Annals of Arid Zone 65(2): 71-80, 2026

Developmental Case Report of Women Empowerment through Sea-buckthorn Based Enterprise in Trans Himalayan Region

Sarla Shashni*

G. B. Pant National Institute of Himalayan Environment, Himachal Regional Centre, Mohal-Kullu 175126, India

Received: February 26, 2026 Accepted: May 29, 2026

Abstract: Women empowerment is key to sustainable development, especially in remote and ecologically fragile regions like the Trans Indian Himalayas. This study explores the role of Sea-buckthorn (*Hippophae* sp.) based enterprises in promoting economic independence, social status, skill development, and environmental conservation among women in the Lahaul & Spiti, Himachal Pradesh. Sea-buckthorn growing wild in the region is locally called as *salla, chharma*, etc. is a hardy and nutrient-rich species, providing income opportunities through the production of high value products, such as food supplements. The species also aids in soil erosion prevention and land rehabilitation in the barren areas of the region. Technological interventions in enterprise development foster both skill growth and economic resilience. The study also highlights how sea-buckthorn enterprise enhance women's socioeconomic status, strengthen local livelihoods, and contribute to sustainable development goals. The empowerment of women through environmental stewardship and business leadership in this region offers a model for resilience and can be replicated in areas with similar conditions.

Keywords: Sea-buckthorn, women empowerment, Trans Himalaya, livelihood.

Correspondence
Sarla Shashni
sarla.shashni@yahoo.co.in

Citation
Shashni, S. 2026. Developmental case report of women empowerment through Sea-buckthorn based enterprise in Trans Himalayan region. Annals of Arid Zone 65(2): 71-80

https://doi:10.56093/aaz.v65i2.176551

https://epubs.icar.org.in/index.php/AAZ/article/view/176551

In the Indian Himalayan Region (IHR), the Trans Himalayan region covers areas like Ladakh, Lahaul and Spiti (HP), parts of Uttarakhand and Sikkim, where the temperature goes as low as -45°C in winters to +35°C in summers (Jigmet *et al*., 2025). The region is characterized by extreme climatic conditions, remote areas, and fragile ecosystems with limited livelihood options, which further constrain socioeconomic development, especially for women (Adhikari *et al*., 2018). At the same time, the region harbors diverse bioresources of significant ecological and economic importance, among which sea-buckthorn (*Hippophae* Spp.) is one of the most important (Stobdan *et al*., 2017; Agnihotri, 2025). Sea-buckthorn (*Hippophae* sp. L.) belongs to the family Elaeagnaceae, is an ecologically and economically important actinorhizal plant of cold desert, in which *Hippophae rhamnoides* L., *Hippophae salicifolia* D. Don, and *Hippophae tibetana* Schultz are the three most common species (Stobdan *et al*., 2017; Shashni, 2021). The species, *Hippophae*

Table 1. Distribution of different species of Sea-buckthorn in Himachal Pradesh

Species	Himachal Pradesh
Hippophae rhamnoides	Tinu, Gemur, Jispa, Darcha, Yangrang, Gondhala, Sumdoh, Shego-Lara, nalda, koloung, Lingthi, Shichling, Kiato, Kiamal, Morang, Miyar Valley, Sumling, Rangrik, Upper Kinnaur
Hippophae salicifolia	Upper parts of Kinnaur, Lahaul, Kaza
Hippophae tibetana	Sangrum, Kibbar Takcha

rhamnoides L., are naturally distributed over the arid, semi-arid and high mountainous ecosystems of Asia, including China, Mongolia, India, Nepal, Pakistan and Russia. Every part of the plant, namely, fruit, leaf, twig, root and thorn has been traditionally used as medicine, nutritional supplement, fuel and fence (Yadav *et al*., 2019; Shashni, 2021). The species is often referred to as the "Golden Bush" owing to its vital role in land rehabilitation, provision of fuelwood, strong soil binding root systems and its high-value nutraceutical properties that have been traditionally utilized (Sharma *et al*., 2015; Tamchos and Dorjey, 2024). Over the past two decades, it has transformed from being regarded merely as a thorny hedge to becoming a valuable resource for sustainable development in the region (Singh *et al*., 2024). In Himachal Pradesh, all three species of sea-buckthorn grow naturally throughout the district of Lahaul and Spiti and some parts of Kinnaur (Table 1). The sea-buckthorn berries are rich in bioactive compounds, antioxidants, vitamins, therefore supporting a rapid growth in the sectors such as food, nutraceuticals, cosmetics and pharmaceuticals (Tamchos and Dorjey, 2024). The fruit is rich in many beneficial nutrients and bioactive compounds, making it useful for the manufacturing of many drugs, cosmetics and food items (Kaushik *et al*., 2025). The cold desert regions of Ladakh and Lahaul-Spiti have a significant natural prevalence of sea-buckthorn, where the plant is locally known by several names such as Tchetalulu, Shangti, Dhurchuk, Chharma, Salla, Tarwaa, Sirmaa, and Chhurmak. In recent years, successful commercialization of sea-buckthorn has led to the emergence of several industries marketing a wide range of value-added products under different brand names (Kaushik *et al*., 2025). In Trans Himalayan region, especially in Ladakh, sea-buckthorn berry processing has been one of the major livelihood activities of the local communities (Dolma and Uniyal, 2025). Similarly, in other parts of the country where sea-buckthorn occurs naturally, its utilization has expanded beyond traditional local consumption, demonstrating an enterprise potential estimated at several hundred crores of rupees (Singh *et al*., 2024; Dolma and Uniyal, 2025). Various case studies from Himachal Pradesh, Ladakh, and Uttarakhand demonstrate that the development of sea-buckthorn value-added products provides a substantial source of income for rural communities in these regions. This livelihood potential can be further enhanced through improved processing technologies, targeted technological interventions, strengthened marketing systems, and cooperative-based enterprise models (Dhyani *et al*., 2011; Singh *et al*., 2012; Dolma and Uniyal, 2025).

In this context, studies conducted in the mountain regions indicate that when women are organized in cooperative natural resource-based enterprises, they get more empowered through income generation, decision-making power, skill development and public visibility (Behl *et al*., 2024; Panta *et al*., 2018; Saripalli *et al*., 2019). The enterprises that integrate women across their value chain from production to marketing have been shown to build women's asset base and market power in remote areas of the country (Panta *et al*., 2018; Saripalli *et al*., 2019; Shrestha *et al*., 2025). Small initiatives and micro level financing can significantly impact women entrepreneurship through skill development, fund utilisation, and market literacy for their overall empowerment (Tiwari *et al*., 2024). Likewise, a small sea-buckthorn products-based enterprise led by women members in the Lahaul and Spiti district of Himachal Pradesh a Trans Himalayan region with a unique convergence of ecological restoration, high-value niche market, and women livelihood diversification, is uniquely converging. The study also demonstrated how organising women around sea-buckthorn cultivation, harvesting, post harvest processing, packaging, labelling, branding and marketing can function as a pathway for multidimensional women empowerment and resilience in the Trans Himalayan regions.

Table 2. Population of Lahaul Valley

Sub-division	Number of households	Total population	Total male	Total female
Lahaul	2222	10218	5415	4803
Udaipur	1869	8889	4482	4407
Total	4091	19107	9897	9210

Material and Methods

The study was conducted in Lahaul and Spiti district of Himachal Pradesh, India, situated in the Trans-Himalayan cold desert region characterized by extreme climatic conditions, low precipitation (<50 mm annually), fragile ecosystems, and limited livelihood opportunities. The district extends over approximately 13,835 km² between 31°44′57″N-32°59′57″N latitude and 76°29′46″E-78°41′34″E longitude. According to the 2011 Census, Lahaul Valley consists of 286 villages, housing a population of 19,107 across approximately 4,091 households (Table 2). Geographically, the valley is divided into three major sub-regions: Tinan, Todh (comes under the Keylong divison) and Pattan valley (comes under Udaipur sub tehsil). A participatory action research framework combined with a case study approach was adopted to evaluate the role of sea-buckthorn-based enterprise development in enhancing women's livelihood security and socioeconomic empowerment. The intervention involved six Women Self-Help Groups (SHGs) and five Mahila Mandals comprising 187 women beneficiaries selected based on their dependence on natural resources, proximity to naturally occurring sea-buckthorn stands, and willingness to participate in enterprise activities.

The methodological framework integrated capacity building, technological intervention, enterprise development, certification support, and market linkage creation across the sea-buckthorn value chain. Baseline interactions were conducted to understand existing livelihood practices, traditional knowledge of sea-buckthorn utilization, and constraints related to income generation and value addition. Structured training programs were organized to enhance technical skills in sustainable harvesting, hygienic handling, cleaning, grading, processing, packaging, branding, entrepreneurship development, and

Table 3. Number of training programs

Particulars	Total no of trainings	Detailed activities covered
Training on Sea-buckthorn (Environmental aspects, harvesting and post harvesting techniques) (1 days)	6	Training was provided to raise awareness about the importance of sea-buckthorn and its benefits for the Trans-Himalayan region and local communities. Participants were guided on the optimal timing and quantity of harvesting leaves and berries, ensuring they are collected at peak maturity for maximum nutritional value. Additionally, post-harvest practices were emphasized, including proper handling, transportation, cleaning, processing, and storage of the produce to maintain quality before and after processing.
Training on drying techniques of leaves and berries (1 days)	8	Training was provided on drying techniques for sea-buckthorn leaves and berries using microwave and solar dryers available in the unit. Additionally, small-scale manual drying methods were demonstrated to the stakeholders. The utilization of these quality-dried leaves and berries, along with appropriate marketing strategies, was also discussed with the participants.
Value addition (2 days) at Unit level for 10 members	5	Training was provided on value addition aspects, including the development of products such as tea, juice or pulp, jam, and processed berries, along with guidance on their proper storage before and after packaging.
Packaging and labelling (1 days)	5	Training was provided on packaging products in various forms and capacities, along with proper labeling to include details such as nutritional composition, date of manufacture, expiry/use-by date, certifications, and other relevant information to enhance acceptability among consumers.
Marketing strategies	3	The training covered the use of various marketing platforms for product sales at local, regional, and national levels. Beneficiaries were also instructed in record-keeping related to sales and profits, as well as the maintenance of retail and wholesale accounts.

financial literacy. Hands-on demonstrations and exposure-based learning methods were employed to strengthen women's participation and entrepreneurial confidence. A Technology Incubation Centre established at Jahalma village served as the central processing facility and was equipped with microwave and solar dryers, pulper, steam jacket kettle, bottling and sealing machines, and vacuum packaging units, while decentralized small-scale dryers were distributed among SHGs to enable village-level processing and reduce labor drudgery.

Women groups were facilitated to develop diversified value-added products such as pulp, juices, squashes, herbal tea, jams, dried berries, and seed oil using a zero-waste processing strategy to maximize economic returns through different training programs (Table 3). Product quality assessment and phytochemical analyses were carried out at the G.B. Pant National Institute of Himalayan Environment, Himachal Regional Centre, Mohal-Kullu, followed by standardization, branding, and Food Safety and Standards Authority of India (FSSAI) certification to enhance market credibility. Marketing interventions included participation in regional fairs, exhibitions, and institutional platforms supported by NABARD and other stakeholders, enabling expansion of market access and strengthening of production-processing-marketing linkages. A women-led cooperative society, "Palden Lamo," was formed to institutionalize collective enterprise management and sustain value chain development.

Data on socioeconomic outcomes and enterprise performance were collected through field observations, group discussions, beneficiary interactions, training records, and project monitoring documentation. The impact of the intervention was assessed using qualitative indicators of women's empowerment, including income generation, skill acquisition, participation in decision-making processes, leadership development, social mobility, and awareness of environmental conservation practices. Environmental sustainability was integrated into the methodology through promotion of sustainable harvesting practices and plantation activities aimed at conserving natural sea-buckthorn populations while enhancing soil stabilization and ecosystem restoration in cold desert landscapes.

Interventions and their Impact

Women's Empowerment

Women's SHGs and Mahila Mandals in the region have increasingly adopted sea-buckthorn-based enterprise, positively transforming their economic and social status. Through a series of training programs on pre and post-harvest processing, technological upgradation, financial literacy programs, environmental awareness, and exposure to marketing management, their entrepreneurial skills have been strengthened. These initiatives have further enhanced their financial independence, decision-making capacities, confidence, leadership qualities, social networking, and psychological well-being as also documented by Pandhare *et al*., 2024. Various studies underscore the importance of leveraging community knowledge systems, popularizing indigenous sea-buckthorn products, establishing decentralized processing units, and promoting women-led collective entrepreneurship in mountain regions to achieve socioeconomic equity and ecological sustainability, which is also being done in the current study (Sati and Juyal, 2008; Singh *et al*., 2012; Dey *et al*., 2025). In Himachal Pradesh, where women contribute 90 per cent of the agricultural output, fostering an entrepreneurial culture around sea-buckthorn within the tribal communities can offer strong potential for innovation and support women led grassroots organizations and their livelihood diversification (Parrey, 2021; Khalid, 2022; Rana and Bisht, 2023). Such integrated efforts not only empower women in the Trans-Himalayan region but also contribute to develop a resilient Sea-buckthorn value chain in the region.

Technological Interventions: To ensure quality processing of Sea-buckthorn products, a Technology Incubation Centre was established in Jahalma village, Lahaul and Spiti. The centre was equipped with modern machinery, including a microwave dryer, solar dryer (25 kg capacity), pulper, steam jacket kettle, bottling machine, vacuum sealing machine, simple sealing machine, and weighing machine, among others. This infrastructure aims to facilitate value addition, standardization, and scaling of Sea-buckthorn-based products at the same time reduction in drudgery involved in the activity. Further, small scale drying units of 5 kg capacities were also distributed among

women members for the easy processing of the produce at their village levels. Integrating technological innovation helped in promoting diversified, ecologically balanced, sustainable and women-centric livelihood development in the area, which is also supported by the studies (Singh *et al*., 2012; Dolma and Uniyal, 2025).

Capacity Building and Skill development: A series of training programs were conducted at various sites of Lahaul Valley, where women participants received hands-on training in the collection, cleaning, washing, and processing of sea-buckthorn (Fig. 2). These sessions also highlighted the direct and indirect benefits of sea-buckthorn, including its role in biodiversity conservation and environmental sustainability. Traditionally, the processing of sea-buckthorn was very unhygienic and labor-intensive, as the pulping was done manually or using pressure cookers, resulting in poor quality product with a limited shelf life. Emphasis was placed on the application of modern processing techniques (through mechanized processing), which resulted in a reduction in drudgery involved, quality products, higher return, product diversification and longer shelf life. All these techniques and technologies were designed as to be socially acceptable, economically viable, environmentally sustainable, easy to use which in turn paved the way for resilient future of the enterprise in the Valley. Similar suggestions were also supported bt the studies conducted by Bal *et al*., 2011; Singh *et al*., 2018 and Yadav *et al*., 2019.

Product development: Various value-added products of sea-buckthorn were developed, including pure concentrate pulp, juices, squashes, herbal teas, jams, dried berries, etc. (Fig 1). The leaves, rich in bioactive compounds, are particularly used for preparing herbal teas, which also increases the importance of the sea-buckthorn plant, other than the berries. The various nutraceutical properties of sea-buckthorn leaves are also documented by Sanwal *et al*., 2023. Besides the leaves, all parts of the sea-buckthorn berries were utilized for the development of value-added products, ensuring a zero-waste approach. The dried berries were marketed directly, the pulp was processed into juice and concentrate, pomace was used for preparing tea and other secondary products, and the seeds were extracted for oil. This comprehensive utilization strategy ensured that no part of the berry was discarded, thereby enhancing resource efficiency and economic returns. In recent years, with the increase in health consciousness among people, the demand of sea-buckthorn based products has increased in India as well as worldwide (Stobdan *et al*., 2012). This has created avenues for sea-buckthorn in food and pharmaceutical industries (Bal *et al*., 2011; Christaki, 2012; Koskovac *et al*., 2017; Kaushik *et al*., 2025). Sea-buckthorn is particularly valued for its rich composition of bioactive compounds, including phenolic compounds, carotenoids (lycopene, β-carotene, lutein, and zeaxanthin), flavonoids (isorhamnetin, quercetin, glycosides, and kaempferol), tocopherols, phytosterols, polyunsaturated fatty acids, essential minerals, vitamins, and omega-3, -6, -9, and the rare omega-7 fatty acids. This unique biochemical profile makes it a highly promising resource as a functional food ingredient and dietary supplement for both human and animal health (Dong *et al*., 2023; Mihal *et al*., 2023; Bośko *et al*., 2024; Kaushik *et al*., 2025).

Certification and Branding: Value-added products derived from sea-buckthorn (pulp, juice, tea leaves, and dried berries) were analysed at GB Pant NIHE Mohal, Kullu, for the anti-oxidant properties, bioactive compounds such as phenolic and flavonoids. The phytochemical analysis of leaves of two species of *Hippophae rhamnoides* and *Hippophae salicifolia*, from Lahaul Valley has been done. The study revealed that the male leaves were significantly ($p < 0.05$) superior in total phenols, flavonoids, and tannins, while female leaves were found to have comparable antioxidant activity along with rich aroma-flavor-producing com ponents (Sanwal *et al*., 2023). In this, *H. rhamnoides* species may be preferable for nutraceuticals processing, whereas *H. salicifolia* may be recommended for tea processing because of its rich flavor and aroma components (Mihal *et al*., 2023). Further, for market viability FSSAI certification and branding of the products have also been done, which is necessary as discussed by Parrey, 2021 and Dey *et al*., 2025.

Marketing: Strategic efforts were undertaken to strengthen existing markets and introduce sea-buckthorn products to new consumer segments. In the initial two-year of the project, the financial support for processing, training programs, testing, certification, procurement of

Fig. 1. Sea-buckthorn processing, training, product development and marketing.

raw materials, product development, packaging and labelling was provided under the project. To expand market outreach, products were showcased and sold at various fairs and exhibitions, supported by NABARD, including popular regional events such as Dussehra, Mandi Shivratri, and Aadi Mahotsav, New Delhi, as well as through other platforms like start-ups working in the Himalayan product segments (Fig. 1). These platforms played a key role in promoting awareness and increasing sales of sea-buckthorn-based products. During the project period, these women SHGs have generated an amount of INR 8.5 lakhs as net income through these seabcukthorn based enterprises. According to a study conducted by Kaushik *et al*., 2025, the sea-buckthorn based enterprise is projected to grow at CAGR of 10.39%, increasing from USD 381.4 million in 2024 to USD 837.26 million by 2032, showing a strong potential for commercial expansion. However, such small scale grassroot enterprises require government support, institutional blackening, capital investment and enabling policies for successful establishment and

SOCIAL IMPACT		ECONOMIC IMPACT		TECHNICAL IMPACT		ENVIRONMENTAL IMPACT	
Pre-Project	Post-Project	Pre-Project	Post-Project	Pre-Project	Post-Project	Pre-Project	Post-Project
Members worked as individuals.	187 members now work in groups and participate in seabuckthorn value chain activities.	Involvement in economic activities was very low.	Sustainable increase in income due to seabuckthorn harvesting and related activities.	Drudgery in processing and harvesting was high.	Reduced drudgery due to increased awareness and appropriate technical interventions.	Awareness about seabuckthorn and its ecological importance was almost nil.	Awareness increased considerably.
Mobility opportunities were low.	Mobility and exposure to markets and institutions increased considerably.	Market access for local products was almost non-existent.	Development of products created market opportunities for local producers.	Awareness of techniques and technology was very poor.	Awareness and adoption of improved techniques and simple technologies increased.	Sustainable harvesting practices were almost nil.	Sustainable harvesting practices adopted by beneficiaries.
General awareness about seabuckthorn was low.	Awareness increased due to training sessions, interactions with banks, and government offices.	Knowledge on commercial value was almost absent.	Awareness and skills improved through training and exposure visits under the project.			Processing and value addition of products were very low.	Value addition activities improved due to training on quality standards.
Confidence level was very low.	Confidence improved markedly through regular group meetings and activities.	Record keeping was negligible.	Skills in maintaining accounts improved significantly.			Environmental conservation awareness was very low.	Awareness about environmental conservation and its benefits increased.
Awareness of government schemes was very low.	Awareness and access to various government schemes increased considerably.						

Fig. 2. Pre and post project impact assessment.

growth. (Baig *et al*., 2021; Parrey, 2021; Pandhare *et al*., 2024).

Value chain creation: During the project implementation period, a sea-buckthorn value chain from production and processing to value addition and marketing has been established in the region. Similar findings has been reported by Stobdan *et al*. (2012); Singh *et al*. (2018), who emphasized technology enabled value chain and its importance for sustainable livelihood generation in Himalayan regions. Baig *et al*. (2021) identified mountain value chain development as a strategic approach to strengthening the socioeconomic resilience and climate adaptation among the local communities in Himalayas.

Cooperative formation: To take the activity further and collectively, a cooperative women led society named "Palden Lamo' has been registered at the district level. Studies carried out in the different Himalayan regions show that women and innovation-based enterprises are transforming the lesser-known species from the rural area as high value marketable products, strengthening women's enterprises and linkages among various stakeholders (Sati *et al*., 2008; Adhikari *et al*., 2018; Dey *et al*., 2025).

Environmental sustainability: The activities carried out through the project brought significant transformation across social, environmental, technical and economic sectors among the women beneficiaries. Socially, 187 women members were trained in pre and post harvesting processes of sea-buckthorn which led to stronger collaboration, enhanced household support, an increase in mobility and higher confidence levels. General awareness increased substantially on government schemes, training programs, banks, etc. Environmentally, awareness on the species, its sustainable harvesting, and conservation practices through its cultivation and plantation has also increased considerably. Studies have also shown that 8 to 10 years of plant can fix 180 kg of nitrogen per ha per year and prevent soil erosion and improve overall soil health (Raghuvanshi *et al*., 2019). Economically, involvement in income generating activities has increased from very low to very good through sustainable sea-buckthorn harvesting and processing. Market opportunities for local produce, previously almost non-existent, improved due to product development and value addition, alongside increased understanding of commercial value and improved skills in accounts keeping and record maintenance. Technically, drudgery has been reduced with the introduction of appropriate interventions and enhanced awareness of techniques and technologies. For the long-term sustainability of the enterprise, plantation of the species has also been done throughout the valley, specifically around

agricultural bunds and community areas. The pre and post project impact assessment as been depicted in Fig. 2.

Conclusions

The present study demonstrates that sea-buckthorn-based enterprises in Lahaul and Spiti are economically viable and highly profitable. However, despite its immense commercial potential, awareness among local communities regarding structured commercialization and market expansion remains limited. The project has addressed this gap by establishing an organized value chain system, wherein benefit-sharing begins annually with systematic procurement of sea-buckthorn berries, pulp, and leaves based on crop availability. Progressive scaling of procurement volume, scientific processing, and quality-controlled value addition has directly translated into enhanced economic returns for women members. The establishment of onsite processing units has further created wage-based employment opportunities, enabling women to generate supplementary income beyond seasonal berry collection. Simultaneously, a structured monitoring mechanism has been developed to prevent overharvesting and ensure ecological sustainability, thereby protecting sea-buckthorn populations in their natural habitat.

The initiative represents a replicable niche value-added enterprise model, integrating branding, quality assurance, and structured market linkages. Its replication across other Trans-Himalayan regions can strengthen regional supply chains to meet growing demand while promoting environmental stewardship. Product diversification; including dried berries, pulp, leaf tea, pomace-based products, and other high-value derivatives, has enhanced market resilience and secured long-term livelihood sustainability. Technological interventions have catalyzed a remarkable transformation in women-led enterprises. The introduction of modern processing techniques aligned with traditional knowledge, coupled with targeted skill development programs, has significantly improved product yield and quality. Women entrepreneurs are now actively managing the entire value chain from sustainable harvesting to finished products thereby moving beyond raw material collection to full-scale enterprise management. By leveraging sea-buckthorn's unique nutritional and medicinal attributes, including high vitamin C content, balanced omega fatty acids, and potent antioxidant properties, they are able to command premium prices in regional and online markets.

Beyond income enhancement, the initiative has redefined women's socio-economic roles within their communities. The model demonstrates strong scalability across Lahaul & Spiti, supported by abundant natural resources, cohesive self-help groups, and institutional technical backing. The activity contributes directly to multiple Sustainable Development Goals, including SDG 1 (No Poverty), SDG 3 (Good Health and Well-being), SDG 5 (Gender Equality), SDG 9 (Industry, Innovation and Infrastructure), SDG 12 (Responsible Consumption and Production), and SDG 13 (Climate Action), thereby positioning sea-buckthorn enterprises as an integrated pathway for sustainable mountain development.

Based on the outcomes of the initiative, several recommendations are proposed to strengthen and scale the sea-buckthorn-based enterprise model in the region. These include obtaining Geographical Indication (GI) certification for regional sea-buckthorn to ensure economic and cultural protection, promoting its cultivation for long-term sustainability and conservation, and encouraging product diversification to maintain market competitiveness. In addition, emphasis should be placed on strong branding, development of high-value products, and implementation of quality certification within a sustainable value chain framework.

Acknowledgement

The author is thankful to Director, GBP 'NIHE', Kosi Katarmal, Almora for providing necessary facilities at Himachal Pradesh Regional Center of the Institute and NABARD, Shimla for the financial assistance under Farm Sector Promotional Fund (FSPF).

Competing Interests

The authors declare no competing interests.

References

Adhikari, L., Shrestha, A., Dorji, T., Lemke, E. and Subedee, B. 2018. Transforming the lives of mountain women through the Himalayan nettle value chain: A case study from Darchula, far

west Nepal. *Mountain Research and Development* 38: 4-13.

doi:10.1659/mrd-journal-d-17-00074.1

Agnihotri, V. 2025. Quality, integrity and safety of medicinal and aromatic plants (MAPs) and wild edibles from Indian Himalayan arid regions. *Annals of Arid Zone* 64(4): 493-497.

Baig, S.M., Khan, A.A., Ali, A., Khan, M.Z., Ahmed, S., Shah, G.M. and Ali, G. 2021. Enhancing socioeconomic resilience and climate adaptation through value chain development of mountain products in Hindu Kush Himalayas. *Environment, Development and Sustainability* 23(6): 8451-8473.

Bal, L.M., Meda, V., Naik, S.N. and Satya, S. 2011. Sea buckthorn berries: A potential source of valuable nutrients for nutraceuticals and cosmeceuticals. *Food Research International* 44(7): 1718-1727.

Behl, P., Osbahr, H. and Cardey, S. 2024. New possibilities for women's empowerment through agroecology in Himachal Pradesh, India. *Sustainability* 16(1): 140.

Bośko, P., Biel, W., Witkowicz, R. and Piątkowska, E. 2024. Chemical composition and nutritive value of sea buckthorn leaves. *Molecules* 29(15): 3550.

Christaki, E. 2012. *Hippophae rhamnoides* L. (Sea buckthorn): A potential source of nutraceuticals. *Food and Public Health* 2(3): 69-72.

Dey, A., Sharma, S., Patel, C., Patel, R., Nadeem, A. and Gupta, A.K. 2025. Towards a robust and inclusive entrepreneurial ecosystem: Insights from the Himalayas. *The Journal of Entrepreneurship* 33(4): 925-939.

doi:10.1177/09713557241308014

Dhyani, D., Maikhuri, R. and Dhyani, S. 2011. Sea-buckthorn: An underutilized resource for nutritional security and livelihood improvement of rural communities in Uttarakhand Himalaya. *Ecology of Food and Nutrition* 50: 168-180.

Dolma, T. and Uniyal, S. 2025. Valuing sea-buckthorn (*Hippophae rhamnoides* L.) ecosystem services for sustainable development and livelihood: A case study in Ladakh cold desert. *Forests, Trees and Livelihoods*: 217-229.

Dong, K., Fernando, W.M.B., Durham, R., Stockmann, R. and Jayasena, V. 2023. Nutritional value, health-promoting benefits and food application of sea buckthorn. *Food Reviews International* 39(4): 2122-2137.

doi:10.1080/87559129.2021.1943429

Jigmet, Namgial, Gupta, S.K. and Dawa, S. 2025. Medicinal plants of Sham Valley in trans-Himalayan region of Ladakh, India. *Annals of Arid Zone* 64(3): 405-411.

doi:10.56093/aaz.v64i3.162395

Kaushik, K., Chauhan, M., Singh, D.P., Pant, M. and Pandey, A. 2025. Sea-buckthorn (*Hippophae rhamnoides* L.): An Economically Important Shrub of Cold-Temperate Regions. *Defence Life Science Journal* 10(4): 276-287.

Khalid, A.M. 2022. Developmental success and the sustainability challenge in a mountain region: Case of Himachal Pradesh in India. *International Journal of Regional Development* 9(1): 47-74.

Koskovac, M., Cupara, S., Kipic, M., Barjaktarevic, A., Milovanovic, O., Kojicic, K. and Markovic, M. 2017. Sea buckthorn oil—A valuable source for cosmeceuticals. *Cosmetics* 4(4): 40.

Kumar, P., Mishra, S., Thakur, S., Kumar, D. and Raman, V.A.V. 2024. Vulnerability of tribal communities to climate variability in Lahaul and Spiti, Himachal Pradesh, India. *Coğrafya Dergisi* 47: 29-43.

Mihal, M., Roychoudhury, S., Sirotkin, A.V. and Kolesarova, A. 2023. Sea buckthorn, its bioactive constituents and mechanism of action: Potential application in female reproduction. *Frontiers in Endocrinology* 14: 1244300.

Panta, S. and Thapa, B. 2018. Entrepreneurship and women's empowerment in gateway communities of Bardia National Park, Nepal. *Journal of Ecotourism* 17: 20-42.

Pandhare, A., Bellampalli, P. and Yadava, N. 2024. Transforming rural women's lives in India: The impact of microfinance and entrepreneurship on empowerment in self-help groups. *Journal of Innovation and Entrepreneurship* 13:62.

doi:10.1186/s13731-024-00419-y

Parrey, I.R. 2021. Role of public entrepreneurship in the progress of agricultural produces in Himalayas. *Sustainability, Agri, Food and Environmental Research* 9(2): 297-310.

Raghuvanshi, M.S., Dorjay, N., Singh, R.K., Manjunatha, B.L., Moharana, P.C., Spalbar, E., Stanzin, L. and Saxena, A. 2019. Ladakh traditional farming: An approach to resource utilization under changing climate. *International Journal of Current Microbiology and Applied Sciences* 8(9): 654-666.

Rana, J.C. and Bisht, I.S. 2023. Reviving smallholder hill farming by involving rural youth in food system transformation and promoting community-based agri-ecotourism: A case of Uttarakhand state in north-western India. *Sustainability* 15(11): 1-28.

Sanwal, N., Mishra, S., Sharma, N. *et al*. 2023. Evaluation of the phytoconstituents and bioactivity potentials of sea buckthorn (*Hippophae* sp.) leaves using GC-MS, HPLC-PDA and ICP-MS: a gender-based comprehensive metabolic profiling. *Food Measurement and Characterization* 17: 2767-2781.

Sati, M.C. and Juyal, R.P. 2008. A gender approach to sustainable rural development of mountains. *Mountain Research and Development* 28(1): 8-12.

Saripalli, B., Chawan, V. and Gunta, S. 2019. Empowering subsistence women entrepreneurs in India. *Society and Business Review* 14(1): 71-92

Sharma, A., Singh, V., Dixit, S.P. and Baghla, K. 2015. Role of sea-buckthorn in improvement of soil fertility in cold desert of Himalayas. In *Proceedings of 7th Conference of the International Sea-buckthorn Association*, New Delhi.

Shrestha, A., Acharya, S., Basnet, S. and Pradhan, M. 2025. Forging partnerships for women's economic empowerment: A case of agro-cooperative-based commercialization of legumes in Ramechhap, Nepal. *New Angle: Nepal Journal of Social Sciences and Public Policy* 7(1): 81–95.

doi:10.53037/na.v7i1.66

Singh, A., Butola, J.S., Samant, S.S., Sharma, P., Lal, M. and Marpa, S. 2012. Indegenous techniques of product development and economic potential of sea-buckthorn: a case study of cold desert of Himachal Pradesh, India. *Proceedings of the National Academy of Sciences, India-Section B: Biological Sciences* 82(3): 391-398

doi:10.1007/s40011-012-0042-0.

Singh, S., Thakur, N., Mir, M. and Sarma, U. 2024. Sea buckthorn in cold arid India: A review of ecological, economic and nutritional benefits. *Journal of Mountain Research* 19(2): 143-154.

doi:10.51220/jmr.v19-i2.16.

Singh, V., Sharma, V.K., Tyagi, S.P., Dhaliwal, Y.S. and Sharma, M. 2018. Sea-buckthorn (*Hippophae* L.) technologies for environmental conservation and development of value chain in Himachal Pradesh. *Progressive Horticulture* 50: 92-107.

Stobdan, T., Dolkar, P., Chaurasia, O. and Kumar, B. 2017. Sea-buckthorn (*Hippophae rhamnoides* L.) in trans-Himalayan Ladakh, India. *Defence Life Science Journal* 2(1): 46-53.

Stobdan, T., Korekar, G., Chaurasia, O.P., Balaji, B., Yadav, A., Dwivedi, S.K., Targais, K., Mundra, S. and Srivastava, R.B. 2012. Sea-buckthorn production for greening and sustainable income generation in cold desert of India. In: (Eds. R.B. Srivastava and W. Selvamurthy). *Innovations in Agro Animal Technologies*. Satish Serial Publishing House, New Delhi.

Shashni, S. 2021. Sea-buckthorn (*Hippophae* Sp.): Medicinally, economically and ecologically valuable plants of Trans Indian Himalaya. *ENVIS Bull Himalayan Ecology* 29: 95.

Tamchos, S. and Dorjey, K. 2024. *Hippophae rhamnoides* subsp. *turkestanica*: A potential species for sustainable propagation in the cold desert of Ladakh. *National Academy of Sciences Letters* 48: 89-94.

Tiwari, N., Bisht, P. and Singh, P. 2024. The role of microfinance in women's empowerment in the Himalayan region. *ShodhKosh: Journal of Visual and Performing Arts* 5(5): 1649-1658.

Yadav, A., Stobdan, T., Chauhan, O.P., Dwivedi, S.K. and Chaurasia, O.P. 2019. Sea buckthorn: A multipurpose medicinal plant from upper Himalayas. In: *Medicinal Plants* (Eds. N. Joshee, S. Dhekney and P. Parajuli). Springer, Cham.

About the Author

Sarla Shashni is a scientist specialising in socio-economic development, rural entrepreneurship, and small business promotion among Himalayan communities of Himachal Pradesh. She holds a Ph.D in Environmental Science from GB Pant National Institute of Himalayan Environment (GBP 'NIHE') and Shoolini University, Solan, along with a Post-Masters Diploma in Non-Wood Forest Products from FRI, Dehradun. Her work integrates environmental conservation with livelihood generation through community-based and research-driven interventions. She has led and contributed to numerous R&D projects promoting sustainable practices in the Indian Himalayas. She was honored on International Women's Day 2021 by the Social Justice and Empowerment Department, Himachal Pradesh, for her contributions to women's empowerment. Her beekeeping initiative received recognition from NABARD, Shimla, and her Wild Rosehip project was featured as a Success Story by the Department of Science and Technology, Government of India. She served as a member of the Scientific Advisory Committee of GBP 'NIHE' (2017-2021) and represented India at the 55th ICIMOD Board of Governors meeting in Thimphu, Bhutan (2024). She currently serves as Convenor of National Mission of Himalayan Studies (NMHS) TSC-03 on Livelihood Development and Employment Generation. She has authored around 50 publications, completed eight funded projects, developed 51 and updated 159 PBRs of Himachal Pradesh.

Printed in June 2026