Sustainability Innovation

Use Bamboo Papers To Replace Wood Papers And Plastics In The Package Industry

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Summary

In our project, we hold an idea of using bamboos to produce paper materials, which can be used in the package industry. The reason why it is emergent to find a replacement for original materials, such as wood papers and plastics, is that they are now concerned as environmentally unfriendly. The plastic can not be decomposed in nature, causing accumulation, polluting land and ocean, increasing toxic in food chains, and damaging species. Moreover, wood paper production causes desertification, runoff, water pollution, global warming, hurricanes, soil nutrition loss, and habitat loss. Though it is better for people to use packages that could be used for several times, this idea is not accepted by the majority for they are not convenient. Thus, there is still a need disposable packages. Bamboos the object of our group this time that there are several good qualities of them make them especially suitable for the future package industry. Firstly, our ancestors invent paper using bamboos instead of woods, which means that is practical and plausible for use to redo bamboo papers--that there must be some records left or villages that keep making bamboo papers, which might become our target. Secondly, they have short growing period-- that bamboos are typically fast-growing perennials, with some species growing as much as 30 cm (1 foot) per day, so when people cut bamboos down, the soil will soon be recovered with new bamboos. Consequently, the span leaving the soil with nothing is limited that the soil destruction, the run-off problem, and water pollution are much less severe than what the logging brings. Thirdly, bamboos are valuable in many countries and they are so abundant. Asia, America, Africa--the existence of bamboos are so widespread. Subsequently, the raw material is very accessible. Fourthly, not only having less harms but also benefiting the environment, planting bamboo could reduce existed pollution. For example, the bamboo thrives in more acidic and less nutritional soil, where other plants might not survive, so planting bamboo in half deserted areas, such as the west region of China and the east region of Africa, is plausible. This plantation could reduce the total run-off on the barren area and gradually release the harsh condition. Fifthly, the problem that bamboo papers were fragile than current paper for people could not make them very thick because of the technical problem could now be sufficiently solved-- that we now are able to used wax to form a layer that is impermeable and strong. In this circumstance, the bamboo papers could be as ideal as current paper. More than just environmental friendly and practical, bamboo papers are also financially ideal because bamboos are not demanding on soil type, they grow easier than trees, and they grow so fast that if using branch seedling, they could grow twenty to thirty centimeters per day in its growing season. During the process, we firstly test the ideal location for bamboo growing. Differ from trees,

bamboos require less demanding growing condition, so the best location should be the barren mountain because bamboos will not damage the local organisms, will reduce the runoff there, and there are numerous condition-meet mountains, which are barren now due to the over logging before. After the selection of location, we use branch seedling, directly planting bamboo roots and branches, for the cultivation because bamboos grow dramatically only after they develop their root system after about two years. This method enables bamboos to grow extremely fast, around 25 centimeters per day. During the period of bamboo cultivation, we schedule meetings with bamboo paper makers in a village, the manager pf paper factory, and package factory. From villages, e learn the basic principal and method of making bamboo paper. When traveling the paper factory, we find out that traditional paper precess is actually is similar to that of bamboo papers, including pulping, making the bamboo into juice, sheet formation, spreading the juice, and drying. Besides, the principles are almost same--pulping of bamboos needs the motion just like what we saw in the factory; sheet formation uses the same separating method; and trying is exactly same. Conclusively, the bamboo paper process is similar to wood paper formation, needs similar machines, and needs same techniques, making the large production especially plausible. After that, we make our first paper using the procedure we learned from both villages and the factory. Moreover, we design the bags to be relatively "green face" that we do not add complex and colorful outer layer to the paper, but rather keep its most true face-- relatively yellow and rough-- because it helps remind people the difference between bamboo paper package and that of wood paper-- benefiting our environment and being closer to the nature. Besides, there is leave on outside. Then, finished bamboo papers are sent to a package factory where we have had a research before, and they are responsible of making bamboo papers into packages, which we designed.

Identify the Challenges

1. Occupying too many lands
As bamboos are hollow, their utilization rate might be less than that of other plants, so we should focus on how to increase the plantation of bamboos. Nevertheless, there is not such wide open space for heavy bamboo planting, so there might be a need to exploit the forest, which result in similar disaster as tree logging does. Even though we find space enough for large cultivation of bamboos, if we suddenly cut down all bamboos, the barren area might induce problems, such as run-off, water pollution, and soil depletion.
2. Long plantation time
Oligostachyum lubricum, the type of bamboo we choose to cultivate for it has the shortest growing period, has a growing period of nearly two to three years, of which nearly two years are used to develop their root system, if we start from seeds. Though comparatively, their growing period is still much shorter that of trees, which need up to ten years, it is still too long for us because we do not have enough time to test the whole growing period. If we want to boost the production, the need to reduce the growing period is very important.
3. Low survival rate
Moreover, not only raising bamboos but also keeping the survival rate of bamboos is bothering for they are well known as "easy-sick gainers"— and they always receive the damage of pests. For example, Meliola SP might kill off an area of bamboos as a whole, and parasites and fungi damage them dramatically. Additionally, there might be some other diseases of bamboos that will occur if we decide to cultivate bamboos in large scale, such as infection, killing abundant bamboos simultaneously. What we need to overcome is to find a way to protect bamboos from these damages.
4. The absence of method records
Furthermore, the most overwhelming problem is where could we find the traditional way of using bamboos to make papers. Records about the methods of using bamboos to make paper materials are too ancient and some of them are even lost. Besides, even though some remain, they are all written in ancient Chinese, which is hard to understand, and ancient people have different recording ways than us, making us even more difficult to conclusively derive the information in there. Before we start any research, the only information we have is on internet and book, which introduce bamboo paper production as having a similar process and technique as that of wood paper. If it is true, it will mean that there will be no extra expenses on new machines for they can share machines with wood paper. All we have to do is change the pulp of trees in paper factories into the pulp of bamboos.

But still, the exact way needs to be explored because the information on the internet is mostly personally published, having less credit.

5. Soft feature

Bamboo papers are so soft that when they are involved in the packaging process, they might not withstand the heavy pressing or folding process, which are automatically set in packaging processes. Even though the bamboo paper packages are successfully produced, consumers might not be able to carry heavy stuffs with it.

6. Permeable feature

Bamboo papers are not waterproof, not able to contain the food that has oil feature. As a result, it is needed to find a waterproof material that either environmentally friendly and cheap and add it to bamboo papers. Besides, as traditional paper is permeable as well, people must have some way to make it water or oil proof when they want to produce packages made of paper. Consequently, we can look at some existed uses and find what can be employed. If the waterproof layer could work as well plastics, bamboo papers could be utilized in wider range, such as the raw material and cooked food packages, instead of only packaging stuffs, such as toys, candies, and pens.

7. No bamboo paper packaging factory

After bamboo papers are produced, there is no factory where we could make the papers into packages. Mostly, package factories only produce the wood paper and plastic packages that their machines might not be suitable for producing bamboo paper packages, which are softer that others. The design, plate making, and printing types, the processes needed in paper package production, of bamboo papers might not be similar to those of wood paper. As a result, we lack the machine, technique, and place for package processing.

8. Consumers' unwillingness to use new product

Consumers, who lack the sense of protecting the environment, might not be willing to try this new product because bamboo papers are new, softer, and less beautiful. Indeed, it is normal for publics to resist the use of newly invented products, especially when they are satisfied with their current counterpart--in this case, wood paper.

Identify a Root Cause

The current package industry is based on two major kinds of materials--plastic and paper. The world account records that the whole world uses 5 trillion bags last year, it grows more that 15 times as the plastic use in 2010. Continually, humans are depend much more severely on plastic that ever before, and this trend is unlike to change dramatically if there is no a proper replacement of plastics.

The plastic could not decompose naturally, which means it will be gathered and fill the world. The waste is now covering the whole world. According to National Geography, "on Henderson Island, an uninhabited atoll in the Pitcairn Group isolated halfway between Chile and New Zealand, scientists found plastic items from Russia, the United States, Europe, South America, Japan, and China. They were carried to the South Pacific by the South Pacific gyre, a circular ocean current," and this circumstance is going to boost-- that "the production increased exponentially, from 2.3 million tons in 1950 to 448 million tons by 2015. Production is expected to double by 2050." The plastic is traveling around the world, accumulated in the ocean mostly, with a rocketing rate.

Moreover, the plastic accumulation caused endangerment of several species. "Millions of animals are killed by plastics every year, from birds to fish to other marine organisms. Nearly 700 species, including endangered ones, are known to have been affected by plastics. Nearly every species of seabird eats plastics." The scientific study shows that not only will the animals be harmed but also will the human. When the human consumes fishes that are fed by plastic, the chemical and toxic will be left in the human body, resulting in diseases, such as heart disease and diabetes.

Then, it comes to the problem of using paper packages. As the demand in the human market of paper is so high, overexploitation becomes one of the most concerning problems. It, firstly, will result in the overall amount of carbon dioxide in the atmosphere. Trees are the major source that transfer carbon dioxide, which is generated either by natural organisms or human industry, into oxygen, a gas that sustain all living things. Are trees severely reduced, there will be an extraordinary unbalance between the actual carbon dioxide rate in the atmosphere and the amount that nature could sustain. In this situation, the gathered carbon dioxide will stay in the atmosphere and keep the heat that should originally be reflected to the space, and the whole world will heat up, resulting in global warming, which causes sea level to rise, species extinction, and dramatic seasonal changes.

These damages are unlike to retrieve because when garbages are dropped into the ocean, which is its major disposal, the tide will drift them all the way, so what we can do not is to reduce the use of plastics.

Moreover, the overexploitation of trees causes the mountains to be barren so long, so when it is rain, the water could run off the mountain with all the nutrition in the top layer of the soil in to the water system. The soil might become much poor and barren over time that plants hardly survive, and then this cycle will continue. The rain, too, will drip under ground, and when the water bed raises, the rain water will go up with the salt, deep underground, and make the top layer of the soil much more salty. This effect might further reduce the chance for plants to grow there. Mover, when the water goes to the river system, the soil might be induced into the river, too, which generate water pollution.
Furthermore, the forest depletion damages the habitat of numerous species, which might lead to species, such as bird and otter, to extinction. The International Union for Conservation of Nature and Natural Resources (IUCN) has a Red List of species officially classified as ''Threatened'' or ''Endangered''. Habitat loss has been identified as being the main threat to 85% of these.

Generate Solutions

1. The problem that cultivating abundant bamboos at the same time might occupy too much spaces could be solved if we utilize the lands that are barren. Having a conversation with farmers who plant bamboos, I find out that bamboos can survive under some harsh environments where other plants hardly exist. For example, bamboos mostly live on mountains that have the steep slope. As these environments are not suitable for other plants, the cultivation of bamboos there might not influence other ecosystems, and there might be plenty of habitats suitable for them. More beneficially, the plantation of bamboos is conducive to nature as well because it can solve the problem of runoff and soil depletion, which are caused by overexploitation. As a result, we decide to plant bamboos on a mountain, where is relatively barren, so that there is no need for extra excavation. Though we do not cultivate for a large region, we do try these methods in a region back of Jingshan. Moreover rotational planting method-- a method which separate bamboo lands in to, says, eight parts, and every time, we only harvest bamboos in one part, so that the other parts of bamboos might still work on resisting run-off and balancing the ecosystem when one part is left to empty--is a fabulous way to reduce the harm of harvesting bamboos.
2. In order to reduce the growing period of planting bamboos, we figure out that branch seedling, directly planting bamboo branches, which have already developed their roots, might be the most effective way for the bamboo plantation. In the first three years, bamboos only develop their root system, and after this period, they start to grow extremely fast for nearly thirty centimeters per day. Thus, if we grow bamboos in the lab by frames, which might reduce the overall occupied space, in the first three years and let them develop their root system, and then transfer them to the mountain, we can sufficiently save time and space. Indeed, using the branch seedling, we develop the bamboo root system in lab. We get the a part of bamboo root by cutting it down from a mature bamboo. The existed bamboo root system enables it to develop much more quicker than directly planting a bamboo from seed because, according to Garden. eco, the bamboo uses most of it lifespan for developing the root system. Planting the bamboo branch with developed root system, we only use about three months to plant the bamboo to about four meters. Comparing to trees' growing period, it really is a short span. According to a professor in Chinese agriculture university, branch seedling not only increase the utilization rate by 15 percent, save about 1500 RMB per acre, but also increase the survival rate to 97 percent.
3. Though bamboos were extremely easy to get disease, people currently already have sufficient ways to release these diseases. Take the most common disease,

bamboo rotting, as an example. Chinese scientists have proved that spurting 50-times wave multi liquid or potassium permanganate once ten days could sufficiently prevent the bamboo rotting disease. As a result, if we keep these measures, which are proven to be useful, the survival rate of bamboos are extremely high.
4. For the question that we are lack of information about how to produce bamboo made paper, we need to sought the method that is more virtual rather than normally searching the data in internet or book, which means that we should go to the small and conservative villages where the traditions in China are still kept. Indeed, in preserved small towns, people are still using the most traditional method to make paper-using bamboos. Visiting there, we learned their methods and try to mix in some mechanic elements because the assistance of machines might help increase the amount of production. During the process, there are pulping, making the bamboo into juice, and sheet formation, spreading the juice, to drying, let the water disappear and only leave the paper. In the pulping process, villagers use rods to press the bamboo and squeeze the juice, but we find it too inconvenient and unproductive. Fortunately, in the paper factory, we find that they use machines to press bamboo, which need much less effort. Besides, we find out that in packaging industry, there is one more process in pulping what we did not learn from the villagers--chemical processing, which needs ammonium peroxydisulfate, the chemical that makes the paper white rather than yellow. Then, the pulping is finished. The sheet formation is let "pulp mixture diluted some more with water. This is then strained through a moving blank made of fine mesh in order to create a fibrous web, and the sheet is almost formed. Then, the moving web of pulp is pressed and allowed to dry. Pressure may be applied to help squeeze out the water". And finally, the air and heat might be added to remove the extra water in the sheet. These processes, except the way of making pulp, are exactly same to that of the traditional packaging, so people could just use the machines they now have to produce bamboo papers.
5. In oder to solve the problem that bamboo papers are too soft to make the packages, we check the method that how current papers could be much stronger even though they the similar producing method as bamboo papers. Actually, if we use a pulper for pulping, the fiber of it can be differentiate into minute fluff, increasing the cohesion between fibers. Subsequently, the product might be very firm. Actually, in the wood paper production, paper pulps that are not be processed by pulper have similar problem according to the paper factory. Thus, it the normal to face the problem that bamboo papers, without being processed by pulper in traditional manufacture, are soft, and it can similar be solve after using the pulper.
6. We want our bamboo papers to hold food that has water and oil on the surface, so we decide to add a waterproof layer, which is made of wax, inside the paper package because wax enables the paper to become stiffened, more strong, and also water proofing, which enable finished products to hold the food even though it has oily surface. We use the spurting bottle to spurting the liquid wax in the paper uniformly, and when it's dried, there is a layer of waterproof material on the paper,

making it suitable for the food that contains some water or oil. (This is the similar method traditional-paper-made-packages use.) In Navbharat industries, a firm that concentrates on producing wax paper packages, wax is well used to produce water proof paper in large scale.(In the attachment, we submit the website of this wax paper firm.)
7. The reason why we once suspected that there might be any factory that make packages by bamboo papers was that bamboo papers are to soft. Nonetheless, it is now improved that bamboo papers actually have similar features as normal paper that they are strong and even waterproof. Consequently, when we ask a factory near our school for the production of packages by our bamboo paper, though in small amount, it willingly accepted, and now we have the way to make bamboo papers into packages.
8. As people are disinclined to use our products because they are new that they afraid whether there are any drawbacks or potential harms of them, we try to start from our home, and then to our friends and classmates. We designed the finished bamboo paper packages just like normal paper packages that no one even notice the differences and ask them after they use the packages whether they feel any inconvenience or uncomfortable. In this way, we could gradually spread our design further.

Navbharat industries

Identify the Criteria

The criterion of this project should be the based on the improvement from the current situation, which means that if our project could beneficially make the packaging industry more sustainable, it is worthy.

1. Is the wax layer in our product works well that is the product now waterproof and functions similar to traditional paper? Could it hold food, such as pancake and pie without contaminate people's hand?

2. When we are doing garbage sorting, do we know what box we have to throw the trash of bamboo-paper-made-package into? Is the trash of the bamboo-made-paper-package damaging the soil or the water system?
(Our project does not hurt the environment. The present package industry mostly depends on plastic and wood paper material. Nevertheless, the plastic materials are proved as environmentally unfriendly because they do not decay naturally, leaving as small particles, polluting soil or descend to the ocean sediment. Though wood papers can naturally disappear, they are produced in an unsustainable way for the paper production needs the exploitation of forest; which might cause serious tornadoes, runoff, and soil depletion; and it pollutes water system because there are some processes needing water to clean off the leftover. Bamboo paper can sufficiently solve this problem because they can be grown in the area that is barren and useless, which means that the production of bamboo is higher than that of wood paper.)

3. Is the cultivation of bamboos and processing expensive? (As bamboo can survive everywhere easily without careful planting, and its payback rate is high as its expense is low and revenue is high. If users and companies find this innovation cost saving, cost efficiency sections should be granted.)

4. Does planting bamboos benefit the environment? (Planting bamboos on the barren slope of mountains might help solve some currently environmental problems. For example, there are some mountains that lack trees because of overexploitation, having high runoff possibility. And the plains where are deserted and have frequently tornadoes can be improved when planted bamboos. If people start to plant bamboos on barren mountains and deserted plain, the current deteriorating situations in some regions might be solved. Thus, if you think that bamboo papers benefit your home town or the environment as a whole, please select this part.)

5. Is planting bamboos much more time saving that planting trees?

Have all the standards are met, using bamboo made paper for package industry to replace traditional paper and plastic material is conducive for it benefits from the aspects of efficiency, cost, and environment.

Evaluate the Solutions

This part is showed in the attachment.

EP. pdf

Make an Action Plan

Our action plan is in the attachment.(we newly added one page)

(some adding part of the recycle could be found in https://www.bamboogrove.com/bamboo-paper.html, where it shows that bamboo papers are actually renewable.)

Plan

Prototype and Test

Prototype Design

Our prototype is in the attachment.

prototype

Feedbacks learnt from users

After making the questionnaire online, we received the feedback from 133 consumers, including students, teachers, and residences. In order to receive the most authentic feedback, I take several fried dough bars, which are held by our bamboo made paper, to ask others for eat and seek their feedback to the package. (The questions are in the attachment. As we could only submit one photos at once, we sent four attachments.)

qualitative feedbacks:
1. 84.21% of respondent reflected that bamboo paper packages could hold the dough bars without contaminating their hands and they did not feel difference between bamboo paper packages and their daily paper packages.
2. 66.92% of the respondent said that they know which garbage box they should drop which part of the bags into.
3. 100% of respondent believed that they would use bamboo paper packages in the future if they are proven to be helping releasing environmental problem.
4. 90.22% of respondent thought that bamboo paper packages are thick and strong enough for them to stop worrying about dropping stuffs.
5. 82.7% of people found our logo indeed worked to remind them with the emergence to act for protecting the environment.
6. 92.48% of respondent thought our product is one of the symbol of China's effort of protecting the environment because the traditional bamboo paper making in China represent the origin of every paper, and bamboos are also a very representative symbol of China.
7. All residents in the area where we grow bamboos said that our plantation did not influence their daily life through the ways, such as attracting insects, producing bamboo waste, and damaging the plants originally grown there.
quantitative feed backs:

1. The idea of bamboo paper sufficiently adds Chinese element into the global environmental protection, which makes the respondents fell fresh and interesting.
2. Respondents said that they were most interested in the recycling part because it was cool to do some DIY, and they were willingly to remake the bamboo paper with their family.
3. We should make the outer package thicker because respondents reflected that they mostly use the outer package to hold something heavy, and the currently inner package is thick enough, while the our one is not thick enough. They recommended us to use two or three layers for the package rather than one layer, the current form.
4. The hole on the package is not big enough, which makes them feel it hard to hole the whole bag.
5. The resident in Jinshan reflected that when we are planting bamboos, we shall better planting for the whole region rather than only on one area because it might not look good.

questionnaire
questionnaire
questionnaire
questionnaire

Improvement for next iteration

1. Some respondents have questioned that whether we are able to produce bamboo paper massively, so we decided to write an introduction on the questionnaire for proving people the accessibility of abundant bamboo made paper packages.
(Here are the concluded content:
Planting bamboo is very widespread that there are numerous bamboos growing around the world, and they could be utilized for paper production. Bamboo paper making actually have similar process as wood paper--including pulping, sheet formation, and drying--so all people have to do for massive bamboo paper production is to change the wood pulp into the bamboo pulp. Besides, when the paper is finished, package factory could process the paper into the package because it has similar feature to wood paper. To concluded up, the whole process of bamboo paper packages is just like that of wood paper, which means it could share machines and techniques with wood paper package production. In this situation, the massive production of bamboo paper packages is plausible.)

2. In order to meet consumers' need of thick out packages, we accept their recommendation of using double layers of sheet to produce them. Moreover, if the doubling do no solve this problems, we decide to find a way to directly make the

bamboo paper thicker. Wood papers could be decided thickness by people, so their might be some techniques, which enable papers to become thicker.

3. For respondents' concern that the hole on the package is too small, we need to redo the 2D model of bamboo packages-- making the radius of the hole greater.

4. Residents in Jinshan concern that our bamboo plantation in only one area rather than the whole might hurt the natural scene there. Nevertheless, we were only testing that whether bamboos could grow in less nutritional area that as we now are convinced, we would choose other places, where live nobody and are very barren. Then, our plantation will not hurt the scene but benefiting the barren area by reducing runoff, decorating, and making there more bio diverse.

5. Some respondents reflect that they do not know which garbage box they should drop our package in garbage sorting, so we decide to print the logo and name of the garbage box they should drop-- recyclable box.

Team Credits

Huang Wanching is responsible for the bamboo cultivation, searching the information of paper production (including doing interviews and combining the current paper production with bamboo paper production), and doing the wax layer searching and a lab about wax spurting. She also designs and draws the model, participates the package processing, and writes the information we need to submit, such as challenges, root cause, solutions, and criterion.

Zhang Yongjie is responsible for the bamboo cultivation, setting the questionnaire, which is in online form, and analyzing the feedback from respondents and check whether there should be any improvement. Moreover, Zhang yongjie focused on checking the model and the information, discussing the feedback with Huang Wanching, in order to make some improvements for the next iteration, and connecting factories.

Judge Comments

" Overall Comments:
I commend the team for documenting the environmental impact of plastic (especially the marine impact) including the effect of chemicals leaching from plastic and how it bioaccumalates and affects the food chain. I also like how thoroughly the team has gone into additional environmental impacts including deforestation, saltwater intrusion and species loss. The team has also done a very good job developing two workable prototypes. I applaud the amount of effort that has been spent on this project and I sincerely hope that the team continues to take it forward.

There are two key points that can be elaborated or explained further –

A discussion on the economics of this packaging option to be missing in the report. How much this solution costs will inevitably decide how widespread the adoption of this product will be. This in turn ill guide how effective this solution will be in addressing some of the complex environmental issues we are looking to address. While this might have been covered in the criteria, the topic requires an in-depth discussion of how costly it is compared to plastic (or other alternatives)

Given that this product is expected to be used for food (hot and cold), a discussion on the chemical composition of the sealers that could be used (wax spray as listed in the project) and potential impacts to food safety also need a thorough discussion.

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