

Sustainable Consumption Cultures, Practices & Lifestyles in India

Research Report 2018

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Preface

“A sustainable lifestyle means rethinking our ways of living, how we buy and how we organize our everyday life. It is also about altering how we socialize, exchange, share, educate and build identities. It means transforming our societies and living in harmony with our natural environment. As citizens, at home and at work, many of our choices – on energy use, transport, food, waste, communication and solidarity – contribute towards building sustainable lifestyles.”¹

A *circular economy* is an alternative to a traditional *linear economy* (make, use, dispose). Looking beyond the current “take, make and dispose” extractive development and economic model, the circular economy is restorative and regenerative by design. Relying on system-wide innovation, it aims to redefine products and services to design waste out, while minimising negative impacts.

The environmental consequences of unsustainable lifestyles and patterns of production and consumption are now widely acknowledged. Unsustainable consumption leads to pressure on natural resources and long-term impacts on the environment. While a section of the globe and the society faces a lack of basic necessities, the high consuming and unsustainable lifestyles of another section places immense stress on the environment. This imbalance in global consumption patterns is reflected in a situation where the richer sections over exploit the available resources and the poorer segments are unable to even meet their food, health, housing and educational needs.

In India, traditional practices that are sustainable and environment-friendly continue to be a part of people's lives. India has a history of low carbon footprint and lifestyle. These need to be encouraged, rather than replaced by more modern but unsustainable practices and technologies. This is also applicable to other developing countries where there is a growing interest in alternative models of development, and on reviving green consciousness drawing on traditional cultures².

This documentation of Case Studies on Sustainable Consumption Cultures, Practices and Lifestyles from different States, Regions, Cultures and Lifestyles in India was a dedicated effort to bring forth the cases on diverse subjects, which have the potential to contribute massively towards Sustainable Development and push for a more responsible model of circular economy. The report compiles the case studies of 15 modern practices, which are either inspired by traditional knowledge and practices or is a conscious effort by socially responsible citizens of India to ‘Be the change they want to see in the World’.

There are many friends to whom we would like to extend our sincere thanks of gratitude starting with Swedish Society for Nature Conservation (SSNC), especially to Sara Nilsson and Alexander Sjöberg for their valuable partnership and unrelenting support for successful completion of this project. The cases were compiled on the basis

¹ Report of the Marrakech Task Force on Sustainable Lifestyles led by the United Nations Environment Programme (UNEP) and the United Nations Department of Economic and Social Affairs (UN-DESA)

² Climate Friendly Lifestyles Practices in India, Ministry of Environment, Forests and Climate Change, Government of India.

of field visits and interaction with innovative minds behind the fabulous ideas. We would not miss the opportunity to make them partners in our happiness and thanking them for their time and patience to provide us with all the relevant details of their work and inputs on the subject.

We would like to thank T.V. Anupama (District Collector, Alappuzha), George C Varughese (President) and team at Development Alternatives; Deependra Prasad, Green Building Consultant for Indira Paryavaran Bhavan; Architect Eugene Pandala; Architect G. Shankar; Smt. Binz C Thomas (District Coordinator, Kerala Suchitwa Mission), Priyanka and Pranav Mokshmar,(Founders)and Vaayu Team; Mansukhbhai Prajapati(Founder), Ravi Prajapati, Raj Prajapati and Mitticool team; Arvindbhai Patel(Founder), Jaymeen Patel & Notion Technocrats India team; C. Sekar, President Jute Weavers Association, Chennai and team; Rakesh(Owner) and Deepam Palm Dish team, Kerala; Jaydeep Mandal(Founder) and Aakar Innovations team; Jayshree Industries, Coimbatore; Kamlesh Salam, Founder-World Bamboo Day; Saurav Saikia(Business Development Manager), ESES Bio-Wealth Pvt. Ltd; Abhinav Kant(Director) Bamboo and Cane Development Institute; Naveen Sood(Proprietor) CaneCraft & Allied Industries; Sunuraj N, Business Manager, Coir Craft; Anil Joshi and HESCO team; Harish RP, Research Associate, Ashoka Trust for Research in Ecology and the Environment, Shailaja Rangarajan and Rimage team; Vijay Krishnan and all volunteers of Thuli ;Vasanthi Gopalan, Founder and all volunteers of Kanika; Srishti Arora Anand, Jyotika Bambari, Rashmi Arora and Wedding Bells team. The study greatly benefitted from these innovative teams who readily agreed for a one-on-one meeting with the CUTS team to provide an in-depth knowledge on their sustainable venture and later providing continued guidance and support for the study.

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Hope this study will help in propagating the traditional practices in India to the wider world and also regaining and retaining those practices.

August, 2018

George Cheriyan
Director, CUTS International

Introduction

Talking about Sustainable Development, the first thought that comes to our mind is Environment Protection. But the concept of interrelatedness, of a shared planet, and of global citizenship cannot be restricted to environmental issues alone but apply to interlinked responsibilities of environment protection and human development. The Sustainable Development Goals (SDGs), which came into effect in 2016 and their respective targets present a holistic understanding of the term “Sustainable” for the world where there is no poverty, no hunger, and no discrimination along with protection of the planet. Since then, the world is talking about sustainable development and to achieve the goals, the concept of ‘Circular Economies’ is being pushed.

Circular Economy is seen as an alternative to traditional linear economy based on the principle of ‘make, use and dispose’. In India, the traditional concept has always been the circular economy, where resources are used as long as possible, extracting optimum value followed by recovery and regeneration of products and materials at the end of each service life. But with the advent of Industrial Revolution in Britain, the situation in India changed drastically with respect to traditional and cultural practices in particular. The country, which believed in sustainable development, somewhere lost its track before independence due to getting exploited by the British; and influence of market forces, Industrialisation, Capitalism, Globalisation and most importantly to gain the tag of “Developed Nation” post-independence.

India has gone through many changes and has been on a path of development that also bears its influence on the culture, however, the belief and exposure of the people to traditional practices and ideas, albeit limited, is not entirely extinct. Some of these ways, means, ideas and traditional practices have influenced the modern practices and have resulted in coming up with innovative ways for a new sustainable world with space to accommodate all.

Most of these techniques and innovative ideas are either hidden in remote areas or have not gained exposure due to their local nature. These practices can serve not only to protect the environment but also to deal with issues of poverty, inequality, gender discrimination and build a just society. This project is, therefore, an attempt to identify cases on Sustainable Cultures, Practices and Lifestyles in India, which are either at local level or are social ventures and have potential of replication on a larger platform at an urban level in relation to the concept of Sustainable Culture and Circular Economy.

Sustainable Marvels from Mud

Introduction

Planning in terms of building materials, taking into account the social and economic context of the society, is probably one of the most neglected aspects of human settlement.³ Last few decades in developing countries has seen an inappropriate and large-scale adoption of western materials and techniques, often ignoring the positives of traditional materials. Mud as a construction material has been extensively used since the dawn of man on earth and has been tested and tried in different forms for thousands of years. The advent to cement, concrete and other building materials with time, usually considered as strong and durable replacement, made mud a lost memory for modern housing.

The most commonly used stabiliser at present is cement but the traditionally indigenous materials like straw, plant juices, gum, sugar or molasses, pulses, cow dung, animal urine, tannic acid, limestone and oil were used in olden days. Some of the magnificent human creations in the form of cities, palaces, monuments including simple habitats are built using mud all over the world. India has a rich tradition in mud architecture and apart from mud houses found in different regions since centuries, an epic example of beauty, strength, and valour is the *Kumher Fort* in Bharatpur, Rajasthan build in 18th century, which has its outer walls build of mud without even a small bit of iron used anywhere. The fort witnessed 13 unsuccessful attacks by British but the strength of mud walls gave it the title of 'Iron Fort of India'.

Mud as a building material has undergone a fundamental change in many developing countries, usually seen as a sign of poverty and best suitable for reducing shortage of housing among low income groups. The world has forgotten the use of this traditional and natural building material with advantage of versatility, energy efficiency, durability along with being economic and easily available. In comparison to mud, use of cement, mortar, bricks and other modern materials is extremely energy intensive and requires high capital.

The world is progressing each day to build the concrete jungles that retain heat and are energy intensive, with little or no space to even breathe a gush of fresh air. The herd behaviour of the people in general, coerce them to make social comparisons and evaluate their possessions and well-being and end up

building house with cement, bricks, metals and with every other



Figure 1: A mud and bamboo house in Guwahati, Assam

³ <https://archnet.org/system/publications/contents/3579/original/DPC0144.pdf?1384775658>

unsustainable materials like glass, plastics, toxic paints, etc. According to United Nations Framework Convention on Climate Change, cement industry alone accounts for 5-6 percent of global emissions.⁴ Such houses therefore are not only a part of destroying the green landscapes but also significantly contributing towards global warming.

It is estimated that still 50 percent of world population live in buildings where mud has been used as a primary material⁵. The lack of knowledge about the advantages of this sustainable building material accompanied by misleading notion about durability of structures made out of it and class conscious attitude of consumers has led to fewer takers at urban level. Mud architecture cannot be popularised again if it is just limited to its advantage as ecological and natural building material just for low cost housing. The governments all over the world have to look into best examples of techniques of using mud to propagate the use of this natural material as not an alternative but as the primary building material.

For centuries, mud architecture is practiced in India with variation in technique depending upon the local skills, knowledge and primarily the climatic conditions of the region. Acting as a natural air conditioner providing cool and comfortable environment also raises demand for mud construction in relatively dry regions.

The skills and techniques have been passed on from generation to generation and are still in practice at the local level, mostly in the villages. But one cannot go on romanticising the use and advantages of mud as building material if it used by the section often considered as marginalised and deprived to construct the house with other modern materials.

To challenge the views and stigma attached with Mud Construction in modern housing, many independent architects, institutions, and organisations have been experimenting with mud to come out with techniques which have all the advantages of mud without compromising with the stability, strength and durability one needs in a house which is usually built once in a lifetime. There are various techniques of mud construction like Cob, Adobe, Wattle, Compressed Earth Blocks and Rammed Earth blocks.

The case study of two architects from State of Kerala, usually known as 'Gods own Country' in India have taken up the responsibility to build energy efficient and sustainable Habitats using mud as the primary material but with their different techniques and ideology. The houses taken as example of their work does not belong to someone with low income or marginalised who are usually considered as best buyers of idea of mud construction.

Sustainable Mud Marvels

1. Bodhi, Quilon, Kerala

In some point in our life we all do dream of settling down in a majestically beautiful lonely little house blended in nature, a small refuge where one could forget everything.

⁴ Bigger Climate Action Emerging in Cement Industry, UNFCCC, 26 October 2017. Accessible at < <http://newsroom.unfccc.int/unfccc-newsroom/bigger-climate-action-emerging-in-cement-industry/>>

⁵ <https://archnet.org/system/publications/contents/3579/original/DPC0144.pdf?1384775658>

A calm and cosy place that helps one to rejuvenate, relax, disconnect and unplug from the otherwise organised chaos of a day remains just a fantasy if one is settled in urban space be it anywhere in the world.

For a fraction of the populace at least, an ideal house is just not four cement plastered walls covered with a concrete roof; instead, for them it has to be a living establishment that blends itself into nature, thereby becoming a part of an imperious scale of beauty. The house should ensure that it promotes better quality of life and involves lesser wastes, better reliability, lower life-cycle environmental impacts, low maintenance and more re-use.

Bodhi, is a humble, traditional mud house in this era of steel, glass and concrete built in 1996 in Quilon district in the State of Kerala. This mushroom shaped house that easily blends with the nature is owned by Retired Joint Commissioner Jithendran, Rural Development Department and his wife Shima.



Figure 2 'Bodhi'-Mud house designed by Eugene Pandala

The house is built entirely with clay rich mud that was procured locally and then stabilised with 5 percent cement content. Cobs or globs of mud are used to build the walls manually.

This cob technique is one of the oldest methods of mud construction. Local labourers were called in for the assistance and their expertise in building with mud was also tapped.

As for the roof, the architect has used the extremely malleable and light-weight ferro-cement topped by a layer of coating with tar and roof tiles placed over to make it more durable and as a shield against heat generation. With lighter roofs, the walls and even the foundation bear comparatively less weight and the well thought out roof designs prevents walls from being exposed to rainwater during monsoons.

The 2500 sq. ft. house is a simple but elegant, with a family room for entertaining guests and a smaller more intimate living room for relaxing and watching television. The living rooms, dining, kitchen and a bed room are

"The cost for constructing this 2500 sq. ft. house was four hundred thousand Indian rupees at that time".

- *Owner of the mud house, Bodhi*

more of a 'front house' design, while the remaining two bedrooms and study room are on the other end, both separated by a beautifully laid out courtyard surrounded by green plants that help in improving the indoor air quality. Posh spacious rooms with modern bathrooms and terracotta flooring that are aesthetically laid out using old and rejected tiles adds oomph to this beautiful nest. There are fans in the rooms, but no air-conditioners as the mud architecture and effective stack and cross ventilations ensures that temperatures are regulated naturally. The storage racks, bed, telephone stand, table and small stools were made of clay, which blended well with the structure.

In spite of 22 long years, the house stands tall in perfect shape after years of its exposure to hot and cold and humid and dry weather conditions. What is more surprising is the fact that the owners till date have spent nothing on maintenance. No wonder, for this commendable work, in 1999, 'Architect of the Year' award was bestowed to Eugene Pandala by J.K. Foundations.

Salient Features

- Mushroom shaped house that easily blends with the nature
- Natural materials, such as soil, lime, etc. are used for construction
- Have adopted Cob technique – one of the oldest methods of mud construction.
- Skills of local labourers were utilised and also helped the labourers to enrich their knowledge on mud construction
- Rejected and old terracotta tiles are used extensively
- Minimised wastes where feasible, and reused materials which might otherwise become waste
- Effectively used natural elements (wind, water, sunlight) to enhance comfort and transform the house into a pleasant and relaxing environment
- Incorporated mud even into the furniture and fixtures of the homes.
- Zero maintenance cost inspite of 22 long years.

Eugene Pandala – An Architect with a Vision

Eugene Pandala, the Indian architect, known for building with values of environmental sustainability completed the modern mud house *Bodhi* that boasts forward thinking designs and peaceful arrangements. Pandala's ranges of works are institutional and industrial buildings, commercial complexes, five star hotels, resorts, residential and conservation and landscape projects in India and abroad. He has authored many articles on sustainable architecture and heritage conservation in leading newspapers and magazines and presented papers on sustainable and cost-effective architecture, and conservation at national and international conferences.

In late 70's during his Master's Programme at Delhi, he happened to attend a seminar by the legendary Egyptian architect Hassan Fathy. The learning from the seminar prompted to read Fathy's book entitled, 'Architecture for the Poor: An Experiment in Rural Egypt'. Around the same time, he happened to visit the Centre for Development Studies office at Trivandrum, one of the classic works of Laurence Wilfred Baker (Laurie Baker), the famous English born architect. Both these experiences, coupled with his deep knowledge on traditional architecture and his love for nature prompted him to turn towards mud construction and sustainable buildings.

Most of his buildings are designed as 'raw material depots'.

When it comes to mud construction, Pandala prefers the cob technique and do not prefer geometrical shapes. His buildings have flowing, curvaceous shapes that one will never find anywhere else. He is known for bringing in

mud even into the furniture and fixtures of the homes he builds. Most of his buildings are designed as 'raw material depots' – materials are placed temporarily and can be relocated and reused in future cycles without loss of quality. This vision of his helps to accelerate the transition from the current Linear Economy to a more sustainable Circular Economy.

His unique architecture style paved way for many awards, and recognition. In 2011, Lalith Kala Academy awarded him the first Laurie Baker award.⁶ The award was in recognition to his contributions to the eco-friendly cost-effective architecture. Likewise, Inside Outside design magazine bestowed him the designer of the year award⁷ in 2007 and a commendation award in 2004 for his heritage Conservation project in East Fort Trivandrum.

Some of the notable projects of his includes a five star hotel in the backwaters of Quilon, the Banasura Hill resort in Wayanad, Revathy Kalamandir studio at Kinfra park at Kazhakoottam and a retreat for wildlife photographer Joanna Van Gruisen wildlife scientist Raghu Chundawat at Sarai near Panna National Park in Madhya Pradesh.⁸ Pandala's Tsunami rehabilitation project done at Quilon and Alapuzha Districts of Kerala for leading local news daily and buildings for hospitality industries receives wide acclaim due to its interwoven complicity with nature.

2. Siddhartha, Trivandrum, Kerala

Imagine a mud house situated at the centre of lush green garden with hundreds of plants, trees, small pond and shed accommodating sheep, cow and chickens. This is dream of a tired and exhausted person with urban lifestyle and looking for a place that offers eco-tourism to relax and meditate. But for Shankar, an architect who has built hundred thousands of sustainable houses both within and outside the country, it is vision to build sustainable habitats replacing the concrete of present.

Shankar's mud residence at Mudavanmugal Trivandrum *Siddhartha* is a magnificent wonder. Spirituality and architecture are synchronised in the hands of this philosophical architect and its impact can be seen in this construction, a fantastic residence based on the spiritual values of Lord Buddha.



Figure 3 'Siddhartha': Mud house designed by G. Shankar

The house stands proud on a land that was once barren and low-lying between two hills. There was no plan to build a house when the plot was purchased, so Shankar and his wife started a small farm first breeding cow, goat and chickens. Years of breeding

⁶ First Laurie Baker Award announced, The Hindu, 30 January 2011.

⁷ Kerala Artist Retreat Bags Best Eco-Friendly Design Award, Business Standard, 25 March 2012.

⁸ Commune with Nature, The Hindu, 05 December 2009.

and accumulation of animal waste on the soil transformed the infertile soil fertile. This encouraged them to plant trees and plants. Now there are more than 140 trees on this plot that has some of the rare species like *Terminalia arjuna*, copper pod tree, *Macaranga indica*, etc.

The house was built without any plan or pre-planned structure. Elevation of the house was not drawn, it just happened. As each day passed by, fresh ideas came through his mind and he just tried to implement those and kept with the flow. All throughout the construction he has exclusively used only mud, as he wants to showcase that the human life is from the soil to the soil.

Adobe bricks (mud bricks) are widely used and they are the basic mud bricks, made of a mixture of earth and water using moulds of metal or timber. After

Following circular economy principles, recycled wood from old buildings were used to fix windows, doors and furnitures.

moulding, it is allowed to dry in the open air, without direct sunlight. The earth should be made up of 80 percent sand and 20 percent clay as too much of clay causes adobe to crack. The roof of the house is also built exclusively using mud. While nice soft mud is used to build the walls, mud blocks were used in the ceiling and soil mixture for wall plastering. Stone lintels are provided in the form of one single piece, with roofs thatched with coconut shells and bamboo.

Following principles of Circular Economy, recycled wood from old buildings were used to fix windows, doors and furnitures, which are given a natural polishing using cashew nut extracts instead of the harmful chemicals. An arch shaped formal sit out welcomes the guest with seats provided on both the sides. The front sides of this entrance are decorated with small bamboo pieces with holes so as to provide privacy to those seated in the porch and at the same to protect from direct sunlight.

As you enter the house, one can feel the cold ambience with adequate breeze and light within the structure. This negates the use of ceiling fans and air coolers. The formal living is separated by well-arranged bamboo pieces to provide privacy to Shankar's private chamber that is on the other side of the living. A long corridor stretch from the living room to the staircase and on the sides are the dining room, kitchens, courtyard and the reading room all arranged aesthetically and neatly. Lot of space up to the roof of kitchen is well utilised by building a storage space with bamboo. Using multi-wood, *Jali* designs have been provided in the elevations through which sunlight seeps through and provides a mesmerising view.

The architect has ensured to construct each room in the ideal location with suitable atmosphere to support the overall purpose. For instance, the window of the reading room is open to the shades of the banyan tree. At night, the symphonies of various insects add charm and encourage reading.

However, the focal point of this house is the patio where nature is blended intelligently. Rainwater, air and sunlight seep through the patio giving freshness to the house all

through the time. A small pond designed with pebbles and bamboos on all sides adds beauty to the patio.

Master bedroom is on the side the long corridor, where the cot is made of stone without using wood. Storage space is also set below the cot. Similar layout is followed in the bedroom, which is built upstairs. The staircase leads us to a small living area adjacent to which is a small photo gallery. The photo shelf was made from the parts of a staircase that was collected from an old house that was ruined. Thus, the house not only uses natural resources but effectively uses recycled old demolished building parts which would have otherwise gone as waste.

By using mud as the primary material, Shankar has imbibed cost-effectiveness, energy efficiency and sustainability intact, which makes *Siddhartha* an ideal model of architecture, in contemporary times.

Salient Features

- Natural materials, such as soil, lime, etc. are used for construction
- Have adopted adobe construction – one of the oldest and most versatile building techniques used by humans
- Coconut shells and bamboo are used in the roof
- Old building parts and woods reused
- Wooden fixtures and furniture's polished using cashew nut extracts
- Tiles from an old school that was demolished were recycled and reused extensively
- Minimised wastes wherever feasible, and reused materials which might otherwise become waste, were consumed
- Effectively used natural elements (wind, water, sunlight) to enhance comfort and transforming the house into a pleasant and relaxing environment
- Barren land was transformed into a self-sufficient organic farm

G Shankar – Towards a Smarter and more Sustainable Future

Considered India's prominent green architect, Gopalan Nair Shankar is the Founder and Chief Architect of Habitat Technology Group, a large not for profit organisation, international architecture firm known for its sustainable projects. Having done more than 150,000 buildings and half a million mass dwelling units, all using sustainable technologies, Habitat Technology Group (HTG), has now more than 35 offices spread all over India with project offices in international locations, such as Bangladesh, Sri Lanka, Nigeria, etc. among others.

My philosophy is to promote sustainable architecture that is sustainable to lifestyles, social climate and cultural milieu; sustainable to the earth and to humanity

- **Padma Shri Shankar G**

A promoter of traditional building methods, Shankar is known for his use of locally available materials to build energy efficient and low-cost buildings. He was greatly influenced

by the architect Laurie Baker, a British-born Indian architect, renowned for his initiatives in cost-effective energy-efficient architecture and designs. Shankar is celebrated for his sensitivity to the needs of the urban poor and this earned him the title of 'People's Architect'. He finds fulfillment not in building magnificent structures but also in constructing cost-effective homes for all strata of the society.

For his tireless efforts to build low-cost yet sustainable buildings all these years in India as well as in neighbouring countries, the Government of India honoured him with the Padma Shri in the year 2011. Shankar has received hundreds of awards and citations for excellence over the years. The National award for slum rehabilitation works instituted by the Ministry of Poverty Alleviation Government of India in 2004; First Laurie Baker award constituted by Government of Kerala for outstanding contribution to low cost housing technologies; and the Best tsunami initiative in India – United Nations Development Programme (India) are few ones.

Other than his concern for environment and urban poor, women empowerment and grassroot level involvement has always been Shankar's priority. His initiative currently provides employment to 800 women and is making efforts to educate and train women in the field of building construction and further more empower them in all aspects of life. More than 50 percent of construction workforces are women.

Since 1987 he is a UN Consultant for disaster mitigation (Srilanka & Maldives)⁹ and also a member of a number of national level bodies, both official and non-governmental. Being an enthusiast of sustainability, Shankar realises that buildings consume a full half of all the energy that is generated, plus cause half of the world's carbon emissions. Nearly 33 percent of energy is consumed in the production process of steel and cement alone. So architects have a responsibility to help change these numbers, i.e. the very reason why sustainable architects like Shankar not often promote use of these products in their construction.

The largest Earth building in the world in the area of 600,000 sq. ft in Dhaka, Bangladesh is also designed by Shankar. His other notable works include rehabilitation housing colonies for Tribals, *Dalits* and fishermen in the States of Kerala, Tamil Nadu, Andhra Pradesh and Orissa.

Way Forward

Though half of the buildings across the globe are still made out of mud, the mindset about it being a poor man's house is what hinders recognition and acceptance among common mass in India. Besides, people's limited knowledge in general about the subject compels them to be wary about the durability of the overall final structure and materials used. They also seem to be under a misapprehension that mud houses are easily prone to termite attacks and requires specialised care and attention on a day-to-day basis.

⁹ Padma Shri Prof. G Shankar, Accessible at <www.cetaa.com/article/111/padma-shri-prof-g-shankar>

If these apprehensions were true then some of the iconic monuments would not have survived till date, including the Great Wall of China and Dejenne Mosque in Mali. In fact mud is non-toxic, non-allergic, rot and termite proof, controls humidity and offers great sound isolation. These structures can balance fluctuations in temperature throughout the year. Most importantly, there is no damage to the environment in any manner. Whatever materials used in construction return to earth after their lifecycle without damaging the ecosystem.

A huge deficit of housing demand in urban and rural areas linked with limited resources on all fronts make it absolutely essential that the housing solution have to be best effective, through optimal and efficient use of all resources of land, finance and building material. But at the same time, it is the responsibility of governments, architects and builders to put forward Mud Construction as the best option for all sections of the society and break the stigma attached with it since decades. It is also important the works of architects like Eugene and Shankar are brought to global level and more research is promoted on the subject to design best technologically stable and strong structures which are environment-friendly.

Goal 11 of SDGs calls for Sustainable Cities and Communities which cannot be achieved if we do not start with intelligent urban planning and management which is not just environmentally-sensitive but needs to be inclusive also. Moreover, how we plan and design our habitats today will directly affect our pledge for Responsible Consumption and Production, as highlighted in Goal 12. The huge amount of carbon footprint added by the construction industry points to the extreme situation we are pushing ourselves into, but the opportunities of change with available alternatives like use of mud, reuse of recycled materials, and reducing the grey energy at every possible step shows the path one should follow immediately.

Low-cost and Compostable Sanitary Napkins

Introduction

“Menstruation”- a word which has been shushed since ages and considered a taboo not just in India but all over the world. A normal routine biological female body process has been associated with numerous myths and the ways to deal with it may give goose bumps. According to a survey by a women’s health app Clue in partnership with the International Women’s Health Coalition¹⁰, there are more than 5,000 alternatives all over the world just to talk about periods (or not to talk about periods). The same survey also highlights, that just 34 per cent women felt comfortable talking about menstruation with males and 17 per cent of survey participants said they had missed school, work or an event because they were “afraid of someone finding out” they were on their period!

In India, the land of religion, traditions and culture, menstruation is considered as ‘unclean’ and women in the house are often discriminated for first three days by restricting their entry to kitchens, temples and ban on touching food items and even people in some cases. Till date, shopkeepers in India pack sanitary napkins in old newspapers or black polybags before handing them over to buyers, treating it as a commodity, which shall not be displayed openly to public.

Similarly, many girls and women in developing countries face unbelievable hardship when it comes to periods, which are far more than just talking on subject but it also impact their health. According to a study, one in 10 girls in Africa do not go to school because of inaccessibility of sanitary products and women all over the world use alternatives as sand, leaves, ash, and even cactus leaves because the basic necessity of sanitary products is still a luxury to many¹¹.

The famous case of ‘tampon tax’ protest in Britain in 2015 and recent case of putting Sanitary napkins under 12 per cent GST slab in India, highlight the plight of women. As recent as 2013, women in villages of Amritsar were reported of using sand, ash or sawdust filled with dirty socks or rags during their menstrual cycle¹² and the live examples can be witnessed in many more rural areas of the country.

According to National Family Health Survey IV whose findings came out in public in early January 2018, as many as 62 per cent young women in the country in the age group 15 to 24 years still use cloth for menstrual protection. The usage of sanitary napkins in rural India is just 48 per cent while at the urban level the usage is 78 per cent. Though, usage of cloth for menses cannot be considered an unhygienic practice if used in a proper way after washing and drying in sun, but in case India (or any developing country) where basic necessity of clean water and toilets are still a target to achieve, 62 per cent of women being still dependent of cloth can be a matter of concern. As per another survey by A C Nielson and Plan India, the penetration of sanitary napkins in

¹⁰ https://www.huffingtonpost.in/entry/period-taboo-survey_us_56d80c9fe4b0ffe6f8e83aad

¹¹ <https://www.telegraph.co.uk/women/womens-life/11970759/Periods-How-women-around-the-world-cope-with-the-luxury-of-periods.html>

¹² <https://timesofindia.indiatimes.com/city/chandigarh/Sand-filled-old-socks-being-used-as-sanitary-napkins/articleshow/21533049.cms>

India is just 12 per cent but even if we take NFHS IV as more appropriate measure with large sample size and authentication from the government of India, there is lot of work still need to be done to promote sanitary hygiene products among Indian women and shattering the taboo associated with the subject.

Sanitary Hygiene for Women

It is important to understand what is restricting the sanitary napkins from becoming a commodity available to all, especially in a developing country like India. The Indian sanitary napkin market is dominated by three players majorly, i.e., Procter & Gamble Co. (P&G), Johnson & Johnson, and Kimberly-Clark with P&G dominating around 60 per cent of the market¹³. All these three players with big names, which does not need introduction, do not have origins in India, thereby limiting the role of local and unorganised players who exist but never get recognition. The second factor is the price of sanitary napkins being sold in Indian markets. The price of market available products start from Rs 4.125 per pad to Rs 26 perpad.

According to gynaecologists, a woman should change her pad after four to six hours to avoid infections and maintain reproductive health. This means during a cycle of five days, a woman requires four pads for every *five days, which is equal to minimum 20 pads per month. Now, for a family with at least one female in the house, around Rs 82.5 would go for sanitary products and the expenditure increases with increase in number of females in the house. Though, this Rs 83 seems like a nominal amount to invest per month per female, but for households earning Rs 6,000-10,000 per month for a family of average five people, these sanitary napkins seems like a luxury and often the money is diverted for other necessities and women compromise with use of cloth and other alternatives.

Low Cost Sanitary Napkins- Community-Owned Model

Arunachalam Muruganantham, famous as Padman of India, brought sanitary napkin revolution in India and gained global recognition for his invention making low cost sanitary napkins available to women.

A school dropout from a poor family in southern India has revolutionised menstrual health for rural women in developing countries by inventing a simple machine they can use to make cheap sanitary pads. He became a case study for best research institutes all over the world and the stories were published in journals, newspapers, and magazines at International and National Level, both on and off internet.



Figure 4: Women manufacturing Sanitary Napkins in a training centre run by Jayshree Industries

¹³ <https://economictimes.indiatimes.com/markets/stocks/news/procter-gamble-to-rise-in-sanitary-segment-while-facing-competition-in-healthcare/articleshow/52612228.cms>

With Muruganantham's community-owned model approach, many local units manufacturing low cost pads came up, which have both male and female workers but the women dominated the units. The model had many benefits for women and society at large:

1. Sanitary napkins became affordable and easily available in the area of manufacturing.
2. Taboo about periods and use of sanitary napkins began to break as local women were involved in the manufacturing. They felt much more confident talking about menstrual hygiene and spread awareness on the issue.
3. It led to women empowerment as women now were employed in the small unit gaining them monthly income.
4. Men in the house did not mind their wives and daughters to work in a unit close to their house adding extra household income and the work environment also suits the societal constraints of India.
5. The flexible working hours and multiple shifts also gave freedom to women to take care of their household chores without any domestic conflicts.

Kanika. Thrissur

Kanika is a NGO working for social cause in the field of education, health, women empowerment, one of them is being menstrual hygiene. Vasanthi Gopalan led initiative has group of women mostly retired and from well off families, who took up the cause of menstrual hygiene for other women in their neighbourhood who could not afford costly sanitary napkins available in the market. In a very interesting way, these women who can afford luxury in their lives have thought about people who could not do it and voluntarily pooled in the money to buy the sanitary napkin machine invented by Muruganatham and set up a small one room in at a rented place in Thrissur, where they themselves work for three-four days in a week and manufacture the pads. The manufactured pads are supplied to nearby girl's home and rest are sold to people who come with their demand under the brand name 'Soukhyam' meaning wellness in Malayalam.



Figure 5: Vasanthi Gopalan with her team manufacturing Sanitary pads.

Safety Concerns

Sanitary pads are made of different layers — the cover stock, acquisition and distribution layer, absorbent core, back sheet, and siliconised paper¹⁴. The pads available in the market come with high absorbency rates (30 times its weight) due to use of Super Absorbent Polymers (SAPs) either in the form of granules within cellulosic fibre matrix or in the form of composite fabric layer. Dioxins are used to bleach the cotton/material used for making absorbent core, and it is responsible for side effects in the body such as pelvic inflammatory disease, ovarian cancer, immune system damage, impaired fertility and diabetes. SAPs are added to increase the absorption capacity, but in 1980s, use of SAPs was restricted in tampons (in the US) due to its possible link with toxic shock syndrome, a potentially fatal illness caused by a bacterial toxin.”¹⁵

The brands available in the market these days claim for all day protection, which promotes wrong attitude that these pads can be used for up to 12 hours. This is leading to increasing cases of infections, which are also often ignored by women, thus eventually leading to more severe infections and diseases.

“In India, for sanitary napkins affordability is not only the issue, there are several other associated issues as well. When Aakar started, we wanted not only to make affordable but good quality pads. The use of sanitary napkins needs to be encouraged but at the same time problem of disposing these pads shall also be tackled. Every year menstrual waste is increasing adding to landfills, which is effecting our environment and increasing health hazards. From all these problems, one solution came out, that we need to make something, which will be affordable, good for health & environment-friendly as well. So we started using bio/organic materials only, which composts after a period of time. Depending upon the conditions, the time may vary from six months to one year but it will become manure only.”

-Jaydeep, Founder, Aakar Innovations

Sanitary Waste

The non-permeable bottom sheet of the pad is made from polyethylene or polyurethane to make it stain free and the outer package of the product is also plastic. When these sanitary pads are disposed, they either end into sewerage waste blocking pipes and flow, incinerated in backyards polluting the environment or end into landfills adding to huge heaps of waste. In India alone, the sanitary waste is estimated to be 113,000 tonnes annually¹⁶ adding to huge burden of solid waste management in the country. If the sanitary napkins continue to be manufactured in the same way, this will add to plight of high pollution levels, which are continuously rising due to use of non-biodegradable plastic and unmanageable solid waste not only in India but in the world.

¹⁴ <https://www.livemint.com/Industry/T3XliwJI31WZuK1IsoUOJL/How-safe-are-sanitary-pads-in-India.html>

¹⁵ <https://www.livemint.com/Industry/T3XliwJI31WZuK1IsoUOJL/How-safe-are-sanitary-pads-in-India.html>

¹⁶ <https://www.hindustantimes.com/fitness/world-environment-day-here-s-how-disposable-sanitary-napkins-mess-up-health-and-hygiene/story-Tf06UvFA6iBcWgUZ0qeWVL.html>

AAKAR- Natural and Compostable Sanitary Napkins

Taking inspiration from Muruganatham and following his footsteps to make low cost sanitary napkins accessible to women in both rural and urban areas, Aakar Innovations has taken a more eco-friendly approach to the issue.

Aakar is a hybrid social enterprise comprising Aakar Innovations and Aakar Social Ventures that enables women to produce and distribute affordable, high-quality, **100 per cent compostable**, low cost sanitary napkins, within their communities while simultaneously raising awareness and sensitization of menstrual hygiene management. Aakar has setup more than 35 units across India and the sanitary napkin produced have a common name and are popularly known as 'Anandi' pads.

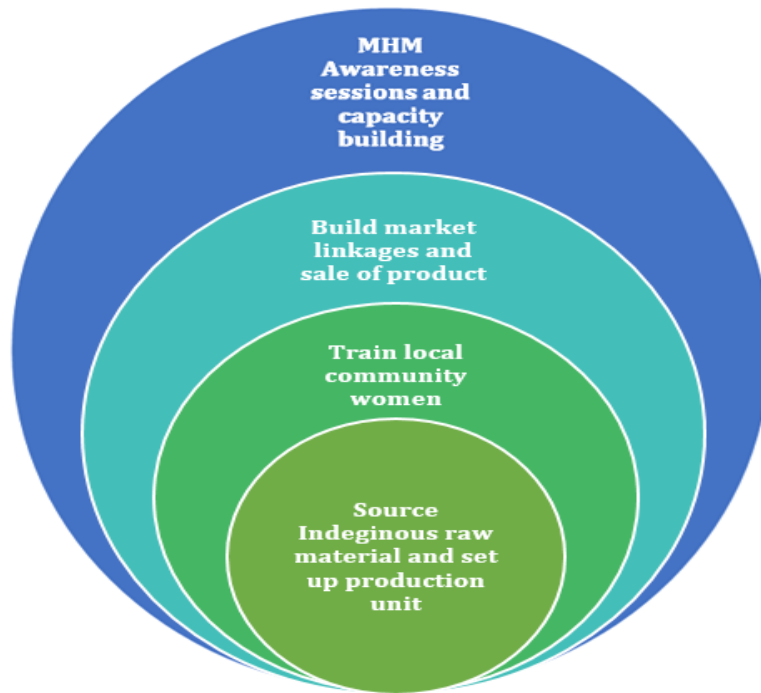


Figure 6: Aakar team in Training and Research Centre in Ulwe, Navi Mumbai

Aakar machines and innovative raw materials produce high-end pads that match the quality and comfort of those produced by MNCs at a lower cost. Beyond the obvious health benefits, there are huge positive outcomes with respect to livelihood and women

empowerment. According to Jaydeep, founder of Aakar, the enterprise works on community-owned model similar to one started by Muruganathan. The manufacturing units employ only women, leading to local employment generation, skill development and increase in disposable income for women. The primary focus is on increasing community knowledge, changing attitudes, behaviours and practice towards better menstrual health and hygiene by creating 'change-agents' within the community.

Aakar's livelihood model led by women has crucial benefits around health, education, and women empowerment. Aakar strongly believes that a true long-term change can materialise only if an initiative is community and women-led and driven. The enterprise sets up small units run by women from marginalised communities in a manner that is sustainable over the long run and provides dignity and hygiene to women in the neighbourhood.



In setting up the unit, Aakar takes up responsibility of:

- Supplying and maintaining the machinery and related technology pieces.
- Supplying raw materials to the unit.
- Training workers involved in production, sales persons, unit managers etc.
- Collaborating with NGOs and Self Help Groups for building awareness on better menstrual hygiene.
- Overseeing operations of the unit and technical support.
- Marketing the brand Anandi and establishing sales channels.
- Arranging bulk sales deals with institutions such as NRHM scheme, hospitals, PHCs etc.
- Arranging buyback for some of the products produced in case they are not sold in the local market.

Benefits of Anandi Pads:

- a) Affordable.
- b) SAP free.
- c) Fully Compostable
- d) No side effects.

“There is no comparison with the plastic napkins. Rather it is beyond comparison. Anandi is either ~100 per cent compostable or normal. After using, one just needs to put it in mud/soil/ even if in kitchen waste, depending upon environmental conditions (time may vary), it will be decomposed and will become manure. This is not at all possible for a plastic napkin. In plastic napkins most of the manufacturer use SAP (Super absorbent polymer), which we don’t use. These pads are affordable to everyone in comparison to the other pads available in the market”.

While discussing on the subject, Jaydeep confidently explains the difference between a Biodegradable and a Compostable pad and why he calls his product as fully compostable and nowhere in the brand description the word biodegradable is being used. According to Jaydeep, the products in the market are being sold with the tag ‘Biodegradable’. Some of the socially responsible customers

who are concerned about environment are buying these products without thinking about the duration of degradation of these used pads. Even the brands do not mention the time required for decomposition anywhere on the package. “A biodegradable product will be decomposed but one doesn’t know the time period, which means it can even be 100 or 1,000 years. Use of word 100 per cent compostable means we are giving guarantee that the pad will decompose anytime between six months to one year”, says Jaydeep.

Aakar has a training and research unit in Ulwe, Navi Mumbai where the women are trained about technicalities of the manufacturing process and quality check and R&D is done in separate research lab. Women are trained to work on both manual and automatic machinery and per day production is about 1,400-1,500 pads. Though, the enterprise promotes compostable napkins but in rural areas where cost is a big issue, regular non-compostable pads are being manufactured and sold at Rs 28/pack of eight pads. The reason for manufacturing non-compostable pads is the higher cost that goes into making fully compostable pads and use of eco-polythene at the bottom layer. Once the women in rural areas start using the pads and the behavioural change is achieved, the promotion of eco-friendly and fully compostable pads is pushed forward.

While the pads manufactured by Muruganatham are eco-friendly but not fully compostable, these Anandi pads come with 100 per cent compostable material as even the bottom layer is made of eco-polythene, which somewhere increase the cost of these

Aakar, Dharavi Unit

Dharavi in Mumbai is popularly known as the “Asia’s Largest Slum”. Although spread across 550 acres, Dharavi has a population density of over 10 times the rest of the city. It is, therefore, a complex city within the larger city of Mumbai, with a number of small and medium industries, housing in unsanitary conditions, schools, and religious and community centers¹. The popularity of the area is such that it has been used as a setting for many movies, the most popular being Danny Boyle’s *SlumDog Millionaire*. Aakar has set up a manufacturing unit in Dharavi engaging local women who come for work according to time which suits them. Mostly, the manufacturing starts only after 2 PM when women are free from their household work like and cooking and cleaning and even the children are back from their schools. The timings have been set according to feasibility of women. Living near the unit and not compromising with time given to the family has given them comfort and freedom to work adding to their monthly income. The team in Dharavi working for three-four hours per week manage to produce around 10,000-12,000 pads per month, which they sell to women in Dharavi at Rs40 for a pack of eight pads and rest of them are bought back by Aakar.



Figure 7: Women trained by Aakar in Dharavi Centre, Mumbai

pads to Rs 40 for pack of eight pads when compared to regular non-compostable pads at Rs 28 per pack. In another effort, the team is working to come out with products made from indigenous materials like jute in West Bengal and banana fibre in South India to promote local economy and work more closely with nature.

Way Forward

The sanitary napkin revolution that started in 1888 with introduction of 'Southhall pads' has advanced with technological innovations and research on the subject. Though, the quality and technology increased giving more comfort to the women, there is still a large section of women in the world for whom use of sanitary napkins is a luxury. The high cost, which restricts the affordability, especially in developing countries, and the menace of sanitary waste adding to already existing problem of waste management all the world, demands for a solution that is affordable and eco-friendly. As an unexpected outcome, the technological advancement is turning into a health hazard for women who directly use chemical-based sanitary products for long hours and indirectly for every living creature on earth who is dealing with rising pollution levels from waste that is generated after disposal of these used sanitary products.

In an effort to deal with the issue, revolutionaries like Muruganatham and social enterprises like Aakar Innovations have become pioneers to show that the solution to every problem exists but we have to find and adopt it properly. The target customers of both the models are women from marginalised and rural setup who are struggling to deal with this natural biological process and are still using dirty cloth, rags, sand, ash, etc. The model does not only targets better health and hygiene of the women but directly promotes local livelihood and skill development in turn leading to women empowerment.

The concept of compostable and affordable sanitary products is the need of the hour not just for a section of society but should be promoted on wider scale at both urban and rural setting and for all sections of the society be it poor, middle class or rich. The products manufactured at present have some challenges for acceptance among women who consider brands safer and of better quality. The Anandi pads are not as thin as products available in the market nor do they come in various size variants, but at the same time they are compostable and do not use any harmful chemicals. The promotion of brands which use SAPs for providing 12 hours protection shall in no way be encouraged as the maximum recommended time to change pads is six hours to avoid infections. As suggested by Aakar team, the government should take initiatives to frame proper rules and specification for using terms like 'Bio Degradable' and 'Compostable', which otherwise deceive the consumers. The local manufacturing of sanitary napkins shall be promoted for penetration of products in every household in India, which in turn promotes the local economy of the country. The challenges regarding the size, quality and comfort can be addressed with more push for such models backed by better research and innovations. The lack of effort and investment in R&D gives way to international brands to capture the market and sell anything to the consumers without any liability of proper information dissemination about the quality of products. The

television commercials highlighting the sanitary napkins with 'Super Absorbent Gel' giving '12 hour protection' does not give any idea about what this gel is and what can be the side effects. The women are just concerned about absorbency of the product and the price, which does not leave them with stains on the pants and hole in their pockets. Muruganatham showed to the world, sanitary napkins can be cheap and if changed in every four to six hours they work well for any women on her menses. Aakar showed that sanitary napkins can be cheap, compostable and without any chemicals benefitting not just the women but also taking care of the environment. The women taking a step forward to deal with taboo of menstruation is a sign that the world is changing and we will not accept any shaming in the name of traditions and culture. The signs are positive and the future is bright!

Green use of Brown Coir- Coir Industry of India

Introduction

Increase in global awareness regarding social and environmental impacts of various manufactured products has led to a surge in demand for new sustainable and environment-friendly products. The case of coir, therefore, perfectly fits in that category, which could easily replace synthetic furnishings, certain wooden building materials and chemical fertilisers.

This case study highlights coir sector as one of the traditional sustainable practices that has a potential of replication on a larger platform in relation to the concept of sustainable culture and circular economy. This case study explores the manufacturing approach that is committed to sustainable and environment-friendly principles and designed to prevent any waste. The study reveals a business model that could also positively contribute towards generating employment opportunities and sustainable household income for the rural community. Hence this type of environment-conscious manufacturing process could address the three pillars of sustainability: social, economic and environment.

Kerala Coir Industry

The coconut tree, commonly referred to as the tree of life, provides some of the basic necessities for humans and its uses are endless. The tree not only provides large sized nuts, which are an excellent source of food and nutritious water but its various parts are also used for shelter, fuel and raw materials. Thus coconut tree is popularly named as *Kalpavriksh*- the all giving tree.

Coir fibre extracted from coconut husk is one of the versatile products of the coconut tree. Naturally blessed with the highest concentrations of lignin, a natural polymer, coir is used for production of various products including geotextiles, floor coverings, door mats, furniture padding, handicrafts, brushes, ropes, coir pith organic manure and as filling for mattresses.



Figure 8: Coir Industry in Kerala

According to the Coir Board, the statutory body established by the Government of India for the promotion and development of coir industry in India, the history of coir and its association with the state of Kerala dates back to the 19th Century. Alleppey district is the nerve centre of the coir industry where both men and women are actively involved in the production of coir. The women are mainly involved in the yarn spinning section and the men in the product-weaving section. The industry enjoys the status as the largest cottage industry in the state of Kerala, giving employment to over a million people.

Other than the Coir Board, the sector has other prominent agencies like the Coircraft and Coirfed who are working towards the upliftment and well-being of workers within this traditional sector. Kerala State Coir Corporation (Coircraft) was formed in 1969 for a systematic improvement of coir industry in Kerala. It is fully-owned by government for the development of coir industry in Kerala. Production and marketing facilities for small scale coir producers are set up by Coir Corporation. Likewise, the Kerala State Co-operative Coir Marketing Federation (Coirfed) is an apex agency of primary co-operative societies of coir industry across Kerala. The main function of the Coir Board is to collect and sell coir products from co-operative societies. The federation has some 842 primary coir co-operatives societies.

The development of Coir Industry is mainly associated with the production of coconut as the fibre is extracted from the coconut husks. As per 2017 statistics, India is leading in the global coconut production and productivity. The annual coconut production is 2,395 crore from 20.82 lakh hectare and productivity is 11,505 coconuts per hectare. Coconut contributes to about Rs27, 900 crore to the country's Gross Domestic Product (GDP). In the year 2016-17, coconut products worth of Rs2, 084 crore were exported.¹⁷ More than one crore population depends on coconut cultivation for their livelihood and its production is largely concentrated in the four southern states, namely Kerala, Tamil Nadu, Karnataka, and Andhra Pradesh.¹⁸

Given the huge production of coconuts, India easily became the major producer of coir among the coir producing countries in the world. There are two types of coir - brown fibre, which is obtained from mature coconuts, and finer white fibre, which is extracted from immature green coconuts. While the entire production of white fibre gets converted to coir yarn that goes for the manufacture of value added products, brown fibre produced is consumed for rope making, curling, for rubberisation, stuffing, upholstery etc.

Until few years before, India was merely a fibre and yarn exporter, but industry underwent drastic changes and the country now became a leading exporter of value-added goods. This has, in turn, brought about a major shift in the total volume and value of exports.

¹⁷ India is the leading country in coconut production and productivity in the world, Press Information Bureau, Government of India, Ministry of Agriculture & Farmers Welfare, 27 January 2018. Accessible at <<http://pib.nic.in/newsite/PrintRelease.aspx?relid=175922>>

¹⁸ J. Nehru Naik, Growth Trends in Area, Production and Productivity of Coconut in Major Growing Countries, IOSR Journal Of Humanities And Social Science, Volume 22, Issue 9, Ver. 12 (September. 2017) PP 47-56.

Coir Economy

According to Coir Board, 9,108 coir units are registered till 2016 in Kerala and the industry provides employment to about 472,100 people. A total quantity of 752,020 MT of coir and coir products valued at Rs1901.42 crore was exported from the country during the year 2015-16 as against an export of 6,26,666 MT valued at Rs1630.33 crore during the previous year. There is an overall increase of 20 per cent in terms of quantity and 16.6 per cent in value over the export achieved during the previous year. During the period from April 2015 to March 2016, while exports of coir pith, coir geo-textiles, handloom matting, tufted mat, power-loom mat, coir rugs and carpets registered growth, products like handloom mat, curled coir, rubberised coir and power-loom matting have shown decline. Coir pith with export earnings of Rs688.09 crore constituted 36 per cent of the total export value of coir products from the country. Similarly coir fibre with an export of Rs417.67 crore constituted to 23 per cent of the value of total exports. All other value added items put together constitutes 41 per cent of the total export earnings of the country.¹⁹



Figure 9: Coir Industry manufacturing Coir Mats and other Products

During this period, 115 countries imported coir and coir products from India. The United States of America (USA) topped the importing countries with 26.2 per cent in value and 15.6 per cent in quantity. China emerged as the second largest importer of coir and coir products from India with a share of 24.3 per cent in value and 37.1 per cent in quantity. The other countries, which imported substantial quantities of coir during the year were the Netherlands, South Korea, the UK, Spain, Italy, Australia, Germany, Canada, France and Belgium.

Sustainable Process & Products

Coir fibre is a natural, biodegradable and environment friendly fibre extracted from coconut husk. The coconut husks collected from the farms are crushed in a crushing machine and soaked in sea water or lagoon water for few days. Traditionally, these are then placed on wooden blocks and beaten with a wooden mallet to separate the fibres. But now this is done mechanically by using bursting and decorticating machines

¹⁹ Coir Board Annual Report 2015-2016. Accessible at <<http://coirboard.gov.in/wp-content/uploads/2017/04/AnnualReport2015-16.pdf>>

respectively wherein the fibre and pith are separated. The fibre so obtained is dried in sunlight for a couple of days and packed by using baling press machine.

Coir fibres obtained from fibre extraction units are then wetted by spraying water and after two-three hours, the wetted fibre is passed through the willowing machine to remove the impurities and then the fibre are placed parallel to each other. The fibre is then fed in to the slivering machine wherein it is converted into sliver form. The slivers are spun into yarn as per specifications in the spinning machine. The yarn is then cleaned and wound in to rolls and is now ready for the market. Coir yarn is the raw material for the manufacture of a whole range of coir products. The by-product obtained during the process of coir fibre extraction is coir pith, which is converted into coir pith blocks.

Box 1: Table highlighting sustainability of various coir products

Coir Products	Uses	Sustainability
Coir Fibre, Yarn, Ropes	Coir yarn is the raw material for the manufacture of a whole range of coir products	Alternative to plastic brushes, synthetic mats, marine cordage and fishnets, plastic ropes.
Coir Mats	Used in interior or exterior door fronts.	Alternative to synthetic mats.
Coir Matting's	Used as a floor furnishing material.	Alternative to synthetic Matting's.
Coir Tiles	Matting's are cut, rubberised and finished with narrow straight edges, enabling it to be laid together to form floor tiles.	The ultimate maintenance saver and easy to replace. 100% biodegradable unlike other hard floorings.
Coir Mattings for Cricket Pitches	Special type of matting provided with canvas or leather bindings at the two ends. It is used to cover the Pitch to protect it from the adverse effects of rain, moisture, storm and other natural factors. It is durable and requires low maintenance.	Alternative to synthetic cricket pitch surface.
Coir Rugs & Mourzouk	Used for furnishing a selected area either at the centre of the room or any part of it.	Alternative to synthetic flooring materials.
Coir Belts	Used for driving machines and as conveyer belts.	Alternative to rubber and leather belts.
Coir Mattings for Roof Surface Cooling	It is an effective, simple, economical and environment-friendly method of improving the indoor thermal conditions and reducing the capital and running cost of air-conditioning in the order of 60% and 30% respectively, under hot-dry conditions.	Alternative to asbestos and aluminium roofing sheets. Reduced use of electrical energy due to minimal use of air conditioning.
Acoustic Barriers	Used for making stylish compound walls and garden landscaping. Used as a noise prevention solution in homes located along highways and other high-traffic roads, in offices and around sporting arenas.	An alternative replacement of synthetic based commercial product.
Coir Geotextiles	Soil erosion control blanket.	An alternative replacement of the geo-synthetics
Cocologs	Mainly used for vulnerable streams, rivers or lake bank to protect scour. For high	Protect natural environment.

Coir Products	Uses	Sustainability
	embankment areas with a variable water level, several Cocolog can be applied as stack.	
Cocobeds	Help plant growth alongside steep streams and purify water to a certain extent, protects sea shore.	Protect and promote natural vegetation.
Coir Composite Boards	Highly suitable for building and construction of doors, window panelling, furniture and other joinery work	An alternative replacement to plastic boards, MDF boards, or hard board made out of wood. 40 cubic meters of coirply can save about 66 acres of forest per annum from deforestation, assuming 100 trees per acre and each tree producing 1.80 cubic meters of wood. ²⁰ This indeed is an alternative to destruction.
Coir Fenders	Used to protect the boat from damages due to hitting the dock or other boats	An alternative replacement to plastic fenders.
Plant Climbers or Coco poles	Give ideal support to plants while creating a perfect moist environment for its roots.	Helps retain moisture thus saving water.
Coir Baskets	Used for the domestic gardening, plants grow faster and healthily in coir baskets	An alternative replacement to plastic pots.
Coco Pots (Moulded Coir Pots)	Used as nursery bags for the seedlings, this can be directly planted without removing the 'nursery bag'.	An alternative replacement to plastic pots and covers.
Coir Fibre Discs (Tree Cover)	Protect the plant from weeds and water evaporation.	Aids in water conservation.
Coco Chips	Mixed into pot plant and in gardens. Add a warm hue to the surroundings.	Ideally replaces hard wood and soft wood bark.
Coco Peat, Coir Pith	Superior growing medium for various crops. Acts as an organic fertiliser. Its capacity to hold moisture is eight times its weight making coir pith an excellent soil conditioner.	Ideal substitute for peat moss. Saves water. Reduce usage of chemical fertilisers.
Coco Lawn	Eco-friendly readymade lawns using natural coir products	An alternative replacement to synthetic lawns, which are costly, non-environment friendly and pose disposal problems.

By using materials which are 100 per cent biodegradable, coir products can be safely disposed of and returned to nature. Thus the concept of circular economy fits in very well within this sector.

Social Significance

A large a number of people from the economically weaker sections of the society depends on coir industry in Kerala. Women constitute about 75 - 80 per cent of the work force in coir industry and majority of them are from rural areas belonging to

²⁰ Christy Fernandez, *Coir for Eco Development*, *Coir News*, Vol. XXXII No.6, 20 June 2003. Accessible at <<http://coirboard.gov.in/wp-content/uploads/2014/07/eco-devel.pdf>>

economically weaker sections of the society. In spite of the mechanisation of the coir spinning sector that could reduce the involvement of women, various studies show that the sector's traditional emphasis on women empowerment has remained unaffected.

One of the special characteristics of the coir industry is that it provides full time employment to unskilled workers and part time employment opportunities to agricultural labourers. As per a study conducted by Centre for Market Research & Social Development²¹, with regard to education profile of workers, the findings indicate 35.1 per cent workers are illiterates while 15 per cent are educated upto matriculation, 16.5 per cent are educated upto higher secondary and 7.2 per cent workers are educated upto graduation and above. However, the younger generation is not actively involved in coir industries due to various reasons like low income, hard work, latest machines in the industries, interest in different jobs, education, etc.

From Waste to Resources

Usually, coconut farmers dispose the husks, shell and leaves by burning or allowing these farm wastes to rot in the land. Such measures have always polluted the environment, when not properly managed. While burning of wastes causes air pollution, allowing such residues to rot in the land lead to accumulation of piles of agricultural wastes that often cause mosquito menace and hygiene problem in coconut plantation.

With increased awareness over the years, coconut value added products made from India has shown an increasing trend and has opened up a potential business source. The value added products developed from such waste supplement the farmers' income.

Way Forward

In spite of growing awareness about environmental degradation and increase in carbon emissions, coir and coir products are finding it almost impossible to catch up with synthetic products. The easy availability of synthetics at competitive prices and the rising cost of wages within the coir sector, paved the way for the synthetics to capture the market unchallenged. This is despite the fact that coir is an eco-friendly, biodegradable natural fibre extracted from a renewable resource - the coconut husk. There is a need to further popularise the eco-friendly aspect of coir products and increase the market potential. Diversified products like wood substitutes, packaging material, garden articles, automobile accessories, and biodegradable geotextiles for soil bio-engineering need to be more popularised for commercial exploitation. Now that the Ministry of Environment & Forest is seriously considering incorporating coir under its new eco-labelling scheme, scope for using this as a tool in the export market promotion is not far.

The domestic market in India, although very vast with good potential, still remains unexploited. Just very recently the organised marketing of coir within the country is being undertaken by the Coir Board, Coir Marketing Federations of the state

²¹ Status of Coir Industries in India; Centre for Market Research & Social Development. Accessible at <<http://coirboard.gov.in/wp-content/uploads/2016/09/Executive-Summary-Survey-of-Coir-Industries-in-India.pdf>>

governments, State Coir Corporations and State Coir Development Agencies, besides the private manufacturers. But the organised coir sales channels in the country are insufficient to tap the unexploited household sector in India. The biggest challenge before the coir industry will be to keep the quality of the products and service levels high, even while keeping costs low.

Eco-Friendly & Natural Tableware from Areca Leaf

Introduction

Leaves have been used as plates for dining purposes for centuries. During the colonial times, bowls, plates and tableware began to be made of wood. Later wooden plates were replaced with those of earthenware, pewter and even silver. By 1840, with the advent of glass factories, plates and dishes were largely made up of glass.

However, with growing awareness about hygiene and sanitation across the world, by 1904 disposable paper plates were invented.²² Soon paper, plastic, foam, aluminium and other alternative material cutleries became common over the next century. It replaced the common drinking cup and plates often used by large number of public as various studies showed that such plates and cups through cross-contamination are spreading many food-borne illnesses.

Subsequently, disposable plates became a necessity whenever food is supplied outdoors. Now street food, bakery shops, food-on-the-go, festival food, religious gatherings, marriage catering, canteens, etc are often not feasible without disposable tableware. It proved to be useful particularly when there are more guests than dishes in the household. These are convenient replacement for crockery and utensils. Moreover, such onetime serving dishes have many advantages over conventional crockery or steel utensils. When compared to conventional plates, disposable plates are economical as it is easy to handle and transport, requires little space during storage and is quick and easy to use. More importantly, it does not require washing before and after serving food like the conventional one, thereby saving labour and water. So disposable plates are well known and accepted all over the globe and this trend remains continue.

Hardly people are aware about the amount of water and energy used in the manufacturing process of the disposable plates, which is much more higher-per-use than the reusable plates that are manufactured once and used for years. Since most disposable plates are made from plastic, aluminium and styrofoam, they can neither be decomposed nor degraded.

Waste Accumulation

Rapid accumulation of waste is becoming a global concern in the 21st century. According to the study, published in journal Science Advances²³, of the 8.3 billion metric tonnes of plastic that has been produced, 6.3 billion metric tonnes has become plastic waste as of 2015. Of that, only nine per cent has been recycled. The vast majority, i.e., almost 79 per cent is accumulated in landfills or sloughed off in the natural environment as litter.

²² Andrew F. Smith, *Food and Drink in American History, A "Full Course" Encyclopedia, Volume 1*, October 2013, ISBN 1610692330, 9781610692335.

²³ Roland Geyer et al. *Production, use, and fate of all plastics ever made. Vol. 3 No. 7, Science Advances*, July 2017. Accessible at <<http://advances.sciencemag.org/content/3/7/e1700782.full>>

India's contribution to plastic waste that is dumped into the world's oceans every year is massive. According to a 2016 Central Pollution Control Board report, almost 15,000 tonnes of plastic waste is generated per day in India. The majority of single-use cutlery items often end up in a landfill and are now considered to be a big part of the country's solid waste. To reduce the plastic menace, the National Green Tribunal had even passed orders²⁴ banning disposable plastic like cutlery, bags and other plastic items at selected places and a complete ban on use of plastic bag all over India, which is below 50 microns. But the country has no legislation in place to implement the same and plastic is being used all over causing pollution.

Health and environment impact

People began to realise that disposable cutleries made from plastic, aluminium and styrofoam pose serious environmental and health issues. The chemical complexes of these materials, several of which are neurotoxic and carcinogenic trickle down into food when served hot. Plastic cutleries take about 100 to 1,000 years to degrade when used in landfills besides polluting air and water around. Accumulation in landfill poses a threat to neighbouring communities by affecting their health other than serious environmental issues such as soil and groundwater contamination.

The way these used cutleries are currently produced, used and discarded, it fails to capture the economic benefits of a more 'circular' approach and harms the environment. There is an urgent need to tackle the environmental problems arising out of production, use and consumption of plastics. Rethinking and improvising the performance of such a complex value chain calls for efforts and greater cooperation by all its key players, from producers to recyclers, retailers and consumers. It also calls for innovation and a shared vision to drive our future in the right direction. There are lots of sustainable alternatives to disposable cutleries. Consumers need to be educated about such alternatives and be given the power to make conscious purchasing choices.

France is the first country in the world to ban plastic plates, cups and utensils, passing a law that will go into effect in 2020.²⁵ While plastic bags are banned in many countries, no country has yet imposed a ban on plastic cutleries. Exceptions will be allowed for items made of compostable, bio-sourced materials. The new law is a part of the country's Energy Transition for Green Growth Act, the same legislation that also outlawed plastic bags in grocery stores and markets. As per the law in three years' time, 50 per cent of the material used to procure such items will have to be organic and compostable, and that proportion will rise to 60 per cent by 2025. The general idea behind the law is to promote a "circular economy" of waste disposal, from product design to recycling. Aside from ecosystem disruptions, millions of barrels of oil are used every year in manufacturing plastic bags and utensils, playing what environmental activists call a significant role in climate change.

²⁴ NGT bans plastic items in towns located along banks of Ganga, *The Times of India*, Dec 15, 2017. Accessible at <<https://timesofindia.indiatimes.com/city/dehradun/ngt-bans-plastic-items-in-towns-located-along-banks-of-ganga/articleshow/62081286.cms>>

²⁵ France becomes the First Country to Ban Plastic Plates and Cutlery, *Independent*, 19 Sep 2016. Accessible at <www.independent.co.uk/news/world/europe/france-becomes-the-first-country-to-ban-plastic-plates-and-cutlery-a7316816.html>

Biodegradable Alternatives

In recent years, many small scale firms have started making cutlery products from various natural materials. All these materials are natural, biodegradable, lightweight, relatively inexpensive, and can easily be moulded into the various shapes of disposable cutlery products. Regardless of what material these products are made with, manufacturing these products is the best alternative to the growing menace of waste accumulation, thereby, ensuring safety to the environment and to the people who use them.

Benefits

- ✚ Ecofriendly
- ✚ Convenient composting
- ✚ Solution to increasing landfills
- ✚ Energy efficient
- ✚ Non-toxic and chemical free
- ✚ Microwave safe and unbreakable

Areca Leaf Plate Making

Deepam Palm Dish at Ollari in Thrissur district in Kerala is one of the many units manufacturing disposable plates from the biodegradable areca sheath. Rajesh Kumar, whose father had set up the factory 20 years ago, says he has exported to almost 16 different countries areca bio-plates including United States, United Kingdom, Australia, Singapore, Germany and the Gulf countries. The company registered as a small and medium enterprise has around 40 employees with almost half of it being women employees.



Figure 10: Areca Tableware manufactured by Deepam Palm Dish

Areca nut also called as betel nut is an important cash crop grown profusely in the tropical regions of India. Most of its production is concentrated in eight states, namely Karnataka, Kerala, Assam, Nagaland, Tripura, Meghalaya, Tamil Nadu and West Bengal.²⁶ As per the Directorate of Arecanut and Spices Development, estimated area

²⁶ Arecanut-Area, Production and Productivity in India. Accessible at <https://dasd.gov.in/images/kerala/ARECANUT-AREA_PRODUCTION_AND_PRODUCTIVITY_IN_INDIA.pdf>

under arecanut during 2013-14 was 445,000 ha. and production was 729,810 tonnes. Karnataka is the largest arecanut producing state in the country with a production of 457,560 tonnes from an area of 218,010 ha. Kerala, Assam, Meghalaya, West Bengal, etc are the other major arecanut growing states in the country.

The raw material used for disposable plates and cups is the arecanut sheath, which is an extension of the dry leaf that are bit harder in nature and golden brown in colour. One areca sheath weighs between 200g and 300g and has dimensions of 0.30 m by 1m. The most noteworthy part is that the raw material of arecanut sheaths are not plucked but

*Converts agricultural waste to a
valuable resource*

fallen naturally from the trees and collected from the ground. That is zero harm to the natural setup even in the initial stage of collecting raw material.

The fallen leaves if not picked are going to be lying around waste in the farm and given its hard texture takes much time to get decomposed, increasing chance of spreading diseases like malaria, etc. Through this sustainable initiative, fallen leaves are collected and turned to value added products. Waste-to-wealth concept is adopted here.



Figure 11: Cleaning of Areca Leaf Sheath

The company has tie ups with various farms in and around Kerala, like Pazhayannur in Thrissur district and Ottapalam in Palakkad district, other than in Bangalore and Shimoga in Karnataka state. It costs the company around Rs3.50 per leaf including transportation charges. The collected dry leaves sheaths are then cleaned thoroughly in water to remove dirt and dust. This is done manually with a brush. During cleaning, the sheaths will absorb water, which will make the sheaths more flexible for pressing. The cleaned leaves are sun dried and segregated based on colour and quality of the sheath. The dried sheaths are then machine pressed to desired shapes and sizes. They are heated by an external energy source and pressed with a certain amount of pressure; this changes the structure of the sheath particles making them fixed in their shape during pressing. Moisture content above five per cent needs to be maintained during pressing or else cracks will appear in the products. Depending upon the size of a sheath, multiple products can be pressed. Quite a few analyses are also carried out to check the quality of the plates before it is packed and despatched. This is to ensure that the final products are sanitised and free from yeast and mould. First quality plates will be targeted for international market while the second quality plates are targeted to local markets like dealers, super market, restaurants and caterers.

The company has three units: two in Kerala (Ollari, Irinjalakuda) and one in Karnataka (Bengaluru) and are into both export and domestic sales. The company sells nearly four lakh areca plates to the Guruvayoor Temple every year. It also sells through bulk dealership all over India and has its products listed in online shopping sites like Flipkart and Amazon.

The plates, glasses, small dishes, spoons, etc are all packed both in sets and separately based on need. The plates and bowls made are available in different sizes -- 14, 12, 10, 9, 8, 7, 6, 5, 4 and 2.5 inches. To ensure hygiene and quality of the plates they are packed air-tight in transparent sheets, which give good look as well to the consumer before purchase. One experienced operator can produce minimum of 5,000 plates per day which is worth Rs5 per plate. Their products have been certified by the Central Food Technological Institute at Mysore, which is a government body. Besides, the company has received many awards for its innovative and ethical business practices and garnered a worldwide reputation.

Deepam also sells areca leaf hand fan, food containers, hat, soup spoons, ice cream spoons and even soap dishes with herbal soaps packed inside. Mostly the customers are big hotels, temples, exotic soap manufacturers and caterers. As regard to the trading of production machines, Deepam manufactures and sells machines required for new entrepreneurs who plan to enter this field. To encourage such entrepreneurs, the company is ready to buy the entire range of manufactured products from them thereby providing security during their initial struggle to find markets. Manual machine cost Rs1 lakh while the hydraulic machine would cost up to Rs5.52 lakh. Already a few women self-help groups have purchased these machines from Deepam and have got into production process.

Recycling production waste

After pressing the plates, the leftover edges of the areca leaves sheath become wastes. This waste is used in making food stock for cattle or composted, because of its mineral composition. The sheath is comparable with paddy straw and has some minerals in higher values as copper, calcium and sulphur, thus making it a preferred meal for the cattle. It can totally replace paddy straw in total mixed rations in sheep and cattle and can be used as sole roughage to an extent of 40-50 per cent of the total mixed ration in dairy cattle rations.²⁷ However, the leftover edges of the sheath needs to be shredded before using it as food stock

Mineral composition²⁸

Calcium %	Phosphorus %	Sulphur %	Copper ppm
0.23-0.60	0.06-0.08	0.61-0.75	15-23

²⁷ Areca Leaf Sheath. Accessible at <<http://14.139.158.230/web/DOC/Areca%20leaf%20sheath.pdf>>







²⁸ Ibid

Sustainable Practice

The biodegradable and eco-friendly arecanut leaf plates and cups are certainly an alternative choice that can be promoted for the betterment of our environment and human health.

Also looking at the social dimension, this sector enhances rural income. Setting up of a

small and medium enterprise of this type can generate additional income to farmers and provide employment to unemployed locals, especially women. Each production unit can provide employment opportunities to 20 young people, on an average. Besides, the producer will be benefited from the income and the consumers will be benefited by using chemical free and non-toxic bio-degradable natural plates made of leaves. More importantly the community as a whole benefit from a reduced burden of plastic and polystyrene foam waste.

-  *Alternative source of income for arecanut farmers*
-  *Rural employment*
-  *Use agriculture waste effectively*
-  *Alternative to plastic and foam disposable cutleries*
-  *Farm land clean – attracts less illness*
-  *Production waste and final product after use is used as vermicompost or cattle feed*

REDUCE – REUSE – RECYCLE

As per a study²⁹ on areca leaf plates manufacturing, in India four lakh hectares of areca crop has been cultivated, near about 5400 million areca leaves are shredded and treated as agro waste. Through such a sustainable initiative, these leaves can be converted as a value added product. One areca leaf plate manufacturing unit needs 195,000 leaves per year. In this scenario, near about 27,700 plates manufacturing units can be established all over India. Around 1.5 lakh fresh employments can be generated in 27,700 units. This particular project can create “A Rural Employment Revolution” in India. At present only 1,500 units are established all over India, out of which around 1,000 units are in southern part of the country.

Challenges

According to Rajesh, arecanut farms are fast disappearing and diminishing from most of the States due to real estate boom. This has led to scarcity of the basic material – the dry sheath. Hence chance of price getting low is very rare and this may affect the acceptability of the final product among the domestic consumers who are largely cost conscious while purchasing. To make things worse, the new Goods & Services Tax (GST) regime has incorporated a five per cent tax on areca leaf products, thus pushing the cost further up. The cost per plate is nearly 30-20 per cent more than other plates available in the market. Nevertheless, the demand for these products has been increasing by the time.

Another major issue observed is the high price for raw material procurement. Although the raw material is abundant and it is an unutilised natural product, the production unit end up paying Rs3.50 per sheath including transportation, leading to high cost of

²⁹ Sriraaman S, Study On Manufacturing of Arecanut Plate, Submitted as part of requirement of the Training under New Entrepreneur cum-Enterprise Development Scheme, Government of Tamilnadu Conducted by Entrepreneurship Development Institute, Guindy, Chennai. Accessible at www.editn.in/projects/Manufacturing%20of%20Areca%20nut%20plate.pdf

production, and subsequently a high cost of selling that affects the market for the product mainly in the domestic market.

Way Forward

Sustainable eco-friendly alternate options will be of great demand in coming generations. There is no doubt that market for such products will rise. In India, though domestic market is yet to pick up for disposable biodegradable products, it will soon catch up given that there are year round public gatherings of varied types at all levels in India and they do contribute to a large part of our landfills. The demand will also go high due to increase in awareness among the consumers about the side effects of traditional disposable cutleries on health. Research shows that Indian consumers are slowly getting more informed, discerning, and health conscious than earlier, so their decision making process will get more logical, rational, and personal than ever before.

Meanwhile, there is a huge and assured market for these products in western countries like Europe and America where there is an increased awareness of climate change and solid waste management. Given that country like France has already taken the step to ban plastic cutleries, efforts to tap this market should be on priority for such producers. This sustainable practice will, therefore, not only promote cash income and employment of the rural people but will also reduce outbreak of various diseases both in the source and the end.

Given the rise in awareness of climate change and importance of circular economy this business enterprise, barring few challenges that are common to such small enterprises, demonstrates great potential for replication. It can easily conquer both the national and international markets with its unique environment-friendly biodegradable products.

Textiles from Natural Banana Fibre

Introduction

Textile tradition of India is rich and diverse. Its origin dates back to the Indus valley civilization when homespun cotton was used for weaving garments. Every region of the country has its own unique textile tradition. While the mountainous region produces finest woollen fabrics, like the *pashmina* and *shahtoosh* shawls of Kashmir, the desert regions of Rajasthan and Gujarat are the richest source of folk embroidery in the world. Likewise, the south and south eastern regions are prominent for light coloured cotton, jute and silk textiles.

The sector holds importance, given the fact that it contributes largely to the country's economy. It holds a distinctive position as a self-reliant industry right from the production of raw materials until the finished products are despatched. The activities of the Ministry of Textiles responsible for policy formulation, regulation, development and export promotion are focused largely to ensure adequate quantities of raw material are produced and thereby enhance the production of fabrics at reasonable prices from both the organised and decentralised sectors of the industry.

Sector Analysis

According to the Ministry of Textiles Annual Report 2017-2018, the share of textile and clothing in India's total exports stands at a significant 12.4 per cent in 2017-18. India has a 5 per cent share of the global trade in textiles and apparel. The industry holds importance from the employment point of view as well. It employs 4.5 crore directly and another 6 crore people in allied sectors, including a large number of women and rural population.

The industry comprises numerous components and actors. The entire production chain of almost all of the wares and materials it produces, originates within the country itself. Both organised and unorganised sectors are active in the sector and hence the use of technology and mechanisation within the sector varies drastically. While the organised sector includes firms that employ highly advanced technology, machinery, automation, robotisation, and skilled labour; the traditional handloom sector uses manual labour and age old equipment but with high quality output. The production centers are spread across the length and breadth of the country.

India's Textiles Export

According to the World Trade Statistical Review 2017 by the World Trade Organization (WTO), the current dollar value of world textiles and apparel exports totalled US\$284 billion and US\$443 billion respectively in 2016. Measured in value, China, European Union, and India remained the top three exporters of textiles in 2016. Altogether, these top three accounted for 65.9 per cent of world exports in 2016.

The exports of textile and clothing products including handicrafts from India have remained at US\$39.7 billion during 2015-16 and 2016-2017.³⁰ The products are exported to more than hundred countries, with the United States and Europe accounting for nearly half of these exports.

Environmental Impacts

Production of textiles is an extensive cycle wherein at every stage involves contribution of gallons of water, chemicals, energy and generating wastes at each stage. Copious detrimental effects on the environment are thus associated throughout each stage of its production. Hence the textile industry as such is a greatest contributor to environmental degradation, particularly within the country. For instance, certain pesticides that farmers use to protect cotton crop can harm the wildlife and contaminate other products and thus the environment. Monocrotophos, though banned in many countries, is still the most widely used pesticide in cotton production in India.

Most commonly used textile fibres – cotton and polyester – cause serious environmental hazards throughout their life cycle.

In addition, immense use of chemical fertilisers and pesticides results in pollution and depletion of the soil thus even injuring and harming the lives of human beings. Cases of blindness,

cancer, liver diseases and nervous system problems from pesticide poisoning have been identified in the cotton growing parts of the states of Maharashtra and Andhra Pradesh. Likewise, untreated toxic waste effluents from several dyeing units and yarn mills end up in the nearby river or canals that give rise to severe water pollution.

The continued dumping of toxic waste into the water bodies ultimately stains the water into yellowish brown making that water unusable. Apart from the stench of chemicals and dyeing materials that emanate from these water sources, deadly chemicals also release numerous volatile agents into the atmosphere that are particularly harmful to human health. Due to this high level of toxicity of the water, it becomes unfit even for irrigation. Moreover, most of the processes performed in textile mills like the spinning, weaving and industrial manufacture undermine norms of air quality. The industry emits different air pollutants especially during processes like printing, dyeing, coating, etc. They usually generate nitrogen, hydrocarbons and sulphur oxides from boilers, drying ovens and from mineral oils in high-temperature curing. Acetic acid and formaldehyde are two major emissions of concern in textiles. The industry's contribution towards noise pollution is also significant. The noise emanating from the clatter of gears, high speed whines of twisting and spinning machinery and impact noise of looms are said to affect the health of the workers and the population in the vicinity.

The industry features a large number of small to medium businesses (SMEs) with low levels of understanding of environmental issues. These enterprises often lack the resources to internally develop knowledge and adopt modern technologies to take advantage of eco-friendly product development opportunities. While the old textile

³⁰ Ministry of Textiles Annual Report 2017-2018. Accessible at <http://texmin.nic.in/sites/default/files/AnnualReport2017-18%28English%29.pdf>

production plants cause environmental impacts such as dust and high noise level, the new, fully automated production processes consume large amount of energy. In addition, yarns are treated with primer in the textile production so that they can cope with the rotation speed of machines without damage. However, at the textile finishing stage the primer is washed off for further processing. In this way the primer pollutes the sewage and nearby canals.

Other than the direct impact on the environment and the workers, there are perceptible health hazards for the users as well; due to non-regulated markets. Many banned amines are still in use during the dyeing stages. Thus the sector to a large extent is unsustainable, and has a high impact on the environment. There is a need for a holistic, cradle-to-grave, life-cycle approach in order to minimise the use of resources, energy and environmentally damaging substances.

Sustainable alternative

With an increasing concern amongst the public about the social and environmental impact of the textile production, purchases and subsequent disposal, manufacturers are beginning to understand the benefits and untapped economic potential of switching to more sustainable textile products and efficient use of natural resources.

Natural fibers are getting a significant deal of attention in modern times due to their characteristics of being sustainable and healthy option. Such products are now largely used in textile industries and handicrafts. The most well-known and commonly used natural fibers, like cotton, wool and silk, are used for textiles since time immemorial. Despite their natural image, these traditional fibers have serious impacts on people and the environment. Increasing use of these resources has forced the industry to find other natural alternatives. Plant fibers such as hemp, pineapple leaf fiber, banana fiber, bamboo fiber and so on, are being experimented more in recent years. For the textile industry to become circular, the whole infrastructure and supply chain must be changed.

Banana Fibre Textiles

Around four kilometres from Pallavaram Railway Station in Chennai, lay a suburb named Anakaputhur. The lanes of the suburb consist of both tiled roof houses and concrete, with a couple of temples that add serenity to the surroundings. Few decades ago, the place used to be a busy weaving hub of Chennai. The artistry passed on from one generation to the next, along with the handlooms and other equipment. Every process is carried out from the home, and the whole family helps out. Thus, the industry is one that flourishes from the homes of these artisans.

Every process is carried out from the home,
and the whole family of these artisans helps
out!

The community's first and successful adventure was over half-a-century ago, when the erstwhile village started developing as a handicraft centre, exporting the famous 'Madras Real Handkerchief' to Nigeria. It was an eight yard garment worn by men and

women in the African country, until the practice of wearing that attire was stopped in the late 1970s when military rule was imposed in Nigeria.

But very soon the community shifted its focus to 'Bleeding Madras' a hand-spun yarn woven that became popular during 1960s. Dyes that were not colourfast were used, resulting in bleeding and fading that gave the fabric a new, personalised look each time it was laundered. As the colours bled during each wash, it was called Bleeding Madras. These shirts were marketed and exported as 'guaranteed to fade'.



Figure 12: Sekar with his wife and son.

The community also gradually then shifted its focus on cotton dress materials and was successfully moving ahead until polyester yarn invaded the markets in 80s and swallowed the entire textile market. Industrialisation, colourfast dyes and the price of cotton yarn thus soon casted a shadow on the handloom process. While there were 5,000 odd handlooms 25 years ago in the community, there are only about 300 today. Of these, about 70 per cent of the weavers weave lungi fabric (rectangular shaped wrap around cloth traditionally worn by men in southern India) and the rest weave silk and cotton saris. It is only a handful of weavers who are into natural fibre textiles.

Inspite of all this turmoil, C. Sekar was one of those few weavers in their community who understood the need to retain hereditary skills. This forced him to spend more time on innovation resulting in successful experiments with jute fabrics. However, destiny had something else stored for him; he stumbled across an article in a magazine on The Ramayana, an ancient Indian epic, where he read that the character Hanuman wove a sari for Sita using banana fibre.



Figure 13: Crafts made from Banana Fibre

Idea struck his mind deeply and encouraged him to do research on the subject. Ten dedicated years of trialling with the banana fibres with the help of some weavers finally bore fruit. He now weaves pure banana fibre fabrics and mixed varieties largely with silk or cotton. Despite the difficulties of using this banana fibre on normal looms, Sekar, with his determination produces saris and yardage. He has even introduced denim materials purely made out of banana fibre and herbal fabrics weaved with natural fibre treated in a solution of neem, turmeric and tulsi. The buttons for denims are made from coconut shells rather than metal and the material is dyed using natural colours.

Together with other weavers, he organised themselves into a formal body - The Anakaputhur Jute Weavers Association (AJWA). The constitution of such a formal body helped them to get bank loans and support from various textile research organisations. He also brought together about 12 women's self-help groups under the banner of the association to extract banana stem fibre. An agricultural waste was thus effectively transformed into yarn.

Production Process

The entire production processes of banana fibre textiles are organic, and are purely handmade. It is a time consuming and complex set of tasks that undeniably take a toll on the weaver's health. Yet, the villagers seem to be conscious about sticking to traditional methods in order to make their own livelihood.

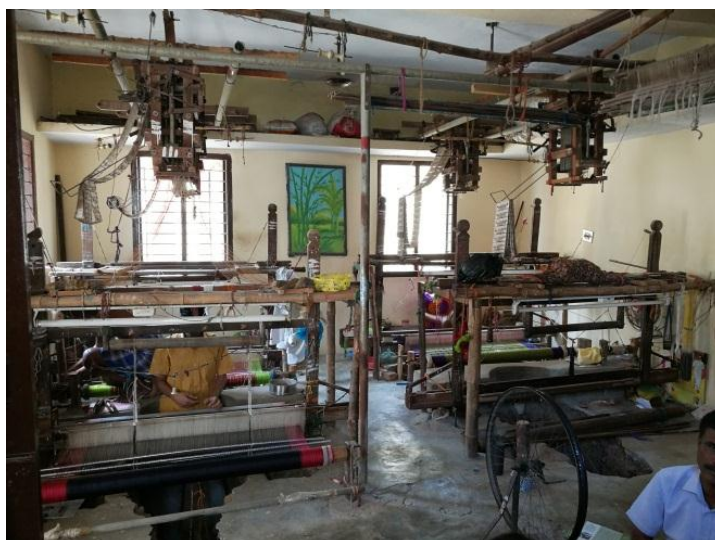


Figure 14: Small Handloom unit setup by Sekar

The process of weaving banana fibre fabric begins with sourcing the pseudo stem of the banana plant (inner part of the banana plant that looks like a trunk). Great amount of care is required to avoid damage while extracting the fibre. The layered sections are separated from the stem and rolled lightly to eliminate the excess moisture. Dirt, if any in the rolled material is removed manually and then cleaned and dried. The outer flesh is scraped off manually from the dried sheaths with quick strokes till the fibres are visible. A single thread of banana fibre demonstrates strength and wiriness with a natural sheen.

Extracted threads of varying lengths are dried and then knotted in one of two ways to make it as a yarn usable on a handloom. Thus the process is a labour and time intensive process. The yarn thus produced is winded on a bobbin and placed in water until it can be used on the loom for weaving. The dyeing can be done either on the yarn or after the fabric is woven. Dyes are extracted from the natural products, including turmeric and indigo. Once dyed, the banana fibre sari looks no different from a silk-cotton one.

Banana fiber fabric breathes better than others in the heat and humidity of summer in most parts of India. With regards to care and maintenance, the cotton in the warp is already treated for shrinkage before the weaving process, and the strength of the banana fibre yarn gives the final fabric a starched appearance. To maintain the new look for longer period, the fabric needs to be hand washed and care should be taken to avoid blue liquid and detergent.

Awards and Recognitions

His company Ananafit Pvt Ltd was the winner of Parivartan sustainability leadership awards 2011 for 'Exceptional Leadership in Catalyzing Sustainability' in the apparel and textile sector. In 2012, the company won the International Star for Quality Award under the 'gold category', in the 37th International Star for Quality Convention, an annual programme of Business Initiative Directions held in Geneva. The same year Limca Book of Records recognised the weavers of Anakaputhur for making saris with 25 varieties of

natural fibres such as the banana stem, cotton, bamboo, jute, pineapple, aloe vera, hemp, sea grass, lemongrass as well as recycled silk, linen and wool fibres, besides others.

In 2015, at the Centenary Auditorium of the University of Madras, Prime Minister Narendra Modi attended the first National Handloom Day celebrations and unveiled a logo for the handloom sector. Among the tributes presented to him that day was a shawl woven by the AJWA using 25 types of natural fibre, including one from the banana stem.

From Waste to Resource

India is the largest producer of banana in the world with 29.7 million tonnes from an area of 0.88 million hectares with a productivity of 37 MT/ha.³¹ A larger part of the banana trunk is discarded as waste every year, after harvesting. In addition, banana grows faster than other plants and this make them easily available. Banana farming generates vast quantities of biomass, after harvesting the fruit bunch, out of which pseudo-stem (30-34 per cent) and peduncle together contribute 40 per cent of the banana plant biomass.³²

At present, less than 2 per cent of these wastes are used for production of fibre and composting under nutrient recycling. Left over are incinerated and wasted due to non-availability of suitable technology for its commercial utilisation. India has huge potential from extraction of natural fibre from banana with its traditional varieties like Red banana, which are highly suitable for making banana fibres and yarn. Also fibres are used for various other purposes such as in paper and handicrafts industry.

Circular economy

The manufacturing practices of Anakaputhur banana fibre textile weaver symbolises some of the key elements of sustainable fashion. Their products are manufactured with an environmental and social responsibility in mind. Significant time is spent to develop 100 per cent sustainable product with unique designs, leaving space for creativity, with premium quality and longevity.

- *Eco-friendly substitute to environmentally hazardous synthetic fibers.*
- *Gives livelihood to rural poor through creation of employment in the fiber producing and processing industry.*
- *Being completely biodegradable and naturally occurring, the banana fiber products are in great demand in the international markets.*
- *Value added products from agricultural waste, would enhance the profitability of banana farming.*

Also the recycling of agricultural waste into natural fibers offers a practical solution to enable circular economy in the textile industry. An increase in demand and production of banana fibre textiles can certainly contribute to lessen the burden of pollution and

³¹ Union Agriculture & Farmers Welfare Minister, Shri Radha Mohan Singh addresses the National Banana Festival, 2018 held in Thiruvananthapuram, Kerala, PIB, 17 Feb 2018. Accessible at <<http://pib.nic.in/newsite/PrintRelease.aspx?relid=176614>>

³² K. N. Shiva, et.al, Banana Yarn: Golden Revolution in Textiles. Accessible at <<http://nrcb.res.in/successstory/13-banana-yarn-textile.pdf>>

simultaneously boost our economy for a better world as otherwise farmer tends to burn these for field clearance. Besides that, banana fibre industry can also improve the livelihood of rural economy by giving employment to rural women and reviving the handloom industry, which is on the verge of extinction. Therefore, a wide range of opportunities are offered thereby contributing towards the circular economy.

Way Forward

The textile sector is water intensive and uneconomical. Bringing in sustainability into textile and clothing industry is the need of the hour. Use of natural fibres in textiles will be a step towards this milestone. Banana fibre textiles have enormous capacity to capitalise the growing trend of circular economy. But unless financial backing to help this type of socially relevant technology is developed, it will be difficult to create more value for everyone. Anakaputhur weavers face production challenge inspite of huge demand. It is not the lack of looms or material, but a lack of space to install pit looms and some finance to extract fibre mechanically that are needed. Though the central government has launched several schemes for handloom weavers, many of these are yet to be implemented by the state.

Also the lack of consumer awareness primarily within the domestic market regarding the importance of natural fiber textiles over synthetic one is a common consumer issue. There needs to be increased clarified consumer awareness on sustainable textiles to reduce the threat of consumer disinterest. Else, such sustainable alternative textiles product might also have to face the consequences of sisal and henequen textiles, where the world consumption of these products dropped and many rural families were desolated due to development of cheaper synthetic materials.

Energy Efficient Structures: Indira Paryavaran Bhawan

Introduction

India ranks third on the US Green Building Council's (USGBC) annual ranking of the top 10 countries for Leadership in Energy and Environmental Design (LEED) certified buildings³³. According to an estimate, the green building market is estimated to double by 2022, driven by increase in awareness level, environmental benefits and support of government to drive the change. As of September 2017, the number of projects

Green building is defined as the practice of using processes and technologies, which are environment-friendly and energy efficient throughout the building's lifecycle from siting to design, construction, operation, maintenance, renovation and deconstruction.

registered for green technology was just 5 percent of the total buildings in India which points towards the huge potential for penetration of green building technology in India.

LEED (USA), BREEAM (UK), DGNB (Germany) and CASBEF (Japan) are a few of the key global entities that

define, categorise and certify green buildings across different countries. In India, IGBC and GRIHA define the green building norms.

The importance of constructing green buildings is known by its contribution in improving environment ecology in multiple ways and potential of reducing the energy consumption by 20-30 percent, water usage by 30-50 percent and reduction in generation of waste by incorporating process of recycling, reuse and reutilise.

The development of infrastructure, especially fulfillment of housing needs is one of the biggest consumers of natural resources and amounts to significant wastes and pollution, globally. It is also a known fact as per multiple reports that the real estate alone ingests about 40 percent of natural raw materials, 25 percent of water and 35 percent energy resources. In addition, it emits 40 percent of wastes and 35 percent of greenhouse gases³⁴.

All over the world, the stakeholders in the real estate sector have started to realise the damage it has done to the environment and natural resources just in a short span of last few decades. The realisation has given birth to fancy concept of 'Green Buildings' and multiple rating systems pushing for sustainable habitats. In the race to 'Go Green' with architecture, the new technologies are being floated to consumers who get swayed away to marketing techniques and agree to pay huge amount to fulfil their responsibility to save Mother Earth.

³³ <https://economictimes.indiatimes.com/news/economy/indicators/india-ranks-third-among-top-10-countries-for-leed-green-buildings/articleshow/62619975.cms>

³⁴ <https://www.thehindubusinessline.com/news/real-estate/indian-green-building-market-to-double-by-2022/article23391602.ece>

One of the majorly important aspects that might be missed in these fancy concepts and new technologies are the solutions that have been in existence since centuries, and are developed and used by our ancestors.

In a well written article³⁵ by an Indian architect, the idea is well framed mentioning, “In India, there is a millennia-old reservoir of knowledge that can help reduce energy consumption in buildings today. Ancient Indian spiritual thought integrates humans with the cosmos, presenting an understanding that the processes of the cosmos are directly related to human existence. With this understanding, ancient Indian civilisation has always respected its environment”.

Typical principles include climate-responsive design, use of local and sustainable materials, water harvesting, etc. Climate-responsive architectural design, is especially sophisticated, with thousands of years of refinement. Architectural structures like courtyards, clusters, wind towers, roof terraces and *Jaalis* (stone lattices), among others, are used for effective climate control and have become social and cultural elements. The challenge is to reconcile these ancient methods with modern technological innovations”.

As mentioned above, India is one of the leaders pitching and practicing the idea of Green Building. There are multiple projects in the country which have their own beauty and attract attention not because of just high ratings on Green Building charts but due to perfect combination of traditional concept blended with modern technology. Catching attention of the world is the one such building of Ministry of Environment, Forest and Climate Change of Government of India, practically leading the change and practicing what it preaches to the world.

Indira Paryavaran Bhawan

Named after the first women Prime Minister of India – Indira Gandhi, Indira Paryavaran Bhawan (IPB) is the office space of Ministry of Environment, Forest and Climate Change (MoEFCC) of Government of India (GoI), situated in the capital of India, New Delhi. The building built with the vision to accommodate all the features of sustainable habitat with perfect blend of traditional techniques and modern technology, provides a space to accommodate three Ministers of GoI along with around 600 officials. The huge campus designed and constructed by Central Public Works Department of GoI, is an epitome of beauty and sustainable design in its own distinct way. The unique and amazing design of the structure has made it topped the LEED India Ratings and GRIHA Green Ratings and made it a very special tag of ‘Net Zero Energy’ building of India.



Figure 15: Indira Paryavaran Bhawan, New Delhi

³⁵ <https://unchronicle.un.org/article/green-architecture-india-combining-modern-technology-traditional-methods>

The GoI has been a pioneer in promoting consciousness in prevention of Climate Change and pushing for Sustainable Development and the building of MoEFCC is one small example to show to the world that India practice what it preaches. The building has been designed taking inspiration from traditional architectural techniques and features have been improved with new technology. The use of Sustainable Building Materials; energy efficient air cooling system and Energy production on site have been detailed in this document. There are other features like Water Conservation and Recycling and Fully Automated Parking but those have been not incorporated in documentation limiting to the agreed scope of the study.

Green Building Rating System

LEED Ratings

Leadership in Energy and Environmental Design (LEED) is a rating system devised by the United States Green Building Council (USGBC) to evaluate the environmental performance of a building and encourage market transformation towards sustainable design. The system is credit-based, allowing projects to earn points for environmentally-friendly actions taken during construction and use of a building.

LEED Certification Levels

Certified: 40- 49 Points; Silver: 50-59 Points; Gold: 60-79 Points; Platinum: 80-110 Points

LEED India

Leadership in Energy and Environmental Design (LEED-INDIA) Green Building Rating System is a recognised point of reference both in India as well as worldwide for the design, construction and further, operation of high performance green buildings. The principal features of a green building include valuable use of soil and landscapes, resourceful utilisation of water, usage of energy efficient and eco-friendly apparatus, operational control & building management systems, use of renewable energy, use of recycled or recyclable materials and most significantly, better indoor air quality and air circulation for health and comfort.

GRIHA Ratings

GRIHA is a rating tool that helps people assesses the performance of their building against certain nationally acceptable benchmarks. It evaluates the environmental performance of a building holistically over its entire life cycle, thereby providing a definitive standard for what constitutes a 'green building'. With over two decades of experience on green and energy efficient buildings, The Energy and Resources Institute (TERI) has developed GRIHA, which was adopted as the national rating system for green buildings by the Government of India in 2007. This tool has been adopted by the Ministry of New and Renewable Energy. This tool, by its qualitative and quantitative assessment criteria, is able to 'rate' a building on the degree of its 'greenness'.

The Central Public Works Department of Government of India was the responsible agency for Planning and Structural Design of the building. The agency has taken care of standards and criteria for Green Building Ratings by various agencies to build a sustainable multi-storey dealing with pollution levels of capital of India. The materials used in construction of building to finishing of interiors are chosen keeping in mind the idea of sustainability at every step.

The major part of this huge building is build using material which is either considered waste or is easily and speedily renewable.

Looking exactly like a structure equal in strength and beauty to one build with conventional bricks and cement, IPB has something more and different

to offer. The bricks used in walls, the concrete, mortars and plasters of entire building have fly-ash in them, which otherwise is considered as a waste from thermal power plants. The use of AAC blocks³⁶ which are around three times lighter than commonly used red bricks along with its heat insulation properties keeps it light as feather and maintains the inner temperature. The materials used for flooring, claddings are locally available stone, and one can prominently see broken marble and Kota stone at the beautiful walking space of the building justifying the concept of Circular Economy. Not just the construction materials but the interior door frames and shutters are made using rapidly renewable bamboo jute composite. The major part of this huge building is build using material which is either considered waste or is easily and speedily renewable.

The building incorporates materials and features which takes care of maintenance of internal temperature and natural light, thus saving on artificial energy consumption. The office space is aesthetically designed and naturally lit; the terrace space has high reflectance properties with PUF (polyurethane foam) insulation for low heat ingress; for outer walls and concrete surfaces rockwool insulation is provided and to facilitate ground water percolation, grass paver blocks are laid on pavements and roads.

Energy Efficient Air Cooling System

The office is Centrally Air Conditioned but the twist and thoughtfulness is clearly evident from the design of the building. The beautiful combination of traditional Passive Air Cooling features are inspired and extracted from Indian Palaces and forts and the Chilled beam system of Air Conditioning using Geo thermal energy for heat exchange, has been very carefully and innovatively used in the building. The design though seems very unique and new, but the roots of innovation go back to 18th century *Deeg* palace in Bharatpur.³⁷

According to Deependra Prasad, Sustainable Design consultant of the project, the IPB project tried to include a range of measures to promote energy efficiency by optimally utilising its site's assets. One of the main possibilities on the site in South Delhi included good and adequate groundwater, available only at 9 m depth which gave the ground thermal (cooling) capacity. The underground cooling can be defined as "Condenser water heat rejection by Geothermal Mechanism,

Dealing with the Climate through building comfortable buildings is a task as old as history itself. Due to an initial absence of comfort cooling (air conditioning) systems, building relied on their design, solar orientation, materials, opening design to remain comfortable throughout the year. Currently, despite having a large variety of cooling / heating technologies, it is important to remember these traditional concepts, since they provide a design palette, which right at the onset significantly reduces the energy loads that a building would be subject to".

-Deependra Prasad, DPAP

³⁶ Autoclaved Aerated Concrete uses lime, sand and rising agent. It is Lightweight (three times than red bricks), Load-bearing, High-insulating, Durable, pest resistant, economically and environmentally superior building product.

³⁷ A city in the State of Rajasthan in India.

with a closed loop piping which minimises the need for make-up water”. The project decided to run pipes into the ground, which would cool the condenser water from 38 to 31 °C. This is akin to cooling of ancient architectural structures, which ran water pipes into the building to cool the structure and also to create pools and water bodies for evaporative cooling. This system of vertical pipes runs 80 m deep into the ground and creates free cooling of the water in a closed loop condition. This will also help in water conservation in cooling towers for HVAC system.

Net Zero-Energy Building

The building is facilitated with Grid Interactive Solar Power Generation System with capacity of 930 kilowatt (KW) peak generation. The terrace is beautifully designed with peaceful sitting space surrounded by green lush terrace garden and the corners are occupied by 2844 raised mono crystalline solar panels all around. The total area covered by these efficient solar panels is around 4600 sq. metre producing around 14 lakh units (KW hour) of energy which is also the annual energy requirement of the space making it Net Energy Building of India.

Grid Interactive Solar Power Generation System

A grid-connected photovoltaic PV power system, or grid-connected power system is an electricity generating solar PV power system that is connected to the utility grid. A grid-connected PV system consists of solar panels, one or several inverters, a power conditioning unit and grid connection equipment.

When conditions are right, the grid-connected PV system supplies the excess power, beyond consumption by the connected load, to the utility grid.



Figure 16: Solar Panels installed on Roof of Indira Paryavaran Bhavan

Way Forward

In this era of a visible debate on climate change, a large variety of mitigation measures includes initiatives targeting sustainable building. These include the construction of green buildings, utilisation of building rating systems, energy codes and many other prescriptions. Within this overall scenario, there are projects which have been

developed at the cutting edge of sustainable building and are developing a new paradigm of self-sufficiency. Net Zero Building projects (NZEB's) are targeting to push the envelope further, by being self-sufficient not just in terms of their electricity consumption, with an overall minimal dependence for their other resource requirements.

Indira Paryavaran Bhawan reflects the growing role of the 'Ministry of Environment and Forests and Climate Change' in regulating and channelising India's development into a sustainable paradigm. This mandate was carried forward by, the Central Public Works Department (CPWD) and the sustainable design consultants, Deependra Prashad, Architects and Planners (DPAP) at every level to design a building which is not just energy efficient but goes far beyond to reach the level of being energy positive, i.e. to be able to create more energy onsite than it consumes over a functional year.

It is noteworthy that the challenges of creating a Net-Zero building on a tight urban site are not just to do with a provision of an on-site energy generation-in this case a solar photovoltaic system – but more to do with a systematic reduction of electrical loads through passive and active measures at all levels of building and service design. The success of this endeavour is expected to pave the way for many other decentralised urban initiatives at self-sufficiency in energy and other resources within the built environment.

Zero Waste Generation: Alappuzha, Kerala

Introduction

Across the world most economies are basically linear by design i.e. 'take-make-dispose' economy, resulting in unnecessary environmental and human health impacts, inefficient use of natural resources and over dependency on resources.

This is largely because in the past, accumulation of waste due to production and consumption of goods was considered as an unavoidable evil. Today the situation has changed, thanks to the rise in awareness about the importance of a sustainable living. Therefore, a shift towards a circular economy would help tone down the pressures and concerns, and deliver economic, social and environmental benefits.

This report examines the successful solid waste management practice in Alappuzha district and how it effectively contributes to the circular economy transition. The paper discusses how wet waste within a municipality can be converted into vermin compost for use in plantations and agriculture. The production of vermin compost reduces the amount of organic waste in the locality and helps to maintain a clean and fresh environment. Vermi-compost also reduces emission of methane gas, which causes global warming.

Sustainable Solid Waste Management – The Scenario

As per the United Nations statistics, the population of India is 1.3366 billion as on 2017. This is equivalent to 17.74 per cent of the total world population and ranks number two in the list of countries by population. Hand-in-hand with this growth, cities produce an ever-growing amount of municipal solid waste. According to Report of Task Force on Waste to Energy, an estimated 62 million tonnes of municipal solid waste is generated annually by 377 million people in India's urban areas, of which 80 per cent is disposed of indiscriminately at dump yards in an unhygienic and unscientific manner by the municipal authorities leading to problems of health and environmental degradation.³⁸

The cost of disposal of large quantities of waste is often beyond the financial capacities of cities and municipalities. There is also poor institutional capacity and low political will to address the problem. Many cities lack the facilities for safe disposal of municipal solid waste and the most common disposal practice across the country is uncontrolled dumping.

Circular Economy Approach to Solid Waste Management

Reducing generation of waste by inculcating simple habits like reuse, repair and recycle, in tandem with proper segregation and treatment practices are the best way to tackle the challenge this sector poses. The concept of the circular economy thus evolved from the thought that waste if effectively treated can turn into a resource, as a result forming

³⁸ Waste to Wealth, Ministry of Housing and Urban Affairs, Govt of India, October 2017. Accessible at <www.swachhbharaturban.in:8080/sbm/content/writereaddata/Waste%20to%20Wealth_2%20Oct.pdf>

a loop in the production and consumption chain. More effective use of resources enable to create more value, both by cost savings and by developing new markets or growing existing ones.

Organic and biodegradable waste, which constitutes 50-60 per cent of country's urban waste, can be converted into compost, thereby solving half of India's waste problems. The market for compost has enormous potential in India, which is predominantly an agriculture-based country. Under Indian conditions, which is mostly tropical, the soils have less soil fertility, texture and organic matter content. Soil conditioners such as compost are, therefore, vital to improve soils.

Background on Alappuzha

Alappuzha is one of the 14 districts in the state of Kerala in India with an area of 1,414 km². There are six taluks, 52 villages and 39 towns in Alappuzha district. According to the 2011 census, Alappuzha district has 0.53 million households with a population of 2.12 million. Out of total population, 46.04 per cent of population lives in urban area and 53.96 per cent lives in rural area.

The district lies between the broad Arabian Sea and a network of rivers flowing into it. In the early 20th century, the-then Viceroy of the Indian Empire, Lord Curzon fascinated by the scenic beauty of the place, in joy and amazement had said, "Here nature has spent up on the land her richest bounties". In his excitement, he exclaimed, Alappuzha as the Venice of the East. Thus the district found its place in the world tourism map.

Total solid waste generation is 58-60 tonnes per day in Alappuzha town, out of which domestic waste constituted 34.5 per cent while offices and wedding halls contributed 24.13 per cent, whereas shops and markets had a share of 17.24 per cent. Out of these, 75 to 76 per cent of the total waste is compostable organic waste; paper constituted 10 to 11 per cent; plastics 4 -5 per cent; cloth, coir, etc 6 – 7 per cent; and metals one percent.³⁹

Background to Solid Waste Management in Alappuzha

Traditionally, with certain exceptions, the waste management sector in Kerala like anywhere else in the country was largely mere 'collect and dump' type model. Wherein, unsegregated mixed wastes from municipal and commercial establishments are collected and disposed of to landfill or through incineration.

³⁹ P. N. Venugopal, *Waste Management – The Alappuzha Approach*, Climate South Asia Network. Accessible at <<http://climatesouthasia.org/waste-management-the-alappuzha-approach-2/>>



Figure 17: Decentralised SWM plant in Allepy

In Alappuzha things were no different, open dumping was a common sight until five years ago. The streets were littered with domestic waste, mounds of rotting rubbish were found routinely on footpaths near markets and commercial areas. With plastic shopping bags fluttering all over in the wind, sewerage and rainwater drains were choked with trash and plastics. Hospitals, restaurants, office buildings, factories all produced waste and were disposed in ways that at best can be described as irresponsible. Even the beaches, lakes and the rivers flowing through the city had become garbage dumps joint in many places, threatening even the districts tourism sector.

The situation got worsened by day and the quality of life went down drastically in and around the municipal area. Aside from many common waterborne diseases such as dysentery and rash being widespread, a large number of local residents had been suffering from chikungunya, a mosquito-borne viral fever. In the year 2012, the total number of people in the district who were affected by this epidemic rose to 34,459.⁴⁰

Now Alappuzha has undergone a dramatic transformation. Streets, lakes and beaches are clean and old dumping spots have disappeared. More importantly, the biggest and dirtiest garbage dumping yard near Vazhicherry in the heart of the city has been transformed into a water and sanitation park with a small shed with six aerobic composting tanks that can covert two tonnes of wet waste into compost in 90 days.⁴¹ However, achieving this positive transformation was not a cakewalk as it is presumed to be and it did bring misunderstanding and chaos.

What Triggered the Positive Change?

In 2014, Alappuzha Municipal Corporation was perplexed and forced to find an alternative to their usual dumping ritual when the residents nearby Mararikkulam Village Panchayat refused to allow any more waste from the urban body.

⁴⁰ Chikungunya virus outbreak in Kerala, ENVIS Centre on Climate Change and Public Health, 23 Feb 2012. Accessible at < http://iictenvis.nic.in/Database/Chikungunya_virus_out_break_in_Kerala_1058.aspx>

⁴¹ Clean Home Clean City. Accessible at <<http://sanitation.kerala.gov.in/wp-content/uploads/2017/12/Clean-Homes-Clean-City-Alappuzha.pdf>>

An agreement with a windrow composting plant was set up by the municipal corporation in early 2005, which was supposed to process the garbage and produce daily 50 tonnes of composts. But when processing started, the plant could process only 5-10 tonnes of waste a day, and the rest of the rotten garbage accumulated on the premise along with waste already dumped earlier. Thus, the poor waste management situation led to a high incidence of sanitation-related illness, which forced the nearby residents to stand up in arms against waste dumping in their village. Protest was so severe that the municipality was forced to bring a closure to the dumping site at the village in 2014. Municipality did not go for legal recourse as they were well aware that this landfill, operated by a private contractor, by grossly violating the Environment Protection Act (EPA) of 1986 and the national waste regulations for sanitary landfills.

Due to the unavailability of other waste disposal sites and lack of any effective community engagement, effort resulted in a dramatic increase of accumulated waste within the municipality. Unauthorised dumping of large volumes of roadside waste within the municipality became a common sight.

When garbage started spreading everywhere in the city, the then local MLA Dr. Thomas Isaac (now the minister for finance, government of Kerala) in discussion with all relevant stakeholders decided to try decentralised waste management. That is managing and processing the waste within the municipality and not sending it to a dumping site or landfills or to a centralised large processing facility. Thus the crisis was viewed as a window of opportunity for transition and transformation towards more sustainable goals.

Nirmala Bhavanam Nirmala Nagaram

The municipality in coordination with district Suchitwa Mission started implementing a project called 'Nirmala Bhavanam Nirmala Nagaram'⁴² (Clean Homes Clean City) since November 2012. The focus of the initiative is segregation and treatment of wet waste at the source itself.

Altogether the Alappuzha Municipality has about 40,000 households in 52 wards. To effectively implement the project, it was decided to approach the whole initiative in a phase by phase manner. During the first phase of work, the project was focused in 12 of the most urbanised wards, which have almost 12,000 houses in total. The plan was to make the maximum number of households owning land, set up portable biogas plants or fixed biogas plants. Those who did not have enough land to set up the plants were advised to go for pipe composting.

The fixed biogas plant designed by the Agency for Non-conventional Energy and Rural Technology (ANERT) at a cost of INR 17,500. About 8-10 kg of waste can be treated in this plant. The plant provides biogas for two-three hours daily. Likewise, the portable

United Nations Environment Programme (UNEP) in its report 'Solid approach to waste: How five cities are beating pollution' recognised Alappuzha amongst five cities in the world that are working towards curbing pollution through their sustainable solid waste management practices.

⁴² Ibid.

biogas plant designed by Integrated Rural Technology Centre (IRTC) is made of fibre and resin. The capacity of this plant is 1,000 litres, and it costs Rs 13,500. In this plant, 5-7.5 kg waste can be converted into compost. Biogas will be available for 80-90 minutes. Suchitwa Mission, the state's nodal agency in-charge of the total sanitation programme, gave 75 per cent subsidy to biogas plants.

The pipe composting system is ideal for a small family. It requires only two pieces of PVC pipes each with a length of 1.25m and a width of minimum eight inches. The pipes should be buried vertically in 30 cm deep pits. Initially, 400 ml cow-dung solution (or jaggery solution) should be poured into the pipe before putting degradable throwaways such as vegetable waste, fish waste, and leftover food items into the pipe on a daily basis.

The pipe would be filled with the degraded waste in a month, which should be kept undisturbed for yet another month. Then for the next 30-35 days waste is put in the second pipe. By the time the second pipe is full, waste in the first one would be converted into compost. A few holes are made on the top part of the pipe for air to enter and to avoid bad smell. Households, which could not install plants due to financial or space constraints were urged to deposit their domestic waste in biogas plants of their neighbour as a cluster programme. To ensure effective implementation of these mini personal plants, every ward had a team consisting of two or three trained women for maintenance.

For the cost not to be a deterrent factor for the public acceptance, municipality offered subsidy while purchasing. For example, a pipe compost unit, which sells in the market for INR 1,000, was offered to households at INR 100-120 with the municipality and the state government sharing the subsidy of 90 per cent. Similarly, a biogas unit, that costs around INR 15,000 was given at a 75 per cent subsidy that translated into an affordable cost of INR 3,750 for each household.⁴³

As for plastic waste, municipality ensured periodic collection on specified date and locations. These collected non-biodegradable wastes were either given to private contractors or the state-owned Clean Kerala Company for recycling.

In 2013, the clean city drive took a new turn with the entry of Thumburmuzhi, a model aerobic composting unit. The model consists of a tank of 4x4x4 feet size made of ferro-cement or bricks. It is designed in such a way that air enters into the tank through the gaps on the sides. It should be kept under a roof to avoid rainwater falling into the tank. About 2 tonnes of waste can be processed into compost in 90 days in this tank. A layer of fresh cow dung or slurry from the biogas plants is put at the bottom of the tank to generate microbes for composting. Above this, a six-inch layer of dry leaves or dry grass or small pieces of paper is placed. This absorbs water oozing from garbage. Over this, layers of bio-waste and cow dung are placed. The temperature inside the tank goes up to 75°C. This prevents mosquitoes and flies and other small creatures from entering. The construction cost of each tank is around Rs 10,000. A unit with two tanks, roof, side

⁴³ Sanchari Pal, *How Kerala's Zero Waste Alappuzha won a Spot among top 5 Cities in UN List, The Better India, 30 Dec 2017*. Accessible at <www.thebetterindia.com/126083/kerala-alappuzha-zero-waste-cleanest-city-india-un/>

walls and water facilities costs about Rs 1-15 lakh (Please get this figure checked. It is Rs 15 lakh or Rs 1.5 lakh?). The model was developed in the Thumburmuzhi campus of Kerala Veterinary and Animal Science University to compost carcasses of animals, hence its name.

According to Binz C Thomas, the District Coordinator, Kerala Suchitwa Mission, till date, the municipality has set up 23 waste collection centres with around 220 Thumburmuzhi bins at public places and the old waste dumping spots. These are maintained by the 170 plus contingent workers of the municipality who used to earlier collect waste from dump spots in the city and transport it to Sarvodayapuram. The households, which do not have other waste processing facilities can bring their waste to the aerobic bins, which are set up within a radius of every one kilometer. About 10,000 households are connected to these collection centres. Apart from the households, 25 per cent of the bio waste from small shops, too, reached these bins. Compost from these is given free of cost to farmers.

These measures taken for effective solid waste management cannot be successful unless effective trainings are not given to all stakeholders. There is a need to ensure that there is a structured training schedule and they are conducted as per the schedule. Realising this, the municipality imparted trainings to all stakeholders, particularly it ensured that the workers are given regular technical training in waste management and personality development so that they can educate the residents and control their displeasure when people bring in waste that are not properly segregated.

Simultaneously, to check garbage disposal in public places and to curb it forever, municipality formed night squads of sanitation workers. If any resident is caught throwing waste, she or he is fined Rs 2,500. If waste is dumped into a canal or a water body, fine may go up to Rs 20,000 under the Section 340 B of the Municipal Solid Waste Rules for contaminating and polluting water sources. For shops and hotels, a closure notice may also be served.

Seeing the immediate impact of the pilot project, gradually Alappuzha municipality rolled out next phase of the project in more wards. As on date, the municipality has established 5,000 kitchen bins, 3,000 biogas plants, 2,800 pipe composting units and 218 aerobic composting units in all its wards. A convenient supply of biogas and manure has been provided to its 1.74 lakh population.⁴⁴

Money saved on diesel used for operating 40-50 trucks to transport the waste to the dumping yard alone comes to about Rs 5 million. The cost of the biogas produced through the plants works out to Rs 6 millions. The fertiliser can fetch up to Rs 3 million.

Interestingly the Clean Homes Clean City initiative has helped Alappuzha municipality earn few awards including the Kerala government's energy conservation awards for 2013- 14, Clean City Award from Centre for Science and Environment in 2016, and the recent recognition by UNEP as one of the five top clean cities in the world.

⁴⁴ Ibid.

Besides, the money saved on diesel used for operating 40-50 trucks to transport the waste to the dumping yard alone comes to about Rs 5 million. The cost of the biogas produced through the plants works out to Rs 6 million. The fertiliser can fetch up to Rs 3 million. The savings are bound to go up when more and more wards join the project.⁴⁵

Way Forward

Alappuzha's experiments with decentralised waste management have inspired other municipalities to successfully replicate the same models within the state. A state policy has been developed to bring 1,000 village Panchayats to install aerobic bins to process organic waste. The Thiruvananthapuram Corporation has already installed biogas plants and pipe composts at few wards.

In Alappuzha, the project is being upgraded. By 2019, they aim to install aerobic units every half a kilometre. Plans are developed to provide bio bins at a 50 per cent subsidy in 30 per cent households who have not installed aerobic units yet. Also in another two years they expect every house in the district to have at least one system of decentralised waste management.

The transition benefits towards a circular economy could be considered by reducing environmental pressures. As seen above, recycling will turn waste into a resource, and will contribute to rise in economy and reduce natural resources consumption. As the circular economy is at the top of the global agenda, it would be beneficial for any country to move slowly away from the old fashioned disposal of waste to a more intelligent waste treatment, like the above model, keeping in view the circular economy approach.

⁴⁵ Kerala's Zero Waste Alappuzha among top 5 Cities in UN List to Successfully Manage Solid Waste, FirstPost, 01 Dec 2017. Accessible at <www.firstpost.com/india/keralas-zero-waste-alappuzha-among-top-five-cities-in-un-list-to-successfully-manage-solid-waste-4236667.html>

No Electricity Use, No GHG Emissions- Clay Refrigerators

Introduction

The use of earthenware in the form of pottery in India goes back to ancient times and speaks volumes about the civilization. The traditional art which began from Indus Valley Civilization has continued through ages in the form of pottery, earthenware and porcelain. The use of pots as an expression of art and storage vessels for water and grains were most popular. Also, before the advent of plastics, stainless steel and Teflon, the only materials that were used for vessels were clay and mud. The Indian traditional cooking style is directly associated with use of earthen vessels which has survived the test of time because of their health benefits and unique flavor added to food. The huge demand for earthenware, clay pots and other articles and artefacts made of mud gave the potter community a unique position in the craft traditions of India. This community still plays a very important role in preserving this traditional art of mud and clay products, which is the most acceptable and best available sustainable alternative to almost every available plastic and metal product in a household.

Earthenware has always been an intrinsic part of the Indian households. Some of the traditional practices in the Indian culture are associated with use of clay products. Tea served in clay cups, popularly known as “*Bhar*⁴⁶”, in the streets of Kolkata is considered the best with a unique earthy flavor. The clay glasses/cups are popular as “*Khullad*” in Northern India and are used to serve sweet buttermilk and tea. There was a time when the clay cups were everywhere, at every railway station, street corner or under a shady tree until plastic disposables made their way in the Indian market and rapidly replaced the clay and the associated tradition. The clay pots and earthenware in Indian kitchen is

Evaporative cooling is a natural, passive cooling process in which a body or an object is cooled by the evaporation of water from its surface. This process has been in use for several centuries to cool water and preserve food.

not something new is intrinsically associated with our ancestors’ sustainable lifestyles. Clay pots, using evaporative cooling technique, keep water naturally cool in hot and dry regions, and earthen vessels to cook and store food are known for being healthy and environment friendly alternatives to Teflon non-stick ware and stainless steel and aluminum vessels. The earthenware in any form is

the best example of sustainable lifestyle and practice of circular economy which is deeply ingrained in the Indian culture.

Apart from the clay products used in households, the tradition of mud construction to build sustainable habitats with high degree of comfort and energy conservation especially in hot and dry regions cannot be forgotten. The case study on mud marvels returning to vogue in urban settings is also taken as part of this project documentation.

⁴⁶ *Bhars* are small, handmade cups made of clay used for serving the sweet, milky tea that is sold on the streets all over India.

With the advent of technology, increase in income and availability of luxurious alternatives, the mud products and the traditional practices are fast becoming a lost memory. Refrigerators emitting harmful greenhouse gasses (GHG) and plastic bottles are preferred over clay pots which are beneficial, environment friendly and act as natural filters for water; Teflon non-stick ware with carcinogenic agents, which with time, deteriorate further and energy-intensive metals have taken over earthen vessels and cooking pots; plastic disposables have replaced eco-friendly clay cups, glasses and natural leaf tableware used by our ancestors; and concrete and cement are considered more strong and durable compared to mud and compressed earth blocks - without thinking about the severe impacts these modern replacements have on environment.

Not everybody is part of this race and few have taken over the responsibility to save Mother Earth. Our ancestors have solutions to every problem created by modernization in the name of technology and development. Mansukhbhai Prajapati from Gujarat has shown this novelty through his initiative “Mitti Cool”.

Mitti Cool: Soul of the Soil

Mansukhbhai Prajapati, belonging to traditional clay craftsmen community known as “*kumhars*” in India, has transformed traditional clay items into an innovative range of products which he calls Mitti Cool, “*mitti*” meaning clay in Hindi. Born in a village in Rajkot district of Gujarat, Mansukhbhai inherited the art from his forefathers as a family heritage. Due to the dying art of clay crafts and less takers for clay products in urban setting, Mansukhbhai had to take up odd jobs - starting his career as a tea stall worker, despite his artistic skills of moulding clay in any desired shape, size and form. It was in the year 1988, that the man decided to leave his job and start his own venture of manufacturing earthen pans, firming his belief in his art of a skilled craftsman. Earthen pans to cook wheat breads were quite popular in India as a traditional method and now generally iron pans are used in urban setting these days. Reminding people of the forgotten method and earthy taste, Mansukhbhai realised that there are many people who want to get back to traditional methods if made available easily to them. Utilizing the opportunity, he started the daunting task of manufacturing earthen vessels like pans, containers, bowls, plates, pots and even water filters. Making the best use of skills and knowledge about properties of mud, there were many experiments with the proportion of clay and other ingredients to design the best, resilient and reliable range of products. With an immense positive response and feedback from customers, Prajapati’s ‘Mitti Cool’ was registered as a trademark in 2001 and became popular amongst Indian and international customers.



Figure 18: Mitti Cool Office and Display Centre in Wankaner, Gujarat

The man who started his journey from a tea stall became the master of his skill and witnessed success with the belief in his art and traditional knowledge of his craft. In the same year, 2001, calamitous earthquake struck the region of Gujarat and the delicate stock of clay products were wrecked along with an enormous damage to life and property in a major part of state, especially in the Kutch region. Mansukhbhai suffered irreparable losses in business but was more saddened by the loss in state where people lost everything in a spur of second.. One fine day, after the earthquake, he came across an article in a newspaper pictured with his broken products along with his designed water filter, captioned “*Garibi ka Fridge Tut Gaya*” meaning “Fridge of the Poor is shattered”. Earthen pots are often kept in rural households to store and keep cool water. Some urban houses use these too.. It was at this moment, that the idea of one of the most innovative, eco-friendly, low-cost and sustainable alternative to electronic refrigerators came to Mansukhbhai’s mind. In 2002, he started working on the refrigerator design and came in contact with GIAN (Grassroots Innovation Augmentation Network), which assisted him in various stages of product development.⁴⁷

At present, Mansukhbhai is assisted by his two sons, Ravi and Raj Prajapati who work tirelessly with their father to take their business to new heights. The two generations working together puts in the right blend of traditions and modern knowledge to bring to light the lost art of clay craft, highlighting the earth’s potential to provide sustainable alternatives. Mitti Cool employs a workforce of around 80 people, majorly women, to manufacture all types of clay products. Products like Water Filter, Clay Refrigerators, and water bottle design have also been patented in the name of Mitti Cool and the innovator.

Clay Refrigerator

Think about days when there were no refrigerators to preserve vegetables, fruits, milk or cool water. Those were the days when our ancestors lived a healthy life because they relied on natural alternatives of earthen vessels, utensils and pots for all these tasks

⁴⁷ <https://www.thebetterindia.com/14711/mitticool-rural-innovation-nif-mansukhbhai/>

without compromising their health and harming the environment with harmful gases emitted by refrigerators these days. The initial high cost of an electronic fridge, recurring electricity and maintenance cost are a huge financial burden for lower economic section of the society, and for those who can afford it the food loses its natural flavor and each machine adds to individual carbon footprint, thus degrading the environment.

Mitti Cool is a natural refrigerator made entirely of clay. It is used to store vegetables, fruits and also for cooling water. It provides natural coolness to the stored material without electricity or any other artificial form of energy. Fruits, vegetables and milk can be stored fresh without deterioration in their quality for 5-6 days and retaining their original taste.

The machine works on the principle of evaporative cooling which is a passive cooling process in which a body or an object is cooled by the evaporation of water from its surface. Since only ambient energy is utilized for the evaporation, evaporative cooling is a very promising method that can be used in the design of storage facilities for perishable food products like fruits and vegetables and for air conditioning in rural areas of developing countries. The same principle is behind the working of earthen pots used to store and cool water. This cooling technique is very relevant and greatly needed at present when depleting fossil fuel reserves and environmental problems are mounting global concerns.⁴⁸



Figure 19: Clay Refrigerator 50 litres Capacity

The upper top chamber of the model is used to store water. Water from the upper chambers drips down the side through porous clay and the capillary action takes water to the outside of the pot, which evaporates, in turn cooling the pot as it loses heat to the leaving molecules' kinetic energy. This process then cools down the interior of the refrigerator by conduction, thus providing natural protection to the stored objects. A small lid made from clay is provided on top. A small faucet is also provided at the front lower end of chamber to tap out the water for drinking. In the lower chamber, two shelves are provided to store vegetables, fruits and milk and other perishables.

⁴⁸https://www.researchgate.net/profile/Siddharth-Chatterjee/publication/233162245_Evaporative_Cooling_of_Water_in_a_Small_Vessel_Under_Varying_Ambient_Humidity/links/0912f50a01d9cb9e0e000000/Evaporative-Cooling-of-Water-in-a-Small-Vessel-Under-Varying-Ambient-Humidity.pdfv

At present, the model is available in 50 litres capacity costing INR 6000-7000 for a single product. The price is reduced for bulk orders. The team is planning to launch a 120 litres capacity model soon, with the look and feel similar to an electronic refrigerator. The refrigerator does not have any recurring cost associated with it, not even the maintenance cost, as one can easily clean it with a wet cloth once a month to maintain performance throughout.

Other Products

Apart from clay refrigerators, Mitti Cool receives huge demand for clay filters which is their patented product and is highly popular in developing countries like Nairobi and Kenya with severe water quality issues. The Clay Water Filter is a combination of two layer storage with a built-in ceramic filter tube inside that purifies water as it passes down from upper to lower level. The product has a huge potential in both urban and rural settings globally to store and treat water naturally.

A huge collection of earthenware like pans, pressure cookers, plates, bowls, cups, glasses, water bottles, pots, storage vessels available in various shapes and sizes is a massive hit amongst the customers craving for the traditional Indian taste. These products are beneficial to the health, eco-friendly and re-usable until they suffer a breakage.



Figure 20 Clay products in Mitti Cool display Centre

Benefits of Earthenware

1. Maintains pH level of food: Due to the alkaline nature of soil, clay utensils are used for cooking. In the process, the acidic substances in the food get mixed with the alkaline soil, thus getting the required pH level in the food.
2. Maintains food nutrition: When cooked in earthenware, the steam remains inside the vessel and is not released like other metal vessel. The nutritious value thus remains intact inside the vessel. Also, cooking in clay pots is said have several minerals such as calcium, phosphorus, iron, magnesium, sulphur from which our body benefits.

3. **Tastier Food:** The porous nature of a clay pot makes it retain moisture and heat within the pot itself ensuring a dish that is perfectly cooked and full of flavor with earthy taste and unmatched aroma.
4. **Eco-Friendly:** The modern utensils are energy-intensive while they are manufactured and when they are disposed. The metals, even if recycled, have a huge energy cost associated with them which is not the case with these compostable earthenware made of mud and which goes back to the earth.
5. Food stays healthy for a longer time when kept in the earthen vessel.
6. Lesser oil, salt and water is required for cooking food in earthen vessel, thus putting a check on lifestyle diseases and high cholesterol problems.

Awards and Recognition

Mansukhbhai and Mitti Cool hold many records and have received recognition for their products and innovative designs. He was awarded in National Innovation Fund's⁴⁹ Fifth National Competition for Grassroots Innovations and Traditional Knowledge in 2009. He was also selected by Forbes in 2010 in their list of most powerful seven rural Indian entrepreneurs whose "invention were changing lives" of the people across the country. Mitti Cool is also the first grassroots innovation enterprise which received ISO certification in India. Till date, the innovator has received more than 80 awards and recognitions on both national and international platforms.

Way Forward

The rapid urbanization and industrialization comes with associated negative externalities for India. Today, India stands at the threshold of profound choices. With its young population and emerging manufacturing sector, the country can make systemic choices that would put it on a trajectory towards positive, regenerative, and value creating development.⁵⁰ The circular economy model of lifestyle has been part of our culture since centuries but got lost in westernization in last few decades. The recent initiative by businesses like Mitti Cool is an effort to bring back the lost memories of our culture. Many state governments have approached the venture to put up training workshops under Skill Development Mission of India and at the same time push for eco-friendly alternatives for unsustainable materials like plastics and metals being used at present. Various government schemes like Clean India, Make in India, Rural Employment Guarantee Scheme, etc. get direct practical support from a venture like Mitti Cool.

Mansukhbhai and his team hope to re-grow the lost roots of Indian Culture into modern urban lifestyles and do their bit in preserving the culture. The vision is to bring the best of clay in front of entire world and highlight the amazing hidden benefits of using clay products. The huge demand of products at local, national and international level shows that people would opt for sustainable lifestyle if alternatives are made available to them

⁴⁹ National Innovation Foundation (NIF) - India was set up in 2000 with the assistance of Department of Science and Technology, Government of India. It is India's national initiative to strengthen the grassroots technological innovations and outstanding traditional knowledge.

⁵⁰ <https://www.ellenmacarthurfoundation.org/publications/india>

readily without additional burden on their pockets. The clay products are made from natural and easily available mud backed by experience and research to provide them with required strength and quality. This makes them cost-effective and at the same time preserves the art through skill development and training, thereby, providing livelihood to a large number of people.

Some of the small efforts in personal and professional spaces like replacing plastic bottles with clay bottles, clay refrigerators to preserve perishables and water filters to store, cool and purify water can make a huge difference and can start a chain of behavioral change required to opt for sustainable lifestyles. Next time when you visit a tea stall, go for a clay cup even if cost a penny or two more and do your bit to achieve the Sustainable Development Goals for India and the world.

Chill Water with Natural Air and Sunlight

Introduction

The demand for energy resources is increasing day by day with increase in temperatures and effects of climate change. Developed countries continue to consume a major part of global energy and developing countries are showing rapid increase in demand. According to International Energy Agency (IEA), global energy demand rose by 2.1 per cent in 2017, more than twice the previous year's rate, boosted by strong global economic growth, with oil, gas and coal meeting most of the increase in demand for energy, and renewables seeing impressive gains⁵¹. The agency also estimated that over 70 per cent of global energy demand growth was met by oil, natural gas and coal, while renewables accounted for almost all of the rest but at the same time carbon emissions reached a historical high. The trend of increasing use of renewable energy and at the same of time, the increasing carbon emissions does not give a very soothing picture of development in energy sector globally. In a developing economy like India, it is estimated that coal will remain the most used fuel, making up 49 per cent of total energy demand in 2040⁵² and similar or worse will be the scenario in other developing countries where the demand of energy is increasing.

Increasing demand of energy and the global increase in consumption has made a term -- 'Energy Efficient' -- popular globally, especially with respect of electrical appliances. More than ever before, energy efficiency has become central to the achievement of a range of policy goals, including energy security, economic growth and environmental sustainability. The recent initiatives and technology changes have had significant impact on global energy demand, reducing consumers' energy bills, holding back emissions growth and making energy systems more secure⁵³. But at the same time, the increasing level of carbon emissions is so high that world is moving swiftly towards a stage where destruction will become inevitable if the measures to control it are not deployed more efficiently and strongly.

Energy efficiency in buildings continues to improve, thanks to policy action and technological advances. The IEA states that efficiency improvements of 10 per cent to 20 per cent are possible in most countries from appliances, equipment and lighting products that are already commercially available. Though, energy efficiency is the need of the hour but the popularity this term has gained in last decade may put the use of zero energy use products on a backseat. There is an immediate need to simultaneously push for appliances operated using renewable energy and traditional methods like evaporative cooling and adding minimum to carbon emissions.

The idea and technology of solar water heaters is not new and we all have heard and most of us have adopted the technology in our lives. In fact, renewable solar energy has

⁵¹ <https://www.iea.org/newsroom/news/2018/march/global-energy-demand-grew-by-21-in-2017-and-carbon-emissions-rose-for-the-firs.html>

⁵² <https://www.economist.com/economic-and-financial-indicators/2015/11/14/energy-demand-in-india>

⁵³ <https://www.iea.org/efficiency/>

been used in various applications like heating, cooking, warming and drying. With more advancement in technology, the use of solar energy to generate electricity as an alternative to conventional thermal energy has been a much discussed subject. The use of solar panels to generate power at commercial, industrial and even residential level is being pushed by the governments all over the world, especially in countries where the sun shines for most part of the year.

Though, the concept of solar water heaters is common, now there are solar water coolers as well with the potential of massive impact on large scale water cooling in the form of water dispensers. The case of Notion Technocrats from Gujarat, India is an example of how natural water coolers can chill water in extremely hot temperatures and save on huge electricity cost.

Natural Water Coolers

In the torrid heat of Indian summer, cool water is a priceless commodity. However, those traveling and living in the rural areas know that with summer comes erratic power supply. The ubiquitous earthen pots prove ineffective once the mercury rises beyond a point. They are also not suitable for public use. Water coolers are expensive and require electricity. Existing water-cooling solutions for public consumption of 150 litre capacity may require more than 1,200W of power to operate and employ air compressors that circulate environmentally harmful refrigerants for cooling to occur. Arvindbhai Patel of Gujarat has developed a water cooler, which provides cool water, consumes less energy (solar PV) and does not require much maintenance.

“Necessity is the mother of invention” is a popular saying. For Arvindbhai Patel from Ahmedabad, his sickness became the mother of invention when the idea of natural

Advantages

- Zero Energy Device and requires no external supply of electricity.
- No moving part inside, so No major maintenance Cost.
- Clean and healthy water due to use of copper pipes and water filter.
- High shelf-life when compared to electrically operated Water Coolers.
- No emissions and environment friendly.

water coolers first came to his mind while his wife was trying to get his temperature down by putting cold packs on his forehead. This gave him an idea to use the same principle to develop a water cooler, which would not require electricity.

The principle of evaporative cooling⁵⁴ was used to design the water cooler, which uses the natural energy from the sun and requires no other artificial source of energy. In his natural water cooler, water is passed through copper coils covered with cotton cloth, which is continuously being moistened by a dripper. Evaporation of water from the cloth wrapped on the coil cools the water inside to 21-22 degree Celsius at atmospheric temperature of 40-42 degree and 50

per cent relative humidity. Also, the use of copper pipes reminds us of Ayurveda, which

⁵⁴ Reduction in temperature resulting from the evaporation of a liquid, which removes latent heat from the surface from which evaporation takes place. This process is employed in industrial and domestic cooling systems, and is also the physical basis of sweating.

prescribes copper enriched water for healthy stomach. Keeping the importance of safe and clean water, the water dispensers come with water filter fitted inside, thus, fighting the threat of water borne diseases.



Figure 21: Jaymeen Patel with Natural Water Cooler

Arvindbhai received support from Micro Venture Innovation Fund (MVIF) scheme of National Innovation Fund⁵⁵ for commercialisation of this technology and also the product was patented with facilitation by GIAN⁵⁶. Notion Technocrats India Pvt Ltd., formally "Nature Technocrats" was started in year 2012 to sell the product with a commercial brand by a team of four members with Arvindbhai being the CEO. The firm is currently managed by Jaymeen Patel, son of Arvindbhai who is bedridden due to his health conditions. Jaymeen operates from a small room in his house while the manufacturing unit is located in their farmland in outer Ahmedabad. The cooler is useful for supplying cool drinking water in hot summer, particularly in areas where electricity is absent or erratic. Initially, Arvindbhai manufactured his water cooler in three different capacities of 5, 10 and 20 litres but at present only 150 litres capacity dispensers are being manufactured due to sustainable designs and technological performance. A single piece cost about Rs 85,000 but the price goes down as the production increases with bulk orders. The cost is recovered after few months as there is no electricity consumption and maintenance associated with the product.

The sustainable model comes with minimum maintenance and maximum use providing cool drinking water at public places like schools, parks, offices, banks, hospitals, and bus and railway stations and similar such places with heavy footfall. Starting with a very humble beginning, the product has got recognition now as the demand is increasing day by day.

⁵⁵ National Innovation foundation is set up with assistance of Department of Science and technology of Government of India to promote & strengthen the grassroots technological innovations and outstanding traditional knowledge.

⁵⁶ Grassroots Innovation Augmentation Network (GIAN) is an organisation set up to scale up and spawn grassroots innovations and help development of successful enterprises. It provide the innovators with adequate linkages to modern science and technology, market research, design institutions and funding organizations.

Arvindbhai Patel

An accomplished technician and fabricator, Arvindbhai Patel is a persistent innovator who has never learnt to give up. With his keen mind, he has developed many innovative products such as Natural Water Cooler, Auto Air Kick Pump, Auto Compression Sprayer and Innovative tongs. For more than two decades, Arvindbhai has devoted himself to the expression of his creative genius, undeterred by economic hardship and lack of support. He was born in the village Vanch, 10 km from Ahmedabad, in 1955 where his family practiced agriculture. Arvindbhai's mind could not be satisfied with this and he wanted to do something different. A long period of struggle and economic hardship followed but he remained undeterred and he probably has the maximum number of technology licensing for several of his innovations among all the grassroot-level innovators.

Youngest among six siblings, he could study only up to class Xth. With nobody else educated in his family, Arvindbhai only had his motivation to pursue his studies. After completing school, he tried to enroll in a commerce course. However, as the medium of education was English, he could not cope with it and had to discontinue. Later he joined an automobile garage and learnt practical skills of auto repairs for two years.

In 1980, he traveled to Saudi Arabia, where he worked for a few years and returned to settle down in his native village. He lived there till 1993 and thereafter moved to Ahmedabad. Arvind's wife Jaishree is a school teacher who holds a Masters in Arts and a Bachelor's in Education. Their son is a mechanical engineer while daughter is a physiotherapist. Both his children have been instrumental in triggering ideas in him for new innovations. Initially, his wife considered him to be over enthusiastic and asked him to concentrate on a steady job and let go of innovation work as it did not give him flow of regular money. But her views changed once the products were widely used and he started getting widespread recognition.

Working Principle

The Natural Water Cooler is a low cost, energy efficient, environment-friendly water cooler that is based on the principle of heat exchange. It cools water naturally according to the external temperature and humidity. Water passes through cotton string covered copper coils, which are continuously being moistened by a dripper. A small DC fan operated through solar panel mounted on roof top facilitates the air circulation and evaporation of water from the cotton string on the coil cools the water inside. It reduces the temperature of input water by 8 to 10 degree Centigrade depending upon the external temperature and humidity. It also has an in-built filter that provides clean and hygienic water. The external casing of copper coil is made of steel with sufficient ventilation. The use of copper tubes for flow of water has health benefits too. It has to be located in an area where there is sufficient ventilation and should not be directly exposed to sunlight.

Arvindbhai's innovations are in diverse fields. However, the ones in the non-conventional energy sector have been more widely appreciated. These include water

cooler, low cost solar water heater, auto air-kick pump, and innovative application of the windmill, amongst others.

Way Forward

There are many reasons attributed to the positive outlook in the electricity-operated appliance market and energy efficiency is one of the fundamental reasons behind the trend. The high-energy-consumption devices and appliances are often termed as 'power vampires' and this has reduced their takers in the market. The governments all over the world are pushing for stringent energy and safety regulations and energy-efficiency programs are being implemented in many regions of the world. At the same time, the rising awareness amongst consumers about the effects of rising emissions and its relation to phenomenon like climate change along with demand for alternatives to combat higher utility bills have pushed for availability of energy efficient options in the market.

While the big market players in the world are investing a massive amount to design energy efficient products, the similar efforts at the local level go unrecognised due to lack of exposure. There are numerous examples of innovations inspired by traditional practices and several new concepts, which if given proper exposure and recognition, have the potential to change the way we look at these grassroot-level innovations. The design of natural water coolers by Arvindbhai Patel is one example amongst many, which if taken through proper technological process through more research and development in the design, can save on huge energy consumption that goes in a similar electricity-operated water dispenser. The product is environment friendly, cost-effective, uses renewable solar energy, implies traditional use of copper and works on a simple principle of evaporative cooling through heat exchange. Imagine a huge campus with more than 50 water dispensers installed at different locations and calculate the high amount of energy that goes in to run those dispensers. A simple design working with freely available solar power, with no greenhouse gas emissions and providing reasonably chilled water to drink may seem like a small effort of change but surely will have a huge impact if we want to change the way we have been destroying the natural resources. A small innovation and a minor change can lead to major visible results.

Socially Responsible Construction: Development Alternatives

Introduction

World is growing and so is its population. Urban environments are in constant pressure to fulfill increasing demands of this population. It is projected that by 2050, urban areas would house 66 per cent of people globally with rural population reaching towards its peak in few decades. In India, where at present 410 million people reside in urban areas, it is estimated that the number will increase to 814 million by 2050 (WUP, 2014). One cannot ignore the link between pollution and urbanisation where world's cities, which cover 2 per cent of global land area account for a staggering 70 per cent of greenhouse-gas (GHG) emissions⁵⁷.

One of the necessity and need of the increasing population is the need of infrastructure and housing to accommodate them. Existing model of development of new cities or urban infrastructure are carbon and resource intensive that generates lot of wastes and are in vast contrast to our age old practices that our ancestors followed centuries ago.

If one looks at the estimate of global pollution that can be attributed to buildings, the condition seems very severe⁵⁸-

Pollution	%
Air quality (cities)	23
Climate change gases	50
Drinking water pollution	40
Landfill waste	50
Ozone depletion	50

It is estimated that around half of all non-renewable resources consumed by mankind are used in construction, which makes it one of the least sustainable industries in the world⁵⁹. We cannot stop urbanisation, it is a continual process necessary for economic growth, but we can mitigate urbanisation's impacts on the environment if thoughtfully approached. As Bryan Walsh had put it, "We're headed towards an urban planet no matter what, but whether it becomes a heaven or a hell is up to us."

Rising Temperatures

According to the United States (US) Environmental Protection Agency, carbon dioxide and methane concentrations have increased substantially since the beginning of the

⁵⁷ <https://www.zdnet.com/article/un-cities-contribute-70-percent-of-global-greenhouse-gas-emissions/>

⁵⁸ *Impacts of construction & build environment, 2010*

⁵⁹ <https://www.willmottidixon.co.uk/asset/9462/download>

industrial era. While carbon dioxide rose from an annual average of 280 parts per million (ppm) in the late 1700s to 401 ppm - a 43 per cent increase, the methane level almost doubled to 1,800 ppb. Almost all of this increase is due to human activities. This increase in concentration of atmospheric carbon dioxide and other GHGs have caused the average temperature on Earth to rise.

According to National Oceanic and Atmospheric Administration (NOAA) of the United States, since 1970, global surface temperature rose at an average rate of about 0.17°C per decade. The average global temperature for 2016 was 0.94 degreeC, surpassing the previous record warmth of 2015 by 0.04 degreeC.

The rising temperatures are directly proportional to increase in penetration of artificial polluting methods to control temperature, most popular being air conditioners. Air conditioning is inevitable especially in tropical regions where high temperature has effect on productivity, education and wealth of people⁶⁰, it brings with it huge environment risks of warming the planet.

Prior to the invent of motorised air conditioning systems, people relied on natural heating and cooling methods like shading, thermal mass, and natural ventilation to achieve thermal comfort. Such methods have been practised from time immemorial. For example, the ancient Babylonians used evaporative cooling to condition their dwellings as far back as 2,000 BC.⁶¹

Now the temperatures are rising, heat is increasing and people need comfort from it. Current building envelope, design and materials do not address such growing issues and the common man has also forgotten the immense insulating properties of traditional building materials that are natural in comparison to the concrete and cement.

An enticing prospect lies ahead of individuals and groups who have studied, understood and incorporated the importance of traditional designs and expertise of our ancestors when it comes to architecture. The history has so much to give us back, only if we are willing to look back and learn from it and suitably incorporate them in our modern lifestyle.

Development Alternatives

Gross Floor Area- 4,775 m²

Workplace Capacity- 245 with more than 200 visitors

Location- Qutab Institutional Area, New Delhi

Architect- Ashok B. Lall

Grey Energy: The hidden energy associated with a product, i.e., the total energy consumed throughout the product's life cycle from its production to its disposal.

⁶⁰ <https://www.economist.com/international/2018/08/25/air-conditioners-do-great-good-but-at-a-high-environmental-cost>

⁶¹ Julia Raish, *Thermal Comfort: Designing for People*, Editor: Werner Lang & Aurora McClain, Center for Sustainable Development, University of Texas. Accessible at <
https://soa.utexas.edu/sites/default/disk/urban_ecosystems/urban_ecosystems/09_03_fa_ferguson_raish_ml.pdf>

Amidst the rising issues of smog in the capital city of India, lies a building standing tall and strong with its head held high in the world where construction sector is shamefully leading the pollution index both directly and indirectly. The building is an example and model for urban development in transitional or emerging economies seeking to improve environment performance.

Right from the stage of production of raw materials to construction and completion of building and further to maintenance in long term, the headquarters of Development Alternatives (DA) in New Delhi has taken care of every step to deal with *Grey energy* in the sector, which is often ignored as a one-time affair. It is often called as the “**Greenest Building in Delhi**”.



Figure 22: Development Alternatives building in New Delhi

The DA is an NGO committed to spreading environmentally appropriate technology and fostering socio-economic equity. Established in 1983, under the leadership of Dr. Ashok Khosla, a physicist and expert in environmental affairs and development, the DA promotes commercially viable and environmentally responsible technology and established services that help predominantly poor people create sustainable livelihoods and sustainable habitats for themselves. The organisation is leading the change with example of its own headquarters built on principles of sustainable development and circular economy. Not just this, the organisation through its every project makes sure that it touches the life of people around in a positive way.

The case study of the headquarters in New Delhi is looked into with details as a model of sustainable habitat and its potential of replication in urban setting in present circumstances is studied thoroughly.

The building illustrates seldom-seen yet reasonable ways of reducing embodied energy in buildings, equitably distributing wealth through the construction project, updating vernacular materials and forms, and curtailing energy consumption and CO2 emissions. When the CUTS team visited the campus, it was not just the words but the reality of thoughts and innovations being depicted in real designs and features incorporated in the building.

The materials and the special configuration of the building based on tradition, especially inspired by architecture of forts and palaces with courtyards, step wells, terraces, screens, balconies, pools and pavilions evolved as a response to climate. Some of the features of the building are described in detail further.

Circular Economy- Recycle, Reutilise & Reuse

The first building of the DA, before this on the same land was built using mud as the main building material, which was cheapest available at that time and was inspired by the traditional concept of mud houses in India. The ancient construction method was combined with modern engineering and the experimentally designed building with thick walls and domes made of **non-stabilised compressed- earth block** (CEB) was completed in 1988. During its 25 years of lifetime, the building suffered substantial weathering but still remained serviceable, but as number of people increased in the DA the need of larger space was felt.

“We need buildings that are energy efficient not only in terms of machines, but which are sustainable from inception of design to its maintenance.”

“We have to be innovative enough to accept the mix of traditions with modern technology to provide the best of both worlds.”

The experience and experiment with the old building made of non-stabilised compressed earth block led to more research and development along with advanced and proven technology of stabilised compressed earth blocks.

New Building with the Soul of Old

The demolished materials of old building form a very important part of new building and one can easily figure out these old bricks of different colour adjusted in an aesthetic manner in the outer walls of the present building. Even the earth removed from the site after the demolition of the original building was recycled into CEB using simple machinery. The fly-ash blocks used in the building were made using fly-ash from local power plant. The durability and life span of new building is expected to be five times longer than its predecessor, strengthening our faith in Sustainable Habitats and use of Stabilised CEB and Fly-ash Blocks.

Limit the use of Metals - Less Steel and No Aluminium

Efficiently built in reinforced concrete and masonry, the building uses less than half the reinforcing steel used in comparable structures of modern designs. Use of highly energy intensive materials like aluminium is shunned in the construction of the building. The building gets an enriching aesthetic value by presence of vaulted pre-cast concrete deck elements and hollow domes, which require 20 per cent less grey energy than standard reinforced concrete, at roughly the same cost. The vaulted elements were precast on site using simple forms and raised into place by chain and tackle and the use of crane was avoided. Vaults are bridged with 4 cm thick sandstone slabs as seen in traditional designs.

Locally Sourced materials and Use of Waste

The DA proudly acknowledges that around 80 per cent of the building material was sourced from within 500 km of the site, which has helped to restrict the carbon dioxide emissions from transportation, the use of unfinished, durable, natural material, which is left to ages with grace, has minimised the cost of maintenance of building many folds. The floors are made of unpolished granite and sandstone from north India and uses large and small flags to minimise waste.

Roof terraces are finished in a random mosaic pattern of broken white tiles bought as waste from factory yards. The insulation of cavity walls is done using expanded polystyrene brought as factory waste and the waste broken mirror glass is used in certain shadowed areas for dramatic effect and beauty.

Local Livelihoods

Not only the use of simple local materials but the use of local labour having traditional skills and fine craftsmanship were given due importance during each step of design, construction, use and recycling of building.

Reviving the Traditions

Experimenting with Earth/Mud

The DA principally works on the thought that practices and ideas that transfer best are those which are affordable, simple and broadly applicable. The architect of the building Mr. Ashok Lal draws on traditions, which are neglected due to industrialisation and commercialisation and embraces it for the sake of future. Ninety per cent of interior and exterior walls are made from cement stabilised CEBs and cement-stabilised fly-ash lime gypsum blocks. The construction & demolition material of the old building is recycled and reused in the new building built on the same land. Both CEBs and fly-ash blocks are manufactured in a way that plentiful local materials are recycled using local labour and low energy.

Natural Lighting- Saving on Power

The orientation of the building and the placement of the windows/openings are designed in a way that all workspaces are illuminated by daylight, which is modulated for glare free distribution. The conference room has roof lights that can be closed with shutters when the room must be darkened.

Cooling System

The system of air cooling in the building is inspired by the traditional techniques of passive cooling. The **hybrid air-handling units** integrate evaporative cooling and refrigerant-based cooling which reduces energy consumption by 30 per cent and reduces water consumption also. The control unit of the system automatically adjust air-handling levels and switch the mode of hybrid unit, with evaporative cooling as the base mode. Considering the high cost of air-conditioning system and huge ecological footprint it would have, the DA staff volunteered to accept the maximum indoor

temperature of 28 degree Celsius (some days even 30) at 60 per cent relative humidity. A small adjustment by staff in favour of sustainability reduced cooling loads, which in turn downsized the cooling system and helped in significant reduction in electricity consumption.

Not just the mechanical system, but even the building design and direction embrace the **passive cooling** techniques very beautifully. The building tilted at 45 degree is placed in such a way that most of the windows are north facing, which is also the direction of wind flow. The north facing windows allow free passage of air into the building, which is ventilated with proper corridors and paths for air to travel and keep the space naturally cool during extreme summers.

Displacement Cooling

Inside the building the sitting space like conference rooms have vaulted roofs for hot air to move up and settle, and the sitting space get surrounded by cooler air, which displace the hot air upwards. The U-columns conduct cool air down to the floor and overhead hollow spaces between the vaulted deck elements carry away the warm air. One can see the use of same technique in Shajahanabad (Old Delhi). This type of displacement cooling is 15 per cent more energy efficient than modern air-distribution systems. Thus, the natural process of air circulation is taken into consideration at the designing phase itself.

Courtyard Effect

The small shaded courtyard like those in old palaces and traditional mansions is connected to the entrance lobby. The courtyard decorated with green plants, lattice screens, terracotta boundary walls of six-storey and small pond in the middle of the building serves the same significance as traditional courtyard effect in ancient palaces for passive cooling. The water in ponds comes directly from rooftop rain water, which gets operational only in summers and monsoons. The cool pleasant breeze passing through the courtyard and entering various connected areas like meeting room, office, corridors, staircases and terraces thereafter gives more motivation to work.

Shading against Sun

The building is designed in a way that it provides shading against the sun in summer, welcomes it in winter and captures the pleasant cool breeze in monsoons. The prism shaped protrusions blinkering the windows in the west façade block the afternoon sun and day light reflectors on the north and south side moderate the summer sun and intense light. Vines are seen climbing the pergolas and east and west walls.

Stepwell

The circular baoli (stepwell) at the DA, a cool, shaded sitting place is a metaphor of traditional Boari in northern India. The loosely concentric steps descend towards a symbolic pool of water at the centre. Though, the place has nothing in common with the use of traditional baoli but provides a sitting space for people. The cylindrical room initially designed to be a library is not being utilised to its full potential at present but

the architecture is fascinating. The 10 clerestory windows and an oculus, which is the entire domed roof itself, are woven with bamboo stalks.

TARA Nirman Kedra (Technology and Action for Rural Advancement)

It provides simple, small scale production systems for low cost shelter and has developed simple small scale production systems for Earth and Fly-ash masonry blocks, precast concrete elements and micro concrete roof tiles¹. The company has developed the technology and machines based on scientific analysis and understanding of the waste materials. The strength of fly-ash blocks is achieved with optimum utilisation of fly ash and lime or cement, along with sand. The unit manufactures and supplies these fly-ash and earthen blocks making machines to clients who are both individuals and builders for onsite production of these eco-friendly building materials. Special training is provided to people who will be dealing with these machines on site to come out with desired strength blocks.



Figure 23: TARA Earth blocks manufacturing machine

The DA building is a perfect example of fusion of locally available materials, traditional knowledge and modern technological advancements. As an organisation, as mentioned, the DA promotes commercially viable and environmentally responsible technology and establish services that help predominantly poor people create sustainable livelihoods and sustainable habitats for themselves. The TARA Nirman Kendra is the construction and engineering arm of the DA and was also an important partner during this process of construction of this Sustainable Habitat.

Maati Ghar

With commitment to promote sustainable building designs, the DA was also involved in building of Maati Ghar (Mud House) in Indira Gandhi National Centre for Arts (IGNCA). The Maati Ghar is in the shape of three concentric rings, and made of sundried stabilised mud blocks giving an image of replica of ancient mud houses in India. The structure was made as an experiment with mud to build an exhibition centre for one year, said Professor in the Centre, but it continued to be in use for the next 10 years. The structure is now closed as per instructions of Centre due to its dilapidated conditions. The largest mud brick dome of its time, Maati Ghar is constructed using only hand tools and with ancient ventilation system of hypocausts¹ as required by exhibition interiors with controlled light and sound facilities.



Way Forward

As the “Greenest Building in Delhi”, the DA bears huge responsibility to take the innovations with blend of traditions to its logical conclusion, which is propagation of sustainable building style for all scales. The building does not have any ratings and certifications from either government or private agencies, which work on set standards, but have its own criteria of improving a step further with each design. The people who are part of the organisation have pride on their smiling faces when they talk to visitors in headquarters who come to see the sustainable design inspired by ancient mud architecture. Right from the inception of design, the building is made in a way to cut down cost at every stage. The use of construction and demolition waste from the old building and sourcing of local materials and labour has saved on cost of construction and transportation. The use of natural materials and innovative technologies has significantly brought down the recurring operating and maintenance cost associated with any other contemporary buildings. The internal calculations done by the organisation suggest that the electricity or power cost associated with the building has decreased by 47 per cent when compared with conventional designs. The building does not require any paints either in exterior or interiors, saving a huge recurring sum in maintenance budget. Apart from monetary savings, the huge amount of reduction in carbon dioxide emission helped in reducing grey energy associated with construction

industry and often ignored, and the use of natural passive air cooling techniques to maintain decent temperatures work to reduce hydro-fluorocarbon emissions in environment.

Promoting and building of sustainable habitats especially to the medium/low-income group of the society has become a huge challenge particularly because of the notions of huge capital outlay required to do so. The use of stabilised earth blocks and fly-ash blocks are considered as huge risks with respect to strength of these materials by people who invest major part of their life savings to build their dream homes. Acceptability of local materials especially earth blocks require a bit of effort and time to plan and construct and incorporation of passive air cooling techniques have become a forgotten story. Luxury and technology have become the main points of selection of designs, where new and costly technologies are always considered superior to traditional practices.

The main challenge with promotion of these sustainable habitats is to break this notion of “More Cost, Better Quality”. Our ancestors have lived a healthy, comfortable and satisfactory life based on need rather than want, by making the best use of materials locally available to them. The best of architectural innovations combining skills, strength and sustainability are still available in every city of India in the form of magnificent historical monuments.

The sustainable materials and incorporation of passive cooling designs are the need of the hour and require initiative from habitants of a city and push from the government. The construction industry acquires huge space and the rising prices of construction materials and transportation has set a wrong perception about sustainable ways. The lobby of builders needs to be taken in confidence by intermediation of government to promote sustainable building techniques.

Sustainable Environment Friendly Hybrid Chillers

Introduction

The average global temperature has been on the rise. The extreme heat wave has been melting roads in UK, and is becoming the leading cause of deaths all over the world. In extreme heat, exhaustion can disrupt the body's functioning and lead to extreme ailments like organ failure and, eventually death. The number of people who die of heat-related illness could rise to more than 250,000 by 2050, according to a World Health Organization report. Everyone will become less productive as they toil under the sun, with some parts of Asia and Africa facing up to a 12% decline in work hours by 2050 as a result of heat stress, according to the Sustainable Energy for All report.⁶² The same report also estimates that some 2.3 billion people in the developing world are on the verge of buying air conditioners, largely due to rising incomes as they leave poverty and enter the new global middle class.

The International Energy Agency (IEA), an intergovernmental organization, estimates that, air conditioners will use as much energy by 2050 as China uses today for all its electricity requirements, which will count for about a threefold increase in energy consumption by air conditioners from today, much of which could come in developing countries that remain heavily reliant on fossil fuels. In United States alone, 25% of the total delivered energy consumption goes into heating or cooling of buildings, domestic water and various industrial purposes⁶³ leading to estimation that cooling is probably the biggest energy consumer especially in developed countries.

Besides intensive energy consumption, the cooling through air conditioners contribute significantly in the much discussed phenomenon of Climate Change, by emitting chemicals like Hydrofluorocarbons (HFCs), known to trap heat in the atmosphere at alarming rates. The HFCs are thousands of times more potent than carbon dioxide. Being concerned about the problem of high and harmful emissions, in 2016, more than 170 nations reached an agreement called the Kigali Amendment, which sets targets to phase out HFCs and will reframe international standards air conditioner manufacture..

Air conditioners set out a vicious circle. It takes heat from inside of a building or a vehicle and pumps out straight into the atmosphere. That extra heat makes cities hotter, raising night-time temperatures by up to 2°C, which then encourages people to turn up their air conditioning even higher.⁶⁴ It is also estimated that the global emissions of HFCs rose by more than half between 2007 and 2012, thus adding to the burden of climate change.

According to IEA⁶⁵, at present, less than a third of global households own an air conditioner. In countries such as the United States and Japan, more than 90% of

⁶² <http://time.com/5342768/air-conditioning-heat-waves-climate-change/>

⁶³ <https://cleantechnica.com/2018/08/27/clean-heating-cooling-systems-more-ways-to-reduce-ghg-emissions/>

⁶⁴ <https://www.theguardian.com/environment/2016/aug/22/why-air-conditioning-vicious-circle-weatherwatch>

⁶⁵ <https://www.iea.org/newsroom/news/2018/may/air-conditioning-use-emerges-as-one-of-the-key-drivers-of-global-electricity-demand.html>

households have air conditioning, compared to just 8% of the 2.8 billion people living in the hottest parts of the world. The growing use of air conditioners in homes and offices around the world will be one of the top drivers of global electricity demand over the next three decades and this stresses the urgent need for policy action to improve cooling efficiency. These numbers also raise the question that if only 8% of people living in hottest parts of the world have access to ACs, how were they surviving the heat all these years? In India, the answers to this lies in passive air cooling techniques incorporated in buildings' designs and more recently, the conventional air coolers working on the principal of evaporative cooling.

Conventional Air Coolers in India

For centuries, people in India, especially living in hot and dry areas relied on desert coolers for comfort. Starting from manually operated wooden air coolers (still preserved in some palaces of India), to electrically-operated metal and wooden machines, air coolers are a huge demand in India.

The machine does not emit any harmful greenhouse gases as is the case with ACs and it uses less than one-tenth of the energy when compared to ACs. All over India, especially in the hot and dry regions of western and northern India, desert coolers can be seen in most of the households. Apart from environment benefits, these conventional air coolers cost about 80-85% less as compared to ACs and are very cheap to install and maintain. Also, these

Working Principle: Desert Coolers

Desert coolers are based on the simple principle that when unsaturated air comes in contact with water, the water evaporates. In the process, the moisture content of air increases, while its temperature decreases. The resulting cold but moist air is used for providing cooling. Thus a desert cooler is a simple device, which consists of an arrangement for blowing dry and hot air over a wet surface and an arrangement for keeping the surface wet continuously. The cooler normally consists of a blower and a pump. Desert coolers are economical (both initial and running costs are low) and are effective in hot and dry areas.

coolers circulate fresh outside air which is cooled and pushed in the room unlike ACs, which works to cool the internal air, removing the moisture and circulates the same dry air inside. The water in the tank of air coolers acts as refrigerant for the machine and it does not use any other artificial harmful gas like HFCs, therefore, acts as the best available sustainable and environment-friendly alternative to ACs.



Figure 26: Manual Wooden Cooler kept in Deeg Palace

Interestingly, the western state of Rajasthan in India is famous for both manufacture and usage of best quality air coolers. Some of palaces like Deeg Palace in Bharatpur district have preserved the wooden, manually-operated air cooler used by the then royal family in 18th century. The manually-operated machine was replaced by an electronic one and districts of Jodhpur and Banswara are famous for their unique design and technology. One can find the best quality

metal air coolers in Jodhpur which is the manufacturing hub of this machine, made with advanced technology to match an AC. The coolers are supplied all over India and some countries in the Middle East because of the performance. Similarly, the wooden coolers manufactured, using up cycled wooden shipment containers in Banswara, are also highly popular amongst masses. These metal and wooden air coolers have higher



Figure 24: Wooden Cooler made from upcycled Pine wood in Banswara



Figure 25: Metal Coolers in Jodhpur

performance and durability when compared to the alternative plastic body cooler available in market these days. The traditional knowledge, low cost and sustainable designs still make these models a big hit amongst masses in India. The big multinationals also manufacture air coolers because of the demand in hot and dry regions, especially in developing countries, but the best model is still being manufactured at the local level. The air coolers are a successful model mainly for hot and dry areas but when the humidity level rises, these are not the best option for customers.

Vaayu Hybrid Chillers

Ever imagined an air cooler which performs like an air conditioner but at the cost of air coolers? The entrepreneur couple from Indore district of Madhya Pradesh has come out with a model combining the best of two widely used cooling machines in India, i.e. air conditioners and air coolers. The innovation is “Vaayu Hybrid Chillers” where “*vaayu*” means “air” in Hindi. Vaayu is a hybrid cooling system which provides an advance cooling solution and consumes 10% of the electricity as compared to any similar cooling device. The hybrid model comes with a unique blend of technology of traditional air coolers with the compressor from ACs. Moreover, Vaayu air cooling technology uses natural air for cooling comfort and avoids using any dangerous chemicals or harmful gases and therefore, is tagged as the ‘green’ product. The presence of compressor and technological in-built of machine is such that it works well in humid conditions too, unlike conventional desert coolers.

At present, Vaayu has a manufacturing unit in Indore and distributors in the ten states of: Madhya Pradesh, Chhattisgarh, Jharkhand, Haryana, Tamil Nadu, Punjab, Telangana, Karnataka, Odisha and Maharashtra. The team supplies Vaayu machines in different sizes and varying power depending upon the area of cooling for both residential and commercial use with huge demand mainly from industries, restaurants and commercial spaces.



Figure 27: Vaayu India team with Priyanka(middle)

The journey to success was not an easy one for both, Priyanka, Chariman and Managing Director and Pranav Mokshmar, Director of Vaayu India. Pranav who is also the brain behind the concept has worked with many multinationals before he quit his job to turn his idea into reality. Having rich experience of 14 years in the field of commercial air conditioning service products, Pranav knew every technical detail about the workings of a cooling machine. The concept of combining the working principle of an AC and air cooler was always in his mind but how to turn it into a working machine was the practical challenge. He started his own venture of commercial air conditioning sales and

service in 2008 while Priyanka worked as a professor in a business school. Pranav kept experimenting to build on his idea when finally he was sure about his model, he tried convincing Priyanka to quit and work to start their own venture. It was too risky for the family if both of them would leave their constant source of income and work full-time towards idea with the probability of failure. Priyanka continued with her job but provided all the support she could to find takers of the idea as they needed financiers to start their venture. She started to write to multiple MNCs dealing in the air cooling business till she got the response from the biggest manufacturer of air coolers in India. The couple presented the idea and concept to Symphony. After analyzing the response, Priyanka who wanted her husband to sell the technology in return of royalty, withdrew and the two started their own venture now known as “Vaayu India”. It was only in 2014 that the company started their commercial business and manufacturing unit and also got the “Super Start Up” award in 2017.

The Vaayu machines are available in multiple variants in “MIG” range termed after MIG fighter planes, as Priyanka belongs to a defense background. There are five variants: MIG 18, MIG 21 Plus, MIG 24, MIG 24 Plus, and MIG 36 covering cooling area of 300 sq. ft., 450 sq. ft., 600 sq. ft., 700 sq. ft., and 1600 sq. ft. The machines price starts at INR 45,000 (MIG 18) which is compensated by the huge saving in electricity thereafter.

Commercial Comparison between Vaayu MIG and Traditional AC

Description	Vaayu	AC
Coverage Area	600 sq. ft	600 sq. ft
Power Supply	Vaayu MIG 24	6 Ton
Power Input	800 W	6,000 W
Per Hr Power Consumption	800 W	6,000W
10 Hr Power Consumption	8,000 W	60,000 W
Monthly Power Consumption	2,40,000 W	18,00,000 W
Monthly Bill	INR 1680	INR 12,600
Yearly Expenses(7 months)	INR 11,760	INR 88,200
Savings Against AC	87%	

Source: Vaayu India

Working Principle of Vaayu Chillers

1. Power is switched on, the compressor starts and the refrigerant flows in the cooling coil to chill water. Chilled water gets circulated on the pads of the machine by pumps.
2. Hot air from outer environment comes in contact with the chilled water and the molecules present in the hot air lose the temperature and become chilled.
3. Detecting the water temperature, the thermostat helps the compressor to auto start and switch off, preventing the compressor from overheating.
4. Condenser cools down the refrigerant and helps in dehumidification of excess relative humidity to control the humidity level.
5. Finally, the machine's fan circulates chilled air in the area where the unit is installed.

Way Forward

In a time when the world is searching for alternatives to the hazardous, unsustainable advancements, small ventures like Vaayu India are working to show the solution. Urbanisation, rising temperatures, and frequent heat waves are driving cooling demands higher in India and the world. The constantly increasing income levels have further raised the demands for air conditioners, especially in developing countries. If the demand has to be met sustainably, the world needs to switch to energy-efficient and climate-friendly alternatives like Vaayu. During the 2016 Meeting of the Parties (MOP) to the Montreal Protocol on Substances that Deplete the Ozone Layer (Montreal Protocol), countries around the world – with the support of industry leaders, experts, and civil society groups agreed to a global phasedown of HFCs called the Kigali Amendment.⁶⁶

No matter what the efforts are to increase the sustainable performance of ACs, the principle of such a machine is such it will still emit harmful gases heat the atmosphere. The idea is to not adapt the machine and make changes to decrease the emissions but to phase out the emissions at all levels and bring down to zero. Several companies all over the world are working on cooling replacements for HFCs which is an initiative in right direction. According to a report, Hydrofluoroolefins (HFOs), the molecules which breakdown in a matter of days, are seen as a substitute to HFCs and is being used by some manufacturers. These alternatives are expensive and complicated to produce but the world does not have time to wait till the process becomes easier and less expensive. In September 2018, India became the first country to come up with its Cooling Action Plan. The overarching goal of the Action Plan is to provide sustainable cooling and thermal comfort while securing environmental and socio-economic benefits for the society. India's cooling needs are set to increase and currently India is looking at an eight-fold increase in its cooling demands in the coming 20 years. Air conditioners comprise more than half of that demand. A document like this is a great initiative considering the situation is not very far. Simultaneously, it is important to promote technologies like Vaayu. The Montreal Protocol that aims to protect the ozone layer by

⁶⁶ <http://www.teriin.org/sites/default/files/2018-04/improving-air-conditioners-in-india.pdf>

eliminating the production and consumption of ozone depleting substances and the very recent Paris Agreement with the concern of GHG emissions can only be made successful if the suitable alternatives are worked on to replace unsustainable commodities in all sectors and Vaayu is an example of the existence of many such alternatives.

Sharing Since Ages- Sharing Economy in India

Introduction

The sharing economy is generally defined as “the peer-to-peer-based activity of obtaining, giving, or sharing the access to goods and services, coordinated through community-based online service” and will soon be an inseparable part of our economy.

Though the term is somewhat relatively new globally, the concept has been a part of India's culture since ages. It was common sight during the olden days when neighbours shared common household items like utensils, particularly during functions and large gatherings at once place. Likewise, people migrating to far of places in search of jobs lived together in shared accommodations with a common kitchen. Besides, hardly new clothes are purchased after birth of every child in a household and it was a common practise for children to wear their elder sibling's clothes or their cousins. However, with changing times and progressive new generation, the habit of using and throwing evolved causing landfills to swell.

However with the onset of recession and depleting resources, reviving and accepting the ancient cultural habits became the need of the hour. Various studies have also pointed out that the major drivers for coming back and accepting the sharing economy is economic, social and environmental. Today, increased connectivity has paved the way for people to share almost everything – from books, furniture's, home appliances, work spaces, homes, agricultural tools, electronic gadgets and even clothes.

Start-ups that facilitate this sharing are now everywhere and the most prominent of this fast growing sector of the economy is the online transportation network that offers shared taxi rides like Ola and Uber in various cities. In addition, 'Rent It Bae' and 'Swishlist' in Delhi, OhLook in Hyderabad are companies that rent out designer and everyday attire on a monthly subscription. Frequip, Rentickle and Voko are companies that rent out furniture and appliances. In the same way, there are numerous other firms, mostly in prominent cities, in India that rent out various other consumer goods like luxury bags, cars and villas.

The growing acceptance of the concept of Sharing Economy also benefited hospitality sector. Homestays have boomed in India, especially with the arrival of Airbnb, the online market place that enables people to rent their homes and apartment to short-term lodgers. However, the growth of the country through sharing economy is not just limited to cabs, furniture's, co-working spaces and homestays. They are taking it into areas that are largely unimaginable.

Friday Market

Reuse and recycle are openly practised since ages in the 200 plus year old Friday Market or commonly referred to as *Sandhai* (in Tamil) at Pallavaram in the outskirts of Chennai, Tamil Nadu. This Pallavaram Friday Market looks much similar to a hamlet with non-resident inhabitants who pack their belongings and arrive at midnight or early

dawn. These small time sellers make the two km long stretch their home for a day, and leave late at night, only to repeat the pattern every week. Most of these sellers have been doing this for ages. The market has anything and everything you can think of. Infact there is a common saying among the locals that “You can find everything other than your parents here!”

Hundreds of kilograms of e-waste, plastics, textiles, metals and other wastes are reused and recycled in this Friday Market every week which would otherwise have ended up filling the dump yards.



Figure 29: Friday Market Second hand Items

More than 1000 stalls are put up overnight and sell a variety of goods regularly since as early as 1800s. Originally, it was known as a popular *mattu sandhai* that sells various types of cattle but gradually the market stretched out to sell a array of goods to the British as well as to the locals, and today one can find everything here. There are a variety of items for sale like clothes, old coins, plastic goods, cattle, pets, computer parts, pen-drives; mobile phones, motorcycles, old CDs and DVDs, food stuffs, agricultural tools, all other electronic items, cycles, table fans, air-coolers, air-conditioners, televisions, lamps, laptops, furniture's, antiques, other household appliances and fresh fruits and vegetables, flower pots and many more. Most of these things that are for sale are second-hand goods and people buy them at throwaway prices.

This is not only restricted to the poor and middle-class but even students who purchase items for their project activities and professional electricians and

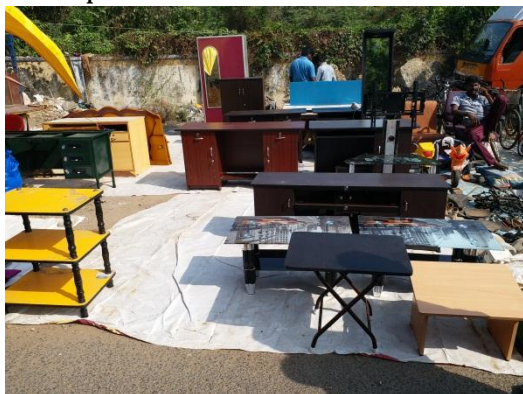


Figure 28: Second Hand Wooden Furniture

Highlights

- Encourage concepts like reuse and recycle
- Source of livelihood to many from economically weaker section
- Hundreds of kilograms of e-waste, plastics, textiles, metals and other wastes are reused and recycled which would otherwise have ended up filling the dump yards
- Ideal model to showcase how the informal sector contributes to sustainable waste management and circular economy

mechanics from different places who are looking for spare parts for doing repair work, feel blessed to shop here in this market.

The market also sells old flex boards, old doors and thick plastic sheets that are largely purchased by the poor to patch up their damaged houses. Generally, the buyers are not just locals but also from far remote areas and even from other states, mostly the small shopkeepers, who buy goods from here at low rates and sell them in their shops for a good price.

As per various reports most of these street traders who put their stalls in this market come from very different sectors. Some of them are scrap collectors, who collect scraps from various households throughout the week and bring them to sell in this market on Fridays. Some sellers of second-hand furniture even procure old furniture through online sites like OLX, Quikr, Justdial, etc. There are also indigenous people selling items like beads, jewellery and handicrafts items.

Almost hundreds of kilograms of e-wastes, plastics, textiles, metals and other wastes are reused and recycled here which would otherwise have ended up filling the dump yards. The market thus chips in greatly for reducing the carbon footprint since ages and is an ideal model to showcase how the informal sector contributes to sustainable waste management and circular economy, something that is overlooked usually.

THULI – Recycling through Charity with Dignity

Even though textiles are the third largest source of waste in most Indian states after plastic, paper and compost waste, the concept of circular economy is near-absent in the apparel sector in the country. This was not the same couple of years before when it was common in every household to see children reusing used clothes of their elder siblings or their cousins.

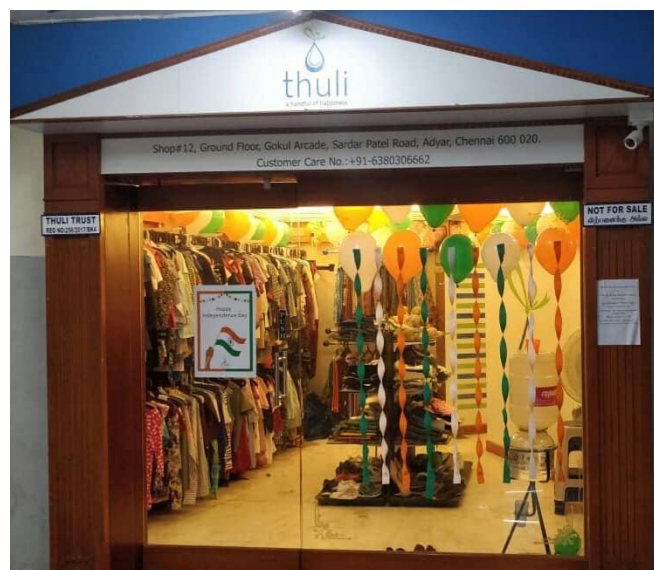


Figure 30: Thuli Store in Chennai

A 2011 Indian Textile Journal mentions that more than 1 million tonne of textiles are disposed every year based on estimates, with most of this coming from household sources. To prevent unutilised clothes from landing in landfill sites, innovation through a paradigm shift towards a circular business model is the need of the hour.

Thuli (which means a drop in Tamil) is a store located in Adyar that aims to offer the shopping mall experience for those who come from the lesser privileged sections of society. A non-profit organisation started by three gentlemen – Ajith

Thulli proudly served more than 2500 delighted customers in a span of just two months.

Kumar, Shivaji Prabhakar and Jey Bala in February 2018, has proudly served more than 2500 delighted customers in a span of just two months. Though charity is the sole intention behind the start-up, the activity which it does do largely contributes to sustainability and circular economy principles.

With the support of around ten volunteers, Thuli aim at setting high standards for the underprivileged by collecting used garments, toys and footwear from people across the country and displaying them at an air-conditioned store in a popular Mall in Adyar, Chennai. But before displaying these donated clothes are segregated by its volunteers based on gender and age groups and then sent to laundry.

The organisation has tie-up with some hotels who does the laundry for free, every week inclusive of washing and ironing. Also the segregation is done based on three categories – first category are the best of the best clothes which are used for display in store; second category are shared with nearby few orphanages and the third ones are those that cannot be reused as a garment and these are given to another Non-government Organisation (NGO) who use it to make cloth sanitary pads.

The cleaned clothes are decently displayed like in other normal stores in a mall with every item tagged with a nominal pricing. Underprivileged children who are identified with the help of few local NGO's approach the store with their families to experience the joy of shopping. To make the kids feel empowered and to avoid feeling hapless, Thuli through the NGOs distribute free vouchers with the maximum price limit quoted for shopping. Also, it is the referral system that is being incorporated and people associated with Thuli or otherwise can purchase vouchers from their offices and distribute to deserving people.

So rather than giving the needy some used clothes, here the underprivileged are given an opportunity to choose according to their taste and fittings. The uniqueness of the whole concept clicked and the start-up began to be recognised and appreciated widely in just few months.

Fashion- An Incredibly Wasteful Sector

Overconsumption and the inevitable disposal of unwanted clothing has become a worrying global problem – and in many cases, this clothing is unnecessarily thrown away filling up landfills. Accordingly to an estimate, a staggering 100 billion clothing items of are being produced annually and 50 percent of fast fashion pieces are disposed of within a year⁶⁷ making it one of the incredibly wasteful sector. By 2050, the fashion industry is anticipated to use up 25 percent of world's carbon budget⁶⁸. The growing concern over environmental impact and contribution to climate change has raised awareness amongst both fashion companies and consumers.

A circular economy seeks to move beyond fashion's linear model of take, make and waste, to close the loop, designing out waste and minimising environmental impacts.

⁶⁷ <http://theconversation.com/clothing-rental-could-be-the-key-to-a-stylishly-sustainable-fashion-industry-100106>

⁶⁸ https://cdn.businessoffashion.com/reports/The_State_of_Fashion_2018_v2.pdf

While fashion brands work to limit their polluting practices through the creation of organic, environmentally conscious collections, there is still a need to limit the sheer volume of waste that fashion creates. One way to solve the problem of this wasteful sector is recycling of clothes but that does not fully address the problem of consumers buying more than they need leading to major part of waste. Between 2000 and 2015, global clothing production doubled, while the average number of times that a garment was worn before disposal declined by 36 percent.⁶⁹

Many resource efficiency agencies all over the world are identifying leasing of clothes as an innovative business to give clothes longer service life and in turn reducing carbon emissions. For India, land of culture and traditions, the concept of renting or leasing of clothes is not new and has been going on for years before the western agencies are looking at it as the solution. The next two case studies of *Johri Bazar*, a market place famous for its clothes and jewellery in Jaipur city of Rajasthan and Wedding Bells, a store in capital of India are just two examples from multiple others in India to prove the sustainable approach of country for fashion.

1. Johri Bazar

Amidst the vibrant culture of city of Jaipur, popularly known as ‘Pink City’ due to colour of stone used in walled city, lies the *Johri Bazar*. *Johri Bazar* is one amongst the many market places located inside the old walled city around the City Palace, residence of royal family of Jaipur. The preferred shopping destination for festivals, weddings and any other celebrations, the market has colourful and vibrant ambience of traditional clothes, jewellery and accessories. Most of the shops in the walled city are decades and have traditional family business passing on from generation to generation.



Figure 31: Shop renting wedding clothes in Johri Bazar since last 50 years

One such business is leasing or renting of traditional clothes, jewellery and accessories for a traditional Indian wedding. Wedding is usually considered as once in a lifetime affair and calls for grand celebration for the family. It is biggest gathering of family, relatives and friends at one place and huge amount of money goes in preparation for

⁶⁹ <https://www.livemint.com/Opinion/eTurKsKXQFU9oxBYUXFGTO/Sorry-no-one-wants-your-used-clothes-anymore.html>

food, clothes, jewellery, venue, decorations, etc. The craze of weddings in India is to such an extent that amount of money spent on weddings is double the amount spent on higher education, and its share in overall spending was only a little than the share of health expenses.⁷⁰

The shop owners and dealers in the market are aware about the craze of wedding and also have perfect understanding of consumer behaviour of all sections of the society. Consumers want best looking and trendy clothes for wedding but affordability is an issue for many as they hesitate in spending a huge amount on attire which will be used only once or mostly twice. The attire of bride and groom have to be best amongst of all but this also calls for a huge amount of money to be invested just for a day.

As a solution to demands for all consumers, many shops in the market have traditionally been dealing in the business of renting clothes, especially for grooms. Depending upon one's budget, one can either order to stitch a new piece of *Sherwani* (traditional wedding dress worn by a boy in his wedding) which will be taken back by the store after the wedding or one can choose from dry-cleaned and well maintained second hand piece. The single fresh piece of *Sherwani* can cost anywhere between ₹30,000-1,50,000 and will not be worn that many number of times to utilise its full value. The piece is kept in the wardrobe for years till there is any other similarly big event to make use of it. Owing to fast fashion and depreciation of value of material, there are no users for it, and eventually it adds up to wasteful sector of textiles and fashion.

Renting a fresh new piece which one can get designed according to one's preference and choice cost less than one-third of the value and the amount further goes down if one prefers for second hand piece properly dry-cleaned and is as good as the new one. There are many other accessories that go with the traditional dress for groom varying from culture to culture in India. All these are just for few hours on the wedding day and will not be used anymore in the lifetime of a person, which makes it attractive and pocket-friendly to rent them than buy and fill up the wardrobes unnecessarily. Similarly, invitees, especially the close family members and friends, want to look their best on the occasion and renting of clothes seems like a best option considering the change of fashion every season.

Though, *Johri Bazar* in Jaipur is taken as case for this documentation, but all over India, in almost all cities, the similar traditional market spaces exist where sharing and renting of clothes is not anything new but part of their business since decades even before the world started to discuss about Circular Economy and its advantages.

2. Wedding Bells

People love to dress and look good, especially when it is wedding season. The attires for bride and groom and close family is one part of wedding which nobody wants to compromise with. This also makes it a one of the area, where huge part of wedding budget is diverted to, despite of the fact that these dresses will not be used second time especially the ones worn by bride and groom.

⁷⁰ https://www.livemint.com/Consumer/0016Mgk5VqBsrprjtDsl00/How-India-spends.html?utm_source=scroll&utm_medium=referral&utm_campaign=scroll

Usually, women are considered more attached to their special dress worn on the biggest day of life - their Wedding Day. The emotions attached to the most beautiful memory of the girl's life remain preserved in everything small or big related to the special day. Traditionally, women are expected to keep their wedding dress preserved all their lifetime whether they use it or not.



Figure 32: Wedding Bells Store, New Delhi

While the business of renting clothes for men have been part of economy of Indian apparel industry, the women are always seen more attached the material memory. Tapping the potential of this untouched market space and increasing awareness amongst young population about reducing waste, Srishti Arora from Delhi started an experimental venture of renting clothes without any gender bias. A young brain understands the dilemma of wearing something new and fashionable, especially in grand celebrations like weddings.

Every time, people want to try a new and fresh look and beautiful but there are so many occasions and one cannot afford to buy a new dress for every occasion. Youngsters have started to realise that spending on expensive clothes are just adding to their wardrobe, and will eventually end up as waste with rapidly changing fashion. The best way to lessen the waste and expenditure without compromising on fashion is to rent the clothes for a day or two and return them for use by next customer.

Srishti worked as an automation engineer in a well-known multinational for six years before starting with her own store in 2015. Naming her store as 'Wedding Bells', the young girl has been able to draw a number of customers looking for best and fresh fashion attire in the market. Initially, the demand for renting clothes was centralised between middle class and people who couldn't afford to buy new clothes but at present, the major customers of the store come from wealthy families, as shared by Srishti.

The bride and groom come together to choose their attires often matching to show their love and togetherness for lifetime. The business has become a huge hit amongst all sections of society thereby challenging the taboo of renting clothes often for people who cannot afford to buy new ones. Srishti has a team of 20 people working along with her,

most of them being women, adding to not just circular economy but helping in women empowerment as well.

Celebrations are important and when done with a little conscious effort to reduce the reckless waste that follows it, can have unimaginable impact to save environment. With the increasing consciousness about the environment and to reduce lavish spending on this one time affair, many people have started to adopt 'lessen waste' approach without compromising on the celebrations. The changing demands are also affecting the market which is offering more eco-friendly and consumer-friendly alternatives and initiatives like 'Wedding Bells' is surely one amongst them.

Way Forward

Consumer understanding of the challenges and potential of the sharing economy is critical. If managed well, the sharing economy can create a lasting and transformative impact on cities. Not just boosting the economy but it can cultivate a sense of community by bringing people into contact with one another and assisting neighbourliness and more importantly better the environment by making the most efficient use of resources.

The Sustainable Development Goals (SDGs) of the United Nations envisage that by 2030, countries should substantially reduce waste generation through prevention, reduction and reuse. The different models and concepts of Sharing Economy like community-driven working models of Pallavaram Weekly Friday Market, charity-driven models of Thulli, traditional business of *Johri Bazar* and Modern lifestyle demand model of 'Wedding Bells', point to the huge potential and opportunities that exist in waste management. There are several other small and big replicable examples all around us which if driven by sense of sustainable approach can lead the world to become a better place to live in without any special effort.

Consumer health and safety is one of the major concerns with sharing economy business models. Traditional firms are subjected to regulations but these are not applicable to emerging sharing economy business models. This leads to a big question as to who is responsible if anything goes wrong. Establishing trust and reputation therefore becomes vital for such activities to be successful. There are several ways to switch to alternatives depending upon the sector and waste it is generating, but at the same time, it is important to tap the consumer behaviour and take on social responsibility to deliver the best and reduce the waste.

The concept of Sharing Economy or Community Sharing is not new for the people of India. In fact, it is part of normal day-to-day lifestyle of people. The innovative ideas of world to push for sustainable development is culture for India and sharing economy is surely one of the many solutions we can offer to train the world.

Save Trees- Use Invasive Lantana' Furniture

Introduction

Global climate change debates centre on forests and their conservation due to their significant role in climate change mitigation and adaption, plus their inextricable association to human survival. Due to vigorous conservation measures, forest and tree cover in India has been increasing since 1987. According to the biennial India State of Forest Report 2017, prepared by the Forest Survey of India, Country has shown a one per cent increase in its total forest cover. This is in spite of the rapid deforestation due to industrialisation and overconsumption.

Other than human interventions, forest covers are constantly in threat of slow extinction due to biological threats like weed invasion. Invasive weeds growing in forests are characterised as forest invasive species. Rampant weeds compete with native plants and trees and are smothering and destroying the landscapes. Though the process is too slow to discern, its proliferation never stops. In fact, usage of the word 'interference' rather than 'competition' is more suitable to describe their effects. Not only they do compete for moisture, nutrients and light but they also interfere with trees by releasing toxins, modifying soil and air temperatures and harbouring pests.

Lantana Weed

Considered by International Union for Conservation of Nature (IUCN) as one of the world's 100 most invasive species, and among the world's 10 worst weeds, Lantana (*Lantana camara*) has particularly become abundant in India's dry-moist forests. The Asia-Pacific Forest Invasive Species Network (APFISN) also listed 49 species as forest invasive species in India, of which Lantana became one of the most obnoxious weeds that has encroached most of the areas under community and reserve forestlands across India. The aggression of the plants is so rapid that these have spread to almost all parts of the country. Lantana has expanded wildly from lower altitude to higher areas up to 1800 m. above mean sea level. In many places, it has virtually overtaken huge chunks of land and thus known as 'Green Fire' or 'Land Eater'. The plants have become a serious threat to agricultural land and especially to ground flora in the forest. Besides, concentrations of dry lantana bushes pose a serious fire risk during the summer months. All the methods used to control this rife, invasive species proved futile.

Usual steps include early detection and eradication of restricted and noxious invasive plants by the forest staff; collection of survey information; destruction of individual invasive plants and reporting new infestations in a timely manner; conducting invasive plant survey to identify potential problem areas; communication between various stakeholders to promote regional awareness; incorporation of invasive plant management in planning phase; education and awareness; and finally controlling invasive weeds by utilising their raw materials for economic purpose.

Though acceptance of a weed might lead to various consequences like loss of quality of life and disruption of various important species, several instances prove that weeds also contribute more positively to local livelihoods. For example, *Acacia* subg. *Phyllodineae* is a weed that has been used as fuel wood, timber and food in different parts of the globe.

Lantana Furniture

Himalayan Environmental Studies and Conservation Organization (HESCO), Dehradun has been a pioneer institute promoting the use of Lantana as a resource rather than a weed.

Dr Anil Joshi with his team of HESCO has been applying knowledge of the environmental sciences and simple technologies to bring consistent development to the rural villages of the Himalayas. Their innovative and ecologically-sound solutions have so far yielded outstanding results in their target regions, and have brought them national and international recognition.



Figure 33: Lantana Furniture manufactured in Dehradun

HESCO draws inspiration from the villagers and devises solutions for their problems. It helps them to focus on their economic and development needs and encourages them to tap local resources that open up new avenues to their self-reliance.

Introduced as a hedge by the British in India in 1941, lantana today occupies almost one lakh hectares of land including a vast area in Himalayan region of the country. Once it takes root, the weed with the small pink, white and yellow flowers is almost impossible to eradicate. It resists manual destruction and biological or chemical methods don't work, posing an environmental risk.

According to Dr Joshi, the most profitable thing about lantana furniture is that the raw material is available free of cost and that too in abundance, is very light weight, strong, long-lasting and shows termite resistance which makes it the perfect resource to act as a replacement to timber products.

After years of research on the use of lantana, taking into consideration the properties of this weed, HESCO started to train villagers in the Himalayan region to convert the dreaded invasive weed into furniture and artefacts. After the product is manufactured,

HESCO provides logistic and marketing support to the villagers, thereby making the business sustainable and profitable for them.

Timber from trees takes years to mature which then cut in a second and used in making furniture, houses, floorings, and numerous small and big artefacts. The irresponsible use of this natural resource is leading to many ecological problems, climate change and destroying the natural habitats. Depletion of wood as a natural resource has raised awareness to search for alternatives in the form of bamboo and cane. According to Dr Joshi, though bamboo and cane provide a good alternative to timber, these have their limitations, as increasing demand for products will lead to depletion of these resources. Before we face such a situation, it is important that we explore more possibilities and search for reliable alternatives. He suggests that if proper attention is focussed on the use of lantana backed by investment in research and technology, the weed has the potential to replace timber, bamboo and cane in all forms. One cannot wait for depletion of all natural resources to extreme levels and then start looking for alternatives.

Other than HESCO, which is working to promote lantana furniture in Northern part of India, Ashoka Trust for Research in Ecology and the Environment (ATREE) in Bangaluru, Karnataka has taken up the responsibility to train villagers and the people of tribal communities in forests of Southern India in it.

Lantana Village

Lacchiwala, a small village in the forest area of Uttarakhand is around 20 km from Dehradun City. Here villagers trained by HESCO have learned the skill making lantana furniture and have been practicing it since more than 20 years. Lantana is picked by the members of households and moulds into fancy designs of chairs, tables, stools, shoe racks, dustbins etc. Some of the houses have walls made out of the lantana and mud.

One such person is Kishan, living with his father-in-law Tek Bahadur. Kishan cannot walk or sit for long hours but has skilled hands when it comes to moulding lantana into furniture. His father-in-law and son gather lantana from the forest and Kishan gives it shape of furniture. The family has also trained many other villagers in the neighbourhood who have moved to other places with their skills, thus, starting a chain for lantana furniture. Working for 8 hours a day, Kishan makes around 2-3 pieces of furniture which is sold to villagers or people who come to buy or is supplied to HESCO, earning him INR 500-600 per day.



Figure 34: Kishan making lantana furniture in his house

Box 1: Chronology of Lantana Development in India

1807	The British introduced South American species <i>Lantana camara</i> , to the Indian landscape. Lantana spread across the forest fields and fallow lands and dominated landscapes at the expense of native plants, wildlife habitat and ecosystem services.
1940	Koravas and other communities start using lantana for basketry.
1992	Dr Anil Joshi, founder of Himalayan Environmental Studies and Conservation Organisation (HESCO), Dehradun, promotes the use of lantana to make furniture in Uttaranchal.
2004	ATREE introduces lantana craft to forest-dependent communities in Male Mahadeshwara Hills, Karnataka.
2005 - 09	ATREE disseminates technology and craft to NGOs and forest communities in Karnataka, Tamil Nadu and Kerala. Establishes Lantana Craft Centre (LCC) to promote lantana craft among tribal and other forest dwelling communities.
2009	Government bodies recognise craftsmen and provide market channels for lantana products.

Source: ATREE - Lantana flyer titled "Lantana Empowers Communities", accessible at www.atree.org/sites/default/files/flyer_lantana.pdf

ATREE

The Ashoka Trust for Research in Ecology and the Environment (ATREE) is a civil society organisation that spearheaded a Lantana Craft Centre as a registered society in the Male Mahadeshwara Hills of Karnataka in the year 2004. Their aim is clear: trying to improve the livelihoods of poor forest dwellers, partake in activities to control an invasive weed and thereby restore native biological diversity. Today local forest dwelling communities from Palani Hills, Malayalis from Javadi Hills and Kurubas from Mudumalai, Tamil Nadu and H D Kote, Soligas from Moyar Reserve Forest and BR Hills, Karnataka use this technology to make baskets, furniture and other utilities that they can sell.



Figure 35: Women making lantana furniture with training from ATREE

It all began when ATREE came to know about Himalayan Environmental Studies and Conservation Organisation and about Dr Anil Joshi promoting the use of lantana to make furniture in Uttaranchal. To replicate this initiative in southern part of the country, ATREE selected a few tribal people who were taken to Dehradun to learn the art.

Rasathi from Manathevu village, Kodaikanal, said, "We are employed to pluck coffee beans. But it is a seasonal job. Whereas lantana products can be created throughout the year and it is an additional income for me. I feel happy to make lantana products, as I work on my own choice and feel proud once the product is completed and sold. In coffee plantation I earn INR Seventy for a day, while we make INR Eight hundred for a lantana shelf, which takes just two days to construct."

Source: Forest dependent communities put a weed to good use ATREE Press Release.

At ATREE, lantana craft training was provided to interested volunteers from the nearby forest dependent villages. All with the strong support of the Forest Department officials of the three states – Karnataka, Kerala and Tamil Nadu. These one-month long trainings primarily focussed on female participants so as to empower them, given that the whole activity was physically less demanding and more suited. The training gave them the option of working close to their homes with flexible timings. To compensate

for their otherwise normal employment options and also to boost their interest, small stipends were paid during the training periods. Besides that, an attendance incentive made it possible to bring in consistent participation.

The training designed by ATREE was provided by experienced trainers in lantana crafts and focussed largely on imparting the technical skills and other related aspects like quality control and raw material specifications.

Progress in Product Design

Initially, the baskets woven from lantana were coarse and had limited market. Also, debarking the lantana stem was laborious and time consuming until an intern from

France at ATREE contributed towards development of product designs. On his suggestion; the stems collected were first boiled to enable easy debarking and bending of stems. This was a path-breaking move which made it possible to make a range of products.

Lantana Production Process by ATREE

- Collecting on weekly basis by people engaged in furniture making.
- Boiling the stems for about four hours, immediately followed by debarking
- Shaping or bending of sticks into the required shapes and assembling the basic structure of furniture.
- Drying of the finished products for a few days, followed by binding of all the edges and final varnishing.

Lantana products being low-cost, durable, resistant to termites and bedbugs, coupled with the added advantages of easy maintenance (a coat of varnish paint annually) and aesthetic appeal have increased the demand among the consumers. Thus the marketing of products

was never a painstaking venture. At local level, the target customers were the local resorts, forest department and local stores selling wildlife souvenir products and nearby villages. At urban level, corporate and individuals were targeted.⁷¹ Likewise, MM Hills' lantana artisan community, Lantana Craft Centres (LCC), and ATREE have been holding a lantana fare every year, from the year 2005, to link the artisans with mainstream marketing and financial institutions, and to popularise lantana craft.⁷² The methodology for developing a value chain included creating a distinct identity for the products, a communication strategy and a pricing model.

The communities now autonomously handle their lantana eco-products business. ATREE helps in networking efforts through which Coligas, Palliyars, Malayalis and Kurubas share their experience on lantana product development and market linkages. Today, lantana craft programme is an alternative for other varieties including bamboo and cane. With dwindling bamboo, resources and restrictions in bamboo harvest, shifting focus on an easily available weed lantana has appeared as a viable and profitable alternative. Apart from making furniture and other utilities, the weed is used as an alternative raw material for making world-famous Channapatna toys⁷³, which are otherwise, made of *Wrightia tinctori* wood which is fast depleting. Thus the community has taken over the whole initiative seriously, with almost 50 households in MM hills deriving more than 80 per cent of their income from lantana crafts.

The whole initiative has been quite successful with a few exceptions. First and foremost, the challenge in starting this initiative was to convince the tribal community to get the lantana weeds from the forest as animal attacks are very common in most of these areas. Likewise, in spite of all the enthusiasm, as months passed by the number of

⁷¹ Report on the Lantana Craft alternate livelihood project at Lakkere Village, Bandipura, Karnataka. Accessible at <<http://indiabiodiversity.org/biodiv/content/projects/project-fc210795-5976-42f6-ad1b-7f96a02dd819/672.pdf>>

⁷² ATREE Annual Report 2011-2012. Accessible at <www.atree.org/sites/default/files/reports/ATREE_Annual_Report_2011-2012.pdf>

⁷³ Channapatna toys are a particular form of wooden toys that are manufactured in the town of Channapatna in the Ramanagara district of Karnataka state.

people working in these units began to dwindle. The trainees failed to make the best use of the learned craft largely due to transportation and marketing challenges.

Way Forward

Today, *Lantana camara* has infested nearly 5000 square km deciduous forest area of Bandipur Tiger Reserve alone, posing a threat to the growth of forest. The cost of removing lantana is not only expensive but also tedious. For 2017 - 18, the state government earmarked INR Two Hundred and One million to remove it in 3,500 hectares under Mahatma Gandhi National Rural Employment Guarantee Act.⁷⁴ Therefore, effective utilisation of the tribal people will not only helps the forest department and the State but also improves the economic state of the families depending on forests. Though no comprehensive study has yet been undertaken to study the impact of this effort on the forest ecosystem, the craftsmen have started observing the transformation locally. Years ago, this obnoxious weed was easily available in abundance on the outer edges of the forest but now tribal craftsmen have to travel more than three kilometres inside the forest to collect their 'raw material'. Even if it's not possible to wipe out the species entirely, at least measures taken positively to contain its spread and manage it in a better, economical way. It is hoped that slowly native species will reclaim these forest areas before lantana sprouts again.

Innovations and community efforts like these will certainly bring about a balance in the ecosystem while simultaneously advancing the livelihood of people for the overall betterment at the grassroots.

⁷⁴ Karnataka gets nature's gift to fight deadly weed, Times of India, Aug 21, 2017. Accessible at <
<https://timesofindia.indiatimes.com/city/bengaluru/karnataka-gets-natures-gift-to-fight-deadly-weed/articleshow/60149200.cms>>

Up cycling Waste - RImagined, Bengaluru

Introduction

According to recent estimates, by 2030 India will need a landfill almost as big as the city of Bangalore to dump its waste if it continues to generate waste at the current rate. According to the Central Pollution Control Board (CPCB) report, every year India generates 62 million tonnes and collects 43 million tonnes of waste. Of the amount collected, 72 per cent is landfilled, and the balance undergoes some form of treatment. Solutions that reduce landfill and increase value recovery, therefore have an important social, economic and environmental role to play in India's urban areas. Upon closer observations it was found that landfill sites are not filled with waste items or items that we don't need any more, but often with materials that we never needed in the first place or only replace. Thus, any attempt to upcycle belongings instead of purchasing new ones, not only encourages reuse of materials but also create something of use instead of buying it, and that's a double advantage for the environment. Growing trend called 'Upcycling' is, therefore, catching up with the public to choose waste products and give them a new life.

While the first step towards maintaining the environment is to generate lesser waste, the next best thing is to make sure that we make the most of the waste generated in a sustainable and eco-friendly manner.

Upcycling commonly refers to reusing an article in a novel way without degrading the material it is made from, as opposed to recycling, which generally involves breaking down the original stuff and making it into something else, using more energy. Such environmentally friendly practices of upcycling have been in operation since ages

in most Indian households. Throwing away something was never a habit those times and there was always a way to repurpose things. It was common to see mothers stitching pillow, bed and cushion covers, scarves, quilts and even curtains using her old saris, converting thick old clothes as shopping bags and door mats, using old cotton clothes as sanitary pads or mop cloths, empty health drink bottles as kitchen storage containers, and worn out tooth brushes used to clean combs, old utensils repurposed as bathroom mugs or plant pots, one side used papers would never be torn or discarded till the last available space was used for scribbling etc. Thus people in developing economies were effectively been upcycling for years, but more out of need than for the environment.

Now with the concept of upcycling taking off in other countries due to increased awareness in eco-friendly products, wider acceptance and demand for such upcycled products, particularly among younger generation in India is seen. New ventures dealing exclusively with upcycled products are now cropping up with people selling extremely unique upcycled products.

Rimagined

Concept of upcycling was the outcome of solid waste management that Shailaja Rangarajan was doing four years as a volunteer in “Whitefield Rising”, a citizen volunteer group. In her own apartment complex she started the waste segregation and in-house composting, that caught the attention of Whitefield Rising who then encouraged her to step beyond her community and share her experience and expertise with nearby communities too. Later, almost three years of her every weekend was totally devoted in educating nearby communities, helping them setup waste management practices and raise awareness of the people. This slowly translated into working closely with senior staff of Bruhat Bengaluru Mahanagara Palike (BBMP), requesting them for more infrastructures to handle the collected dry wastes. Unfortunately, this still remains to be addressed and it is a common sight to see more

waste on roads and our surroundings than in dry waste collection centres.



Figure 36: Women converting Rags to Resource

It is this predicament that made her realise that the best way to manage any waste, therefore, is not to produce it in the first place! Reducing waste is much better option environmentally and financially than recycling or adopting any other waste disposal practices. Bulk of the day-to-day waste can easily be avoided if people make a concerted effort to reduce, reuse

and recycle when they can. If every individual consciously cut down the amount of waste they create, they can save money, and reduce their burden on the environment.

After almost seven months of comprehensive and in-depth research, Shailaja recognised that upcycle can be an alternative lifestyle that can contain the steep rise in overall garbage generation. Through further research and one-to-one interactions with experts on waste management, Shailaja got the opportunity to interact with individuals who do some amount of upcycling more out of interest, but who find it hard to get regular customers. For them, their customers were confined to their friends’ circle, and their ventures weren’t making money or profit. To address this concern, Shailaja volunteered to find them prospect customers and act as a bridge between the makers and the consumers. Thus in 2016, Shailaja started



Figure 37: RImagine Products

Rimagined with the aim of giving new life to all kind of usable waste and bring them back into the consumption cycle as useful consumer products.

She placed Rimagined on an online marketplace with 10 vendors and almost 60 products. To gain a greater reach and better visibility, she also put up stalls with these products at local events hosted in Bengaluru. Though it helped in gradually taking Rimagined to greater heights, she soon realised that

Thumb rule of Rimagined is minimum use of virgin material and maximum use of wastes. Rimagined also avoid usage of chemicals and artificial stuffs because the thought process is that today when we are making a product and when it gets discarded what is the environmental impact it will have.

this approach of merely acting as a bridge was not sufficient and reliable when they are trying to make a dent, particularly when people need to think of producing bigger volumes at specified timings to create a larger positive impact. That's how later the business model of Rimagined evolved, with first Rimagined label of products made with tyre tubes was introduced. Later Shailaja collaborated with upcycle designers such as Devika Krishnan who in association with multiple livelihood and artisans groups across the country started a unit called 'Joy at work' where she trained migrant women's to make a range of products from Tetra Paks. The collaboration led to productions of various upcycled products like jewellery, furniture and home decors, most of which are now sold online and through their store in the Bangalore city.

In between these activities, Shailaja happened to visit her friend in Kolkata, who was a teacher at a special needs school for children, largely hailing from underprivileged sections of the society. She noticed that many mothers spent close to four to five hours waiting for their children in the school premises. These were impoverished women whose financial state was in shambles due to the lack of opportunities. So the very thought of earning around Rs.2,000-3,000 per month brought a big smile on their faces. Following a discussion with these women, she chalked down a three month training program for those interested and within a month, production-ready pieces with quality finish were produced. Thus the birth of the second production unit in Kolkata with around 45 women was achieved.

Currently, with centres in Bengaluru and Kolkata and other tieups with local scrap dealers, solid waste management vendors and tailors, Rimagined procure all kinds of waste. Textiles, glass, plastic, wood, electronic, rubber, leather and even ceramic wastes are upcycled in these two centres. Shailaja personally conducts regular waste collection drives locally to recover discarded material. Locally available materials are only used, since transporting waste defeats the whole purpose of putting waste to use. Once designs are finalised after taking into consideration the waste materials available, the team decides the groups of women who can create the products. The procedure involves training and handholding them through learning and trials. Once skilled, the team gets into production mode.

Further, to educate the consumers and make them realise their positive contribution in minimising waste generation, Rimagined shares the details about the waste materials upcycled to make that particular product purchased. In the same way to highlight the ecofriendliness of a product a 'Rimagined Score' out of 100 is tagged on each product. More the score, more easily its content can be decomposed and more number of wastes are kept out of landfills.

How Rimagined score the products?

1. Rimagined Quotient identifies three major waste materials that go into making the product. All major ingredients have a score based on their average contribution to overall trash. They depend on
 - How recyclable they are
 - How long they take to decompose
 - How much they contribute to the trash
2. Rimagined Quotient is calculated for each product based on % weight of the input material – a 5 point scale that shows impact it has on landfill avoidance.

	High Score	Low Score
% in trash	Plastic bottles, Glassware	Ceramics, Cloth rags
Recyclability	Chips packets covers, CD's	Paper, Cardboard
Time to decompose	Glass bottles, Metal scraps, Foam	Cotton, Paper, Canvas

Source: www.rimagined.com

Other than upcycling, the organisation thus empowers women from poor families by providing them with employment opportunities and skill development. Aim is to create an identity for these women by facilitating their financial independence. Self help groups from diverse part of the country are now trained to convert tailor waste and other discarded items such as torn and used clothes, cardboard boxes, wood waste, Tetra Paks and used tyres into beautiful and useful products.

One of the key pillars of this venture is women empowerment through dignified employment.

Two Rimagined trained women from the Bangalore unit started training a new team of women in a village near Bhubaneswar.

These trainers themselves hail from Odisha and had migrated to Bangalore in search of opportunities. Thus things have come to a full circle. Now they are training women in their native state which will help them earn a livelihood without having to look at migrating to other places. Thus one more Rimagined centre at Odisha is taking off!

Thus Rimagined that was started as a movement to promote an ecosystem for conscious consumption ended up simultaneously creating livelihoods for women in the urban poor and rural sectors. According to their website, every product that consumers choose from Rimagined is living the good *karma* life. The materials used to make them are not sourced from any store or supplier. Every material used was used earlier and nothing new is used.







According to Shailaja, in 2016, Rimagined kept about 240 kilograms

of waste out of landfills. This includes all types of low value waste, such as waste that does not decompose or does not get effectively recycled. While she believes upcycling is the way forward, Shailaja confesses that the Indian market for upcycled goods is still growing whereas European costumers are appreciating the concept.

Challenges

As with every new social and environment friendly initiatives, the journey towards upcycled products wasn't a smooth one. One of the many challenges thus Rimagined face was lack of awareness within the country about upcycling. The other challenge that prompted Shailaja to get into retail is the mindset of people towards upcycled products. First time consumers are usually apprehensive about quality and price. People generally tend to think that products from waste materials are much cheaper. They do not understand the effort that goes into this kind of transformation.

Highlights

-  Ideal solution to solid waste management.
-  Reusing waste products in a novel way without degrading the material it is made from.
-  Minimum use of virgin material and maximum use of wastes.
-  Women empowerment through dignified employment.
-  Helped in keeping tonnes of waste out of landfills.
-  Ideal model for circular economy through upcycling.

Way Forward

India faces major environmental challenges associated with waste generation and inadequate waste collection, transport, treatment and disposal. Current systems in India cannot cope with the volumes of waste generated by an increasing urban population, and this impact the environment and public health. The challenges and barriers are significant, but so are the opportunities. While upcycling is significant from sustainability perspective, when done in small volumes its environmental impact is comparatively low. At times, the intensive pre-processes overweigh the environmental gain expected. When considering to use upcycling into practice, it is therefore vital to address such uncertainties so as to ensure results with positive impacts.

The Rimagined model of upcycling wastes is certainly an ideal model for replication at larger scale across the country; it can help in bringing back the traditional way of living practised by our ancestors besides helping the country manage its waste in a creative and sustainable manner.

Rethink Timber, Go for Bamboo Wood

Introduction

Bamboo is the most important non-wood species growing abundantly in most of the tropical and subtropical zones. After China, India is the second largest producer of bamboo in the world. Despite this, bamboo has yet to take-over as the replacement of wooden furniture, construction and interiors. In last few years, with the increasing concern over depleting forest resources and rising consciousness to save environment, bamboo is emerging as a strong alternative to timber. People are accepting the use of bamboo and are gradually realising that it is an eco-friendly substitute to wood, steel, iron and plastic. Bamboo has several such properties which makes it the best available alternative to save natural resources from further depletion.

There are more than 100 species of bamboo available with each variety having its own properties. Some bamboo species can be harvested in 1 to 5 years while it takes anywhere from 10 to 50 years for softwood and hardwood. Harvests are possible every second year for up to 120 years. The bamboo yield is 25 times higher than timber hardwoods like oak tree, which takes at least 40 years to mature before harvesting.⁷⁵

According to Indian Forest Act, bamboo has been considered as a variety of tree since the last 90 years, which has acted as a major barrier in progress of this resource in commercial market. For several years now, the classification of the bamboo, with its multifarious uses as an edible item, furniture and construction, as a tree meant that it couldn't be easily ferried across the Indian state borders. It also required permits from village councils and couldn't be cultivated in non-forest areas.⁷⁶

Technically, bamboo is a grass popular as 'vegetable steel' with a tensile strength of 28,000 per square inch. The tensile strength of steel is 23,000 per square inch. When bamboo is cut, new shoots sprout and mature in just five years. The other hardwood species take at least 50 years to grow back. The resource has the potential to be converted into any desired form of furniture, paper, flooring, charcoal, building material and beautiful handicrafts.

Untapped Potential of Bamboo in India

Bamboo is one of the most abundant, environmental-friendly and sustainable resources available in India, which is not being used to its full potential. According to a Forest Survey of India Report (2017) about 125 indigenous and 11 exotic species of bamboo belonging to 23 genera are reportedly found in India.⁷⁷ The same report also highlights that bamboo is naturally available in almost all parts of India except Kashmir and more than 50% of the bamboo species occur in Eastern Indian in the states of Arunachal

⁷⁵ <https://www.thehindu.com/features/homes-and-gardens/ecofriendly-substitute-to-wood-steel-and-iron/article3781453.ece>

⁷⁶ <https://www.thehindu.com/sci-tech/energy-and-environment/bamboo-ceases-to-be-a-tree-freed-of-forest-act/article20716924.ece>

⁷⁷ <http://fsi.nic.in/isfr2017/isfr-bamboo-resource-of-the-country-2017.pdf>

Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, and Tripura along with the state of West Bengal.

The tribal populations' diet and income is significantly dependent on high diversity of bamboo resources, especially in North-East India. Tribal communities of the region use this potential resource for food, shelter, furniture, handicrafts, medicines and various ethno-religious purpose. The skill of working with bamboo is widespread with a large percentage of the ethnic population capable of refined craftsmanship in this material. North East's thriving bamboo-craft tradition gets the most creative expression through the artistry of the various North Eastern tribes. Intricate structures and many types of cuts and profiles made from numerous chisels are richly illustrated in the artefacts. The items they make often include things like trays, unique furniture, bamboo and cane mats, decorative lamp shades, stools, hand fans, baskets, hand bags, and jewellery.

Bamboo also called poor man's timber, has potential to make major contributions to the rural economy of India. The female population makes up the majority of the rural work force in this sector. Inextricably woven in the tradition and culture of the North Eastern people, bamboo sustains 70 percent of rural work force in the region.⁷⁸ Examples of the art deeply-rooted in the lifestyle of the North Eastern people can be witnessed in villages like Nalchar in Sipahijala district of Tripura in India.

Nalchar Village, Tripura

Nalchar is a small village located around 70 km from the state capital of Agartala in Sipahijala district of Tripura. The village is popular for the bamboo baskets and crafts like *Dulla* or fish basket, *Pathee* or rain shield, trays, pencil holders, lamp shades, table mats, decorative fans, door screens, stools, vegetable baskets, shopping bags and many more. The bamboo baskets are supplied all over India from this village. The art of bamboo basketry is not an occupation but an art passed down through generations in every single household in the village, irrespective of age and gender.

The Tripura Bamboo Mission was created by the Government of Tripura in the year 2006 to provide a strong and vibrant platform to the lakhs of tribal and rural community who depend on bamboo for their livelihood. In Nalchar, a Community Facilitation Centre has been set-up under the Mission where women of the village

come according at their ease and work on bamboo craft. The design and manufacturing orders are



Figure 38: Bamboo baskets and Crafts, Nalchar Village

⁷⁸ <http://www.nedfi.com/node/402>

placed by the government or local middle men who sell them in the market. Though, only a few women come to this centre to work for around 4-5 hours a day, it is interesting that each household is designing bamboo baskets and other products which they sell to the middle men. The absence of direct link between these villagers and market is a major challenge, as the income they make is less than half of what their products are worth in the market. Another hurdle in bringing these villagers out of extreme poverty and showcasing their natural skills is the lack of training and skill development to design more than baskets and similar products. They are unaware about the increasing demand of bamboo furniture, floorings, tiles, and other commercial products. Also, they are clueless about how to become part of this rising industry. The stagnation in the field and presence of middle men exploiting the talent and hard work of the tribal artists seem like major obstacles in development of the bamboo industry and people associated with it.

Kamlesh Salam: Taking Bamboo to the World

Bamboo has always been a natural resource with untapped potential, especially in India, where it is naturally available in abundance. At the community level, villagers have been associated with bamboo since generations. Even so, bamboo still needs promotion and hype to substitute timber. . In this regard, Kamlesh Salam from Assam has taken the conscious responsibility to work for development of bamboo industry and the community associated with it.



Figure 39: Bamboo Structure constructed by Kamlesh Salam

Kamlesh is a skilled Bamboo Consultant with 25 years of experience in the bamboo sector, especially bamboo processing, skill development, capacity building, planning, expertise in machinery and development strategies. Kamlesh has an extensive managerial exposure to the developmental work in the bamboo and rattan

processing and manufacturing industries and communities. Salam is currently Founder and Executive Director of South Asia Bamboo Foundation (SABF) working tirelessly to: elevate the potential of bamboo, protect natural resources and the environment, ensure sustainable utilization, promote new cultivation of bamboo for new industries as well as promote traditional uses locally and for community economic development.

During Salam's tenure as President of World Bamboo Organisation in 2009, 18 September was officially established as the World Bamboo Day (WBD) by the Thai Royal Forest Department at the 8th World Bamboo Congress held in Bangkok, Thailand. This declaration was an effort to increase the awareness of bamboo globally. The first World Bamboo Day was celebrated in Kohima, Nagaland in the year 2010 with the support of Bamboo Mission of India and the state government. .

The World Bamboo Day-2018 was celebrated at the Grand Hornbill Park, Morigoan District, Assam. The CUTS team visited the Park to capture the bamboo house that was being built under supervision of Salam. The efforts of individuals like Salam are surely the great push needed to get due recognition for Bamboo.

ESES Bio Wealth

The culture of new entrepreneurs taking lead in bringing about social development is blooming in India. The youth of the country, starting their ventures which are not just capital driven but have an equal proportion of social responsibility, is the new India. People have started to realize their responsibility towards the environment and their role in sustainable development. ESES Bio Wealth is a bamboo wood industry which started in June 2017 in Assam and manufactures high-quality bamboo floorings and furniture thus challenging the conventional wood products. According to founder Saurav Saikia, the main challenge in promotion of bamboo products is that understanding and acceptability of bamboo wood and sustainability. The highly developed wood industry also poses a challenge to bamboo wood. At present, only paper mills are using bamboo extensively in India. Its use in



Figure 40: Bamboo Wood Furniture by ESES Bio Wealth

Bamboo to Bamboo Wood

Before being converted to bamboo wood for floorings and furniture, the raw bamboo has to go through series of steps like:

- Primary process of Splitting and Knot removal.
- Treatment to extract organic substances to make it termite and bore resistant.
- The treated bamboo is dried, glued and again dried in tunnel dryer.
- The final products, after pressing in moulds of beam, are obtained and then converted into desired products like wooden beams.

other industries apart from handicrafts is very limited. Saurav's father Sanjeev Saikia realized the potential of bamboo when he visited China when he saw the wide usage of this natural resource as a major commercial product. It was with this realization that the idea of setting up of a commercial unit came to his mind, and in 2011 and the plan was initiated.

ESES is the only manufacturing unit of bamboo floorings and furniture in Assam considering it's a niche industry at a nascent stage in India. The bamboo for the manufacture is procured locally and some farmers are also engaged to cultivate bamboo to fulfill the material requirements and at the same time uplift the local economy.

'Tulda' is main specie being used to manufacture tiles and furniture out of more than 100 species of bamboo due to the lesser silica content and

softness. The raw bamboo is sourced from a supplier. The processing and

manufacturing is done in the unit itself. The unit employs around 55-60 people and most of them are women. The unit is at an initial stage with floor-tiles being manufactured the most - considering the huge market, ease of inter-state transportation. It should be noted that export of furniture from the North East region increases the transportation and logistics costs because of the rough terrain.

Sustainability is gaining recognition rapidly. As such, ventures like ESES Bio Wealth are making provision for others to follow.

Bamboo and Cane Development Institute, Agartala

In an effort to understand the reasons of untapped potential of Bamboo, especially in North East India which is home to more than 50 percent of bamboo species in India, the CUTS team also visited Bamboo and Cane Development Institute (BCDI) which is a Government of India undertaking under the Ministry of Culture.

The Bamboo and Cane Development Institute was set up to cater to the changing design and technology needs of buyers and to provide support to artisans and craftsmen in these two aspects. The Institute conducts training programmes and workshops and acts as a resource centre. The Centre has been set up with a view to providing an overall support system to the cane and bamboo sector so as to build sustainable enterprises. BCDI is involved in the creation of a sustainable supply chain management for the artisans who are involved in basketry and other bamboo product development, as well as the facilitation for the production of green craft.

According to Abhinav Kant, Director, BCDI, India has huge availability of Bamboo but there is a lack of capacity to take it forward as an industry. While the neighbouring country of China has progressed, India is at a very initial stage. The traditional bamboo handicrafts industry in India is unorganised and works informally with middle men taking away the major profit, despite the efforts made by the government with initiatives like Bamboo Mission. The export of bamboo products also is affected as the demand is for high-level product specifications, and for an informal industry, it is a challenge to achieve the standards. Bamboo wood industry is at a nascent stage in India and requires great efforts with serious research to substantiate it as a viable alternative.

Way Forward

The past few years have seen a shift in attitudes of people as a consumer. The rising demand for eco-friendly, renewable and sustainable products shows the rising awareness amongst the people towards their social responsibility. Countries are searching for alternatives to the unsustainable products and practices. The local resources and traditional knowledge is taken up as a major subject to design these solutions all over the world. The availability of bamboo in tropical and sub-tropical regions is one such alternative. This can save our natural forests from further depletion.

Bamboo has many popular uses that vary from region to region. It can be grown without much.. Traditionally popular as a cheap raw material for building rural dwellings and for manufacturing utilitarian goods like baskets and various beautiful crafts - majority

of the bamboo species have various applications in industry, such as in the manufacture of bamboo floor boards, bamboo mat corrugated sheets, bamboo mat boards, bamboo ply boards, bamboo particle boards, etc. Various other products such as incense sticks, bamboo mats, bamboo slivers and strips are manufactured at the cluster level by the primary processors in the region.⁷⁹

It is estimated that there are about 1500 documented applications of bamboo, of which the major ones include use in building materials, agricultural tools, furniture, musical instruments, food items, handicrafts, large bamboo-based paper-pulp industries, rayon and packaging. Replacing conventional timber with bamboo wood is full of challenges in areas such as manufacturing technique employed and also the acceptability of bamboo. Bamboo and wood have several differences like macroscopic and microscopic characteristics, chemical composition, physical and mechanical properties. The methods, technology and equipment for wood processing cannot be directly applied in bamboo utilization and further research on the bamboo properties, cost-effective technologies and managements needs to be carried out. With modern techniques and adapted technologies, bamboo can be processed into a wide range of products which can compete successfully with wood and other raw materials.⁸⁰ Since the last few years, bamboo has emerged as a strong alternative to traditional raw materials with a promise of being eco-friendly and the tag of being a more sustainable building material. Various architects all over the world are using bamboo in their designs.

The wide application of bamboo right from making incense sticks to manufacturing floors, furniture and even building material - makes it best available option to replace wood, metal and plastics in multiple sectors. The recent initiative by India to free bamboo from the tag of being a 'tree' by amending India Forest Act, is a major change to promote cultivation of bamboo in non-forest areas and also its availability to promote this renewable resource at a commercial level. The high tensile strength, easy availability, cost-effectiveness and flexibility of change forms makes this eco-friendly and easily renewable resource the major game changer to build a sustainable World.

⁷⁹ <http://www.nedfi.com/node/402>

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