# Morphological Differences between Ramie & Hemp

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### Morphological differences between ramie & hemp: How these characteristics develop different procedures in Bast fiber production industries

This paper focuses on the morphological differences between ramie and hemp; the former produced in Hansan County and the latter produced particularly in Andong County. Hansan is well-known for ramie and Andong is distinguished by hemp production. Hence, the fabrics produced in these regions are named after the regions. How differences between these plants and their fibers led weavers to develop the distinctive yarn-making processes of bast fibers will be discussed.


**Figure 1: Hansan and Andong, ramie and hemp producing areas in South Korea. Excerpted Rad McNally, Universal World Atlas, 1988.**

On the Korean peninsula (Fig. 1), Hansan County is located five to ten kilometers from the shore of the Yellow Sea on the west coast, and about 600m above sea level. Andong County

is located to the east, across the country from Hansan, and is surrounded by high mountains, 800m above sea level[1]. Consequently, there is more rainfall in Hansan County than in Andong County. Because Hansan County is on a lower latitude than Andong County[2], the Hansan region is warmer than Andong; also it gets stronger, warmer wind from the Yellow Sea. Summer begins earlier in June and warm weather stretches out until late September, which allows for three ramie harvests throughout the year in Hansan. Both regions have the same type of soil, to which cultivation of both ramie and hemp is well-suited.

Ramie and hemp are two major fibers among the other traditional fibers (cotton, silk, hemp, ramie, and wool) used in Korea. Ramie and hemp have a very long history of use, going back to as early as the first century A.D. In the past, both fibers were recorded as Ma, which means 'bast' fiber. However, starting in the ninth century, ramie fiber came to be differentiated from hemp fiber and it was given the name Jeo Ma – which means ramie in Chinese character[3]. The term, Ma, is still used to indicate hemp fabrics.

Ramie fabric, used for summer clothing, was enjoyed by the upper class, royal families, and scholars. Buried clothing made of ramie fabrics has been excavated from tombs along with silk shrouds and other burial garments. At the present time, ramie clothing is still appreciated as popular summer clothing in the countryside. However, one cannot avoid recognizing the decrease in the demand for ramie fabric. There are few people who want to continue the tradition of ramie fabric production, despite the fact that the government has been making a considerable effort to maintain the tradition and prevent its disappearance. On the other hand, hemp fabric was worn by the middle class and the lower class, such as people who worked as labourers in the fields. Hemp fabrics have also been used for funerary costumes and shrouds[4]. Funerary costumes made of hemp fabric continue to be used today, although this tradition is not being practiced in metropolitan areas. Shrouds made with hemp fabric were formerly used mostly by working class people; however since the 1960s, these shrouds have become popular once again, and now Korea is a big importer of hemp from China.

Ramie is a herbaceous perennial plant in the nettle family Urticaceae, native to eastern Asia. Its Latin name is Boehmeria nevea[5]. Ramie plants are cultivated from their roots. The plants spread either on their own by their roots, or by three to four year-old root cuttings which are then transplanted to other areas. The plants begin to sprout in the middle of March. At the end of the growing season, the ramie roots in the field are covered with rice hay to protect them from freezing.

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[1] Rad McNally, "Universal World Atlas", New Revised Edition, pp.33
[2] http://www.mapsofworld.com/lat_long/south-korea-lat-long.html
[3] Kil-ja Min, "Jeontong Otgam (Traditional Cloths)", pp.24
[4] Hamilton and Milgram, "Material Choices", pp.79-80
[5] http://en.wikipedia.org/wiki/Ramie

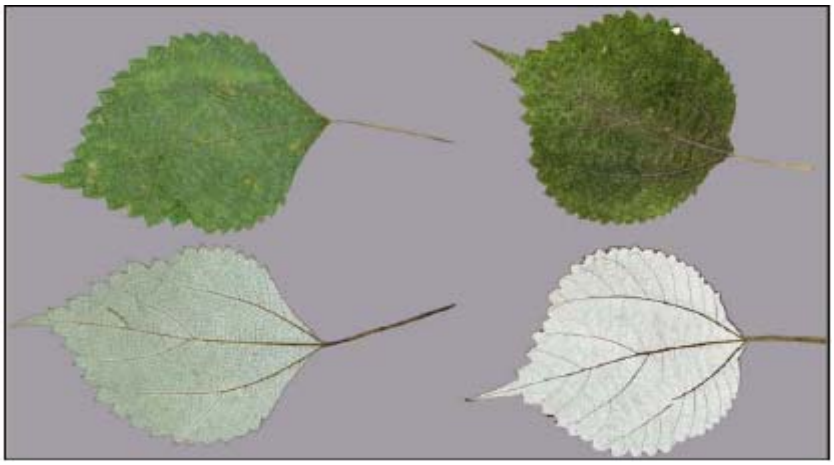

**Figure 2: (Left) Aboriginal ramie plant leaf. (Right) Hybrid ramie plant leaf. Image by author.**

In Korea, there are two kinds of ramie plants being cultivated today. One is the aboriginal ramie species and the other is a hybrid species which was imported in the 1960s[6]. (Fig. 2)

The aboriginal ramie's leaves are small and pointy. Its youngest leaves tend to have white hairs on the underside; however, the full-grown leaves do not have much of this white hair on the underside, and is as green as the upper side.

The hybrid ramie plants, on the other hand, have large heart-shaped leaves with much white hair on their undersides. These hairs reflect so much sunlight that when the wind blows, ramie fields can be recognized by the reflection of the leaves' hairs, even from 100-200 meters away. One interesting fact is that although ramie belongs to the nettle family, the dense small hairs on the undersides of the leaves do not sting.

In "The Textile Fibers", two different ramie species are described as existing in Asia. One is known as "green ramie" or rhea growing in the tropical areas of Asia, and the leaves are green on both sides. The second ramie species is "China Grass" or "white ramie" and it has large heart-shaped leaves covered on their undersides with white hairs[7]. Based on my observation of both plants, Korean aboriginal ramie has characteristics similar to those of green ramie, and the hybrid species fits the description of China Grass. The question of whether Korean aboriginal ramie is green ramie and the hybrid ramie is truly China Grass, or they are both China grasses but have developed differently, needs to be further researched and analyzed from a botanist's perspective.

In addition, the aboriginal ramie plants grow more slowly than the hybrids do. The stalks of aboriginal ramie are thinner and shorter than those of the hybrid ramie. In addition, their thinner and shorter growth pattern affects their weight and results in lower income for farmers.

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[6] Youngsook Kwon, "Hansan Mosi Jjaki (Hansan ramie weaving)", pp.30

[7] J. Merritt Matthews, Ph.D. "The Textile Fibers: Their Physical, Microscopical and Chemical Properties", pp.410

**Figure 3: Cloth woven with Aboriginal ramie plant fibers. Image by author.**

Beside the different physical growth pattern of the two ramie plants, the farmers wanted to cultivate ramie plants with fewer leaves. In botany, when the leaves fall or are removed at the nodes of the stem (or stalk), the plant reacts chemically, showing brown (dark) stains on the epidermis. This staining is called "leaf scar"[8]. Many times, these stains remain attached to the fiber layer as remnants of epidermis even after the epidermis has been scraped off, and may be misunderstood as stains on the fibers themselves. These stains become more noticeable when the fabric is woven. (Fig. 3) Natural and chemical bleaching procedures such as repeated exposure to sunlight, or chemical bleaching, do not completely remove these brown remnants of epidermis either. The more leaves the stalks of the ramie plant have, the more nodes the stalks will have. Farmers and weavers have detected more brown stains in the ramie fibers of the aboriginal ramie plants, which grow many leaves. Because of their many stains, these aboriginal ramie yarns became commercially less profitable, obviously another drawback to growing the leafy aboriginal ramie.

Since the Korean War (1950-1953), the demand for ramie fabric has increased and these two drawbacks became the main reasons for farmers to pursue the better plant variety. Therefore the hybrid ramie plants, which grow faster and taller with fewer leaves than the aboriginal ramie plants, have been imported since the 1960s and are more popularly cultivated than the aboriginal ramie species[9].

There is however one advantage to the aboriginal ramie plant. It is said that the fiber layers of the aboriginal plants can be split more finely than those of the hybrid ramie. In order to produce finer yarns for weaving finer fabrics, some weavers continue to use the native

[8] http://www.britannica.com/EBchecked/topic/333709/leaf?anchor=ref286336
[9] Youngsook Kwon, "Hansan Mosi Jjaki (Hansan ramie weaving)", pp.31

plants. At the present time, many ramie farmers have started to do business with clothing manufacturers who do not care about the quality of the plants. Farmers tend to leave the plants to grow as tall as possible because they are paid by weight and do not consider the quality of the yarn the plant will produce.

**Figure 4: Hemp plants and its seeds. Images by author.**

In contrast to ramie, which is a perennial plant, hemp is annual and dioecious (having a male and female plant) and is in the Cannabaceae family. Its Latin name is Cannabis Sativa[10]. It has been grown in Asia & the Middle East for more than 10,000 years. (Fig. 4)

Unlike the two kinds of ramie plant, there is only one hemp plant being cultivated in Korea. Hemp plants grow from seeds and unlike ramie, which grows in designated fields hemp is seeded in the rice fields or vegetable fields; the plants start to grow in late March or April, and are harvested in late June or July. Afterwards, rice or other vegetables seedlings are transplanted into these same fields. The farmers plant seeds close to each other for finer yarn production (thinner plants produce finer yarns). Eventually the plants are sorted by the thickness of their stalks and sold by the bundle, not by weight.

It is hard to pinpoint when and how people developed such different procedures for these two bast fibers. One can only imagine how farmers and weavers in the ramie and hemp industries learned the varied qualities of the two by handling them directly without any scientific knowledge. People must have understood the difference between ramie and

[10] J. Merritt Matthews, Ph.D. “The Textile Fibers: Their Physical, Microscopical and Chemical Properties”. pp.417

hemp plants and their fibers, by experimenting with various methods to find the best ones to maximize the productivity of the two fibers. I strongly believe that the yarn-making procedures of ramie and hemp were developed from a thorough understanding of their different characteristics, and to some extent, realizing each plant's unique morphology. When I got to this point in my research, I decided to approach the processes of ramie and hemp fiber-making by observing the morphological difference of ramie and hemp plants under the higher magnification of both compound and stereo microscopes to better understand why people use two distinct yarn-making methods to process these two fibers.

For this analysis, transverse sections of ramie and hemp stalks were studied. The ramie for this study was not decorticated; the hemp was steamed and not decorticated. Next, more than ten fiber samples of ramie and hemp were studied and analyzed longitudinally and in cross-section.

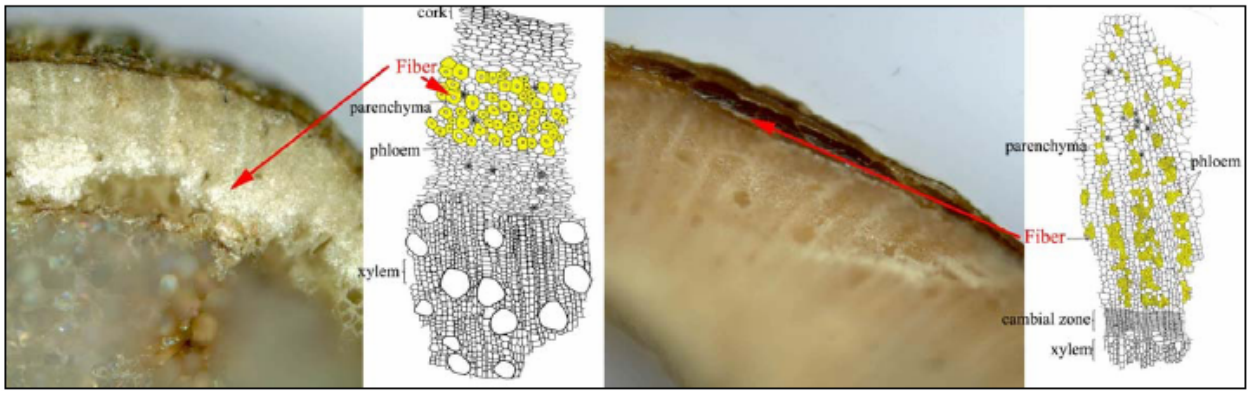


**Figure 5: (Left) Morphology of a ramie stalk. (Right) Morphology of a hemp stalk. Images by author. Diagrams excerpted from Identification of Vegetable Fibers.**

The cross-sectional image of the stalk shows that a ramie stalk is composed of pith, xylem (water transporting cell tissues), and phloem (living tissue and an inner layer of the epidermis), fibers with parenchyma (one of the ground tissues and capable of cell division), cortex (inside of the epidermis), and epidermis (bark). (Fig. 5) The diagram of ramie visibly shows that the large areas of fiber cells are distinguished from the neighbouring tissues and there are less concentrated ground tissues (parenchyma) between individual fiber cells in the fiber layers[11]. The hemp stalk in cross-section, on the other hand shows that the ground tissues (parenchyma and phloem) are closely associated with the fiber cells.

Longitudinal images of both fiber samples do not show much difference between the two. Both show irregularly spaced cross markings: some markings appear singularly and others are in multiples. Lumina of ramie fibers are more pronounced than those of hemp and can be clearly distinguished in cross-section.

[11] D.M. Catling and J. Grayson, "Identification of Vegetable Fibres", pp.20, pp.32

In the other hand, comparison of cross-sectional images of the two fibers shows how different these two fibers actually are.

The cross-sectional image of ramie fiber, with 200x and 400 x magnification, shows more clearly how an individual fiber cell is formed in the fiber layer. Each fiber cell is elongated, flattened, or curved into a crescent, and the lumina are visible. The cells are well-separated individually and many are not associated with other adjacent ground tissues. This composition creates easily separable fibers. Meanwhile, an examination of three month-old (immature) hemp shows that the typical hexagonal shape seen in the mature cells is not yet present. This mature cell structure is not developed in Andong hemp plants, which proves they are harvested at an immature stage. Many of the shapes show, with 200x and 400 x magnification that they are beginning to develop the characteristics of mature hemp cells, and some even display the layers of inner walls inside the cell. Immature hemp fiber cells appear somewhat similar to that of the ramie fiber cells. Most hemp fiber cells have slits like lumen. Individual cells are constrained by adjacent cells and are flush against each other with no space between, thus pressing them into irregular shapes. As mentioned previously, ground tissues, which are between fiber cells, are closely associated with fiber cells - to separate and to single out the fiber cells becomes more difficult[12]. (Fig. 6)

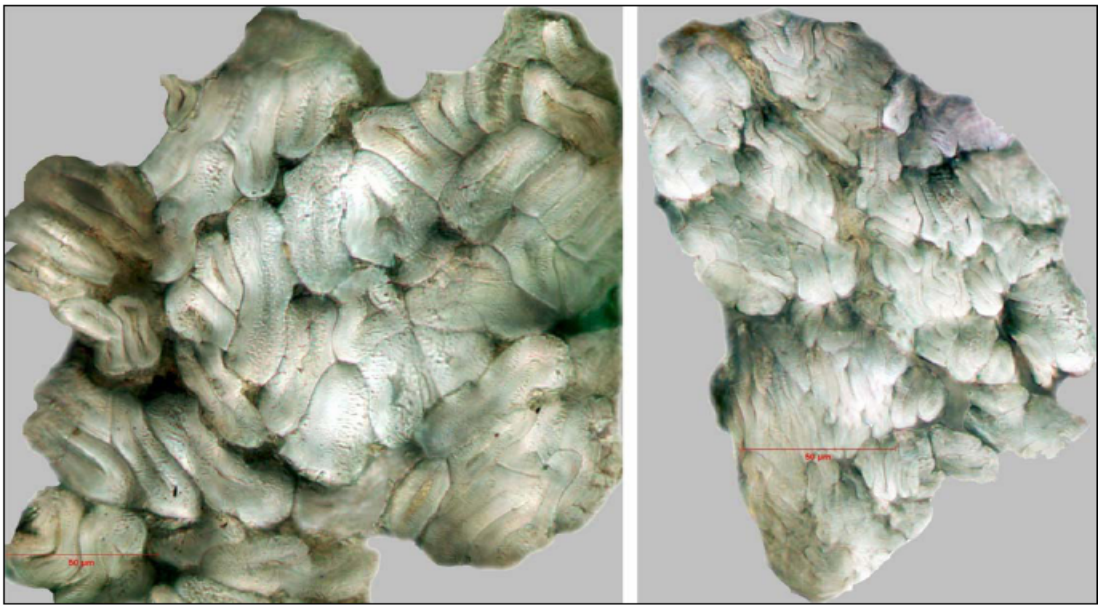

**Figure 6: Morphology of ramie (Left) and hemp (Right) fibers in cross-section. Images by author.**

These specific characteristics of ramie and hemp plants eventually led to the development of different processing techniques used by the two industries.

[12] D.M. Catling and J. Grayson, “Identification of Vegetable Fibres”, pp.22-23

The steps of ramie and hemp yarn-making and fabric production are summarized below and followed by in-depth explanations.

**Ramie**

1. Ramie stalks cut in the fields
2. Manual removal of leaves from the stalks
3. Decortication: Peeling the fiber layer from the pith, from the root end up to the tip
4. Scraping off bark from the fiber layers without using a board and sorting of the fibers by quality
5. Hanging to dry
6. Splitting:
    - Wetting, creating a fiber layer ball
    - Splitting the fiber layer with teeth, assisted by hands
    - Softening the root sides of the fibers to make them finer
7. Hanging to dry
8. Splicing to make yarn bundles, only one twist method
9. Warping: measuring the length of the warps to be woven
10. Reeding-in: threading warps in the reed
11. Starching: applying starch on the warps over low heat
12. Weaving
13. Bleaching the fabric (optional)

**Hemp**

1. Hemp stalks cut in the fields
2. Steaming the stalks: leaves are removed during the steaming (no manual leaf removal necessary)
3. Drying the stalks
4. Retting small quantities of dry stalks for 5-7 hours
5. Decortication: Peeling the fiber layers from the stalk from the direction of the root up to the tip
6. Scraping off bark from the fiber layers on a board and sorting of the fibers by quality
7. Hanging to dry
8. Splitting:
    - Wetting, creating a fiber layer ball
    - Splitting fibers using the right thumb with the long fingernail
    - Softening the root sides of the fibers to make them pliable and finer
9. Hanging to dry
10. Splicing to make yarn bundles
11. Warping: measuring the length of the warps to be woven
12. Reeding-in: threading warps in the reed
13. Starching: applying starch on the warps over low heat
14. Dressing the loom and weaving

15. Bleaching the fabric
16. Dyeing yellow with gardenia seed pods

From these summarized steps of ramie and hemp fabric production, there are several procedures to be emphasized in relation to the different morphologies of the two fibers.

The first difference in the fiber-producing process is that ramie stalks can be decorticated without steaming or retting. The epidermis with the fiber layer can be peeled off the pith without any special technique. In contrast, hemp stalks must be steamed and retted in order to remove the fiber layers from the pith. Steaming hemp stalks in a closed chamber dissolves much of the pectin and cellulose fibers in the stalks, which eventually helps in splitting and separating the fiber layers[13].

After the steaming and retting, decorticating the hemp fiber layers is actually easier than decorticating ramie. However, it is still easier to separate the fiber layers from the epidermis of ramie than from that of hemp due to the morphology of ramie that was mentioned earlier.

**Figure 7: Scraping off the epidermis from the ramie (Left) and hemp fiber layers (Right). Images by author.**

To separate the epidermis from the ramie fiber layers, the weaver folds the decorticated section, with the fiber layer up, over a small knife – blade edge facing up. Then the decorticated section is pulled across the knife edge to remove the epidermis. It is important to scrape the section in one movement, as stopping in the middle will stain the fiber layer. The epidermis of the hemp, on the other hand, is difficult to separate from the fiber layer because the ground tissues are well associated with the fiber cells. A special scraping skill and quite a bit of force is required. The epidermis is first laid on a board with the fiber layer

[13] http://www.ili-lignin.com/aboutlignin.php

facing down. While being pressed by the blade, the fiber layer is yanked in one movement and the epidermis is scraped off. (Fig. 7)

For both ramie and hemp, when the fiber layers have been prepared for splitting, they are wet and are wound up around the left thumb in a ball shape; the splitting then takes place layer by layer. One interesting thing I want to point out in this process is the different splitting methods.

To split Ramie fiber layers, the four front teeth – upper and lower – are used. Of the eleven weavers I interviewed, ten needed tooth implants as a result of splitting the ramie fiber layers in this way over decades. For splitting hemp, weavers keep their right thumbnail long to use as a splitting tool.

In splicing the ramie strands, one strand with the tip end and the other with the base end (which is 1/3~1/4 of the length of the tip), are combined and twisted slightly in a Z-direction. The twisted segment is then folded down toward the side of the base end of the second strand and twisted again in an S-direction. Because the base end twisted in a Z-direction with the tip end is much shorter, it is barely visible when the splicing is complete.

When hemp strands are spliced, two methods may be used[14]. The primary splicing method begins with splitting the tip end of a strand. Next the base end of a second strand is inserted between the two split ends of the first strand. The base and one of the split tip ends are put together and twisted in a Z-direction. Last, these Z-twisted ends and the other tip end are twisted together in an S-direction. The secondary splicing method is very similar to that for splicing ramie. The only difference is that the same length of the tip and the base ends of two strands are combined and twisted. This creates thicker joins and uneven yarns, which is not desirable for weaving. This secondary splicing method is used only to reconnect yarns broken during warping or weaving. (Fig. 8)

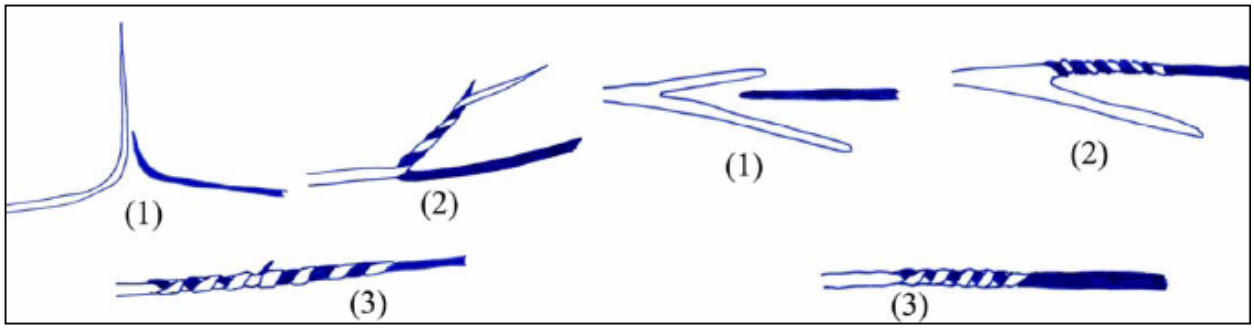


**Figure 8: (Left) Ramie splicing. (Right) Hemp splicing. Diagrams by author.**

[14] Hamilton and Milgram, “Material choices”, pp.83

Splicing both fiber yarns involves rolling the strands on the worker's thigh or a custom-made stand wrapped with plastic sheeting or fabric.

After splicing the fiber strands to produce yarn bundles, the warping, reeding-in, starching, and weaving of both fibers take place in the same general manner; however there are variations applied to each fiber yarn because of their different characteristics.

Rice bran is used to warp the ramie yarn bundles. The bran's natural oil helps the strands pull out smoothly from the yarn bundles and also makes the yarn heavy enough to weigh down the yarn bundles. Hemp yarns, by contrast, which are split thicker than ramie yarns, are too heavy to be weighed down by rice bran; therefore sand is used instead.

**Figure 9: (Left) Starching ramie yarns over a gas-heated metal plate, Hansan. (Right) Starching hemp yarns over burned rice husks, Andong. Images by author.**

For starching the warped yarn bundles, it is interesting to see different materials being used on ramie yarn and hemp yarn to achieve the same effect: Finely ground soybean paste with salt is used for ramie. For hemp, fermented soybean paste with cooked millet grain is used. The soybean paste does not need to be removed from ramie after the weaving, whereas hemp fabrics must be washed when weaving is complete, to remove the soybean paste/millet mixture. (Fig. 9) In addition, the starching process of ramie yarns in Hansan is conducted over a gas-heated metal plate, which is built into the ground, and the yarn bundles are set on the rail track. As the weaver cranks up the fabric bolt to wind the starched yarn bundles on it, the yarn bundles are automatically pulled towards the weaver. The whole mechanism enables one weaver to perform the starching process alone. On the contrary, with hemp, continuation of the traditional starching method over burning rice husks is observed in Andong and the fabric bolt and the yarn bundles have to be manually handled, requiring at least two people for starching. The weaving of both ramie and hemp fabrics is done in the same manner.

**Figure 10: Ramie production area: outside and inside of the building. Images by author.**

There is, however, one significant difference between ramie and hemp production and that is the location where the yarn-making and the weaving process are conducted. In the ramie industry, all the activities take place indoors. Although the tensile strength of ramie is slightly higher than that of hemp, ramie is more vulnerable to dry air because ramie yarns are much finer than hemp yarns[15]. As a result, weavers, who perform warping, starching, and weaving where yarns are under tension for the entire time, work in a designated space that is set apart. In particular, ramie becomes much stronger when it is wet[16], so the space must not only be humid, but also must have a constant level of humidity, provided by a humidifier. Traditionally, weavers kept their looms inside a cave for weaving[17]. Now, they find a space at the bottom of a hill and build a structure into the hill so that the work area is partially buried in the ground, in order to keep the space naturally humid. (Fig 10)

Ramie fabric is bleached and sold as white fabric, whereas hemp fabric is bleached and then dyed yellow with gardenia seed pods.

The morphological characteristics of ramie and hemp fibers affect the yarn-making processes as mentioned earlier. They also influence the type and the quality of yarns and therefore the final product - the cloth.

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[15] Milton Harris, Ph.D. “Handbook of Textile Fibers”, pp.135-138
[16] Milton Harris, Ph.D. “Handbook of Textile Fibers”, pp.135-138
[17] Youngsook Kwon, “Hansan Mosi Jjaki (Hansan ramie weaving)”, pp.141

In conclusion, ramie yarns, which are less processed than hemp, produce an exquisite quality cloth, which has been nationally appreciated as summer clothing. Hemp cloth, which requires more processing, labor, and time than ramie cloths, has limited demand in the market place – though demand is decreasing rapidly for ramie as well.

One thing these two fibers have in common is that yarn-making and fabric production in both industries will cease to exist in 20 to 30 years because those workers and weavers are over 60-70 years old, and there are only a few young ones starting out.

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