Value Chain Analysis of SEABUCKTHORN (*Hippophae rhamnoides* L.) in Leh Ladakh

November 2017

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Directorate of Arecanut and Spices Development MINISTRY OF AGRICULTURE AND FARMERS WELFARE (Department of Agriculture, Co-operation & Farmers Welfare) Government of India

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EXECUTIVE SUMMARY

Seabuckthorn (*Hippophae* spp. L.) is an ecologically and economically important plant of trans-Himalayan Ladakh. The plant is hardy and it can withstand extreme temperatures from -43°C to 40°C and it is considered to be drought tolerant. Seabuckthorn berries are among the most nutritious of all fruits. The medicinal value of Seabuckthorn was recorded as early as the 8th century in the Tibetan medicinal classic *rGyud Bzi*. Seabuckthorn grows naturally in Ladakh without much of human interference. After the transfer of a Seabuckthorn-based technology by Defence Institute of High Altitude Research (DIHAR) to a private firm in year 2001, collection of berry has become an important income generating activity. The collection period is short and the return is high. Popularity of Seabuckthorn as a source of income can be judged from the appreciation in price of the fresh berry from Rs 8 per kg in year 2001 to Rs 45 per kg in 2017. Currently, the demand for Seabuckthorn has the potential to be a key means of sustainable development for trans-Himalayan Ladakh.

Ladakh remains the major site for natural Seabuckthorn resource with over 70% of the total area (13,000 ha) under Seabuckthorn in the country. Despite the vast area under natural forest, the mean annual berry harvest is less than 5% of the total available Seabuckthorn resource in the region. Primary processing of Seabuckthorn berry is done in Ladakh while various components such as the pulp, seed and hull are segregated for further value addition by firms located outside the region.

This study analyses each link in the value chain of Seabuckthorn in Ladakh region and recommend ways to effectively use the existing resources and improve marketability of Seabuckthorn. The study also undertakes missing links that deter cultivation of Seabuckthorn in the region. Value chain analysis was carried through primary and secondary research. Primary survey involved personal interviews with berry collectors (n=828), farmers (n=567) and processors (n=5). A structured open ended schedule was used to obtain data from Leh and Nubra valley. Qualified personals (graduates and post-graduates) were engaged for collection of data from primary sources. Secondary research was done through available literature and documents available with research institute (DIHAR) and government agencies.

Overview of Seabuckthorn industry

- Total acreage of Seabuckthorn is reported about 3.0 million hectares worldwide (both wild and cultivated cover). Approximately 90% of world's Seabuckthorn is found in China, Mongolia, Russia, Northern Europe and Canada. China is the largest producer of Seabuckthorn.
- Potential of Seabuckthorn in India has been recognized by several R&D organizations. However, Seabuckthorn industry is still in its nascent stages. Total area under Seabuckthorn is 13,000 ha. Approximately 600 tons of berry is harvested annually.
- Ladakh remains the major site for natural Seabuckthorn resource with over 70% of the total area (13,000 ha) in the country.

Seabuckthorn harvesting and processing in Ladakh

• Approximately 500 tons of berry is harvested annually, which is less than 5% of the total available Seabuckthorn resource in the region. This is mainly due to short harvesting

season, coincidence of harvesting period with that of other crops, and unorganized plantation, which all restrict harvesting of only a fraction of the available resource.

- Berry is harvested by hand using 'beat the bush' method in September. Tip of a branch is held with one hand while beating with a stick with the other. Harvested berry is transported to the processing unit.
- Majority of the Seabuckthorn stand is on land under the executive control of Forest Department. Strict regulation is in force regarding time and method of berry collection. Local communities require permission for berry collection from the Forest Department in the area under its jurisdiction.
- Primary processing of Seabuckthorn berry is done in Ladakh and various components such as the pulp, seed and hull are sold to firms located outside the region for further value addition.
- Seabuckthorn berry collection has become an important activity in Ladakh region since year 2001. Berry harvesting is done for a short period of 20-30 days in September. Approximately 0.8% of the total populations of Leh district are directly benefitted from berry collection. Average collection per individual collector was 254.8 kg resulting in a net income generation of Rs 11,466 per head in 5-10 days. The average income generation for an individual who devoted an average of 12.6 days in the season was Rs 25,840.
- Majority of the berry collectors are from the needy section of the society and women constitute 67.4% of the work force.

Value chain mapping and actors in Ladakh

- The major actors in existing value chain are berry collectors, individual farmers, community, processors, Forest Department, commission agents, manufacturers, exporters and research institutes.
- Processors are amongst the most important actors in the value chain. They determine the price of berry and purchase raw material from the berry collectors. They also carry out the primary processing while various other components such as the pulp, seed and hull are sold to manufacturers or commission agents. There are twelve Seabuckthorn berry processors in Leh district.
- Berry collectors are the most valued actors in Seabuckthorn value chain. They harvest berry from Forest/community/private land. They sell the berry directly to the processors. Approximately 1,500 households are engaged in berry collection in Leh district.

Constraints and intervention required in value chain

- Less than 5% of the natural Seabuckthorn available in Ladakh is being harvested. There
 is a need of a Government policy for converting the dense Seabuckthorn forest into
 productive stand.
- Seabuckthorn berry harvesting is a tedious process. Currently berry is harvested by beating the bush method. The harvesting tools at R&D stages need to be studied in field conditions. Commonly used harvesters in other countries such as China, Russia and Canada need to be studied in conditions of Ladakh.

- Seabuckthorn berry is a delicate and highly perishable one. It needs to be processed the same day of harvesting. There is a need to develop cold chain facilities in major Seabuckthorn growing areas to prolong the time between harvest and processing.
- Seabuckthorn harvested in Ladakh are wild harvest. Efforts need to be made to certify Seabuckthorn of Ladakh as organic. There is a need for GI tagging of Seabuckthorn of Ladakh origin.
- Over 90% of the Seabuckthorn harvested in Ladakh are sold after primary processing. Government support is required in providing incentives for developing value added products in Ladakh.
- Market linkage for Seabuckthorn is poor. There are many small players in the value chain. In order to strengthen the market linkages there is a need to set up a single window online system for providing information and services related to Seabuckthorn trade. Local entrepreneurs focus only on selling the raw material. Their risks taking capacity is low, and are fully dependent on demand for raw material from outside the region. Formation of 'Ladakh Seabuckthorn Cooperative Society' comprising of all the local entrepreneurs would strengthen their role in Seabuckthorn value chain.
- There is gap in demand and supply. Demand for Seabuckthorn far exceeds that of the supply capacity of the region. Government policy is required for increasing the raw material supply.

Potential of Seabuckthorn cultivation on vast barren land in Leh Ladakh

- The vast barren land in the region can be brought under Seabuckthorn plantation either by planting along existing water resources or through lifting of water from the rivers. As per an estimate of the Forest Department, 2500 ha of barren land can be brought under Seabuckthorn plantation without much investment in Leh district.
- Cultivation of Seabuckthorn on 2500 ha in Ladakh is projected to result in net income of Rs 491 crore per annum in 2030 from raw material harvesting and its primary processing. Income generation will increase many-fold if value added products are also manufactured in the region.
- Farmers have shown keen interest in growing Seabuckthorn.

Constraints and intervention required in Seabuckthorn plantation

- Seabuckthorn is considered as forest crop. There are no policies or incentives to promote Seabuckthorn as horticultural crop.
- There is no standard package of practices for large scale Seabuckthorn cultivation. Works being done on experimental fields at Defence Institute of High Altitude Research should be continued and carried forward.
- There is no released variety of Seabuckthorn in India. There is a need to undertake multi location trials of high yielding selections available at Defence Institute of High Altitude Research, Leh and CSK HPKV Palampur. There is a need to initiate R&D on varietal development. Commercial varieties available in China, Russia, Mongolia and Canada need to be exploited for varietal trial.
- Vast geographical areas in cold desert are barren primarily due to lack of irrigation. Area under forest cover is only 0.064% and total cropped area is just 0.2% in Leh district. Existing vast barren land can be converted into green patch by planting Seabuckthorn.

Policy Suggestions

Promote Seabuckthorn for National Security: People living along the international border play key role in securing the border. However, in recent years a trend in migration of people living along the international border to the nearby Leh town has been observed due to economic reasons. Promote Seabuckthorn cultivation in villages along the international border to improve the socio-economic status of the villagers and to discourage abandoning their settlement.

National mission on Seabuckthorn: Developmental work on Seabuckthorn needs to be carried on mission mode. There is a need to initiate a National Program on Seabuckthorn.

Focus on Ladakh: Over 70% of the Seabuckthorn natural resource is in Ladakh. Developmental activities on Seabuckthorn, therefore, need to be focused in Ladakh. The successful model can then be replicated in other Himalayan region.

Promote Seabuckthorn as horticultural crop: Seabuckthorn is considered as a forest crop. The crop needs to be declared as a horticultural crop.

Organic certification and GI registration: Seabuckthorn harvested in Ladakh are wild harvest and believed to be superior due to climatic condition of the growing areas. For all activities related to Seabuckthorn, organic certification may be made mandatory. Efforts need to be made for GI tagging of Seabuckthorn of Ladakh origin.

Value added products: Over 90% of the harvested raw material is currently sold outside the region. There is an opportunity for development of value added products in the study area. Hence, government needs to create a favourable environment for the investors through partial support in the form of subsidies, training and skill development on value added products.

Convert thick forest into productive stand: Less than 5% of the natural Seabuckthorn available in Ladakh is being harvested. There is a need to have a government policy for converting the dense Seabuckthorn forest into productive stand.

Convert barren land into green patch: Vast geographical areas in cold desert are barren primarily due to lack of irrigation. Area under forest cover is only 0.064% and total cropped area is just 0.2% in Leh district. There is a need to convert the vast barren land into green patch by planting Seabuckthorn.

Increase raw material: Most of the processors and manufacturers reported non-availability of raw material for large scale commercial activities. Government support is required for scientific cultivation of Seabuckthorn. Involvement of private players for large scale cultivation may also be considered.

Quality planting material: Import commercially available Seabuckthorn varieties from Russia, China, Canada and Mongolia for growing in Ladakh.

Support local entrepreneurs: The local processors are key players in the value chain. They are in need of financial assistance to create infrastructure facility to augment their business prospects. Hence, the banks and government should come forward to provide financial support in addition to technical support.

Chapter 1

INTRODUCTION

S eabuckthorn (*Hippophae* spp. L.) is an ecologically and economically important plant that belongs to the family Elaegnaceae. The species is a wind pollinated dioecious shrub. It has silvery deciduous leaves and colourful red, orange or yellow berries that remain on the shrub throughout the winter. The plant is hardy and it can withstand extreme temperatures from -43°C to 40°C and it is considered to be drought tolerant. The shrub develops extensive root system having ability to fix atmospheric nitrogen. It is therefore an ideal plant for soil erosion control, land reclamation, wildlife habitat enhancement, and farm stand protection in temperate region.



1.1 Nutritional Attributes

Seabuckthorn berries are among the most nutritious of all fruits. Fruit juice is rich in sugar, organic acids, amino acids, essential fatty acids, phytosterol, flavonoids, vitamins and mineral elements. Vitamin C represents a nutrient of major importance in Seabuckthorn because of its presence in large quantities ranging from 53-3,909 mg/100g. Considering that fresh orange juice contains 35-56 mg/100ml and Aonla contains 478.5 mg/100 ml, the value of Seabuckthorn as a source of vitamin C is apparent. It is estimated that there is enough vitamin C in the berries of Seabuckthorn plants across the world to meet the dietary requirements of the entire human population. Besides vitamin C, the juice also contains vitamin A, vitamin E, Riboflavin, Niacin, Pantothenic acid, vitamin B, and vitamin B, Concentration of vitamins B_2 , B_3 , B_5 , B_6 , B_{12} , C and E is much higher than other fruits such as apricot, banana, mango, orange and peach. Presence of these vitamins in high quantity indicates its strong antioxidant property. Seabuckthorn juice is rich in various free amino acids, 18 kinds of free amino acids have been detected in juice of which eight are essential for human body. Seabuckthorn seed is a source of valuable oil characterized by high oleic acid content and one to one ratio of omega-3 and omega-6 fatty acids. Besides, it also contains omega-7 and omega-9 fatty acids. Seabuckthorn leaves contain many nutrients and bioactive substances such as carotenoids, free and esterified sterols, triterpenols, and isoprenols. It contains approximately 15-20% proteins. Flavonoids content in leaves ranges from 312-2100 mg/100 g of air-dried leaves. It serves as a valuable ingredient in animal feed, therapeutic agent having antiviral activity against a wide spectrum of viruses and can be used as a source of unconventional protein for human food.

1.2 Health Applications

Seabuckthorn is mentioned in the writings of ancient Greek scholars such as Theophrastus and Dioscorides. The plant is known as a remedy for horses. Leaves and branches were added to fodder to induce rapid weight gain and shiny coat, and in fact, the generic name Hippophae is classical Latin for 'shinning horse'. The medicinal value of Seabuckthorn was recorded as early as the 8th century in the Tibetan medicinal classic *rGyud Bzi*. In Ladakh region, even today Amchies (local traditional doctors) often prescribed preparations from Seabuckthorn for treatment of common problems like indigestion, throat infection, gynecological problem, ulcer, gastritis, bronchitis, acidity, diarrhea, hypertension, blood disorder, fever, tumor, gallstone, cough, cold, food poisoning etc. There are more than a hundred popular Seabuckthorn-based formulations in various pharmacopoeias of Sowa Rigpa (Tibetan medicine). Modern day laboratory and clinical studies confirm the efficacy of Seabuckthorn for its medicinal properties for treatment of oral mucositis, vaginal mucositis, cervical erosion, duodenal ulcers, skin ulcers, cancer, sluggish digestion, stomach malfunctioning, neoplasia, thrombosis, hepatic injury, tendon and ligament injuries etc. Clinical trials on patients with ischemic heart disease have shown that total flavonoids of Seabuckthorn reduce cholesterol level and improve cardiac function. The oil absorbs ultraviolet light and promotes healthy skin and this unique property of Seabuckthorn oil is being recognized and sought by the cosmetic industry.

1.3 Historical Account

- Seabuckthorn is believed to be the favored food of Pegasus, the winged flying horse of Greek mythology.
- The medicinal value of Seabuckthorn was recorded as early as the 8th century in the Tibetan medicinal classic *rGyud Bzi*.
- There are more than a hundred popular Seabuckthorn-based formulations in various pharmacopoeias of *Sowa Rigpa* (Tibetan medicine). The three major species of Seabuckthorn has been established in Tibetan medicine as Sa-sTar for *H. tibetana*, Bar-sTar for *H. rhamnoides* and Nam-sTar for *H. salicifolia*.
- Seabuckthorn is credited as one of the factors that contributed to the Mongolian Genghis Khan's conquest of a large part of the world during the 12th and 13th century.
- The development of superior Seabuckthorn cultivars was a closely guarded secret under the Russian space program during the space race of the 1960s and 1970s.
- Commercial cultivation of Seabuckthorn started in Russia during the 1920s with development of cultivars for large commercial farms.
- Russian cosmonauts were supplied with Seabuckthorn beverage to enhance their health and resistance to stress. It was the first fruit juice in space.
- Seabuckthorn oil was used by Russian cosmonauts for protection against harmful radiation.
- Seabuckthorn oil is approved for clinical use in China where it was formally listed in the Pharmacopoeia in 1977.

1.4 Distribution of Seabuckthorn in India

Table 1: Distribution of Seabuckthorn (Hi	рро	phae s	sp.)) in	India
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Species	Ladakh	Himachal	Uttrakhand	Sikkim
Hippophae rhamnoides	Indus valley, Nubra valley, Suru valley, Changthang valley	Tinu, Gemur, Jispa, Darcha, Sumdoh, Shego-Lara, Lingthi, Shichling, Kiato, Kiamal, Morang, Sumling, Rangrik, Upper Kinnaur		Nathula
Hippophae salicifolia		Upper Kinnaur, Lahaul, Kaza	Gangotri, Harsil, Yamunotri valley, Har-Ki-Dum, Hanumanchatti, Badrinath, Niti valley, Tambara- Gaurikund, Kali valley, Bogdiar, Gori valley, Budhi, Byanse, Darma	Lachen, Zema I, Zema II, Zema III, Lachung
Hippophae tibetana	Zanskar valley, Changthang valley	Sangrum, Kibbar Takcha	Raini, Niti, Gomukh, Gori valley, Milam, Shin-La	North Sikkim
Total Area (Ha)	9,267	1000	2000	800
Area (%)	70.9	7.6	15.3	6.1

1.5 Seabuckthorn in Ladakh

Ladakh region in trans-Himalaya is home to a number of endemic species and thus provide considerable scope for area-specific comparative advantages. However, indigenous resources with potential comparative advantages remain neglected and the path to development continues to be searched along the conventional lines. Seabuckthorn (*Hippophae rhamnoides* L.) is an ecologically and economically important native plant. Seabuckthorn grows naturally in Ladakh without much of human interference. After the transfer of a Seabuckthorn-based technology by Defence Institute of High Altitude Research (DIHAR) to a private firm in year 2001, collection of berry has become an important income generating activity. The collection period is short and the return is high. Popularity of Seabuckthorn as a source of income can be judged from the appreciation in price of the berry from Rs 8 per kg in year 2001 to Rs 45 per kg in 2017. Currently, the demand for Seabuckthorn has the potential to be a key means of sustainable development for trans-Himalayan Ladakh.

1.6 Valued Added Products

In view of increased production of free radical in human exposed to high altitude, Defence Institute of High Altitude Research developed several antioxidant rich products from fruit and leaf of Seabuckthorn to combat high altitude related oxidative damage. Some of the developed products and its commercialization status are shown in Table 2.

Product	Part Used	Patent (India)
Seabuckthorn beverage	Berry	Granted (231773)
Seapricot beverage	Berry	Filed (635/DEL/2009)
Herbal tea	Leaf	Granted (242959)
Oil capsule	Seed	Filed (1430/DEL/2011)
Seabuckthorn jam	Berry	Granted (195059)
Antioxidant herbal supplement	Berry	Filed (635/DEL/2009)
Adaptogenic appetizer	Berry	Filed (987/DEL/2012)
UV protective oil	Seed	Filed (91/DEL/2010)
UV protective cream	Seed	Filed (2919/DEL/2014)
Feed supplement	Leaf, berry	Filed (1000/DEL/2014)

Table 2: Seabuckthorn based products developed by Defence Institute of High Altitude Research, Leh



Seabuckthorn-based products developed by Defence Food Research Laboratory, Mysore

Bakery products: Biscuits containing certain amount of Seabuckthorn pulp and leaves. The biscuit is rich in dietary fibre, flavonoides and other phyto chemicals. Other bakery products like buns, bread, rusks and cakes have also been developed.

Jelly: Seabuckthorn mixed fruit jelly by blending Seabuckthorn with papaya, watermelon and grapes. The product has an attractive glossy colour with pleasant flavour. Particularly the Seabuckthorn-grape jelly exhibits good organoleptic characteristics with high sensory score.

Health drinks: Health drink such as spiced squash and squash blended with other fruit such as mango, pineapple, apple, guava, grapes etc.

Wine: Wine from Seabuckthorn pulp along with grapes.

Food colourant : Seabuckthorn yellow isolated from the residues after extraction of pulp.

Animal feed : Animal feed from left overs after extraction of colourant.

Yogurt: Yogurt containing Seabuckthorn as major constituent along with milk and bifido bacteria.

1.7 Rationale of the Study

Seabuckthorn grows naturally in five Himalayan States (Jammu & Kashmir, Himachal Pradesh, Uttrakhand, Sikkim and Arunachal Pradesh). Ladakh remains the major site for natural Seabuckthorn resource with over 70% of the total area (13,000 ha) under Seabuckthorn in the country. Using satellite data, it is estimated that area under pure Seabuckthorn in Ladakh is 7184 ha while the area under mixed Seabuckthorn is 2083 ha. Despite the vast area under natural forest, the mean annual berry harvest is less than 5% of the total available Seabuckthorn resource in the region. The annual berry harvest is approximately 500 MT. This is largely due to short harvesting season (20-30 days in September), coincidence of berry harvesting period with that of other crops, and unorganized plantation that restrict harvesting of only a fraction of the available resource. Long distance transportation of fresh berry is challenging since the berry is highly perishable in nature. Primary processing of fresh Seabuckthorn berry is being done in Ladakh and various components such as the pulp, seed and hull are sold to firms located outside the region for further value addition. Development of value added products has been a major challenge. The situation can be improved if gaps in value chain are identified and suitable measures are taken to fill up the gaps. Till date there is no large scale cultivation of Seabuckthorn in the country. Collection of berry is being done from naturally growing Seabuckthorn in the region. However, there is immense potential for sustainable development of Ladakh region through cultivation of Seabuckthorn.

This study analyses each link in the value chain of Seabuckthorn in Ladakh region and recommend ways to effectively use the existing resources and improve marketability of Seabuckthorn. The study also undertakes missing links that deter cultivation of Seabuckthorn in the region.

Objectives

- 1. To improve the value addition of Seabuckthorn at various stages of the value chain
- 2. To study the potential of Seabuckthorn cultivation on vast barren land in Ladakh

Scope of the Study

- 1. To study the missing links in value chain of Seabuckthorn in trans-Himalayan Ladakh
- 2. Suggest measures to increase berry harvest from natural stand
- 3. Suggest measures to improve post harvest losses of Seabuckthorn berry
- 4. Suggest measures to take up Seabuckthorn cultivation on vast barren land



Chapter 2

APPROACH AND METHODOLOGY

2.1 Approach and Methodology

The study was carried through primary and secondary research. Primary survey involved personal interviews with farmers, berry collectors and processors. A structured open ended schedule was used to obtain data from berry collectors, farmers and processors from Leh and Nubra valley. Qualified personals (graduates and post-graduates) were engaged for collection of data from primary sources. Training was imparted prior to data collection. A meeting was organized to obtain data from the local processors. Recommendations made during the National Conference on Seabuckthorn, 22-24 Sept 2017, at Defence Institute of High Altitude Research, Leh Ladakh were also taken into consideration to identify gaps in Seabuckthorn value chain. Secondary research was done through available literature and documents available with research institute (DIHAR) and government agencies.

2.2 Sample Size

Random sampling technique was used to select berry collectors, villagers and processors in Leh and Nubra valley in Leh district. The overall sample size included 828 berry collectors, 567 farmers and 05 processors of the district.



Chapter 3

OVERVIEW OF SEABUCKTHORN INDUSTRY

3.1 World Scenario

Inspired by the ancient literatures, scientists in the former Soviet Union carried out research on Seabuckthorn from the 1930s onward. In 1940s, especially after the Second World War, nutritionists and pharmacologists analyzed the vitamin components and found that Seabuckthorn could be used not only as a food but also as a medicine. Several countries including the Russia, Mongolia, Poland, Germany, Finland, Italy, Norway, Hungary, Canada and USA have been studying this amazing plant. Seabuckthorn is known in different languages as *Shaji* in Chinese; *Duindoorn* in Dutch; *Sanddorn* in German; *Olivello Spinoso* in Italian; *Oblepicha* in Russian; *Tyrni* in Finnish; *Espino de Mar*, *Falso Espino, Espino Amarillo* in Spanish; *Havtorn* in Swedish.

Forty countries including Afghanistan, Azerbaijan, Belarus, Bhutan, Britain, Bulgaria, Canada, China, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, India, Iran, Italy, Kyrgyzstan, Kazakhstan, Latvia, Lithuania, Moldova, Mongolia, Nepal, Netherlands, Norway, Pakistan, Poland, Portugal, Romania, Russia, Slovakia, Sweden, Switzerland, Turkey, Ukraine and Uzbekistan have Seabuckthorn. Total acreage of Seabuckthorn is reported about 3.0 million hectares worldwide (both wild and cultivated cover). Approximately 90% of world's Seabuckthorn is found in China, Mongolia, Russia, Northern Europe and Canada.

China: China is the largest producer of Seabuckthorn. Total area under wild Seabuckthorn is 740,000 ha and that of cultivated field is over 300,000 ha. Seabuckthorn has been used extensively for desertification control. Search for a suitable plant species in terms of survival rate, multiplication and soil improvement coupled with economic benefit has resulted in identification of Seabuckthorn as the most appropriate species for desertification control. Seabuckthorn afforestation through air-seedling has been carried out since the 1950s in the mountainous area of northwestern China. Large area is put under Seabuckthorn cultivation each year in China for berry production as well as eco-environmental improvement. There are over 200 Seabuckthorn-based products available in Chinese market.

Russia: Russians were the pioneer in Seabuckthorn research and product development. The development of superior Seabuckthorn cultivars was a closely guarded secret under the Russian space program during the space race of the 1960s and 1970s. Commercial cultivation of Seabuckthorn started in Russia during the 1920s with development of cultivars for large commercial farms. Seabuckthorn oil was used by Russian cosmonauts for protection against harmful radiation.

Mongolia: Total area under wild Seabuckthorn is 13,500 ha and that of cultivated field is 6000 ha. Mongolia harvested 900 tons berry in 2011 and capable of harvesting 30,000 tons berry annually. The country has adopted National Seabuckthorn Program. Products developed and commercialized include juice, pulp oil, sauce and jam. Approximately 2-3% of Seabuckthorn is exported to Japan, South Korea and Taiwan. Mongolian National Association of Seabuckthorn Growers and Producers (MNASGP) was established in 2007 and is active in promotion of Seabuckthorn in the country.

3.2 Indian Scenario

Potential of Seabuckthorn has been recognized by several R&D organizations. Defence Research & Development Organisation (DRDO) has pioneered the Seabuckthorn research in India and started several R&D projects since early nineties. Biotechnological potential has been recognized by Department of Biotechnology (DBT), Govt. of India, which initiated a project exclusively on Seabuckthorn involving several R&D institutes and universities. Similarly, in the year 2008, Indian Council of Agriculture Research (ICAR) has approved a mega programme 'A Value Chain on Seabuckthorn (*Hippophae* L.)' in which research institutes of ICAR, ICMR and NGOs are collaborative partners. However, Seabuckthorn industry is still in its nascent stages. Total area under Seabuckthorn is 13,000 ha. Approximately 600 tons of berries are harvested annually from wild plants. There is no serious initiative to cultivate Seabuckthorn in the country.

3.3 Ladakh Scenario

Seabuckthorn is considered a means for sustainable development of the region. Area under wild Seabuckthorn is 9267 ha. Ladakh remains the major site for natural Seabuckthorn resource with over 70% of the total area (13,000 ha) under Seabuckthorn in the country. Seabuckthorn berry collection from natural habitat has become an important activity in the region since the year 2001. Approximately 500 tons of berries are harvested annually. Over 90% of the harvested raw material is sold outside the region. Currently the demand for Seabuckthorn of the region far exceeds the supply.



Chapter 4

STATUS OF SEABUCKTHORN HARVESTING AND PROCESSING IN LADAKH

4.1 Berry Harvesting

Berry is harvested by hand using 'beat the bush' method in September. Polythene sheet is placed on the ground just below the canopy. Tip of a branch is held with one hand while beating with a stick with the other. The berries that fall on the polythene are collected in a bucket. Harvested berry is transported to the processing unit in 10 kg capacity food grade plastic tray. Since majority of the Seabuckthorn stand is on land under the executive control of Forest Department, strict regulation is in force regarding time and method of berry collection. Berry collection is allowed only during morning hours when it is easy to harvest without damaging the shrub. Local communities require permission for berry collection from the Forest Department in the area under its jurisdiction. The mean annual berry harvest from 2004 to 2015 is 231 MT (Table 3), which is less than 5% of the total available Seabuckthorn resource in the region. This is largely due to short harvesting season, coincidence of harvesting period with that of other crops, and unorganized plantation, which all restrict harvesting of only a fraction of the available resource. Unlike many other places, berry harvesting is done for a short period of 20-30 days in September. Overripe berries are generally not harvested in Ladakh. The mean percent share of berry processed by private players is 56% as against 44% by the Cooperative Society. The trend is changing as private players are now processing over 90% berry in the region (Table 3).



	Berry	% Berry p	processed	Cost of berry	Selling price of	
Year	harvested (MT)	Cooperative Society	rative Private (Rs iety firms		pulp (Rs/kg)	
2004	170.4	79.0	21.0	15.0	62.0	
2005	328.4	65.4	34.6	15.0	70.0	
2006	196.9	55.4	44.6	16.0	72.0	
2007	286.6	79.0	21.0	23.5	80.0	
2008	138.2	0.0	100.0	23.5	75.0	
2009	166.0	42.6	57.4	23.5	72.5	
2010	90.9	63.0	37.0	24.5	76.0	
2011	160.4	35.4	64.6	25.0	80.0	
2012	183.0	63.4	36.6	28.0	85.0	
2013	297.6	30.7	69.3	32.0	105.0	
2014	180.5	5.5	94.5	32	110.0	
2015	361.3	8.6	91.4	35	120.0	
Mean	231.4	44.0	56.0	24.4	84.0	

Table 3 : Year-wise collection and processing of fresh Seabuckthorn berry in trans-Himalayan Leh Ladakh

4.2 Processing of Seabuckthorn Berry

Reports describing the processing of Seabuckthorn berry are rather limited. An integrated pilot scale patented processing of fresh berry for oil and juice has been described wherein continuous centrifugation and supercritical CO_2 extraction are involved. However, in practice, integrated processing is not done primarily because Seabuckthorn grows in remote Himalayan region in India where use of costly and sophisticated equipments is challenging. Besides, long distance transportation of fresh berry is tricky since the berry is highly perishable in nature and long distance transportation requires maintenance of cold chain. Therefore, primary processing of fresh Seabuckthorn berry is being done at the site of berry collection and various components such as the pulp, seed and hull are sold to firms located outside the region for further value addition. Besides processing fresh berry, dried Seabuckthorn leaf is also being collected from the district since 2011. Every year 1-2 MT of dried leaf is sold at Rs 200-300 per kg.

Berry cleaning : Berry inspection and cleaning is an important step to remove damaged berries, twigs, leaves and other debris collected during harvesting. The first step in cleaning is done by rolling the berry on a wet surface (L×W: 7'6" × 3') placed at an angle of 40-50°. The leaves and damaged berries stick to the wet surface and are removed manually. Twigs and other debris that does not stick to the wet surface are removed by hand. The berry is then washed in water and the remaining leaves and damaged berries that float on the surface are removed with a sieve. Water is drained from the berry before juice extraction.

A schematic diagram of the processing of fresh Seabuckthorn berry is shown in Figure 1. During cleaning process, a loss of 4.73±0.89% (w/w) during rolling and 8.45±2.46% (w/w) during washing was recorded, which together amounts to 13.18±3.0% (w/w). Large quantity of damaged berries, leaves, twigs and other debris in the harvested berry is primarily due to the crude method of berry harvesting.

Juice extraction : Juice extraction from berry is done with a pulper. When cleaned berries are fed into the pulper, pulp (73.82±3.33%) and cake (24.14±2.96%) containing unbroken seeds are obtained (Figure 1). The extracted juice is collected in food grade 50 kg capacity drums and potassium metabisulphate is added as preservative. The pulp is the main marketable component and currently fetches Rs 110-120 per kg. Occasionally, the pulp is passed through filtration unit to get cake and a clear aqueous solution (pH 2.7; TSS 10.6°B). The cake is packed in 50 litre capacity drum for sale. However, the clear aqueous solution remains unused. The cake containing unbroken seed



Figure1: Primary processing of fresh Seabuckthorn berry. Values in bracket show the percentage (w/w) of various components obtained from processing of 100 kg of clean berry. Products in red box are generally sold from Ladakh for further value addition outside the region

is sun dried and seed is separated by rubbing the dried residue with hands to get clean seed and the hull. Both seed and the hull are source of valuable oil and are sold either separately or along with the pulp. If the cleaned seed and hull are sold separately, it fetches Rs 250-300 and Rs 20-30 per kg, respectively. The seed of Seabuckthorn is in great demand since 2011 as it contains omega rich oil, which is generally extracted by supercritical CO₂ extraction method.



Drying : Drying of whole berry is also practiced since 2011 as there is a demand for whole dried berry. A kilogram of dried berry fetches Rs 200-300. A combination of open sun drying and electric drying is practiced in the region. Open sun drying is a tedious method and generally takes more than a month to get the finished product. Besides, it requires large area for drying and need protection from rain and wind. In view of the cumbersome method of sun drying and the risk involved, the local entrepreneurs do not commit supplying of large quantity of dried berry. Currently, 2-5 MT dried berry are being sold annually from Leh district. There is a need to develop a low cost electric dryer suitable for the region. On an average, 33.25 ± 3.12 kg of whole dried berry is obtained when 100 kg of cleaned berry is put to get dried in the sun.

4.3 Harvesting the leaf

Seabuckthorn is a dioecious shrub and gender differences and seasonal variation in bioactive compounds have been reported in leaf. Male exhibits significantly higher phenolic compounds and antioxidants than female. October is the best time for harvesting the leaf. Harvesting is done by shaking the branches and fallen leaves are collected and cleaned. Shade drying is practiced to remove excess moisture.

4.4 Income Generation

Seabuckthorn berry collection has become an important activity in Ladakh region since year 2001. Berry harvesting is done for a short period of 20-30 days in September. In year 2013, 0.8% of the total population of Leh district have directly benefitted from berry collection. Average collection per individual collector was 254.8 kg resulting in a net income generation of Rs 8, 154 per head in 5-10 days (equivalent to Rs 11, 466 in 2017). However, the average income generation by an individual who devoted an average of 12.6 days in the season was Rs 18, 375 (equivalent to Rs 25, 840 in 2017). Majority of the berry collectors are from the needy section of the society and women constitute 67.4% of the work force. Currently, the demand for Seabuckthorn far exceeds the supply capacity of the region. Therefore, Seabuckthorn has the potential to become an important means for sustainable livelihood in Ladakh.



Chapter 5

ASSESSMENT OF SEABUCKTHORN VALUE CHAIN MARKETING SYSTEMS IN LEH LADAKH

5.1 Value Chain Mapping and Actors

The value chain of Seabuckthorn in Leh Ladakh is presented in the value chain map (Figure 2). Overall, the existing value chain mainly comprise of Forest Department, community, individual farmers, berry collectors, processors, commission agents, manufacturers, exporters and research institutes.



Figure 2: Value chain of Seabuckthorn in Ladakh and the role of actors

5.2 Actors and Roles

Research institutes : Research institute, particularly Defence Institute of High Altitude Research of DRDO plays an important role in the value chain. The institute develops Seabuckthorn-based products and transfers technology to the manufacturers, which resulted in purchase of raw material from Ladakh. Seabuckthorn being a lesser known shrub in the country, DIHAR played a key role in promotion of Seabuckthorn in the country. DIHAR organizes seminar, conference and workshop exclusively on Seabuckthorn at Leh Ladakh (such as in 2004, 2009, 2010, 2017). Through popular articles and research papers, manufacturers approach DIHAR for transfer of technology and raw material. The institute provides platform for the buyers and suppliers of Seabuckthorn raw material. DIHAR also provide technical guidance to the buyers, processors and berry collectors.

Forest Department : Majority of the Seabuckthorn stand is on land under the executive control of Forest Department. Local communities require permission for berry collection from the Forest Department in the areas under its jurisdiction.

Community : Seabuckthorn growing on community land is allowed for berry harvesting by the members of the community. However, few communities take money in return from the processors for berry collection.

Farmers : Individual farmers collect berry from Seabuckthorn growing around agricultural field and on private land. They also allow other berry collectors to harvest berry from private land.

Berry Collectors : They are the most valued actors in Seabuckthorn value chain. They harvest berry from Forest/community/private land. They sell the berry directly to the processors. Approximately 1,500 households are engaged in berry collection in Leh district.

Processors : Processors are among the most important actors in the value chain. They purchase Seabuckthorn berry directly from the berry collectors. They determine the price of berry. Most of these processors have established collection centres across major Seabuckthorn growing areas. They carryout primary processing of fresh berry and sell various other components such as the pulp, seed and hull to manufacturers or commission agents. Besides processing fresh berry, they also undertake drying of berry and leaf as per demand from manufacturers or commission agents. They collectors and research institute. There are twelve processors in Leh district and each employ around 20 skilled and semi-skilled youth during processing.

Manufacturers : Few Indian manufacturers purchase Seabuckthorn pulp, seed and hull directly from processors in Ladakh. They manufacture products and sell in Indian and international market. Every year, few manufacturers purchase small quantity of Seabuckthorn from Ladakh on trial basis for product development.

Commission agents : Small portion of Seabuckthorn from Ladakh reach manufacturers and exporters through Commission agents. However, they role in the value chain is not highly significant.

Exporters : Exporters perform sale of pulp and seed of Seabuckthorn in the international market. Commission agents are involved in supply of Seabuckthorn to the exporters.



Chapter 6

CONSTRAINTS, SUGGESTED SOLUTIONS AND INTERVENTION REQUIRED IN VALUE CHAIN

6.1 Underutilized Natural Resource

Gap : Less than 5% of the natural Seabuckthorn available in Ladakh is being harvested. It is primarily due to thorny nature of the plant in thick forest. Currently berry harvesting is done only from the periphery of the thick forest.

Suggested solutions : Thick forest can be turn into productive stand by making alleyways through the dense growth. The clearings can be made in winter months with earth movers.

Intervention required : There is a need of a government policy for converting the dense Seabuckthorn forest into productive stand.



6.2 Harvesting Tools

Gap : Seabuckthorn berry harvesting is a tedious process. Currently berry is harvested manually by beating the bush method. Several harvesting tools were developed by R&D institutes and Universities but till date there is no user friendly harvesting device available.

Suggested solutions : The developed harvesting tools need to be studied on a variety of field conditions. Harvester that worked for *H. rhamnoides* may not be suitable for *H. salicifolia* and vice versa. Commonly used harvester developed in China, Russia and Canada need to be studied in field conditions of Ladakh. However, it may be noted that most of the

berry harvester are developed for Seabuckthorn planted in orchard system. Feasibility of using the same in thick forests needs to be looked into.

Intervention required : The harvesting tools at R&D stages need to be studied on a variety of conditions. Commonly used harvesters in other countries such as China, Russia and Canada need to be studied in field conditions of Ladakh on *H. rhamnoides* subsp *turkestanica* (most thorny species).

6.3 Highly Perishable Berry

Gap : Seabuckthorn berry is a delicate and highly perishable one. It needs to be processed the same day of harvesting.

Suggested solutions : Cold chain facilities can be developed in major Seabuckthorn processing areas. Berry can be kept in cold chain facilities to extend its time of processing and development of value added products.

Intervention required : There is a need to develop cold chain facilities in major Seabuckthorn processing areas.

6.4 Long Distance Transportation

Gap : Seabuckthorn growing in remote locations are not harvested due to need for transportation of highly perishable nature of the berry over a long distance for processing.

Suggested solutions : Use reefer vans for transporting berries to processing units.

Intervention required : Provide incentives to processors or Cooperatives for making the reefer vans available.

6.5 Organic Certification

Gap : Seabuckthorn harvested in Ladakh are wild harvest. However, it is not certified as organic. Additions of chemical preservatives after primary processing turn it into a non-organic produce.

Suggested solutions : Certify Seabuckthorn of Ladakh origin as organic. Organic integrity and the vital qualities of the harvested berry can be maintained by modern techniques.

Intervention required : Certify Seabuckthorn of Ladakh as organic. Develop facilities at berry processing sites to maintain organic integrity and the vital natural qualities of the wild harvests.

6.6 Value Added Products

Gap : Over 90% of the Seabuckthorn harvested in Ladakh are sold after primary processing without value addition.

Suggested solutions : Several formulations are being developed by DRDO and other research institutes. Value added products can be developed in Seabuckthorn growing regions. Promote Seabuckthorn as a unique health product both domestically and internationally.

Intervention required : Provide incentives for developing value added products in Ladakh. Government support is required in infrastructural development due to remoteness of the region. Promote Seabuckthorn as a unique product of Ladakh. There is need to focus on skill development.

6.7 Strengthening Market Linkages

Gap : Market linkage for Seabuckthorn is poor. There are many small players in the value chain.

Suggested solutions : Market linkages can be strengthening by providing a single window online system for the buyers and the sellers.

Intervention required : Set up a single window online system for providing information and services related to Seabuckthorn trade.

6.8 Local Entrepreneurs

Gap : There are few small local players in Seabuckthorn growing areas. They focus mainly on selling the raw material. Their risk taking capacity is low and are fully dependent on demand for raw material from outside the region.

Suggested solutions : Strengthen the local entrepreneurs and encourage them to develop and market value added products. Formation of 'Ladakh Seabuckthorn Cooperative Society' comprising of all stakeholders would strengthen their role in Seabuckthorn value chain.

Intervention required : Government support in strengthening the local entrepreneurs. Need to form 'Ladakh Seabuckthorn Cooperative Society'

6.9 Insufficient Raw Material

Gap : There is gap in demand and supply. Demand for Seabuckthorn far exceeds that of the supply capacity of Ladakh region.

Suggested solutions : Increase berry harvesting from existing Seabuckthorn forests especially in Nubra valley. Undertake large scale Seabuckthorn plantation as horticultural crop.

Intervention required : Government policy for converting the dense Seabuckthorn forest into productive stand. Provide incentives for establishing processing units in Nubra valley. Promote Seabuckthorn as horticultural crop.

Chapter 7

POTENTIAL OF SEABUCKTHORN CULTIVATION ON VAST BARREN LAND IN LADAKH

7.1 Potential of Seabuckthorn as Horticultural Crop

Seabuckthorn is considered a forest crop and no major initiative have been taken to grow the plant on farmer's field as horticultural crop. However, considering the socio-economic importance of the plant it needs to be promoted as horticultural crop. Some of the comparative advantage of Seabuckthorn as horticultural crop in cold desert region includes:

New fruit crop : It is a lesser known fruit in India and therefore its potential is still untapped. Potential buyers include nutraceutical, pharmaceutical, cosmetics and food industries.

High returns : Berries sell at premium price, e.g. farmers get Rs 45/kg of berry in 2017. The price will appreciate further since Seabuckthorn based products are now being promoted as nutraceuticals.

Hardy plant : It is a hardy plant species which can withstand extreme temperatures and is drought tolerant. Therefore, the plant can be grown on vast uncultivable land in cold desert Ladakh.

Improve soil fertility : Seabuckthorn has symbiotic association with *Frankia* that fixes atmospheric nitrogen thereby improving the soil fertility.

Early fruit bearing : Seabuckthorn plants raised from cuttings start bearing fruits from fourth year onward and its average productive life is 30 years.

Region specific cultivation : *Hippophae rhamnoides* L. is a temperate crop and therefore its cultivation can be done only in temperate region.

Insect, pest and disease : Insect, pests and diseases have not been reported in Seabuckthorn and therefore it requires less management.

Product development : Over 200 products have been developed from Seabuckthorn in various parts of the world. The product list will expand further since number of R&D centers and Seabuckthorn based industries are expanding.

Environmental benefits : Seabuckthorn has extensive root system and grows fast. It is an ideal plant for control of soil erosion, land reclamation, wildlife habitat enhancement and farm stand protection. Seabuckthorn plantation, therefore, has both economical and environmental benefits.

Firewood : The calorific value of dry Seabuckthorn is 4,785.5 calories per kg. The shrub is fast growing and can be stumped after every 3-5 years. It reduces harvesting pressure on other native woody plant species.

7.2 Income Generation from Existing Natural Resources

Table 4 displays the year-wise collection and processing of Seabuckthorn berry in Leh Ladakh during 2004-2015, and the projected increase in berry harvest and income generation from 2016-2030. The basis for analysis of projected income for year 2016-2030 from natural Seabuckthorn resource was calculated based on certain assumptions. These assumptions include: Firstly, berry harvest would increase at 10% per annum. Secondly, price inflation of pulp is 6.32% per annum. Thirdly, cost of berry inflates at 37.83% of the the selling price of the pulp. Fourthly, cost of packaging material inflates at 6.32%. Fifthly, total cost incurred would be 20% of the gross income generated. Gross income generated is calculated as product of quantity of pulp and selling price of pulp. Net income generated is calculated as difference between gross income generated and total cost incurred. With the current trend, the berry harvest would reach 1509 MT in 2030 and net income would be Rs 20 crore from existing natural Seabuckthorn resources.

Year	Berry harvest (MT)	Cost of berry (Rs/kg)	Selling price of pulp (Rs/kg)	Gross Income (Rs in Crore)	Total Cost Incurred (Rs in Crore)	Net Income (Rs in Crore)
2004	170.4	15.0	62.0	0.6	0.1	0.5
2005	328.4	15.0	70.0	1.4	0.3	1.1
2006	196.9	16.0	72.0	0.9	0.2	0.7
2007	286.6	23.5	80.0	1.4	0.3	1.1
2008	138.2	23.5	75.0	0.6	0.1	0.5
2009	166.0	23.5	72.5	0.7	0.1	0.6
2010	90.9	24.5	76.0	0.4	0.1	0.3
2011	160.4	25.0	80.0	0.8	0.2	0.6
2012	183.0	28.0	85.0	0.9	0.2	0.7
2013	297.6	32.0	105.0	1.9	0.4	1.5
2014	180.5	32.0	110.0	1.2	0.2	1.0
2015	361.3	35.0	110.0	2.4	0.5	1.9
2016	397.4	44.2	117.0	2.8	0.6	2.2
2017	437.2	47.0	124.3	3.3	0.7	2.6
2018	480.9	50.0	132.2	3.8	0.8	3.1
2019	529.0	53.2	140.6	4.5	0.9	3.6
2020	581.9	56.5	149.4	5.2	1.0	4.2
2021	640.1	60.1	158.9	6.1	1.2	4.9
2022	704.1	63.9	168.9	7.1	1.4	5.7
2023	774.5	67.9	179.6	8.3	1.7	6.7
2024	851.9	72.2	191.0	9.8	2.0	7.8
2025	937.1	76.8	203.0	11.4	2.3	9.1
2026	1030.8	81.7	215.9	13.4	2.7	10.7
2027	1133.9	868	229.5	15.6	3.1	12.5
2028	1247.3	92.3	244.0	18.3	3.7	14.6
2029	1372.0	98.1	259.4	21.4	4.3	17.1
2030	1509.2	104.3	275.8	25.0	5.0	20.0

Table 4 : Year-wise collection and processing of Seabuckthorn berry during 2004-2015, and projected increase in berry harvest and income generation from 2016-2030 in Leh Ladakh

7.3 Projected income from Seabuckthorn Cultivation on 2500 ha

Plantation of Seabuckthorn on barren land by Forest Department and local community for greening and income generation is slowly gaining momentum in the region. The vast barren land in the region can be brought under Seabuckthorn plantation either by planting along existing water resources or through lifting of water from the rivers. As per an estimate of the Forest Department, 2500 ha of barren land can be brought under Seabuckthorn plantation without much investment in Leh district.

Following assumptions were made for projecting income generation from Seabuckthorn cultivation on 2500 ha. Firstly, plantation is phased over a period of 10 years, wherein each year 250 ha of land is planted. Secondly, Seabuckthorn is planted at 3.0×1.0 m spacing which accommodate 3300 plants (female: 2970; male: 330) per ha. Thirdly, commercial yield begins in the sixth year from the date of plantation. Fourthly, each female plant bear 5 kg berry and 80% of the berry is harvested. Fifthly, 0.5 kg leaf is harvested from each mature plant. Sixthly, cost of cultivation is Rs 1.5 lakh per ha. Other assumptions remain same as that of Table 4.

Table 5 & 6 display the year-wise harvesting and income generation from cultivation of Seabuckthorn on 2500 ha. The gross income from berry harvest and its primary processing would result in income generation to the tune of Rs 446.8 crore per annum in 2030 (Table 5). Similarly, income generation from leaf harvest from mature plant would result in income of Rs 169.2 crore per annum in 2030 (Table 6). The net income from harvesting and primary processing of Seabuckthorn berry and its leaf would be Rs 491 crore in the year 2030. Income generation will increase many-fold if value added products are also manufactured in the region.

Year	Berry harvested (MT)	Cost of berry (Rs/kg)	Selling price of pulp (Rs/kg)	Gross Income (Rs in Crore)	Total Cost Incurred (Rs in Crore)	Net Income (Rs in Crore)
2016	0	44.2	117.0	0	0.0	0.0
2017	0	47.0	124.3	0	0.0	0.0
2018	0	50.0	132.2	0	0.0	0.0
2019	0	53.2	140.6	0	0.0	0.0
2020	0	56.5	149.4	0	0.0	0.0
2021	0	60.1	158.9	0	0.0	0.0
2022	2999.7	63.9	168.9	30.4	8.5	21.9
2023	5999.4	67.9	179.6	64.65	18.1	46.5
2024	8999.1	72.2	191.0	103.1	28.9	74.2
2025	11998.8	76.8	203.0	146.2	40.9	105.2
2026	14998.5	81.7	215.9	194.2	54.4	139.9
2027	17998.2	86.8	229.5	247.8	69.4	178.4
2028	20997.9	92.3	244.0	307.4	86.1	221.3
2029	23997.6	98.1	259.4	373.5	104.6	268.9
2030	26997.3	104.3	275.8	446.8	125.1	321.7

Table 5: Projected year-wise collection and processing of Seabuckthorn berry when commercially cultivated on 2500 ha

Year	Berry harvested (MT)	Cost of berry (Rs/kg)	Selling price of pulp (Rs/kg)	Gross Income (Rs in Crore)	Total Cost Incurred (Rs in Crore)	Net Income (Rs in Crore)
2016	0	44.2	117.0	0	0.0	0.0
2017	0	47.0	124.3	0	0.0	0.0
2018	0	50.0	132.2	0	0.0	0.0
2019	0	53.2	140.6	0	0.0	0.0
2020	0	56.5	149.4	0	0.0	0.0
2021	0	60.1	158.9	0	0.0	0.0
2022	2999.7	63.9	168.9	30.4	8.5	21.9
2023	5999.4	67.9	179.6	64.65	18.1	46.5
2024	8999.1	72.2	191.0	103.1	28.9	74.2
2025	11998.8	76.8	203.0	146.2	40.9	105.2
2026	14998.5	81.7	215.9	194.2	54.4	139.9
2027	17998.2	86.8	229.5	247.8	69.4	178.4
2028	20997.9	92.3	244.0	307.4	86.1	221.3
2029	23997.6	98.1	259.4	373.5	104.6	268.9
2030	26997.3	104.3	275.8	446.8	125.1	321.7

Table 6 : Projected year-wise collection of Seabuckthorn leaf when commercially cultivated on 2500 ha



SATELLITE IMAGES OF AREA UNDER SEABUCKTHORN IN LADAKH (RED PATCHES)

7.4 Seabuckthorn Cultivation at Defence Institute of High Altitude Research

Anticipating the high demand for Seabuckthorn, studies have been undertaken at DIHAR to meet the long term goal of mass cultivation of Seabuckthorn on vast barren land in Ladakh. Since Seabuckthorn is a relative new-comer as a crop, a little is known about its cultivation practices. There is no available high yielding varieties that can be cultivated and propagated on a large scale.

High yielding selection : One of the basic inputs for Seabuckthorn cultivation is high yielding plants. One approach for selecting a superior genotype could be screening the natural Seabuckthorn population for desirable characteristics such as high berry yield, ease of berry harvest, less thorny, rich in bioactive content etc. Extensive survey was conducted in trans-Himalayan Ladakh for selection of high yielding genotypes. A total of 187 native genotypes were selected that yield more than five kilogram berry per plant. Based on desirable traits, six high yielding genotypes have been further selected. Mass propagation of the elite genotypes is underway with the aim to promote mass cultivation.





Propagation: Seabuckthorn can also be propagated by seed. However, the method is not preferred for propagation of Seabuckthorn for commercial cultivation (being a dioecious species). Successful cultivation of the high yielding genotypes requires efficient vegetative propagation system. Methods have been standardized for propagation of a pencil thick (7.5±1.7 mm diameter) hardwood stem cuttings with high rooting success. Use of silverblack plastic mulching film was found to increase rooting success by 10%. Suppression of weed emergence by the plastic mulch resulted in 75.8% time saving in manual weeding by farm workers. In view of the availability of lesser number of a pencil thick stem cuttings per plant, an improved method of propagation of Seabuckthorn was developed using the previous season's growth for the stem cuttings (2.9±0.8 mm thickness). Overall, using a less than half the pencil thick hardwood cuttings resulted in much higher rooting success than those reported for conventional method of propagation. Seven-fold more number of cuttings can be taken from each shrub as compared to that of pencil thick hardwood cuttings. Using the developed propagation methods, a large scale propagation of elite selections are being carried out at experimental farm at DIHAR. Every year 15,000-20,000 rooted plants are being raised at DIHAR, Leh.



Orchard : A model Seabuckthorn orchard has been established at DIHAR, Leh. High yielding selections are planted at 3.0×1.0 m spacing which accommodate 3300 plants (female: 2970; male: 330) per ha. Mulching is used to enhance crop growth in cold desert conditions and for water conservation.



CONSTRAINTS, SUGGESTED SOLUTIONS AND INTERVENTION REQUIRED IN SEABUCKTHORN PLANTATION

8.1 Promote Seabuckthorn as Horticultural Crop

Gap : Seabuckthorn is considered as a forest crop. There are no policies or incentives for growing Seabuckthorn as a horticultural crop.

Suggested solutions : Seabuckthorn needs to be declared a horticultural crop. Incentives may be given along the lines of other horticultural crop.

Intervention required : Demonstrate high yielding Seabuckthorn orchards in all potential Seabuckthorn growing regions. Declare Seabuckthorn a horticultural crop. ICAR may initiate research and extension on Seabuckthorn.

8.2 Package of Practices

Gap : There is no standard package of practices for large scale Seabuckthorn cultivation.

Suggested solutions : Defence Institute of High Altitude Research, Leh and CSK HPKV Palampur have initiated studies on developing packages and practices in Leh (Jammu & Kashmir) and Lahaul (Himachal). Vegetative propagation is well established at DIHAR. A model orchard is established at DIHAR Leh. More focused attention is required in this direction for commercial cultivation.

Intervention required : Works being done on experimental fields at Defence Institute of High Altitude Research need to be continued and carried forward.

8.3 Quality Planting Material

Gap : There is no released variety of Seabuckthorn in India.

Suggested solutions : High yielding Seabuckthorn selections are being identified and maintained at Defence Institute of High Altitude Research, Leh and CSK HPKV Palampur. The same need to be tested at multi locations in all potential areas. ICAR may undertake programs to develop Seabuckthorn varieties suitable for cold desert conditions of Ladakh.

Intervention required : Undertake multi location trials of existing high yielding selections available at Defence Institute of High Altitude Research, Leh and CSK HPKV Palampur. Initiate R&D on varietal development.

8.4 Convert Barren Land into Green Patch

Gap : A vast geographical area in cold desert Ladakh are barren primarily due to lack of irrigation. Area under forest cover is only 0.064% and total cropped area is just 0.2% in Leh district.

Suggested solutions : Vast barren land in cold desert can be turned into green patches. Indus River that flows in Leh Ladakh can be explored for irrigating the surrounding barren land. Seabuckthorn being a native pioneering plant with nitrogen fixing property is the ideal plant for plantation.

Intervention required : A mission mode project for converting the vast barren land in Ladakh into green patch by planting Seabuckthorn.

Chapter 9

SUMMARY, CONCLUSIONS AND POLICY SUGGESTIONS

Seabuckthorn (*Hippophae* spp. L.) is an ecologically and economically important plant of trans-Himalayan Ladakh. The berry harvesting period is short and the return is high. The price of the berry appreciated from Rs 8 per kg in year 2001 to Rs 45 per kg in 2017. Ladakh remains the major site for natural Seabuckthorn resource. Despite the vast area under natural forest, the mean annual berry harvest is less than 5% of the total available Seabuckthorn resource in the region. Primary processing of fresh Seabuckthorn berry is being done in Ladakh and various components such as the pulp, seed and hull are sold to firms located outside the region for further value addition.

This study analyses each link in the value chain of Seabuckthorn in Ladakh region and recommend ways to effectively use the existing resources for improved marketability of Seabuckthorn. The study also undertakes missing links that deter cultivation of Seabuckthorn in the region. The study was carried out through primary and secondary research. Primary survey involved personal interviews with berry collectors (n=828), farmers (n=567) and processors (n=5). A structured open ended schedule was used to obtain data from Leh and Nubra valley. Secondary research was done through available literature and documents available with research institute (DIHAR) and government agencies.

9.1 Summary and Conclusions

Overview of Seabuckthorn industry

- Total acreage of Seabuckthorn is reported to be about 3.0 million ha worldwide (both wild and cultivated cover). Approximately 90% of world's Seabuckthorn is found in China, Mongolia, Russia, Northern Europe and Canada. China is the largest producer of Seabuckthorn.
- Potential of Seabuckthorn in India has been recognized by several R&D organizations. However, Seabuckthorn industry is still in its nascent stages. Total area under Seabuckthorn is 13,000 ha. Approximately 600 tons of berries are harvested annually from wild plants. There is no serious initiative to cultivate Seabuckthorn in the country.
- Seabuckthorn is considered a means for sustainable development of Ladakh region. Area under wild Seabuckthorn is 9267 ha. Ladakh remains the major site for natural Seabuckthorn resource with over 70% of the total area in the country.

Status of Seabuckthorn harvesting and processing in Ladakh

- Approximately 500 tons of berries are harvested annually, which is less than 5% of the total available Seabuckthorn resource in the region. This is largely due to short harvesting season, coincidence of berry harvesting period with that of other crops, and unorganized plantation, which restrict harvesting only a fraction of the available resource.
- Berry is harvested by hand using 'beat the bush' method in September. Harvested berry is transported to the processing unit.

- Majority of the Seabuckthorn stand is on land under the executive control of Forest Department. Strict regulation is in force regarding time and method of berry collection. Berry collection is allowed only during morning hours. Local communities require permission for berry collection from the Forest Department in the area under its jurisdiction.
- Primary processing of fresh Seabuckthorn berry is being done at the site of berry collection and various components such as the pulp, seed and hull are sold to firms located outside the region for further value addition.
- Seabuckthorn berry collection has become an important activity in Ladakh region since year 2001. Berry harvesting is done for a short period of 20-30 days in September. Approximately 0.8% of the total populations of Leh district are directly benefitted from berry collection. Average collection per individual collector is 254.8 kg resulting in a net income generation of Rs 11,466 per person in 5-10 days. However, the average income generation for an individual who devoted an average of 12.6 days in the season is Rs 25,840.
- Majority of the berry collectors are from the needy section of the society and women constitute 67.4% of the work force.
- The demand for Seabuckthorn far exceeds the supply capacity of the region. Therefore, Seabuckthorn has the potential to become an important means for sustainable livelihood in Ladakh.

Value chain mapping and actors

- The major actors in existing value chain are community, individual farmers, berry collectors, processors, Forest Department, commission agents, manufacturers, exporters and research institutes.
- Processors are among the most important actors in the value chain. They determine the price of berry and purchase Seabuckthorn berry directly from the berry collectors. They also do the primary processing and various components such as the pulp, seed and hull are sold to manufacturers or commission agents. There are twelve processors in Leh district.
- Berry collectors are the most valued actors in Seabuckthorn value chain. They harvest berry from Forest/community/private land. They sell the berry directly to the processors. Approximately 1,500 households are engaged in berry collection in Leh district.

Constraints and intervention required in value chain

- Less than 5% of the natural Seabuckthorn available in Ladakh is being harvested. It is primarily due to thorny nature of the plant in thick forest. Currently berry harvesting is done only from the periphery of the thick forest. There is a need of a Government policy for converting the dense Seabuckthorn forest into productive stand.
- Seabuckthorn berry harvesting is a tedious process. Currently berry is harvested by beating the bush method. There are no user friendly harvesting tools. The harvesting tools at R&D stages need to be studied in field conditions. Commonly used harvesters

in other countries such as China, Russia and Canada need to be studied in conditions of Ladakh.

- Seabuckthorn berry is a delicate and highly perishable one. It needs to be processed the same day of harvesting. There is a need to develop cold chain facilities in major Seabuckthorn growing areas to extend its time of processing and development of value added products.
- Seabuckthorn growing in remote locations are not harvested due to need for transportation of perishable nature of the berry over a long distance for processing. There is a need to provide incentives to the processors or Cooperatives for running of refrigerated vans.
- Seabuckthorn harvested in Ladakh are wild harvest. However, it is not certified as organic. Addition of chemical preservatives after primary processing turns it into a non-organic produce. There is a need to develop facilities at berry processing sites to maintain organic integrity of the wild harvests. There is a need to certify Seabuckthorn of Ladakh as organic. Further, there is also a need for GI tagging of Seabuckthorn of Ladakh origin.
- Over 90% of the Seabuckthorn harvested are sold after primary processing without value addition. Government support is required in providing incentives for developing value added products in Ladakh. There is a need to promote Seabuckthorn as a unique product of Ladakh.
- Market linkage for Seabuckthorn is poor. There are many small players in the value chain. In order to strengthen the market linkages there is a need to set up a single window online system for providing information and services related to Seabuckthorn trade.
- There are few small local entrepreneurs in Seabuckthorn growing areas. They focus mainly on selling the raw material. Their risks taking capacity is low, and are fully dependent on demand for raw material. Formation of 'Ladakh Seabuckthorn Cooperative Society' comprising of all the local entrepreneurs would strengthen their role in Seabuckthorn value chain.
- There is gap in demand and supply. Demand for Seabuckthorn far exceeds that of the supply capacity of the region. Government policy is required for converting the dense Seabuckthorn forest into productive stand.

Potential of Seabuckthorn cultivation on vast barren land in Leh Ladakh

- The vast barren land in the region can be brought under Seabuckthorn plantation either by planting along existing water resources or through lifting of water from the rivers. As per an estimate of the Forest Department, 2500 ha of barren land can be brought under Seabuckthorn plantation without much investment in Leh district.
- Cultivation of Seabuckthorn on 2500 ha in Ladakh is projected to result in net income of Rs 491 crore per annum in 2030 from berry and leaf harvest and its primary processing. Income generation will increase many-fold if value added products are also manufactured in the region.

Constraints and intervention required in Seabuckthorn plantation

- Seabuckthorn is considered as a forest crop. There are no policies or incentives to promote Seabuckthorn as a horticultural crop. Seabuckthorn needs to be declared a horticultural crop.
- There is no standard package of practices for growing Seabuckthorn on large scale. Works being done on experimental fields at Defence Institute of High Altitude Research should be continued and carried forward.
- There is no released variety of Seabuckthorn in India. Undertake multi location trials of existing high yielding selections available at Defence Institute of High Altitude Research, Leh and CSK HPKV Palampur. Initiate R&D on varietal development. Commercial varieties available in China, Russia, Mongolia and Canada need to be imported for varietal trials in Ladakh.
- Vast geographical areas in cold desert are barren primarily due to lack of irrigation. Area under forest cover is only 0.064% and total cropped area is just 0.2% in Leh district. Convert the vast barren land into green patch by planting Seabuckthorn.

9.2 Policy Suggestions

Promote Seabuckthorn for national security : People living along the international border play key role in securing the border. However, in recent years a trend in migration of people living along the international border to the nearby Leh town has been observed due to economic reasons. Promote Seabuckthorn plantation in villages along the international border to improve the socio-economic status of the villagers and to discourage abandoning their settlement.

National mission on Seabuckthorn : Developmental work on Seabuckthorn needs to be carried on mission mode. There is a need to initiate a National Program on Seabuckthorn.

Focus on Ladakh : Over 70% of the Seabuckthorn natural resource is located in Ladakh. Developmental activities on Seabuckthorn, therefore, may be focused in Ladakh. The successful model can then be replicated in other Himalayan region.

Promote Seabuckthorn as horticultural crop : Seabuckthorn is considered as a forest crop. Seabuckthorn needs to be declared a horticultural crop. Incentives should be given along the lines of other horticulture crop.

Organic certification : Seabuckthorn harvested in Ladakh are wild harvest. For all activities related to Seabuckthorn, organic certification should be made mandatory.

GI registration : Seabuckthorn of Ladakh origin are wild harvest and believed to be superior due to climatic conditions of the growing area. Efforts are required for GI tagging of Seabuckthorn of Ladakh origin.

Value added product : Over 90% of the harvested raw material is currently sold outside the region. There is an opportunity for development of value added products in the study area. Hence, government needs to create a favourable environment for the investors through partial support in the form of subsidies, training and skill development on value added products.

Convert thick forest into productive stand : Less than 5% of the natural Seabuckthorn available in Ladakh is being harvested. It is primarily due to thorny nature of the plant in thick forest. Currently berry harvesting is done only from the periphery of the thick forest. There is a need of a Government policy for converting the dense Seabuckthorn forest into productive stand.

Support local entrepreneurs : The local processors are key players in the value chain. They are in need of financial assistance to create infrastructure facility (cold storage, up gradation of processing facilities, transportation facilities, etc) to augment their business prospects. Hence, the banks and government should come forward to provide financial support in addition to technical support.

Convert barren land into green patch : Vast geographical areas in cold desert Ladakh are barren primarily due to lack of irrigation. Area under forest cover is only 0.064% and total cropped area is just 0.2% in Leh district. There is a need for policy to convert the vast barren land into green patch by planting Seabuckthorn.

Increase raw material : Most of the processors and manufacturers reported non-availability of raw material for large scale commercial activities. Government support is required for scientific cultivation of Seabuckthorn. Involvement of private players for large scale cultivation may also be considered.

Quality planting material : Import commercially available Seabuckthorn varieties from Russia, China, Canada and Mongolia for of growing in Ladakh.



Chapter 10

PROPOSED ACTION PLAN UNDER MIDH (Mission for Integrated Development of Horticulture)

Action plan proposed as per existing MIDH guidelines for enhancement of Seabuckthorn value chain in Ladakh is given below :

Sr.No.	Component	Cost Norms	Pattern of Assistance	
Α.	RESEARCH & DEVELOPMENT			
1.	Multi-location trial of high yielding Seabuckthorn selections identified at DIHAR involving DIHAR, DIMAAR and ICAR and the best ones taken up for cultivation	Project Based	100% assistance	
2.	Development of package of practices and cost estimation for cultivation	Project Based	100% assistance	
3.	Standardization of pruning methodologies and harvesting tools for ease of harvesting through research trials in various centers	Project Based	100% assistance	
4.	Feasibility of drying methodolo- gies for both leaf and berry. Existing cardamom/ nutmeg dryer may be tested	Project Based	100% assistance	
5.	Preservation studies for maintaining organic integrity of the harvested berry	Project Based	100% assistance	
6.	Germplasm collection units to be maintained at research centers for future development	Project Based	100% assistance	
7.	Introduction of exotic Seabuckthorn varieties from China, Russia and Canada for evaluation and its further cultivation	Project Based	100% assistance	
Β.	DEVELOPMENT (THROUGH S	TATE HORTICULTURE	DEPARTMENT)	
B.1	Production of planting materia	I		
	a. Establishment of nursery for raising rooted cuttings of high yielding Seabuckthorn varieties	Rs. 25.0 lakh/ha for Hi-tech nursery; Rs. 15.0 lakh/ha for small nursery	100% to public sector; credit linked back- ended subsidy @ 40% of cost to private sector	
B.2	Establishment of new garden (2500 ha in Leh district	@250 ha/year)	
	 a. Integrated package with drip irrigation and trellis on government/community/pr ivate land 	Rs. 4.0 lakh/ha	100% to public sector; credit linked back- ended subsidy @ 50% of cost to FPO/private sector	

	 a. Without integration on government/community/pr ivate land 	Rs. 1.25 lakh/ha	100% to public sector; credit linked back- ended subsidy @ 50% of cost to FPO/private sector
B.3	Rejuvenation/ replacement of	senile plantation, can	ppy management
	a. Establishment of productive block in the wild grown Seabuckthorn forest	Rs. 0.4 /ha	100% to State Forest Department; 50% subsidy to individual and community
B.4	Creation of water resources		-
	a. Community tanks with use of plastic lining	Rs. 25 lakh /unit	100% of cost to irrigate 10 ha of command area
	 b. Water harvesting system with use of plastic lining @ Rs 125/- cum 	Rs. 1.8 lakh /unit	50% cost to individuals
B.5	Protected cultivation		
	 Passive greenhouse structure with wall on north-side suitable for trans-Himalayan region for raising of nursery (recommended by DIHAR) 	Rs. 2500/Sq.m	100% to public sector; 50% cost to individuals
	a. Black plastic mulching (100 GSM recommended by DIHAR)	Rs. 36,800/ha	100% to public sector; 50% cost to individuals
B.8	Organic farming	•	
	a. Adoption of organic farming	Rs. 20,000/ha	100% to public sector; 50% cost to individuals
	b. Organic certification and labeling	Project based	100% to public sector
	c. Organic compost unit (30'×10'×2.5' recommended by DIHAR for Ladakh)	Rs. 1.0 lakh/unit	100% to public sector; 50% cost to individuals
B.13	Technology dissemination thro	ugh demonstration / fro	ont line demonstration
	a. Technology dissemination through demonstration / front line demonstration	Rs. 25 lakh	75% of cost in farmers field; 100% cost in farms belonging to Public sector
B.14	Human Resource Development		
	a. Training of youths in Seabuckthorn cultivation and processing	Project based	100% of the cost
	b. Formation of Farmers Producer Organizations (FPO)	Project based	100% of the cost

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	С.	IN	TEGRATED POST HARVEST	MANAGEMENT			
		а.	Establishment of primary processing units for pulp extraction	Rs. 25.0 lakh/unit	100% of the cost to public sector and Cooperatives; credit linked back-ended subsidy @ 55% of cost to private sector		
b. Cold storage		Cold storage	Project based	100% of the cost to public sector and Cooperatives; credit linked back-ended subsidy @ 50% of cost to private sector			
		C.	Refrigerated transport vehicle	Rs. 26.0 lakh for 9 MT	100% of the cost to public sector and Cooperatives; credit linked back-ended subsidy @ 50% of cost to private sector		
	D.	ESTABLISHMENT OF MARKETING INFRASTRUCTURE			E		
		а.	Marketing infrastructure through Societies	Project based	100% of the cost to public sector and Cooperatives; credit linked back-ended subsidy @ 55% of cost to private sector		
	Ε.	FC	OD PROCESSING				
		а.	Establishment of units for development of Seabuckthorn value added products	Project based (max 800 lakh/unit)	100% of the cost to public sector and Cooperatives; credit linked back-ended subsidy @ 50% of cost to private sector		
		b.	Drying units	Project based	100% of the cost to public sector and Cooperatives; credit linked back-ended subsidy @ 50% of cost to private sector		

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Annexure 1

Views of berry collector and processors on status, benefits and constraints faced in value chain of Seabuckthorn

The study was carried through personal interviews with berry collectors and processors. A structured open ended schedule was used to obtain data from berry collectors (828) and processors (5) from Leh and Nubra valley. Qualified personals (graduates and post-graduates) were engaged for collection of data from primary sources. Results of the survey conducted in Leh and Nubra valley among berry collectors and processing unit holders are as follow:

Table 7: Views of berry collector (n=828) on status, benefits and constraints faced in value chain of Seabuckthorn

Query no.	Query	Response	
1	Since how many years you have been collecting Seabuckthorn berry?	3.8±2.6 years	
2	Quantity of Seabuckthorn berry collected in 2016	282.9±363.4 kg	
3	Number of days spent for Seabuckthorn berry collection in 2016	10.6±8.3 days	
4	Average time spent per day for berry collection in 2016	4.2±1.4 hrs	
5	Amount received per kg Seabuckthorn berry in 2016	36.8±9.3 (Rs)	
6	Are you satisfied with the price of berry in 2016?	58% (Yes); 1% (No); 41% (no comments)	
7	Will you collect Seabuckthorn berry this year (2017)	90% (Yes); 1% (No); 9% (no comments)	
8	What is the best time for berry collection?	6:30 am to 9:40 am	
9	What are the benefits from berry collection (ranking from 1-3; 1 being most beneficial and 3 the least)	 Extra income (96.9% respondents) Berry freely available (96.1% respondents) Other reasons (32.8% respondents) 	
10	Main problems being faced during berry collection (ranking from 1-11 based on severity; 1 being most severe and 11 the least)	 Lack of proper harvesting tool (96.9% respondents) Highly thorny plant (96.5% respondents) Difficult to harvest during the day time (after 9 am) (95.2% respondents) Cannot entered into thick Seabuckthorn forest (94.2% respondents) Berry highly perishable (85.3% respondents) Berry highly perishable (85.3% respondents) No regular buyers (75.1% respondents) Religious taboo (74.2% respondents) Long waiting for buyers to collect berry (74.0% respondents) Govt officials do not allow berry harvesting (16.2% respondents) 	
		11. Any other (13.8% respondents)	

Table 8: Views of processors (local food processing unit holders, n=5) on status, benefits and constraints faced in value chain of Seabuckthorn

Query no.	Query	Response	
1	Since how many years you have been processing Seabuckthorn berry?	9 years (average)	
2	Quantity of Seabuckthorn berry processed in 2016	93 tons (average)	
3	Amount received per litre pulp in 2016	110/kg	
4	Are you satisfied with the price of pulp in 2016?	40% (Yes), 60% (No)	
5	Number of days spent for Seabuckthorn berry processing in 2016	53 days (average)	
6	Average time spent per day for berry processing in 2016	12 hr 30 min (average)	
7	Will you process Seabuckthorn berry this year (2017)	100% (Yes)	
8	Do you develop and market Seabuckthorn value added products	20% (Yes); 80% (No)	
9	Apart from Seabuckthorn, which other fruits do you process in the unit?	Apricot (100%)	
10	For how many days you run the processing unit in a year	85 days (average)	
11	What are the benefits from berry processing? (ranking from 1-2; 1 being	1. High demand for Seabuckthorn (80%)	
	the most beneficial)	2. High return in short time (60%)	
12	Main problems being faced during berry processing (ranking from 1-9 based on	1. Administrative problems in berry harvesting (100% respondent)	
	being the most severe)	2. Berry highly perishable (100% respondent)	
		 Do not get sufficient raw material (100% respondent) 	
		4. Competition from other processing units within Leh (100% respondent)	
		 Do not receive advance demand from buyers (100% respondent) 	
		6. Religious taboo (100% respondent)	
		7. No regular buyers (100% respondent)	
		8. Social taboo (80% respondent)	
		9. Do not get payment on time from the buyers (80% respondent)	
13	Do you feel that we should develop value added products in Leh?	80% (Yes); 20% (No comment)	
14	What are the problems in development of value added products in Leh? (ranking	1. There is no regular buyers (100% respondents)	
	from 1-4 based on severity of the problem being faced; 1 being the most	2. High transportation cost to outside Ladakh (100% respondents)	
	severe)	3. Lack of trained human resource (100% respondents)	
		4. Higher cost of production (100% respondents)	
15	Support required from Government (ranking from 1-6 based on importance)	1. Financial support in establishment of unit (100% respondents)	
	1 being the most important)	2. Support in marketing (100% respondents)	

Query no.	Query	Response	
		3.	Policy on Seabuckthorn berry harvesting from forest (100% respondents)
		4.	Financial support in upgradation of existing units (100% respondents)
	5. Human resource food proces respondents)		Human resource development on food processing (100% respondents)
		6.	Seabuckthorn plantation (100% respondents)

Annexure 2

Views of farmers and berry collectors on status, benefits and constraints faced in Seabuckthorn cultivation on vast barren land

The study was carried through personal interviews with berry collectors and processors. A structured open ended schedule was used to obtain data from farmers (567) and berry collectors (828) from Leh and Nubra valley. Qualified personals (graduates and post-graduates) were engaged for collection of data from primary sources. Results of the survey conducted among berry collectors and farmers are as follow:

Table 9: Views of farmers (n=567) on status, benefits and constraints faced in cultivation of Seabuckthorn on vast barren land

Query no.	Query	Response	
1	Do you know Seabuckthorn?	99% (Yes); 1% (No comment)	
2	Do you know that one kg of Seabuckthorn berry fetch Rs 40-50/kg?	25% (Yes); 7% (No); 68% (no comment)	
3	Do you know that Seabuckthorn cultivation is more profitable than traditional cereal crops?	39% (Yes); 61% (No)	
4	Do you feel that we should go for Seabuckthorn plantation in orchard system?	33% (Yes); 60% (No); 7% (no comment)	
5	If you get double the income from Seabuckthorn plantation as compare to traditional cereal crops, will you go for Seabuckthorn plantation?	43% (Yes); 50% (No); 7% (no comment)	
6	What are the advantages of Seabuckthorn plantation? (ranking from	1. Higher income than traditional cereal crops (82.4% respondent)	
	advantage)	2. Require less maintenance (80.7% respondent)	
		3. No need of plantation every year (80.6% respondent)	
		4. Require less water (80.6% respondent)	
		 Seabuckthorn has multiple uses (fencing, firewood, fodder etc) (77.9% respondent) 	
		6. Can be grown on barren land (72.5% respondent)	
		7. Improve soil fertility (71.9% respondent)	
		8. Hardy plant (71.2% respondent)	
		9. Any other (39.1% respondent)	
7	What are the main constraints in Seabuckthorn plantation? (ranking from	1. Spread to agricultural field (85.9% respondent)	
	1 to 7; 1 being the main constraint)	2. Do not know how to cultivate (81.5% respondent)	
		3. Do not know source of planting material (80.5% respondent)	
		4. No land for cultivation (80.4% respondent)	
		5. Social taboo/ socially not acceptable (76.3% respondent)	

Query no.	Query	Response		
		6. No irrigation facility (75.5% respondent)		
		7. Any other (35.9% respondent)		
8 Where will you cultivate Seabuckthorn, if you decided to do so? (ranking from 1		1. Owned barren land (85.0% respondent)		
tc	to 5; 1 being the most preferred)	2. Only if the Govt provides incentives (48.1% respondent)		
		3. Only if the Govt provides land (44.8% respondent)		
		4. Agricultural field (43.7.0% respondent)		
		5. Any other (26.6% respondent)		

Table 10 : Views of berry collector (n=828) on status, benefits and constraints faced in Seabuckthorn cultivation on vast barren land

Query no.	Query	Response	
1	Do you feel that we should go for Seabuckthorn plantation in orchard system?	70% (Yes); 3% (No); 27% (No comment)	
2	If you get double the income from Seabuckthorn plantation as compare to traditional cereal crops, will you go for Seabuckthorn plantation?	77% (Yes); 3% (No); 20% (No comment)	
3	What are the advantages of Seabuckthorn plantation? (ranking from	 Higher income than traditional cereal crops (93.8% respondent) 	
	1 to 9; 1 being the most important advantage)	2. No need of plantation every year (89.7% respondent)	
		 Seabuckthorn has multiple uses (fencing, firewood, fodder etc) (88.7% respondent) 	
		4. Can be grown on barren land (83.4% respondent)	
		5. Improve soil fertility (82.4% respondent)	
		6. Require less water (80.9% respondent)	
		7. Require less maintenance (53.4% respondent)	
		8. Hardy plant (48.9% respondent)	
		9. Any other (14.8% respondent)	
4	What are the main constraints in Seabuckthorn plantation? (ranking from	1. Spread to agricultural field (90.5% respondent)	
	1 to 7; 1 being the main constraint)	2. Do not know how to cultivate (87.6% respondent)	
		3. Do not know source of planting material (87.3% respondent)	
		4. No land for cultivation (85.4% respondent)	
		5. No irrigation facility (80.6% respondent)	

Query no.	Query	Response		
		6. Social taboo/ socially not acceptable (70.5% respondent)		
		7. Any other (14.5% respondent)		
5 Where will you cultivate Seabuckth if you decided to do so? (ranking fra to 5; 1 being the most preferred)	Where will you cultivate Seabuckthorn, if you decided to do so? (ranking from 1	1. Owned barren land (90.5% respondent)		
	to 5; 1 being the most preferred)	2. Only if the Govt provides incentives (64.1% respondent)		
		 Only if the Govt provides land (55.5% respondent) 		
		4. Agricultural field (52.2.0% respondent)		
		5. Any other (9.9% respondent)		

EXPENDITURE & PROJECT TEAM

Expenditure

SI. No.	Head	Sanctioned (Rs)	Expenditure (Rs)
1.	Hiring of manpower for data collection	80,000.00	80,000.00
2.	Hiring of vehicle/ POL (Leh and Nubra valley) for data collection	70,000.00	0.0
3.	Office expenses	50,000.00	15,000.00
4.	Interactive meet	15,000.00	0.0
5.	Misc	35,000.00	24,640.00
	Total	2,50,000.00	1,19,640.00

Project Team

SI. No.	Name, Designation and Affiliation	Role in the Project
1.	Dr Tsering Stobdan, Scientist 'E', Defence Institute of High Altitude Research	Chairman
2.	Dr. MS Raghuvanshi, Senior Scientist, Central Arid Zone Research Institute, Leh	Member
3.	Dr Deldan Namgyal, Scientist, Sher-e-Kashmir University of Agricultural Sciences and Technology	Member
4.	Sh Tsewang Phunchok, Chief Horticulture Officer, Ladakh Autonomous Hill Development Council, Leh	Member Secretary

ABOUT AUTHORS

Dr. Tsering Stobdan, Scientist 'E' is the Head of Plant Science Division at Defence Institute of High Altitude Research (DRDO). He received his B.Sc in Horticulture from University of Horticulture & Forestry, Solan; Masters in Molecular Biology & Biotechnology from G B Pant University of Agriculture & Technology, Pantnagar; and Ph.D in Molecular Biology & Biotechnology from Indian Agricultural Research Institute, New Delhi. He served as scientist in Biotechnology Division at CSIR-Indian Institute of Petroleum for four years before joining DRDO in 2006. He has 5 patents including one in USA, over 50 publications in reputed national and international journal, two monogram and 20 book chapters to his credit. He is reviewer for 4 national and 14 international journals. Two Research Fellows have been awarded Ph.D degree in Biotechnology under his supervision. Two Seabuckthorn-based technologies developed by him have been successfully transferred to Industries. Agro-technologies that he has developed for trans-Himalayan region are widely practised by the farmers in Ladakh. He has been awarded National Science Day Medal in 2008 & 2015, National Technology Day Medal in 2016 and Laboratory Scientist of the Year Award in 2009 by Defence Research and Development Organisation. Dr Stobdan has also been honoured with 'Young Scientist Award' in 2015 by Seabuckthorn Association of India for his contribution in the fields of Seabuckthorn genetic diversity, cultivation technologies and improvement of livelihood of farmers in Ladakh. He organized National Conference on Seabuckthorn in 2009 and 2017 at Leh Ladakh. He is the executive member of Seabuckthorn Association of India.

Shri Tsewang Phunchok is the Chief Horticulture Officer, Ladakh Autonomous Hill Development Council, Leh Ladakh. He received his B.Sc in Agriculture from Sher-e-Kashmir University of Agricultural Science & Technology, Jammu in 1993; and Masters in Postharvest Technology from Sher-e-Kashmir University of Agricultural Science & Technology, Kashmir in 2006. He has over 25 years of experience in working closely with farmers in Ladakh region.

> Value Chain Analysis of SEABUCKTHORN (Hippophae rhamnoides L.) in Leh Ladakh

Directorate of Arecanut and Spices Development MINISTRY OF AGRICULTURE AND FARMERS WELFARE (Department of Agriculture, Co-operation & Farmers Welfare) Government of India