HANDMADE HEMP-BASED PAPER IN A LETTERPRESS CONTEXT

Kirstin A. Dunlap

Various hemp-based papers were created via the handmade papermaking process in order to pull handsets of paper to test through the letterpress printing process. The tests were then observed for quality in terms of how the papers reacted to the embossing and ink application through the printing process. The handmade paper types all held properties different from a standard sheet of letterpress paper. It was found that each paper trial yielded properties that were optimal for different parts of the process. Overall, a combination of hemp and OCC yielded paper that resulted in the least amount of embossing and ink transfer to the backside of the paper. This paper performed even better than the control paper which experienced embossing transfer to the backside of the paper. Although the surface is much coarser than the other papers, it resulted in well-printed text. These trials encourage further refining of the processes to create an ideal letterpress paper that is more sustainable.

Keywords: Hemp; Hand sheets; Print media; Letterpress printing

Contact information: State University of New York, College of Environmental Science and Forestry, One Forestry Drive, Syracuse, NY 13210, Department of Paper and Bioprocess Engineering.
**Corresponding author: kadunlap@syr.edu*

INTRODUCTION

Hemp (C*annabis sativa)* has been a topic within the environmental and sustainability communities for decades; especially in recent years to its resurgence and legalization for medical uses. The properties of the plant extend far past medicine though as it may be a key source of reducing carbon within our atmosphere and reducing the use of more environmentally-harming materials (Ely et. al., 2022). Ancient societies also noticed the importance of the crop as it required little necessities for growing conditions and is resistant to rodents, weeds, and many other growth inhibitors. All of this has resulted in the crop being grown in over 30 countries, making is widely accessible (Ahmed et al., 2022). As shown in figure 1, the uses of hemp are expansive. Reincorporating hemp into the modern fabrication of goods can result in numerous environmental advantage as its reward is spread so wide.

Due to all of the advantages as well as the historical uses of hemp, it was decided to examine ways in which hemp can be refined and used for papermaking. Referencing back to ancient Asia, hemp was a prominent material in the production of paper. The practice of preparing the crop then forming hand sheets was a tradition passed down through communities to create materials for record-keeping and artistic purposes (Liu et al., 2017).

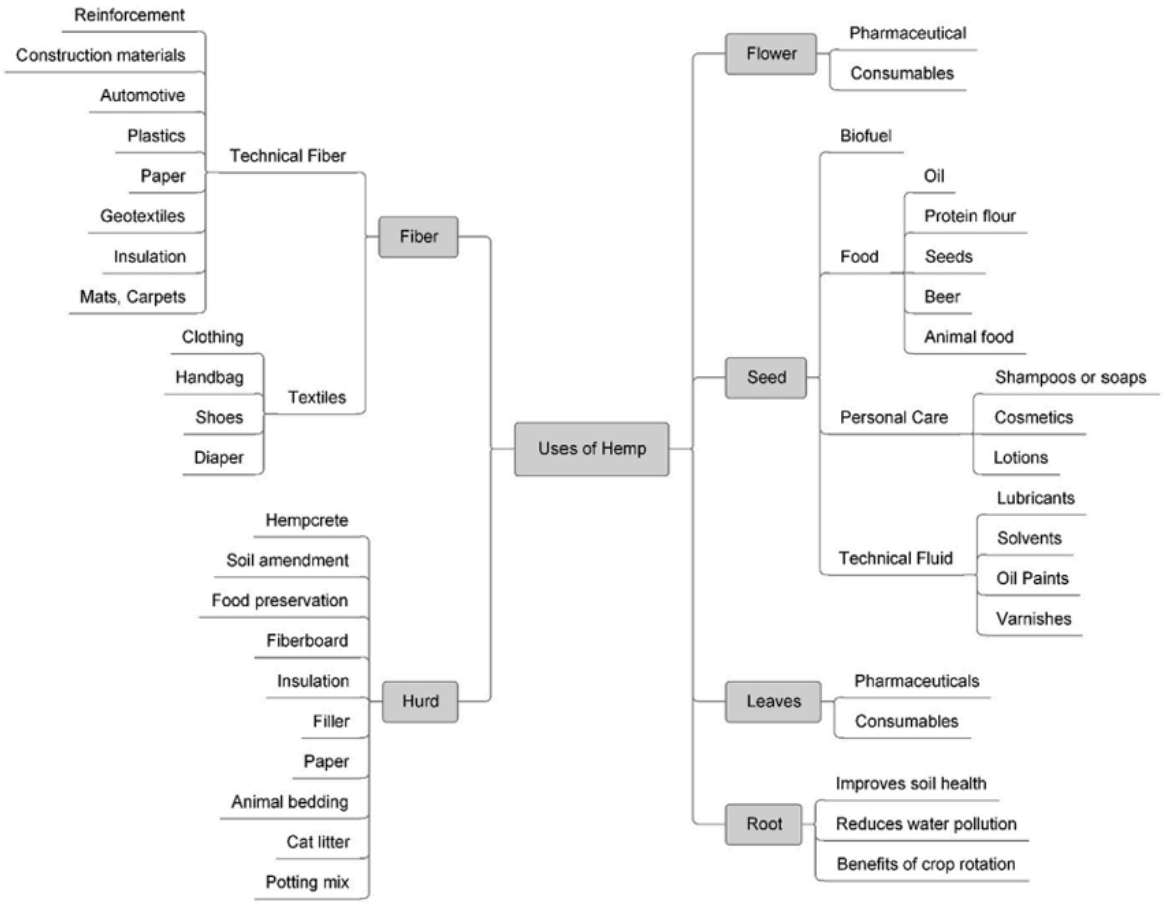

Figure 1. Uses of hemp for various purposes (Ahmed et al., 2022).

HAND SHEET PROCESSES THROUGH HISTORY

Ancient methods of hand papermaking

Papermaking is largely agreed to have been invented by Ts'ai Lun in 105 A.D. China. It is said that Lun formed the idea from the inspiration of how wasps make their nests. Wasps chew plant materials to a pulpy consistency and regurgitate it out to form what became known as a paper-like structure. This idea much reflects that by which paper is made today still.

Papermaking methods throughout history still reference much the same properties in which it is done today. In ancient China, pulverized fibers would either be spread or poured across flat cloth-covered frames, known as moulds. Not long after, craftsmen began dipping the frame in a bath of the pulp and water mixture which resulted in better sheets that could be produced more quickly. All of the mentioned methods are still practiced today, varying from one craftsman to another (Hunter, 1978). Hemp was the first material used for pulping and paper making. As the practice grew, other materials including tree bark, bamboo, and other plants began being used for pulp as well (Vickerman, 1995).

Over time, the qualities of the paper would change as different civilizations implemented slight variations of the technique of paper making and would use a wider range of materials for pulp. This resulted in some papers being off-white, thinner, more brittle, and would tear easily (Vickerman, 1995). The wide range of experimentation within the practice has resulted in the wide variety of papers and paper purposes we know today.

Modern methods of hand papermaking

As industrialization occurred, the papermaking process has also been converted to machinery to accommodate for the demand of large output. The first step of the process, pulping the material, can be done either mechanically or chemically. The pulp is then cleaned and refined additionally to meet the standards required for the desired result. The next step of suspending the pulp slurry on a mesh to form a sheet is done on large machines that also complete the drying phase through heated elements. Altogether, the process is relatively quick (Bajpai, 2018).

Paper is still made by hand though, usually for craft or artistic purposes. The methods used for hand papermaking in the modern era reflect that of ancient methods. The fibers may be prepared through a chemical or mechanical process and purchased by the craftsperson, or they may be done by hand using beating, beating, and blending techniques specific to the fiber used. The pulped slurry is then placed into a vat where a meshed frame can be dipped in to cover the mould. Excess water is pulled out using sponges or cloth and the sheet is transferred to a flat surface to dry for a few days.

HAND SHEET EXPERIMENT PROCESSES

Experimental Process

For my testing of using hemp as a prime component for paper making, I employed the techniques described above. Hemp pulp was processed through the Paper Science and Engineering department at SUNY ESF. I also acquired OCC pulp and blue denim pulp from the same source. In addition, I hand-processed flax to create pulp as well. To do so, flax was soaked in boiling water for one hour to soften the fibers. Small amounts of the fibers were then blended in a kitchen blended with water to create a similar consistency to that of the other pulps.

Three different combinations of papers were created. Below are the types and measurements used to create each slurry.

A. Hemp and OCC
    A. 1000 ml hemp pulp
    B. 1011 ml OCC 1.57% pulp
    C. 2 quarts water
B. Hemp, OCC, and blue denim
    A. 890 ml hemp pulp
    B. 890 ml OCC 1.57% pulp
    C. 1000 ml blue denim pulp
    D. 2 quarts water
C. Hemp and flax

A. 500 ml hemp pulp
B. 500 ml OCC 1.57% pulp
C. 1000ml flax pulp
D. 2 quarts water

Figures 2-4 below depict documentation of the process that took place to pull each hand sheet. In these images, paper A (hemp and OCC) is being pulled.

In Figure 2 from left to right: pulp slurry is being agitated by hand to ensure pulp is evenly distributed in the water and not settled at the bottom on the vat. A mould comprised on one square, mesh-covered frame and a circle frame for shaping, is submerged through the mixture. The mould is then raised evenly above the slurry to allow for excess water to begin to drain.

Figure 2. Steps 1-3 of the handmade paper process.

Figure 3. Steps 4-6 of the handmade paper process.

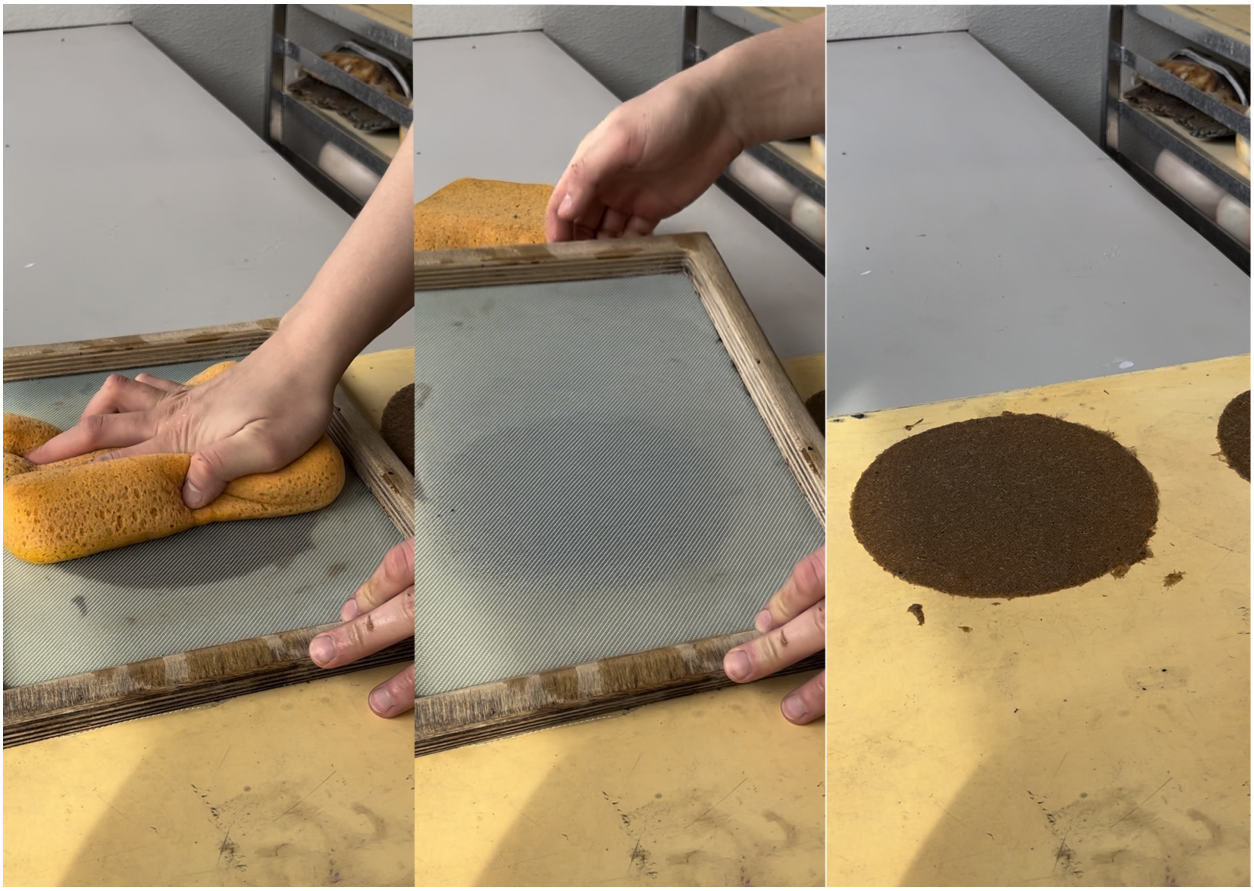

Figure 4. Steps 7-9 of the handmade paper process.

In Figure 3 from left to right: pulp outside of the circle shaping frame is scraped off of the mesh and dropped back into the slurry vat. The remaining mould with a circle of pulp is set aside and a second mesh-covered frame and maid on top of the pulp, sandwiching the pulp between two frames. A sponge is then pressed onto the frame multiple times to draw out excess moisture and compact the fibers.

In Figure 4 from left to right: one frame is removed from the previous step. The frame with the pulp circle is then laid pulp-side-down on a flat surface. A sponge is used to further draw out moisture to aid in releasing the pulp from the screen. The screen is lifted and the pulp circle is left on the surface to dry. Drying time varies depending on the fiber used, thickness, and room humidity; averaging 2-4 days.

Hand sheet outcomes

Here four types of paper will be described in texture and quality. These paper types will then be used for performance testing in the letterpress printing process. The papers will include the three types described in the previous section, as well as one control paper.

The control sample is a standard, white, cotton paper whose quality is comparable to ones often used in the letterpress process. The fiber distribution is uniform as is the color and thickness. There is no difference in texture between the front and back sides of the sheet. The thickness is similar to a lightweight cardstock which was the goal thickness for all handmade papers pulled for this testing. When folded the paper cracks before folding

Paper type A has visible fibers across the surface. The front side of the paper which was exposed to air is fairly coarse. The backside which was laid on a smooth board for drying in the handmade paper process is much smoother. When folded the paper only slightly cracks on the front side. The backside remains intact.

Paper type B has visible fibers although they are more minimal in comparison to paper A. The coloring is more blotchy as the denim is blue and the hemp and OCC mixture are tan. The front side of the paper is slightly coarse, the backside is very smooth. Overall, this paper is smoother and more flexible than paper A. No cracking occurs on either side when the paper is folded.

Paper type C most resembles paper type A in appearance and texture. The fibers are slightly less noticeable than paper A though. Again, the front side is fairly coarse and the backside is extremely smooth. No cracking occurs on either side when the paper is folded.

Overall, the three test papers, types A, B, and C, are all coarser on the front side with a very smooth back side where the papers were dried against a flat, smooth surface. Types A, B, and C all have noticeable fibers, making their appearance uniform though not consistent like the control which is a smooth cotton paper that was factor made and bleached.

HAND SHEET TESTING THROUGH PRINT MEDIA PRACTICES

Letterpress Process

Letterpress printing reflects the oldest printing method. The process is also referred to as Relief Printing, where raised lines are inked, paper is laid on top, and pressure is applied to the paper from either a printing press or handheld brayer in order to transfer the ink to the paper.

Letterpress printing was most commonly used for newspaper and magazine printing. Lead or wood type is hand-arranged onto a printing bed. The text is then inked and is run through a press (Lacy, 1957).

This method is the same to be used for testing the paper types created. Lead type was hand arranged on a printing bed and inked up by hand in a forest green color. Green was selected as the ink color as it is less opaque than black ink and would thus test the paper more rigidly when it comes to seeing how the paper fibers show through the ink.

Letterpress outcomes

Each type of paper took the embossing and ink absorbing in varying ways. It is noted that the thicknesses of the paper are as consistent as possible given the hand made paper process, but they do vary slightly due to the nature of the materials pulped for each test.

Each paper is being examined based on how much the fibers interfered with the test, how the embossing worked on the fibers, and how much of the ink seeped through to the back side of the paper.

The control sample is depicted in figure 5. The control paper is a standard paper that can be used for letterpress printing. It is a slightly fluffier, thicker cotton paper compared to a standard sheet and roughly 85 lbs. text weight. As shown in the images above, there have been no interference of the text due to the fibers of the paper. The embossing is present but does not puncture through the paper. Although when turned over there is a vague shadow of where the text is. This is partially due to the embossing as well as from the oily ink seeping through.

Figure 5. Control letterpress printing.

Figure 6. Paper test A: hemp and OCC.

Figure 6 shows paper type A, hemp and OCC, after the letterpress process. The fibers created only a slight interference with the text. The ink is not applied entirely even due to the different ways the various fibers absorbed the oil-based ink. Embossing was not interfered with though as the fibers still compressed well to create a sharp embossing. When turned over, the embossing is only viable when the paper hits the light just right. There is no ink that bled through or created a shadow on the backside. The fibers were able to absorb the ink at a nice rate which preserved the backside of the printing very nicely.

Paper test B, a combination of hemp, occ, and blue denim, is shown in Figure 7. The ink application is largely even, with only a few inconsistent spots where the fibers show through a

Figure 7. Paper test B: hemp, OCC, and blue denim.

small amount more. The embossing and ink were still able to be executed in a sharp manner. No interference from the fibers for the embossing. When turned over it is shown that the embossing may have worked slightly too well as the embossing is viable. No ink bled or showed the backside of the paper though.

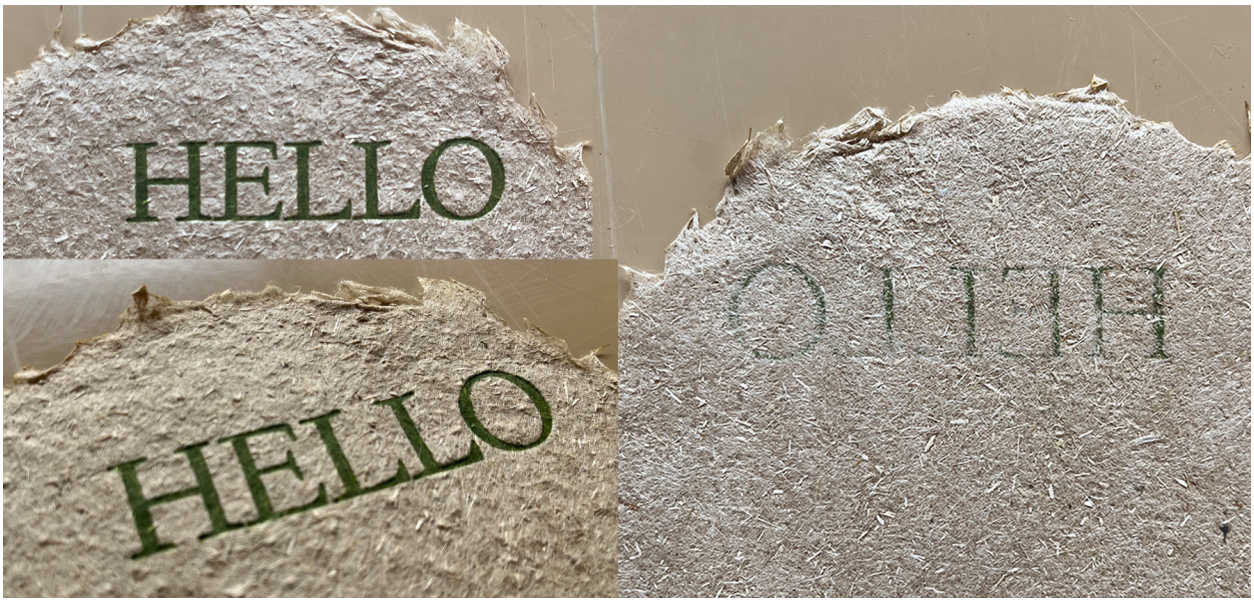

Figure 8. Paper test C: flax, hemp, and OCC.

Figure 8 shows paper type C which combines flax, hemp, and OCC. This example is the most drastic among the samples tested. To begin with, the paper is slightly thinner than the other paper types due to difficulty pulling thicker sheets while using the hand paper-making method. It is still comparable to the other paper types though.

Paper type C was able to take the ink with little interference from the fibers. the discoloration within the letters is minimal and overall would be considered fairly uniform. The embossing was slightly disturbed due to the divers as it is not as crisp as it has been in the other figures. Lastly, the ink bled through paper type C worst of all as the letters are highly viable when the paper is turned over.

Letterpress results compared

After examining the different paper types' ability to work with the letterpress process, it is reported that paper type A, a combination of hemp and OCC, resulted in the most uniform printing job. The results are comparable to the controlled printing with a slight improvement in a reduction of bleed and backside embossing.

Paper type B, hemp, OCC, and denim, took the embossing and ink well on the front side of the paper where the printing process is applied. The addition of denim gave the paper a more cotton-like feel, reflecting that of standard letterpress printing paper. Cotton-like fibers result in a desired softness that takes well to the embossing of the printing process. This paper type would

work well in a cardstock fashion where the sheets are much thicker to avoid excessive embossing and bleed of the ink onto the backside.

CONCLUSIONS

The addition of hemp into paper pulp yielded a strong, courser, and more fibrous paper that proved to work well for letterpress printing. Hemp the larger fibers made it easier to pull handsets that mimicked the desirable letterpress qualities of cardstock without needing to be as thick as cardstock. These qualities mimicked included the ability to take an embossment without it imprinting to the backside of the paper and to absorb the heavy oil-based ink without bleed.

Out of the paper pulp mixtures tested, Paper Type A which was a half-and-half combination of hemp and OCC material was the most successful. The resulting quality of the printing warrants further tests to push the paper more. This could lean well to a number of possible uses including cardstock, packaging, boxes, and more.

References

Ahmed, A. T., Islam, M. Z., Mahmud, M. S., Sarker, M. E., & Islam, M. R. (2022). Hemp as a potential raw material toward a sustainable world: A Review. *Heliyon*, *8*(1). https://doi.org/10.1016/j.heliyon.2022.e08753

Bajpai, P. (2018). Brief description of the pulp and papermaking process. *Biotechnology for Pulp and Paper Processing*, 9–26. https://doi.org/10.1007/978-981-10-7853-8_2

Ely, K., Podder, S., Reiss, M., & Fike, J. (2022). Cannabis/hemp: Sustainable uses, opportunities, and current limitations. *Cannabis/Hemp for Sustainable Agriculture and Materials*, 59–87. https://doi.org/10.1007/978-981-16-8778-5_3

Hunter, D. (1978). *Papermaking: the history and technique of an ancient craft*. Courier Corporation.

Lacy, L. P. (1957). Modern Printing Processes. *The Journal of Criminal Law, Criminology, and Police Science*, *47*(6), 730–736. https://doi.org/10.2307/1140073

Liu, F. H., Hu, H. R., Du, G. H., Deng, G., & Yang, Y. (2017). Ethnobotanical research on origin, cultivation, distribution and utilization of hemp (Cannabis sativa L.) in China.

Vickerman, K. D. (1995). Papermaking: Then and Now. A History of Hand Papermaking from Its Beginning, Plus a Process for Using Natural Fibers To Make Paper.