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Analyzing the Past and Projecting the Future: Jute as an Eco-Friendly Solution to Plastic

Rupali Gangarde[1], Aarya Balwadkar[2], Ali Altam[3], Abhilaksh Saini[4], Ahmed Mohammed[5]
[1]Assistant Professor, CSE Symbiosis Institute of Technology, Pune, India
Email: rupali.gangarde@sitpune.edu.in
[2-5]Student, CSE Symbiosis Institute of Technology, Pune, India
Email: {aarya.balwadkar.btech2023, ali.altam.btech2023, abhilaksh.saini.btech2023, ahmed.mohammed.btech2023}@ sitpune.edu.in

***Abstract*— The global concern for environment-friendly products has led to the potential for jute to make a significant contribution. Unlike Plastic, which emits harmful substances and greenhouse gases, jute actively cleans the air by absorbing a significant amount of CO2 and releasing oxygen. Furthermore, many plastic products can be replaced by jute products, which reduces plastic dependency and eventually drives out harmful plastic products from the market. Data is collected on production area, yield, and prices of Jute and Plastic products. The study aims to evaluate the environmental impact of Jute and Plastics and to provide predictions on prices and the environment, with a specific focus on carbon dioxide (CO2) emissions, if jute production increased by 3%. To fulfill this, an analysis of historical trends in the production and examination of historical trends in the prices of jute and plastic is carried out. To realize this, we recommend providing affordable saplings to farmers, establishing camps for jute product manufacturing using the latest technologies, raising awareness of the environmental benefits of Jute and Jute products, formulating a jute policy, and developing research institutions.**

***Index Terms*— jute area, plastic production, amount of CO2 absorption by jute, amount of CO2 emission by plastic, plastic prices**

I. Introduction

The constantly increasing use of plastic products in everyday life raises an issue of need for an environment-friendly solution. Here, Jute emerges to be one of the solutions which can reduce this threat to the environment as well as economic problems up to a large extent.

A dicotyledonous fiber crop, jute (Corchorus spp.) is a member of the genus Corchorus and family Tiliaceae. A naturally occurring fiber known as "golden fiber" is jute. Next to cotton (Gossypium spp.), jute is the most important and least expensive textile fiber. It is extensively used to create a variety of packaging materials for a range of industrial and agricultural goods. Jute is one of the most affordable natural fibers. In terms of the production of natural fibers and variety its uses, it is only the second largest. It falls in the bast fibers category. The fibers are of white to brown and ranges from 1-4 meters long. It is also known as “Golden Fiber” because of its colour and substantial financial value. It is a rainy season crop. Jute lost a sizable share of the export market with the introduction of ready-made clothing and then prawns. However, with the current trend towards

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environmentally friendly products and awareness of using synthetic products, there is a special chance to expand the jute market. With roughly 60 percent of the world's production, India is the single biggest producer of jute goods worldwide. An eco-friendly crop, jute is predominantly cultivated in the Ganges delta. The only areas of India where jute is frequently grown are the eastern and northeastern sections. In India, 98.41% of the total area used for jute cultivation and 98.43% of the total amount of raw jute produced are produced in the states of West Bengal, Odisha, Bihar, and Assam. 71% of the world's raw jute production, or 73.09% of the total, originates solely from the region of West Bengal. It is primarily grown in the West Bengal districts of Murshidabad, Nadia, North 24 Parganas, Cooch Behar, Hooghly, Malda, and Dakshin Dinajpur.

Around the world, people are already experiencing the effects of climate change in a variety of ways, including altered precipitation distribution, crop losses, receding ice caps, elevated frequency and intensity of droughts and floods, and severe ecological irregularities. Significant financial losses have also been brought about by all of these effects [1]. The environment is not significantly impacted by the production of fiber crops. Research contrasting the production stage of fiber crops with that of synthetic products or glass fibers demonstrates that fiber crops have a positive impact on the environment, lowering greenhouse gas emissions and the need for fossil fuels. Jute is also utilized in the manufacturing of other value-added goods like pulp and paper, geo-textiles, composites, and home textiles in addition to its traditional uses. Due to its high biomass production per unit land area and ease of biodegradation, jute is a yearly renewable energy source whose products can be disposed of without harming the environment.

Plastics are versatile and find application across a diverse range of uses because these are lightweight, high tensile strength, flexibility, low production cost, and availability. In fact, plastics have even replaced glass and paper in packaging. However, plastic waste poses a significant environmental threat by ending up in landfills, soil, oceans, and water bodies, and endangering both humans and other living creatures and plants. Additionally, the fragmentation of petroleum-based plastics and the associated carbon footprint is a pressing global concern. Furthermore, the processing and transportation of jute fiber releases one-sixth of the CO_2 generated during the production of PP. Jute products are more energy-efficient and have a smaller carbon footprint than traditional plastic products. Just 9% of the 7 billion tons of plastic produced were recycled in India up until 2022. Approximately 80% of plastics used in India's packaging industry are consumed there. Despite being less than the global average, India's per capita consumption of plastic is only 15 kg (Tata Strategic). According to a study carried out by the Central Pollution Control Board (CPCB) produces about 4059 T/day of plastic waste) in 60 top Indian cities.

So, the study aims to evaluate the environmental impact of jute and plastics, with a focus on carbon dioxide (CO_2) emissions, and provide predictions on prices and the environment if jute production is increased by 3% in the context of India.

II. LITERATURE REVIEW

Controlling the atmospheric stock of greenhouse gases (GHGs), particularly CO_2, is necessary to avert anticipated and unanticipated disasters. Studies show that jute assimilates CO_2 at a rate that is many times higher than that of other trees. One hectare of Jute crop throughout its lifetime, absorbs about 15 tons of CO_2 and contributes about 11 tons of O_2 to the environment [2].

Adopting a low-carbon production system for jute can enhance adaptation, mitigation, and stability in the jute-based agricultural system, while also promoting national sustainability [3]. Moreover, jute products have a significantly lower manufacturing energy requirement and carbon footprint than traditional plastic products made from petrochemicals [4]. The two primary processes that emit greenhouse gases are fertilization and fiber processing. Bast fibers, as compared to synthetic or artificial fibers, typically have a 20-50% lower carbon footprint. Jute products offer a lower carbon footprint and higher energy efficiency than conventional plastic products [5]. Chinmayee Patra used the ARIMA Model to estimate the trend of jute production, area, and yield in India from 1950 to 2017 [6]. The findings revealed a negative growth of 0.2 in the jute cultivation area between 1990-1991 and 2015-2016 [7]. However, while the jute area was growing at a negative rate, productivity, production, export quantity, import value, and export unit price were all growing positively [8]. Market arrival and price were highly correlated during the COVID-19 pandemic, as more jute entered the market, causing its price to decrease [9]. One of the studies also concluded that the exporters in countries producing large amount of jute have mainly focused on raw jute while jute goods have high potential. Thus, not able to catch the high-value market [10].

Udita Biswas has examined the gradual declining trend of production of jute goods in India from 2011-12 to 2017-18, 4.477% decline in the export of jute in India from 2014-15 to 2017-18 and 2.102% decline in the domestic consumption of jute good during 2010-11 to 2017-18 [11].

Barman and colleagues' study has initial goal is to evaluate the net ecosystem exchange (NEE) of CO_2 flux from jute crops in the Indo-Gangetic plain employing the open-path eddy covariance (EC) technique. The results showed that the jute ecosystem served as a net sink of CO_2 every day, with the exception of the first nine days following sowing, when day and nighttime CO_2 fluxes were combined [12]. The research conducted by Paul Stegmann and his colleagues analyzes three potential paths for mitigating CO_2 emissions in the global plastics industry by the year 2100, considering the entire life cycle from production to waste management. One of these paths, a circular economy strategy, reduces resource consumption by 30% without requiring a bioeconomy push, achieves 10% more emission reductions before 2050, and reduces the likelihood of long-term negative emissions [13]. Additionally, it was found that approximately one-sixth of the CO_2 produced during the production of polypropylene (PP) is released during the processing and transportation of jute fibers. In India, only 9% of the 7 billion tons of plastic produced was recycled up until 2022. The majority of plastics used in the packaging industry in India are consumed there. According to Tata Strategic, India's per capita plastic consumption is only 15 kilograms, which is less than the global average. The Central Pollution Control Board (CPCB) conducted a study in 60 major Indian cities and found that these cities generate approximately 4059 T/day of plastic waste. Furthermore, research on microplastics contributes to the greenhouse effect (n.d.). The production of methane and carbon dioxide increases with the size of the microplastic particles [14].

Convenient algae cultivation could be a major factor in encouraging the use of algae biomass to reduce plastic-related CO_2 emissions. The study's goal is to forecast and outline strategies for meeting future demand for plastic production (by 2050) while reducing CO_2 emissions by substituting bio-based plastic with conventional plastic. The analysis conducted by Abdul-Latif, Ong, et al. utilizes carbon emission pinch analysis to assess the potential reductions in CO_2 at three different levels: 25%, 50%, and 75% [15]. In terms of addressing the issue of plastic pollution, bans can be seen as a determined and decisive approach to reduce its presence in the environment. These bans have a certain level of shock value and strictness, effectively raising public awareness. However, it is important to recognize that they may not always achieve the desired outcomes and only tackle a fraction of the overall complexity of the issue at hand [16]. Based on Tania Afrin's study, participants are confident that jute bags offer greater environmental friendliness compared to plastic bags [17]. The market analysis report also conducted a comprehensive investigation of key regional markets such as India, Bangladesh, and China, among others. India had the largest market share, according to the report [18]. Other alternatives to jute include bioplastics/biodegradable plastics/compostable plastics and other substitutes, as well as the current state of technology on plastic alternatives with lifecycle assessment development. The increase in demand for affordable jute products coincides with increased production, which benefits the environment [19].

III. Objectives

The objective of this study is:

1) To analyse the historical trends in the production of jute and plastic.
2) To examine historical trends in the price of jute and plastic products.
3) To predict the decrease in CO_2 emissions and increase in price of plastic products, thus making jute products more acceptable in the market.

IV. Methodology

Initially, a substantial dataset was obtained from the Office of Jute Commissioner, Ministry of Textiles, Government of India, as well as various studies on jute, plastic, and the environment. The average prices, production, and CO_2 absorption of jute, etc were calculated for the years 2006-2007 to 2021-2022(Figure 1).

This dataset was then utilized for data analysis on jute cultivation, CO_2 absorption, CO_2 emission, and plastic prices for the same period. Lastly, predictions were made for the decrease in CO_2 emissions and increase in plastic prices by 2029-2030, assuming a 3% increase in jute cultivation area.

A. Source of Data

This is an analytical paper. The information utilized is artificial. The following sources provided the information that was gathered: Life Cycle Assessment (LCA) Study of Plastic Packaging Products, by the Office of Jute

Commissioner, Ministry of Textile, The Central Pollution Control Board (CPCB) of the Government of India, under the Ministry of Environment, Forests, and Climate Change.

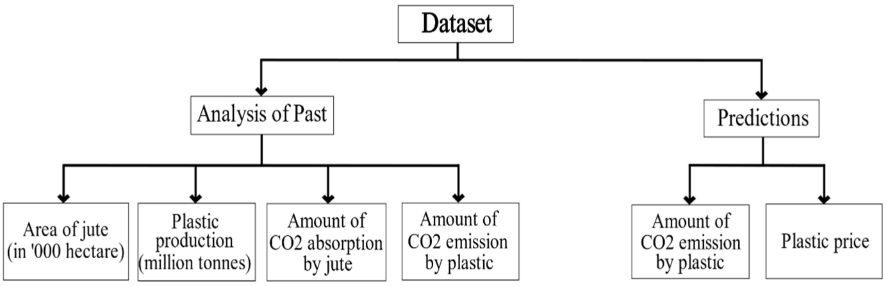

Figure 1. A visual exploration of Methodology through flowchart

B. Sample design

The information includes the following: Jute Production Area, Jute Yield, Hessian 40x10(M.T.) cost, the costs for sacking B.Twill (2 1/4), B.Twills 50 kg (665 gm), A.Twills 1190 gm, and D.W. Flours 2.5 LBS Jute's CO_2 absorption capacity, plastic production, price, and plastic's CO_2 emission capacity for a 16-year period, from 2006–2007 to 2021–2022, are all included. "Life Cycle Assessment (LCA) Study of Plastic Packaging Products" is the source used to illustrate how plastic pollution affects the environment [20].

The information has been examined through the application of several statistical methods. The study has analyzed data and made conclusions using growth, mean, percentage, and other metrics.

V. Results And Discussions

A. Past Data Analysis

Based on the analysis of past data, jute production has remained relatively stable over the years. However, there was a decrease in production in 2021-2022 compared to 2006-2007. Furthermore, the area under jute cultivation showed a decreasing trend, while productivity demonstrated an increasing trend, with overall production experiencing fluctuations.From the year 2006 to 2022, the total area of land used for jute cultivation in India fluctuated, starting at 935.10 thousand hectares and peaking at 960.30 thousand hectares in the following years, before falling to 667.30 thousand hectares by 2021-2022 (Fig. 2.) resulting in decrease of CO_2 absorption by jute (Fig. 3.). Similarly, the yield of jute experienced a trend of increase until the year 2015-2016, reaching approximately 4718 kg/hectare, followed by a decline to 2738 kg/hectare in 2021-2022. This decline in jute production is largely attributed to the rise in production and cheaper prices of plastic goods. Plastic production increased from 11.9235 million metric tonnes in 2006-2007 to 34.0059 million metric tonnes in 2021-2022 (Fig. 4.), while the price of plastic has not significantly increased, its lower cost has made it a more attractive option for producers. This trend is worrisome as it contributes significantly to environmental pollution.

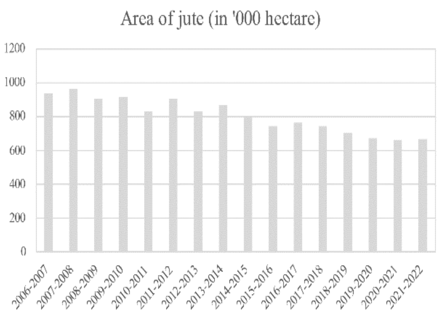

Figure 2. Area of jute (in '000 hectares) from the year 2006-2007 to 2021-2022

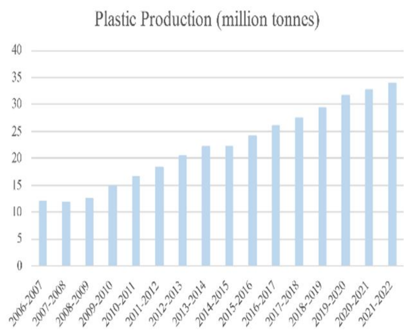

Figure 4. Plastic Production (in million tonnes) from year the 2006-2007 to 2021-2022

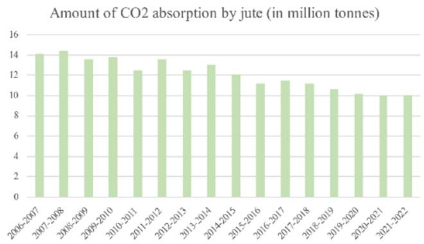

Figure 3. Amount of CO2 absorption by jute (in million tonnes) from year the 2006-2007 to 2021-2022

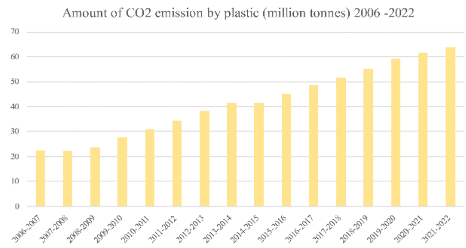

Figure5. Amount of CO2 emission by plastic (in million tonnes) from the year the 2006-2007 to 2021 -2022

The relationship between the sale of plastic products and the amount of plastic waste generated is evident, with the most significant plastic products being Glass Bottles, Polyethylene Terephthalate (PET) Bottles, Milk Pouches, Polypropylene (PP) woven sacks, HDPE Bags, Polypropylene (PP) Cups, and Compostable Plastics Bags. This relationship also extends to CO2 emissions, which have increased from 22.3041 million metric tonnes to 63.6113 million metric tonnes over the years (Fig. 5.). This trend is concerning as it is likely to cause more significant issues soon, if left unchecked.

B. Future Predictions

Jute is a potential solution to this problem as it can absorb CO2 and is environment friendly. According to research, one hectare of Jute crop can absorb up to 15 tons of CO2 and release 11 tons of O2 into the environment. Additionally, jute products can replace many plastic products, making jute an important eco-friendly solution to the problem of plastic waste. However, the production of jute has been decreasing, which has resulted in the decrease of the absorption of CO2. To avoid a potential environmental disaster, it is necessary to increase the production of jute.

A feasible growth rate of 3% for increase in jute production has been assumed over the next 7 years, and the predictions have been made accordingly. Plastic will emit 61.703 million metric tonnes of CO2 in the year 2023–2024; by the year 2029–2030, that number will drop to 51.3969 million metric tonnes. Furthermore, if we keep continuing, it can be decreased further more (Fig. 6.).

Increase in jute production will guarantee that more jute products are available, lowering their price and increasing the number of items that are sold out. Because of the increased demand for a cost-effective jute product in the market, there will be a corresponding decline in plastic production. It is likely that by the end of 2030, prices will have increased from 138 rupees per kg in 2022–2023 to 175.5 rupees per kg (Fig. 7.). Plastic production in 2022-2023 was approximately 34.006 million tonnes, while jute production was approximately 1.83 million tonnes, a very small portion (Fig. 8). Plastic production in 2022-2023 was approximately 27.47 million tonnes, while jute production was approximately 3.12 million tonnes, a very small portion (Fig.9).

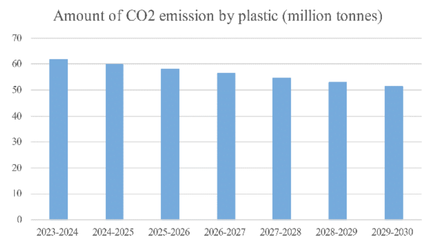

Figure 6. Amount of CO2 emission by plastic (in million tonnes) Vs. 3% increase in Area of Jute (in '000 hectare)

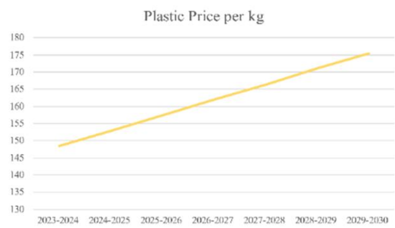

Figure 7. Prediction of plastic price per kg from the year 2023-2024 to 2029-2030

Figure 8. Production of plastic (in million tonnes) vs. production of jute (in million tonnes) in 2022-2023

Figure 9. Production of plastic (in million tonnes) vs. production of jute (in million tonnes) in 2029-2030

V. CONCLUSION

According to historical data analysis, there has been a concerning decline in jute production. Specifically, production has decreased from 935.1 thousand metric tons in 2006-2007 to 667.3 thousand metric tons in 2021-2022. This decrease can be attributed to the growing prevalence of low-cost plastic production. Additionally, jute's absorption of CO_2 is trending downward, from 11.9235 million tons in 2006–2007 to 34.0059 million tons in 2021–2022, more plastic was produced. It is extremely concerning that the data also demonstrates the rising trend in plastic-related CO_2 emissions. Given jute's essential role in reducing air pollution, absorbing greenhouse gases along with releasing oxygen and absorbing CO_2, it is imperative to promote it as an environmentally-friendly substitute to counteract the problem at hand. The environmental impact of jute has been lessened, though, due to decreased production.

A feasible resolution entails a 3% yearly rise in jute production, and over the next seven years, estimates indicate a noteworthy decrease in CO_2 emissions caused by plastic. Plastic will emit 61.703 million metric tons of CO_2 in 2023–2024; by 2029–2030, that number would drop to 51.3969 million metric tons. A decrease in plastic production coincides with an increase in demand for affordable jute products, which benefits the environment.

To achieve all the eco-friendly goals related to jute, increasing production of jute is not in itself a sufficient move. There is a requirement of planning various methodologies, improving our current technology by innovation and invention. Moreover, encouraging, advertising and creating an awareness of jute and jute related products must be done by both the government and the citizens of India.

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