc. are unmanageable but farmers always try to manage such problem. Frost, severe cold, flower drop, diseases and pest are seldomly controlled. For management of such problems farmers spend a huge amount of money on fogging, irrigation and pesticides. These all

inputs/ activities are costly and is not eco-friendly also increasing the cost of cultivation. Therefore, it is highly necessary to reduce the cost of cultivation.

Keeping in view of above factors RIL introduced a non woven fabric cloth to minimize risk against frost, severe cold, diseases and pest incidences. It is experiment of its type for Kanpur region was conducted at Vegetable Research Farm Kalyanpur, C.S. Azad University of Agriculture & Technology, Kanpur.

OBJECTIVES :

1. To study the effect of Repol Polypropylene based non - woven fabric cover on yield attributes of tomato.
2. To study the effect of Repol Polypropylene based non - woven fabric cover on frost, severe cold, diseases and insect incidences.
3. To assess the over all effect of Repol Polypropylene based non - woven fabric on quality and productivity.

METHODOLOGY OF THE EXPERIMENT :

1.	Crop/ Variety	:	Tomato/ Azad T-6
2.	No. of Treatment	:	T ₀ - Control (Open uncovered crop)
		:	T ₁ - Cover of the crop through Repol Polypropylene based non - woven fabric.
3.	Total No. of plants under treatments	:	T ₀ - 75 plants
		:	T ₁ - 75 plants
4.	Replication	:	03
5.	Design	:	RBD
6.	No. of plants under observation	:	5 plants randomly selected from each bed (6 beds X 5 plants = 30 plants)
7.	Size of plot	:	7.0 m X 1.20 m
8.	Season/ Year	:	Rabi - 2012-13
9.	Package of practices	:	All recommended package of practices were followed for both treatments simultaneously.
10.	Location	:	Vegetable Research Station, C.S.A.U.A. & T., Kalyanpur, Kanpur (UP)

CONCLUSIONS :

To know the effect of non-woven fabric as a source for protection to the tomato crop from frost as well as severe cold and others, an experiment entitled "IMPACT OF REPOL POLYPROPYLENE (RELIANCE INDUSTRIES LIMITED) NON- WOVEN FABRIC COVER ON WINTER TOMATO" was planned. Experiment was laid out in RBD with three replications. The crop was covered through Repol Polypropylene (RIL) Non- Woven Fabric under treatment and on the other hand, the crop was opened under control. All the inputs were applied and operations were done as per recommendations. The observations on different morphological as well as yield attributes were collected at different intervals. The salient findings which can be concluded from this experiment are as under :

1. The morphological character i.e. number of branches per plant was affected by the treatment and recorded 3.68 % higher.
2. All the yield attributes character like number of bunch per plant, number of fruits per plant, fruit weight and fruit yield per plant were found 6.81%, 8.71%, 10.65% and 22.61% higher, respectively, under treatment.
3. Fruit yield/ ha of tomato crop is obtained 22.62% higher under treatment.
4. The crop is healthy under treatment because of nil incidences of diseases and pest and protect from cold and frost.
5. Nil incidences of disease and pest were observed under treatment.

6. An additional picking under treatment in the month of March added significantly towards hectare productivity.
7. The fruits were found comparatively dark red in colour and good in looking under treatment.
8. How ever, the strength of Repol Polypropylene (RIL) non- woven fabric is rated weak as it was damaged 3 times during the crop period due to rain, heavy dew and heavy wind. Therefore, it is suggested that strength of cloth may be improved to make it more convenient and commercial.
9. To have more conclusive and reliable data such experiments should be repeated three times.



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