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PARTNERSHIP FOR LAND USE SCIENCE (FOREST-PLUS) PROGRAM

Direct Seeding Techniques for Oak and Horse Chestnut in Himachal Pradesh, India

BEN CALDWELL

August 2017

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ACRONYMS AND ABBREVIATIONS

CAMPA	Compensatory Afforestation Fund Management and Planning Authority
CAT	Catchment Area Treatment
CEDAR	Centre for Ecology, Development and Research
CHEA	Central Himalayan Environment Association
EPA	Entry Point Activity
FDA	Forest Development Agency
Forest-PLUS	Partnership for Land Use Science
GoI	Government of India
HPFD	Himachal Pradesh Forest Department
ISFR	India State of Forest Report
JFM	Joint Forest Management
JFMC	Joint Forest Management Committee
MoEFCC	Ministry of Environment, Forest and Climate Change
NGO	Non-governmental Organization
NTFP	Non-Timber Forest Product
REDD	Reducing Emissions from Deforestation and Forest Degradation
SFD	State Forest Departments
SHG	Self-Help Group
TTMs	Tools, Techniques, and Methods
USAID	United States Agency for International Development

EXECUTIVE SUMMARY

The Partnership for Land Use Science (Forest-PLUS) is a five-year program designed by the United States Agency for International Development (USAID) and the Indian Ministry of Environment, Forests and Climate Change (MoEFCC) to improve land use management in forested landscapes in India. In its implementation, Forest-PLUS works closely with MoEFCC, State Forest Departments (SFDs), local governments, and other organizations to develop and deploy new tools, techniques, and methods (TTMs) of forest management.

One of Forest-PLUS's pilot landscapes is in the Rampur Working Circle of Himachal Pradesh, India. Sited in the Western Himalaya, Rampur is a landscape of steep mountains, fast-moving streams and rivers, diverse vegetation, and a hearty, warm population of residents. Ecotypes include mixed deciduous and coniferous forest containing various kinds of oak, fir, and pine species, among others. The vegetation in turn supports a variety of wildlife and is a source of forest products and ecosystem services for humans.

To improve forest management, Forest-PLUS works to increase the productivity of forest for local residents. Evergreen tree species such as the three types of oak (Ban oak [*Quercus incana*], Kharsu Oak [*Q. semecarpifolia*], and Moru oak [*Q. dilatata*]) and deciduous chestnut (Indian horse-chestnut [*Aesculus indica*]) are valuable species for Himachal. These trees are a reliable and high-quality source of fuelwood and fodder for the cold winters these areas experience, and are less prone to disruptive forest fires than pine. Historically neglected in favor of pine (which was planted for timber), oaks are underrepresented in the state's forests. Although most people in Himachal would like to correct this imbalance, technical problems have thus far proved an impediment. Forest-PLUS introduced an inexpensive and accessible solution: direct seeding techniques for oak and chestnut. "Direct seeding" or "direct sowing" refers to planting seeds in the field to germinate in place.

For both species, direct seeding was found to be simple and cost-effective. The main challenges to establish the species in Himachal Pradesh are grazing and fire. These can be mitigated by proper site selection and community surveillance. Seed collection is another challenge, which can be overcome by involving forest-dependent communities in the process of seed collection. Both of these species and techniques are particularly suitable for engagement with forest-dependent community members to increase the productivity and usefulness of forests for people and animals directly dependent on forests.

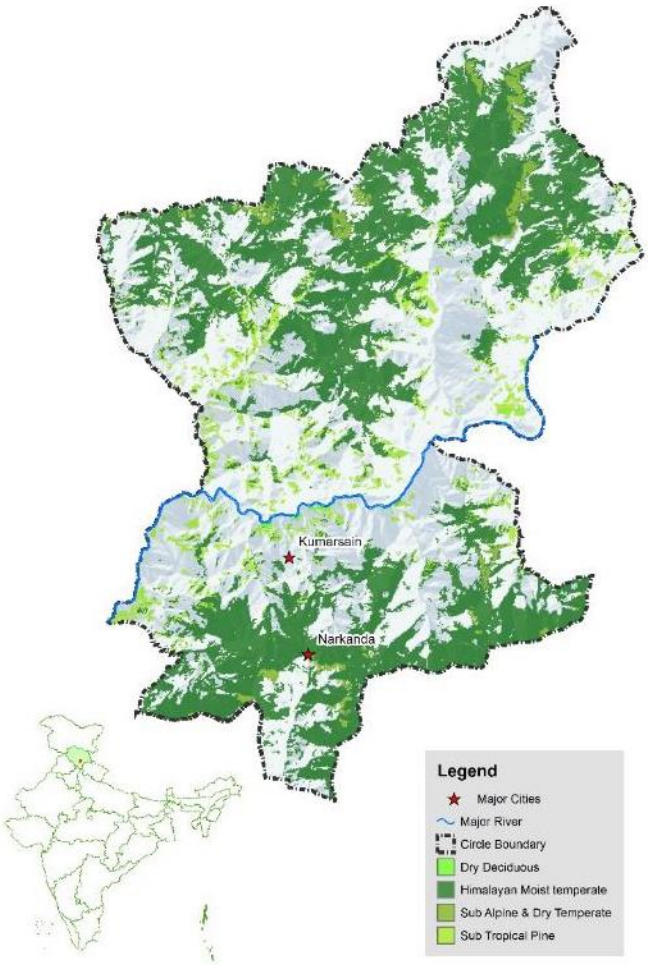
1 INTRODUCTION

Forest-PLUS landscape demonstration programs applied various facets of the Forest-PLUS – ecosystem approach to forest management (EAFM), forest management tools, techniques and methodologies (TTMs), carbon MRV (Measurement, Reporting and Verification), and training and communications to enable rural Indian communities, particularly those directly dependent on forest resources, to participate in and receive benefits from REDD+ and EAFM. These programs included follow-ups to Forest-PLUS technical trainings, local community communication/outreach programs, local interventions in livelihoods and EAFM for JFMCs, NTFP, silviculture, and grazing TTMs, and community-level carbon inventory. Each regional approach was appropriately different, with the common objective being to connect Forest-PLUS to the most local stakeholders in their own language. The programs were primarily designed and implemented by the Forest-PLUS regional teams to be responsive to local stakeholder interests, needs, and demands.

The vison of the program in Rampur was "By 2017, the landscape would be able to present climate change technology demonstrations, tools and techniques ready to be adopted by the Forest department, local governance institutions, stakeholders (Government and private) and local communities. Pilot village sites and selected forestry institutions initiated during this period would become role model for the entire Himachal Pradesh on climate change adaptation technologies and methods". The Forest PLUS vision for Rampur landscape was achieved through an integrated process of awareness generation, research, development, testing and demonstration of technologies. Strengthening of community-based institutions led to greater involvement of local communities in ecosystem management and forest protection and reduced carbon emission. Awareness on global climate change motivated communities to adopt improved tools and technologies to reduce biotic pressure on existing forest resources. Approaches were developed to improve silviculture, NTFP management, reduce the pressure of grazing and fuelwood on the forest and address the issue of forest fire.

This report describes the learning from two techniques for direct seeding of broadleaf trees that Forest-PLUS piloted in Himachal Pradesh. The direct seeding techniques were co-developed with Himachal Pradesh Forest Department and with other residents in the Forest-PLUS landscape. Experimental plots were established, and successes and learning transferred back to Rampur through the people's direct involvement in the direct seeding trials, and indirectly through trainings, flyers, and reports such as this one on the technique.

FIGURE 1-1: MAP OF THE RAMPUR LANDSCAPE



2 DIRECT SOWING OF OAK

2.1 BACKGROUND

In the Himalayan region, oak forests are suppressed by pine (*Pinus roxburghii*). During Forest-PLUS' interaction with community members and the Forest Department, both groups stressed the importance of oak as an indigenous multipurpose tree species. Forest-PLUS learned that oak regeneration is facing problems due to short seed viability, forest fires, wild animals, and grazing. In the search for solutions, Forest-PLUS explored tree regeneration work and found that the Centre for Ecology, Development and Research (CEDAR) and Central Himalayan Environment Association (CHEA) are successfully implementing oak regeneration in the forests of Uttarakhand state using cost-effective techniques. In February 2016, Forest-PLUS organized an exposure visit to field sites in Almora, which was followed by demonstrations in three forest divisions of Rampur Forest Circle i.e. Ani, Kotgarh, and Rampur Forest Division. The technique was also demonstrated in Kinnaur Forest Division. With active involvement of local communities and Van Panchayats, the sowing technique is being used to support natural regeneration of oak in degraded areas and afforestation of blank forest patches in Van Panchayat forests.

2.2 DISTRIBUTION AND LOCAL ECOLOGY OF OAK

In India, the genus *Quercus* is common in Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Sikkim, and Northeastern states. *Quercus leucotrichophora* (Ban Oak), the species that underwent direct acorn sowing, is an evergreen species in the mid-Himalayan region with a high presence in Jammu and Kashmir, Himachal Pradesh, and Uttarakhand. Ban Oak occurs between 1,500–2,300m from sea level, reaches 15–25m high, and grows together with *Pinus* species, Rhododendron *species*, *Alnus nepalensis* and *Myrica species*. Oak requires moist sites and good soil depth.

2.3 THE UTILITY OF OAK

2.3.1 ECOSYSTEM SERVICES

Ecosystem services of oaks include provisioning and regulating services. Some of the latter include:

- Oak leaves produce good-quality compost that enriches soil nutrition. The thick leaf litter layer in oak forests help reduce soil erosion.
- Oak forests conserve moisture and support good under-canopy herbaceous growth. Therefore, fire incidences rarely occur in oak forests.
- Oak trees support a variety of flora and fauna. Oak branches may bear growth of moss, lichen, and orchids. Leaf litter and compost serve as home for microorganisms, insects, and nematodes.
- The deep root systems of oaks help absorb rainwater, which then percolates deeper into the soil layer and recharges the water sources.
- Robust oak stems and branches are a huge store of carbon and nutrients.

2.3.2 LIVELIHOODS

Oaks contribute to livelihoods in a variety of ways, including fuelwood and fodder.

Fuelwood:

- *Quercus leucotrichophora* is a preferred species for fuelwood in hilly areas. It releases more heat than other species with a high calorific value of 5,623.96 kcal/kg, produces less smoke emission, and burns longer.
- Oak wood can be used to produce good-quality charcoal.

Fodder:

- Oak foliage is a major source of green fodder (feed from green crops) from December–June, when there is an acute shortage of fodder available in the mountains.
- Oaks produce very hard and strong wood. The wood can be used for agriculture tools, low-grade house construction, and durable poles for domestic use. The wood is very resistant to insect and fungus attack because of its high tannin content.
- Oak is an important species of traditional Himalayan agro-forestry systems. Growing turmeric (*Curcuma longa*) and ginger (*Zingiber officinale*) produce high rhizome yields when grown under oak canopy.
- Acorns are eaten by gray langurs, macaques, rodents, and pheasants.

Due to low fire incidences, oak forests are home to valuable non-timber forest products (NTFPs) used in the traditional healthcare system.

2.4 THE SILVICULTURE OF OAK ESTABLISHMENT USING DIRECT SEEDING

Oak is a slow-growing species that mostly regenerates through acorns. It also responds well to coppicing during its early stage. Young oaks grow best in partial shade; mature tree stands require sunlight. The fruit of the oak is a nut called an acorn or oak nut and is borne in a cup-like structure known as a cupule. Each acorn contains one seed and takes 20–22 months to mature, depending upon site conditions. In a good seed year, an oak tree can produce large quantities of acorns. Acorns contain significant amounts of stored food material, which supports seedling growth during adverse conditions. After falling from the mother tree, acorns lose viability on exposure to direct sunlight. Therefore, in natural conditions, few acorns germinate and reach the seedling and sapling stage. When buried properly, acorns have up to 90% likelihood of germination. A cost effective method of increasing germination success is direct acorn sowing. Acorns can be sown by using dibbling (making a small hole in the ground) or the small pit method to assist natural regeneration or afforestation programs.

2.4.1 ADVANTAGES

Cost Savings

Direct acorn sowing is simple and cost effective. It reduces the regeneration investment by eliminating costs related to nursery raising, transportation of nursery-raised plants to planting sites, and plantation expenses. The approximate cost per hectare of afforestation using nursery-raised planting material is INR 33500–41800 (Compensatory Afforestation Catchment Area Treatment plan 2015–16 for 1,100 plants), which is 10 times more than the cost of direct acorn sowing. Other inputs like fencing and maintenance are assumed to be the same for plantation and direct acorn sowing area (Table1).

TABLE 2-1: COST OF DIRECT SOWING OF ACORN IN THE FOREST

Activity	Cost INR
Acorn (@ INR100 per kg from community for 1,100 pits X 3 acorn per pit; acorn weight 350 acorn per kg)	950

Activity	Cost INR
Labor (11 workdays @ 200)	2,200
Total cost	**3,150**

Community Involvement

Local communities can easily partake in direct sowing. Communities can easily collect good-quality acorns from mother trees, grade them, and store them for late sowing. Forest-PLUS worked with local communities that are part of local community forestry institutions to pilot direct acorn sowing. Community members were involved in mother tree selection from a nearby locality, acorn collection, grading, storage, and direct sowing. Community members are also protecting seedlings from cattle, and taking measures to save seedlings during grass cutting. The impact of direct acorn sowing has gone beyond the demonstration area as members are also sharing acorns with other villages for direct sowing along their fields and grasslands.

2.4.2 SEED STOCK

Acorn Collection

Seed trees can be identified for acorn collection in suitable locations during the months of October and November. Acorn collection times vary by altitude from mid-December to January. After collection, acorns can be stored for two to three months under suitable conditions. Depending on weather conditions, acorns can be planted from March to April. The germination period also varies with climate, running from June through July.

Acorn-bearing trees for acorn collection should be healthy and mature. Trees should have a large canopy, robust main stump and thick branches bearing large acorns. Very thin and tall trees are not suitable for acorn collection. Trees on steep slopes should also be avoided.

Mature acorns can be plucked by hand from branches. If collection cannot be avoided on steep slopes and difficult terrain, branches can be shaken to separate acorns onto cloths spread over the ground below the tree. Large, weevil-free acorns are considered good for direct sowing. Diseased, decayed, and weevil-infested acorns should be taken out from freshly collected stock.

Seed Treatment and Storage

After removing the calyptra (the cap of the acorn), a floating test is advisable for selecting good-quality acorns for further use. Acorns that float should be discarded. The remaining acorns should be spread under shade to remove excess water. After excess water is removed, the acorns are suitable for further storage out of direct sunlight. The floating test should also be used during storage and before sowing to remove weevil-infested acorns.

Acorns can be stored in a mixture of soil and sand. The soil and sand mixture should be air dried. After mixing acorns with the soil and sand, fill jute bags with the mixture, and close the bag so that it fits snugly around the mixture. These bags can be buried under 15–20 cm of soil. Proper drainage arrangements are required in stored pits. Sites that are too moist and damp are not good for storage. The stored acorns should be frequently monitored for sprouting/germination in 15-day intervals. As soon as a few acorns start germinating, the whole lot is ready for direct sowing.

2.4.3 PLANTING

Considerations for Siting

Oak grows well in clay and loamy soils that are fertile and rich in organic matter. Oak does grow well in sandy, dry, and shallow-depth soil. It prefers moist sites along water sources, and furrows of hill slopes. Irrigation is not required when planting in forest areas. Newly planted acorn-sown areas require protection from forest fires and wild animals' grazing and browsing. A barbed fence can be used to keep animals out of the area.

Planting Techniques

300–400 graded acorns weigh about 1 kg. Direct acorn sowing can be done by using dibbling or making a small pit for sowing. In open sites under normal moisture conditions, two to three acorns should be buried in each pit and covered with loose surface soil up to three to five centimeters deep. In very moist and shady sites, acorns can be buried up to one to two cm deep. The distance between two pits can be managed according to the requirements of the afforestation area. A mature oak if grown in the open can easily occupy a ten square meter area. Oak can be grown at a higher or lower density depending on whether the management goals are to keep the area more open (for example, in a silvi-pastoral setting) or closed (in a mixed species closed canopy forest).

After Care and Treatment

During the seedling and sapling stage, regular weeding, manuring, and irrigation can accelerate plant growth. Pruning excess branching at the tree base helps the main stem to grow faster.

2.4.4 ESTABLISHMENT

Protection

Acorns are prone to damage by wild animals like monkeys and pheasants. These animals can damage acorns up to two years after direct sowing. For example, in the pilot study pheasants dug out acorns from every planting pit. Spreading dry oak leaves or leaf litter over the acorn-sown pits helps to minimize damage. Oaks are sensitive to forest fire and animal browsing and require protection in their initial stage of growth, or until they grow out of reach for cattle in the latter case.

During the first year, maintaining moisture in the soil increases survival rates by encouraging root system growth. Beyond the first year, with a strong root system established, seedlings are able to withstand normal environmental shock.

Maturation and Utilization

Oak is slow-growing and takes 20–25 years to be ready for fuelwood or fodder purposes.

2.4.5 CHALLENGES OF THE TECHNIQUE

The main challenge for implementing the direct acorn sowing technique is protecting acorns from damage by monkeys and pheasants in the seed production area. Normal fencing cannot keep monkeys and pheasants away from the area. Apart from building special protection structures, community surveillance can be an effective method of addressing this challenge. In unfenced areas, sites that are beyond the normal livestock grazing grounds should be selected for direct seeding.

3 DIRECT SOWING OF HORSE CHESTNUT

3.1 BACKGROUND

During Forest-PLUS' testing of direct seeding of ban oak (*Quercus leucotrichophora* (syn. *Q incana*), Forest Department of Himachal Pradesh officials suggested using the technique to promote propagation of other native species. In consultation with local communities and the Forest Department, Forest-PLUS chose the Indian horse chestnut (*Aesculus indica*) to demonstrate propagation by direct seeding. Indian horse chestnuts were chosen because the species is in decline due to the conversion of moist temperate forests between 1,000 meters to 3,000 meters to orchards, and the limited emphasis on the species in reforestation or regeneration efforts.

Forest-PLUS demonstrated direct seed sowing techniques for horse chestnut regeneration in Ani Forest Division and Kotgarh Forest Division, where regeneration occurs naturally in adjoining forests.

3.2 DISTRIBUTION AND LOCAL ECOLOGY OF HORSE CHESTNUT

The Indian horse chestnut, locally referred to as *Khanor*, is a fast-growing plant species in the Sapindaceae family, native to the lower slopes of the north-west Himalayas. It currently occurs from north-east Afghanistan, western Pakistan, Kashmir, Himachal Pradesh, and Uttarakhand to western Nepal. Horse chestnuts are one of the dominant trees of deciduous forests of the Himalayas, growing alongside oak, maple, and birch. These deciduous trees have a straight trunk with branches that grow in whorls, and are found at an altitudinal distribution of between 900 and 3,600 meters. Horse chestnuts grow up to 20–30 m tall; have a girth of about 97 cm; and have upward peeling, grey-green bark. Their large leaves (10–20 cm long by 2–6 cm wide) are also ornamental, and mature trees form a beautiful round canopy. The leaves have 5–9 thin, finger-like leaflets on each leaf-stalk, with the central leaflets longer than the outer ones. Young leaves are reddish-bronze, turning glossy dark green as they mature, and finally golden in the autumn. Horse chestnuts flower from May–June, and the seeds ripen in October. The seeds are eaten by humans and wildlife. The flowers are zygomorphic, hermaphroditic (i.e., they have both male and female organs) 3 5 mm long, 2 to 2.5 cm in diameter when fully open; inflorescence, a compound raceme, 42 cm long, 12.5 cm broad at the base, bearing, on an average, 385 flowers; and are carried in upright spikes[1]. Individual flowers have four petals, the upper pair mainly white with a yellow blotch at the base turning red, while the lower two petals are tinged with pink. The fruits are smooth and spineless and contain a shiny, slightly wrinkled, seed. The trees have a preference for well-drained soil and can grow in nutritionally poor soil. Horse chestnuts can tolerate strong winds and atmospheric pollution.

3.3 THE UTILITY OF HORSE CHESTNUT

Indian horse chestnuts provide many direct and indirect benefits for the ecosystem and local communities.

3.3.1 ECOSYSTEM SERVICES

Indian horse chestnut trees catch rainfall on leaves, branches, and bark, slowing the flow of water as it hits the ground. This allows the water to seep into the soil and enter the aquifer or the tree's root system, thus preventing soil erosion. The trees also reduce the impacts of air pollution by absorbing pollutants through their leaves, intercepting particles in the air such as dust, ash, or smoke, and releasing

[1] Parmar, C. and M.K. Kaushal. 1982. Aesculus indica. p. 6–9. In: Wild Fruits. Kalyani Publishers, New Delhi, India.

oxygen. The trees help to reduce atmospheric carbon by sequestering (i.e., "locking" up the carbon) in their roots, trunks, stems and leaves. They retain this carbon even after being harvested for lumber to build homes and furniture. Flowering occurs in month of June-July and supports pollinators which pollinate higher altitude orchards. Thus making the tree a valuable resource for bees and other pollinators and for the pollination of apple and other orchard plants.

3.3.2 LIVELIHOODS

The horse chestnut wood is close-grained and easy to work with. In India, horse chestnut is carved and used to make pots, boxes, and spoons, among others. Horse chestnut leaves are used as fodder after being converted to flour. The flour can also be combined with wheat flour to make bread, sweets, or porridge. Saponins found in the seed are used as a soap substitute, or by some hunting tribes as fish poison. The saponins can be easily obtained by chopping the seed into small pieces and infusing them in hot water. This water can then be used for washing the body and clothes. Crushed seeds can be fed to cattle and are reported to improve the quality and quantity of milk. The large leaves and flowers of the horse chestnut also make it suitable for use as large-sized bonsai.

Indian horse chestnut is also said to reduce energy costs as its canopy can provide shade to buildings in the summer, and help block cold winds in the winter, thus reducing cooling and heating needs.

3.3.3 MEDICINAL VALUE

Aesculin (or esculin), the toxin found in the seeds, is used in microbiology to aid in the identification of some species of bacteria (such as Listeria and Enterococcus species). The horse chestnut seed is astringent, acrid, and narcotic. It is used in traditional Indian medicine, where the oil from the seed is applied externally in the treatment of skin disease and rheumatism. The juice of the bark is also used to treat rheumatism. A paste made from the oil cake (the material produced after the oil is extracted from the seed) is applied to the forehead to relieve headaches. The seeds have been investigated scientifically and have been shown to have anti-inflammatory activity. The fruits have been used in ethno-veterinary medicine for treating horses. The seed is given to horses suffering from colic. It is also used as an anthelmintic on horses to rid them of intestinal parasites.

3.4 THE SILVICULTURE OF HORSE CHESTNUT ESTABLISHMENT USING DIRECT SEEDING

Direct seeding is a very simple and cost-effective technique to propagate horse chestnuts when compared to raising it in nurseries and transplanting.

3.4.1 ADVANTAGES

Cost Savings

Indian horse chestnuts can be directly sown on a large scale to avoid significant costs associated with nursery development, raising, and transplanting. The associated costs and savings are similar to those discussed for oak in Section 2.4.1.

Community Involvement

In the Himachal Landscape, success of any plantation largely depends on the simplicity and cost effectiveness of the technique, and the community ownership and involvement in the process. Forest-PLUS shared direct seeding techniques with the community and Forest Department, in addition to providing hands-on training to community members and Forest Department field staff. Local

communities from community forestry institutions identified mother trees, collected seeds, and graded seeds before seeding. The community and front line staff of the Forest Department took part in site selection and direct seeding. Community involvement and participation resulted in higher survival rates of germinating seedlings due to social fencing (community surveillance) and prevention of grazing and fire by the local communities.

3.4.2 SEED STOCK

Seed Collection

Seeds from identified mother trees are collected from October–December, depending on the altitude and aspect of the slope where the tree is growing. Mother trees should be healthy, and of mature age, with large canopy and thick branches. Steep slope sites should be avoided for seed collection for safety reasons and because the seeds often roll down thus making collection harder. The fruits, capsules approximately two to three cm long and three to four cm in diameter, are yellow in color and contain a hard, shiny black rind and lime white cotyledons (the embryonic seed leaves) inside. The fruits attain their full size in October and can be harvested at that time. However, the fruits remain on the tree up to the first week of December. The seeds are quite large at about three to four cm in diameter and 10 gm in weight, and are easily harvested by collecting from the ground, or shaking branches to make the ripe seed fall to the ground or on collection cloths. Mature trees in the wild yield an estimated 60 kg of seeds yearly. Direct sowing should be carried out within 10–20 days of seed harvest and before onset of snow in the higher altitudes. Germination starts with the snow melt between March–April, depending on weather conditions.

Seed Treatment

After collection, fruits of the Indian horse chestnut should be left in shade to dry slightly for two days to ease seed removal from their covering. Further drying should be avoided, as it causes the seeds to shrivel and leads to complete failure of seed germination. The extracted seeds look shiny and fresh while overdried seed will look withered and dull with lot of wrinkles and would feel lighter in comparison to fresh seed.

Grading Seed

To grade the seed, the yellow covering of the seed is removed. Wrinkled, dried, damaged, and diseased seeds should be discarded. On average, one kg of collected harvest includes 30–35 seeds.

Seed Storage

Seeds should be kept in shaded to avoid losing too much moisture after harvesting. Although it is commonly reported that seeds last up to six months after harvesting, the Forest-PLUS team found that the seeds become unviable after two to three months of outdoor storage.

3.4.3 PLANTING

Considerations for Siting

Indian horse chestnuts tolerate all types of soils, but prefer a well-drained environment. Direct seeding should be done in moist places between 1,000 meters to 3,000 meters altitude. Seeds grow well along the streams and riverine areas. In early stages of growth, Indian horse chestnuts are susceptible to grazing and fire. Therefore, sites that are fenced or are beyond the normal livestock grazing grounds should be selected for direct seeding. Places infested with rats and porcupines should be avoided, as they feed on the seed and cause significant damage to germinating plants.

Planting Techniques

Since Indian horse chestnuts have deep roots, direct sowing is a better option than nursery raising as it does not disrupt the taproot when transplanting. Direct seeding of collected, dried, and graded seeds should ideally take place soon after the seeds and site have been selected between November-January to reduce the chances of shriveling before the onset of snow. Seeds that are sown before the snow arrives show better germination. Direct seed sowing can be done by using dibbling or making small pit of around six to eight cm depth. One to two seeds can be placed in each pit and covered with loose surface soil up to three to five cm depth. To reduce the chances of seed shriveling, seeding should be done in moist conditions. To account for possible mortality and damage, seeds can be sown at a high density, and based on the requirements of the afforestation area, thinned to desired levels later.

After Care and Treatment

After direct seeding, care should be taken to prevent damage by rats, porcupines, deer, and squirrel discussed further in 3.4.4. Covering the seed or sapling with grass straw at germination helps reduce the probability of detection and damage by porcupines and rats. Excessive grass/weed growth around germinating plants should be removed to provide necessary nutrients to the horse chestnuts and prevent damage due to excessive moisture/water.

3.4.4 ESTABLISHMENT

Protection

The direct-seeded horse chestnuts need protection from rats and porcupines. Porcupines move in a trail and dig the seed and eat the cotyledons, leaving the shell behind. Since conventional control mechanisms for rats and porcupines are not cost-effective, simple techniques like covering seed pits with leaf litter or grass straws can be used to reduce the damage. Horse chestnuts are also susceptible to damage due to grazing and fire and therefore require protection until they grow out of the reach of cattle. Selecting fenced areas and sites beyond livestock grazing areas is very effective in raising horse chestnuts plants from direct seeding.

Maturation and Utilization

The seeds starts germinating around February–March and reach almost 30 cm height within a few months, growing at a rate of 40–60 cm annually. However, they remain susceptible to grazing and fire for three to four years. They grow beyond grazing height in six to seven years. The Indian horse chestnut tree starts to flower after seven to eight years, and can live up to 300 years.

3.4.5 CHALLENGES OF THE TECHNIQUE

The main challenges to establish Indian horse chestnuts in Himachal Pradesh are grazing and fire. These can be mitigated by proper site selection and community surveillance. Rats and porcupines pose another challenge by feeding on seeds and saplings.

4 CONCLUSIONS

Oak forests in the Himalayan region are gradually being overtaken by pine forests. Increasing biotic interferences in the form of lopping for fuel and fodder, forest fires, and development activities affect the growth of the useful oak species. The direct acorn sowing technique is suitable for enriching oak-degraded areas where oak regeneration is absent due to biotic interference. Oak regeneration techniques can also be used in suitable locations where oak forests are shrinking or lost. This low-cost and simple technique is suitable for assisting natural regeneration in mature oak stands facing regeneration challenges. Since it requires minimal transportation inputs, the technique can be used in remote locations. Oak regeneration techniques can also be used along water sources to potentially improve water quality and quantity over a period of time. The technique can be used for replacing pine forests near villages to increase community involvement in forestry programs.

Direct seeding is a simple, cost-effective technique of promoting native species plantations in Himachal Pradesh and similar altitudinal Himalayan states of western India. It should be carried out in moist, shaded riverine sites. Indian horse chestnuts are relatively fast growing native species and establish well with minimal maintenance. The horse chestnut has a deep root structure and is resistant to winds. Traditionally, its wood has been used in making different artifacts and boxes. The seed is eaten by human in higher altitudes with limited food resources and in famine conditions. One of the first deciduous trees to leaf out, flower in May as the temperatures warm up, and beautiful clusters of white flowers cover the oval to rounded crown in early to mid-May providing excellent food for the pollinators and supporting the fat dwindling pollinator population supporting the orchards. The leaves provide fodder for livestock. It mitigates climate change and aids in carbon sequestration, providing shade and shelter to humans and wildlife.

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