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Chilgoza pine nut – The wonder nut of Kinnaur and its sustainable management

Arun Kumar*, Pramod Kumar and D.P. Bhandari

Regional Horticultural Research and Training Station, Sharbo and Krishi Vigyan Kendra (Dr Y.S. Parmar University of Horticulture and Forestry, Nauni), Reckongpeo, Kinnaur 172 107

Chilgoza pine nut is India's only commercially traded conifer nut and a defining livelihood resource for the tribal communities of Kinnaur district, Himachal Pradesh. It grows naturally in the dry temperate valleys at 1,800–3,350 m amsl. In 2025, Kinnaur produced approximately 1,60,000 kg of chilgoza valued at around ₹18 crore. Despite its high nutritional value, the species faces serious threats from destructive harvesting, near-absent natural regeneration, plantation failure due to irrigation scarcity, and hydropower projects affecting prime forests. This caused its classification under 'Near Threatened' on the IUCN Red List (2011). In this regard, the article discusses the ecology, nutritional significance, community-based harvesting system, nursery technology, intercrops suited to Kinnaur's agro-climatic conditions, and actionable conservation strategies for this invaluable mountain forest resource.

Keywords: Conservation, Dry temperate Kinnaur, Pine nut, Tribal livelihood

CHILGOZA pine (*Pinus gerardiana* Wall. ex D.Don), family Pinaceae, is locally called *'Ree'* or *'Ri'* by the Kinnauri people, *'Neoza'* in Hindi and *'Jhalgoza'* in Afghanistan. It is the only conifer species in India whose seeds are commercially traded as a food nut, making it unique among all Himalayan tree species. The species is distributed across the dry inner valleys of the north-western Himalayas at elevations between 1,800 and 3,350 m amsl, primarily in Kinnaur and Pangi forest divisions of Himachal Pradesh, and in Kishtwar and Marwah Forest divisions of Jammu and Kashmir. Kinnaur district, with its characteristic rain-shadow valleys and rocky south-facing slopes along



the Sutlej River system, hosts the most productive chilgoza forests in India. Chilgoza is a slow-growing, long-lived species with a lifespan of 150–200 years. It bears cones only once every two years (biennial bearing) and commercial nut production begins only 20 or more years after planting. These biological constraints, combined with increasing anthropogenic pressure and climate variability, have led to the IUCN classifying the species as 'Near Threatened' in 2011. For the Kinnauri tribal community, chilgoza is far more than an economic product. It is woven into the cultural fabric of the region, used in religious ceremonies, traditional hospitality, and as a staple winter food. The annual chilgoza harvest season is itself a community event that has defined the social and economic rhythms of Kinnaur's villages for centuries.

Botanical description

Chilgoza is a medium to large evergreen tree growing 10–25 m in height with a trunk girth of 1–3 m. Its most distinctive feature is the arrangement of three needles per fascicle (5–10 cm long), a reliable taxonomic marker separating it from associated species like blue pine (*P. wallichiana*, two needles) and *chir* pine (*P. roxburghii*, three needles but larger and curved). The bark is highly distinctive, flaky, grey-orange, separating in irregular puzzle-like plates, giving the tree an ornamental appearance unique in Himalayan forests. Cones are large (12–25 cm long, 8–12 cm wide), ovoid-cylindrical, and each cone contains 60–100 seeds. The seeds, 2–3 cm long, covered in a hard dark-brown shell, are wingless, which means they depend on birds and animals for dispersal rather than wind. This characteristic also makes them valuable as food but vulnerable to over-harvesting.

Ecology and distribution in Kinnaur

In Kinnaur, chilgoza pine replaces *chir* pine near Wangtu and extends along the Sutlej up to Dubling village, forming nearly pure forests on dry, rocky, south-facing slopes. At higher elevations, it forms mixed forests with deodar and blue pine. Understorey shrubs include *Caragana, Berberis, Rosa webbiana, Amygdalus* spp. and aromatic herbs like *Thymus* spp. The tree uniquely colonises extremely dry, shallow, calcareous, rocky slopes where most other species cannot survive, making it a critical anchor for soil conservation on what would otherwise be bare rock hillsides. Kinnaur has suitable climatic conditions like annual rainfall 370–750 mm (predominantly snowfall); summer temperature 20–35°C; winter down to -20°C; soil pH 6.5–8.5 (calcareous, alkaline); and shallow, stony, and sandy-loam soils.

Table 1. Block-wise chilgoza production in Kinnaur district (2025)

Block	Forest area (ha)	Production (kg)	Major area
Pooh	2,062	1,00,000	Jangram Valley, Jangi, Moorang, Ribba
Kalpa	782	60,000	Purbani, Kalpa, Kothi, Kilba
Nichar	40	Negligible	Scattered
Total	2,884	1,60,000	

Note: Market price: ₹1,500–2,000/kg (in-shell); estimated annual trade value: ₹18 crore.

Nutritional value and health significance

Chilgoza nut is one of the most nutritionally dense foods produced in the Indian Himalayas. Per 100 g of dry kernel provides approximately 673 kcal of energy, making it an energy-rich food ideally suited to the demanding physical life of mountain communities in high-altitude cold climates. Nearly 90% of the fat is unsaturated, mainly linoleic acid (51%) and oleic acid (37%). It also contains catechins, carotenoids and tocopherols. The kernel is also rich in manganese, potassium, magnesium, phosphorus, zinc, iron and calcium, vitamins E, K, B_1 and B_2, and protein, containing all essential amino acids.

Table 2. Proximate composition of chilgoza kernel (per 100 g dry weight)

Nutrient	Amount
Total fat	50%
Protein	14–16%
Carbohydrates	22%
Dietary fibre	2.2%
Minerals and ash	3%
Moisture	7.5–8.7%
Energy	673 kcal

Community ownership and the auction system

The harvesting rights for chilgoza in Kinnaur are governed by a deeply embedded traditional community-based system that is fundamentally different from individual crop cultivation. All productive chilgoza trees in Kinnaur exist on natural forest land, and the cone-harvesting rights vest collectively with the inhabitants of the village or locality within whose customary boundary the forest lies. Harvesting is never carried out on a tree-by-tree basis by individual residents. Instead, the entire cone-bearing forest block of a defined geographical area is auctioned as a single unit to one contractor, and the auction proceeds are distributed equally among all right-holding inhabitants. This system inherited over generations, efficiently distributes forest income to the local community.

However, this auction system carries a severe ecological cost. The winning contractor, seeking maximum returns on his investment, invariably instructs labourers to harvest every accessible cone from every tree, leaving none for natural regeneration. Himalayan Forest Research Institute (HFRI) identifies this complete cone-lopping as the primary driver of chilgoza forest decline in Kinnaur. In the 1950s, traditional rules required a proportion of cones to be left on trees; commercial pressure has since obliterated this practice. Individual planting of chilgoza by farmers on private land is negligible across the district, given the 20-plus year pre-bearing period and the community-ownership culture, which offers little incentive for individual investment.

Forest department plantation and the survival challenge

To address the decline in natural



Harvesting of cones through telecopic pruner



Harvested cones



Cones packed in gunny bags

chilgoza stands, the Himachal Pradesh Forest Department has periodically undertaken plantation programmes, relying on local farmers either on a voluntary community basis or as contractual daily-wage workers. Despite these efforts, post-plantation survival has remained the most persistent challenge. The fundamental problem is the acute scarcity of irrigation in the remote, rocky, dry temperate forest areas where plantations are established. The HFRI, Shimla has documented: 'Germinants and small seedlings cannot tolerate drought and long spells of drought prove fatal for their survival in the nursery and plantation area.' In Kinnaur's forest areas, no perennial water source or irrigation infrastructure is available to provide supplemental watering during dry summer months. Post-planting maintenance, weeding, gap filling, and protective watering, is essentially absent once the formal plantation phase ends. A critical physiological paradox exists here: mature chilgoza trees are remarkably drought-tolerant and can survive extreme dryness on bare rocky slopes; yet their seedlings and transplants are highly sensitive to moisture stress during the first two growing seasons. This contradiction, mature resilience versus seedling vulnerability, must be the starting point for any improved plantation design. Key recommendations for improved plantation survival are:

***Site selection*:** Prioritise locations near natural seepage zones or seasonal streams where soil moisture is retained longer.

***Plant size*:** Use only well-hardened polybag seedlings of minimum 2.5–3 years with well-developed root systems.

***Planting time*:** March-April, immediately before snowmelt/ monsoon season to maximise natural moisture.

***Water harvesting*:** Install small check dams and moisture conservation pits around plantation sites.

***Aftercare contract*:** Community-based 2-year maintenance with performance-linked payments and survival targets.

***Fencing*:** Barbed wire plus social fencing protocols involving gram panchayats.

Nursery technology

***Seed collection and storage*:** Chilgoza bears biennially, with cones maturing only once every two years. Cone collection is best timed around 4th October, when specific gravity (0.87) and moisture content (43%) point to peak seed maturity and highest germination (73%). Among Kinnaur seed sources, Jangi in Pooh block performed best, with a seedling vigour index of 921 and a maximum seedling length of 11.10 cm. Seeds keep well in earthen pots at 0 ± 1°C, retaining 58% germination for up to nine months.

***Pre-sowing treatments*:** Natural dormancy is a major constraint. Cold stratification at 4 ± 1°C for 60 days raises germination to 64.35%, and a 24 h soak in GA_3 at 100 ppm after warm stratification pushes it to about 78%. Seeds stored at -10°C for up to three years still give 60% germination without any pre-treatment.

***Nursery management*:** The nursery medium is soil, FYM and sand in a 2:1:1 ratio, filled into 18" × 5" polybags. Two seeds go into each bag at 3–4 cm depth during November-December, and germination (80–90%) follows in March-April. Seedlings stay in the nursery for 2.5–3 years, since roots outgrow the shoot and the polybags must be shifted 2–3 times to prevent root spiralling. For field planting, use 2.5 cm × 2.5 m or 3 m × 3 m spacing with 45 cm × 45 cm × 45 cm pits.

Intercrops during the pre-bearing phase

Intercropping under young



Splitting of cone with *Basola*



Extracting chigoza pine nut



Extracted pine nut



New developing cone



Cones after natural release of seeds on tree



Pine garland and pine nuts

chilgoza pine in Kinnaur is feasible during the early pre-bearing years. Fencing is very difficult on rugged terrain, so young trees face heavy grazing from livestock and wild animals. Since commercial nut production begins only after 20+ years, intercrops are the main early income and also help conserve soil. They must suit the dry temperate climate (1,800–3,000 m amsl) and its short growing season from May/June to October. Legumes (pea, rajmash) fix nitrogen and benefit chilgoza seedlings. Potato and rajmash give high commercial value to offset costs, while *phafra* and *ogla* are drought-tolerant, short-duration crops well-suited to poor soils and non-competitive with young trees. Proper spacing ensures both intercrops and chilgoza grow successfully in this harsh environment.

Harvesting and post-harvest management

Cones are harvested in September-October. The traditional method uses a sickle (locally called *Basola* or *Basing*) to cut cone-bearing branches, a destructive practice that injures the tree and eliminates seeds for natural regeneration. The HFRI recommends that at least 30% of cones be left on each tree at every harvest. After harvest, cones are dried in a shaded room for 15–20 days before seeds are extracted manually, a process carried out primarily by women using traditional tools. Sun-drying to safe moisture levels is the current practice. Recommended post-harvest technologies include:

***Solar tunnel dryer*:** Provides uniform drying and better-quality preservation validated by YSPUHF Nauni.

***Packaging*:** Glass jars and aluminium laminate pouches give the longest shelf life for shelled kernels.

***Aflatoxin monitoring*:** *Aspergillus flavus* infests stored nuts and produces aflatoxin, testing is essential before export-market sale.

***Cold storage*:** In-shell nuts retain viability best at 0 ± 1°C in earthen pots or airtight containers.

***Value addition*:** Branded retail packs of graded, sorted kernels can fetch 2–3 times market premium over loose in-shell trade.

Table 4. Year-wise recommended intercrops for chilgoza plantation in Kinnaur

Year	Intercrops
1	Potato + Rajmash + Pea
2	Potato + *Phafra/Fafra* (buckwheat) + Rajmash
3	Pea + *Ogla* (*Amaranthus hypochondriacus*) + Barley or naked barley + Vegetables (radish, turnip)
4	Spring wheat + *Phafra* + Rajmash; beekeeping (1 hive/ha)
5+	Shade-tolerant pea and rajmash; beekeeping; Non-timber forest products collection (mushrooms, medicinal herbs)

Threats to chilgoza forest

The species faces multiple, simultaneous threats that compound each other. Destructive cone harvesting, complete lopping with no seeds left for natural regeneration, leads to natural regeneration of less than 15% in most stands. Livestock grazing damages young seedlings; wildlife including monkeys, rats and crows consume seeds; cone borers (*Leptoglossus corculus, Tetyra bipunctata*) and dioryctria moths cause pre-harvest losses. *Aspergillus flavus* and other storage fungi degrade post-harvest quality. Of particular concern is the existing and about to establish hydro-power projects like 804 MW Jangi-Thopan-Powari Hydroelectric Project, which directly threatens the Jangram Valley forests of Pooh block, the highest-producing chilgoza zone in India. Climate change, manifesting as reduced winter snowfall, disrupts the moisture regime essential for both cone production and seedling establishment.

Way forward

A multi-pronged approach is needed to reverse the decline of chilgoza. Retaining at least 30% of cones on every tree should become a binding clause in auction contracts, enforced jointly by the Forest Department and gram panchayats. Pine trees should be identified in Jangram Valley with HFRI and HIMCOSTE, seed should be sourced from Jangi, and a Seed Production Orchard should be set up in Pooh block. Jangram Valley (2,200–2,800 m amsl) can be developed as a Centre of Excellence, with RHR&TS Sharbo as a research and *ex-situ* conservation node. A Geographical Indication (GI) tag for chilgoza was applied on 2nd November 2018 through a proposed society of chilgoza growers in Kinnaur, but the application was withdrawn on 28 August 2020, and no effort has been made since nor has awareness been created among growers in Kinnaur and Chamba districts, where chilgoza commercial has importance. With Kinnauri apple and other local products now GI registered, the application should be revived to protect the provenance of chilgoza and help fetch better

prices. Organising producers into Farmer Producer Organisations and using e-commerce platforms would further support direct marketing and value addition.

SUMMARY

Chilgoza, locally known as *Ree/ Neoza*, is a high-value forest resource and an important livelihood source for the tribal communities of Kinnaur, with about 1.60 lakh kg production valued at ₹18 crore in 2025. The slow-growing, biennial-bearing species begins commercial production after 20+ years and is threatened by destructive harvesting, poor natural regeneration, grazing, moisture stress, climate variability and developmental activities. Sustainable management requires leaving at least 30% cones on each tree, scientific nursery production, moisture conservation, community-based protection and improved post-harvest handling. Local value should be revived to establish its geographical identity, strengthen market recognition and improve returns to local producers. Jangram Valley can be developed as a Centre of Excellence for chilgoza conservation, research and sustainable production, supported by RHR&TS Sharbo, while FPOs, value addition and direct marketing can further enhance community benefits.

*Corresponding author email: arunkumar.negi@gmail.com

