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SEABUCKTHORN RESOURCES AND ITS UNDEREXPLOITED POTENTIAL IN THE HIMALAYAN REGION

Lu Rong-sen

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International Centre for Integrated Mountain Development

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PREFACE

ICIMOD's approach to problem oriented research involves both knowledge reviews and field studies. The focused reviews and field studies conducted by the Mountain Farming Systems' Division cover various aspects of agricultural development. Since early 1988, a series of 'state of the art' reviews of agricultural policies and programmes were sponsored by ICIMOD in different countries of the HKH Region. The purpose of these studies and the subsequent National Workshop in different countries was to understand some of the constraints and prospects of mountain area development. These exercises were also aimed at acquiring comparative perspectives of the development approaches and strategies in different countries.

This paper is a part of this series of studies commissioned by ICIMOD. It gives a preliminary explanation of the potential of the several species and sub-species of seabuckthorn (*Hippophae rhammnoides*) that grow wild throughout the vast areas of the Hindu Kush-Himalayas. It is not the concluding work of Lu Rong-Sen on this topic.

CONTENTS

LIST OF TABLES

Abstract and Introduction

Seabuckthorn (*Hippophae L.*), a deciduous shrub or tree is widely distributed in the temperate zones of Asia and Europe and in the subtropical zone of Asia at high altitudes. Its berries are rich in nutrients and bioactive substances such as sugar, organic acid, and Vitamins. The Vitamin C content is 5-100 times higher than any fruit or vegetable known.

Growing at altitudes from 60-5,200m, *Hippophae* can resist low temperatures of minus 60°C and does not wither under the summer heat of 40°C. Some species can grow well in regions that only have a precipitation of 300mm and some species can endure inundation. Some species grow in pH 9.5 and soils which contain 1.1 per cent salts.

Hippophae is capable of fixing atmospheric nitrogen. The extensive root system controls soil erosion besides secreting some acidic compounds to improve alkaline soils.

Seabuckthorn can be propagated by both bisexual and asexual means. On good soil it often forms mass bushes on the slopes of a hill or along the banks of rivers. With luxuriant foliage and a strong root system it can retain the surface run-off and prevent the erosion of soil by wind and water.

Seabuckthorn is a source of fire wood. On testing, it was found that the calorific value of the wood is more than 4,000 Kcal/kg.

Resources of *Hippophae* are abundant in the Hindu Kush-Himalayas. According to the taxonomic listing, there are four species and four subspecies in this Region and another five subspecies are in Eurasia. It is considered that the Hindu Kush-Himalayas, and in particular the Qinghai-Tibetan Plateau, are the main areas of distribution and origin for this genus.

According to statistics, the total natural seabuckthorn area in China is 670,000 ha of which 49,000 ha are scattered in the Eastern Himalayas (including East Tibet, West Sichuan, and North-West Yunnan). A recent survey estimated that about 22,000 tons of seabuckthorn berries lie hidden and unutilised in the Eastern Himalayas of China alone.

Seabuckthorn berries are collected from natural forests. Because of the number of thorns on the stems or branches, some farmers sell the trees rather than pick the berries. Such methods damage seabuckthorn resources.

In the Eastern Himalayas, especially in Eastern Tibet and Western Sichuan, most seabuckthorn resources are far away from transportation lines and cities, so only some seabuckthorn resources are used commercially.

In order to develop the permanent and stable use of seabuckthorn resources, the Chinese Government has established a series of policies. The focus of the policies is on protecting resources and setting up new plantations.

China is further establishing vast shelter-forests of *Hippophae* in the Northeast, the North, and the Northwest.

Seabuckthorn has enabled farmers living in the mountains to earn good incomes. Many processing factories have been established. Since 1985, in the middle reaches of the Yellow River, the farmers have been earning more than 1.06 million U.S. dollars from seabuckthorn fruits every year.

To sum up, seabuckthorn is a new horticultural crop with tremendous potential. It is, and will be, playing an important role in improving the economic conditions of mountain farmers and sustaining stable development in mountain regions. There are rich resources of *Hippophae* in the Hindu Kush-Himalayan Region.

The Economic Significance and Ecological Value of Seabuckthorn

Economic Significance

Seabuckthorn (*Hippophae rhammnoides*) a deciduous shrub or tree, belonging to the family *Elaeagnaceae*, is widely distributed throughout the temperate zones of Asia and Europe and at high altitudes in the sub-tropical zones of Asia. The berries, usually yellow in colour, are rich in nutrients and bioactive substances such as sugar, organic acid, amino acid, carotene, flavone, and Vitamins B., C., E., K., and P. The Vitamin C content is 5-100 times higher than in most fruits and vegetables (Table 1). The pulp and seeds also have a high content of oil (Table 2). Therefore, seabuckthorn is used in the food and medicine industries.

In 19th century Russia, the berries were used for making wines, jams, and other types of food. Interest in the plant began to increase at the beginning of the 20th century when horticulturalists started to introduce the plant into orchards. In the 1940s, especially after the Second World War, nutritionists and pharmacologists analysed the vitamin components and found that seabuckthorn could be used not only as a food but also as a medicine. Several countries, including the USSR, Mongolia, Poland, West Germany, Finland, Italy, Norway, Hungary, Canada, and the USA have been studying this amazing plant.

Table 1. Comparisons of the Vitamin Content of Seabuckthorn and other Fruits (mg/100g) and Vegetables

	V_A	V_{B1}	V_{B2}	V_P	V_K	V_C
Seabuckthorn	11.00	0.04	0.56	1000.0	100-200	300-16000
Cili (*Rosa roxburghii*)	4.83	0.05	0.03	2909.0	-	1000-3000
Hawthorn	0.82	0.02	0.05	-	-	100-150
Kivi fruit (*Actinidia chinensis*)	-	-	-	-	-	-
Oranges	0.55	0.08	0.03	-	-	50
Tomatoes	0.31	0.03	0.02	-	-	11.8
Carrots	4.00	0.02	0.05	-	-	8.0

Source : Author

Table 2. Comparision of the Composition of Fatty Acids, Vitamin F, and Vitamin A in Seabuckthorn Oil and Other Nutrient Oils

	Fatty Acid Component (%)			V_E	V_A
	Saturated acid	Unsaturated acid	Linoleic Linolenic acid	(mg/100g)	(mg/100g)
Seabuckthorn Oil	13.7	86.0	64.6	93.2	4.35
Wheat Embryo Oil	-	-	-	33.8	-
Sunflower Oil	8.0	92.0	81.4	3.3	-
Maize Oil	15.2	84.8	48.3	34.0	0.81
Soyabean Oil	14.8	83.7	62.8	7.5	0.11

Source : Author

Ecological Value

Growing at altitudes between 60-5,200m the distribution of *Hippophae* is extremely wide throughout various geographical areas of the world. The plant is capable of withstanding temperatures of -60°C and does not wither at a heat of 40°C. Some species grow well in regions with precipitations as little as 300mm and others can endure inundation. Yet others can grow in soils having a pH factor of 9.5 and which contain 1.1 per cent salts.

The plant has excellent nitorgen-fixing properties, and its extensive root system is valuable in controlling soil erosion. On average, a six year old seabuckthorn plant will have 180g of root nodules or 100-140 nodules/m^3 of soil. A hectare of seabuckthorn can fix 45 kg, or more, of nitrogen, and this is twice the amount that is fixed by soyabean plants within the same area of land.

Farmers on the Loess Plateau of China often plant out seabuckthorn along with potatoes. Because the seabuckthorn bushes make the soil more fertile, the potato yield in such fields is much greater than in fields without seabuckthorn bushes. In addition, the root systems of seabuckthorn secrete acid compounds that improve alkaline soils.

Through bisexual and asexual propagation, masses of bushes are formed on hillslopes or along the banks of rivers. With its luxuriant foliage and strong root system, it can retain the surface run-off and prevent soil erosion by wind and water. Moreover, the masses of bushes increase the content of organic matter in the soil and improve its physical and chemical properties. For example, in Yunnan County, in the Shanxi Province of China, there was no vegetative covering along the Changtau River 15 year ago, and thousands of tons of soil were washed down into the Yellow River. To prevent a reoccurrence, seabuckthorn was planted along the banks of the Changtou, and now, it is estimated, its dense bushes prevent the loss of between 3-5 million tons of soil per annum, surface run-off has decreased by 80 per cent, and erosion has decreased by 75 per cent.

Seabuckthorn is also an excellent source of firewood, since the calorific value is more than 4,000 Kcal/kg.

Distribution of *Hippophae* throughout the Himalayan Region

Geographical Distribution

This plant can be found in all the countries of the Himalayan Region, and its distribution extends for over 35 00 km from east to west. It grows abundantly throughout this vast mountain area. There are four species and nine sub-species worldwide, of which four species and four sub-species are in the Himalayas and the other five sub-species are distributed throughout Eurasia. It is believed that the Hindu Kush-Himalayas and the Qinghai Tibetan Plateau are the main areas of distribution and origin of this genus.

The following Tables (3 and 4) contain data on the uses of *Hippophae* in the Hindu Kush-Himalayan Region and its uses and potentials are subsequently discussed.

Table 3: Principal Chemical Components of the Juice of Seabuckthorn (*Hippophae L.*) in the Himalayas (China)

Species	Collecting Province	Wt per 100 fruits (g)	Rate of juice (fresh wt%)	Soluble sugar (%)	Organic acid (%)	Vitamin C (mg/100ml)	Free amino (mg/100ml)
H. rhammnoides L. sub sp. *gyantsensis rousi*	Zhedang, Xizang	6.5	33.5	3.7	2.2	23.4	65.7
H. rham. L. sub sp. *turkestanica rousi*	Huocheng, Xinjing	19.5	80.8	7.2	3.5	471.5	122.0
H. rham. L. sub sp. *yunnananensis rousi*	Zhongdian, Yunnan	16.5	78.1	6.1	4.6	1129.0	108.0
H. rham. L. sub sp. *sinensis rousi*	Xiaojin, Sichuan	18.3	79.1	6.8	6.2	1289.5	83.6
H. thibetana schelechlend	Hongyuan, Sichuan	40.0	82.5	8.9	3.0	159.8	76.4
H. neurocarpa S. W. Liu et. T. N. He	Daocheng, Sichuan	4.5	trace	2.1	1.6	3.5	666.6

Source : Author

Table 4: The Chemical Components of the Fatty Acids in Seabuckthorn (*Hippophae L.*) in the Himalayas (China)

Species	Collecting Place	Fruit part analysed	Oil content (%)	Fatty Acid Component (%) Sat (%)	Unsat (%)	Linoleic & Linolenic acid
H. rhammnoides sub sp. *sinensis rousi*	Xiaojin, Sichuan	Seed	9.87	13.7	86.6	64.6
		Pulp	2.02	27.3	71.2	11.4
H. rham. L. sub sp *turkestanica rousi*	Huocheng, Xizang	Seed	12.86	11.1	88.9	74.2
		Pulp	2.03	31.7	64.8	15.4
H. Rham. L. sub sp. *yunnanensis rousi*	Zhongdian, Yunnan	Seed	10.21	16.9	83.0	62.3
		Pulp	2.59	25.1	74.9	17.9
H. rham. L. sub sp. *gyantsensis rousi*	Zedang, Xizang	Seed	9.82	16.0	83.9	60.0
		Pulp	4.03	27.7	72.3	44.4
H. salicifolia D. Don	Chuona, Xizang	Seed	10.85	17.3	82.7	63.0
		Pulp	1.58	26.3	73.7	8.2
H. thibetana Schlechtend	Honyuan, Sichuan	Seed	19.51	11.7	88.2	64.9
		Pulp	3.50	16.1	81.3	8.0
H. neurocarpa S. W. Liu et T. N. He	Daocheng, Sichuan	Seed	16.12	14.0	85.9	65.5
		Pulp	8.60	24.1	75.8	47.7

Source : Author

Properties, and Uses

1. *Hippophae rhammnoides L.* of the sub-species *sinensis rousi* occupies the largest area, and is distributed throughout Shanxi, Shaanxi, Gansu, Qinghai, Sichuan, Nei Monggo, Hebei, and Liaoning at altitudes varying from 50-3,800 m.a.s.l.

This sub-species is most widely distributed in China and the plants are commonly found. The berries vary in shape, size, and shade of colour indicating diversity. The data in Table 3 indicate that this sub-species is a rich source of Vitamin C and organic acid and can, therefore, be used for making fruit juices. From the data in Table 4, it can be seen that the pulp and seeds are rich in oil, and linoleic and linoleic acid in the total fatty acids total more than 60 per cent. Therefore, this sub-species has a number of uses.

Currently, seabuckthorn products are extracted from plants that are growing naturally, and, because natural grooves are dispersed over a wide area, the yield is unstable. To enhance production from seabuckthorn, good seedlings with large berries should be selected which have a high content of Vitamin C. Dwarf-sized plants with a minimum of thorns are the best. These can be propagated by asexual reproduction and plantations established to raise the commercial value of this sub-species.

2. *Hippophae rhammnoides L.* of the sub species *turkestanica* grows on the terraces of river valleys, on open slopes, and in river valleys at altitudes between 800 to 3,000m in Western Xizang in Tibet, the USSR, Afghanistan, Northern Pakistan, and North-west India. It is found throughout the arid regions of Xizang and Central Asia. From Table 3, it can be seen that the content of Vitamin C in this sub-species is much lower than in *Hippophae rhammnoides L.* of the sub-species *sinensis*, so it is not a good source of fruit juice. However, the oil content of the seeds is 12.86 per cent higher than in other sub-species. The arid climate in which it grows, abundant sunshine, and a wide range of temperatures are favourable for oil formation.

3. *Hippophae rhammnoides* of the sub-species *yunnanensis rousi* is distributed throughout the gorges and along the river banks of North-West Yunnan, South-West Sichuan, Eastern Tibet, and Northern Burma. The characteristics of this sub-species are very similar to those of the sub-species *Sinensis*. The two sub-species are often found together in Southern Sichuan and Eastern Tibet, and it is difficult to identify them by plant morphology. From Tables 3 and 4 it can be seen that there are no distinct differences in berry quality between the two sub-species. Both of them are used for making fruit juices.

4. *Hippophae rhammnoides L.* of the sub species *gyantensis rousi* grows on terraces and river banks at altitudes from 3,200m to 3,800m along the Yaly Tsangpo River in Tibet and Sikkim. The berries have ridges on them. Table 3 shows that the juice extraction rate is only 33.5 per cent, and this is half the rate of other sub-species. The Vitamin C content is also much lower, so it is not suitable for making juices. However, the pulp and seed oil can still be used.

This sub-species is distributed throughout the arid region of Tibet and flourishes in river valleys where the precipitation is below 300mm. Its introduction into other arid and semi-arid regions is considered feasible. This sub-species differs from others in terms of morphology, biological features, geographic distribution, and chemical composition. Taxonomist A. Rousi identified it as a sub-species under *Hippophae rhammnoides*. The author believes that it should be subjected to further study.

5. *Hippophae salicifolia D. Don* is found in gorges and on the edges of forests in alpine areas, at altitudes ranging from 2,800-3,700m, in Southern Tibet, Kashmir, Nepal, Sikkim, and Bhutan.

It is an endemic species in the Himalayan Region; grows vigorously and has few thorns. Compared to *Hippophae rhammnoides L.*, sub-species *sinensis*, the quality is better. The

amounts of Vitamin C, sugar, organic acid, and free amino acid are higher than those of the sub-species *sinensis*. Most important is the fact that the Vitamin C content is 1,700mg/100ml, and this is much higher than in any of the other sub-species. This species is widely distributed throughout Southern Tibet and it is necessary to introduce it into other regions also.

6. *Hippophae thibetana Schlechtend* is distributed throughout the grasslands and on the river banks of the Qinghai Plateau, Gansu, Tibet, Sichuan, Sikkim, Nepal, and Northern India at altitudes from 3,000 to 5,200m.

It is a short species, ranging in height from eight to 60 cm, with few thorns. From Tables 3 and 4, it can be seen that its berries are the largest and its juice the richest. Although the content of Vitamin C is lower than that of sub-species *sinensis*, the pulp and seed oil contents are higher, making it useful for the production of oil. Being a dwarf plant, with large berries and few thorns, it is easy to pick and suitable for close planting. In the alpine areas and on the plateaux, this species is of both economic and ecological significance making it an excellent resource for propagation and cultivation purposes.

7. *Hippophae neurocarpa S. W. Liu et T.N. He* is distributed throughout the river valleys and plateaux at altitudes ranging from 2,800 to 4,300 m in Qinghai, Gansu, Sichuan, and Tibet.

From Tables 3 and 4, it can be seen that this sub-species has the smallest berries, little juice, and a low content of sugar, organic acid, and Vitamin C. The pulp and seed, however, contain oil with more than 75 per cent of fatty acids. In particular, the content of linoleic and linoleic acid in its pulp oil is higher than in other sub-species.

In areas above 3,500m, where it is difficult to find trees other than the willow, *Hippophae neurocarpa* grows to a height of from one to three metres. Moreover, it can resist strong winds and grows in masses in natural groves which makes it of importance ecologically.

To conclude, all seven species and sub-species have their own particular characteristics which make them important for cultivation and propagation. Because of the rich juice content of the *Hippophae rhammnoides* sub-species *sinensis*, *yunnanensis*, and *salicifolia*, they are suitable for a number of food and drink products. The high oil content in the *Hippophae rhammnoides* sub-species *turkestanica* and *thibetana* are suitable for producing oil and *gyantsensis* and *neurocarpa* also.

Each one of them has a different ecological adaptability and can be grown throughout the Hindu Kush-Himalayas in different natural conditions.

Current and Prospective Uses of Seabuckthorn

China was the first country to use seabuckthorn. It can be traced to the Tang Dynasty in a book entitled "*Si By Yi Dian*" where seabuckthorn berries are described as a medicine.

Current Use

Since 1983, some of the provinces and autonomous regions in the north, north-west, and south-west, such as Shanxi, Shaanxi, Neimeng, Gansu, Qinghai, Sichuan, and Xizang have been using seabuckthorn with favourable results. Its use has been introduced into the development economies of mountain regions and its prospects are promising.

There are 670,000 ha of natural seabuckthorn in China and 49,000 ha of these are in the Eastern Himalayas (including Eastern Tibet, West Sichuan, and North-west Yunnan). A recent survey showed that about 22,000 tons of seabuckthorn berries are produced but remain unused in the Eastern Himalayas.

By the end of 1987, 150 processing plants for seabuckthorn had been built in China. The basic process consists of the crushing and concentration of the juice at the collection site. The product is then transported to the cities for further processing. In Western Sichuan there are three primary processing plants (in Xiaojin, Sichuan, and Muli counties) who sell their products to Chengdu, Chongquing, Wuhan, and other cities where they are processed further to produce soft drinks, wines, jams, and medicines.

Economic and Ecological Benefits

Economically, farmers in mountain regions have become better off through their involvement in the manufacture of Seabuckthorn products. From 1985 to 1987, farmers living along the middle reaches of the Yellow River earned a total annual income of five million *yuan* by picking seabuckthorn berries. One small village of 42 families, in Fangshan County of Shanxi Province, received 180 *yuan* per family, in the Autumn of 1984, through the sale of berries. In Qingshi County of Gansu Province, a distillery, that had been running at a loss before 1983, turned over to the production of seabuckthorn products, and, by 1985, had wiped out its deficit and, by 1987, had made a profit of 164,900 *yuan*.

Sichuan Province became involved in seabuckthorn products much later. However, there have been a number of achievements, and these are shown in Table 5.

Table 5: Seabuckthorn Processing in Sichuan Province

Name of Factory	Annual Production Capacity	Varieties of Products	Annual output Value (*yuan*)	Annual Profit (*yuan*)
Xiaojin, Seabuckthorn Beverage Factory	100 tons berries processed	Crushed juice, Condensed juice, Solid juice, wine	135,000	20,000
Jinchuan Seabuckthorn Beverage Factory	100 tons berries processed	Crushed juice, Solid juice	135,000	18,000
Muli Seabuckthorn Beverage Factory	100 tons berries processed	Crushed juice, Syrup	130,000	15,000
Chengdu Fruit Processing Factory	50 tons berries processed	Crushed juice, Condensed juice, Syrup, Soft drink	1,000,000	150,000
Chongquing Jiangbei Beverage Factory	50 tons berries processed	Crushed juice, Syrup, Soft drinks	150,000	50,000

Source : Author
Note: There were 4.73 yuan to the dollar in 1989.

Ecologically, the benefits are extremely important. China now has a big Shelter-forest Programme in its north-eastern, north, and north-western regions. After many years of experimentation, forestry experts have come to the conclusion that shrubs should first be raised in shelter-forests in order for them to thrive. Among the shrubs, seabuckthorn is the most important because of its different ecological uses. It has been used to stabilize the mountain slopes and the river banks in Yanyan County, and Shanxi Province has planted seabuckthorn on a large scale. Since the 1950s, more than 15,000 ha have been planted in order to control water run-off and soil erosion.

Problems Involved in the Use of Seabuckthorn

The berries are currently collected from natural stands. Because of numerous thorns, some farmers resort to cutting down the shrubs to pick the berries and this damages the resource base.

The plant is deciduous, and in natural forests the ratio of male to female is not equal. The ratio of males is higher and female plants are scattered and difficult to harvest.

In the Eastern Himalayas, especially in East Tibet and Western Sichuan, almost all the groves are away from transportation facilities and are far away from the cities making it difficult to have access to processing facilities as well as to markets.

In order to use these Seabuckthorn resources fully, the Chinese Government has formulated a policy to protect them and to cultivate new plantations.

For Shanxi Province the salient points of this policy are:

- the determination of authority over the forests (of which parts are State, Collective, or individually owned);
- the protection of seabuckthorn groves;
- The conversion of wastelands and orchards to seabuckthorn groves after which they can be contracted to farmers under a "Household Contact";
- the reforestation benefits to accrue to whoever reforests over a period of 50 years;
- the prohibition of the felling of seabuckthorn groves and trees; and
- the strict enforcement of Forest, Water, and Soil Conservation Regulations.

Due to the efforts of the last five years, more than 150,000 ha of seabuckthorn groves have been established in North and North-west China.

Conclusion

Seabuckthorn is a new horticultural crop of tremendous potential. It does and will play an important role in improving the living standards of mountain farmers and in maintaining ecological stability. There are vast resources of *Hippophae* in the Hindu Kush Himalayas, and it is suggested that the countries of the Region work out a programme to survey their respective resources of this plant and harness its numerous potentials.

ICIMOD is the first international centre in the field of mountain development. Founded out of widespread recognition of environmental degradation of mountain habitats and the increasing proverty of mountain communities, ICIMOD is concerned with the search for more effective development responses to promote the sustained well being of mountain people.

The Centre was established in 1983, and commenced professional activities in 1984. Though international in its concerns, ICIMOD focuses on the specific, complex, and practical problems of the Hindu Kush-Himalayan Region which covers all or part of eight Sovereign States.

ICIMOD serves as a multidisciplinary documentation centre on integrated mountain development; a focal point for the mobilisation, conduct, and coordination of applied and problem-solving research activities; a focal point for training on integrated mountain development, with special emphasis on the assessment of training needs, the development of relevant training materials based directly on field case studies; and a consultative centre providing expert services on mountain development and resource management.

Mountain Farming Systems constitutes one of the four thematic research and development programmes at ICIMOD. The programme deals with agriculture defined broadly to cover all land-based activities (cropping, horticulture, forestry, livestock farming, etc) and their support systems. Currently the major focus of the programme is on the factors and processes contributing to the sustainability/unsustainability of mountain agriculture. This is carried out by examining (through both knowledge reviews and field studies) the sensitivity of public and private interventions to specific mountain conditions. The explicit consideration of the latter conditions can alone assure a mountain perspective to public policies and programmes in the agricultural sector.

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