

## **AGRO-TECHNIQUES FOR PROPAGATION OF "SEABUCKTHORN" - A MULTIPURPOSE OPTION FOR FRAGILE AND MARGINAL MOUNTAIN AREAS**

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Ladakh, a high altitude cold arid desert exhibits a great diversity in soil, climate, vegetation and topography. The climate and vegetation changes gradually and sequentially corresponding with the altitudinal transitions. The area, though characterized by rugged terrain, low annual precipitation and humidity, fluctuating temperatures and high desiccating winds, offers great potential for several medicinal and aromatic plants of very high economic value in general and "Hippophae" (Seabuckthorn) locally known as "Sarbone" or "Tserma" in particular and provides a multipurpose option for fragile and marginal mountain areas of cold arid regions of Trans-Himalayas. The Hindu-Kush Himalayan Mountains share common characteristics in terms of accelerated degradation of the environment and natural resource base, un-sustainability of the current resource use pattern and deterioration in economic conditions as the resource base continues to erode at an alarming rate. This calls for focusing on multiple, goal centered strategies for resource conservation and rehabilitation. An important component of such strategies would be choice of the species that can simultaneously satisfy the long term conservation needs as well as the short term economic needs of the people depending upon rapidly degrading mountain resources.

'Seabuckthorn' is one such species that has great potential for such situations. The total distribution of seabuckthorn in three of the main producing countries (China, Mongolia and former USSR) is approximately 8.10 (natural growth) and 3.0 (Plantation) lac hectares, respectively. This paper, discusses some of the Agro-techniques for propagation of seabuckthorn in Cold Arid Region of Ladakh in particular.

However, for generating location specific technology, there is a need to take up systematic and scientific studies for exploiting its true potential.

### **PLANTATION AND MANAGEMENT TECHNIQUES**

Seabuckthorn, has vast potential to support high value commercial activities, meet the biomass needs of the people and perform resource conservation upgradation functions. However, level and quality can be substantially raised by adopting scientific techniques and management of seabuckthorn plantations.

### **TRANSFORMATION OF NATURAL SEABUCKTHORN FOREST**

Natural seabuckthorn forests exist not only in China and former USSR but in the Hindu Kush-Himalayan Region in the countries such as Afghanistan, Pakistan, India, Nepal, Bhutan and Burma. Ecologically, these natural seabuckthorn forests are generally distributed along river banks and wider beaches and form mass forests. Therefore, the use and transformation of these mass seabuckthorn forests into semi cultivated forests is of a universal significance. Drawing of the Chinese experience, experiments have been conducted by the Beijing University of Forestry and results are quite inspiring.

### **1. MEASURES FOR TRANSFORMING NATURAL SEABUCKTHORN FORESTS**

#### **1.1 Intermediate strip cutting**

This is suitable for seabuckthorn forests that are neat and have plants from young to middle age. According to design, the reserve strip should be 2 m wide and intermediate space should have width of 2 to 2.2m. In the reserve strip, other trees that are not required, male seabuckthorn trees and the dead and diseased plants should be dug out completely. But strip

cutting and pruning the trees should be spaced 1m apart. In addition, each strip should contain a male-female mix in which there should be male plant as a polliniser every 4 to 5m so as to make a male-female ratio of 1:8. In the reserve strip, if seedlings are missing, large seedlings should be planted in these empty spots. In order to avoid growing coppice shoots, the roots of the felled trees should be dug out and then hollows should be leveled.

### **1.2 Intermediate strip cutting and After-planting**

This is suitable for agglomerate seabuckthorn forests since there are areas of seabuckthorn growth within agglomerate forests. Intermediate strip cutting and chopping can be carried out of lands with seabuckthorn forests. To carry out operations after planting in these area, the large seedlings should be planted out following the model of intermediate strip cutting. The distance between the trees and the rows should still be 1 m and ratio of male-female 1:8. Usually the size of the planting pit is about 40x40x40 cm and the height of the big seedling 2m, with a root system of 30x30x30 cm. After seedlings are planted, 25-50 percent of the crown of the tree should be pruned.

### **1.3 Wide Intermediate strip cutting**

This is suitable for tall and old seabuckthorn forests. Curing above the root collar and improvement cutting are measures adopted. The reserve strip has a width of 4 to 8m. In this strip, most female plants are kept with the distance between the trees of 1 m. Where there are no female plants, some male plants should be reserved. In intermediate places, the seabuckthorn trees are kept above the root collar without digging out stumps. After turions grow out of the collar, they should be cut, maintaining a distance of 1m.

### **1.4 Cutting Above the Root Collar**

This is suitable for seabuckthorn forests that are accompanied by other trees. All the trees should be cut above the root collar. The stumps of non seabuckthorn trees are dugout. Once the seabuckthorn shoots sprout out and shoots grow up to be trees that can be identified as male or female in order to maintain the proper ratio of male and female plants. Some of the plants should be weeded out and number of male plants reserved as pollinisers. Generally seabuckthorn trees bear fruit during the fourth year. This measure is specially suitable for the regeneration of old seabuckthorn forests.

### **1.5 Improvement cutting**

This is suitable for seabuckthorn forests with neat form of middle age and accompanied by other trees. First the other trees and the male seabuckthorn trees have to be cut down and the females spaced out 1-2m apart depends on the size of the canopy and density. Second, care should be taken that the female plants are well distributed, i.e., without missing any plants after intermediate cutting. Because the original seabuckthorn forests are not altered very much and there already exist trees of fruit bearing age and these can produce high yields following their transformation.

## **2. ARTIFICIAL PLANTATION**

Demand for seabuckthorn fruit, and especially for oil is significantly on increase and establishment of seabuckthorn plantations to meet the demand of industries is an urgent task. Therefore, experience gathered from different countries are very valuable till location specific technologies are generated. Discussed below are some points in reference to establishment of new artificial plantations.

### **2.1 Plantation establishment**

**Site selection:** River banks are most suitable for setting up plantations on large scale and if plantations are to be established in arid areas, a good water supply has to be assured. On river banks, seabuckthorn can tolerate inundation because flood water contains oxygen, however, shallow kettle holes where rain and snow are easily gathered, are not suitable for their

establishment. In places, where the ground water level is less than 0.5m, are also not suitable for seabuckthorn. Sandy soil and loamy rather than clayey are preferable.

## 2.2 Land preparation

The land should be kept in dead fallow for 1-2 years before planting. During this period, land should be ploughed deeply and harrowed. Perennial weeds with deep root systems should be destroyed by using herbicides such as ammonium 2, 4-D, Dalapon or sodium trichloroacetate. In order to ensure the fertility, composting would be an ideal treatment and if the content of the humus is more than 4 percent, the amount of organic fertilizer spread on it can be reduced by 50% of the applied manure. In the absence of org. fertilizer green manure can be used instead. Sowing green manure crops continuously for two years can provide 100-200 tones of green organic matter. If the soil is acidic in nature, lime should be added into the soil in order to raise the efficiency of mineral fertilizer. Seabuckthorn plant is very sensitive to the increase of phosphorus in the soil and further, it does not activate the plant in anyway. Therefore, it is better to apply 100-200 kg per hectare of calcium super-phosphate to soil before ploughing it deeply.

## 2.3 Planting time

Seabuckthorn is one of these plants for which autumn is not a suitable planting period because of the constraining feature of the roots. Scientific studies have proven that the survival rate of the seedlings planted in autumn is much lower than of these planted in spring. Over wintering is the main cause of the mortality. Seedlings planted in autumn die over the following winter. Even if seedlings are dug out in autumn, temporarily planted over winter and dug out again for planting in the field next spring. The survival rate is still low. A high survival rate is ensured only when the seedlings are dug out and immediately planted in the field during early spring before the seedlings start sprouting. A word of caution that if the time taken for temporary planting in spring or the time for transporting seedlings from the nursery to the field is too long, the survival rate decreases. The roots of the seabuckthorn are sensitive to wind and sunshine. It is good to place the roots in muddy water before planting.

## 2.4 Disposition of polliniser

Seabuckthorn is a typical dioecious plant. The number and disposition of pollinisers directly influence the over all production. The scientific evidence reveals that every two lines of female plants there has to be a male plant. Generally the distance within which the female plants can be pollinated is about 100m. Investigators have shown that as the distance from female to male plants (polliniser) increases (6-1m or so) the yield of the female plants decrease. For more effective pollinisers, male seedlings that have different blooming periods a higher pollen preservation rate and tolerance of bad weather should be selected as polliniser. If both male and female plants are vegetative seedlings, the male plants will blossom at the same time. If the weather is not suitable can concomitantly ripe pollen can not be spread by the wind and hence the process of pollination can not be carried out.

## 2.5 Irrigation

The experimental findings reveal that the minimum moisture contents permissible for specific soils are as follows:-

Clay loam	-	70%
Heavy clay	-	80%
Slightly sand oil	-	60%
Sancy loam	-	65-70%

When the moisture levels are lower, especially during the blossoming and fruit growing periods irrigation is required. The average amount of irrigation required is 500-600 m<sup>3</sup>/ha and should be soaked to a depth of about 7080 cm.

## 2.6 Fertilization

Seabuckthorn needs proper nutrition but its optimum requirements are not known as yet. During spring, the seabuckthorn which has borne fruit begins to grow quickly by pumping the stored nutrients. During first phase of the growing period, because seabuckthorn needs a good supply of nitrogen, nutrients are consumed to form roots and branches and to blossom. During the later phase of the growing period, the branches stop growing and nutrients are consumed by the formation of the fruit and flower buds. The nutrients then flow gradually from leaves to the trunk branches and roots. During this period, the seabuckthorn plants need phosphate and potash fertilizers (Bukshenov *et al* 1985).

## 2.7 Form pruning

By the end of the first four years, seabuckthorn grows up to 2-2.5 m and forms its crown based on the growth of its central branch. The aim of form pruning is to make the scaffold branches take proper positions and to keep the crown compact and low in order to make it convenient for harvesting. For this purpose, the crown should be pruned regularly. Usually, the branches that overlap and these that are not in correct positions should be pruned off, and the slim and long branches should be cut short. From the fifth year, central leading branches stops growing and the plant no longer increases in height. The branches then grow out from lateral buds. Mean while, the seabuckthorn enters into the stage of mass bearing if the crown is dense, some branches should be pruned off. So as to let sunshine penetrate the crown. During the following spring, all diseased, withered and very low branches must be pruned. Generally, seabuckthorn begins to bear fruit in large quantities in the fourth or fifth year. The peripheral branches of the crown grow or bear alternately. In order to prevent seabuckthorn from premature senescence, pruning for rejuvenation should be carried out on three year old branches.

## 3. PROPAGATION

Artificial plantations are established with cultivated seedlings, cuttings, grafted seedlings and other propagated materials such as the seedlings from root turions or the plantlets produced through tissue culture. But the most important propagation methods are to cultivate seedlings from seeds and to use cuttings from hardwood/softwood trees.

### 3.1 Cultivating seedlings from seeds

Cultivating seedlings from seeds is a simple technology and has some definite advantages to produce a greater number of seedlings, involves lower costs than other propagation methods, and seedlings thus produced survive better and grow faster compared to cuttings. This technology involves:-

**3.1.1 Pretreatment of seeds:** Chinese seabuckthorn (*H. rhamnoides* L., subsp. *sinensis*) seed is medium in size and one kilo of air dried seeds contains 130-140 thousand seeds. If the germination rate reaches 80-95%, one kilo of seed can produce 104-133 thousand seedlings. Before sowing, the seeds should be put into water at a temperature 60-70°C and soaked, for 2 days, when the seeds have expanded sufficiently they are taken out and dried for sowing.

**3.1.2 Seed bed preparation:** Seed bed should be established in a place close to the expected plantation plot with irrigation facilities. Before the seed-bed is prepared sufficient barnyard manure should be applied and land ploughed to depth of 20-25 cm. Generally, the seed bed is 10x1m. This is convenient for operation and irrigation.

**3.1.3 Sowing:** As the temperature of the soil (5-10 cm depth) rises to 15-20°C in spring, it is suitable for sowing. Ditch and drill seedling is commonly practiced in China. The drill furrow is 4 cm in width and 2.5 cm in depth. The drill spacing is 20-25 cm across the seeded. The seeds are sown in the drills evenly and covered with 1-2 cm of soil.

After about 12-18 days, most seedlings sprout. Then the key period follows if soil becomes dry and hard, seedlings can not sprout, should be protected from strong sunshine. Seedlings should be covered with a mulch of straw to conserve moisture, or covered with shade to protect young seedlings.

**3.1.4 After care:** When the seedlings sprouts, 3-5 pieces of microphylla, the seedlings is not likely to die and weeding should be carried out frequently, otherwise the weeds will inhabit the growth of the seedlings. Insects living underground may also damage the young seedlings. Insecticides such as gammexame and dylox can be used to control these pests, when the growth is at 3-4 cm, dense seedlings should be thinned down and weeds pulled out. Attention has also to be paid to drainage aspects and if the accumulated water floods over the top of the seedlings, they will die when the water recedes. To produce a seedling which is suitable for transplanting will take 6-18 months in nursery (L Ruzhi, 1990).

#### 4. HARDWOOD CUTTING

Seabuckthorn is a dioecious, wind pollinated plant. The seedlings propagated by seeds can not maintain the fine biological characteristics and economic properties that are genetically identical to mother plants.

Among the seedlings, there are usually more male than females and it is difficult to distinguish males from females before flowering and fruiting. Cutting propagation can produce scion-rooted seedlings with the same genetic properties as those of their mother plants in a short time and these can bear fruit 1-2 years earlier than the seedlings. this is an important technology for propagating improved varieties for introducing and acclimatising new species of seabuckthorn and for building artificial plantations. The series of techniques for hardwood cutting propagation are:-

- \* The adventitious roots of hardwood cuttings of seabuckthorn usually strike above the leaf scars in a scattered manner. Each cutting has 3-5 roots which grows from the epidermis of the stem. Although the cuttings root easily, the rooting is unstable and sensitive to change in environmental conditions.
- \* In a cold environment adapting large and small film canopies, the hardwood cuttings can be planted atleast 30-40 days before plantation in the open field. Covering with straw screens at night can increase temperature, retain moisture and protect the cutting from frost. The cutting begin to sprout roots eight days after being planted when the accumulated temperature (equals to or above 10°C ion 5 cm depth of land) reaches 121.6°C. The cuttings take root in large numbers by the fifteenth till the twentieth days when the accumulated temperature reaches 315-317°C. After 30 days a complete, semi woody root system with lateral roots and nodules is formed. At this time, the seedlings of hardwood cuttings can be planted in the field.
- \* Adequate aeration and water permeability in the soil are required when hard cuttings form adventitious roots. Comprehensively, considering the rooting rate and survival rate, the better rates for the medium should be sand: humic acid: the soil under seabuckthorn vegetation 5:3:1. In addition all the cuttings of different ages have the capacity to form adventitious roots. Among them, the three year old cuttings have the highest percentage of root formation.
- \* The best time to take cuttings form mother trees is from Oct. to Jan. The cuttings should be stored in wet sand at low temperature in moist dark environment. Another good time to take cuttings form mother trees is middle or late March and these cuttings should be immediately planted under the canopy. Standard cuttings should be taken from the base of a 2-3 year old shoot, 10-25 cm in length and 0.8-1.5 cm in diameter.
- \* Before planting, the base of the cuttings are soaked in running water for 24 hours or immersed into a container filled with water, when the base of the cuttings are given a quick dip in 300-500 ppm NAA (naphyacetic acid), rooting rate is increased. If the cuttings are immersed in 50 ppm NAA solution for 24 hrs. the same effects can also be achieved (Hno Shuhua *et al* 1989).

#### 5. SOFT-WOOD CUTTING

Usually, soft wood cutting is an effective propagation method needing artificial mist sprays and a plastic film house with other equipment. The basic technique is summarised below.

##### 5.1. Selection and collection of cuttings

The cuttings from small (15-20 cm length) are cut off from the mother trees, they should be immediately put into plastic film bags to prevent them from wind drying and withering. These cuttings can also be maintained in water for one week without loosing their rooting capacity.

##### 5.2 Treatment of cuttings

Each cutting must be cut into two sections of 7-10 cm length. One third of the leaves on the cuttings should be eliminated from the base of these cuttings. Then the cuttings should be placed in water

to stay fresh. Before auximone treatment these cuttings are taken out of the water and bundles of 50 cuttings, bound together with a rubber band, are put into a box filled with solution of IBA (Indolebutyric acid) at a depth of 3-4 mm. The concentration of IBA solution is 50 ppm in the box. All cuttings soaked in IBA solution should be covered with a plastic film to keep the moisture in and the solution in the box should be maintained at a temperature of 20-25°C for 16 hours. The cuttings treated with auximone like IBA can strike massive adventitious roots. Before planting, these cuttings should be taken out from the IBA solution and washed in order to remove the auximone.

### 5.3 Cultivating softwood cuttings

This needs to be carried out in the plastic film house equipped with an artificial mist sprayer and drainage facilities. The seeded needs to be made flat and the medium of the seed bed should be of sand and humic soil mixed in a ratio of 3:1. Before cultivation, the seeded needs to be watered to keep the medium wet enough. Before inserting the cuttings, use a marker to rule small shallow furrows in the seeded (distance between furrows should be 7 cm and 3 cm between cuttings at a depth of 1.5-2 cm).

#### Strategy

- \* Large scale plantation of seabuckthorn as part of resources conservation for fragile slopes.
- \* Conservation of wild plantations into a managed system to enhance productivity by changing the ratio of male female plants and by introducing methods of easy harvesting and processing of seabuckthorn fruits.
- \* Development of processing technologies for different seabuckthorn products and establishing processing units and marketing channels.
- \* Generating awareness.
- \* Field exposure and training.
- \* Establishment of demonstration units.
- \* Generation of location specific technology.
- \* Involvement of people for the ultimate success.

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