

Booklet on

ECO-FRIENDLY HANDMADE PAPER MAKING



**Shri AMM Murugappa Chettiar Research Centre
Taramani, Chennai –600113.**

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INTRODUCTION

Paper is a fundamental part of most aspects of society; world-wide a total of approximately 300 million tons of paper are produced each day and approximately 90% of this paper is produced from mature pulp wood. In addition the demand of paper is expected to increase. Today the finest of papers are produced all



over the world. But one dismaying fact is that millions of trees are fell in a day to make paper. Increased demands of paper production and limited wood resources have directed researchers to look for appropriate additional resources of non-wood materials for pulp and paper manufacturing. Several kinds of non-wood lingo cellulosic by-products of agricultural cultivation have been investigated by the researchers.



Papers made by conventional method causes high pollution problem. This disastrous effect will affect our world's beautiful ecosystem. Papers are made from tree free materials like Silk Cotton, Cotton, Bagasse, Banana fibres, Mat grass, Kenaf, and agave and jute

waste. In addition to these alternate sources, the waste paper available in plenty can be recycled for production of handmade papers. Microbial pulping is pollution free technology. One of these areas of research at Shri A.M.Murugappa Chettiar Research Centre, (MCRC) Chennai. Eco-friendly paper production is alkali-free and non-polluting process that has advantages over conventional process. This ecofriendly method saves our mother earth from global warming.



Significance of eco-friendly paper making:

Conventional method of paper making uses cellulose, the form of wood chips obtained by felling trees, which increases global warming. Moreover in this method, chemicals are used and this releases toxic substances that cause environmental pollution (air pollution, water pollution, and noise pollution) resulting in the need for treatment of water. Surveys state that for manufacturing of 1 ton of paper 277 eucalyptus or 462 bamboo plants are required. Moreover 1, 00,000 greeting cards on hand made paper can save 500 trees.

Handmade paper making for rural development:

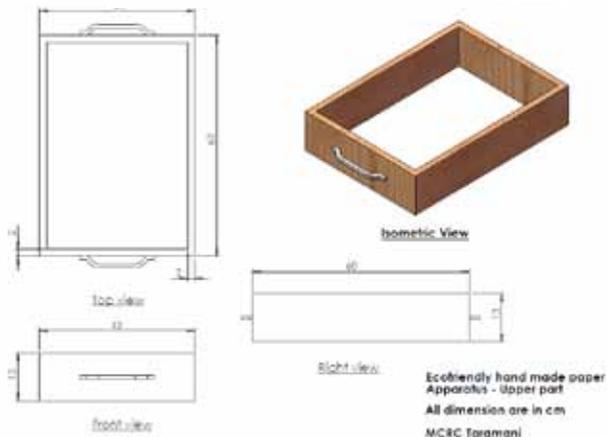
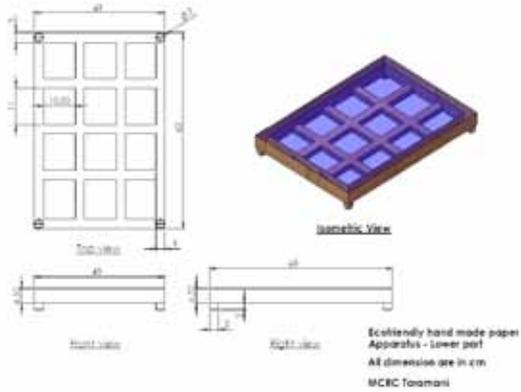
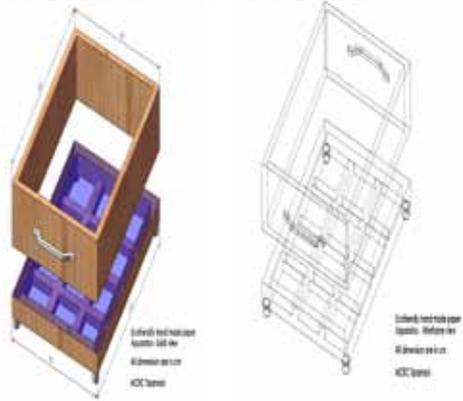


In Tmilnadu generate large quantity of agricultural wastes and dried plant materials every day. These materials when accumulated in large quantities could cause environmental pollution and unhygienic conditions. In The waste materials generated in the city could be recycled and converted into useful products to create an eco-friendly environment. Shri A.M.Murugappa Chettiar Research Centre,(MCRC) Chennai has always applied science and technology to help various communities to improve their life standards and to create pollution free environment. This centre has been engaged in research activities on waste utilization and management through appropriate technologies. The main aim is to promote understanding of the science and technology techniques for recycling of wastes into eco-friendly handmade paper. These activities not only create awareness among rural people but also help to develop various skills so that the future generation develops greater self-confidence and scientific temper.

Materials Required :

- Hand auto vat with following specifications
 - (22”x 16” inner) teak wood frame
 - Aluminum handle 4”x 2”x 15”
 - Brass hook 5”x2”x15”
 - Rubber beading
 - Nylon mesh
- Mixer/Beater
- Microbial Culture.
- Handmade vat
- Iron box
- Paper cutter
- Hammer
- Plastic mug
- Rope for handle
- Clip
- Eyelet
- Gum
- Nylon rope
- Gada cloth piece
- Star ad hole punch

SCHEMATIC DRAWING OF HAND-VAT



Mould and deckle:

This easy apparatus could be made easily with a carpenter's help. The mould comprises a rectangular wooden frame. A layer of mesh (nylon net) is stretched on this mould. The deckle (top portion), again made of wood, is of the same size as the mould and is an open frame (lacks a net), which rests on top of the mould. The wet pulp is deposited onto the mesh before it is pressed and dried into sheets of paper. Prepare the mould and deckle as follows: Take 180 cm (6 ft) length of 2cm (3/4in) square wood and cut it to i) four 25cm (10 in) lengths and ii) four 25 cm (8 in) lengths and nylon mesh with 12 to 20 holes per cm (50 holes per in); water proof adhesive; nails .now arrange the cut wood to make two frames of the same size ad shape. The mesh must be stretched tightly over the top of one of the frames. Nylon stretches when it is wet, so dampen the mesh before stretching it. Excess mesh should be trimmed.



Hand Vat

Steps Involved in Hand Made Paper Making

Collection of Agro waste/Waste paper materials



Sorting out for quality control



Soaking



Bio-Pulping/Bio-Bleaching



Evenly spreading the pulp on a VAT



Formation of sheet on cloth



Screw pressing



Drying



Ironing



Cutting



Preparation of paper products

MCRC PROCEDURES INVOLVED IN HAND MADE PAPER MAKING

Step 1: Raw material selection

Collection of the non woody plants

Papers are made from tree free materials like Silk cotton, Cotton, Bagasse, Banana fibers, mat grass, Kenaf, agave and jute waste. In addition to these alternate sources, the waste paper available in plenty can be recycled for production of handmade papers.

Step 2 : Extraction of Fiber from Plants

The Banana and Kenaf plant is ready for harvesting 3-5 months after the sowing, for fiber purposes, the harvesting is done at any stage of growth. The pseudostems and kenaf stem fibre are cut off and the bundles stepped vertically in water for 2-3 days to soak the thick basal parts. They are then stepped in a horizontal position. The period of retting varies from 6-10 days depending upon the maturity of the plant at the same time of harvesting, the temperature of water and the types of micro-organisms present.



Step 3 : Soaking

Soak the collected plants in water for prior to pulping.

Step 4 : Screening of Microorganisms for biotreatment

Sample collection : Soil samples collected from different areas.

Dilution method :

10g of soil sample is dissolved in 100ml of sterilized distilled water and mix the sample well and consider the dilution as 10⁻¹.



Plating technique :

Sterilized Nutrient Agar & PDA prepared and poured into petridishes. After solidification of the medium, 0.1 ml of sample was poured into agar medium plate. By using L-rod, spread the sample evenly over the agar surface and then incubated at 37°C for 24 hours.

Nutrient agar medium:

Beef extract	- 3 g
Peptone	- 5 g
Nacl	- 5 g
Agar	- 15 g
Distilled water	- 1000 ml
pH	- 6.8

Potato Dextrose Agar

Potato	- 250 g
Dextrose	- 20 g
Agar	- 2 g
Distilled water	- 1000 ml
pH	- 6.5

Step 5 : Bio Pulping & Bio-bleaching

The fiber is bleached by subjecting to microbial treatment in a separate tank. The duration of treatment is 3-5 days. The fungi called *Trichoderma* sp and *Pythium* sp are employed for this purpose. Hemicellulose and lignin are responsible for the dull color of the fiber. These fungi acts on cellulose and breaks the bonds between the lignocellulosic complex structures and lignin and hemicellulose are broken down and leached out. This helps to enhance the brightness of the paper. This can be rightly called as bio-bleaching of fibers.



Banana Fibres & Kenaf Fibres microbial treated

Loosening the fiber

The fungi act on the fiber and digest the cellulose along with the bonds randomly and sets free of cellulosic-fiber clusters from the core lignocellulosic complex. This results in the softening of the fiber. It makes the pulping process easier.

Step: 6 (Pre) washing

After the fungal treatment which has been done for 3-5 days, the banana fiber has to be washed to remove unwanted materials and microbial strains. *Trichoderma* sp and *Pythium* sp are harmless and safety gloves can be used to avoid infection by other microbes from environment and grown during the enhanced fermentation.

Step : 7 Beating and blending

The fiber is converted in to pulp in this process. Beater plays a vital role in this process. Beater here employed is Hollander beater. It consists of an oval tank with heavy rolls that revolves against a bedplate. Roll can

be adjusted to the pulp. Generally 2/3rd of the beater's capacity is filled with water. The roll is driven by an electric motor. The pulp is formed as a result of compression and tearing action. The roll acts as a paddle wheel and moves the wet pulp. The partition in the beater provides a continuous channel. Additives in required amount are added during the beating process.



Beater

Step 8 : Placing Hand VAT in the sink :

Thoroughly mixed pulp should be poured on the Hand Vat which is kept inside the plastic tube (or) sink made out of cuddappah slabs. The sink (2' W x 3'L x 1'D) should be bigger than the hand-vat so that the vat could be firmly hold and dip in the water for upward & downward motion. Required level of water should be filled in the sink before placing the hand vat. Make sure water is filled only in the half portion of hand vat for pouring pulp for paper formation.

Step 9 : Adding Binding materials

Starch

Various agents are added to paper stock to enhance or to modify the bonding and coherence between the fibers. To increase the dry strength of paper, the materials most commonly used are starch, polysaccharide resins, and natural gums such as locus bean gum and guar gum.

Step 10 : Processing of sizing

The process of retarding the wetting and penetration ability of paper is called sizing. Sizing reduces porosity hence reduce absorption ability. Sizing is starchy, glue like substances mixed in to the paper pulp.

Step 11 : Refining

Paper can be made using continuous cylinder mould or manual vat. We

employed Hand vat to make paper. Single sheet can be at a time. Hand vat consists of a wooden frame with wire mesh and immerse in to water. Then



shake it so that the pulp uniformly settles over the mesh. Take the mesh out of the tank as the water drain through it. The process of depositing formed paper over the wet cloth is called couching. Thickness of the paper can be adjusted by changing the quantity of pulp used for making paper in the mesh.

Step 12 : Formation of sheet on cloth:



Take a piece of Gada cloth that has sufficient size to cover the entire outer surface of the vat. Place a neat & wrinkle free Gada cloth over the mesh (that now has the pulp) in such a way that no gaps, folding or water bubbles occur in the pulp formed on the cloth. For each sheet of pulp use different layers of cloths and place it one over the other. Once the sheets formed on the cloth or stacked together then place it in the screw pressing to remove the water.

Step 13 : Screw pressing

Remove the evenly formed wet sheet by placing gada cloth interfacing over the finished sheet and repeat the process to make many sheets. This wet paper contains moisture and air bubbles. The water remains in the wet paper has to be removed thoroughly by applying even pressure on the paper so as to obtain smooth surfaced paper. In the conventional process, big types of screw presses are used to squeeze the water from the wet paper which involves huge cost and requires more man power to operate. The cloths embedded with pulp should be stacked neatly one over another in between the two plates of screw press. Once the sheets are placed, the nuts provided in the four corners of screw press should be evenly tightened so as to squeeze the water from the gada cloth.



Screw Press

Step 14 : Drying

Remove the stocked pulp cloths from the screw press and remove or peel off from the each cloth. Once the pulp adhered to the cloth and keeps them for drying process. Hang over the pulp cloth on the ropes running parallel for drying. It may take six hours to dry under room temperature. Remove the sheets from the cloth only when it completely dried. To get a rough paper the sheet can be left for a complete drying. Now gently peel off the paper from the cloth.



Step 15 : Ironing:

To achieve smoothness in the paper and to remove wrinkles, press the each dried papers separately using iron box

Step 16 : Cutting:

Cut the sheets to the required size and shape. The paper thus made can be further converted into various paper products.



Finished paper



BANANA PSEUDO STEM PAPER



KENAF FIBRE PAPER

Preparation of paper products

The following products can be prepared using the papers produced through the above mentioned process.

- Carry Bags
- Files
- Visiting cards
- Greeting cards
- Invitation covers
- Envelops
- Scribbling pad



Benefits of Handmade Papers

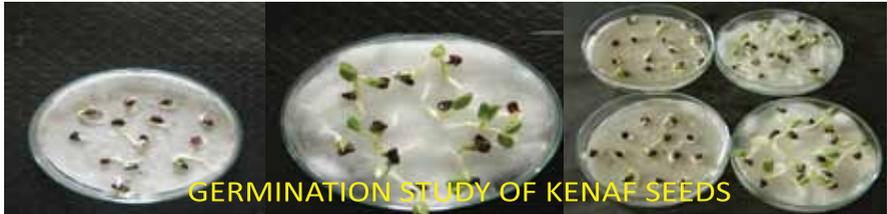
- Handmade paper products conserve resources and generate less pollution.
- Producing Handmade paper uses much less total energy than producing virgin paper
- Reduces the total number of trees that are cut down to make paper and can reduce overall demand for wood.
- Handmade paper products are more economical when compared to virgin paper.

ECO-FRIENDLY HANDMADE PAPER TRAINING AND VALUE ADDED MODULES :



ECO-FRIENDLY HAND MADE PAPER PRODUCTION FROM NON-WOODY FIBERS WITH BIOPULPING AND BIOBLEACHING PROCESS.

GERMINATION STUDY & CULTIVATION OF KENAF SEEDS
FIBER EXTRACTION-MICROBIAL ISOLATES FOR BIOBLEACHING



**ECO-FRIENDLY HAND MADE PAPER TECHNOLOGY
FROM NON-WOODY FIBRES**



Bio-treated fibers



Beating



Biopulp is poured to hand vat



PAPER MAKING PROCESS USING HAND VAT



COUCHING & PRESSING OF PAPER

ECO-FRIENDLY HAND MADE PAPER TECHNOLOGY



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