International Journal of Financial Management and Economics

P-ISSN: 2617-9210
E-ISSN: 2617-9229
IJFME 2023; 6(1): 234-238
www.theeconomicsjournal.com
Received: 24-03-2023
Accepted: 02-05-2023

Konakalla Veerabhadra Rao
Research Scholar, Department of Management, Sikkim Professional University, Gangtok, Sikkim, India

Dr. Vikrant Chauhan
Professor, Department of Management, Sikkim Professional University, Gangtok, Sikkim, India

Corresponding Author:
Konakalla Veerabhadra Rao
Research Scholar, Department of Management, Sikkim Professional University, Gangtok, Sikkim, India

A comparison of environmental impacts between fibre variants and contribution analysis of agriculture and industrial subsystem

Konakalla Veerabhadra Rao and Dr. Vikrant Chauhan

DOI: https://doi.org/10.33545/26179210.2023.v6.i1.202

Abstract
Awareness of the environmental issues caused by wastewater discharge is crucial, especially in light of industrialization. Pre-treatment, dyeing/printing, finishing, and other technologies are all used in the processes of textile printing and dyeing. Pollution of the water resources is a result of all finishing processes. Additionally, depending on the situation, singeing, mercerizing, base reduction, and other procedures should have been carried out prior to dyeing or printing. India's textile sector has a significant impact on the country's economic development. The expansion of the textile industry has an effect on not only the domestic economy of a nation but also the international economy and the knowledge transfer between nations. However, the textile sector also produces a significant amount of trash in the form of discarded fibres, sludge, and chemically contaminated rivers. When mixed with these natural resources, the chemically contaminated textile effluent affects their quality and concurrently depends on habitats and the environment. Due to the issue with solid and liquid waste, the textile industry is having serious issues with environmental pollution. Therefore, the textile businesses and researchers are concentrating on reducing textile effluent and developing substitute effective treatment methods that don't harm the environment. As a result, the current literature review focuses primarily on the various wastewater treatment approaches and their benefits. Additionally, the study's main objective is to outline techniques for reducing environmental waste and effectively using reclaimed water with a zero wastewater management strategy. The analysis also advises using solid wastes after wastewater treatment in other industries, such as building, to prepare low-grade tiles and possibly bricks in place of cement as an alternative strategy for reducing textile waste.

Keywords: Environmental impacts, fibre, variants, textile effluent

1. Introduction

Due to a rise in worldwide population and rising textile living standards, textile production and consumption have significantly increased in recent years in India and other developing nations. The majority of textile products are used in the majority of manufacturing industries, primarily in the fashion sector. Either by adopting lower consumption habits, improved production techniques, or ultimately by recycling and upcycling techniques, this waste from the fashion sectors needs to be eliminated. Globally, there are more textile solid wastes being produced as a result of the increased use of textile products. According to SEPA's, Sweden's textile consumption increased by 40% over the previous ten years, although yearly consumption of home textiles and clothes remained at 15 kg per person. Similar to other nations, the consumption rate in Finland and Norway was 13.5 and 22 kg per capita. These textile items are made of several textile fiber kinds, including natural, natural cellulosic, synthetic, and rayon and viscose fibers, respectively. The global financial recession caused a 4.3% reduction in the consumption rate in 2008, although it then climbed again by around 13% from that point on.

With the development of textile products and the improvement in the state of the world economy, the textile industry has continued to expand, which has drawn attention to the fact that substantial amounts of waste are being produced that pose a serious threat to the environment. These wastes eventually mingle with river water, causing global environmental problems. Thus, striking a balance between economic growth and environmental protection is a fantastic challenge. The majority of researchers were interested in reducing waste textile effluents by recycling the textile wastes while also focusing on economic and technological advancements.

It is mostly grown as a kharif crop, which is sown in May and June to coincide with the start of the southwest monsoon and harvested in September and October. Sunnhemp crops are not easily harmed by insects, pests, or illnesses and can be treated as needed. Being a legume and a rotating crop, sunnhemp has the ability to meet its nitrogen needs since it can fix atmospheric nitrogen using bacteria found in nodules in the root, which improves the soil. Sunnhemp cultivation is suited for loamy soil. Typically, sunnhemp crops may be cultivated in both irrigated and rain-fed environments. The yield can be higher under irrigated conditions. 90 days after seeding, the crop is either picked by hand or a mechanised harvester during flowering or when the seeds are fully ripe. The majority of the crop is gathered by cutting the plants close to the ground with a sickle. The tops of the plants are typically hacked off shortly after harvest and used as cow fodder or mixed with the soil to enhance it in most of Uttar Pradesh (UP), West Bengal (W.B.), and Bihar. Processing stages for the harvested FGM include retting, sun drying, and stripping. The removed plants' upper (20 cm) sensitive portions are utilised to make green manure, while the remainder plants are tied into little bundles and left in the field for two to three days to shed their leaves. The bundles are horizontally submerged in water for retting after defoliation. After drying, the fibre is manually removed, rinsed in freshwater, and then sun-dried for five days. In certain places, plants are immediately sent for retting after the leaves have been manually removed. The process of removing hemp fibre from retted stems varies depending on where in the nation you are. As soon as the stems are retted, the fibre is extracted in West Bengal, Andhra Pradesh, and Maharashtra. After stripping, the fibre is thoroughly washed to get rid of any leftover stem or gum fragments, etc. Then, after being tied into little bundles, the fibres are dried in the sunlight. These techniques result in fibre that is largely free of sticks. In the Madhya Pradesh, Gujarat, Pilibhit, and Moradabad regions of Uttar Pradesh, the stems are dried before being stripped. Each stem is broken, either near the butt end or multiple times, to remove the fibre. The fibre is loosened as a result, and the remaining stem is then stripped of it using one hand to catch it. The strands of fibre are folded, given a few twists, and then tied at the butt end with the upper end of the strands to form hanks (known locally as gundi or gichhi).

2. Research methodology

2.1 Fibre production (cultivation and fibre processing)

The optimal time to sow flax in India is from the last week of October to the first week of November before it becomes too cold and negatively impacts seed germination, fibre yield, and fibre quality. Flax is largely a Rabi season crop. Diseases, pests, and insects don't significantly hinder flax production and are only used when necessary. First-hand weeding is carried out after sowing at 21–25 days, while second-hand weeding is carried out at 40–45 days. Flax crops may typically be cultivated in both rain-fed and irrigated circumstances, but irrigated conditions can result in better productivity. For good quality fibre, two irrigations are advised at 35 days and 65 days following seeding. Compared to cotton, which needs 150–180 days to reach maturity, flax fibre crops take about 120–125 days. When two-thirds of the plant has become yellow and around two-thirds of the leaves have dropped, it is harvested before the capsules have fully developed. Once the plant goes brown, the quality of the fibre deteriorates. Plants are dug up from the ground and tied into little bundles with a diameter of 15-20 cm to be harvested. Early harvesting leads in low yields of tender, fine fibre, whereas late harvesting produces higher yields of lower-quality fibre. To get greater fibre length, the plants are pushed up with the roots (instead of being clipped).

Plate 1: CRIJAF scutching machine

Site: SRS, CRIJAF, Pratapgarh Site: SRS, CRIJAF, Pratapgarh

Plate 2: Scutched long fibres

Following the removal of the seeds, the flax plants are allowed to dry before being subjected to retting. Under concrete tanks, the tied bundles are submerged in water that is 20–25 cm deep. Three days are required to finish the retting process (72 hours). Following a thorough cleaning with fresh water, the bundles are allowed to dry in the Sun. When stems are dried, the fibres are removed from the dried plants either manually (in households) or automatically (using a scutching machine, invented by CRIJAF, Barrackpore, Plate 1) to separate into scutched long fibre, short fibre (tow), and shives.
A series of the questionnaire was produced following a thorough literature review in our earlier publication by the same group. Major issues like labour input in the textile industry, policy ramifications, dyes and additives, wastewater treatment and disposal, energy consumption and carbon dioxide emissions, productivity in the textile industry, and textile reuse and recycling were identified in order to complete the survey procedure. Improvement of sustainability-related performance, with economic performance, environmental impact, and operational performance as the performance indicators, respectively. The specific site selection for the survey, data collection methods, survey data analysis, normality and reliability analysis, development of structural equation modelling, confirmatory factor analysis, and validation of results for sustainability of textile wastewater management are the main topics of this research work.

3. Results and Discussion

The findings section primarily focuses on the no allocation scenario and presents the results of all impacts, keeping in mind that the manufacturing of fibre, which is the main output of the fibre production stage, is the source of every impact.
The process of producing yarn had the greatest impact on all indicators, followed by the processes of producing fabric and fibre. When examined more closely, the following was found:
Irrigation is the primary contributor among all fibres at the fibre stage for the fossil fuels FAETP and ADP. Irrigation had a significant impact on AP, CC, EP, HTP, and MAETP impacts for cotton, flax, and sunn hemp. The repercussions on POP were mostly caused by TETP irrigation, herbicides, and fertilisers, as well as ODP resource depletion (elements). The impact on the stage of fibre production caused by electricity utilised for fibre processing was second only to irrigation in importance.
The consumption of electricity was the primary factor informing all effect categories among the industrial operations (yarn and fabric manufacture). Steam was the next significant contributor, followed by chemicals used in bleaching, groundwater extraction, and emissions from freight transport. Except for ODP, where steam had an impact potential similar to electricity, impacts on fabric production were primarily caused by the usage of electricity. The impacts were dominated by bast fibres during the fabric fabrication process. The results of the impact assessment are presented and discussed in the part after that:

3.1 Acidification potential

The assessment focused on acidification, the cause of acid rain, because it has a direct impact on the quality of the air, soil, and water and is thought to be pertinent to agricultural systems. The acidification potential of textiles is displayed in kg SO2-eq in Figure 1.

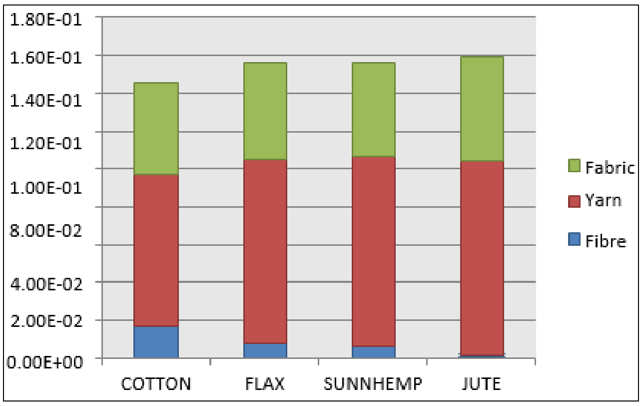

Fig 1: Acidification potential impact in fibre, yarn and fabric phases of textiles in kg so_2-eq

According to this study, cotton's AP is 0.0168 kg SO2 eq./kg of fibre. The cotton SO2 equivalent values ranging from 0.0115 kg to 0.0187 kg/kg fibre. 0.0442 kg-SO2 eq. by was reported as a somewhat higher value. 0.0022 kg SO2 eq./kg fibre, however this work determined the AP for flax as 0.0081 kg SO2 eq./kg fibre. In this investigation, AP for sunnhemp was determined to be 0.0061 kg-SO2 eq./kg fibre, compared to values of 0.036 kg SO2 eq./kg fibre and 0.0063 kg SO2 eq./kg fibre provided respectively. In this investigation, the impact on jute was estimated to be 0.0017 kg SO2 eq./kg fibre. The fibre phase had a significant impact on cotton farming, primarily because of irrigation. Other elements included the use of diesel in tractors, the manufacturing of pesticides, electricity, and freight transportation. A component of the impact is the electricity consumed in ginning. Irrigation makes a smaller contribution to flax, sunnhemp, and jute production than other elements like ground water extraction and energy needed for retting and dressing.
AP for flax yarn was computed in this study to be 0.1055 kg SO2 eq./kg flax yarn, while the predicted value for cotton yarn is 0.0969 kg SO2 eq./kg yarn. AP was reported as 0.0816 kg SO2 eq./kg yarn for water retted flax yarn, as opposed to a higher value of 0.146 kg SO2 eq./kg yarn by other researchers. In this investigation, an estimate for sunnhemp yarn was 0.1066 kg SO2 equivalent/kg. calculated 0.0738 kg SO_2 eq./kg yarn, which is comparable to the current results. An estimated AP for jute was 0.1042 kg SO2 equivalent/kg yarn. In the yarn phase, bast fibres had a slightly higher influence. The majority of the acidity impact was due to electricity utilised in spinning. The use of steam and bleaching agents has further effects. Other variables contributing to acidity in the spinning process included groundwater extraction and transportation.
According to this study, the AP for cotton is 0.1457 kg SO2 eq./kg of fabric, almost twice as much as Cotton Inc. published value of 0.0742 kg-SO2/kg fabric, but not quite as much as the 0.1610 kg-SO2/kg fabric. In this study, the estimated AP from cradle to gate for the manufacture of flax fabric was 0.1560 kg SO2 eq./kg fabric. Jute's effect was calculated to be 0.1589 kg SO2 eq./kg fabric, while sunnhemp's AP was estimated to be 0.1560 kg SO_2 eq./kg fabric. Although there was barely any difference in impacts within bast fibres, cotton showed a somewhat low total impact. The manufacturing of raw materials has the most

impact on fabric construction, followed by energy. Steam, starch compounds, and ground water extraction all had less of an influence.
The affects on bast fibres were the greatest overall. A careful examination of stage-by-stage consequences reveals that bast fibre manufacturing had a bigger impact than cotton fibre production. The AP measured for cotton fibre in this investigation was comparable to that of several other studies. All fibres' yarn and fabric phases showed outcomes that were relatively similar to those of other studies, despite the fact that there aren't many studies to compare them with. Fossil fuel burning, irrigation, and the usage of energy in agricultural activities all have an impact on AP. Power generation, diesel engine combustion in tractors, ammonia emission (depending on the amount of nitrogen applied), and the production of energy and raw materials are the main sources of sulphur dioxide and nitrous oxide emissions. By converting to natural pest and weed management, using organic fertilisers, using less fossil fuel, increasing material efficiency, and rotating leguminous crops, acidification in cultivation can be reduced. The main cause of AP in the spinning and weaving operations is electricity, which can be reduced by using renewable energy.

3.2 Comparison between different allocation choices
The LCA practitioner must make a crucial decision on the allocation mechanism to be used. Each crop produces several useful by products while it is being grown, including I cotton fibres, cottonseed, and stalks. The primary resources used in the upstream processes were divided into the main product (fibre) and the by-product based on mass and economic values because all the crops studied in this study produce more than one useful product. For all the outputs coming from the cultivation and fibre processing phases of the fibre production process, cost-based and mass-based allocation values are provided in Table.

Table 1: Mass and economy-based ratios of fibres compared to their coproducts

	Cotton	Flax	Sunn hemp	Jute
Mass allocation	18.18	45.28	18.75	37.65
Economic allocation	69.62	71.01	85.08	88.45

The outcomes of the agriculture subsystem with midway economic and mass allocation decisions are shown. Since the economic value of fibres is proportionately higher than their mass value, it was noted that the results of economic allocation for all effect categories were higher than the results of mass allocation. Outcomes with economic allocation were observed to be nearly twice as good as results with mass allocation. Since the major motivation for growing these crops is for their fibres, even though economic values are less constant than physical values, it is preferable to apportion impacts based on economic value. For textile systems, mass-based allocation was deemed to be a poor option since it would distribute a larger proportion of the impacts to co-products like seed and straw. These outcomes further proved that LCA allocation decisions have a big impact on the study's outcomes.

4. Conclusion
As was mentioned in the opening, it is challenging to determine whether one fibre performs better or is a more sustainable alternative than the others. However, this would need to be supported by additional research. This study's comparison of the four fibres revealed that the manufacturing of flax, hemp, and jute fibre has slightly less of an impact on the environment than the other three. Irrigation, the manufacture and emissions of fertilisers, and pesticide emissions are unquestionably environmental hotspots for all fibres. However, LCA of additional industrial processes demonstrates that how fibre is handled during yarn production, processing, and fabric creation can have a variety of effects on the overall life cycle consequences of the finished good.
This study offers high-quality LCA inventory data on the production of jute in West Bengal, flax and hemp in Pratapgarh, Uttar Pradesh, and lint cotton in Punjab. However, while evaluating the findings, it is important to take the study's shortcomings into account. Though the data is primary and meets the majority of requirements, it is vital to keep in mind that it is only one point in the inventory, and using data from a wider range of source points would increase the results' representativeness. The industry data in this study is current, first-hand information, whereas the agricultural models employed were validated data from research centres. Thus, it can be argued that it covers all pertinent pollutants and permits both a thorough LCI setup and LCIA for both industrial and agricultural systems. A description of the consistency of the systems being compared, an assessment of the significance of the differences found, uncertainty and sensitivity analyses, and additional efforts in assessing the precision, completeness, and representativeness of the data used are all necessary for an ISO-compliant comparison of product systems.
The LCA methodology has a drawback in that it only considers resource usage efficiency (in this case, functional unit 1 kg output) and does not permit inferences about the overall effects of complete production systems or the ability of the ecological systems in question to withstand these impacts. Results from the LCIA are merely relative indicators of possible effects; they do not forecast actual effects.
There is room to examine many more environmental categories that are developed in the LCA technique, which could enlarge our understanding of how fibres perform in terms of the environment (e.g. particulate matter, smog creation). In light of the aforementioned observations and the fact that the social and economic dimensions of sustainability have not yet been touched upon, it is clear that additional factors must be taken into account in order to arrive at a comprehensive evaluation of the sustainability of various products.

5. References
1. Hawley J. Economic impact of clothing and textile recycling. In Hethorn, J. & Ulasewicz, C. (Eds.) Sustainable fashion: Why now? New York: Fairchild; c2008. p. 207-232.
2. David P, Ealender M, Watson D, Kiorboa N, Salmenpera H. Towards a Nordic Textile Strategy - Collection, Sorting, Reuse and Recycling of Textiles. IVL Swedish Environmental research institute Ltd., Stockholm; c2014.
3. Briga-sá A, Nascimento D, Teixeira N, Pinto J, Caldeira F, Varum H, *et al*. Textile Waste as an Alternative Thermal Insulation Building Material Solution. Construction and Building Materials

2013;38:155-60.
4. Zamani B. Carbon Footprint and Energy Use of Textile Recycling Techniques- Case Study: Sweden. Master thesis report, Chalmers University of Technology; c2011.
5. Glavič P, Lukman R. Review of sustainability terms and their definitions. Journal of Cleaner Production. 2007;15:1875-1885.
6. Brundtland G, Khalid M, Agnelli S, Al-Athel S, Chidzero B, Fadika L, *et al*. World Commission on Environment and Development (WCED). Oxford University Press. USA; c1987.
7. Becker B. Sustainability Assessment: A Review of Values, Concepts, and Methodological Approaches. World Bank; c1997.
8. Hart SL, Milstein M. Creating sustainable value. Academy of Management Executive. 2003;17:56-69.
9. Banat I, Nigam P, Singh D, Marchant R. Microbial decolorization of textile dye containing effluent: a review. Bioresource Technology. 1996;58:217-227.
10. Bakshi DK, Gupta KG, Sharma P. Enhanced biodegradation of synthetic textile dye effluent by *Phenerochaete chrysoporium* under improved culture. World Journal of Microbiology and Biotechnology. 1999;15:507-509.
11. Senan RC, Abraham TE. Bioremediation of textile azo dyes by aerobic bacterial consortium. Biodegradation 2004;15:275-280.
12. Suman K, Anjali P, Asok A. Utilization of silica gel waste for adsorption of cationic surfactant and adsolubilization of organics from textile wastewater: A case study. Desalination. 2011;276:142-147.
13. Antonella A, Barbara P, Federica S, Valeria T, Valeria P, Giovanna CV. Decolourisation and detoxification in the fungal treatment of textile wastewaters from dyeing processes. New Biotechnology. 2011;29:38-45.
14. Iva R. Determination of engineered nanoparticles on textiles and in textile wastewaters. Trends in Analytical Chemistry. 2011;30:1159.