

Handmade Paper Industry: A Sustainable Approach to Rural Industrialization and Employment Generation

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Abstract

The handmade paper industry in India is a traditional village-based industry with the potential to contribute to both environmental sustainability and rural economic development. Unlike conventional paper production, handmade paper utilize cotton rags, hosiery waste, agricultural residues, natural fibres and other locally available materials, providing an opportunity to convert waste and underutilized resources into useful and value-added products. This review examines the role of the handmade paper industry in promoting sustainable rural industrialization and employment generation in India. It discusses the use of alternative fibres and waste materials, scope for rural entrepreneurship, livelihood diversification, participation of local communities, along with the environmental benefits and reduced dependence on conventional raw materials. It also highlights the existing challenges faced by the sector, including raw material availability, increasing costs, limited infrastructure, market competition and the need for improved technology and skills. With appropriate institutional support, technological improvement, skill development and better market opportunities, the handmade paper sector can provide greater value to rural resources while creating sustainable livelihood opportunities. The industry therefore has the potential to serve as a link between environmental responsibility, rural entrepreneurship and inclusive economic development. Khadi and Village Industries Commission (KVIC) and the Kumarappa National Handmade Paper Institute (KNHPI) as a research and development wing of Khadi & Village Industries Commission under Ministry of Micro, Small & Medium Enterprises (MSME) has played pivotal role for the said cause.

Keywords: KNHPI, KVIC, MSME, Handmade paper, rural industrialization, Sustainable Industrialisation, sustainable entrepreneurship, India

Introduction:

In India, Handmade paper industry has been identified as one of the village industry and it has witnessed significant growth in recent past because of improved demand of handmade paper not only on national level but also in the international arena [1].

The Institute (Kumarappa National Handmade Paper Institute, Jaipur) came into existence under the UNDP-KVIC project in 1990s for “strengthening the handmade paper industry in India”. The Handmade

paper industry is basically based on Cotton rags and Hosiery waste from textile industries which consist more than 95% of cellulosic content, that's why these raw materials are most preferred in Indian Handmade Paper Industry. Since the Institute came into existence, it has worked on different raw materials like Banana, Jute, Sunn Hemp, Ankara, Daphne, Pineapple, Ramie, Sisal, Paper mulberry, Silk Mulberry etc. which are locally available and easily pulpable with little or no chemicals.

The Industry is highly fragmented varying from a very tiny sized unit (average 200 Kgs per day.) to reasonably sized unit (more than 2 tonnes per day). The industry has achieved remarkable growth in the past, in terms of both production and exports. [2] Handmade Paper Industry normally engages 10-25 personnel depending on the capacity of the unit. The sellable products of this Industry is off the machine just to convert the paper into products like envelopes, file covers, boxes, folders, lamp shades etc. However, in the recent past the industry has been struggling for its sustenance due to various reasons. The most prominent reason encountered is the scarce availability and continuously increasing price of the cotton hosiery waste, one of the commonly and traditionally used raw material for handmade paper making [1].

There are around 500 units of handmade paper, paper boards & products spread all over the India with a installed capacity of about 50,000 tonnes [2]. However, about 50% of these units are fully functional as on date. More than 80% of the handmade paper units exist in the form of clusters located in various regions of the country, some of them are at Kalpi, Sanganer, Kurukshetra, Mehboob Nagar and Pune etc.[3], [5]. As per the recent report, the industry provides employment to about 35,000 skilled, semi-skilled and unskilled people with the annual turnover of 350 crores out of which more than 50% is due to export of paper & paper products [4], [5].

With the growth in various sectors such as education, industry and consumable products, the per capita consumption of paper in India has increased more than double in the last decade from 8 Kgs per capita to 16 Kgs per capita whereas the global average is 57 Kgs per capita. It is expected that by 2030 per capita paper consumption will be 28–30 kg per person in India and 65–70 kg per person worldwide [20]. Handmade paper production meets only less than 0.5% of the India's requirement of paper. Thus, there is a considerable scope for the handmade paper industry for abridging the said gaps by partially replacing the mill made paper with more of handmade paper and paperboard. [6].

Definition and Classification of Handmade Paper

By definition, the paper is a thin layer of mostly cellulosic plant fibre, produced on a screen by dewatering slurry of fibre. The water slurry is called pulp. Despite recent developments (proteinic or synthetic fibre, chemical additives, coatings etc), the cellulosic plant fibres are the main, not exclusive, component of paper and water is used in preparing the pulp and in forming the paper web [7].

The classical definition of handmade paper or board is the paper or board '*produced by hand in the sheet making processes*'. If the sheet is formed by means of a Cylinder Mould and Vat or on a Fourdrinier table, it cannot be called a handmade paper even if the subsequent pressing and drying operations are carried out discontinuously [4]. The above definition has undergone some changes with the course of time and business obligations. KVIC includes paper and boards made in cylinder mould vat / machine (CMV / CMM) up to a maximum deckle width of 105 cm in the handmade paper category. On adoption of Cylinder Mould Vat (CMV) in 1987, KVIC changed the definition of the Handmade Paper as **"the paper made from the pulp sheet by sheet"** [4].

Historical Development of Handmade Paper in India

The history of paper is comparable to the history of human culture and civilization. The Egyptians, Greeks and Romans wrote on “Papyrus”, a paper like material. Today's kind of paper was first developed and used in China [3]. Paper was the most important carrier of information in the past. It was only with increasing paper production that the transfer of knowledge, education and information to a larger portion of society became possible.

Handmade paper manufacturing is one of the traditional industries of the world as its invention in China dated back to 105 A.D. by T'sai Luin who was one of the imperial guards. However, Indians are reportedly credited to have used paper made from cellulosic fibres even during the 3rd century B.C. Prior to this period, the palm leaves were the medium of writing in India. 'Papyrus' from which the word 'Paper' has been derived, on the bank of Nile river in Egypt, has been the medium of communication in Egypt [1][2]

Handmade paper became well known and used along the Silk Route, the ancient overland trading route between China and the West. In the year 751 the Chinese were defeated by Islamic forces in Talas (or Tharaz), a location along the Silk Route in Samarkand [8]. Chinese papermakers [9], were taken as prisoner and forced to work in Samarkand, where there was abundant flax [10]. This story may not be true, but the subsequent change in political control resulted in relatively rapid spread of the handmade papermaking technology, acquired from Chinese papermakers, to Baghdad, and thereby, throughout the Islamic world. Paper was used this time in the dissemination of religious texts [11]. Paper replaced papyrus for making copies of the Koran and for general use. However, in journey to westward down the Silk Route, the papermakers learnt to size the paper sheets by dipping them into solutions of starch or gelatin after their formation, followed by drying them again.

In India, Sangner has 'Kagzi' (paper makers) community who are the primary owner of the handmade paper industry. The Kagzi history goes back to the 14th century when the ruler was Feroz-e-Shah Tughlaq. Even in those days, the royalty used handmade paper made by them for official documents, miniature paintings, calligraphy, and to make copies of the religious book and to maintain account books. In the 16th century, the then ruler of Amber, Raja Man Singh brought the Kagzis to Sangner and settled them on the bank of the river Saraswati, where clean water was easily available. Thus, the town emerged as one of the biggest paper producing centers in north India.

Under the British regime, Indian Handmade paper industry received a serious setback as the British encouraged the import of mill-made paper from the Western countries. By the 1930s, there were only a handful of people from this community practicing their traditional trade [11]. At this point, Mahatma Gandhi provided them the much-needed support by buying handmade paper in bulk for his Ashram and other associates. After independence, the Khadi and Village Industries Commission (KVIC) included handmade paper in the list of crafts to be promoted. Over the years, the Indian handmade paper industry has grown slowly but steadily.

Processing Technologies

Waste textiles I: The trimming of cloth i.e. discarded textile fibres have been a major source of fibres for the manufacture of paper. Scraps left over from the trimming of textiles could have been instrumental in the invention of papermaking. It has been reported that occasional twisted fibres and even some woven fragments of textiles were found in some of the oldest surviving paper specimens from China, giving clear evidence of prior usage as cloth.

Waste textiles II: Rags clearly were used as a major source of fibres when the technology spread along the Silk Route, to the Islamic world, to Europe and then to the United States [8][9]. It would be a mistake to think that rags would be either plentiful or inexpensive relative to other possible fibre sources. Using recycled textiles took time and energy. A possible explanation for using recycled rather than virgin cotton involves the fibre length. In the process of fermenting, then heavily beating the rags, it is reasonable to expect substantial shortening of fibres, reducing the fibres tendency to form flocks [12].

Fibre blends - By blending different types of fibres, papermakers through the ages have achieved combinations of properties that they were unable to produce using only one fibre type. Often it seems that the main goal was to save money, relying mainly on an inexpensive fibre, then supplementing the recipe, as needed, with long, strong fibres suitable for reinforcement. For instance, a minor quantity of long cotton “staple” fibres can overcome a cracking tendency of paper structures made entirely from the linters, which are shorter [12].

Separating the Fibres (Pulping and Beating) - Pulping is the act of separating a lignocellulosic material into its component fibres. Beating (or “refining”) is the application of mechanical action to separate the fibres. In mechanical pulping processes, mechanical energy is used both to separate the fibres from each other and to impart a suitable amount of flexibility to the fibres so that they can be formed into a sheet of suitable uniformity and strength. At the other extreme, chemical pulping operations require much less subsequent application of mechanical energy to separate the fibres, since the chemicals attack the natural binding agent. Between these extremes, represented by pure mechanical pulping of wood, vs. kraft pulping, hand papermakers have achieved different balances between chemical and mechanical treatments, which together result in the conversion of materials into fibres(pulp).

Lignin removal with alkali - Alkaline treatments have been used since ancient times for the pulping of lignocellulosic materials. In the earliest times it is likely that the alkaline solution was prepared mainly from ashes. For instance, in Japan it was common to prepare dilute solutions rich in KOH by first burning straw or reeds, then using water to leach the alkali from the ashes. This type of solution was gentle in comparison to the strongly alkaline solutions used in modern pulping operations. Even with soaking times of an hour or more, the strength of the fibres tended to be preserved. In India they used lime powder for the soaking (retting) of hemp before it was used for papermaking [8]. Hand papermakers in Europe treated rags with alkaline solutions to aid in their conversion to tractable fibres for papermaking.

Rotting and fermenting: Another way to prepare fibres to come apart more easily is to let them rot (or be retted). This technique was widely used in regions where rags were the main source of fibre. The fermented fibres responded quickly to mechanical refining. Sorted piles of rags were washed and then kept wet for up to 6 weeks. Sometimes lime was added to speed up this retting process [13]. The retting of fibres reduced the strength and yield of fibres from a given amount of rags. As paper production grew in Europe, the shortage of rags became critical, and it became increasingly important to avoid loss of material. To maintain a high yield, modern hand papermakers generally skip the retting step, tear rags into small pieces, and use high-quality refining equipment.

Beating or refining of pulp fibres: Papermakers from almost all traditions have applied some kind of pounding or shearing action to the wet fibres either as part of the pulping process (i.e. “mechanical pulping”) or after the fibres have been freed from each other as a result of cooking with alkaline solutions. The effectiveness of pounding or shearing masses of cellulosic fibres can be attributed to their

layered nature. As a result of this structure, repeated compression or shearing tends to cause delamination within the fibre walls, and the fibre surfaces can become fibrillated. The tubular or somewhat rectangular cross-section of many cellulosic fibres tends to become flattened as a result of beating, leading to higher strength of the paper.

Bleaching: Another approach to increasing the brightness of fibres is bleaching. One of the earliest bleaching methods involved exposing the fibres to sunlight. Bleaching became a more effective process after 1792, when chlorine was first used to treat paper pulp [8]. Sometimes a bleaching agent was added before or during the beating operation. Bleaching with chemicals, especially in the early years, caused pollution. Recent advances have reduced the polluting effects of pulp bleaching to very low levels by use of different oxidizing agents like hydrogen peroxide, ozone, chlorine oxide etc. and by effective treatment of wastewaters. Most hand papermakers today avoid the use of bleached pulps, while others incorporate bleaching as a routine practice [13]

Share in Export Market:

World export scenario — Year 2024

Country	Export value (\$)Million
JAPAN	24.223
CHINA	17.840
EUROPEAN UNION	11.435
FRANCE	9.889
INDIA	4.143

Ref: World Bank – World Integrated Trade Solution (WITS). (2026). Hand-made paper and paperboard exports by country (HS 480210) in 2024.

Table: Export figure for India export.

Country	Export value (\$)Million
United States	1.120
United Kingdom	0.978
Germany	0.226
Jordan	0.197
Netherlands	0.143

Ref: (2025, November 6). Paper export from India: Key trends and global opportunities. <https://www.exportimportdata.in/blogs/paper-export-from-india.aspx>

Raw materials evaluated by KNHPI

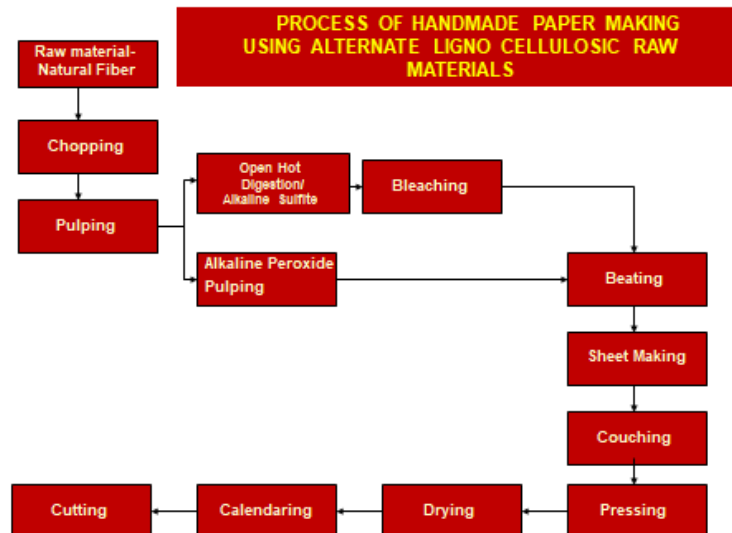
The table given below indicates the raw material from different parts of the Country which has been evaluated so far by KNHPI, Jaipur for its suitability for making Handmade paper. It can increase the opportunities for employment generation thereby increasing their earnings.

COMMON NAME	BOTANICAL NAME	AVAILABILITY
Shogun (Lokta)	<i>Daphne Papyracea</i>	At an altitude of 6000-7000 ft. in Himalayan mountain, Tehri Garhwal, Nainital, Nepal, Tawang District of Arunachal Pradesh.
Pineapple	<i>Ananas Comosus merr.</i>	North-Eastern regions, Part of Karnataka, Assam, Tripura, Manipur, Arunachal Pradesh.
Sunn Hemp	<i>Crotolaria Juncea</i>	Uttar Pradesh, Madhya Pradesh.
Silk Mulberry	<i>Moru Alba</i>	Karnataka, W.B., J&K, Assam, Andhra Pradesh, M.P, TN, Manipur, Orissa, Himachal Pradesh, Bihar
Paper Mulberry	<i>Broussonetia Papyrifera</i>	Himalayan region at an altitude, of 3300 mtrs. Uttarakhand, Karnataka W.B, J&K, Andhra Pradesh, TN.
Bhimal	<i>Grewia Oppositifolia Roxb.</i>	Uttarakhand, HP, Saharanpur (UP) Siwalik forests.
Sisal	<i>Agave Sisalina</i>	Karnataka, Kerala, Orissa, Jharkhand.
Kheep	<i>Leptadenia pyrotechnica</i>	Border region of Rajasthan and Gujarat.
Bodha Grass	<i>Chloroxylon coloratus</i>	Andhra Pradesh
Banana extracted fiber	<i>Musa Sapientum</i>	T N, A P, Kerala, Assam W.B. MP, Bihar, Orissa, Maharashtra
Elephant Dung	<i>Pachyderma dung</i>	Forest department of Cooch Bihar (W.B.)
Jute	<i>Corchorus Capsularis</i>	UP, W.B. Assam, Bihar, Orissa.
Mentha grass	<i>Mentha Piperita</i>	Muradabad, Rampur, Bareilly
Shredded currency	-	Reserve Bank of India
Ankara	<i>Calotropis Procera</i>	Rajasthan, Gujarat, Bihar, UP
Sabai Grass	<i>Eulaliopsis Binata</i>	Bihar, Jharkhand, UP, Orissa.
Common Hemp (Bhang)	<i>Cannabis Satva</i>	UP, Bihar, Rajasthan
Water Hyacinth	<i>Eichhornia Crassipes</i>	T.N. Karnataka, Andhra Pradesh, W.B.
Sun Flower	<i>Helianthus Annuus</i>	Haryana, Punjab, Rajasthan
Aka	<i>Hibiscus Macrophyllus</i>	Rajasthan, MP, UP
Wheat Straw	<i>Triticum Vulgare</i>	Punjab, Haryana, UP, MP, Bihar, Orissa etc.
Rice Straw	<i>Oryza Sativa</i>	UP, Bihar, MP, WB, TN, Uttarakhand, Assam etc.
Bagasse	<i>Saccharum</i>	Maharashtra, UP, Bihar, MP, Haryana, Punjab etc.

	<i>Officinarum</i>	
Mustard Stick	<i>Brassica Juncea</i>	Rajasthan, Gujarat, Bihar, UP
Dhaincha	<i>Sesbania Bispinosa</i>	MP, TN, Karnataka
Lemon Grass	<i>Cymbopogon Ciatrus</i>	Karnataka, Kerala, UP, Assam, Sikkim, Arunachal Pradesh
Besharam (Kolumu)	<i>Ipomea Carnea</i>	Assam, Bihar, Jharkhand, Rajasthan etc.
Aloe Vera	Aloe barbadensis Miller	Rajasthan, Gujarat, Haryana,
Sliver waste	<i>Corchorus olitorius</i>	Karnataka, Kerala, MP, UP,
Cow dung	Bovine feces	Mostly In all states
Waste Paper		Mostly In all states
Soft Bamboo	<i>Dendrocalamus arundinacea</i>	Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, and Tripura.
Junglee Babool	<i>Prosopis juliflora</i>	Gujarat, Rajasthan, Haryana, Punjab, Tamil Nadu
Cotton Rags	<i>Gossypium herbaceum</i>	Maharashtra, Gujarat, Andhra Pradesh, and Karnataka.

Flow Chart for Handmade paper making from Wastepaper, Hosiery waste and alternate lingo-cellulosic raw materials with identified pulping processes





IDENTIFIED/RECOMMENDATED PULPING PROCESSES

- Soda pulping
- Alkaline peroxide pulping
- Urea pulping
- Ash lye pulping
- Oxygen delignification
- Acid Pulping
- Alkaline Sulphite Process

PRODUCT DEVELOPMENT & DIVERSIFICATION

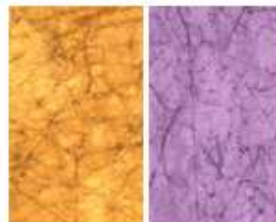
These are some of the handmade paper and its products developed from different raw materials.



VARIETIES OF HANDMADE PAPER



FLOWER PETALS PAPER



BATIK PAPER



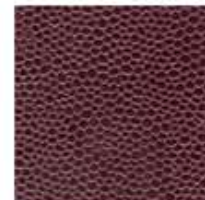
MARbled PAPER



EMBROIDERY PAPER



HAND BLOCK PRINTED PAPER



CROCODILE PAPER

Contribution to Rural Industrialization

The handmade paper industry can play an important role in promoting rural industrialization by creating employment and income opportunities in rural areas. Since the industry can use locally available materials such as agricultural residues, natural fibres, waste paper and textile waste, it helps convert locally available, cheap resources and waste into useful and marketable products. According to the Census of India 2011, India had **640,867 inhabited villages**, providing a broad base for decentralized

economic activities and rural enterprises. At the same time, the rural economy is gradually becoming more diversified, with the share of non-farm employment increasing from **30.19% in 2004–05 to 51.44% in 2023–24**. [14][15] The handmade paper sector can become part of this transition by providing opportunities for rural entrepreneurship.

Employment can be generated not only in paper production but also in raw-material collection, processing, transportation, finishing and the manufacture of value-added products. The industry can also provide opportunities for employment of women and local communities. The importance of handmade paper and fibre-based activities within the rural industrial sector is also reflected in government programmes, where **Handmade Paper & Fibre Industry is recognized as one of the village-industry groups supported through KVIC initiatives**. Thus, by linking local resources with employment, entrepreneurship, skill development and value addition, the handmade paper industry can contribute to a sustainable model of rural industrialization.

Government Policies and Institutional Aids for the Handmade Paper Industry in Rural India

Handmade paper is included among the village industries under the Khadi and Village Industries framework, which gives the sector an institutional base for government support. For rural areas, such support is important because handmade paper units are generally small in scale and often require assistance not only for setting up the unit but also for technology, skill development, finance and access to markets. Over the years, the Government of India, particularly through the Ministry of Micro, Small and Medium Enterprises (MSME), KVIC and related institutions, has introduced several programmes that can directly or indirectly support the sector [16].

1. Gramodyog Vikas Yojana (GVY)

Gramodyog Vikas Yojana (GVY) is one of the most directly relevant programmes for the handmade paper sector. It is implemented by KVIC for the development of village industries and includes a dedicated vertical covering **Handmade Paper, Leather and Plastic Industry (HPLPI)**. The programme helps by strengthening artisans through training, distribution of tools and equipment, technological support and other assistance. This is particularly relevant for rural areas where artisans may possess practical knowledge but have limited access to technology [17].

2. Prime Minister's Employment Generation Programme (PMEGP)

The **Prime Minister's Employment Generation Programme (PMEGP)** is an important financial support mechanism for establishing new micro-enterprises. It is a subsidy programme implemented through KVIC, State Khadi and Village Industries Boards and District Industries Centres.

For the handmade paper sector, PMEGP can help a prospective entrepreneur establish a new production unit by reducing part of the financial burden associated with the project.

3. Scheme of Fund for Regeneration of Traditional Industries (SFURTI)

The **Scheme of Fund for Regeneration of Traditional Industries (SFURTI)** was introduced to improve the productivity and competitiveness of traditional industries by organizing artisans and enterprises into clusters.

The cluster approach is particularly useful for handmade paper because individual small units may find it difficult to invest in common infrastructure, testing facilities, machinery, training or marketing on their own. Under a cluster-based approach, such facilities can be developed collectively. This can also encourage cooperation between artisans, enterprises, raw-material suppliers and other supporting activities.

4. Credit Guarantee Scheme – CGTMSE**5. Procurement and Marketing Support Scheme (PMS)****6. A Scheme for Promotion of Innovation, Rural Industry and Entrepreneurship (ASPIRE)**

ASPIRE was introduced to promote innovation and rural entrepreneurship through mechanisms such as Livelihood Business Incubators and Technology Business Incubators.

Its relevance to handmade paper lies in encouraging rural enterprises to move beyond traditional production methods and explore new products, processes and business models. For example, a rural entrepreneur can potentially develop new handmade paper products, alternative-fibre applications or other value-added products with the support of incubation and technical facilities.

7. Raising and Accelerating MSME Performance (RAMP)**8. MSME Sustainable (ZED) Certification****9. Research, Technology Development and Institutional Support through KVIC and KNHPI**

Government assistance to the handmade paper industry is not limited to financial schemes. **Research, technology development, training and consultancy** are also important forms of institutional support. KNHPI can provide all of these. KVIC has maintained Handmade Paper and Fibre Industry as a distinct village-industry group, while specialized institutional support is available through organizations working in the field of handmade paper technology.

Environmental and Socio-Economic Benefits

The handmade paper industry offers benefits that go beyond the production of paper itself. One of its major environmental advantages is the possibility of using agricultural residues, recycled paper, textile waste and other non-wood fibres as raw materials. This provides an opportunity to convert materials that may otherwise be discarded or poorly managed into useful products. Recent research has also highlighted the importance of agricultural residues as alternative sources for papermaking as they can reduce dependence on wood-based raw materials and support more sustainable resource use [18].

The use of agricultural waste also helps in waste management, better utilization of agricultural waste can reduce environmental problems associated with its improper disposal. In the case of handmade paper, materials such as crop residues and natural fibres can therefore become an additional source of value for rural communities rather than being treated simply as waste [19].

The socio-economic contribution is equally important. Handmade paper production is generally more labour intensive than highly automated paper manufacturing and thus can generate employment for many. It can create opportunities at different stages including collection of raw materials, fibre preparation, papermaking, drying, finishing and the manufacture of value-added products. This makes it suitable for rural and small-scale enterprise development. The small-scale production can support household income and local livelihoods, although challenges such as limited infrastructure, changing consumer demand, intermediaries and competition from cheaper industrial products remain important concerns.

Another important benefit is the potential for livelihood diversification. Rural households involved in agriculture can potentially earn additional income through collection or supply of suitable fibres and residues, while local enterprises can develop products such as handmade stationery, packaging materials, decorative products and seed paper. Government programmes such as the Prime Minister's Employment Generation Programme (PMEGP) also recognize the importance of village based enterprises and traditional industries in creating self-employment and supporting rural livelihoods.

Overall, the handmade paper industry can bring together waste utilization, resource conservation, local employment and rural entrepreneurship. Its environmental and socio-economic benefits are strongest when locally available fibres are responsibly sourced, production uses efficient processes, waste and wastewater are properly managed, and rural producers receive adequate access to skills, markets and technology. Thus, handmade paper can be viewed not simply as an alternative paper product, but as a potential link between environmental sustainability and rural livelihood development.

Conclusion

The Indian handmade paper industry can be said a handicraft industry rather than manufacturing industry because the end products like file covers, folder, carry bags, diaries, photo frames, lampshades, boxes, pen stands, stationery items etc. are marketable items. Government should mandate the use of handmade paper items like files and folders in government offices supporting rural employment.

Some of the Indian handmade papers like Drawing papers, Archival paper/tissue paper have very high export potential because of its eco-friendly nature and high durability. Indian handmade paper has higher strength properties compared to the mill based paper. A standardized Handmade Paper Circularity Index could further provide a quantitative mechanism for benchmarking enterprises and clusters. The competitiveness of handmade paper in the future era should not depend only on its heritage value but also on its long-term viability which shall depend on economic value creation. The transformation from traditional handmade papermaking to sustainable rural circular industry could therefore provide a replicable model not only for India but also for other regions where agricultural residues, traditional knowledge and rural labour coexist with limited industrial infrastructure.

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References

1. Gupta, H. K., Kumar, A., & Agrawal, S. (2001). Role of handmade paper units in improving paper quality and efficiency of recycled waste paper-based mills. *IPPTA Journal*, 13(4), 47–51.
2. Sharma, A. K., & Satyapal. (2011). An overview of Indian handmade paper industry. In *Handmade Paper and Product Souvenir, Paperex-2011*. New Delhi, India.
3. Panda, A., Singh, S. N., Bhoomiah, M., & Khandekar, V. (1995). Handmade paper making in India: Prospects, possibilities and problems. In *International Seminar on Pulp and Paper Industry, Paper-Ex 1995* (pp. 157–187). New Delhi, India.
4. Sycom Projects Consultants Private Limited. (2009). *Market research in Indian handmade paper industry* (Vol. I, p. 1). New Delhi, India.
5. Central Pulp and Paper Research Institute. (2011–2012). *Unpublished report for 12th Five Year Plan for the pulp and paper sector: Submitted to the Planning Commission, Government of India*. Saharanpur, India.
6. Kumar, A., Singh, B. P., Jain, R. K., & Sharma, A. K. (2013). The use of alternate ligno-cellulosic raw materials banana (*Musa sapientum*), ankara (*Calotropis procera*) and pineapple (*Ananas comosus*) in handmade paper & their blending with waste paper. *American Journal of Engineering Research*, 2(9), 171–189.

7. John-Plowman. (2002). *The craft of handmade paper*. The Apple Press.
8. Bloom, J. M. (2001). *Paper before print: The history and impact of paper in the Islamic world*. Yale University Press.
9. Blum, A. (1934). *On the origin of paper*. R. R. Bowker Co.
10. Hunter, D. (1939). *Papermaking by hand in India*. Prynson Printers.
11. *Khadigramodyog: The journal of rural economy*, 41(9–10). (1995, June–July).
12. Kerekes, R. J., & Schell, C. J. (1992). Characterization of fiber flocculation regimes by a crowding factor. *Journal of Pulp and Paper Science*, 18(1), J32–J38.
13. De Lalande, J. le Français. (1976). *The art of papermaking* (R. M. Atkinson, Trans.). The Ashing Press. (Original work published 1761)
14. Office of the Registrar General & Census Commissioner, India. (2011). *Primary census abstract: A-01—Number of villages, towns, households, population and area*. Census of India 2011.
15. Ministry of Rural Development, Government of India. (2026). *Non-farm employment in rural ndia*.
16. Ministry of Micro, Small and Medium Enterprises, Government of India. (2025). *MSME schemes booklet 2025*.
17. Ministry of Micro, Small and Medium Enterprises, Government of India. (n.d.). *Gramodyog Vikas Yojana: Operational/programme guidelines*.
18. Phiri, R., Rangappa, S. M., & Siengchin, S. (2024). Agro-waste for renewable and sustainable green production: A review. *Journal of Cleaner Production*, 434, 139989. <https://doi.org/10.1016/j.jclepro.2023.139989>
19. *Insights into lignocellulosic fiber feedstock and its impact on pulp and paper manufacturing: A comprehensive review*. (2024). *Sustainable Materials and Technologies*, 40, e00922.
20. Mittal, P. (2024, February 19). New capacities in Indian paper industry, and scenario of demand, expansion and technology. *The Pulp and Paper Times*. <https://thepulpandpapertimes.com/news/new-capacities-in-indian-1005>