CHAMP MONOGRAPH

(Michelia champaca)

Hariyo Ban Program

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Citation:
WWF 2019, Champ Monograph *(Michelia champaca)*. Hariyo Ban Program, WWF Nepal

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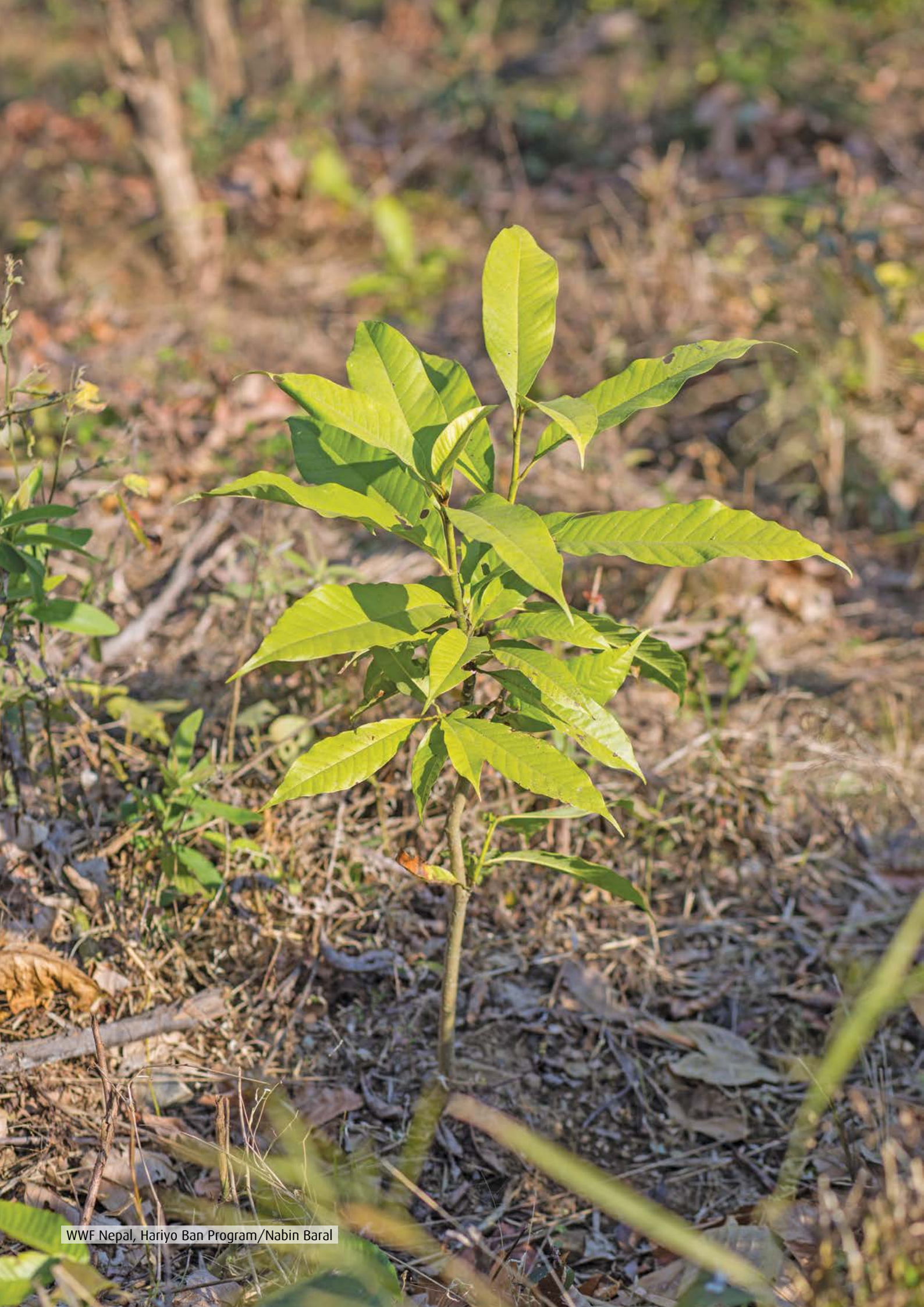
Acronyms and Abbreviations

°C	Degree Celsius
CBO	Community-based Organization
Cft	Cubic feet
CFUGs	Community Forestry User Groups
CHAL	Chitwan-Annapurna Landscape
cm	Centimeter
DFO	District Forest Office
DoF	Department of Forests
DoFSC	Department of Forests and Soil Conservation
DPR	Department of Plant Resource
FECOFUN	Federation of Community Forestry Users Nepal
GoN	Government of Nepal
IUCN	International Union for Conservation of Nature
kJ/kg	kilojoules per kilogram
m	meter
mm	millimeter
MoFSC	Ministry of Forest and Soil Conservation, now Ministry of Forests and Environment
NBSAP	National Biodiversity Strategy and Action Plan
NGO	Non-governmental Organization
NTNC	National Trust for Nature Conservation
ppm	parts per million
PROSEA	Plant Resource of South East Asia
Spp	Species
TAL	Terai Arc Landscape
TISU	Tree Improvement and Silviculture Unit
USAID	United States Agency for International Development
WWF	World Wildlife Fund



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INTRODUCTION

Michelia champaca is an evergreen tree species which grows in Nepal between 450 to 1500 meters above sea level and tends to favor higher rainfall areas, such as east of the Arun River and along the mid-hills. It is found in the Salin inner Terai and are found mixed with *Castanopsis indica* and *Schima wallichi* around bank of Kaligandaki river in west (DoF 2018) of moister region. For good growth, it needs a moist and well drained deep fertile soil (Homfray 1936). It is a large tree with straight cylindrical bole of greyish color. In addition, its bole looks very neat and clean because its lower branch sheds very easily. It is a moderate light demander, but seedling and sapling grow under high shade. Young seedlings are liable to be damaged by browsing. Two species of *Michelia* genus *M. champaca* and *M. kisopa (Lek champ, Ban champ)* (Jackson 1994 I and Jackson 1994 II, GoN/ MoFSC 2014) have been reported from Nepal. *Michelia champaca* is sensitive to fire and severe fires may kill the trees. It is well coppicer and also considered as fodder species with high value as a timber.

Champ is one of the focal species of Hariyo Ban Program. The program has supported for conservation and management of the species, mostly in hilly districts including Tanahun, Lamjung, Kaski, Syangja and Gorkha. This species is protected, and its felling, transportation and export is banned by Government of Nepal since 1995, but the ban was lifted in 2007 and the species can now be harvested like other common species.

IUCN Status

There is no reliable information available about present current population trend in Nepal. In the Eastern Ghats it has been described as being common. In Thailand it has been described as widespread and rather common (Gardener *et al.* 2007). The wood of this timber is exploited which may be threatened populations at a local scale. It is listed as Least Concern in IUCN Red List (Khela 2014).

Species Distribution

Michelia champaca belongs to the family *Magnoliaceae*. It consists of 12 genera and 220 species of evergreen trees and shrubs, native to tropical and subtropical South and Southeast Asia (Karthikeyan *et al.* 2016). *Michelia champaca* occurs naturally in the eastern Sub- Himalayan tract (Zabala 1990) and is also commonly found in Nepal. The species is fairly common in Bangladesh, Assam (India), Myanmar, and Southern India. In Nepal, there is no outright champ forest, although it is distributed sporadically in middle hills as an associate of other species.

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SPECIES AND TAXONOMICAL DESCRIPTION

Champ generally grows in moist, deep, well-drained and good quality soil. It grows in deep valleys, while some grow best in foothills (Zabala 1990). The size of the tree ranges from 18 to 21 m tall without buttress. Leaf is simple lanceolate, 13-35 cm long, 5-9 cm wide, sometimes ovate, finely acuminate and glabrous, glabrescent underneath; the petiole is 1.8 to 3.0 cm long, slightly channeled, and usually pubescent; the old leaves are yellow (Troup 1921). Bark is thick, grey to grayish white in color, inner bark fibrous, yellow to brown in color, crown conical or cylindrical. Flowers are large, axillary, solitary or rarely in pairs, tepals 6-21, in usually 3-6 subequal whorls, pale yellow to orange in color, fragrant; many stamens, anthers with a short to prominently elongated connective; gynoecium stipitate, with spirally arranged, free or connate, carpels containing many ovules (Kundu *et al.* 2012).

Table 1: **Morphological Characteristics of Plant**

Root It is a dicot plant and has well defined shallow and brittle tap root system.
Stem/bole Stem is aerial, erect, branched, woody and solid. Long straight cylindrical bole (Negi and Gupta 1987) of 18 to 21 m with a close tapering crown composed of ascending branches. It is a medium-growing tree, attaining a height of 33 m or more and under ordinary forest conditions a girth of 2.4 to 3.7 m or more. 
Bark Bark surface is smooth, grey to greyish-white, inner bark fibrous, yellow to brown and about 2 cm thick.

Leaf

The yellow-flowered variety produces new leaves in March; the white-flowered variety later in the hot season (Troup 1921). The process of formation of new leaves and buds continues up to November. Leaves are simple, entire, arranged spirally; stipules adnate to or free from the petiole with pointed tip. Leaves are generally 13 to 25 cm long, 5 to 9 cm wide, lanceolate, sometimes ovate, finely acuminate, glabrous and more or less shining above, glabrescent underneath; the petiole is 1.8 to 3.0 cm long, slightly channeled, and usually pubescent; the old leaves are yellow (Troup 1921).

Crown

Michelia champaca is a medium or large evergreen or semi-deciduous tree with a crown conical to cylindrical. The old leaves abscised before the arrival of new leaves and the tree remain barren for nearly 15 to 20 days; therefore, *M. champaca* belong to brevi-deciduous type (Borchert 1999). Annual growth in terms of elongation of the branches apices commonly consist of new apical buds being formed from the middle of February.

Flower

The color of the flower varies according to locality. The large, scented, yellow flowers grow singly, each from base of a leaf. The tree starts flowering after the age of 4-5 years (Oyen and Xuan Dung 1999). During the flowering period, the tree is covered with thousands of golden yellow flowers with powerful and diffusive fragrance. Flowers on short, axillary brachyblast, solitary or rarely in pairs, large, tepals 6-21, in 3-6 usually subequal whorls, white to yellow; stamens many, anthers with a short to prominently elongated connective; gynoecium stipitate, with spirally arranged, free or connate carpels containing many ovules. The tree flowers and fruits throughout the year (Orwa *et al.* 2009). The flowers are protogynous and are pollinated by beetles, which feed on the stigma, pollen, nectar and secretion from the petals. The tree starts flowering at an early age, fruits are produced abundantly, sometimes periodic fruiting with 2-3 years interval.

Fruit and seed

Fruiting carpels dehiscing along the dorsal suture when free or fused and forming a fleshy or woody syncarp. Aggregate fruits consist of long clusters of 3-20 brown capsules, on a spike about 7.5-15 cm long. Seeds hang from its funicle (Kundu *et al.* 2012). Each capsule contains 2-6 reddish seeds. The fruit ripens after August. Seeds are dark brown and angular, covered with pink fleshy anillus (Zabala 1990c). Seed-year records from the Kurseog and Tista Divisions in West Bengal (India) show a good seed crop almost every year (Troup 1921). A large quantity of seed is destroyed by birds and rodents (Orwa *et al.* 2009).

Wood

Michelia champaca is basically a timber tree. The wood is yellowish to olive brown, some what lustrous, smooth, straight-grained or slightly interlocked, medium-textured, light and soft (Kundu *et al.* 2012). The timber is moderately refractory but can be air or kiln-seasoned without difficulty or degradation, if properly handled. However, the wood discolors slightly and is inclined to become dull. It is also liable to crack with improper care (Troup 1921). *Michelia* are generally not very durable woods although they have been known to last for fairly long periods when used as posts or under water. The sapwood is narrow and white. The heartwood is light yellowish-brown to olive-brown and some what lustrous, without characteristic odor or taste. The heartwood of this species is strong, durable, and capable of taking a high polish (Bor 1953). The wood is light (specific gravity 0.53) and straight grained; even- and medium-textured growth rings are distinct, being delimited by light lines of terminal parenchyma (Troup 1921). The heartwood of *Michelia spp.* is refractory to treatment; side or end penetration is almost nil (Indian Standards Institution 1955).

Taxonomical Description

Domain: Eukaryota	Superorder: Magnolianae
Kingdom: Plantae	Order: Magnoliales
Subkingdom: Tracheobionta-Viridaeplantae	Family: Magnoliaceae- Magnolia family
Division: Magnoliophyte	Subfamily: Polemonioideae
Class: Magnoliopsida- Dicotyledons	Tribe: Polemonieae
Subclass: Magnoliidae	*Genus: Michelia*
	Species epithet: champaca- L.
	Botanical name: Michelia champaca

(Source: Thakur and Thakur 2014)

Varieties-hybrids

Magnolia (Michelia) champaca varieties and hybrids include:

- *Michelia champaca* var. *champaca*-upto 30m tall, documented in China.
- *Michelia champaca* var. *pubinervia*-upto 50m tall or taller, documented in China. (Anon 2018a)
- *Michelia alba*-white-flowered hybrid of *Michelia champaca* and *Michelia montana* (Anon 2018b)

Taxon Name: *Magnolia champaca* (*L.*) Baill. ex Pierre

Synonym(s)

- *Michelia champaca L.*
- *Michelia rufinervis Blume*
- *Michelia tsiampacca L.*
- *Michelia tsiampacca variety blumei Moritzi* (Khela 2014)

Vernacular Names

The most commonly used names are the variations of the word *champaca* or abbreviated to *champa*, e.g. fragrant *champaca* or golden *champa*. Other vernacular names in English include Joy Perfume Tree, Yellow Jade Orchid Tree and Fragrant Himalayan *champaca*.

Table 2: **Vernacular Names of *Champ***

Language	Vernacular Names
Nepali	Champ, Suna champ, Aule champ, Phul champ, Soyemba (Limbu), Chaswan (Newari), Lukbhung (Rai), Chempe (Tamang)
English	Golden champa, Yellow Champa, Fragrant Champaca, Orange Chempaka
Hindi	Chempaka
Sanskrit	Champaka
Bengali	Champaka, Champa
Burmese	Mawk-sam-lung
Indonesian	Cempakakuning, Capaka, Cempak
Thai	Champapa, Champakhao, Champa
Philippines	Ilang-ilang
Malaysian	Chempakamerah, Chempaka, Champaka
Vietnamese	Ngocian, Sunam
Lao	Solo
Tibetan	Tsam-pa-ka

(Orwa et al. 2009)

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MULTIPURPOSE CHAMP

Champ is a multipurpose tree. Its wood, leaves, flower and seed as well as fruits are used in various purposes according to locality and knowledge. Wood can be used for several purposes, such as structures, furniture, or carving. It is also a well-known medicinal plant valued especially for its fruits and leaves. Most of the flowers are used for ornamental purposes and for worshipping. However, small quantities are processed for its essential oil (Rout *et al.* 2011). Its fruits and flowers are attributed to several useful properties (Chopra *et al.* 1956). The flower has several cosmetic, medicinal and economic uses. Fresh flowers can be taken as natural fragrant and can also be extracted into perfumes and medicinal products such as cure for coughs and rheumatism (Armiyanti *et al.* 2010). The plant is very good source of esters of benzoic acid, benzaldehyde, benzyl alcohol, isoeugenol and sesquiterpene lactones. Literature also suggest that *Michelia champaca* has been reported to contain michelia - A, liriodenine, parthenolide and guaianolides (Kazuoito *et al.* 1963, Hoffmann et al. 1977). Bark fractions active as topoisomerase inhibitor (Zuhrotun *et al.* 2016). The flower buds are commonly used by many traditional healers in most of herbal preparations for diabetes.

Fodder: The leaves of champ are also used to raise silkworms.

Fuel: The gross calorific value of the heartwood is about 21,070kJ/kg, and the tree is used as fuelwood.

Timber: Heartwood of champ is an excellent wood for furniture and carving. It is also suitable for plywood for tea chests, packing cases, boxes, battery separators, and pencils (Kundu *et al.* 2012).

Table 3: **Phytochemicals Present in Plant Part of *Michelia champaca L.***

Plant part used	Extracts used	Phytochemicals present
Stem bark	Petroleum ether	Triterpenoids, Steroids
	Diethyl ether	Alkaloids
	Ethyl acetate	Glycosides
Leaf	Acetone	Alkaloids, Glycosides, Amino acids
	Ethanol	Alkaloids, Glycosides, Carbohydrates, Amino acids, Flavanoids
	Aqueous	Tannins, Amino acids, Flavanoids
	Benzene	Sterols
	Chloroform	Alkaloids, Glycosides, Amino acids, Sterols
	Petroleum Ether	Sterols
Flower	Acetone	Tannins, Glycosides, Carbohydrates, Amino acids, Flavanoids, Sterols
	Ethanol	Alkaloids, Tannins, Glycosides, Carbohydrates, Amino acids, Flavanoids, Sterols
	Aqueous	Tannins, Amino acids, Flavanoids
	Benzene	Alkaloids, Sterols
	Chloroform	Alkaloids, Glycosides, Amino acids, Sterols
	Petroleum ether	Alkaloids, Sterols

(Kodongala *et al.* 2010)

Essential oil: The leaves, flowers, seeds, and fruits are used for essential oils and medicine (Nalawadi *et al.* 1988). The sweetly scented flowers are used in India for hair adornment and for essential oil extraction. Flowers yield an essential oil used in perfumery. Its flowers are also used for perfume and worn as hair decoration and room decoration. Its fatty oils extracted from the seeds show antibacterial activity.

Poison: Leaf extract is toxic to the rice fungus, *Pyriculariaoryzae*. Fatty oils extracted from the seeds show antibacterial activity against *Bacillus pumilus, B. subtilis, Salmonella typhosa, S. paratyphi, Micrococcus pyogenesvar albus* and *Staphylococcus aureus*.

Medicine: The plant has medical properties. Various parts of champ have been widely used for anti-inflammatory, anti-pyretic, anti-microbial, cardiotonic, purgative, diaphoretic, stimulant, diuretic and anti-leprotic purposes (Zuhrotun *et al.* 2016). The leaf is also known for its anti-inflammatory effects, anti-hyperglycemic activity, radical scavenging activity, wound healing activity, diuretic activity, antiulcer activity, and anthelmintic activity (Raja *et al.* 2014). Balurgi *et al.* (1997) showed that the leaves contain parthenolide. Ethanolic, methanolic, and aqueous extracts of *M. champaca L.* exhibit antioxidant and free-radical scavenging activity.

The bark is considered stimulant, diuretic and febrifugal; dried root and root bark are purgative; the juice of the leaves is used in colic. Throughout the east, the bark is used to reduce fever. In Malaysia, a decoction of the bark may be used after childbirth as a protective medicine. The barks are used as febrifuge.

Flowers and fruits are useful in dyspepsia, fever and in kidney diseases. Seed oil has antibacterial properties (Kundu 2012). In Myanmar, the flowers are used to treat leprosy and leaves are used against colic. Liriodenine compounds extracted from *Michelia champaca* branch are found to be strongest inhibitor on human breast and lung cancer cells (Yeh *et al.* 2011). *Michelia champaca Linn* flower and leaf (alcoholic & aqueous) extracts display gastroprotective activity, as demonstrated by its significant inhibition of the formation of ulcers induced using different models as well as by its ability to decrease gastric secretions (Orwa *et al.* 2009).

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PROPAGATION OF CHAMP

Commonly, *Michelia champaca* is propagated by means of seed and vegetative pathways throughlayering.

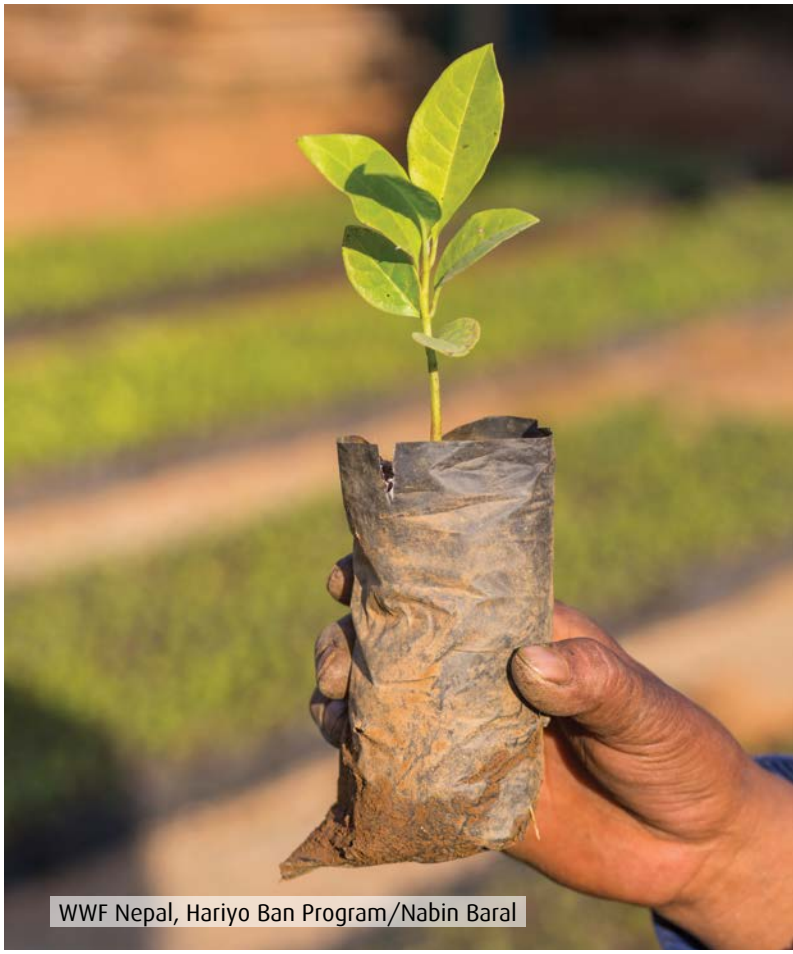
a. From Seed (Sexual Reproduction)

Seed collection

Fresh fruits are collected from the trees by lopping the fruit bearing branches or plucking the fruits. Ground collected seeds are often attacked by insects. Proper care should be taken while collecting the seeds as fruit ripening takes more than one year; therefore, branches bearing mature fruits also bear the flowers of the current year. The optimum period of collection is when fruit is fully mature. At that time, the fruits turn grayish brown and start to dehisce exposing the soft, red pulp inside. The color of the seed should be black, and the moisture content of seed is 20-25 percent.

Processing and handling

Fruits are spread in shade for 2-3 days until they open. Seeds are then separated by gentle thrashing. The red pulp is washed off in water by rubbing on wire net and hardware cloth (Troup 1921). There are 10000-29500 seeds/kg. Seed viability can be maintained by moist storage at 50°C for about seven months or in pits at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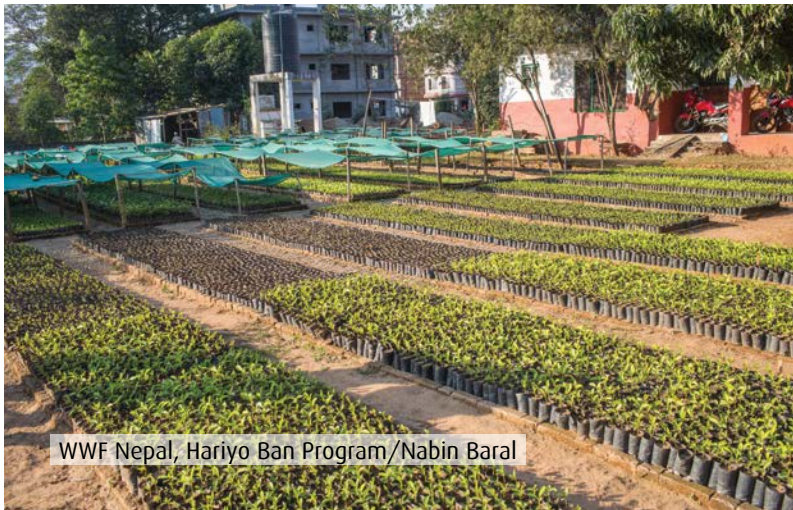
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130°C for about four months. Clean seeds are then dried under shade. At the time of washing, water test should be performed to discard the light seeds which float on water. Seeds can be treated with an insecticide before sowing to prevent insect damage (Kundu *et al.* 2012).

Dormancy and pre-treatment

Its natural regeneration is rare. Hence, the species is usually propagated from seeds but with great difficulties. The 'hard' seed/fruit coat has been suggested to be responsible for delayed germination implying the presence of physical dormancy. Seeds are oily and quickly lose viability. Loss of viability can be minimized by moist storage especially at low temperatures (5°C) for up to ninemonths (Fernando *et al.* 2013). Regeneration is poor because the number of seeds that germinate is low (Zabala 1990) and hence, it is often grown in nurseries from seeds with great difficulty before out-planting (Bahuguna *et al.* 1987; Armiyanti 2010). Seeds have physiological dormancy and pretreatment with gibberellic acid (GA3) at the rate of 500 ppm for 24 hours can improve the germination up to 80 percent. Dormancy at ambient temperature or moderate cooling to 10°C seeds will maintain viability for only about 6 months at any moisture content. However, seeds can be viable for more than one and a half year in aerated moist storage at 5°C (Kundu *et al.* 2012).

Sowing and germination

The *Michelia champaca* tree is one of the most coveted of tropical trees. The reason is its heady, heavenly scent, which is used to make one of the world's most sought-after colognes. Known also as the "Joy Perfume" tree, yellow jade orchid tree and fragrant *champaca*, it is a woody, ornamental tree. Seeds are released within 3 days and are depulped and dried at room temperature for one day. Initial germination of seed lots is 68 percent, and moisture content is 21.2 percent (Bahuguna *et al.* 1987). Germination percentage dropped markedly during storage at 5°C. Seeds are mixed with red-oxide before sowing to prevent its damage by the rodents. Birds and wild boar also eat seeds.

Sowing is done immediately after the collection and cleaning (de-pulping) of seeds. Fresh seeds are sown in shaded nursery either broadcast or in drills 8-10 cm apart, with a thin layer of earth sprinkled over the seeds. Thatch grass or brushwood may sometimes be spread over the bed to hasten germination. Germination is completed after about 45 days. Germination varies from 20-70 percent. Seedlings can be prick out when they attain three leaf stages in the polythene bags or transplanted in beds at a spacing of 10 cm. One-year old nursery seedlings, with ball of earth, are fit for planting out in the following rains. The tree coppices well and stump planting has also been successful at some places.

b. Vegetative Propagation (Asexual Reproduction)

The champis a species of fragrant flowering tree within the Magnolia genus. It is also called the "Yellow Jade Orchid" tree, Fragrant Champaca, Himalayan Champaca or *Magnolia champaca*. Although the plant eventually reaches 25 to 30 feet tall and wide at full maturity, it is an extremely slow grower and bloomer, sometimes taking as long as 10 years to produce flowers. Trees sprouted from grafts tend to bloom in as little as 1 to 2 years, significantly faster than those grown from seed. Grafting forces a small piece of vegetative tissue to regrow the parts it needs to survive.

First, *Michelia champaca* for grafting must be located to cut a small branch from it. This small branch, called a scion, will be the beginnings of new tree. Trees from the Magnolia family graft best when cuttings are taken at the semi-hardwood stage of growth, which occurs just after a major growth spurt in mid-July to early fall. In vegetative propagation the Forkert method shows 46.5% success, the T-method 44.4%, and the Patch method 37%, whereas the side veneer method was unsuccessful (Rashid *et al.* 1986). When 8- to 10-month old seedlings were decapitated 25 to 30 cm from the ground and previously defoliated scions were grafted in early August, 40% success was obtained (Nalawadi *et al.* 1988). Extracts of girdled and etiolated shoots contained a higher level of root-promoting substances than shoots that were only girdled or fresh shoots (Gowdam and Jayanthi 1988). *Michelia champaca* can also be propagated by treating fresh or pre-girdled and etiolated layers with indole butyric acid. The best rooting (93.3%) and survival of rooted layers (92.1%) was obtained with pre-girdled and etiolated layers treated with indole butyric acid at 5000 ppm (Channaveetappa and Gowda 1984). Roots of 1-year old *M. champaca* exhibited vesicular-arbuscular mycorrhizas (Thapar *et al.* 1992).

Method of grafting (with steps)

- Choosing the scions should have both current and past growth on it.
- Choose healthy branches without wilt or fungus.
- Cut a 4-6 inch long piece. It is smart to cut a few to attempt to root since the growing process is not 100% guaranteed to work every time.
- Sterilize pruning shears with one-part bleach mixed with nine parts waters to avoid spreading disease to new tree.
- Soak the blades in the solution for five minutes.
- Use the cleaned, sharp shears to cut scions from the tree.
- Remove any flowers and flower buds from the scions so all of the tree's energy can route to growing new roots rather than to reproduction.
- Keep the scions in a cool and moist area if unable to transplant them immediately. Place them in a baggie with a wet paper towel and store them in the refrigerator or a cooler until ready to plant them.
- Prepare a 4-inch pot with a mixture of equal parts of peat and course sand. Dip the cut end of one of the scions into rooting hormone and insert it 1/3 to 1/2 of its length into the pot, making sure the buds are pointed up.
- Repeat this process with each scion. Water the cuttings as needed and, when leaves grow, moist them a few times a week. Keep the seedlings in a pot for at least a year to increase its chances of survival in the ground.

c. Propagation by Tissue Culture (*in vitro*)

Commonly, *M. champaca* is propagated by means of seed and vegetative pathways throughlayering. However, seed propagation is time consuming (5 weeks to 4 months to germinate) and generally low percentage in germination and quick loss of viability (Zabala 1990). On the other hand, vegetative propagation through layering does not produce large number materials for large scale planting within short period of time. The difficulties of *M. champaca* propagation through technique cause researchers to try to look for the alternative to solve the problems. Meanwhile, the expansion in *champaca* industry has led to an increasing demand for plant. It is therefore the *in vitro* system or tissue culture technique which is the suitable approach that can be employed in plant propagation of *M. champaca* (Noraishah *et al.* 2009; Armiyanti 2009). Plant regeneration systems of *Michelia champaca* through somatic embryogenesis was successfully developed from immature seed. The protocol of somatic embryogenesis from immature seeds of *M. champaca* developed in this study could serve as a potential tool with a suitable application in genetic transformation and production of large number and quality of planting materials (Armiyanti *et al.* 2010).

Site Selection and Plantation Management

Site selection is the most essential part of plantation for conservation and management interventions. The most potential site for plantation of any species is pre-occurrence (natural or plantation) of the species for plantation.

Table 4: **Favorable Aspects/Environmental Conditions for Champ Plantation**

Aspects	Favorable Conditions
Soil	Deep, moist, shady, loamy or sandy loam textured well drained, acidic fertile soil is favored and so rocky and dry site should be selected.
Climate	Tropical and subtropical climate altitude ranging from 500-1500 m with rainfall ranging from 2000mm to 5000 mm.
Light (Exposure)	It requires mean annual temperature ranging from 7°C to 38°C. Though it is moderate light demander, it prefers shady site at early stage (seedling and sapling). The best location for *Michelia* is the place where it receives direct and ample sunlight in early morning but partial light for the rest of the day.
Planting Method	The most successful method of propagating *M. champaca* is by planting out nearly one-year old seedlings at the break of the monsoon of the following year. Planting out with ball of earth or with naked roots, though success chiefly depends upon congenial planting weather. The ball of earth being 7.5 to 10 cm in diameter and 15 cm long.
Spacing	The spacing adopted is 1.8 x 1.8 m^2 in West Bengal and 2.4 x 2.4 m^2 in Assam. Weeding will not be required after the second or third year, as the plantation closes up rapidly. The first thinning in well-stocked plantations will normally be required in the 5th year if the spacing is about 1.8 m x 1.8 m.

Production and Growth Rate

The growth form of *Michelia* is according to Roux's architectural tree model, which is characterized by a continuously growing monopodial orthotropic trunk with plagiotropic branches. *M. champaca* grows well in cultivation and can reach a height of 27 m with a trunk diameter of 55 cm in 27 years; the mean annual increment is 1-1.8 m in height and 1.5-2 cm in diameter. Flowering starts when the tree is 4-5 years old. To get mature timber, based on silviculture system, cutting rotation of *champ* plant is 35 years. An annual height and stem diameter growth are between 1 to 1.8 m and 1.5 - 2 cm respectively. At the age of 16 years, the diameter trunk reaches 48 cm with a height of 19.7 m and at the age of 34 years, it reaches 20.2 m high with a trunk diameter of 65 cm (Asumijarto 2002 in Iskandar 2003). At the age of 30 years, it reaches a diameter of 60 cm and the timber production reaches ± 5 m^3/tree (Prajadinata *et al.* 2011).

Pest and Diseases

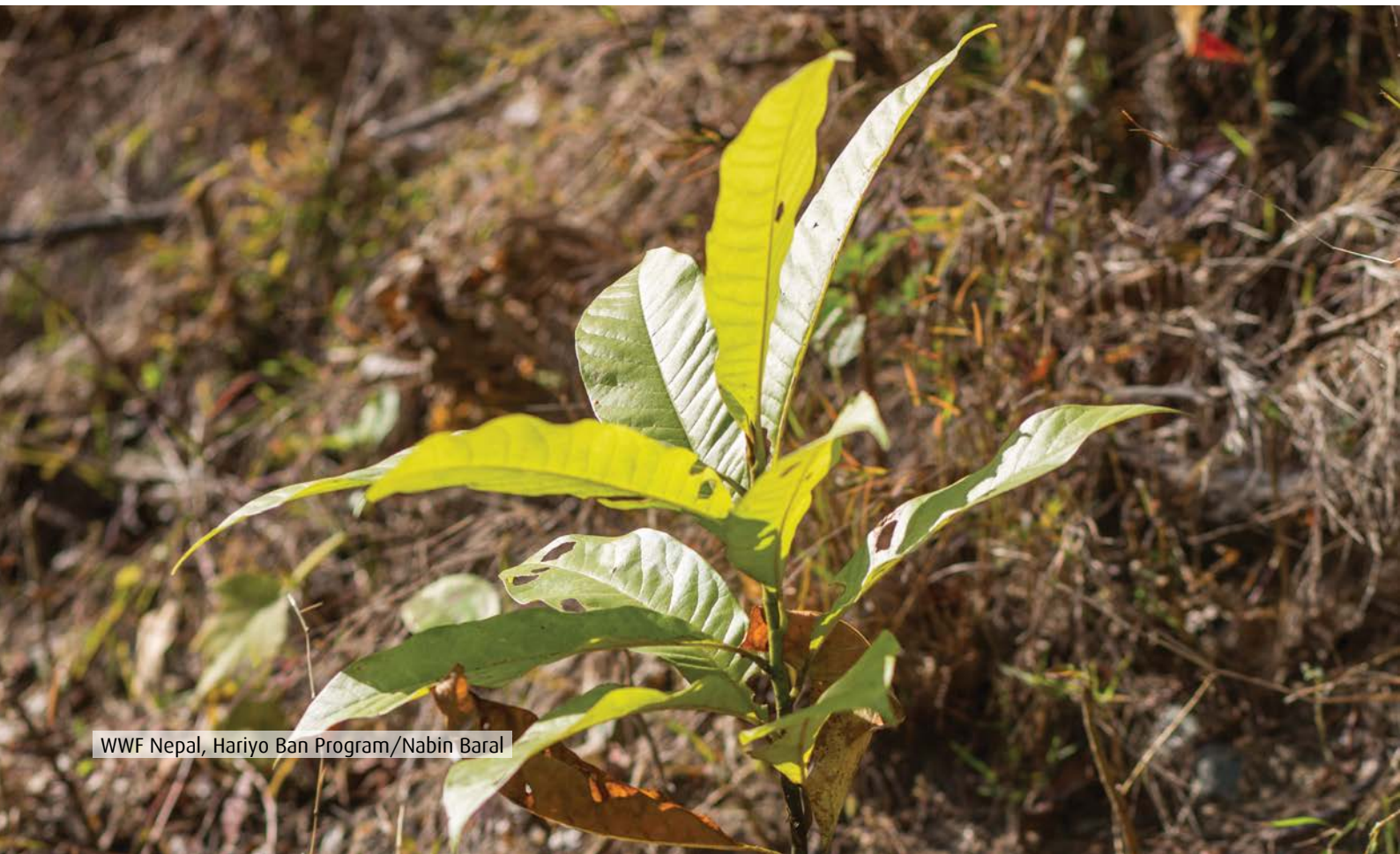
Urostylis punctigera is a serious pest of *Michelia champaca*. Spraying with a suitable mixture of nicotine sulphate and soap water or smoking under the affected trees is helpful. Biological control by *Pachyneuron pentatomivora,* a parasite, *Calvia tricolor,* a predator or red ant can be introduced. *Rynchothrips champaceae,* another insect, attacks the leaves resulting in dying off. *Rhizoctonia solani,* a soil borne fungus, causes leaf spotting and blight of seedlings in the nursery can be controlled by proper sanitation and cultural practices or raising of seedlings in polypots instead of beds (Mehrotra 1992).

Control Measures

A mixture of *Champ* with other non-susceptible species will appreciably prevent intrusion. Young plantations should be frequently inspected, so that direct remedial measures may be adopted to destroy or restrict the centers of multiplication and spread. Spacing with a suitable mixture, such as nicotine sulphate 1 part and soap 1.8 kg in 450 liters of water is helpful.

Biological Control

The natural enemies of the bug such as *Pachyneuron pentatomivora,* a parasite and *Calvia tricolor* a predator, can be introduced. Red ants collected and freed from a sack kill and eat all the bugs of *U. punctigera* and made new nests on the champ, spreading over a huge area. In Assam, Loranthus attack has been reported in *M. champaca* plantations (Anon 2018c). Mixed plantation keeps away pest and disease to some extent.



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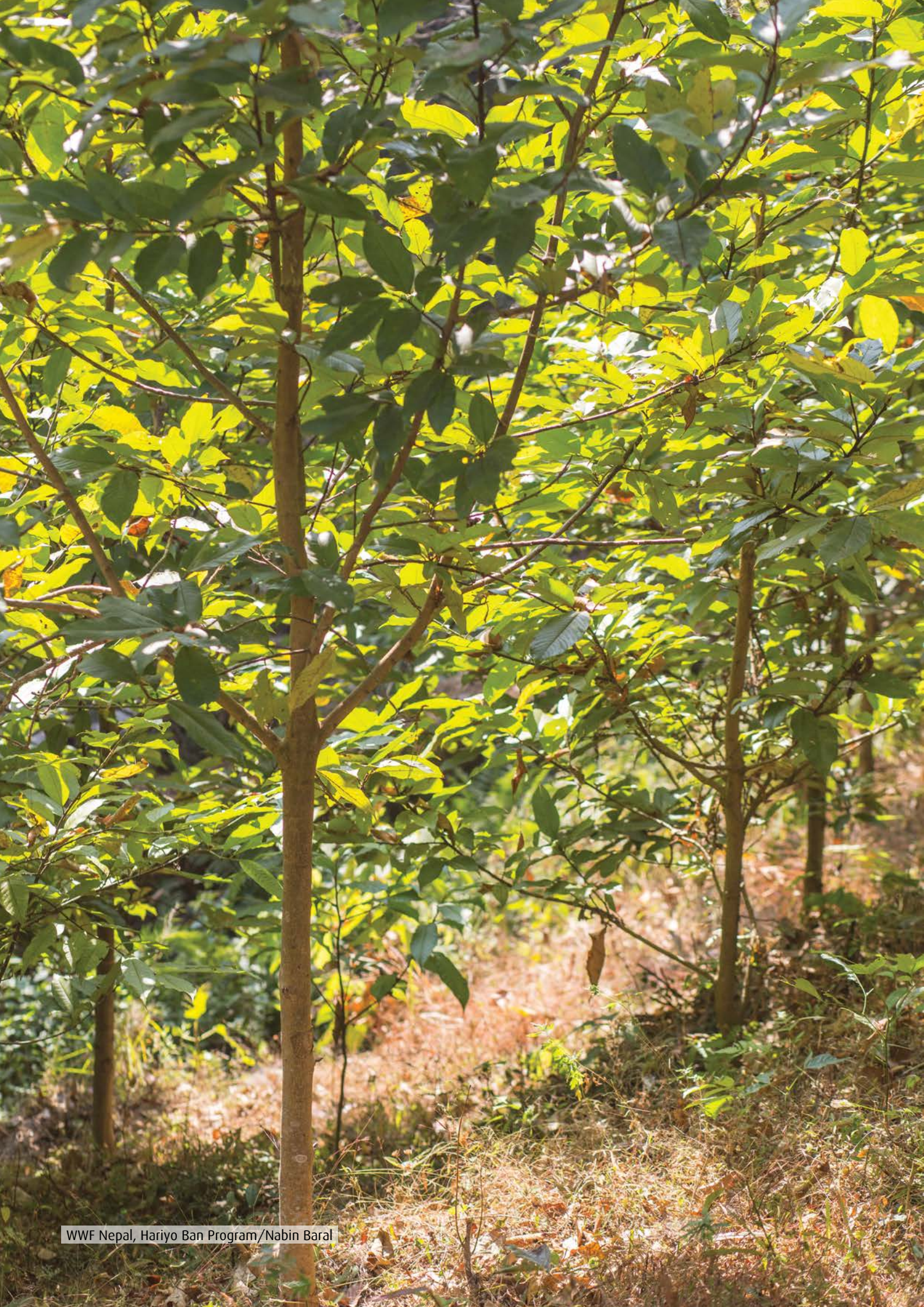
RULES AND PROVISIONS

Though Nepal government kept *Michelia champaca* as a banned species for collection a couple years, very little concern has been given for its conservation and management. A seminar of the International Board for Plants Genetic Resources held on 23-25 Sept 1981 in Kathmandu listed *Michelia champaca* as a threatened and vanishing tree species out of 25 threatened and vanishing listed species (Luoma-aho *et al.* 2004).

A seed stand of 10 hector has been established in Palpa district and a Breeding Seed Orchard (BSO) of 1.4 hector has been established in Kathmandu by Nepal government (TISU 2013). Special garden had been established for conservation of *Magnoliacea* by Department of Plant Resource (DPR 2018). Very recently, USAID's Hariyo Ban Program has been promoting champ conservation through seedling production, plantation and plantation management activities in few districts of Chitwan-Annapurna Landscape (CHAL) such as Kaski, Syangja, Lamjung, Tanahun and Gorkha.

Nepal has provisions to declare certain plant species to ban for harvest, transport and export and revise them according to current species status aiming for better conservation of those species. Forest act (1993) and regulation (1995) had listed *Champ (Michelia champaca)* under banned species for felling, transport and export to foreign countries as business along with *Khayer (Acacia catechu), Sal (Shorearobusta), Simal (Bombax ceiba), Satisal (Dalbergialatifolia), Bijaysal (Pterocarpus marsupim)* and *Okhar (Juglans regia)* to conserve them (GON 2007). However, Nepal Gazette dated 5 November 2007 removed *Michelia champaca* from banned list along with other two banned species; Khair *(Acacia catechu)* and Simal *(Bombax ceriba)*. "If community forest management plan has *champ* harvesting in their approved operation plan, then users can harvest those amounts of *Champ*," District Forest Offices (DFOs) of Gulmi and Tanahun districts further clarified on this provision. Annual progress report of DFO Lamjung shows that *Champ* was the third highest (498.78 cft) timber sold in Community Forest User Groups (CFUGs) and the highest in private lands with 2768.56 cft (DFO Lamjung 2016). Approved operation plans of CFUGs also have provisions of *Champ* harvesting (Nag Bhairab CFUG 2015).



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HARIYO BAN INTERVENTIONS ON CHAMP CONSERVATION

USAID's Hariyo Ban Program has been promoting *Champ* conservation through seedling production, plantation and plantation management activities. The program provides funds to DFOs for seedling production and to local Non-governmental Organizations (NGOs) for transportation. Local NGOs are also responsible for demand collection and plantation group selection. Hariyo Ban Program is promoting conservation activities of four species: *Bijaysal* and *Satisal* in Terai Arc Landscape (TAL) and *Champ, Okhar* and also *Tatelo (Oroxy lumindicum)* in CHAL (WWF HB 2015). HB program is conducting community awareness, capacity building, protection and management of community forests, seedling production and plantation of these species, and inventory of existing stocks (WWF HB 2015).

Champ is highly threatened due to over exploitation; to conserve this species, the Program is supporting *Champ* seedling production and plantation in CHAL areas as they include some of the *Champ* favorable sites. Among the 16 districts in CHAL, the Program is supporting *Champ* plantation in five districts; Kaski, Syangja, Tanahun, Lamjung and Gorkha purposing to plant in barren or open lands, to earn or for long-term benefit, without any specific motive, to experiment species or site, and to fulfill demand of fodder. In those districts *Champ* is found in private, public as well in forest lands showing potentiality of *Champ* plantation in these areas. A total of 225,000 *Champ* seedlings were produced and planted in 57 community forests, and private lands in Kaski, Tanahu, Lamjung, Gorkha and Syangja districts. A large number of seedlings were also planted in the shifting cultivation area along the Seti and Trishuli river corridors in Tanahun with the aim to revegetate those areas. In 2015, seedlings were also distributed to 516 individuals in Tanahun.

Final assessment in *Champ* plantation areas revealed that average survival rate of studied sites was (Kaski, Tanahun, Lamjung, Gorkha, and Syangja districts) was only 17% after three consecutive years of plantation. This result shows that *Champ* plantation was not very promising. The reasons responsible for failure (or very low survival rate) were poor site selection, lack of protection measures, inappropriate planting methods, lack of ownership by communities, grazing and forest fire, lack of coordination among different level, weak management, and lack of technical expertise during *Champ* plantation. Study found that the saplings survival rates were higher in the sites with good soil fertility, moist and shady areas and also resulted that private plantations had better survival rates than community forests, and the poorest results were where the community had low demand for *Champ* seedlings. The findings were shared with the Department of Forests, DFOs and community representatives to aware them on the poor survival status and need for urgent actions for better results. The assessment recommended for proper site selection before seedling distribution, seedlings distribution based on users' demand and most importantly, to aware communities about current status of *Champ* that it is no longer a banned tree species, are imperative for successful conservation and management of *Champ*.

The Program has targeted plantation of 500,000 Champ saplings in Gorkha, Lamjung, Tanahun, Kaski and Syangja districts of the Gandaki Sub-river Basin. This will be complimented by annual monitoring and high value seedling production that will help to offset mortality rates. For long term promotion of Champ in Nepal, Hariyo Ban Program will provide support to prepare detail implementation plan for Champ conservation and management action plan for five years in collaboration with the Department of Forests and Soil Conservation (DoFSC). Private sector and CBOs will be strategically involved in this process. Hariyo Ban Program's consortium partners Federation of Community Forestry Users Nepal (FECOFUN) and WWF Nepal will be jointly involved in implementation of these activities. It is expected that Phase II will re-establish a highly exploited forest species which is preferred for its high value timber, creating huge natural capital for the use by coming generation.

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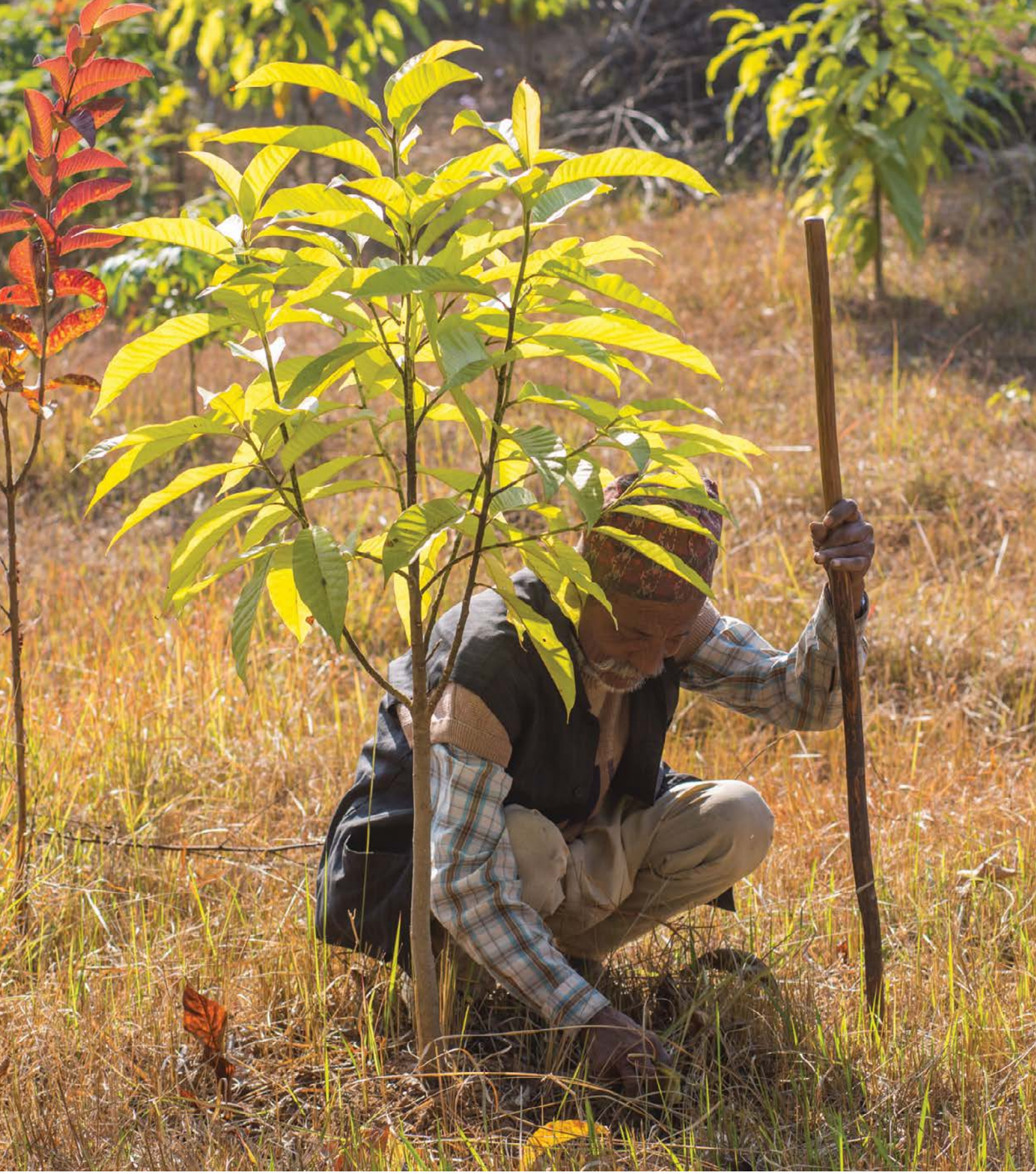

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