

Seabuckthorn (*Hippophae* sp. L.): New crop opportunity for biodiversity conservation in cold arid Trans-Himalayas

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ABSTRACT

In India, seabuckthorn (*Hippophae* sp. L.) is widely distributed at high altitude, cold arid Trans-Himalayan regions of Ladakh, Lahul-Spiti, parts of Chamba and upper Kinnaur district of Himachal Pradesh, Sikkim and Arunachal Pradesh. It plays an important role in soil erosion control, slope stabilization, reclamation of degraded and wastelands. The vigorous vegetative reproduction and the strong complex root system with nitrogen fixing ability make seabuckthorn an optimal pioneer plant in soil and water conservation and reforestation for fragile and marginal mountain areas of Trans-Himalayas. It conserves wildlife by providing an excellent habitat for a number of wildlife species. There are ample opportunities to bring change in the livelihoods of high mountain people by utilizing this kind of hidden treasure of the Himalayas.

Key words: Nitrogen fixation, Seabuckthorn, Slope stabilization, Soil and water conservation

Seabuckthorn (*Hippophae* sp. L., Elaeagnaceae) is a winter hardy, deciduous shrub with yellow or orange berries (Bailey and Bailey 1978). It has been used for centuries in Europe and Asia for food and pharmaceutical purposes. In India, it is found along riversides, in mountainous areas, and in sandy and gravel ground at elevations of 2,700 to 5,200 m. above msl. Seabuckthorn is a very rich source of vitamins and important bioactive compounds (Xurong *et al.* 2001). Recently, it has attracted considerable attention from researchers around the world mainly for its nutritional, medicinal and

environmental value.

Distribution of Seabuckthorn in India

In India, seabuckthorn has been found in cold deserts and other regions of Himalayas, comprising the states of Himachal Pradesh, Ladakh in Jammu and Kashmir, Uttarakhand, Sikkim and Arunachal Pradesh. Three species, namely *Hippophae rhamnoides* sub sp. *Turkestanica*, *H. salicifolia* and *H. tibetana* have been found in Indian Himalayas and their general characteristics and distribution have been described in Tables 1 and 2 respectively.

Table 1: General characteristics of Seabuckthorn species found in India (Dwivedi *et al.* 2009)

Species	Distribution	Growing altitude (m)	Plant height	Flowering time	Fruit ripening time
<i>Hippophae rhamnoides</i>	India, China, Tibet, Kyrgyzstan, Kazakhstan, Uzbekistan	600–4,200	5–6 m	May	September–October
<i>Hippophae salicifolia</i>	India, Tibet, Bhutan, Nepal	2,700–3,700	3–10 m	June	October
<i>Hippophae tibetana</i>	India, Tibet, China	3,000–5,200	0.8–1.2 m	May	August–September

Source: Seabuckthorn in Ladakh. In: Seabuckthorn (*Hippophae* spp.): The golden bush. p. 38.

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Table 2: Distribution of Seabuckthorn species in India (Dwivedi *et al.* 2009)

Species (Local name)	Ladakh (Tsermang)	Himachal (Chharma)	Uttarakhand (Ames, Chuk, Chu)	North East (Tare, Tarooobo)
<i>Hippophae rhamnoides</i>	Indus, Nubra, Suru, Changthang valley	Kukumsari, Lakauk, Kaza, Tabo, Kaza,	–	–
<i>Hippophae salicifolia</i>	–	Lahaul	Yamunotri, Kai, Badrinath, Gori, Harindun, Buddi, Dharma, Bagnitiyar	Lachen, Lanchug, Dormang
<i>Hippophae tibetana</i>	Zaskar	Sangrum, Kibbar, Takcha	Gomukh, Niti, Ranimani, Brtal, Nelung, Shinla, Milan	North Sikkim

Source: Seabuckthorn in Ladakh. In: Seabuckthorn (*Hippophae* spp.): The golden bush. p. 38.

Ladakh is the northern most part of India situated at an altitude of 8,500 to 15,000 ft above msl, lying approximately between 33° to 35° N and 76° to 79° E. The topography is rugged with rocky terrains. Valleys are sandy, open, long broad with some water bodies. The region, popularly known as a cold desert, is characterized by severe, arid conditions.

Seabuckthorn is the only dominant woody plant of this region. It has been reported that seabuckthorn is growing in Indus, Nubra, Zaskar and Suru vally of Ladakh region. It grows well on the riverbeds and mountain slopes upto 4,200 m above msl. Satellite imagery conducted by Defence Institute of High Altitude Research, DRDO in collaboration with Defence Electronics Application Laboratory, DRDO, Dehradun has found about 11, 500 ha under pure Seabuckthorn stand and 30,000 ha under mixed forest plantation in the Ladakh region (Dwivedi *et al.* 2003).

Role of Seabuckthorn in Biodiversity Conservation

Seabuckthorn as an effective nitrogen fixer: Seabuckthorn has a highly efficient relationship with a bacterium of the genus *Frankia*, which is mainly found in the root nodules of non leguminous plant. This symbiotic relationship allows it to convert atmospheric nitrogen to a form that can be used for nutrition. Root nodules of Seabuckthorn have been found to fix as much as 180 kg N/ha/year, which generally improves soil fertility (Jike and Xiaoming, 1992). The resulting improved root growth enhances the entire soil ecosystem in the form of rich organic matter, more oxygen, and more soil organisms, which means more soil biodiversity. The older plant has more root nodules than the

young one and therefore fixes more nitrogen. In one seabuckthorn stand on the east coast of England, annual nitrogen fixation was estimated to be 170 kg/ha/year. All of the plant's characteristics, especially its strong nitrogen-fixing ability and rapid growth, make seabuckthorn a good species for improving soil fertility.

Effect of Seabuckthorn roots on soil nutrition

Seabuckthorn has an extensive and profuse root system. The roots not only grow up and respire in soil but also suck up the moisture and the nutrition materials. In addition, roots, dead body, falling matter and exudates stimulate the activities of the microbes in soil and thus improve entire soil ecosystem. It has been observed that there is a high correlation between seabuckthorn stand and concentration of different nutrients in the soil. As for the effects of seabuckthorn plantations on the soil nutrition, its effects on N, P and K in the soil are higher than those in the farmland and the grassland. Especially, seabuckthorn plantations have an obvious role in improvement of N and the organic matters. From the various study it has been found that whether in the topsoil or subsoil, the order of the correlativity between the percentage contents of nutrient elements in the seabuckthorn roots' surface area is K > P > N > Mg > Ca.

Use of Seabuckthorn for soil and water conservation

Mountain ecosystems are known to be susceptible to human impact. They need conservation and improvement to maintain their ameliorating impact on down stream ecosystems, fresh water resources and social conditions. Seabuckthorn forests in the mountain areas plays a

vital role in the amelioration of different forms of life found on the mountain ecosystem. Certain characters of seabuckthorn such as wide ecological adaptation, fast growth, strong coppicing and suckering habit coupled with efficient nitrogen fixation makes this plant well suited in soil and water conservation, soil improvement and marginal lands reclamation (Rongsen 1992; Khosla *et al.* 1994). Studies have shown that seabuckthorn promotes the growth of other plants like poplars, pines and other tree species in mixed stands (Lei *et al.* 1983; Shi *et al.* 1987). Seabuckthorn shows a strong tolerance for various toxic pollutants in the soil and air. It can thus be used to revegetate heavily industrialized areas or to reclaim mining sites. With its hardy drought resisting attributes, this species is ideal for afforesting marginal areas. China has now well managed seabuckthorn forests covering more than one million hectares for soil and water conservation and fuelwood production. In Canada, Hungary, Russia, Romania and Germany, seabuckthorn has been used to reclaim wasteland or mined areas. In Canada, seabuckthorn is utilized for enhancement of wildlife habitat, farmstead protection, erosion control, riparian protection and mineland reclamation (Schroeder, 1990). A forest of wild seabuckthorn bushes represents characteristics of a good forest on the sloping lands and river valleys, as well as economically productive features of a fruit orchard. Once the plant is established it propagates naturally very fast. Thereby, it prevents soil and water erosion and enriches the surrounding environment by fixing atmospheric nitrogen. It is an effective soil binder and helps in sand dune fixation in Nubra valley of Ladakh (Singh 2004). It's plantation near river side not only prevents land slides, but also reduces siltation of major river dams. This plant could be propagated near all the major rivers in the trans-Himalayas. So, the Himalayan fragile ecosystem will be protected apart from its economic benefits to the local mountain people. Farmland shelterbelts are important components of agriculture in the cold arid Ladakh region. Seabuckthorn shelterbelts are commonly planted around the edges of fields on farms to provide shelter from the wind and to protect soil from erosion. These shelterbelts modify the climate surrounding the farmlands, reduce energy costs for home heating, filter pollutants and attract beneficial wildlife. The species also provides effective snow trapping during winter periods.

Seabuckthorn for slope stabilization and erosion control

Seabuckthorn can stabilize slopes, reduce surface runoff and stream flow, formed by rainstorm. Therefore, it can change the runoff and sediment transportation characteristics. Together with the change of slope, land tillage method and engineering works in slope and gully, soil erosion may be controlled. The developed root system of seabuckthorn has formed an underground big biomass. Root of a three year old seabuckthorn can expand about 6 m in horizontal level direction and over 2 m in vertical direction. From the various experiment, it was found that surface runoff coefficient in seabuckthorn forestland is only 0–3% at 50 mm daily rainfall (Cifen and Zhao 2003). Various studies clearly proved the function of sediment retention by seabuckthorn stand (Table 3).

Table 3: Accumulated infiltration within 30 minutes in a rainfall (Cifen and Zhao, 2003)

Landform unit	Seabuckthorn forest (mm)	Waste grassland (mm)	Farmland (mm)
Positive slope	708.323	77.160	94.107
Negative slope	179.231	94.767	28.401
Slope bottom	131.788	59.890	64.487
Slope top	205.425	62.642	75.266
Average	306.192	73.615	65.566

Seabuckthorn as habitat for wildlife

It plays a significant role in conserving wildlife by providing an excellent habitat for a number of wildlife species. For promoting wildlife, seabuckthorn may be very valuable, especially in its native range. Many animals use it for food and shelter. In the Ladakh region, the shrubs provide valuable habitat, source of food and protection for the native wildlife like various bird species and small rodents. In the Canadian prairies, seabuckthorn is considered to be valuable habitat for the sharp-tail grouse, Hungarian partridge and pheasant (Schroeder 1995). Observations and surveys show that many birds and animals utilize seabuckthorn for food and shelter (Ma and Sum, 1986).

Strength of Seabuckthorn cultivation in Trans-Himalayan region

If we evaluate the strength of seabuckthorn cultivation in this trans-Himalayan cold desert, it

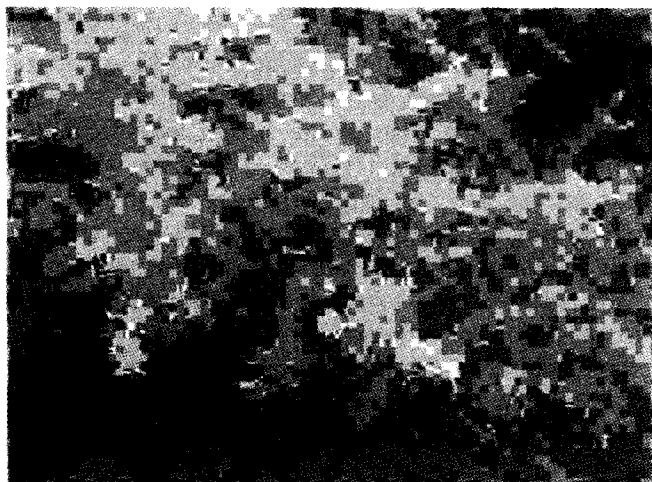


Fig. 1: Seabuckthorn plant with fully ripe orange berry

has immense potential for environmental as well as economic benefits. Seabuckthorn has also become an important source of income generation from fruit and oil extracts (from pulp and seeds) (Anon 2006). The trans-Himalayan Ladakh region has waste lands in its surroundings which could be protected from soil and water erosion apart from enrichment of soil by fixation of atmospheric nitrogen by extensive seabuckthorn plantation. The land slides could be prevented when cultivated in slopes. This plant can also change the socio-economic scenario of local farmers and generate employment opportunities to the local youths.

CONCLUSION

The most promising tool for biodiversity conservation in trans-Himalayas is revegetation and seabuckthorn is one of the species successfully could be used on a large scale. Even though this plant grows naturally in the cold desert Trans-Himalayan region, it has not been given sufficient emphases for its environmental conservation and economic benefits. There are plentiful opportunities to work on genetic diversity, propagation, root nodulation, environmental conservation and medicinal value of seabuckthorn. The local people have so far reaped a small fraction of its benefit despite the great potential of this species. There are ample opportunities to bring change in the livelihoods of high mountain people by utilizing this kind of hidden treasure of the Himalayas.

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