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# PLANT FIBERS: EXPLORING HANDMADE PAPER IN GHANA

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**Abstract**

*Handmade papermaking technology was mass accepted and considered as one of the very valuable commodities in the papermaking industry. After industrialization, handmade papers were replaced by wood pulp-based machine-made papers which destroyed the production of handmade papers. Consequently, industrialized production of paper has wrecked handmade paper production. This situation has also resulted in encouraging dependency on the importation of foreign materials in the teaching and creation of art. This presents a problem regarding sustainability especially in the area of good sources for cellulose-yielding plants that grow at fast rates due to global warming. In view of the above, the study employs a practice-based research methodology. In this exploration, twenty-two plants were collected and experimented with to test their ability to produce good sheets of paper in Ghana. The results showed an interesting array of sheets of different shades and strengths that can be used for artistic purposes. It is eco–friendly, biologically degradable, and can be recycled and affordable. It is recommended that artists, small and medium-scale enterprises, and local industries in Ghana see the value and encourage the use of handmade paper production as a traditional technology for its social, economic, and environmental benefits.*

**Keywords:** Cellulose, Fibers, post, handmade paper, Invasive local plants, Sustainability, Vat.

## INTRODUCTION

Paper as a means of expression, can be regarded as one of the excellent mediums of artistic expression among others, because of its packaging abilities, printing, writing, and creative explorations (Jain & Gupta, 2021). The creative exploration technique of handmade paper production is an excellent medium of artistic expression where each piece of paper is unique and handcrafted. The handcrafted technology of paper production has been in existence since the beginning of history. From ancient times to the present-day era, paper is considered as one of the valuable and serviceable commodities. Present paper technologies, both handmade and industrialized, are the rectified version of paper technology.

In today's technological world, paper has been a very important material since its invention. Fast forward to the age of machines, from the analog to the digital, artificial intelligence, and augmented reality, we still have paper. Today People are using paper like they have never used before. From the cooperate world to the classrooms and the art world, paper still remains an essential material. Historically and contemporary, there is a demand for paper as an important material for teaching and making art by teachers, students, and professional artists. This raises issues of sustainability especially in the area of good sources for cellulose-yielding plants that grow at fast rates due to global warming.

Handmade papermaking technology was mass-accepted and considered one of the very valuable commodities in the papermaking industry. (Jain & Gupta 2021). The age of industrialization changed things, handmade papers were supplanted by wood pulp-based

machine-made papers which were fast and could deliver large sheets in greater quantity. Consequently, industrialized production of paper has wrecked handmade paper production which was invariably an environmentally safe production. Therefore, the exploration of handmade paper was given little attention up until the 1990s in the College of Art and specifically at the Department of Painting and Sculpture as an important element in teaching and creating art.

This situation has also resulted in encouraging dependency on the importation of foreign materials in the teaching of art. Changing and introducing a paradigm shift regarding the specificity of handmade paper as material for artistic expression also becomes the focus of this study. Such a paradigm shift has become part of the drive in the new wave of pedagogy that gives students independence in their creative abilities, bringing an equal playing ground in the practice of contemporary art. Thus, helping students to better bridge the history and practice of art in its proper and more accurate context. This goal also necessitated the exploration of the papermaking capabilities of these non-pulp fibers. These fibers have not been extensively explored to record their economic and artistic value to the country of Ghana.

The knowledge and recorded uses of locally sourced plant fibers for papermaking and their potential in other departments such as Textiles and Fashion, Communication Design, and the Book Industry Departments of the College of Art do not exist.

In view of that the study aims at exploration and creation of handmade paper at the College of Art, Painting and Sculpture department. Therefore, the objective of this study is to explore alternative sources of sustainable non-pulp fibers focusing on invasive and other local plants in Ghana. The second objective of the study is to explore the viability of handmade paper for artistic expression. In order to find answers to the objectives of this study, the following research questions are raised. How can non-pulp fibers be explored to create handmade papers? Secondly, how can the viability of handmade paper for artistic expression be explored?

## LITERATURE REVIEW

All over the world from the East to the West, North and South, handmade Paper as an art and an industry has thrived. Today's environmental concerns make it even more important to the survival of this industry. Archeological finding has thrown some light on this thousand-year-old industry records and archives have stored knowledge about materials and tools needed and have been used in this industry with very little change that has come down to us (Hunter, 1978). Of special interest has been the botanicals from which paper can be made apart from recycling used paper. And cotton rags. From East China, bamboo, rice straw, and Japan Kozo Gampi and Mitsumata are treasured plants for making paper (Barret, 2006). Since then, many other plant sources have been chronicled for posterity. It has become necessary in Ghana to see how handmade paper from local plant sources can be made.

Statistics show that the vast bulk of paper used in this country, especially for teaching and making art, is imported. These specialized papers mention a few for example watercolour papers such as Cottman, Winsor, and Newton Rowney, and cartridge papers are

very expensive. These were imported for student use and for practicing artists in the country from the 1950s to the 1970s. As mentioned above, the shift in pedagogy to emancipate and ensure a proper understanding of the practice and making of art meant also a look at the use of some materials for making art in the College of Art specifically in the Painting and Sculpture department (Seid'ou, 2014). Rethinking the narrow understanding of the potential inherent in the use of paper for making art the exploration of local fibers for handmade paper became necessary (Du Preez 2009).

Political upheavals and the economic downturn in the country meant that the Schools and Universities could no longer afford the importation of these specialized papers for making art. Students had to resort to using industrial papers for printing books for making fine art. Specifically watercolor paper as with other types of papers used, the cost keeps rising every year. Subsequently, the stakeholders to know what types of local plant fibers in Ghana can make affordable but very good paper for artworks. With the dynamic shift in approach to teaching and learning art researching local botanicals became imperative coupled with the contemporary shift for sustainable ways of using earth's resources.

Giving the students the knowledge and ability to explore handmade paper is the more exciting way in their art practice. In creating space in the curricula, to accommodate new practices in doing art it is important not to overlook the importance of taking the students on a collaborative adventure. The resultant effect is that these students who come from rich then begin to own the knowledge they are gaining from their experience of making handmade paper. Their diverse sociocultural, community, and economic backgrounds are challenged bringing to the table different repositories of knowledge from these sources they make rich works of art that are very contemporaneous. The potential that this opens up goes beyond the classroom or the studio.

## Plant fibers

Fibers may be classified based on their origin. The botanical world differs in how much fiber they can produce and, in their quality, also (Rowell, 2008). Plants yield their fibers from different parts, such as bark, fruits, or leaves. Fiber produced may also have different structure types; it may be broad, long, narrow, porous, short, or stiff. This research deals mainly with fibers from plant sources narrowed to non-wood pulp. Three main sources of fiber for handmade paper were experimented with. Grass, Leaf, and Bast fibers are recognized as being in this category of fibers. Africa, Asia, and Latin America are generally credited for the production of large amounts of these types of fiber. Specific countries from other regions such as China, Italy, Japan, India, Mexico, Polynesia, Spain, and Turkey have been known over the centuries to have used these non-wood fibers in the production and manufacture of paper.

In these countries as well as elsewhere, fibers from naturally growing sources such as (1) cane, and bamboo from grass sources. (2) Agricultural wastes from grains and (3) those planted purposefully for use in other manufacturing sectors such as abaca and sisal are also used for ropes. Most of these are well-tested non–wood fibers exist in abundance in Ghana. For instance, here in Ghana there exist in most parts of the country rice paddies that harvest

large quantities of paddy rice of which straws are left to decompose after the rice is harvested as well as other farm produce such as sorghum and maize farms.

There are also large tracks of plantain and banana farms spread across the countryside. In the third category, we can point also to the cotton farms that are harvested only for the production of yarns for the textile industry but beyond that the papermaking capabilities of all these plant sources are left unexplored. In all these categories are also other plant sources that are not agricultural in nature but can be found in abundance because Ghana abounds with forests and grasslands. Many of these plants are considered to be invasive and a threat to subsistent farmers. These botanicals can be explored to create handmade papers.

## Morphology of Non–wood Fibers

The table below shows the type of plant sources experimented with for their papermaking properties.

**Table 1**

| Botanical name | Local name (English) | Local name | Parts plant extracted fibers |
|---|---|---|---|
| Broussonetia papyrifera | Mulberry (invasive) | York /bronsam hama (Twi) | Bast (invasive) |
| Thevetia peruviana | Milk bush /yellow Oleander | | Bast |
| hibisceae | Hibiscus/rose mallow | | Bast |
| Carica papaya | Paspaw | Akpakpa (Ga) Bofre (Twi) Adiba (Ewe) | Young Stem |
| Pisidium | Guava | Gowa (Ga) | Bast |
| Mellettia Thonningii | Turburks | Taatso (Ga) Soko dua (Twi) Turburku (Hausa) Ito (Yoruba) Ati dudu (Ewe) | Bast |
| Diospyros mespilliformis | African Ebony (Ficus) | Baganha (Mamprusi) Amangye dua (Twi) | Bast |
| Bischofia trifoliata | Bishop wood | Awotwea (Twi) | Bast |
| Pennistetum purpureum | Elephant grass | Esere (Twi) Sogbe (Ewe) | Grass |
| Bambusodae | Bamboo | Pamplo (Ga) Pampro (Twi) | Grass (sheaths) |
| Hyparrhenia hirta | Thatch | Mopil’ mori (Dagbani) | Grass |
| Sansevieria trifasciata | Snake plant | | Grass |
| Eichhornia crassipes | Water hyacinth | | (invasive see fig 1) |
| Panicum maximum | Guinea grass | | Grass |
| Typha folia | Cattail/bulrush | | Grass |
| Saccharum Officinarum | Sugar cane | Ahwede[(Twi) Sh² (Ga) | Grass Pseudo Stem |
| Cocos nicifera | Coconut | Akooshi (Ga) Kube (Twi) | Leaves/ Coir, husk |
| Zea mays | Maize/Corn | Abele (Ga) Aburo (Twi) | Leaves |
| Elaeis guineensis | Oil Palm | Ab² (Twi) ŋme (Ga) Edeti (Ewe) | leaves |
| Citrus Sinensis | Orange | Akutu (Ga) Ankaa (Twi) | leaves/fruit |

| | | | |
|---|---|---|---|
| Ananas comosus | Pineapple | Abrob² (Twi) Blofo nme(Ga) Atotor (Ewe) | Stem/leaves/fruit |
| Musa paradesiaca | Plantain | Amadaaŋ (Ga) Brode (Twi) Ablajo (Ewe) | peels |
| Musa balbisiana | Banana | Akwadu (Ga) Kwadu (Twi) | Leaves |
| Tectona Grandis | Teak | | Leaves |

Some common non–wood plants that have been already tried and tested and are being used for handmade paper are linen, hemp, Jute, and kozo (York). However, Paper Mulberry (Broussonetia Papyrifera) kozo (in Japan) or York as known locally in Ghana originates from Asia. Similarly, the water hyacinth which is recorded as being indigenous to Brazil a tropical country obviously could have spread to other countries worldwide. These two plants as shown in **Table 1** are not native to Ghana but are currently abundant in the middle sector of the country, especially around the Ashanti region. It grows abundantly in the environment at Kwame Nkrumah University of Science and Technology campus. Water hyacinth is known to impede water flow in rivers and water bodies thus creating other environmental problems such as the breeding of mosquitoes (Appiah, et al. 2019). These plants, York (Apetorgbor, and Bonsu, 2010) and Water Hyacinth are classified as invasive plants by the Ghana Forestry Commission.

The plants shown in **Table 1** have fibers that are found in tissues of these plants known as the phloem and the outermost bark. Several types of cells make the phloem these may be longer and thicker than others depending on how close they are to the bark with dimensions ranging between fractions of a millimeter to 5m (1½ft). The short fibers (between 5 and 1mm long) come from the heartwood when the whole plant is used (Asuncion 2001). Straw from grains is known to have strong fibers that make good paper. Most of the plants shown here in Table **1** are considered weeds and, therefore, are often slashed and burned, especially in the grass category. Thus, finding economic use for them enhances their value. Further, since they are fast growing there is no issue of sustainability since there will always be enough to work with in making paper for teaching and making art.

## METHOD

The study employs qualitative research methodology. Thus, this study employs a practice-based research approach. The study is an original investigation undertaken in order to gain new knowledge, partly by means of practice and the outcomes of that practice. (Candy, 2006) Whiles the significance and the context of the claims of this study is described in words, the full understanding can only be obtained with direct reference to the outcomes. Candy 2006 posits that this kind of research gives rise to new concepts and methods in the generation of original knowledge. Scrivener 2002 also argues that the importance of practice-based research is one that gives birth to fresh ideas. In This studio practice, plant samples used for the experiment were collected from around the Kwame Nkrumah University of Science and Technology. In this exploration, twenty-two plants were collected and experimented with to test their ability to produce good sheets of paper in Ghana. The studio-based research practice aims at engaging students, investigating sites for materials, exploring the potential of fiber for handmade paper, and using the resultant material in art

production (Mathews, 2010) Using this methodology, knowledge is gained through practice and the outcomes (de Freitas, 2002, Schrag, 2019)

**Collection and treatment of plants**

The plant samples used for the experiment were collected from around the KNUST campus with the exception of the thatch, *Bagandha* a seasonal crop that was brought in from Tamale and West Mamprusi in the Northern sector of Ghana. The Water hyacinth was harvested from an infested stream at Nsenie a village near KNUST, and the pineapple, plantain, and banana were collected from the market as waste peels and stocks. In all twenty-two different plants were tested individually. Some of them were dried, others were retted whiles others were worked on whiles still fresh and green. A recipe fact sheet was developed to record each step of the process. This is important as the information kept helps to reproduce the same quality and quantity of sheets if the fibers are successful in making good papers.

**Process of making handmade paper**

The tools and materials used in preparing the fibers were very basic and easy to build up for any school and studio for papermaking. Tools such as a cutlass for harvesting the plants can easily be obtained on the market, such as a kitchen knife or pen knife, a strainer (colander), a wooden mortar and pestle, as well as a flat wooden baton for beating the cooked fiber. There are plastic bowls and buckets for holding water and paper pulp, a cauldron for cooking the fiber, a table with a flat wooden top, a heavy-duty kitchen blender, mold, and a deckle for forming the sheets. Felts can be made from old blankets or stiffs (interfacing fabric), press and flat metal sheets or plates, and a rack for drying the papers. Caustic Soda (sodium hydroxide) was used as the chemical alkaline agent in isolating the fiber.

The following steps were taken to process each plant fiber. In preparing the bast fibers they were first steamed to remove the bark from the heartwood next these were cleaned of their skin which is often the first layer of the bast fiber. This step is however optional depending on what and how the artist or art teacher wants the paper finished. The bast fiber may then be dried crisp in the sun and stored for later use. However, if not then the next step is the cooking process. During this step, a pot filled not to the brim is put on fire. In our experiment, a campfire was built with three stones for the pot to sit on in the open. (Fig 2) The fiber weighing about 2 kg (4lbs dry weight) was then added to the water which had been mixed with caustic soda varying between 3-4 tablespoons full for the grasses and leaves and for the bast fibers an ideal milk can full was used for measuring (205g).

The cooking time varied between 2 to 6 hours depending on the type of fiber being cooked. By touching the fiber, it shouldn’t be resistant to tearing and should be soft this test shows that the cooking is done. It is important to check frequently for these changes in the fiber. As all fibers are not the same in strength cooking produces weak fibers thus resulting in poor sheets of paper. It is very important to wear protective hand gloves during this process as the caustic soda is capable of burning and scouring the skin and hands.

When the fibers were ready, they were then strained in a colander and washed thoroughly with fresh water until the escaping water was clear to remove the impurities and

the caustic soda (sodium hydroxide). The next step was the beating this was done partly with the mortar and pestle and finished lightly for about 15 min to 30 minutes each depending on the toughness of the fiber in the kitchen blender. Here the timing of blending is important as this also affects the quality of the paper produced. This process is the beating process that turns the fibers into pulp. The pulp was then transferred into a vat for sheet formation. The final stage is using the mold to do the sheet formation. The wet sheets were then couched in between felt into a post. The post is transferred to the press to have excess water pressed out. The sheets were then transferred onto flat metal plates and dried in the sun. (Figs 3 – 5)

## RESULTS AND DISCUSSION

In making paper its quality greatly depends on the overall properties of the plant cellulose that make them. It is generally estimated the cellulose fiber should have high resistance to traction, must be adaptable, flexible, and have the ability to conform. There should be the presence of establishing bonds between the fibers. Thus, the lumens' size, length, diameter, and wall thickness contribute greatly to one fiber being better than the other.

Though most lignin has to be removed for a good pulp it is the relationship between the length and diameter as well as the wall thickness of the fiber that is used in determining good pulp. It is accepted and tested that long fibers make it difficult to produce uniform sheets. This makes non-wood fibers a good choice because they produce thinner and not too long or too thick fibers that have a greater ability to bond with one another. The test findings for each of the papers are done by observation through the visual and tactile feeling of them while they were being produced using a recipe fact sheet.

**Test tables showing paper suitability results.**

| FIBER | | | African ebony | Bamboo | Banana | Cattail | Coconut | | Elephant grass |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Coir | leaves | |
| | | | 100 % | 100 % | 100 % | 100 % | 100 % | 100 % | 100 % |
| BEATING TIME* | | | 1 hour | 45 mins. | 1 hour | 1hour | 1hr | 45 mins | 45 mins |
| WET | Drainage | | fast | slow | slow | slow | fast | slow | fast |
| | Set | | secure | secure | easy | secure | delicate | secure | secure |
| | Lay | | secure | secure | easy | secure | delicate | secure | secure |
| DRY | Smooth | | smooth | smooth | smooth | rough | rough | smooth | smooth |
| | Colour | | Chocolate brown | Golden brown | Dark brown /almost black | beige | brown | Grayish green | Green |
| | Deckle edge | | Serrated hard | serrated | hard | serrated | Threads and soft | Threads and | Soft with threads |
| | Resistance | Traction | 8 | 7 | 6 | 8 | 7 | 6 | 7 |
| | | Rupt | 8 | 7 | 6 | 8 | 7 | 6 | 7 |
| | | Fold | 8 | 7 | 5 | 5 | 2 | 6 | 6 |

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| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | 7 | 6 | 2 | 8 | 7 | 6 | 7 |
| | Rattle | | Dull stiff | dull | Metallic, | Dull, card like, stiff | | dull | dull |
| | Feel | | Smooth, hard | Soft and smooth | Smooth/a little hard | Rough, little hard | Rough very little body | Smooth And soft | Smooth with body |

Table 2. Observation sheets Durability test/shade/colour (Table after Asunción 2001) *beating time includes pounding in the mortar and in the blender.

| FIBER | | | Guava | Guinea grass | Hibiscus | Maize | Milk bush | mulberry |
|---|---|---|---|---|---|---|---|---|
| | | | 100 % | 100 % | 100 % | 100 % | 100 % | 100 % |
| BEATING TIME | | | 1hr | 30 min | 1hr | 45 min | 1hr | 45 mins |
| WET | Drainage | | easy | fast | fast | fast | slow | fast |
| | Set | | secure | easy | easy | secure | delicate | secure |
| | Lay | | secure | easy | easy | secure | delicate | secure |
| DRY | Smooth | | Very smooth Few bumps | Many bumps | Minor waves | Minor bumps | Wrinkles and waves | Smooth, with few bumps |
| | Colour | | tawny | Pale green | Pale yellow | yellow | Pale brown | Off white |
| | Deckles | | Few elegant | Few/hard | Few, with threads | Hard and serrated | Hard and serrated | |
| | Resistance | Traction | 9 | 9 | 6 | | 8 | 9 |
| | | Rupture | 9 | 9 | 6 | | 8 | 9 |
| | | Fold | 7 | 6 | 4 | | 5 | 9 |
| | | Tear | 9 | 5 | 5 | | 7 | 9 |
| | Rattle | | dull | Sharper sound, stiff | Dull, card stiff | Sharp metallic A little stiff | Sharp, slightly stiff | Crispy, more flexible |
| | Feel | | Very Smooth, lots of body, velvety | Hard, rough | Thick, rough | Thick not too smooth | Light translucent rough | Smooth and soft |

Table 3. Observation sheets Durability test/shade/colour

| FIBER | Pineapple | Plantain | Snake plant | Sugarcane | Teak | Thatch | Water hyacinth |
|---|---|---|---|---|---|---|---|
| | 100 % | 100 % | 100 % | 100 % | 100 % | 100 % | 100 % |

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| BEATING TIME | | | 30 mins | 1hr | 1hr | 1hr | 15 mins | 15 mins. | 1 hr. |
|---|---|---|---|---|---|---|---|---|---|
| WET | Drainage | | fast | fast | fast | medium | fast | fast | medium |
| | Set | | delicate | easy | secure | easy | easy | easy | easy |
| | Lay | | delicate | easy | secure | easy | easy | easy | secure |
| DRY | Smooth | | Slightly wavy | rough | Slight waves | Slight waves | Slight bumps | bumpy | bumpy |
| | Colour | | Pale yellow speckled | Speckled Pale brownish gray | Smoke Pale yellowish grey | Pale yellow | Grayish brown | Pale grayish green | grayish green |
| | Deckles | | Serrated and cracked | Serrated soft | irregular | Serrated with threads | Irregular with threads, and cracks | Irregular With threads | irregular |
| | Resistance | Tract | 3 | 7 | 7 | 7 | 7 | 8 | 4 |
| | | Rupt | 3 | 7 | 7 | 7 | 7 | 8 | 6 |
| | | Fold | 5 | 6 | 5 | 7 | 6 | 6 | 6 |
| | | | 3 | 7 | 5 | 7 | 5 | 7 | 6 |
| | Rattle | | Sharp, metallic | sharp | sharp | Raspy | dull | dull | sharp |
| | Feel | | Soft and less body | rough | Smooth with body | Rough And hard | Soft and hard | Rough hard | rough |

Table 4. Observation Sheets Durability test/shade/colour

| FIBER | | | Oil palm | Orange | Baganha | Bishop wood |
|---|---|---|---|---|---|---|
| | | | 100 % | 100 % | 100 % | 100% |
| BEATING TIME | | | 1 hr | 30 miins | 1hr | 1hr |
| WET | Drainage | | slow | fast | slow | slow |
| | Set | | easy | delicate | secure | secure |
| | Lay | | easy | delicate | secure | secure |
| DRY | Smooth | | Minor waves | waves | smooth | waves |
| | Colour | | khaki | Light lemon green | brown | Reddish brown |
| | Deckle egdes | | Few short | Irregular with threads | Irregular with threads | Irregular, with threads |
| | Resistance | Traction | 7 | 7 | 8 | 7 |
| | | Rupture | 7 | 7 | 8 | 6 |
| | | Fold | 5 | 7 | 6 | 5 |
| | | Tear | 9 | 8 | 7 | 5 |
| | Rattle | | Dull/not very stiff | dull | Raspy | Dull/not very stiff |
| | Feel | | Soft/smooth | smooth | smooth | Rough/hard |

Table 5. Observation Sheets Durability test/shade/colour

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These characteristics were observed 1. when the sheets were wet and 2. after they have been dried. When wet during the formation of the sheets

Wet Characteristics:

1. The drainage time
2. The Setting: how hard it is to tear the sheet or whether it stays intact
3. The lay: after pressing, testing how difficult it is to separate the formed sheet from felt without tearing. Table 2 shows how each fiber fared in resulting in good papers or not,

Dry Characteristics:

Smoothness and stability of surface, wrinkles, or bumps

Deckle edges describe the shape of the paper edge

Table 6. Showing the Result and Appearance of sheets from Different types of Plants use for the Experiment:

| | |
|---|---|
| Mulberry (invasive) |  |
| Milk bush /yellow Oleander |  |
| Hibiscus/rose mallow |  |

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| | |
|---|---|
| Pawpaw |  |
| Guava |  |
| African Ebony (Ficus) |  |
| Bishop wood |  |
| Elephant grass |  |

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| | |
|---|---|
| Bamboo |  |
| Thatch |  |
| Snake plant |  |
| Water hyacinth |  |
| Guinea grass |  |

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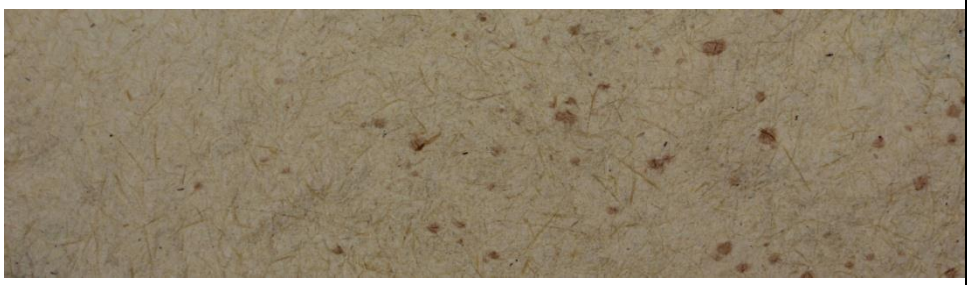
| | |
|---|---|
| Cattail/ bulrush |  |
| Sugar cane |  |
| Coconut |  |
| Maize/Corn |  |
| Oil Palm |  |

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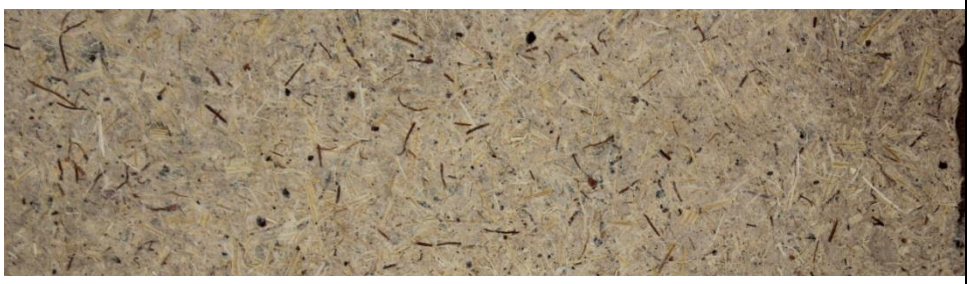
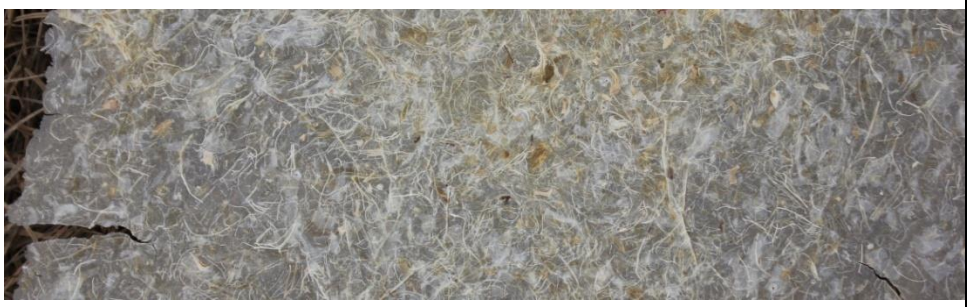
| | |
|---|---|
| Orange |  |
| Pineapple |  |
| Plantain |  |
| Banana |  |
| Teak |  |

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Resistance to traction, creasing, tearing, and rapture each sheet is rated between 1 – 10, (1-lowest/poor and 10- highest/ very good)

The rattle of the paper describes the sound produced when the paper is stuck by hand or shaken and the relative stiffness of sheets

Feel describes the sensation upon touch, whether it is smooth/rough, and the body that is the volume of the sheet.

Fig 1 A Stream at Nsenie near K.N.U.S.T showing how it's been invaded by Water Hyacinth

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Fig 2 Fiber cooking in a pot on campfire

Fig 3 Primary School art teachers in a workshop trying their hands on Hand paper making from local plants sources

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**Fig 4** sheets on a drying rack

**Fig 5.** Student piece: handmade paper and printmaking and pen

## CONCLUSION

Paper science and art is also growing concurrently alongside the other dimension of things. One thing is for sure mankind will never rid itself of the use of paper but rather would find better and more sustainable uses for it. The exploration reveals that there is so much potential for the use of paper in Ghana, in the classroom, for the professional artist at the tertiary, secondary, and primary levels of education in Ghana, and for the industry as a whole.

It was observed that whilst some of the sheets were stronger than others a combination of such fibers produced very good sheets. In other cases, the fibers could best serve as decorative additives of the stronger fibers which served as a base structure for the sheets made. It goes without saying that today Ghana is glutted with plastics that have become an environmental menace. Here as shown by this exploration into plant fibers is a material that abounds most of which are invasive in nature and thus can be controlled, others seen as agricultural waste can be utilized more economically by using them for paper making. This can help cut down this problem posed by plastic waste. Most important the sheets lend themselves to use in areas such as drawing and printmaking (fig 5), book arts, and sculpture using mixed media and other techniques in art such as making yarns for weaving in textile fashion.

The future holds in itself new and safe technologies that we are yet to see and experience in the processing of plant fiber for paper making that will make it possible to make papers from plants that hitherto were not possible through the current processes being used. The control and flexibility inherent in handmade paper as a material bring to the artist and teacher the making of art and crafts that stimulate creativity and new visual vistas that are boundless. Encouraging teaching and learning this art form to artists, teachers, and children allows for the self-expression and growth of the intellect. So much has been done and continues to be done and said about the internet and computers but it is not a one-way road.

It is also recommended that in the present era of sustainability, artists, small and medium-scale enterprises, and local industries in Ghana see the value and encourage the use of handmade paper production as a traditional technology for its social, economic, and environmental benefits.

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