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Comparative Study of Hand Sheet Paper from Banana Pseudo stem with Recycled Paper.

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PROJECT THESIS
COURSE NO: FWT- 4114

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DECLARATION

I, Al-Amin Shaikh, declare that this thesis is the result of my own works and it has not been submitted or accepted for a degree in any other university. I also declare that this thesis or any information of this paper can not be used industrially or commercially without any prior permition of the author.

I, hereby, give consent for my thesis, if accepted, to be available for photocopying and for inter-library loans, and for the title and summary to be made available to outside organizations only for research and educational purposes.

Signature

Al-Amin Shaikh,

Dedicated
To
My beloved Parents

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July, 2018

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APPROVAL

This project thesis has been submitted to the Forestry and Wood Technology Discipline, Khulna University, Khulna, Bangladesh, for the partial fulfillment of professional BSc.(Hons) degree in Forestry. I have approved the style and format of the project thesis.

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Abstract

In today's modern world, use of paper has increased massively. Traditionally, paper is manufactured from cellulosic materials. The use of forest sources fiber to produce paper has increased greatly. It is now widely accepted that alternative source must be found. Paper making industries are faced with significant environmental and raw material availability challenges. In this perspective, it is looking for alternative raw materials. As banana and recycled paper is available.Thisstudy presents a proposal for use of banana pseudo stem and recycled paper. After banana harvesting, the pseudo stems are cut and left on the ground, this waste is then causes emission of harmful gases (CO2). In order to add value to banana plantation, the pseudo stem could be processed into valuable products (Paper). Waste Banana stem is a very good source of cellulose. It contains 39.12 % cellulose and 11.34% lignin. Cellulose can be easily separated from lignin without using toxic chemical during process. The 100% recycled paper shows the highest brightness. The 100% banana shows the highest tearing strength and 50% banana and 50% recycled paper gives the highest tensile strength. Over all, the using of 50% banana pulp and 50% recycled pulp mixing shows the best quality paper. Due to large availability of banana stem waste and paper waste in the country, it is important to implement Cleaner Production and Green Chemical Technology to utilize waste banana pseudo stem and paper waste into useful products (paper).

CHAPTER 1: INTRODUCTION

1Background and Justification of the Study

Bangladesh is an over populated country. The demands of daily necessary commodities are rising in this country with population. Paper is such sort of daily needing material, the demand of which is rising every day in Bangladesh as well as with the world. But the country failed to meet the demand of her own. Moreover many paper making mills have been compelled to shut down due to shortage of raw material. The raw material of paper has been importing in the private sector to meet this demand of paper. The acute scenario of the pulp and paper making field is the scarcity of raw material which is one of the mentionable obstacle to the development of this sector. We use wood, bamboo, sugar cane, jute, Gewa, Nalkhagra grass, etc. as raw material. We also use recycled pulp for making paper.

The conventional paper is derived from wood that is the paper industry is mainly depending upon forest resources, as a result deforestation take place to meet the availability of raw material for paper making industry. Forests are declining at the alarming rate of 13.0 million hectares per year in developing countries (Anon. 1997).It is broadly accepted that the deforestation causes environmental pollutions and global warming. In recent year, people have placed a high emphasis on forest preservation and rational use of forestry and agriculture residues (Shiyu Fu Li et al. 2010). Hence, due to harmful effects of deforestation, it is important to search for alternative cellulose containing resources. Studies have shown that the production process of paper from non-wood fibre is significantly less expensive than from wood fiber .There are three reason of cutting of stems, the very first reason is that banana stem are cut off when fruits are harvested, the second reason of cutting off banana stem is due to diseases (that is because attack of fungi which are grown in result of waste banana stem) and female banana stem are also cut off after the maturity of male plant. So that a massive organic waste is produced because the banana stems cannot be used as an animal feed or other alternative. The waste is then causes of emission of toxic gases including CO2 and also gives growth to the harmful fungi which attack on remaining banana trees. It is estimated that, Banana is cultivated on 13.3 million hectares in Bangladesh. The availability of the large scale of banana stem waste in the country and shortage of raw materials for producing pulp and paper, it make sense to use waste banana stem for paper making.

Development of the use of recovered paper in the paper industry is a success story of the second half of the 20thcentury. As the threshold of the next century, recycled fibers are indispensable raw material in the global paper industry to satisfy the need for fibers in industrialized and developing countries. About 80% of all waste paper comes from three sources: corrugated boxes, newspaper and office paper . Less than 20% of waste paper is deinked to be used in newsprint, tissue or other bright grades. Most waste paper is used in paperboard, chipboard and roofing material where color

is not important. The impact of environment through green movements and level of acceptance in the market of paper made from recycle fibers are additional driving force. It is accepted that recycled fibers preserve forest resources and energy for production of pulps for paper manufacturing.

As banana and recycled paper is available, we can use easily to make paper manufacturing.

1.2 Objectives of the study

- To show the potentiality of banana as an alternative source for paper making
- To overview the potential of recycled paper in the context of Bangladesh.
- To compare the properties of banana and recycled paper

CHAPTER 2: LITERATURE REVIEW

1Banana Production

1.1 World

Musa spp., banana and plantain, constitute the fourth most important staple food commodity of the world, after rice, wheat and maize. In Asian and Pacific regions, banana has great socio-economic significance. The region is the major Centre of diversity and most of the edible bananas are believed to have originated in South-east Asia and Western Pacific regions. Banana is now distributed in most of tropical and sub-tropical countries. The world production of banana was about 95 million tons and most of the production was consumed locally (Ganapathi et al., 2002). Meanwhile, two decades ago the world banana and plantain productions are of 41 and 20million tons respectively (FAO, 1984). This indicates that the world banana production trends increasing significantly as staples and export commodity. Recent FAOSAT (2008) tells that total banana production in the world was 96 million tons in 49 million ha in 2009. In South-east Asian countries produce 19.0 million tons. Major banana exporting countries are Ecuador (5.2 milliontons), Costa Rica (2.0 million tons), the Philippines (1.9milliontons) followed by Colombia and Guatemala. We also notice, however, that in many Asian and Pacific countries, bananas are mainly consumed domestically. India, for example, is not a banana exporting country but the largest banana producer in the world with 26 million tons followed by the Philippines (8.6 million tons) and China (8.0 million tons). As banana importing countries, many non-banana producing and developed countries are listed such as USA (4.0 million tons) and Japan (1.0 million tons).Production and horticultural characteristics of bananas are well documented by Robinson and Sauco (2010).

1.2 Present status of banana production in Bangladesh

Bangladesh is ranked 30th among banana-producing countries in terms of banana production (Promusa,2017).

Major Districts of cultivated Banana: Bogra, Narsingdi, Rangpur, Nator, Pabna, Noakhali, Faridpur, Khulna.

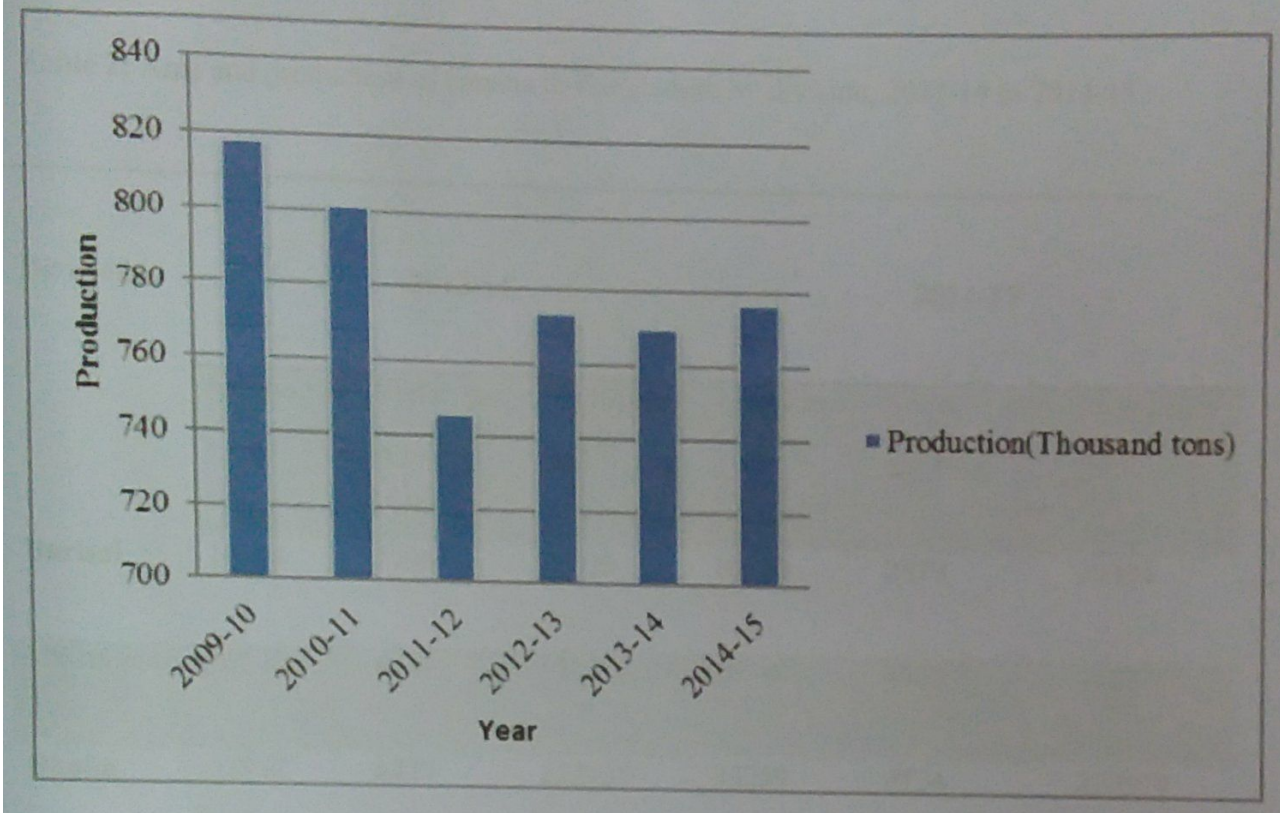
Districts of wild grown Banana: Sylhet, Moulvibazar, Netrokona, Rangamati, Khagrachori, Bandarban. Generally banana plants are found throughout the country in most of the rural homesteads.

Table 1: Area under banana production in Bangladesh, 2009-10 to 2014-15

Year	Area(acres)
2009-10	133305
2010-11	130589
2011-12	121718
2012-13	119325
2013-14	114669
2014-15	115434

Source: (Yearbook of Agricultural Statistics, 2013, 2015)

From table 1 it is seen that, year by year (2009-10 to 2013-13) area under banana production in Bangladesh gradually decreased. In 2014-15, it is slightly increased.



Source: (Agriculture Wing, BBS, 2015)

Figure 1: Yearwise production of banana in Bangladesh, 2009-10 to 2014-15

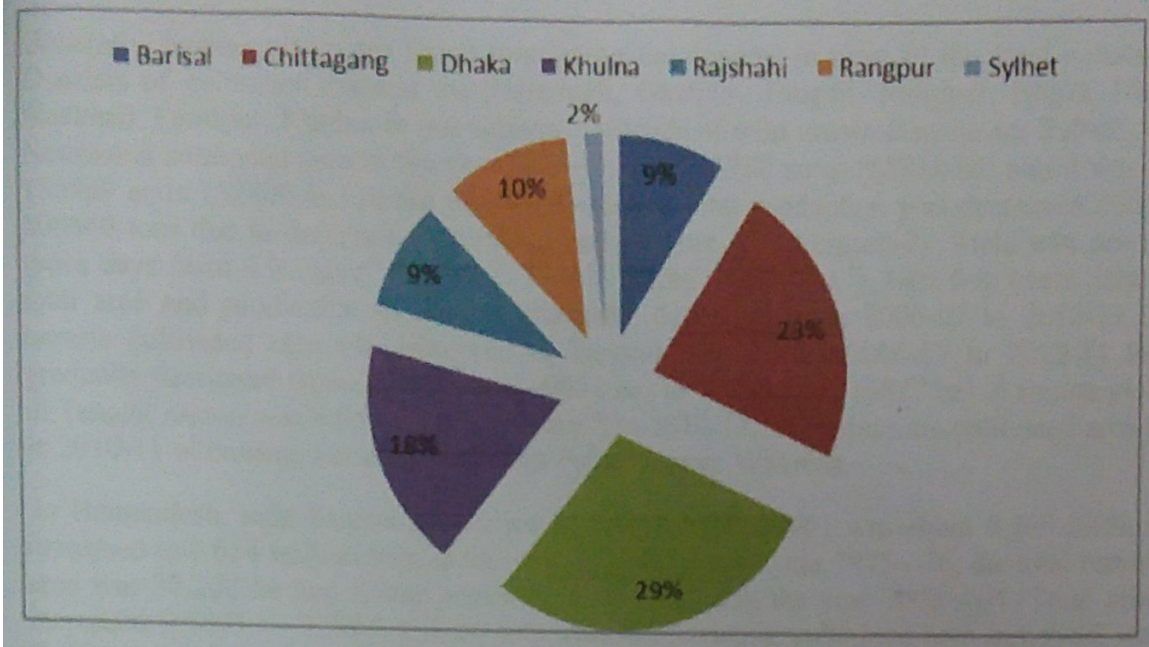
From the above figure 1, it reveals that production of banana in Bangladesh is highest in 2009-10 and lowest 2011-12.

Table 2: Area and production of banana in Bangladesh by division, 2013-14 to 2014-15

Division	2013-14			2014-15		
	Area(acres)	Yield per acre(Kg)	Production (MT)	Area(acres)	Yield per acre(Kg)	Production (MT)
Barisal	10024	2796	28029	10210	2879	29394
Chittagang	26300	4381	115226	26540	4455	118232
Dhaka	32932	6757	222535	33259	6734	223979
Khulna	21145	8229	174012	21133	8227	173857
Rajshahi	10342	8743	90422	10369	8814	91389
Rangpur	12457	11094	138196	12106	11395	137943
Sylhet	1469	1295	1903	1817	1449	2633

Source: (Yearbook of Agricultural Statistics, 2015)

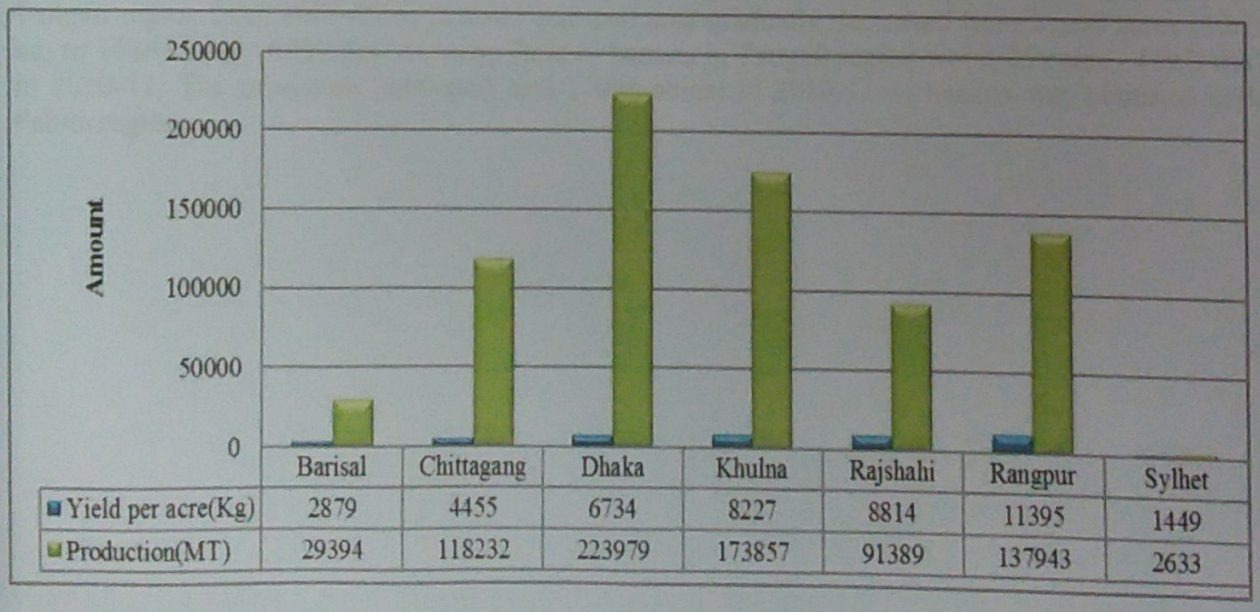
n table 2, it shows that Dhaka division provides highest part of banana production and lowest banana roduction area is Sylhet in the year of 2013-14 to 2014-15.



Source: (Yearbook of Agricultural Statistics, 2015)

Figure 2: Area under banana production in Bangladesh by division, 2014-15

From figure 2, it is clear that major area is Dhaka and small area is Sylhet for banana production in Bangladesh in 2014-15.



	Barisal	Chittagang	Dhaka	Khulna	Rajshahi	Rangpur	Sylhet
Yield per acre(Kg)	2879	4455	6734	8227	8814	11395	1449
Production(MT)	29394	118232	223979	173857	91389	137943	2633

Source: (Yearbook of Agricultural Statistics, 2015)

Figure 3: Banana production in Bangladesh by division, 2014-15

Generally, banana plants are found throughout the country in most of the rural homesteads. Major Districts of cultivated Banana are Narsingdi, Gazipur, Tangail, Rangpur, Bogra, Natore, Pabna, Noakhali, Faridpur, Khulna in our country. Districts of wild grown Banana are Sylhet, Moulvibazar, Netrokona cultivated area in the year 2006-07 was 145280 acres (58818 ha) and it was decreased to 130589 acres (52870 ha) in the year 2010-11 and total production was decreased 1004520 tons to 800840 tons due to decreasing cultivated area (Figure-1 and Figure-2). Yield was decreased during those days from 6.9 t $acre^{-1}$ (17 tha^{-1}) to 6.13 t $acre^{-1}$ (15.1 tha^{-1}). Last five years data showed that total area and production of banana gradually decreased from 2006-07 to 2010-11. The highest banana cultivated area was observed in Tangail region from 2006-07 to 2010-11 but total area gradually decreased from 26260 acres (10631 ha) to 16863 acres (6827 ha). Average yield of banana in Tangail region was 8.05 t $acre^{-1}$ (19.9 tha^{-1}) in 2010-11. The minimum cultivated area (1056 acres) in 2010-11 of banana was obtained under Pabna region. Whereas,

In Bangladesh, total banana production in year the 1999-2001 was about 0.580 million tons but it increased to 0.654 million tons in the year 2003 [2]. In the year 1975 - 76, the total banana cultivated area was 37,200 ha and it was increased to 49,280 ha in the year 2003 - 04. Total production was increased 0.5691 to 0.7065 million tons due to increasing cultivated area but yield was decreased during those days from 15.07 tha^{-1} to 14.33 tha^{-1} due to constrains of banana cultivation [9, 10]. Considering the year round availability, popularity and production, banana is considered the number one fruit in Bangladesh. The average yield of banana is 14 tha^{-1} , which is lower compared to other banana-producing countries in the world. However, in commercial orchard, yield is not less than 30 tha^{-1}

.Rangamati, Khagrachhari, Bandarban. In Bangladesh, the total banana cultivated area in the year 2006-07 was 145280 acres (58818 ha) and it was decreased to 130589 acres (52870 ha) in the year 2010-11 and total production was decreased 1004520 tons to 800840 tons due to decreasing cultivated area (Figure-1 and Figure-2). Yield was decreased during those days from 6.9 t $acre^{-1}$ (17 tha^{-1}) to 6.13 t $acre^{-1}$ (15.1 tha^{1}). Last five years data showed that total area and production of banana gradually decreased from 2006-07 to 2010-11. The highest banana cultivated area was observed in Tangail region from 2006-07 to 2010-11 but total area gradually decreased from 26260 acres (10631 ha) to 16863 acres (6827 ha). Average yield of banana in Tangail region was 8.05 t $acre^{-1}$ (19.9 tha^{-1}) in 2010-11. The minimum cultivated area (1056 acres) in 2010-11 of banana was obtained under Pabna region.

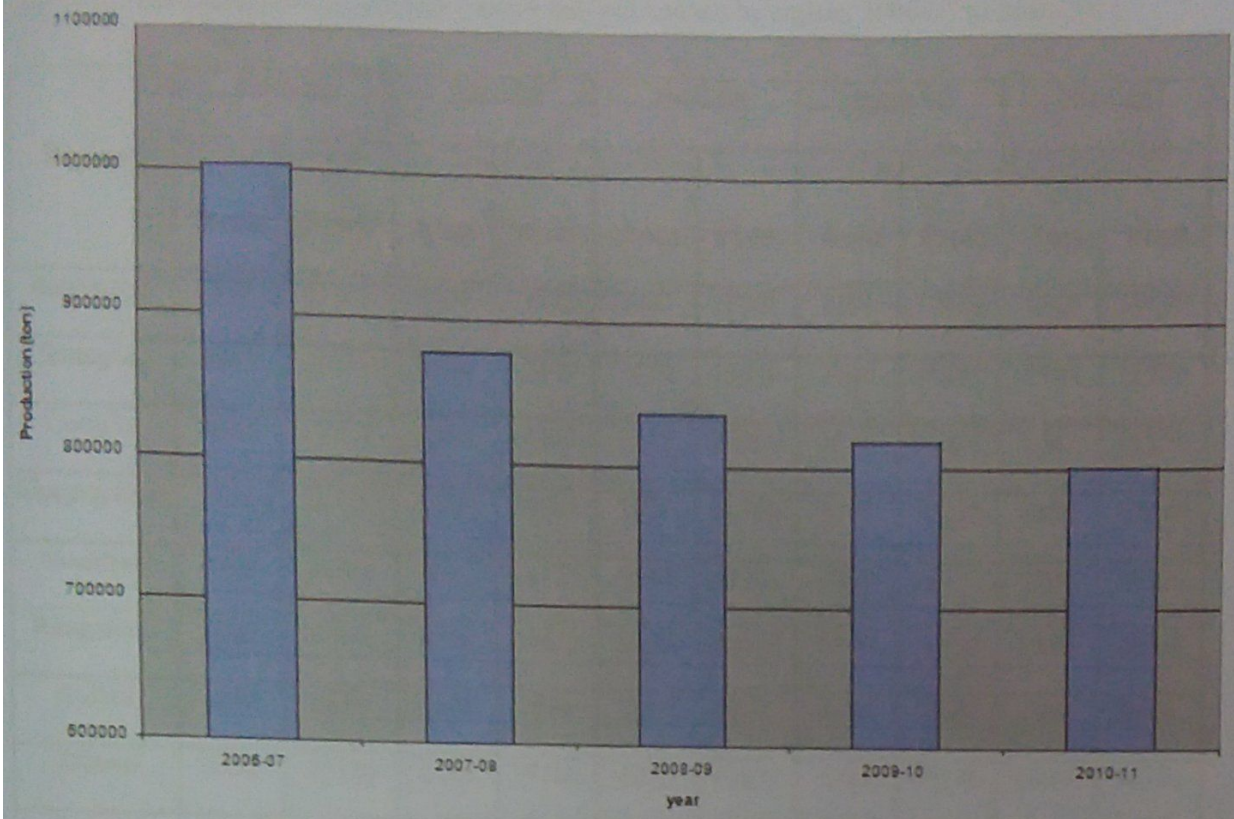


Figure-4. Banana production in Bangladesh (2006-07 to 2010-11)

Table-3. Area (acres) and production (metric tons) of banana by region, 2006-07 to 2010-2011

Regions	2006-07		2007-08		2008-09		2009-10		2010-11	
	Area	Prod.	Area	Prod.	Area	Prod.	Area	Prod.	Area	Prod.
Bandarban	3545	23565	3120	18843	3187	18701	3201	17846	3449	17870
Chittagong	4640	14505	3334	15427	3479	16010	3499	16011	3596	16771
Comilla	2420	10720	2369	15357	2177	13890	2058	10813	2087	11259
Khagrachhari	1025	10435	1355	13065	3427	10366	3775	10278	3855	10458
Noakhali	4845	18225	4545	18175	4648	17921	4738	18193	4700	18020
Rangamati	7900	37310	8590	40459	9110	44562	9305	40874	9416	44249
Sylhet	1350	2850	1425	2854	1453	2872	1447	2691	1456	2598
Dhaka	6550	53120	6184	38126	6250	42851	6285	43146	6148	44336
Faridpur	4405	28765	4789	37737	4862	39030	5881	42946	5838	42117
Jamalpur	2510	14045	2506	13998	2441	13639	2459	13780	2429	13561
Kishoregan	2235	14930	2261	15831	2243	15747	2220	14950	2193	14802
Mymensingh	5745	21685	5176	17078	5689	21413	5871	24003	5394	20854
Tangail	26260	228070	22399	186851	20496	170088	18226	152128	16863	135829
Barisal	15100	70305	12890	34420	15243	33577	16413	38977	16566	35876
Jessore	12355	109220	11663	68723	11995	60855	12193	63155	11375	55098
Khulna	8405	39125	6909	34765	4323	29265	4315	29185	4031	25345
Kushtia	10170	136890	9867	129964	8857	108861	8483	102800	8262	103166
Patuakhali	1765	8350	1638	7851	1609	7071	1615	7086	1520	7480
Bogra	4030	30205	3158	23447	2703	20393	2579	19549	2546	18481
Dinajpur	3830	29060	4042	30814	4032	31704	4234	30483	4360	35120
Pabna	1550	7030	945	8040	957	7530	1039	8578	1056	9030
Rajshahi	7445	55875	6069	55862	5681	41313	5741	42523	5702	47131
Rangpur	7200	40235	6402	49431	7552	68524	7728	68259	7747	71389
Bangladesh	145280	1004520	131636	877118	132414	836183	133305	818254	130589	800840

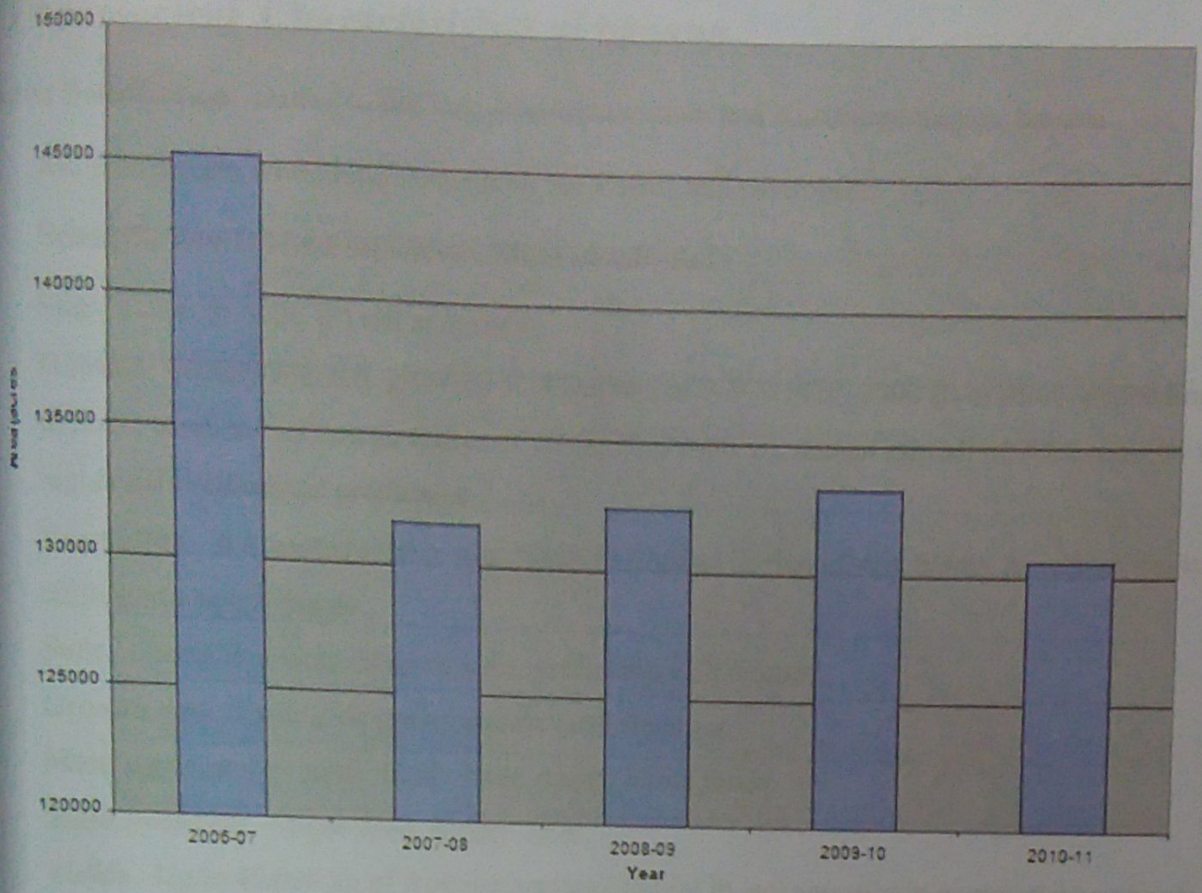


Figure-5. Banana production area in Bangladesh (2006-07 to 2010-11).

2 Characteristics of Banana Fiber

The physical and chemical properties of banana fiber are considered below:

- The chemical composition of banana fiber is cellulose (50-60%), hemicelluloses (25-30%), pectin (3-5%), lignin (12-18%), water soluble materials (2-3%), fat and wax (3-5%) and ash (1 -1.5%) (http://www.lifei.com/products/4/e2.htm) (Mukhopadhay*et al.*, 2008).
- Its appearance is similar to that of bamboo and ramie fiber; however banana fiber has better fineness and spin ability. It has shiny appearance depending upon the extraction and spinning process (Rao and Mohana,2007).
- It has very strong fiber with 3% elongation and light weight.
- Its average fineness is 2386 Nm, average strength is 3.93 cN/dtex and average length is 50 ~ 60 mm (or 38mm) (http://www.lifei.com/banana.htm).
- It absorbs and releases moisture easily.
- It can be spun by different methods like ring spinning, open-end spinning, bast fibre spinning, and semi-worsted spinning.
- It is bio-degradable and has no negative effect on environment and thus can be categorized as eco-friend fiber (Mukhopadhay *et al.*, 2008).

2.3 Phenological Characteristics of banana

Banana Distribution Native to the Indo-Malesian, Asian, and Australian tropics, banana and plantain are now found throughout the tropics and subtropics.

Scientific name: Musa sapientum, Musa paradisica L.

Size 2–9 m (6.6–30 ft.) tall at maturity.

Habitat Widely adapted, growing at elevations of 0–920 m (0–3000 ft) or more, depending on latitude; mean annual temperatures of 26–30°C (79–86°F); annual rainfall of 2000 mm (80 in) or higher for commercial production.

Vegetation Associated with a wide range of tropical lowland forest plants, as well as numerous cultivated tropical plants.

Soils Grows in a wide range of soils, preferably well drained.

Growth rate Each stalk grows rapidly until flwering.

Main agroforestry uses Crop shade, mulch,living fence.

Main products Staple food, fodder, fiber.

Yields Up to 40,000 kg of fruit per hectare (35,000 lb./ac) annually in commercial orchards.

Intercropping Traditionally grown in mixed cropping systems throughout the Pacifi.

Invasive potential Banana and plantain are not considered to be invasive.

2.4 Definition of Secondary Fiber:

The fibers that have previously been used in manufacturing paper or paper board or other purposes that is called secondary fiber.

2.5 Characteristics of recycled paper

- Single fibers strength is not affected recycling.
- Recycled single fibers are somewhat flatter than new fibers.
- Recycling increases fines materials content in a pulp.
- Fines materials become less active in establishing bonds.
- Treating fibers in alkali will raise swelling somewhat.
- Newsprint from recycled pulp is considered as having good printing.
- Paper fiber recycling is expanding rapidly. It is predicted that a recycling rate of some 55% -60% is attainable.
- Many fibers will be turned into paper several times.

2.6 Properties of Paper Recycling:

During the past two decades, numerous studies have been conducted on the potential of papermaking from recycled fibers. Most studies have shown that the strength properties of fibers and paper are reduced upon recycling. The effects of drying are presumed to be the main factors in reducing the strength properties of recycled fibers. Drying influences fiber strength, fiber swelling and bonding potential, which are the important factors to the strength of paper made from recycled fibers .It seems that strength properties of recycled paper, such as tensile and bursting strengths, which are dependent on fiber bonding, are dramatically decreased with recycling. However, for strength properties of recycled paper where fiber bonding is not the main factor, such as tear strength, recycling seems to have a beneficial effect up to a certain level of recycling.

2.7 Paper for Recycling Classes

Class I - Mixed Grades

Waste and scrap of paper or paperboard, including unsorted waste and scrap.

Class II - Corrugated and Kraft Unbleached Kraft paper or paperboard or corrugated paper or Paperboard.

Class III - Newspapers and Magazines Paper or paperboard made mainly of mechanical pulp (for example, newspapers, journals and similar printed matter). Including old and unsold newspapers and magazines, telephone directories, brochures and printed advertising material.

Class IV - High Grades

Other paper or paperboard made mainly of bleached chemical pulp, not colored in the mass.

2.8 Studies related to Production of Banana

Earlier studies relating to the productivity of banana cultivation of different varieties of banana in various places, importance of banana, uses of the byproducts, factors influencing banana production and measures adopted for increasing banana production are as follows:

Sangili (1980) found that there is inverse relation between the area under banana and paddy cultivation in Anandanallur Block, Madurai. Another fact pointed out by this study is that banana is a substitute crop for paddy fields and hence people cultivate more bananas. He also proved that there is

a negative correlation between the cost of production and the net profit of banana. He also pointed out that profitability of banana is higher for owners or cultivators than for tenant cultivators.

Hayeer (1990) in his study 'Fruit growing in India' studied about the areas where banana is grown throughout the country and also in foreign countries. He estimated that the kathali variety is cultivated in half of the banana cultivable areas in Tamil Nadu, Assam and Travancore. Kathali is a popular variety even today. He has noted that Tamil Nadu has long dry areas for the cultivation of banana. Having a long dry season through cold winters and hot wind in summer affects banana cultivation in the northern parts of India

Pandiyarajan et al., (1994) shows how the edible banana is given the name "Musa Paradisica". The prominent varieties suitable for export to Central America, South America and Europe are Rasthali, Red Banana and Ney Poovan.

Emile Frison et al., (1998) in their article remarked that bananas and plantains are extremely important crops throughout the developing countries of the tropics. They are not only a staple food crop for millions of people, but they also provide an essential source of income through local and international trade. The plant is versatile and, as well as being an important food source, also provides fiber, starch and alcohol. Different types of bananas are important in different regions, but everywhere, banana and plantain producers face growing hardships, as a result of increasing pest and disease pressures, more specifically, the rapid global spread of black sigatoka disease, to which many important cultivars are susceptible. Relatively limited resources are being directed towards banana improvement. So a considerable investment in this area is still required. It is therefore essential that researchers, donors, and indeed the general public are made aware of the global importance of this crop, in order to ensure that a level of resources commensurate with its importance are directed towards its improvement in the future.

2.9 Studies related to recycling paper:

Howard noted in his 1990 paper, The Effects of Recycling on Paper Quality that some investigations into the effects of recycling began in the late 1960s. That research focused on establishing the cause and effect relationships that lead to negative impacts of recycling papers. The study posited that the major cause of the change in properties was the reduced bonding ability of the fibers in the paper composite after recycling of the pulp. While loss of intrinsic fiber strength had been expected, a range of results were observed some

Indicating loss, no change or even an initial increase in fiber strength.

Nazhad (1994) demonstrated that the degradative effects of recycling result in the loss of potential bonding of recycled fibers, a loss that translates into "hornification"a series of irreversible changes that cellulose fibers undergo when exposed to cycles of wetting and drying, and loss of fiber wet flexibility. The term hornification is a technical term used in wood pulp and paper research literature that refers to the stiffening of the polymer structure that takes place in lignose cellulosic materials upon drying or water removal. When wood pulp fibers are dried, the internal fiber volume shrinks because of structural changes in the fibers. If fibers are then again suspended in water, the original water-swollen state is not regained. The effect of hornification can be identified seen in the results from physically testing the paper such as burst or tensile testing. Nazhad's research showed that the overall result of drying and rewetting is a reduced swelling ability of the fibers, with most of the change taking place in the first cycle. Repeated cycling then further reduces the plasticity and therefore flexibility of the fiber.

Recycling should not be considered a modern phenomenon. A program for recycling was established in Southern Africa in 1826.Research in this country noted increases in strength properties after the first and or second cycles and then a sharp decrease in mechanical performance. It was suggested that this reduction was due to the increase in deformation of fibers in the paper assembly with these degraded fibers having reduced surface accessibility for bonding. They found that the rate of tensile strength loss from

chemical (beaten) pulp was twice as high as that of unbeaten pulp with the recycled process indicating a similar trend between bending stiffness and tear strength. In his 2008 thesis, Effect of Progressive Recycling on Cellulose Fiber Surface Properties, Brancato employed atomic force microscopy to assess the effects of hornification the irreversible changes in cellulose fibers exposed to cycle of wetting and drying. These changes in the cellulose fiber surfaces indicated two separate effects; a) a decrease in the water absorption and retention capacity of recycled pulp, and b) a change in surface roughness of the recycled paper, resulting in a smoother surface. It was proposed that the free micro fibrils of the fiber surface formed intra fiber hydrogen bonds, essentially laminating and presenting a more homogeneous surface on the recycled paper. The reduced swelling capacity of recycled fibers is caused by irreversible hornification and is the accepted morphological reason for strength loss in recycled papers.

Brancato also describes Jayme's introduction of the water retention value (WRV) measurement by centrifugation. The definition of irreversible hornification is described in terms of decrease in WRV

and expressed as a percentage of the original value. The decrease in WRV was found to correlate well with fiber thickness measured in electron microscopic images; though no change in fiber width was detected after multiple fiber drying. Repeated recycling showed progressive variations in these properties.

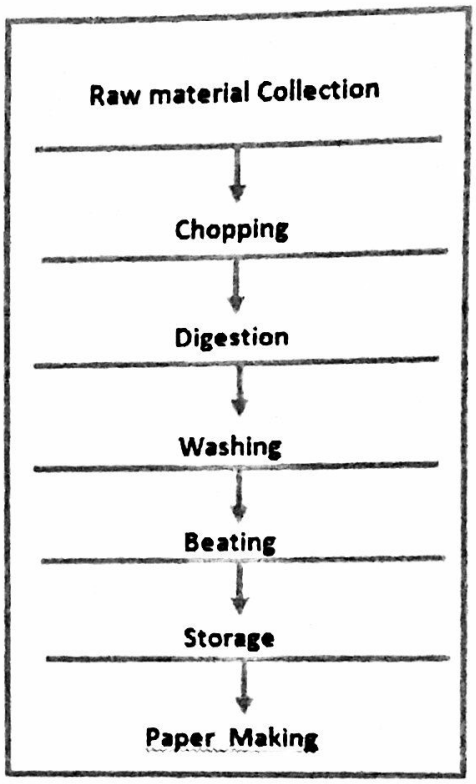
Improvements to the quality of recycled papers have been in the interest of consumers, producers, and scientists alike. McKee's concern in 1955 for significant physical property difference shown between "repulped or regenerated fibers (and papers made therefrom)" and virgin fibers predate the term 'recycled paper' by years. At LC,efforts by McComb and Williams (1981) suggested that recycled fiber from alkaline paper was more akin to the properties of virgin fiber, and would produce recycled paper with better long term properties.Doshi compiled and edited Recycled Paper Technology:An Anthology of Published Papersin 1994. The text includes a comprehensive examination of all aspects of the paper recycling. The essays range from discussions of public policy, equipment technology, paper chemistry, paper strength, quality control, and permanence and should be referenced by any reader wishing to pursue this topic.

McKinney, editor of Technology of Paper Recycling and another expert on the subject wrote that "recycled pulp potential can be maximized by blending with virgin pulp had a disproportionately large effect in improving recycled pulp properties." It is important also to note that the "softwood to hardwood fiber mixture is within the 20-80% range normally utilized in the manufacture of printing and writing grades of paper. "That is to say the type of virgin pulp also has an effect on the end product. Additional fillers in the furnish of the paper have tremendous implications for chemical stability as well. The addition of calcium carbonate as a filler, economically advantageous to the paper producer also adds pigment for enhanced brightness and an alkaline reserve which will be shown in his report to provide the chemical stability required of permanent papers.

CHAPTER 3: MATERIALS AND METHODS

3.1 Paper Making processing Steps

Fig.1: Paper Making Processing Steps



3.1.1Raw Material Collection:

The raw material was the entire length banana waste Stem and recycled paper. Banana was collect from a Banana field in Dighalia, Khulna. Banana stem waste is thrown away by farmers after harvesting of fruits, is obtained as raw material The stem consists of layers which can be easily separated by hands. The Stem was chopped in small pieces of about 3-5cm. It was then dried in open sun light for 3 days and the Recycled paper collects from local market.

3.1.2 Chopping:

The stems are chopped into small pieces of 3-4 inch in size.

3.1.3 Digestion:

The material is soaked in 10% NaOH for appropriate period. The alkali loosens the ligno-cellulosic bonds, thereby softening the material.soda pulping were conducted to extract the fibers maintaining bath ratio at 1:8 and varying cooking time 2-3 h at boiling temperature 120-140^{0}c.It is digested under pressure free condition.

3.1.4 Washing

The softened material is washed with water to remove the black liquor of Sodium lignite and unused alkali.

3.1.5 Beating

The washed material is then subjected to beating. Beating is required for a getting good quality pulp, depending upon the quality of paper to be produced.

3.1.6 Storage

After beating, the desired pulp is produced which is then stored in storage.

3.1.7 Blending

Blending is needed to remove the aggregation of the pulp.It also helps to mix the pulp uniformly.

3.1.8 Paper Making

Paper is then making from the pulp of desired quality.

3.1.9 Drying

The wet papers are then allowed to dry in dryer at 100^0C at 20-25 minutes

3.2 Recycled Pulp Preparation

At first I collect the waste paper from the local market .Then it is cut in 2-3 inches and soaked into water for 2-3 dayes.Then I applied beating and washing. It removes the ink and chemical of the waste paper.Then I get recycling pulp from waste paper.

3.3 Sample preparation Method

In the study, I have compared banana pseudo-stem and recycled paper in different ratio like 100:0,75:25,50:50,25:75 and 0:100.From them I have found out the best quality producing paper.

3.4 Sample Testing and Analysis Method

Paper test is important to know the quality of the paper. I have applied Tensile strength test, Tear strength test and Brightness test.For testing I follow TAPPI (Technical Association of the Pulp and Paper Industry) method

CHAPTER 4: RESULTS AND DISCUSSION

Treatment:

Name	Banana : Rycled fiber
1. B-100	100:0
2. B-75	75:25
3. B-50	50:50
4. B-25	25:75
5. R-100	0:100

4.1 Physical Properties Test

4.1.1 Brightness Test

Treatment	Brightness
1	7.99
2	12.75
3	16.36
4	19.8
5	28.54

Anova: SingleFactor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	5	15	3	2.5
Column 2	5	85.44	17.088	60.1562

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	496.179	1	496.179	15.8381	0.00406	5.31765
Within Groups	250.625	8	31.3281			

Total	746.80	9

As the calculated value is greater than tabulated value. So null hypothesis is rejected and alternative hypothesis is accepted. There is significance difference among the treatment.

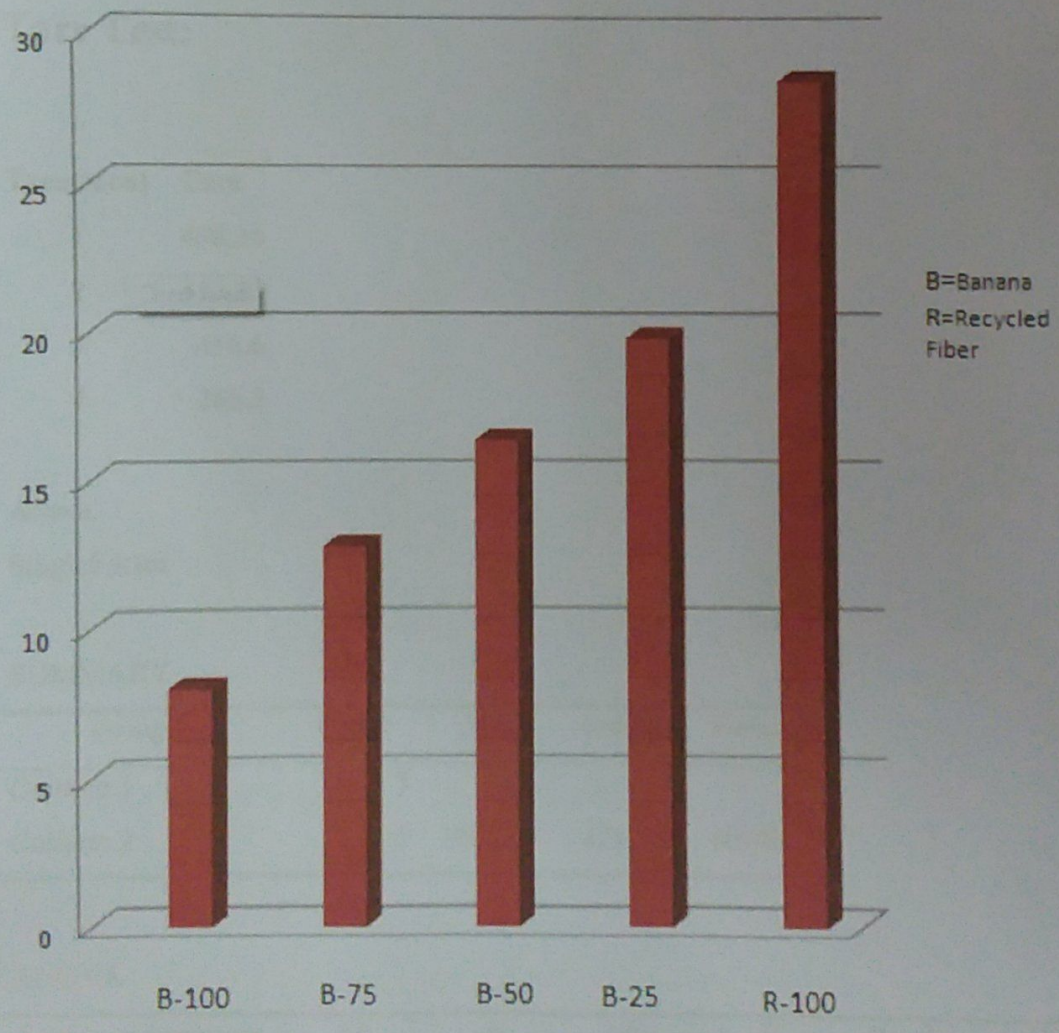


Fig:1-Brightness test among the treatment.

The graph shows that the brightness of R-100 is better than other treatments.

4.2 Mechanical Properties Test:

4.2.1 Tare Test:

Treatment	Tare
1	430.36
2	313.53
3	416.6
4	266.3

Anova:

SingleFactor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	5	15	3	2.5
Column 2	5	1607.69	321.538	10943.36

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	253666.1	1	253666.1	46.34926	0.000137	5.317655
Within Groups	43783.42	8	5472.928			
Total	297449.6	9				

As the calculated value is greater than tabulated value. So null hypothesis is rejected and alternative hypothesis is accepted. There is significance difference among the treatment.

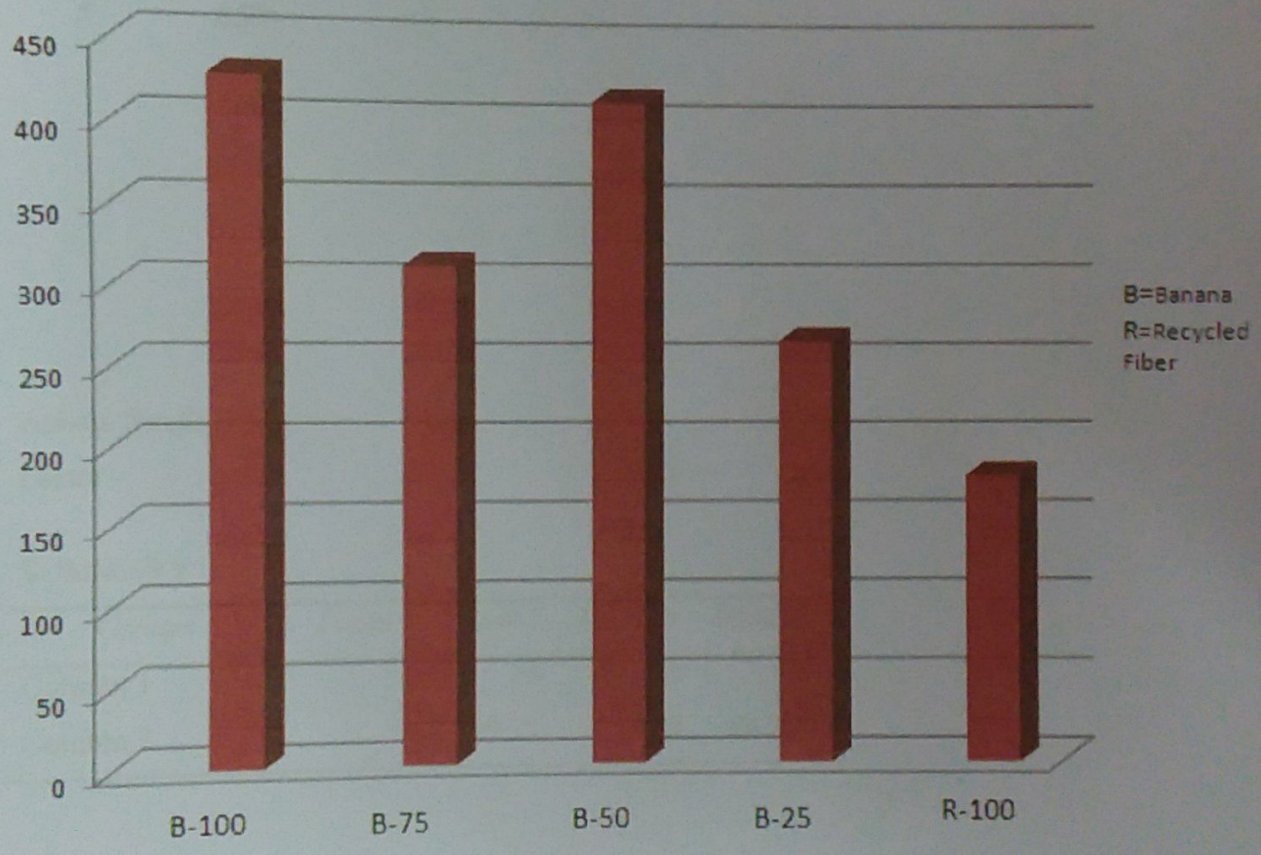


Fig:2-Tare Strength test among the treatment

The graph shows that the tearing strength of R-100 is better than other treatments,

4.2.2 Tensile Test

Treatment	Tensile
1	23.86
2	24.3
3	27.9
4	16.32
5	6.97

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	5	15	3	2.5
Column 2	5	99.35	19.87	69.7596

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	711.4923	1	711.4923	19.69267	0.002175	5.317655
Within Groups	289.0384	8	36.1298			
Total	1000.531	9				

As the calculated value is greater than tabulated value. So null hypothesis is rejected and alternative hypothesis is accepted. There is significance difference among the treatment

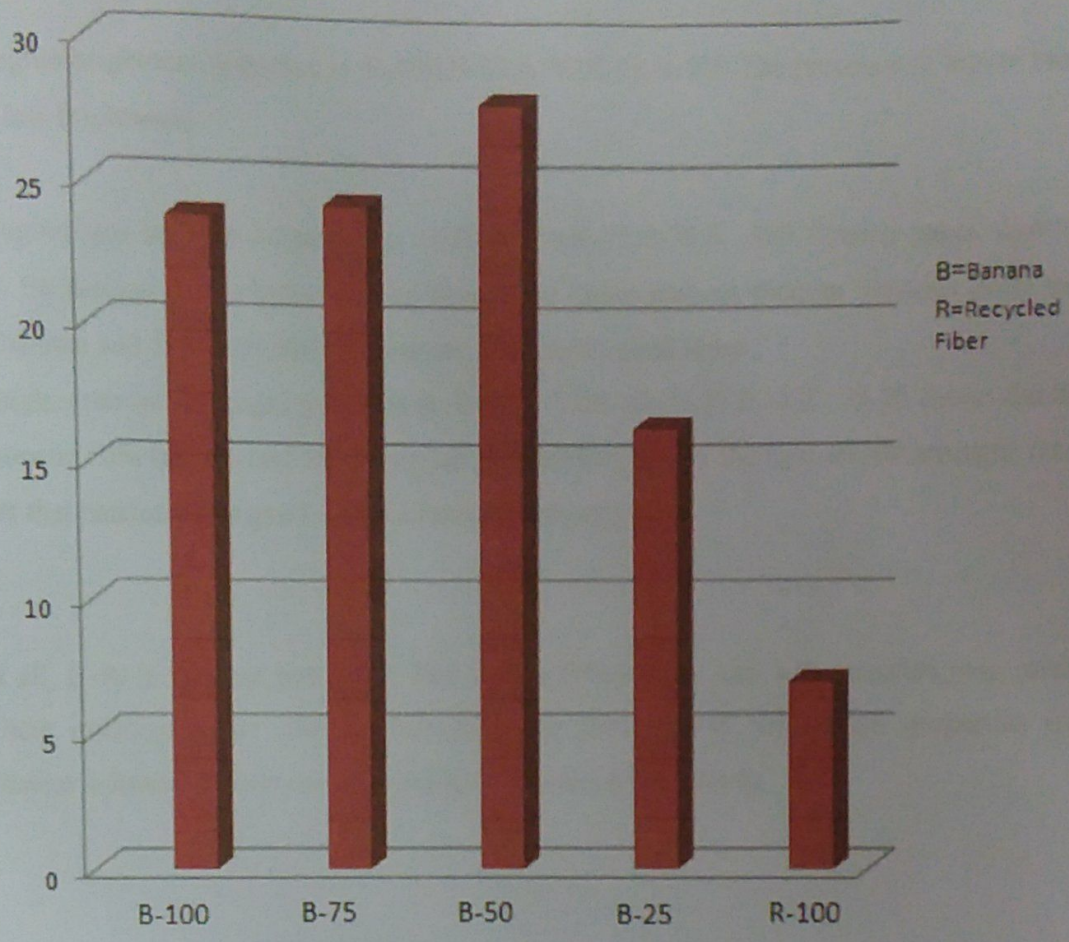


Fig:3-Tensile Strength test among the treatment

The graph shows that theTensile strength of R-50 is better than other treatments,

4.3 Discussion

The higher brightness sequence is R-100,B-25,B-50,B-75,B-100.The presence of higher banana pulp gives low brightness.

The higher tear strength sequence is B-100,B-50,B-75,B-25,R -100 Banana paper shows the best result. So banana shows better tearing strength of paper making process .Besides B-50 that means 50% banana and 50% recycled pulp mixing also shows good result.
The higher tensile strength sequence is B-50,B-75,B-100,B-25,R -100. B-50 shows the best result that means 50% banana and 50% recycled pulp mixing shows the best tensile strength result. Fig:3 shows that banana gives good tensile strength properties.

Over all, B-50 is the best treatment. That means 50% banana and 50% recycled pulp mixing gives the best qualities paper .Besides banana paper shows good mechanical properties though its brightness is lower. But we can improve its brightness by bleaching.

CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

The study shows that Banana stem which is currently wasted after harvesting fruits is good cellulosic source and contains very low content of lignin. This waste is also causes environmental pollution. The chemical composition of banana stem shows that banana stems which wasted, is a good raw material for Pulp and paper making industry. The pulping of banana tree residue with NaOH requires minimum heating conditions.

Paper recycling has been around as long as paper itself. Paper companies have always recognized the environmental and economic benefits of recycling. The paper industry is one of the largest water polluters in the world. Recycled paper reduces water pollution by 35%, reduces air pollution by 74%, and eliminates many toxic pollutants. In recent years, paper recycling has become popular with everyone as a way to help protect our environment by reusing our resources and conserving landfill space. Recycled paper production does use less energy, less water and creates less pollution.

As both banana and recycled paper is available, we can be easily used as raw material to make paper manufacturing. Thus the utilization of waste banana stem and waste paper help us to save our forest and decrease environmental issues. The using of 50% banana pulp and 50% recycled pulp mixing shows the best quality paper. So we can use it in industrial purposes.

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