Asian case study

Seabuckthorn: A multipurpose plant for mountain people

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1. History of the initiative

Humans have been using seabuckthorn for at least 12 centuries, as recorded in the Tibetan medicinal classic the *rGyud bzi* ("Four books of pharmacopoeia"), written by Yu Tuo Yuan Dan Kong Bu and completed during the Chinese Tang Dynasty (618 to 907 AD). The *rGyud bzi* gives 84 different set prescriptions for the preparation of seabuckthorn medicines.

During the 13th century the *rGyud bzi* was disseminated through Mongolia, and seabuckthorn began to be used in traditional Mongolian medicines. In the Qing Dynasty (1821 to 1850), the Mongolian scholar, Losan Quepei, wrote a 120-chapter book, *A selection of traditional Mongolian medicine*, 13 chapters of which document the properties of seabuckthorn and its effects in clinical cases. There are 37 different set preparations based on seabuckthorn.

However, it is only in recent decades that people have had a better understanding of seabuckthorn. The scholars who are engaged in scientific research on seabuckthorn in various countries have revealed its important value to human beings by carrying out a large number of scientific experiments. Russian and Chinese scientists in particular have made a considerable contribution to the research and development of seabuckthorn.

Inspired by ancient Chinese literature, scientists in the former Soviet Union carried out research on seabuckthorn from the 1930s onwards, and developed many new varieties. They developed various medicinal preparations, including health products for astronauts and pilots. Since 1985, the Chinese Government has developed seabuckthorn production nationwide in a systematic manner.

Encouraged by success stories from China, many South Asian countries such as Nepal, Bhutan, India and Pakistan started their own seabuckthorn development programmes in the 1990s.

A project entitled Seabuckthorn Exploitation and Development in Pakistan was initiated by the National Arid Land Development and Research Institute (NADRI) of the Ministry of Food, Agriculture and Livestock (MINFAL), Islamabad in 1997. Pakistani seabuckthorn (*Hippophae rhamnoides* subsp. *turkestanica*) grows over an area of 3 000 ha in northern areas of Pakistan. Wild forests of this plant can be found in the valleys of Hunza, Gilgit, Skardu, Shigar, Astore and Chitral. Since 1997, a number of new developments have been made based on this resource.

Nepal is very rich in natural resources of seabuckthorn. Two valuable species of *Hippophae* – *H. salicifolia* and *H. tibetana* – occur in northwestern Nepal, and cover total areas of 2 364 and 870 km^2, respectively. In 1996, the Tree Improvement and Silviculture Component (TISC) initiated a comprehensive programme that includes conservation of these species. The programme's long-term intention is to provide practical options for farmers to increase their income through the effective utilization of seabuckthorn resources.

2. The product

PRODUCTS INVOLVED

The rich nutritional and bioactive substances in seabuckthorn have attracted many people who are interested in the production or utilization of nutritional and medicinal seabuckthorn products for preventive or curative purposes. There is strong recent or re-emerging interest in such products in Europe, North America and Asia.

Nutritional use: The berries of seabuckthorn are among the most nutritious and vitamin-rich fruit known. They contain large amounts of essential oils and vitamin C. Seabuckthorn is also rich in protein, especially globulins and albumins, carotene, fatty acids (saturated and unsaturated), free amino acids, flavonoids and vitamin E. The leaves contain many nutrients and bioactive substances. Nutritious seabuckthorn products include tea, juice, purée, wine, jam and snacks. The residues left after juice and oil extraction are used as food and feed additives.

Medical use: Various medicinal products and uses derived from seabuckthorn. Pioneering countries in the development of such products are Russia and China, where seed and pulp oils and flavonoids are well-established products. In both countries, seabuckthorn oils have been clinically tested and are approved and decreed medicines.

China listed seabuckthorn in the Pharmacopoeia in 1977. The oils are used to treat cardiovascular diseases, cancer, mucositis, radiation damage, burns, ulcers, inflammation, sores, etc. Flavonoids are extracted from the fruits and are used especially in the treatment of cardiovascular problems. Only recently, however, have the oils begun to attract attention in Western medicine. For example, seabuckthorn oils are now increasingly used as auxiliary products in cancer therapy in the West. Besides its strictly medicinal applications, and because of its protective effects on the skin, seabuckthorn oil is also used in the preparation of cosmetics, including sun blocks.

A total of 23 seabuckthorn products have been successfully prepared on an experimental basis in collaboration with the Pakistan Council of Scientific and Industrial Research (PCSIR), Peshawar. The food products include juice, oil, jam, carbonated beverages, breakfast cereals, powder, rice pops, juice powder, fibrex mix, toffees, biscuits, and cosmetic products such as facial cream and shampoo. A solvent extraction unit with a capacity of 50 kg/day is being established for the extraction of seabuckthorn oil at Skardu, Pakistan.

In 2000, a survey carried out by TISC demonstrated that between 10 and 50 percent of the population in the districts of Mustang and Manang, Nepal have benefited from the production and sales of seabuckthorn juice, primarily to tourists visiting those areas. The selling price is about Rs. 230 to 350 (US$3.1 to 4.7) per litre. In addition, local people also make vinegar from seabuckthorn juice.

As most seabuckthorn products are derived from natural forest and plantations where there is no air and water pollution, and no chemical fertilizers, pesticides or fungicides are used, many seabuckthorn products have been certified as Green Foods (a Chinese standard that is similar to the Organic Food standard). Some Chinese seabuckthorn products, such as seed oil, pulp oil and flavone capsules, were selected to be shown at The World Organic Trade Show, which was held in Nuremberg, Germany from 18 to 21 September 1999.

GEOGRAPHICAL DISTRIBUTION OF SEABUCKTHORN

Many scholars and experts have certified that the genus Hippophae originated in the Himalayan mountain regions, and then spread to southwest, northwest and northern China and eastern Inner Mongolia, as well as to the northwest regions of Eurasia, where one route west reached the Alps via the Caspian and Black seas before finally arriving at the northwest shore of the Scandinavian peninsula. Another route progressed northwest to reach northwestern Mongolia and southern Siberia in the Russian Federation via India, Nepal, Pakistan, Afghanistan, the Xinjiang Uygur Autonomous Region in China and several Central Asian countries of the former Soviet Union. In other words, seabuckthorn is a typical temperate plant of the Eurasian continent, widely distributed between longitude east 9º to 122º and latitude north 68º to 27º. Considering the vertical range of elevations, seabuckthorn

has a very strong ecological adaptability. It can grow from the seashore of the Baltic Sea in Europe to 5 200 m above sea level in the Qumulangma Mountains (Everest) in Asia.

Generally, seabuckthorn grows in temperate regions of the world. It grows well in the following climatic conditions: the monthly average temperature of the hottest month is 15 to 25 °C, and the maximum radiation on clear days in the vigorous growing season is 23 500 to 26 000 cal/cm²; annual rainfall ranges from 250 to 500 mm. Seabuckthorn naturally occurs in the arid, semi-arid and high mountainous ecosystems (1 500 to 3 500 m) of Eurasia.

Most natural resources of seabuckthorn are accessible, with the exception of those that grow in very remote areas such as the Hindu-Khush-Himalayan mountains and the Tibetan plateau. Cultivated plantations are established near villages or communities. These plantations are connected by roads, so there are no problems in terms of harvesting and transportation.

BENEFICIARIES AND STAKEHOLDERS

The first beneficiaries are farmers who receive a cash income from selling the berries and leaves of seabuckthorn. The second are businesses that make profits from processing various products. The third are local governments, which obtain tax revenue from businesses. Seabuckthorn enterprises can also create significant employment opportunities in the countryside and towns.

3. Technological aspects

Both the berries and leaves of seabuckthorn are used to manufacture various products.

PRODUCTION AND PROCESSING PROCEDURES FOR BERRIES

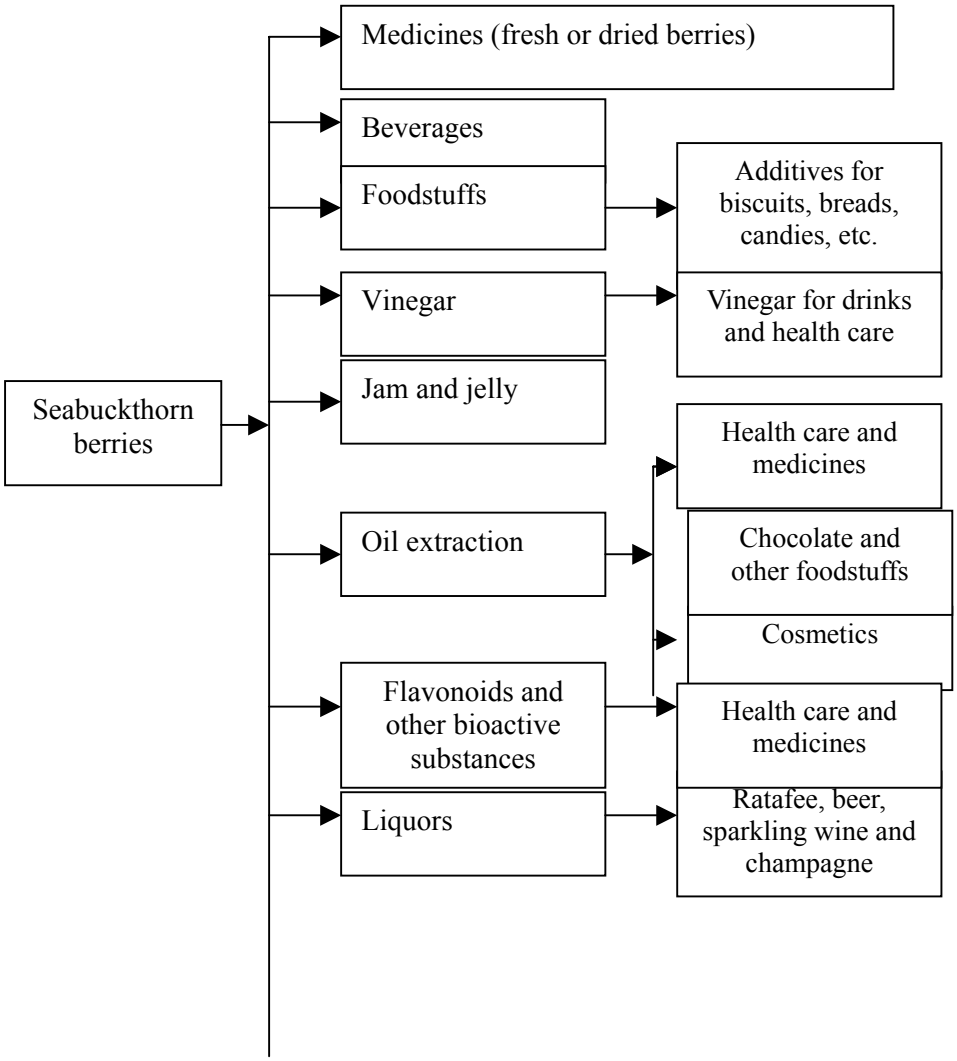
Seabuckthorn berries can be used to make the many products shown in Figure 1.

PRODUCTION AND PROCESSING PROCEDURES FOR LEAVES

The tender leaves of seabuckthorn are used for making tea. The processing procedure is as follows:

- collection of leaves;
- quick frying;
- twisting;
- primary stir-frying;
- moistened;
- second stir-frying;
- fluttering;
- packaging/sterilization;
- storage.

Figure 1: Products from seabuckthorn berries



4. Economic aspects

Since 1985, about 1.33 million ha of seabuckthorn plantations have been established in China. By 2002, in addition to the 0.67 million ha of natural seabuckthorn forest, the total area of seabuckthorn had reached 2.0 million ha. Now there are more than 200 seabuckthorn processing factories in China, producing more than 200 different products. Every year, about 50 000 tonnes of seabuckthorn berries are harvested and processed into 200 000 tonnes of products valued at more than US$120 million, of which profits and tax account for 10 percent.

Growing and processing seabuckthorn and its products has become an industry that benefits not only farmers, but also businesses and government. The following are some examples:

- In the main seabuckthorn growing areas in northwest China, the average farmer can earn US$15 per year by selling seabuckthorn berries and leaves. About 50 000 households have increased their incomes by grazing cattle and sheep in their seabuckthorn plantations.
- In Tanyaqu village, Zhunger County, Inner Mongolia, China, 120 households have established 300 ha of seabuckthorn plantations. In 2002, each villager earned US$37.4 from selling seabuckthorn berries. This cash income accounts for 15 percent of the total per capita

income. Among the 120 households, 30 families earned even more, each reaching US$602.4, which accounts for 50 percent of the total household income.

- In Burduliang village, Erduos city, Inner Mongolia, China, over a period of 20 days in 2002, each household increased its income by an average of US$144.6 by collecting leaves; some households earned up to US$253. Generally, cash income from seabuckthorn accounts for 30 to 50 percent of total cash incomes, rising to 70 percent in some cases.
- The Ganbao Seabuckthorn Beverage Factory is a rural enterprise located in Lixian County, Aba Tibetan Autonomous Prefecture, Sichuan Province, China. After an initial investment of US$108 000, the factory can produce 60 tonnes of seabuckthorn granules and soft drinks at a running cost of US$102 500 per year. Once the production costs are accounted for, the factory can earn a net profit of US$12 000. The factory employs 40 people (seven as managers, technicians, accountants and drivers, and the other 33 as workers), all of whom come from the countryside outside the town.
- In 2000, Pakistan's National Arid Land Development and Research Institute (NADRI) acquired more than 10 tonnes of seabuckthorn from local farmers at the rate of US$2 per kilogram. The initial high purchase rate helped to create awareness of seabuckthorn and its uses among local farmers in the northern areas of Pakistan.

5. Institutional aspects

INSTITUTIONAL DEVELOPMENT

The Chinese Government listed seabuckthorn as both a food and a medicine in the Pharmacopoeia of China in 1977.

In 1985, the National Seabuckthorn Coordination Office was established in China. The office was under the leadership of the Chinese Ministry of Water Resources, which was responsible for coordinating all activities related to the development of seabuckthorn nationwide. In 1999, the office changed its name to the Chinese Administration Centre for Seabuckthorn Development. In addition, since 1985, a series of provincial seabuckthorn coordination offices have also been established in Shanxi, Shaanxi, Liaoning, Inner Mongolia, Gansu and Qinghai provinces.

In 1996, NADRI was established under the leadership of the Ministry of Food, Agriculture and Livestock (MINFAL), Islamabad, Pakistan to be responsible for coordinating activities relating to the development of seabuckthorn throughout the country. Since 1997, various government agencies, businesses and non-governmental organizations (NGOs), including the Aga Khan Rural Support Program (AKRSP), have become involved and play important roles in the development of seabuckthorn in Pakistan.

In 1994, a development organization, the Tree Improvement Programme (TIP), was established in Nepal. Supported by the Danish International Development Agency (DANIDA), TIP has made significant efforts to promote the development of seabuckthorn in northern Nepal. In 1996, TIP changed its name to the Tree Improvement and Silviculture Component (TISC). Several farmers' organizations (Seabuckthorn User Groups) were formed in Mustang District in 1999. Later, similar organizations were established in Manang, Humla, Jumla, Mugu and Dolpa districts.

In 1995, the International Centre for Research and Training on Seabuckthorn (ICRTS) was set up in Beijing, and 11 countries joined the organization.

In 2001, the International Seabuckthorn Association (ISA) was established in New Delhi, India. The first congress of ISA was held in Berlin, Germany in September 2003, and ISA's constitution was approved.

EXISTING LAWS AND POLICIES

Seabuckthorn has been used as a traditional medicinal plant for thousands of years in the Hindu-Khush-Himalayan mountain region, especially in India, Bhutan, Pakistan, Nepal and China. Even now, local people in this region still collect berries for medicine, graze animals in the forest, and plant seabuckthorn to protect water channels and to fence their farmland. So the utilization of seabuckthorn resources does not transgress any laws in the region.

In order to protect seabuckthorn resources and encourage people to establish seabuckthorn plantations, the Chinese Government has made a series of laws and regulations since 1985. The following are examples: the Forest Law of the People's Republic of China; the Law of Water and Soil Conservation; the Pledge of Forest Protection; the Basic Law of Protection of the Environment; the Regulation on the Management of Forest Harvesting and Regeneration; the Chinese Biodiversity Conservation Action Plan; the Regulation of the People's Republic of China for the Protection of Wild Plants.

Generally, farmers establish their seabuckthorn plantations on barren or marginal land without using valuable agricultural land. According to Chinese law, all land belongs to the government, so the key issue is who is the owner of the plantation. Since the beginning of the 1990s, China has adopted a policy whereby whoever sets up the plantation is its owner. Furthermore, if farmers establish seabuckthorn plantations on barren or marginal land, these plantations will belong to them for 70 years. This policy is confirmed by a legal contract between farmers and the government. As a result, farmers are very happy to establish plantations.

6. Environmental benefits

Seabuckthorn brings many environmental benefits, including soil and water conservation, desertification control, land reclamation and rehabilitation, erosion and water loss control (gully control, flood control, etc.), reforestation, and the establishment of wildlife habitats in natural reserves of China. Seabuckthorn has been used in the reclamation of opencast mines and post-industrial dumps and wastelands, as well as in the establishment of farm shelterbelts in farming areas, etc.

For example, seabuckthorn has been used to control desertification in Jianping County, Liaoning Province, Northeast China. In the nineteenth century, Jianping County enjoyed a time when the mountains were green and the water was clean. However, a century of indiscriminate logging resulted in a forest cover rate of only 1.9 percent. The eroded area reached 81 percent of the total area. The semi-arid climate, frequent disasters such as floods, droughts and storms, and the degraded natural environment made Jianping County one of the poorest areas in China.

Having been recognized as one of the most competitive species in controlling water losses and soil erosion, seabuckthorn was planted over a total of 67 000 ha in the county. The establishment of seabuckthorn plantations created the largest seabuckthorn forest in the world, which helped to increase the area's vegetation cover from 4 percent in the 1950s to 34 percent in the 1990s. Runoff and soil erosion were reduced by 90 and 70 percent, respectively. Fodder, fuelwood and berries now contribute to the local economy. Several wild animal species have found a habitat in this forest, including pheasant, hare and fox. Poverty has been reduced in the county, and employment has risen, especially for rural women.

In 1998 to 1999, 0.3 million seabuckthorn plants were transported from northern areas to Balochistan, Pakistan, where they were supplied to various organizations and departments for

field plantation. Owing to a severe drought in Balochistan, the success of these plantations was very limited. More than 0.185 million plants were supplied for field plantations in Balochistan, Northwest Frontier Province (NWFP) and Punjab in February 2000. A 50 to 60 percent survival rate has been observed at various sites in Balochistan.

Experimental aerial and hand seeding of 6 tonnes of seabuckthorn seed was undertaken in the areas of Loralai and Ziarat during March 2000 in order to propagate seabuckthorn in Balochistan, as well as to conserve the juniper forests by providing alternative supplies of fuelwood for local people.

7. Propagation and cultivation

PROPAGATION

Seabuckthorn can be propagated easily by several means, including through seeds, cuttings (hardwood and softwood cutting) and air seeding.

- *Propagation by seeds.* This is the most popular way to produce seedlings. The seeds to be sown can be obtained from the processing factory or collected from plantations. One kilogram of seabuckthorn seeds contains from 90 000 to 120 000 seeds. The germination rate of seeds is about 80 to 95 percent. The sowing quantity is 50 to 75 kg/ha. One hectare of nursery can produce 370 000 to 400 000 seedlings. A normal standard seedling is about 30 cm in height and 0.3 cm in diameter. Given proper training, farmers can produce seedlings themselves for their own plantations.
- *Propagation by cuttings.* Seabuckthorn is a dioecious plant with separate male and female plants. Generally, the ratio of males to females in the natural forest is about 1:1. Cuttings are used to obtain more female plants and produce improved seabuckthorn varieties. In order to produce cuttings, equipment such as greenhouses or plastic tunnels, irrigation facilities and controlled autosprayers is needed. Cuttings are normally produced in professional nurseries.

CULTIVATION

According to the different purposes of cultivation, seabuckthorn plantations can be categorized as ecological-economic or economic plantations.

- *Ecological-economic plantations:* The purpose of these plantations is to make use of degraded barren land and obtain proper economic benefits for growers. Such plantations are usually established by growing seedlings. After three to four years, the plantations can significantly reduce soil erosion and water loss. Farmers can harvest berries and leaves, graze their animals and obtain fuelwood from the plantations. If a household owns 3 to 5 ha of seabuckthorn plantation, the biomass and fuelwood produced are sufficient to supply its daily needs.
- *Economic plantations:* The purpose of these plantations is mainly to harvest berries and leaves. Such plantations are usually established by growing cutting saplings (improved varieties). The plantation looks like an orchard, and the ratio of male to female plants is 1:10 or 2:8. After three to four years, the berries and leaves can be harvested. As the plantations are propagated by improved varieties, and the planting materials are cutting saplings, more than 80 percent of plants are female, so the berry yield of a plantation per hectare is much higher than that of plantations propagated by seedlings. These plantations are usually used only to provide berries for the processing factories.

8. Cultural and social benefits

Seabuckthorn is the best example of how an ancient cultural heritage brings benefit to modern society through scientific research. As mentioned before, seabuckthorn was used as a medicinal plant 12 centuries ago in Tibet. Owing to seabuckthorn's obvious effectiveness in curing many diseases, the plant was considered as holy and was grown in the Potala and Robulinka palaces in Lhasa, Tibet. Even today, seabuckthorn is still used as an important composition of the remedies that are produced in many Tibetan pharmaceutical companies. The uses of seabuckthorn have continued to be developed, and the plant is now truly multipurpose, with a modern industry created around it. To demonstrate how far seabuckthorn has been developed in the modern age, some people have even suggested that a new field of study should be declared, which could be known as "Hippophaenology".

The cultivation of seabuckthorn has also brought considerable social benefits. In the 1980s, in the village of Luofugou, Jianping County, Liaoning Province, China, poverty forced many villagers to migrate in search of other means of livelihood. In the 1990s, the village planted about 6 000 ha of seabuckthorn. With more food, fuelwood and cash income, the villagers' lives improved to the extent that those who had migrated away returned back to their homes.

9. Sustainability and replicability

Population increase, environmental degradation and poverty are three big issues faced by people throughout the world, especially in developing countries. The development of seabuckthorn could help to solve these three big problems.

The experience of the past 20 years has proved that seabuckthorn is a wonderful plant, with significant potential to play a crucial role in the development of arid and semi-arid lands and fragile mountain areas, and to address issues of global dimensions. In particular, the obvious economic and environmental benefits are basic aspects that make this initiative a highly sustainable way of changing the lives of people in mountain areas.

Seabuckthorn offers a significant opportunity to millions of people to improve their living standards by developing seabuckthorn products. Millions of hectares of degraded land could be reclaimed by planting seabuckthorn. The main constraint is lack of awareness of the importance of seabuckthorn on the part of leaders, decision-makers and the general public.

As increasing population, environmental degradation and poverty are common problems all over the world, seabuckthorn could be introduced in many countries that have similar physical, climatic and socio-economic conditions to those areas where it has already been successfully developed. In particular, some developed and semi-developed/developing countries where the ecological environment is not especially degraded have shown an interest in the economic benefits of developing seabuckthorn. Countries with more temperate climatic conditions are more interested in both the economic and ecological benefits. In other words, about a quarter of all the countries in the world could benefit from the development of seabuckthorn. The following are particularly adapted to its development:

- the countries that have developed seabuckthorn: the Russian Federation, Belarus, Ukraine, Estonia, Latvia, Lithuania, Poland, Hungary, Romania, Azerbaijan, Kazakhstan, Uzbekistan, Kyrgyzstan, China, India, Pakistan, Nepal, Bhutan, Tajikistan, Mongolia, Finland, Sweden, Germany, France, Italy, Switzerland and Canada (27 countries);
- the countries where seabuckthorn could be developed: Turkey, the Islamic Republic of Iran, Afghanistan, the Syrian Arab Republic, Israel, Iraq, the Republic of Korea, the Czech

Republic, Slovakia, Austria, former Yugoslavia, Bulgaria, South Africa, Ethiopia, Lesotho, the United States, the United Kingdom, Chile, Argentina, Peru and Bolivia (21 countries).

The difficulties of developing seabuckthorn in the Hindu-Khush-Himalayan mountain region are the result of:

- lack of awareness of the importance of seabuckthorn: seabuckthorn is a new innovation, and many farmers, as well as decision-makers and officers, are unaware of its importance.

lack of leadership: because seabuckthorn development is a systematic process, the establishment of a seabuckthorn industry requires considerable effort, and is not possible without strong organization and leadership;
lack of social concern: the development of seabuckthorn involves farmers and various other sectors; it requires the participation of broad sections of society such as government, social workers, businesses and investors.

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Annex 1: Inventory tables

Table 1. Seabuckthorn development in China

A	Product name	Seabuckthorn
B	Product category	Non-timber forest product
C	Geographical location	Eurasia continent
D	Price	Berries: US$0.2 per kg; seeds: US$2 per kg in China
E	Production	Raw juice, seed and pulp oil, flavonoids, additives, seeds, leaves for tea, etc.
F	Sales	Welcomed by consumers and market
G	Markets	First, domestic market; second, regional market; third, international market
H	Market linkages/distribution channels	Berries and leaves are collected by farmers: → primary processing plant → final product factory → wholesale → retail
I	Promotion strategies	Media: TV, advertising in newspapers, magazines, etc., exhibitions
J	Real impact on local economy	Farmers obtain revenue from the sale of berries and leaves. Businesses make profit from processed products. Local government receives tax revenue
K	Production techniques	Food and beverage production, health care, production of medicines and cosmetics
L	Processing techniques	General processing techniques for food, beverages, wine, tea, health care and medicines and cosmetics
M	Infrastructure	Roads, transportation facilities, water supply, power, equipment, housing, etc.
N	Ecological ecosystem	Temperate climate ecosystems in mountain and hilly areas; arid and semi-arid ecosystems in temperate regions of the world
O	Impact on conservation	Very useful for soil erosion control and rehabilitation of degraded ecosystems
P	Laws	Laws permit the use of seabuckthorn and produce-related products
Q	Soft laws	Forest Law of China; Law of Water and Soil Conservation of China, etc.
R	Policies	Government encourages people and businesses to grow and process seabuckthorn
S	Stakeholders	Farmers, businesses, local government
T	Cultural aspects	Ancient cultural heritage (medicinal) is preserved, awareness of protecting the environment
U	Social aspects	Reduction of village migration to cities
V	Opportunities and constraints	Increased opportunities for generating cash income and improving degraded ecosystems; constraints are lack of knowledge and funding
W	Mountain-specificity	Marginal mountain and desert land is made full use of without occupying cultivated land
X	Sustainability/replicability	An excellent way to realize sustainable development in rural areas; can be replicated in many countries of the world
Y	Other	
Z	Value for a case study	One of the most valuable mountain products for case study
	References/links	See reference list at end of the paper

Table 2. Seabuckthorn development in Nepal

A	Product name	English: Seabuckthorn Nepalese: Dalechuk, Amilchi, Tarechuk, Ashuk Scientific name: *Hippophae rhamnoides* Linn
B	Product category	Seabuckthorn berries can be used for making juice
C	Geographical location	Seabuckthorn is found in mountainous regions of altitudes of 1 400 to 4 500 m and temperature range of -40 to +40 °C
D	Price	Seabuckthorn juice (from Myagdi Enterprise alone): NRs 200/bottle (US$3/bottle) (bottle contains 1 litre of juice)
E	Production	Approximately 200 to 250 bottles are produced in the Myagdi area in a year. About 230 bottles of juice were produced in 2002
F	Sales	US$750 (total)
G	Markets	The major markets are local and national: cities, trekking routes, etc.
H	Market linkages/distribution channels	Myagdi Enterprises Inc., Kathmandu , Nepal, P.O. Box No. 8975, EPC 1990; Tel.: 977-1-5525410 Fax: 977-1-4220161, 977-1-5546331 E-mail: langhalijagat@hotmail.com
I	Promotion strategies	The use of seabuckthorn as a medicine in the treatment of pain, muscle ache, fungal infections, burns, mouth ulcers, etc. will be made clear in labelling, and advertisements will be published in the daily newspapers. There will be a logo of the company involved, as well as a brief description that recounts the role of seabuckthorn in increasing the economic and health standards of mountain people
J	Real impact on local economy	The people of Gurja depend on agriculture and collect medicinal plants from the forest. The majority of the people of this region are of Chhantyal ethnicity. More than 300 local people are directly or indirectly involved in the production of seabuckthorn juice, two months per year. One person can produce about 6 litres per year, for which he or she is paid NRs 150 per litre. The seeds also have medicinal values
K	Production techniques	The local people find the seabuckthorn plant in the forest and pick the raw fruits, which are then brought to their houses where processing takes place. The plants can also be cultivated as required, and do not require much care once they reach maturity. The fruits should be picked carefully, as they are delicate and prone to bursting, and picking one fruit can damage those nearby. The farmers sell the fruits to businesses and agents for local and international markets
L	Processing techniques	The raw fruits are collected and compressed so as to obtain a liquid. A clean cloth is used to filter the liquid and other substances such as seeds. The liquid is then boiled in a bronze vessel to increase its density, and is kept in the vessel for about 12 to 24 hours to allow sedimentation. The liquid is then transferred to bottles, where water and sugar are added as required. Honey can be added instead of sugar to improve the taste
M	Infrastructure	The compressing machine is portable and mechanical so it can easily be carried to different places for processing. In future, for the processing of large amounts, an electrical compressor can be used
N	Ecological ecosystem	Seabuckthorn is mainly cultivated on barren land
O	Impact on conservation	The seabuckthorn plant prevents landslides and erosion and helps to increase the fertility of the soil
P	Laws	No
Q	Soft laws	No
R	Policies	No
S	Stakeholders	Farmers, households, local communities of Gurja, government
T	Cultural aspects	In the past, when the people of Gurja had no access to lemons, they used to collect seabuckthorn and use it with pickles and curry to increase the flavour. Later, when other foods were used for their sour taste, the people of Gurja began to use seabuckthorn as a medicine for diseases such as *hade* (the local name for tonsilitis) and as pain relief (used in massage). Those who had no access to seabuckthorn began to exchange other crops for it. Now that the people of Gurja know about the medicinal value of seabuckthorn, they have begun to organize the proper management and production of the plant
U	Social aspects	The people of Gurja use the leaves of the seabuckthorn plant to feed their livestock. The farmers pick the fruits, and the women are involved in the processing
V	Opportunities and constraints	Opportunities: In the local market the demand for seabuckthorn is increasing daily. The plant prevents landslides and increases the fertility of the soil, thus helping the natural conservation of forests and wild animals. It is a multipurpose item. As the requirements are minimal, it is considered a profitable source of income for the people in Gurja and other mountain regions. Constraints: Because of the poor quality of the roads, it is difficult to carry the liquid from mountainous regions. Governments have never contributed to improving the production of

		seabuckthorn. Local people are unaware of the benefits and the technicalities of seabuckthorn production
W	Mountain-specificity	From ancient books it can be seen that seabuckthorn was used during the Chinese Tang Dynasty (618 to 907 BC). We are not sure at what point seabuckthorn began to be used in Nepal, but according to the older generation, it was used in the past as a sour-tasting foodstuff and was also exchanged with other crops when the barter system still existed in Nepal. Seabuckthorn was later used as medicine for the treatment of common diseases such as tonsilitis, tooth ache, muscle ache, etc.
X	Sustainability/replicability	Once a plantation is fully grown it does not require daily care, and can be cared for once a month, so farmers are free to look after other crops. A type of Actinomycetes – Flankia – which is found in the root of seabuckthorn helps to fix nitrogen in the soil. Seabuckthorn berries are rich in carbohydrates, amino acids, organic acids, and vitamins A, B, C, K and P. The seabuckthorn plant protects farmland from landslides and erosion and helps to increase the fertility of the soil
Y	Other	Seabuckthorn was unknown to many people a few years ago, but when it was introduced by ICIMOD and other NGOs people began to recognize its importance. Nowadays people prefer to cultivate and use natural organic crops rather than substances produced chemically. We can therefore state that demand is increasing not only within Nepal, but also in the international market Although the production of seabuckthorn is less of an investment than a good profitable job for the people of mountain regions who depend entirely on agriculture for their livelihood, the cultivation of this kind of plant helps them to improve their socio-economic status. However, as yet, the government has not taken any steps to improve production. The government should train farmers, provide them with plants, and manage access to the international market, given that the demand for seabuckthorn is increasing day by day
Z	Value for a case study	Mountain people depend mainly on agriculture, which cannot fulfil their daily income requirements. The production of seabuckthorn not only provides them with a job, it also helps to increase the standard of living within the family. The production cost is nearly zero, but the profit is good. With minimal investment, farmers can use seabuckthorn not only for juice production, but also for medicinal uses. The money they earn from selling products can be used for their children's education and to fulfil their daily needs – buying salt, oil, etc. All family members can be involved in the production as there is no need for heavy-duty maintenance. The seabuckthorn plant also has aesthetic value. It enhances the mountain landscape and the berries are used by bees
	References/links	For further information on this subject the books used for reference were: Rongsen, L. *Seabuckthorn: A multipurpose plant species for fragile mountains.* ICIMOD. *Introduction to seabuckthorn* Trade Promotion Centre Nepal, Kathmandu, Nepal, Kartik 2058 Myagdi Enterprise Inc., Kathmandu , Nepal, P.O. Box No. 8975, EPC 1990 Tel.: 977-1-5525410 Fax: 977-1-4220161, 977-1-5546331 E-mail: langhalijagat@hotmail.com Web site: http://myagdi.tripod.com

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Table 3. Seabuckthorn development in Pakistan

A	Product name	Seabuckthorn
B	Product category	Non-timber forest product
C	Geographical location	Indo-Pakistan subcontinent
D	Price	Fresh berries: US$0.5 per kg; dry berries: US$1.0 per kg
E	Production	Raw juice, jam, jellies, seeds, seed oil, traditional (Unani) medicines
F	Sales	Seed exported, welcomed by locals as high-value medicinal products
G	Markets	Primary or local market; secondary or city market; international market
H	Market linkages/distribution channels	Dry berries are generally collected by farmers → local market → secondary market → international market Fresh berries collected by farmers → cottage products → local and city market as per demand
I	Promotion strategies	Electronic and print media: TV, newspapers, magazines, etc., and exhibitions
J	Real impact on local economy	The sale of seabuckthorn berries and cottage products has emerged as a potential source of income for poor farmers during the winter, when other livelihood activities are extremely limited in the northern mountains of Pakistan. Local and city traders are making profits by exporting products
K	Production techniques	Food, health care and medicinal products are being produced as a cottage industry
L	Processing techniques	Food and health care products are now produced by local farmers, particularly women, after necessary capacity building by local NGOs such as AKRSP. Medicinal products are mostly produced in lowland areas by traditional experts in medicines, who are locally called Tabeeb or Hakeem, using their traditional knowledge and expertise
M	Infrastructure	Roads, transportation facilities, water supply, power, equipment, housing, etc.
N	Ecological ecosystem	Temperate climates in the northern mountains; arid and semi-arid ecosystems in the Hindu-Kush-Himalayan region
O	Impact on conservation	Very useful in controlling soil erosion and in the rehabilitation of degraded ecosystems. Provides ideal habitats for birds and other endangered species
P	Laws	Laws allow the use of seabuckthorn and produce-related products
Q	Soft laws	-
R	Policies	The Government of Pakistan is promoting seabuckthorn development and has launched a major project to undertake the required R&D steps to build the capacity of local farmers by involving local NGOs
S	Stakeholders	Farmers, NGOs, businesses, local government
T	Cultural aspects	Ancient cultural heritage (medicinal) is preserved; awareness of protecting the environment is promoted
U	Social aspects	The winter migration of local people to the lowlands has been considerably reduced wherever seabuckthorn has been properly promoted
V	Opportunities and constraints	Increased opportunities to generate cash income and improve degraded ecosystems; constraints are lack of knowledge and funding
W	Mountain-specificity	Great potential to exploit marginal land, including steep slopes, gullies, etc. in mountainous regions and deserts without occupying cultivated land
X	Sustainability/replicability	One of the best ways of realizing sustainable development in rural areas; it can be replicated in many countries around the world
Y	Other	-
Z	Value for a case study	One of the most valuable mountain products for case study
	References/links	See the reference list at the end of the paper

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