UBC Social Ecological Economic Development Studies (SEEDS) Student Report

Rapidly Renewable Materials:
Wool And Cork

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ABSTRACT

This report presents an investigation into the feasibility of using two rapidly renewable materials, cork and wool, in the new student union building. The prime objective of this report is to analyze these materials in terms of their economical factors, environmental factors, and social factors. This analysis is also referred to as triple-bottom-line assessment.

Rapidly renewable materials (RRMs) are materials that can be regenerated within ten years. The short generation cycle make these materials significant in the LEED qualification. It is believed that using RRMs can reduce our demand on finite raw material and thus, promote the sustainable development.

In the following paragraphs, the cost effectiveness, environmental impacts, and social impacts of cork and wool are discussed. Comparison between RRMs and alternative materials are presented. We are confident that the valuable information elaborated in this report will help the shareholders of the new student union building make appropriate decisions pertaining to the use of construction material.

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LIST OF ABBREVIATIONS

RRMs – Rapidly Renewable Materials

LEED – Leadership in Energy and Environmental Design

FAO – Food and Agriculture Organization

VOCs – Volatile Organic Compounds

1.0 INTRODUCTION

Rapidly renewable materials (RRMs) are products that are made from animals and plants, which can be harvested within a ten-year life cycle or less. A few examples of these RRMs are: bamboo, straw, cotton, cork, wool, wheat board, etc. These materials are considered sustainable because of their rapid regeneration. Leadership in Energy and Environmental Design (LEED) found significance in these sustainable materials. Implementing these materials in a building will qualify for various LEED credit. The idea is that these products have a short life cycle and using them does not deplete the finite raw material. This is only one of the many sustainable characteristics of RRMs. A triple-bottom-line analysis will be done for wool and cork. This report will focus on the environmental, economic and social impacts of wool and cork, and their advantages and disadvantages.

This report divides into the following primary sections:

- Wool
- Cork
- Conclusion

2.0 WOOL

Wool is harvested through shearing live sheep with the use of a powered hand clipper or a blade shear. It is harvested once a year depending on the type of wool. The wool is separated into four main categories: fleece, broken, bellies, and locks. This is done by a technique known as wool classing. Before the wool can be used for commercial purposes, the wool must be cleaned. Scouring is the process of washing wool in warm water and detergents to remove the contaminants, and then drying it. In industrial applications, detergents, alkali and special equipment are used.

2.1 ENVIRONMENTAL IMPACTS

Wool is a rapidly renewable resource. It has environmental impacts that ranges from beneficial to benign to highly destructive. These negative impacts may be reduced through changes in management practices. Factors that need to be considered are: pesticide treatments of the flock, sheep farming maintenance, chemical treatments of the wool.

2.1.1 Sheep Farming Maintenance

Sheep farming can negatively impact the soil environment through trampling causing wide-scale land degradation. According to the Food and Agriculture Organization of the United Nation (FAO), overgrazing and compaction cause 20% of

pastures considered as degraded. In addition, FAO also stated that livestock uses 30% of the Earth's land surfaces. [1] This can be reduced through maximization of land usage and better livestock management. On the other hand, litter from the sheep can act as a fertilizer and enhance the nutrition of the soil.

Sheep is part of the ruminant family thus their manure emits methane gas (CH_4), which is a greenhouse gas that is 21 times more potent than carbon dioxide (CO_2). [2] This has a negative effect on the gaseous composition of the atmosphere around the farms. Sheep urine also produces ammonia (NH_3) that contributes to acid rainfall. By improving the sheep's diet, methane gas emissions produced by the sheep can be reduced. Setting up biogas plant initiatives to recycle manure can also help reduce the impact.

2.1.2 Pesticide Treatments of the Flock

Sheep are often treated with insecticide and fungicide to ward off lice and ticks. Studies done in the United Kingdom show that pesticides used on sheep causes damage to the nervous system of workers that have been exposed to it. Long-term exposer also causes reduced bone formation. Without proper disposal or if used incorrectly, these chemicals can cause contamination to groundwater. Proper irrigation and sewage systems will reduce environmental risk factors. Also, reducing large-scale livestock concentration close to cities will reduce the human risk factors. [3]

2.1.3 Chemical Treatments of the Wool

Cleaning wool takes a large amount of water. In addition, highly toxic dyes and chemicals are used to mothproof harvested wool. This may cause health problems as well as produce waste matter. [4] Improper disposal of this contaminated water may lead to further contamination of rivers, and run the risk of destroying marine life. A proper irrigation system is needed to prevent the spread of waste matter to rivers and underground water.

2.1.4 Transportation

Transportation plays a vital role in the analysis of environmental impact. There are numerous sheep farms around Canada, one of which is located in the Frazer Valley in BC. The close distance saves a significant amount of energy and fuel during transportation. Also, very little energy is required to produce wool. [5]

2.1.5 List of Environmental Advantage and Disadvantage

The following are some of the major advantage of wool. [6]

- Natural, renewable and sustainable
- Abundant available source
- Sheep's are able to graze on dry, unusable land
- Able to absorb and retain Volatile Organic Compounds (VOCs)
- Natural fire retardant and antistatic
- Easily cleanable

- Biodegradable
- Reusable and recyclable
- Requires only a fraction of energy to produce compared to that of man made counterparts
- Multiple layered wool fibers effectively reduce airborne sound transfer and noise pollution

The following are some of the major disadvantage of wool. [6]

- Often involves the use of pesticides and fertilizers
- Sheep farming can degrade the land
- Wool scouring can consume large amount of water and chemicals, and produce heavily polluted waste-water
- Insect-resist / mothproofing treatments may cause health problems as well as producing effluent, toxic to aquatic life
- Often involves the use of water polluting, heavy metal dyes.

These negative impacts can be reduced through better management systems that can be put into practice. Comparing with the alternative, maintenance of cotton farm requires a lot of fertilizers and requires the use of nitrates. This releases greenhouse gases to the atmosphere also. In addition, pesticides are also used in cotton farm and it requires a large amount of water for irrigation.

2.2 ECONOMICAL IMPACTS

Wool products in the construction industry are getting more popular. The environmental benefits of wool are being realized, and builders are trying to find new ways to incorporate it into buildings. One of the most common uses for wool in construction is insulation. Incorporating wool insulation into the new SUB will help increase the amount of LEED credits the building earns.

2.2.1 Insulation Efficiency

Insulation efficiency is measured in R-values. R-value is a measure of the thermal resistance of building materials. It is the ratio of temperature difference across an insulator. The higher the R-value of an insulator, the better its insulating property is. [7] The R-value of wool insulation is 3.5 to 3.8 per inch of material thickness. Fiberglass insulation on the other hand has an R-value of 3.2 per inch of material thickness. These values vary depending on the quality of the insulation. On average wool insulation will have an R-value about 0.3 to 0.6 points higher than that of fiberglass insulation.[8]

Wool insulation also has other benefits as an insulator when compared to the alternatives. It has the ability to absorb 30 – 40% of its own weight in moisture without affecting its insulating qualities. As wool absorbs moisture in winter, it releases heat into its surroundings, thus providing a warming effect in winter. [8] In

the summer, the wool insulation releases the moisture trapped in it and cools its surroundings. This feature greatly reduces heating costs during winter and cooling costs in the summer. Wool insulation also acts as a sound insulator and can help make the walls more fire resistant.

2.2.2 Material and Installation Cost

In the lower mainland of British Columbia, the minimum code requirement for insulation is R-20 in the walls and basement walls, and R-40 in the ceiling. [9] This means that you would require approximately 6-inches of wool insulation in the walls and 12-inches in the ceilings. Wool insulation is available as a batch or a rope. Ropes are used to insulate around doors and windows and are sold in rolls. They cost about $0.75 per foot. Batches are used to insulate walls and ceilings. They are available in rolls of 16-inches or 24-inches wide with an R-value of 19 and cost approximately $2.40 per square foot. [10] The price of the insulation usually includes installation costs, so you don't need to spend extra for installation.

Figure 1 Batch of Wool Insulation

Fiberglass insulation with an R-value of 19 will cost a lot less than wool insulation. The average cost for fiberglass is $0.75 a square foot installed. Wool insulation costs three times as much as fiberglass insulation, but its ability to cool and warm the surrounding area can greatly reduce heating and cooling costs.

2.2.3 Maintenance and Recycling

Wool insulation is maintenance free. There is no regular maintenance required if it is installed correctly. If there is moisture build up between walls, wool insulation will be able to withstand this without affecting its insulation properties. Wool can last for thousands of years without the need for treatment. Fiberglass insulation on the other hand is very susceptible to water damage. If fiberglass comes into contact with water, it compromises its insulating property. The lifetime of fiberglass insulation is also very good if it is installed properly. It has the ability to last as long as the house itself, but the air pockets within the insulation decreases thus reducing its R-value.

Wool insulation is 100% recyclable and does not go to waste. Recycled wool insulation gets used to make new insulation, as well as carpets and clothing. It can be recycled for only a few hundred dollars and it takes very little energy to recycle wool. [11] Wool recycling involves breaking apart the wool fibers and then washing it with a disinfectant before sending it out to be reused. Fiberglass insulation is not recyclable and therefore all of it goes to waste once it has reached its useful lifetime.

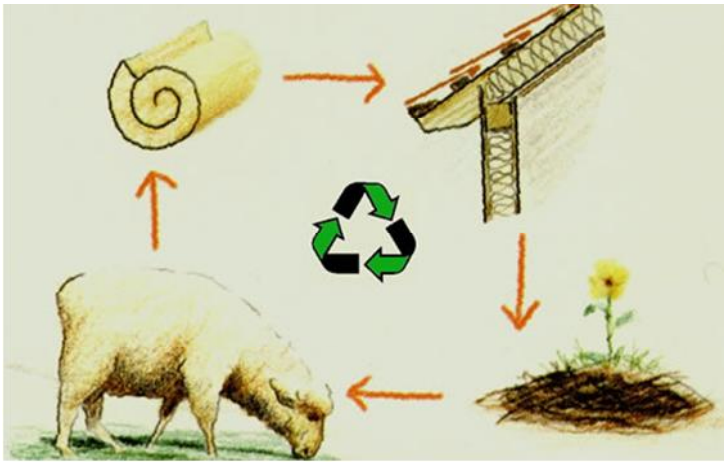

Figure 2 Life Cycle of Wool Insulation

2.3 SOCIAL IMPACTS

Wool is one of the oldest RRMs used in human history. However, unlike cork, which has a prominent reputation, the wool industry has caused a huge controversy in the past decades. In the following paragraphs, we will study wool's impact on human health, and some disputable issues regarding the sheep farms.

2.3.1 Impact on Human Health

Wool is commonly used inside buildings as carpet or wall insulation. Therefore, it has huge influences on the indoor air quality. In fact, many researchers and studies indicate that wool insulation, and other wool products can improve the indoor air quality by trapping pollutants.

Recently, the most common indoor pollutants are combustion products, such as sulphur dioxide, nitrogen oxide, and formaldehyde, which is often used in resin-based wood products and other building material [12] Emissions from cooking and heating with gas or solid fuels can further contaminate the indoor air. These unwanted particles and gases might cause respiratory diseases in occupants. However, there is reasonable evidence showing that the wool carpet can trap these particles due to its special physical structure. New Zealand researchers, using a purpose-built controlled environmental chamber, have demonstrated that wool carpet can reduce high levels of introduced formaldehyde to virtually zero in 4 hours. [13] Similar experiments were also done by the US Gas Research Institute. Their results also prove that wool carpet can absorb a significant amount of nitrogen dioxide. [14]

2.3.2 Controversy in Sheep Farm

Sheep farms are the only source for the wool; therefore, the welfare of the sheep is also studied in our report. Based on our investigation, we found that the sheep farms are becoming more and more controversial today due to the high death rate of sheep.

A tremendous amount of documents indicate that the condition of the sheep farms in Australia, the largest exporter of wool, is terrible.[15] It is reported that Australia exports more than three million live sheep to other countries around the world. In

some trips to the Middle East, sheep have to endure extremely high temperatures of up to 45 degrees Celsius. High temperatures and poor ventilation in the cargo tank often encourage diseases to spread quickly among sheep and kill thousands of them. The situation of sheep in the Australian sheep farms is also terrible. Evidences have emerged showing that sheep are suffering from inhumane treatment and are being slaughtered in the farms.

2.3.3 Local Sheep Farm

Canada is also one of the largest wool exporters in the world. The wool industry is an important element in the Canadian economy. It is estimated that thousands of tons of wool, which accounts for 70% [16] of Canadian wool production, are exported to China and India for clothing manufacture and generate an annual profit of several million dollars.

Through our investigation, we also found that the situation of sheep in BC is much better than the sheep in Australia. Many regulations have been enforced to ensure the welfare of sheep. The BC Sheep Federation, the representative of the local sheep industry, also has policies to encourage the sustainable development in the wool industry.

3.0 CORK

Cork is another rapidly renewable material. Cork oak trees are harvested every nine years without damaging the trees and the environment. Harvesting cork is done entirely by hand and requires no modern machinery. This is better for the health and preservation of the trees and also uses less energy and produces less pollution during the harvesting process. During the harvest, only a small percentage of the bark from the cork oak tree is removed to retain the protection of trees during regeneration. When harvesting cork, not a single tree is cut down.

3.1 Environmental Impacts

Cork oak trees have proven biodiversity, environmental and ecological value. Producing cork does not have a significant negative impact to the environment and it leaves minimal ecological footprint. In fact, cork oak trees help reduce greenhouse gases and prevent global warming. It also plays a vital role in safeguarding a wide range of habitats. Key factors of cork oak trees and cork production that play an important role in the environment are: carbon sink, soil conservation, wildlife habitats, and transportation. [17]

3.1.1 Carbon Sink

Cork oak trees act as a carbon sink. The effects of global warming and the impacts of climate change are already visible. Cork oak trees play a key role in trapping carbon with its unique cell structure, which reduces the global warming effect. It also produces oxygen through photosynthesis. A study done by the School of Agronomy concluded that an area of 2.2 million hectares of Mediterranean cork forest acts as a carbon sink for 14 million tones of carbon dioxide yearly. On average, 5.5 tones of carbon dioxide are emitted from a typical passenger vehicle. [18] This equates to 2.5 million cars being compensated for by the cork trees.

3.1.2 Soil Conservation

Cork oak trees also play a vital part in preventing wind erosion and increases the rate of at which rainwater infiltrates and replenishes groundwater. In addition, cork oak trees also reduce soil erosion by reducing the amount of water run-off.

3.1.3 Wildlife Habitats

In a cork oak landscape, such as The Mediterranean Basin, is a home to thousands of plants and animal species. It is an ideal winter habitat for migratory birds. It also protects endemic wildlife and endangered animals. [19]

3.1.4 Transportation

Cork oak trees are mainly found in Mediterranean areas and the manufacturing of cork is mostly done in Europe. This causes a significant amount of energy and fuel to be used during shipping. Since manufacturing of cork uses a low amount of energy, it compensates for the transportation energy consumption.

3.1.5 List of Environmental Advantage and Disadvantage

The following are some positive impacts of cork or cork flooring [20]

- Natural, renewable and sustainable
- Uses less carbon and chemicals in its manufacture
- Excellent heat insulation
- Cork flooring has a 50-100 years life span
- Reduces sound pollution
- It absorbs impact upon landing
- Does not off gas or shed microfibers
- Natural moisture, mold, rot, insect, and bacteria resistant
- Recovers from compression
- Recyclable
- Easy to clean and maintain
- Flame retardant

The following are some negative impacts of cork or cork flooring [20]

- Only production is in Mediterranean places
- Fades in direct sunlight
- Interacts with climate condition (High humidity causes cork flooring to be more spongier)

Choosing to buy cork products helps the survival of cork oak trees, which reduce the greenhouse gases, improves the environment, and protects the habitants of wildlife. Producing cork flooring is more environmental friendly compared to bamboo or hardwood flooring. Growing bamboo sometimes require the use of fertilizers and a large amount of land are cleared to make room for planning bamboos. Hardwood floorings are made from trees. Manufacturing hardwood will require cutting down of trees, unlike cork, which does not require trees to be cut down. Harvesting cork does not damage the tree, and there are no pollutions and greenhouse gases associated in the production of cork with the exception of the shipping process.

3.2 ECONOMICAL IMPACTS

The leading use of cork in industry today is for making whine corks stoppers. Almost 70% of cork being produced in the world today gets used to make cork stoppers. According to cork importers, $1.1 billion in raw cork sales go directly into the production of cork stoppers, whereas all other combined uses only represent $400 million dollars. [21] Although very little cork is used to produce products other than cork stoppers, it still has many important uses. These include clothing, furniture but most of all flooring. Cork flooring is mostly made of 100% recycled cork and can be a good way to incorporate rapidly renewable materials into the new sub building.

3.2.1 Benefits of Cork Flooring

Cork floors have many properties that give it some advantages over hardwood floors. Cork floors are softer when compared to hardwood and they have many tiny air pockets trapped within them. These air pockets allow the cork floors to have good thermal insulation and sound proofing. Cork floors are not susceptible to damage. They can resist denting and scratching because of its elastic like property. Cork flooring can compress up to 40% and still come back to its original shape. [22] It is also resilient to water damage, mold, mildew and pests. The aesthetics of cork flooring is also very pleasant. They are available in many different shapes, colors and sizes. Another bonus property that cork floors have is that they are very comfortable to walk on. It feels like walking with running shoes on because it is really soft and has some give.

Figure 3 Cork Floor

3.2.2 Material and Installation Costs

Cork floors are available in many different shapes, sizes and patterns; therefore there is a wide price range for this product. The cost of cork flooring can be anywhere from $2.00 a square foot to $5.00 a square foot. [22] The prices can be higher depending on the quality and the type of cork being used. This is not very expensive when comparing it to hardwood and bamboo floors. Hardwood and bamboo floors are in the same price range as cork flooring and can be purchased for $2.00 to $5.00 a square foot. The savings are more evident in installation costs. Installing cork flooring can be a very easy DUI project. It easily sits on top of any type of sub floor and is really easy to cut and shape. Hardwood floors may need professional installation if you are not very handy. Depending on the cost of labor, installation of hardwood floors can cost anywhere from $2.00 to $3.00 a square foot. If you do decide to get the cork floors professionally installed, it will cost $1.00 to $2.00 a square foot because less labor is required to install them.

3.2.3 Maintenance and Recycling

Cork flooring does not require regular maintenance or re-finishing and only costs $100 to $200 dollars to maintain. If taken care of properly, cork floors can last indefinitely. The only required maintenance is mopping with a damp mop once a month to prevent the cork from fading. Keeping the surface clean by regular sweeping and vacuuming can also prolong the life of the floor. Hardwood floors

have to be sanded and stained every 10 to 15 years. They only have a lifetime of approximately 30 to 50 years and will need replacement [22]. Over its lifespan, hardwood floors will cost a lot more to maintain than cork flooring.

Cork is a 100% recyclable material. Most cork floors are recycled back into newer cork floors. There is a cork-recycling program here in Canada that takes back old cork and recycles the cork into its raw product and is sold to flooring companies at a very low price. Recycled cork costs $0.75 cents per pound and when compared to the raw material, it is a lot cheaper. This helps keep the cost of new cork flooring low and competitive with hardwood and ceramic flooring. Hardwood floors cannot be recycled and most of them end up in the landfills or get incinerated. If the hardwood has not been treated with any type of chemicals, they can be composted, but it is rare to find untreated hardwood flooring.

3.3 Social impacts

As one of the well-known RRMs, human has harvested cork for over one thousand years. Currently, 99% of the cork productions are from the Mediterranean and most of the cork becomes wine stoppers, which accounts for 66% of the revenue in the global cork industry Cork is getting its popularity in the construction industry due to its thermal insulation and other physical properties. The waste from the manufacture of the wine stopper can be manufactured to flooring material. To study

cork in the social perspectives, we will focus on cork product's' impacts on human health and local industry.

3.3.1 Impacts on Human Health

Cork harvesting has been going on for over one thousand years. The method used to harvest bark hasn't changed all that much [23]. Nowadays, harvesting is still done by hand with specially designed axes. To meet the increasing demand of cork, thousands of workers are hired to peel bark in the harvesting season. In this human labor-intensive industry, the safety and working environment of workers become our priority concern. Through our investigation, we found that most countries that produce cork are developed countries in the Euro. They tend to have high standards for working safety and working environment. Workers are well protected and undergo comprehensive training before they start working. These procedures not only significantly reduce the workers' risk of getting injury but also minimize damage to the cork trees due to inexperienced workers. Besides putting in effort to prevent work place accidents, the cork industry also tries to protect their employees from getting occupational diseases. During the process of agglomerating the cork, binders are added to hold the ground cork granules together. High VOC chemicals, such as Urea Formaldehyde (UF), were used in the past. Scientific evidences show that people working in environments with high VOC levels have a higher chance of getting respiratory disease. [24] And today, in order to minimize the VOC

concentration in the work place, low VOC chemicals, such as Urea Melamine (UM), Phenol Formaldehyde (PF), are more commonly used in the industry [25]

In addition to cork's impacts on workers' health, we also study cork product's impacts on the health of occupants. Cork does not off-gas or shed microfibers and is naturally moisture, mold, and rot resistant. [25] Using cork flooring can help improve the hygienic of the interior environment. Cork is highly abrasion resistant on its own, but minor routine maintenance, such as mopping, is needed to maintain its durability. Using standard chemicals might introduce a large amount of VOC into the air. It is recommended to select low or non-toxic products for these purposes. [25]

3.3.2 Impacts on Local Industry

As we mentioned above, cork only grow in the Mediterranean. Therefore, all the cork farms and cork manufacture companies are located outside of Canada and don't offer direct job opportunities to our local community. However, with our increasing demand for natural and non-toxic cork products, importing cork from Euro has become a prosperous business, which creates thousands of jobs in transportation and retail.

4.0 CONCLUSION

Rapidly renewable materials are just starting to be discovered and recognized as sustainable products. Using cork floors can be a great way to incorporate rapidly renewable materials into the design of the SUB building. Cork floors are really sustainable and are mostly made of recycled cork stoppers from whine bottles. It costs the same as hardwood and ceramic floors but have many benefits that make cork floors more superior than its alternatives. Cork floors will give the building a unique look and requires very little maintenance. It is also mold, mildew and pest resistant, thus making it ideal for high traffic areas.

Using wool insulation would be a great way to insulate the building, but it is very costly when compared to the alternatives. It costs almost three times as much as fiberglass and is not worth incorporating into the new SUB. Wool may be a rapidly renewable material, but producing wool is controversial. It is not produced in the most sustainable way. Sheep farming has many negative impacts on the environment and the sheep themselves are not well looked after.

The use of rapidly renewable materials in the new SUB building will lead by example and in the process increase our chances of becoming the most sustainable building in North America. The use of wool insulation may not be the best, but cork floors are a great alternative to ceramic and hardwood floors.

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