

Indigenous Techniques of Product Development and Economic Potential of Seabuckthorn: A Case Study of Cold Desert Region of Himachal Pradesh, India

**Ashok Singh, Jitendra S. Butola,
S. S. Samant, Pankaj Sharma, Manohar
Lal & Sunil Marpa**

**Proceedings of the National
Academy of Sciences, India Section B:
Biological Sciences**

ISSN 0369-8211

Volume 82

Number 3

Proc. Natl. Acad. Sci., India, Sect. B Biol.

Sci. (2012) 82:391-398

DOI 10.1007/s40011-012-0042-0



Your article is protected by copyright and all rights are held exclusively by The National Academy of Sciences, India. This e-offprint is for personal use only and shall not be self-archived in electronic repositories. If you wish to self-archive your work, please use the accepted author's version for posting to your own website or your institution's repository. You may further deposit the accepted author's version on a funder's repository at a funder's request, provided it is not made publicly available until 12 months after publication.

Indigenous Techniques of Product Development and Economic Potential of Seabuckthorn: A Case Study of Cold Desert Region of Himachal Pradesh, India

Ashok Singh · Jitendra S. Butola · S. S. Samant · Pankaj Sharma ·
Manohar Lal · Sunil Marpa

Received: 30 December 2010 / Revised: 2 January 2012 / Accepted: 9 February 2012 / Published online: 6 June 2012
© The National Academy of Sciences, India 2012

Abstract Seabuckthorn (*Hippophae rhamnoides* L. subsp. *turkestanica* Rousi, *H. salicifolia* D. Don and *H. tibetana* Sch.), a well recognized multipurpose plant species, is a vital natural resource of cold desert region. The present study was undertaken to document indigenous techniques of product development and assess economic potential of these species in Lahaul and Spiti district, Himachal Pradesh, India. Surveys were conducted in 31 villages each of Lahaul (2,721–3,743 m) and Spiti (3,129–4,172 m) valleys. Comprehensive information on indigenous techniques for development of seabuckthorn products like pulp, tea, jam and wine were documented and cost benefit analysis of the products done. It was observed that selling of pulp is most profitable followed by wine. During the survey, economic potential of seabuckthorn for socio-economic development of the area and major hurdles in the process are thoroughly discussed and documented. Based on the study, the authors advocated that there is an urgent need to (i) initiate value added processes of the products developed through indigenous techniques (ii) popularize the indigenous products locally and outside the districts (iii) establish processing units for seed oil extraction to facilitate optimum use of seeds which is presently being wasted (iv) establish strong linkages for improved marketing and provide financial and technical backup to seabuckthorn co-operative societies and (v) conserve and manage natural populations of seabuckthorn

through executing sustainable harvesting practices and mass plantation (vi) need to remove all the quarries of the grower, harvester, purchaser, product manufacture and market availability concern. The study concludes that tribal communities of the region are great beneficiaries of seabuckthorn and it has great potential and is an important resource to accelerate pace of their socio-economic development.

Keywords Seabuckthorn · Indigenous techniques · Products · Cost–benefit analysis · Economic potential and Cold Desert

Introduction

The Indian Trans-Himalaya represents a distinct biogeographic zone, characterized by distinct cold arid ecosystem that is spread across Himachal Pradesh (Lahaul-Spiti and Kinnaur districts), Jammu & Kashmir (Ladakh and Kargil districts), Uttarakhand and Sikkim. In cold desert environment natural resources are limited and only a few plant genera like *Hippophae* are adapted to cope up with the harsh climatic conditions. Genus *Hippophae* (family-Elaeagnaceae) represents 7 species and 8 sub-species worldwide [1]. All these species are native to Eurasia and commonly called as ‘Seabuckthorn’. The term *Hippophae* is a derived from two Latin words, ‘Hippo’ which means Horse and ‘Phae’ means to shine. In India, four species namely *H. rhamnoides* L. subsp. *turkestanica* Rousi, *H. tibetana* Sch., *H. salicifolia* D. Don and *H. rhamnoides* subsp. *gyantsensis* Rousi are reported to occur [2].

The species of *Hippophae* are widely distributed in China, Pakistan, Mongolia, Russia and other countries of Asia and eastern Europe. It is a dioecious or occasionally monoecious, spinaceous and arborescent shrub varying in

A. Singh · S. S. Samant · P. Sharma · M. Lal · S. Marpa
G.B. Pant Institute of Himalayan Environment and
Development, Himachal Unit, Mohal-Kullu 175 126,
Himachal Pradesh, India

J. S. Butola (✉)
Herbal Research and Development Institute, Mandal,
Chamoli 246 401, Uttarakhand, India
e-mail: butolajs@rediffmail.com

height from 50 cm to a >8 m. It can withstand wide range of temperatures from -43 to 40 °C. This unique feature enables the species to adapt very well in harsh climatic conditions. Its ecological, agricultural, nutritional, medicinal, food, fuel, fodder, timber and ornamental values are well known and fruits are most valuable being a rich source of vitamins A, B₁, B₂, B₅, C, E, K, P, etc. [3–8]. Food products such as syrup, carbonated juice, sweet wine, beer, jam and jelly, etc., prepared by processing the fruits are highly demanded in national and international markets. Besides its economic value, its wide ecological adaptation, rapid growth and easy suckering habit have offered it as a promising species for combating desertification and rehabilitating degraded areas. Its thorny nature provides protection, cover and food for various birds and small rodents [9] and thus forms important habitation for wildlife.

In Himachal Pradesh, three species of seabuckthorn (*H. rhamnoides* L. subsp. *turkestanica* Rousi, *H. salicifolia* D. Don and *H. tibetana* Sch.) are found. All the three species of *Hippophae* are mostly found in Lahaul and Spiti district of Himachal Pradesh. However, *H. salicifolia* D. Don. is recorded in Kinnaur (Baspa valley), Chamba (Pangi area), Kangra (Dhauladhar ranges), Shimla (Dodrakwar) and Kullu (Parvati and Sanj valleys) between 2,000 and 4,500 m asl. It is locally called Chharma, Sutz, Tirkug, Chasterlulu, Sarla or Pilickcha, in Himachal Pradesh; Tsemarang and Chasterlulu in Ladakh; Tare and Taroobo in north-east region and Ames and Chuk in Uttarakhand [6, 10].

Various products of seabuckthorn have consistent demand in regional, national and international markets. To meet the demand of its raw material, it is planted over 500,000 ha in China [11]. However, in India, most of the supply of raw material is mainly done by harvesting the wild populations which are sparse. Recently in India CSK Himachal Pradesh Agriculture University, Palampur has started mass scale plantation of high yielding forms of Seabuckthorn at Lahaul-Spiti district in Himachal Pradesh [11]. Due to over-exploitation, habitat degradation and lack of plantation, it has become threatened in some Indian Himalayan states like Himachal Pradesh and Jammu and Kashmir [12].

Realizing the importance of seabuckthorn for ecological, social and economical development, a number of scientific studies have been undertaken in India [4–8, 10, 11, 13–17] and abroad [18–22]. Modern processing techniques and food value of seabuckthorn products are well known [23–25]. However, indigenous techniques of product development are poorly documented, particularly from cold desert region of IHR except Maikhuri et al. [26]. This paper deals with the findings of a study on documentation of indigenous techniques of product development of seabuckthorn and assesses its economic potential for socio-

economic upliftment of tribal communities of Lahaul and Spiti district.

Material and Methods

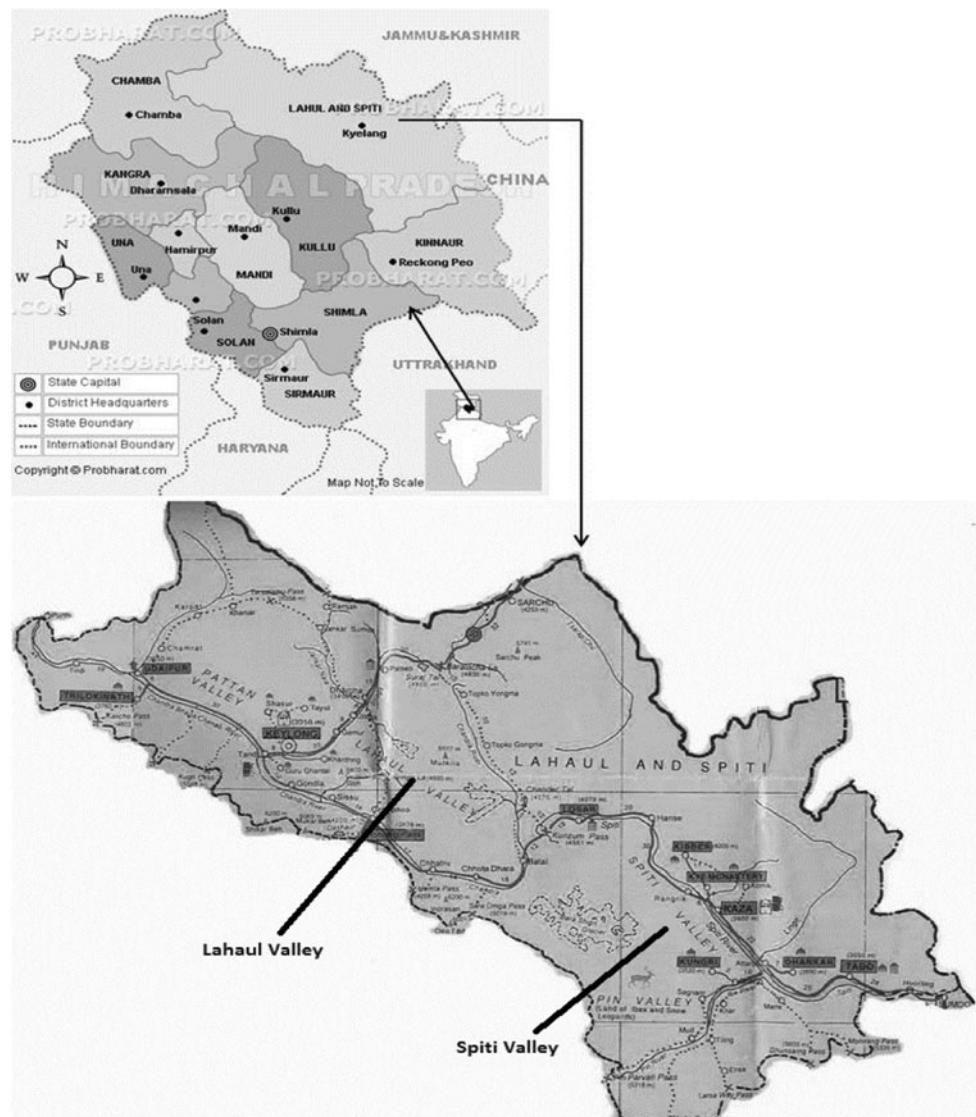
Description of Study Area

Lahaul and Spiti district of Himachal Pradesh are located at $31^{\circ}44'57''$ and $32^{\circ}59'57''$ N Latitudes and $76^{\circ}46'29''$ and $78^{\circ}41'34''$ E Longitudes which extends from 2,400 to 7,000 m asl (Fig. 1). The geographical area of the district is 13,835 km², with total population of 31,835, averaging 2 persons per km². The district faces severe climatic conditions with average rainfall of 25 mm to a maximum of 400 mm (low rainfall); snowfall 3–12 feet (high snowfall) and temperature ranges from -20 to 33 °C. For basic means of life, the local inhabitants are largely dependent on the biodiversity of the area. Of the total 985 species of vascular plants [27], the Seabuckthorn (*Hippophae* spp.) are major dominant tree/shrubby woody species in the riverine, along the road side, irrigation channel side and grasslands habitats. Willow (*Salix* spp.), poplar (*Populus* spp.), walnut (*Juglans regia* L.) and apricot (*Prunus* sp.) are planted under traditional agroforestry systems. Local people practice cultivation of traditional crops like amaranthus (*Amaranthus paniculatus* L.), barley (*Hordeum vulgare* L.), rajmash beans (*Phaseolus vulgaris* L.), maize (*Zea mays* L.) and buckwheat (*Fagopyrum esculentum* Moench and *F. tataricum* Gaertn. Fruct.), cash crops, i.e., pea (*Pisum sativum* L.) and potato (*Solanum tuberosum* L.), cauliflower (*Brassica oleracea* L. var. *botrytis* L.), cabbage (*Brassica oleracea* L. var. *capitata* L.), lettuce (*Lactuca sativa* L.), cut flowers i.e. liliium (*Lilium bulbiferum* L.), gladiolus (*Gladiolus communis* L.) and medicinal herbs, i.e., kuth (*Saussurea costus* (Falc.) Lipsch.), manu (*Inula racemosa* Hook. f.), hops (*Humulus lupulus* L.) and patish (*Aconitum heterophyllum* Wall.).

Survey and Documentation

Extensive and intensive surveys were conducted in Lahaul and Spiti district, of Himachal Pradesh, during June 2006–July 2008. Thirty-one (31) villages of Lahaul valley, i.e., Thiro, Shansha, Rashil, Junda, Kirting, Goushal, Raape, Tholang, Baring, Jahalma, Kamring, Gorma, Raping, Billing, Shashen, Khangsar, Keylong, Khorpani, Mooling, Kardang, Yurnath, Gompathang, Namchi, Trilokinath, Lapchang, Stingri, Gemur, Jispa, Darcha, Yocha and Rarik ranges from 2,721 to 3,743 m and 31 villages of Spiti valley, i.e., Hurling, Sumrang, Tabo, Lari, Kurith, Omrang, Poh, Sesnalla, Sichling, Lingti, Shego, Lidang, Tangtsey, Guling, Goma, Rangrik, Lara, Khar, Sagnum, Kaza,

Fig. 1 Map of study area showing Lahaul and Spiti Valleys



Tailing, Kalapurti, Dankhar, Mikkim, Sumling, Hal, Morang, Kha, Losar, Kibber and Takcha ranging from 3,129 to 4,172 m were surveyed. These villages were surveyed on the basis of occurrence of different species of Seabuckthorn (*H. rhamnoides* subsp. *turkestanica* Rousi, *H. salicifolia* D. Don and *H. tibetana* Sch.) and their extraction and utilization. Every care has been taken to represent each valley in the district because of distinctiveness of climatic and edaphic factors.

Seabuckthorn collectors (co-operative society members, local amchies/larjeys and local people), growers (local people and lamberdars/village head), product manufacturers (co-operative society members, local amchies/larjeys, workers of the functioning seabuckthorn units, and NGO peoples), selling agents and representatives of different government and non-government agencies working on seabuckthorn, were interviewed through random sampling techniques to gather relevant information on indigenous

techniques of product development. The information from current processing units was also gathered. During the survey, economic potential of seabuckthorn for socio-economic development of the area and major hurdle in the process were thoroughly discussed and documented. The quantity of fruits and juice obtained from the individual plant was also practically observed at field site and working processing units in Spiti valley. Cost benefit analysis of the products was done on the basis of cost of the products (in local market), raw materials (like quantity of extraction and availability of berries), rate for purchase of berries @ Rs. 25/kg from local collectors, rate of preservative used, rate of fermenting agent, rate of packing materials bottles/polybags, Kerosene and sugar etc. and labour and transportation cost involved for collection and processing. The use of raw materials varies from type of product to be prepared (Table 1). Other permanent assets (buildings) and equipments were excluded for cost benefit analysis. The

Table 1 Indigenous techniques of product development of seabuckthorn

Sr. no.	Products	Way of preparation
1.	Jam	Fresh fruits are collected in a pan, washed with fresh water and crushed. Juice is extracted with the help of sieve. On an average 1.5 liter juice is obtained from 2.5 kg of fresh fruits. The residue (seeds and pulp) is sun dried and used for making tea. 0.5 kg of sugar is added to the juice and boiled till the formation of jam. The jam is kept in a cool place. After cooling, KMS (Potassium meta Sulphate) or Sodium Benzoate powder is added as preservative to preserve the jam up to 2 years. The jam is stored in the sterilized bottles
2.	Seabuckthorn Pulp	Fresh fruits gathered in a pan are thoroughly washed with running water. After that the fruits are crushed in a jar and sieved with the help of a sieve. The seeds and pulps are separated. The extract is dried and used for making tea. As per the quantity of juice, sugar is added and mixed with the juice. KMS power (0.25–0.30 g/liter) is added in juice to preserve the juice for at least two years. The juice is stored in sterilized bottles
3.	Wine preparation	10 kg of fresh fruits gathered in a pan are washed. After washing, the fruits are crushed. 200–400 g of fermenting agent (enzyme of yeast ready available in the market), locally known as 'Fab', is added in the juice mixture. The mixture is kept for fermentation for 4–6 months. The pot is covered with warm clothes during fermentation period. The fermented juice is distilled with the help of locally made distillation unit. Sweet wine is obtained which is locally known as 'Chang/lugri'. The distilled liquor, locally known as 'Sara' is stored in the sterilized bottles
4.	Tea from fruits	The residue separated from pulp is sun dried for a week. After complete drying, it is packed in boxes. The dried residue is locally known as 'Bangma'. The dried residue is packed in paper bags for sale as 'Seabuckthorn tea'. For preparing 2 cup of tea, 2 cup water, 1 tea spoon of dried residue, a pinch of ordinary tea leaves, ginger and cardamom and 2 tea spoons of sugar/honey/jaggery are boiled in a pan, filtered with a sieve and consumed Similarly, 2 cup of water and 2 tea spoon of sugar are boiled for 5–10 min. After boiling, 2 tea spoon of juice is added and sipped/taken
5.	Tea from leaves	For making tea from the male leaves, the disease free male leaves are collected and washed in running water. Female leaves are also being used for the purpose, but the biochemical constituents are comparatively lesser than male leaves. The leaves are dried under shade for a week. After complete drying, 3–4 dried leaves are added in one cup of water and boiled for 3–4 min. This is locally known as 'Kaaru'. One tea spoon of sugar is added and drunk

income generation of the produce from seabuckthorn was thoroughly assessed at individual concern of the society member, harvestor and seller to different markets. The society member head and lamerdars/village head were interviewed for the average per annual income generation by the individual or village concern.

Results and Discussion

Product Development and Marketing

Government departments (Agriculture, Forest and Horticulture), non-government organizations (MUSE, Eco-sphere Spiti Eco Livelihoods, Pragya, STAG and HMASS), Lahaul-Spiti Seabuckthorn societies, Lahaul potato grower society and private companies (Seabuckthorn INDAGE) are working on various activities pertaining to seabuckthorn in the study region. Out of total villages surveyed, Jispa, Kolong, Gemur, Billing Nallah, Shansha of Lahaul valley and Rangrik, Sego, Tabo, Shunshnag of Spiti valley were found involved in the preparation of seabuckthorn products. However, other villages were engaged in collection and selling of fruits. Among all the units, Shego unit produces maximum products, followed by Rangrik unit then Lahaul Seabuckthorn units at Billing. Most of the product development activities in Lahaul valley were

confined only at house hold level; however in Spiti valley, products are being developed in processing units through co-operative societies and MUSE NGO. Women groups were actively engaged in the whole process (collection and processing) of product development and for marketing purpose of local NGO MUSE and co-operative society members are working.

The indigenous techniques used by the tribal communities for making these products are given in Table 1. Major food products are Seabuckthorn pulp, tea, jam and wine (Fig. 2a–f). Processes of product development are very simple to adopt. All these products are highly beneficial for human health due to the presence of valuable chemical contents. All parts of the plant especially leaves and berries are important source for various biochemical contents. Keeping this in mind, research wing at 'Defence Research and Development Organization' (DRDO), Leh has been supplying these products to the defense personnel posted at borders of the region. Besides, these products are being greatly appreciated and demanded by the tourists and local consumers. The marketing of products under eco-tourism activities is more established in Spiti valley than that in Lahaul valley. The cold climate of the area offers great advantage to keep raw materials and products fresh for a longer time even without adequate storage facilities. This advantage enables the manufactures to sell their products as and when there is high market demand

Fig. 2 *Hippophae rhamnoides* subsp. *turkestanica* in fruiting (a); harvesting of fruits (b); collection of fruits (c); drying and packing of pulp for tea (d); juice selling without any brand name (e); pack of 'Tsering tea' (f)



locally and outside district within territories of Himachal Pradesh. Branded and quality tested products attract consumers, particularly tourists, from different countries and thus, they purchase these products without any hesitation. The people who know the importance of Seabuckthorn products, purchase raw seabuckthorn pulp, juice, tea (berries husk and dried leaf), wine and jam even without a brand name.

Cost Benefit Analysis of the Products

As per input–output analysis, Seabuckthorn pulp and wine are the most profitable products (Table 2). The processing of pulp and tea is very easy; it can be prepared with little effort even also by unskilled labourer. To popularize the products among the customers, tea made of pulp or dried

Table 2 Cost benefit analysis of seabuckthorn products developed by different local co-operative societies in Lahaul & Spiti

Name of products	Rs.		
	Input	Output (market price)	Net profit
Jam (per kg)	100.0	150.0	50.0
Pulp (per l)	80.0	150.0	70.0
Seabuckthorn tea (100 g)	23.0	45.0	22.0
Wine (per l)	110.0	250.0	140.0
Dried leaves (per kg)	35–45	160.0	115–125
Fresh fruits (per kg)	15.0	25–30	10–15

leaves or dried husk of berries is available at local dhabas in the district. A cup of tea is sold at the rate of Rs. 5/-. An approximate 700 cups of tea can be prepared from 1 litre of pulp, as it is very sour. Net profit from the tea made of pulp

is 20 times higher than actual market price of one liter pulp. To prepare one glass of cold drink only one tea spoon each of pulp and sugar is enough.

Selling raw materials (leaves and berries) is also profitable as it does not include processing charges. The price of fresh berries ranges from Rs. 15–25 per kg. The universities and other research organizations are purchasing fruits at the rate of Rs. 70–80 per kg only for research purposes. In both the valleys, a number of households are engaged exclusively in collection and marketing of berries and leaves. Usually the collection of berries is done early in the morning through beating/shaking operation and the harvesting of berries is carried out from September to December. The berries are sold to different co-operative societies. It was estimated that one hectare of Seabuckthorn stands can provide 750–1,500 kg of berries per year. On an average a mature plant of seabuckthorn yields 500 gm to 2,000 g of fresh berries and a maximum of up to 4 kg/plant were recorded in the natural habitat. In a lot of 50 g berries, the number of berries ranges from 590 to 610. The fruit pulp is packed in drums and transported to Delhi or other places for developing the products.

The seed oil of seabuckthorn has great value in pharmaceutical and cosmetic industries. Traditional and modern uses of oil in healing of skin diseases including eczema, burns, healing wounds, sun burn, therapeutic radiation treatment and cosmetic laser surgery are well documented [28]. Unfortunately, there is no any unit in the district undertaking extraction of seed oil and therefore, most of the seeds go waste.

Economic Potential

During 2006–2007, ‘Lahaul-Spiti Seabuckthorn Co-operative Society’ has earned a profit of Rs. 5.5 lakhs per annum from the seabuckthorn products. However, per household income of Darcha village was Rs. 5,000–10,000/annum. Some innovative farmers at village Gemur are practicing such practices since 25 years back and presently earning approximately 1–1.5 lakh rupees/annum on regular basis. From Rangrik and Shego Units on an average of Rs. 2,000–2,500/annum was earned by each member of Kaza Block. The market of seabuckthorn products developed in Ladakh district especially Leh block and Nubra valley is highly established. Recently, fruit pulp worth Rs. 1.4 crore has been sold from the district [29]. As in Ladakh, various national and multinational companies are trying to approach Lahaul and Spiti for setting up industries to develop Seabuckthorn products prior to sufficient supply of raw materials. This has opened new avenues of income for the tribal communities.

Besides indigenous products, other products like multi-vitamin herbal beverage developed by DRDO; “Tsering

tea” (old rate @ Rs. 45/100 g pack and new rate @ Rs. 90/100 g pack) by Spiti Seabuckthorn Society; ‘Spiti Magic Squash’ and ‘Spiti Magic Beverages’ by Ecosphere Spiti Eco Livelihoods, ‘Leh Berry’ (@ Rs. 75/L) juice by Godrej Industries Ltd. at Bhopal (M.P.) in joint venture with Ladakh Foods Ltd. and recently in year 2010–2011 ‘Rohtang Special Squash’ by Lahaul Potato Growers Society are already available in the market. During 2006–2007, 14 tons of berries were collected by co-operative societies with the active involvement of ‘Ecosphere Spiti Eco Livelihoods’ in Spiti valley, which produced 12 tons of pulp.

The above data clearly indicates that seabuckthorn has potential to boost up the economy of the tribal communities. Moreover, the government agencies (like MOE&F, DRDO, ICAR etc.) have prioritized seabuckthorn as the most potential crop for the cold desert region. Financial and technical helps are being provided to the tribal communities and NGOs for mass scale nursery development and plantation of this species. Recently the species of Seabuckthorn were declared under Horticulture crop by the Horticulture Board of India. It will boost the commercial cultivation in the area.

People’ Perception on Potential and Constraints

Until 1990, the local communities, the native peoples of cold desert areas of India were not aware of the high potential of seabuckthorn. Considering it a very ordinary useless and thorny bush they tried to eradicate its populations from the fringes of their cultivated land and even from nearby forests. After consistent motivation by various government and non-government agencies with regard to its huge potential for ecological, social and economic development of the area, the scenario has completely changed. Now, the people have accepted it as useful plant for overall development of the area and at present, a number of research and developmental projects are being run in the region, following participatory approach for its mass plantation.

According to the local people, seabuckthorn supports various means of life in the form of food, medicine, firewood, fodder, timber and congenial environment. During the discussion with local people it was noted that they were aware of the significance of seabuckthorn as an effective soil binder which improves soil fertility by fixing atmospheric nitrogen. As the species is growing in the natural habitats, the older people and farmers know its extent of proliferation of roots for soil binding properties and increase of diversity of herbaceous species underneath of stands. They were enthusiastic to acquire more scientific knowledge about seabuckthorn. Since ancient time, it has been used prominently as fuelwood being one of the rare

resources to support human life during prolonged winter season when high scarcity of fuelwood occurs in the region. The authors estimated that the mean annual collection of fuelwood from seabuckthorn in Lahaul valley is about 875 kg/hh/year and about 1,294 kg/hh/year in Spiti valley [30, 31]. The higher demand and collection of seabuckthorn for fuel wood in Spiti valley is because of the availability of less woody vegetation than in Lahaul valley and its dominance. During summer season, it is browsed by the sheep and goats and lopping is rarely practiced. It is also used to make small agricultural implements and as bio-fence in kitchen gardens and along canals. Besides, fruits are used for making Chutney (indigenous preparation) and pickle. Fruit cake or tea is used to cure severe cold, cough and throat infections. Local people and amchies/larjeys have strong conviction that seabuckthorn fruit juice or tea helps in prevention of intestinal and other forms of ulcer/cancer.

Local people are less aware about the correct identification of *Hippophae* species and therefore, the fruits of all the species are mixed together to develop the products. Particularly, they were unable to differentiate between *H. rhamnoides* L. subsp. *turkestanica* Rousi and *H. salicifolia* D. Don; male and female plants. Moreover, the skilled workers of processing units were less concerned about the type and source (species level) of fruits they used. The authors observed that besides *H. rhamnoides* subsp. *turkestanica* Rousi L., leaves of *H. salicifolia* D. Don. are being used for tea preparation. In some cases, the fruits of *H. tibetana* Sch. were also found to be used for pulp and tea preparation.

As reported by Arimboor et al. [25], the fruits of Indian *Hippophae* species have higher potential compared to the Chinese and Russian *Hippophae*. In spite of this, seabuckthorn is not so much popularized in India. According to the local people, the main constraints being (i) old mind set of people towards cultivation of thorny species (ii) availability of high value cash crops such as Pea, Potato, Kuth, Manu and Hops (iii) difficulty in the harvesting of fruits and leaves because of unmanaged nature of natural stands (iv) natural availability of seabuckthorn near their agricultural lands and habitation since ancient times with less interest to cultivate (v) lack of proper marketing facilities (vi) fear to eradication and control by root suckers because of its high proliferation rate near their agricultural land (vii) demand for introduction of high yielding varieties with lesser thorn (viii) need of sophisticated harvesting equipment for berries and leaves.

Future Approach

Based on the study the authors recommend that there is an urgent need to (i) initiate value addition processes with

proper chemical investigation of the products developed by indigenous technique; (ii) establish processing units for extraction of seed oil (iii) establish strong linkages to improve marketing and provide financial and technical backup to seabuckthorn co-operative societies (iv) conserve and manage natural populations of seabuckthorn through sustainable harvesting practices and mass plantation; and (v) to enhance cultivation of seabuckthorn species on the marginal/barren lands to increase the area under forest cover and also by considering the crop as additional source of income in spite of occurrence of other high yielding cash crops (Pea, potato, Cabbage, Cauliflower, Lettuce, Hops, Kuth, Manu, Liliium etc.).

Conclusions

The present study provides comprehensive information on indigenous techniques of product development and economic potential of seabuckthorn to improve socio-economic status of the people. The information will be helpful for local farmers and policy makers to develop effective action plan for sustainable use and conservation management of seabuckthorn in cold desert region in particular and Himalayan region in general.

Acknowledgments The authors are thankful to Dr. L.M.S. Palni, Director of the Institute for facilities and encouragement. Thanks are also due to Mr. Ram Nath, Ecosphere Spiti Eco Livelihoods, local inhabitants and traders of Lahaul and Spiti for providing relevant information.

References

- Swenson U, Bartish IV (2002) Taxonomic synopsis of *Hippophae* (Elaeagnaceae). Nord J Bot 22:369–374
- Naithani HB (2004) *Hippophae* Linn. (Seabuckthorn) in India: a review. Ind Forester (September), pp 1045–1056
- Singh RP, Bahar N, Prasad B, Gupta MK (1991) Ecological studies on *Hippophae rhamnoides* L. (Seabuckthorn) in the cold desert of Himachal Pradesh. Ann Arid Zone 30:99–122
- Chauhan AS, Rekha MN, Ramteke RS, Eipesen WE (2001) Potential of seabuckthorn in processing of health food: Seabuckthorn—a resource for health and environment in twenty first century. In: Proceedings of International Workshop on Seabuckthorn, 18–21 February; New Delhi, India pp 255–263
- Singh V, Kallio H, Sawhney RC, Gupta RK, Rongsen Lu, Eliseev IP, Khabarov SN, Korovina MA, Skuridin GM, Shchapov NS (2003) Seabuckthorn (*Hippophae* L.) a multipurpose wonder plant. Harvesting and processing technologies. Indus Publishing Co, Delhi
- Singh V, Yang B, Kallio H, Bala M, Sawhney RC, Gupta RK, Jorg-Thomas Morsel, Rongsen Lu, Tolkachev ON (2006) Seabuckthorn (*Hippophae* L.) a multipurpose wonder plant. Vol. II (biochemistry and pharmacology). Daya Publishing House, Delhi
- Singh V, Kallio Yang, B, Morsel, Jorg-Thomas, Sawhney RC, Bala M, Dwevedi SK, Geetha S, Tyagi SP, Li TSC, Rongsen L, Shunguang L, Zubarev YA (2008) Seabuckthorn (*Hippophae* L.):

- a multipurpose wonder plant. Vol. III. Advances in Research and Development. Daya Publishing House, Delhi
8. Singh V, Li TSC, Lu R, Zubarev Y (2008) Seabuckthorn: modern cultivation technologies. Daya Publishing House, Delhi
 9. Hansen NE (1931) The shrubs and climbing vines of South Dakota. Bull. 263. Brookings: South Dakota Agricultural Experiment Station
 10. Dhyani D, Maikhuri RK, Rao KS, Kumar L, Purohit VK, Sundriyal M, Saxena KG (2007) Basic nutritional attributes of *Hippophae rhamnoides* (Seabuckthorn) populations from Uttarakhand Himalaya, India. *Curr Sci* 92:1148–1152
 11. Singh V, Sharma VK, Sharma M, Tyagi SP, Dhaliwal YS, Rana RK, Saini JP, Pathania P, Lal M, Singh Ashok, Sharma RK, Sharma V, Devi R, Kumar R (2010) Fifteen years of research on seabuckthorn in CSK Himachal Pradesh Agriculture University, Palampur. In: Singh et al (ed) Proceedings of national conference on Seabuckthorn: emerging trends in Production to Consumption, 16–18 February, Palampur, HP
 12. Ved DK, Kinhal GA, Ravikumar K, Prabhakaran V, Ghate U, Vijaya Shankar R, Indresha JH (2003) Proceedings of the workshop on conservation assessment and management prioritization for the medicinal plants of Jammu & Kashmir, Himachal Pradesh & Uttaranchal, 22–25 May, Shimla, Himachal Pradesh, India
 13. Anonymous (1997) The wealth of India, raw materials, vol. II. CSIR Publications, New Delhi
 14. Singh RP, Jishtu V, Negi DV (1997) Studies on nursery techniques of *Hippophae rhamnoides* L. in Spiti valley of Himachal Pradesh. *Ann Arid Zone* 30:99–122
 15. Roy PS, Porwal MC, Sharma L (2001) Mapping of *Hippophae rhamnoides* L. in the adjoining areas of Kaza in Lahul and Spiti using remote sensing and GIS. *Curr Sci* 80:1107–1111
 16. Dhyani D, Maikhuri RK, Misra S, Rao KS (2010) Endorsing the declining indigenous ethnobotanical knowledge system of Seabuckthorn in Central Himalaya, India. *J Ethnopharmacol* 127:329–334
 17. Butola JS, Badola HK (2008) Chemical induction of seed germination and seedling growth in Seabuckthorn (*Hippophae rhamnoides* L.): a multipurpose plant species. *J Plant Biol* 35:75–80
 18. Rousi A (1971) The genus *Hippophae* L. a taxonomic study. *Ann Bot Fenn* 8:177–227
 19. Ma YC (1989) Proceedings of international symposium on sea buckthorn (*H. rhamnoides* L.). Yangling, Shaanxi, China
 20. Rong-Sen L (1990) Research on seabuckthorn (*Hippophae* L.) resources in China. *Acta Horti Sin* 3:177–183
 21. Rong-Sen L (1992) Seabuckthorn: a multipurpose plant species for Fragile Mountains. Kathmandu, International Centre for Integrated Mountain Development, Nepal
 22. Li TSC (1999) Seabuckthorn: new crop opportunity. In: Janick J (ed) Perspectives on new crops and new uses. ASHS Press, Alexandria, pp 335–337
 23. Li TSC (2002) Product development of sea buckthorn. In: Janick J, Whipkey (eds) Trends in new crops and new uses. ASHS Press, Alexandria, pp 393–398
 24. Lebeda AF (2005) Processing methodologies of Seabuckthorn (*Hippophae rhamnoides* L.) Food Products. In: Singh V (ed) Seabuckthorn (*Hippophae* L.): a multipurpose wonder plant, vol 2. Daya Publishing House, New Delhi, pp 533–541
 25. Arimboor R, Venugopalan VV, Sarinkumar K, Arumughan C, Sawhney RC (2006) Integrated processing of fresh Indian sea buckthorn (*Hippophae rhamnoides*) berries and chemical evaluation of products. *J Sci Food Agric* 86:2345–2353. doi:10.1002/jsfa.2620
 26. Maikhuri RK, Rao KS, Saxena KG (2004) Bioprospecting of wild edibles for rural development in the central Himalayan mountains of India. *Mountain Res Dev* 24:110–113
 27. Aswal BS, Mehrotra BN (1994) Flora of Lahaul Spiti. Bishen Singh Mahendra Pal Singh, Dehradun
 28. Zeb A (2004) Important therapeutic uses of sea buckthorn (*Hippophae*): a review. *J Biol Sci* 4:687–693
 29. Stobdan T, Angchuk D, Singh SB (2008) Seabuckthorn: an emerging storehouse for researchers in India. *Curr Sci* 94(10):1236–1237
 30. Ashok S (2007) Assessment of plant diversity and conservation status of forest vegetation in a cold desert biosphere reserve of North Western Himalaya. Ph D thesis Kumaun University, Nainital
 31. Samant SS, Singh Ashok, Sharma Pankaj, Lal Manohar (2010) Studies on diversity and conservation status of plants in a proposed Cold Desert Biosphere Reserve of Trans and North West Himalaya. Final Technical Report submitted to Ministry of Environment and Forest, Government of India, New Delhi