Ensuring the future of the pygeum tree (*Prunus africana*)

Briefing on *Prunus africana* cultivation and harvesting

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Supporting cultivation

This brief is aimed at trainers and support organisations for farmers and tree owners, as well as commercial tree nursery operators, government extension agencies and NGOs, among others, who are interested in cultivating the pygeum tree.

Growing pygeum on farms is one way to provide a secure, sustainable supply of bark for the following reasons:

- Mountain forests generally have high rates of fragmentation, deforestation and degradation (1, 2).
- Climate change is negatively affecting mountain forests (3, 4).
- There is continued high demand for pygeum bark.
- International agreements regulate the trade in wild-harvested pygeum.
- Many exporting countries are having difficulties to meet international requirements to sustainably manage wild-harvested bark.

The genetic profile and level of biochemicals in pygeum bark vary across the regions of natural occurrence (5) in Central Africa, East Africa - west and east of the Eastern Rift Valley, East Africa - east of the Rift valley, Southern Africa, and Madagascar. The main differences are between Madagascar, East and West/Central Africa (4, 6). There are also more minor differences between mountain ranges within some countries, for example, in Cameroon, pygeum in Adamaoua is somewhat different from that in the Northwest and Southwest highlands.

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A multiple-use tree

Pygeum (*Prunus africana*) is a long- lived tree species native to mostly mountain tropical forests in sub-Saharan Africa. It is also known as red stinkwood, iron wood, African plum, African prune, African cherry, and bitter almond, as well as having many names in local languages. It occurs in the wild generally 800 metres above sea level and higher, and has been described in 22 countries in Central, East and Southern Africa. Pygeum's hard, durable wood is used for axe handles, poles, carving and fuelwood; it is an important tree for bees and honey yields; the bark and seeds are used in traditional medicine for genito-urinary complaints, allergies, inflammation, kidney disease, malaria, stomach ache, fever and for veterinary remedies. The bark, peeled off the tree, dried and chipped or powdered, is used to make an extract included in treatments for benign prostatic hyperplasia, a non-cancerous glandular disorder affecting men mainly over forty.

Prunus africana has been listed since 1995 on Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). This means that the species is seen as not necessarily now threatened with extinction but may become so unless trade is closely controlled through annual quotas. Legally binding on government parties, CITES does not replace national laws but provides a framework for implementation in national legislation.

The highest level of genetic diversity has been found in Uganda, particularly in Kibale and Ruwenzori National Parks. Cultivated pygeum trees have generally, but not always, been sourced from seedlings and seed locally, and so normally have almost similar genetic and biochemical profiles to naturally occurring pygeum in the same regions (5, 7). Natural changes in climate over the last millennia have influenced where pygeum grows and how patterns of genetic diversity occur (8). Human influence on forest cover and climate change are expected to affect where the tree can survive in the wild and where it can be successfully cultivated in the future. Countries most likely to be negatively affected by changes in mountain climates are Tanzania, Madagascar, Cameroon, DR Congo and Uganda.

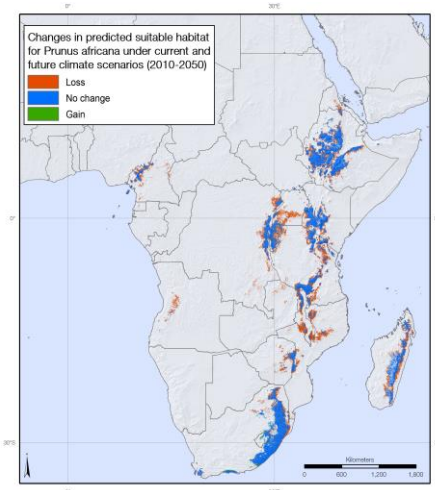

Figure 1 Predicted changes in forest habitats suitable for pygeum for the year 2050 (1, 2)

Map based on predicted future climate scenarios from IPCC5. (Source: Hannes Gaisberger [c])

Methods for cultivation and harvesting

Information on current best practices for cultivation and bark harvesting has been collated from the experiences of scientists, foresters, harvesters and farmers. Recommendations are made cautiously, bearing in mind the long timescale of managing the tree and its multiple uses.

Best cultivation practice

How to obtain planting material

Ripe fruit can be collected from the crown of a matured tree (where possible) or fallen fruit from underneath them. Fruit production has 'mast' years with an abundant year often followed by low fruit production in the following years. More reliable than collecting fruit to gather wildings and leafy stem cuttings which can then be rooted. More details can be found in guides (9, 10). When collecting fruit and wildings:

- Source from tall, straight and healthy 'mother' trees (10, 11).
- Source from at least 15 different mature trees distributed throughout a forest stand, to ensure a representation of all the different tree types in the collection area.
- Avoid collecting from very old trees
- Collect from slightly lower elevations than where cultivation will take place. This may help to ensure that the material planted at a site is appropriate for the warmer temperatures that may occur due to human-mediated climate change (60).
- Check with traditional medical practitioners, farmers and harvesters where to find the most abundant and most robust wildings, and trees that produce seed most regularly. Sacred forests, when used with permission, may be good sources.
- Collect wildings from recently fallen fruit. Some wildings sprout two or three years later, but these often don't grow well when transferred to a nursery.

Record the source of planting material. This makes it helps possible to return to superior sources that produce the best saplings and trees in the future.

Generally, it is best to gather fruit and wildings from close to where trees will be planted, as it is likely that such sources are well adapted to the local environment (although there are exceptions to this rule and, as noted above, climate change affects sourcing strategy). Sourcing planting material locally is beneficial from a conservation perspective as it retains the 'genetic integrity' of populations.

When gathering wildings:

- Collect vigorous, healthy plants (10). The whole tap root (growing vertically downwards), must be included.
- Gather and plant during the rainy season to ease extraction from the soil and to increase the chance of new roots and leaves developing.
- Incorporate some of the soil surrounding the wildings in the potting substrate, as this soil usually contains arbuscular mycorrhizal fungi (fungi associated with tree roots), that enhances seedling growth (12).

When collecting fruit:

- Take only mature (purple-coloured) fruit (13, 14) from the crown or from underneath the tree.
- Do not collect fruit damaged by rats, primates and birds. During the ripening season, visit trees every morning to collect fallen fruit that is not damaged (10).
- A plastic sheet under the tree can help to collect fallen fruit.

Vegetative propagation
Take leafy stem cuttings (the stalk and one leaf, cut to an area of around 20 to 25 cm^2) from plants with healthy and vigorous shoots. Insert the cutting into sawdust or sand in a non-mist propagator. The rooting process can be speeded up by treating leafy stem cuttings with 100 to 200 µg of the growth hormone auxin (IBA) (15). A protocol for the construction of non-mist propagator, and for the rooting, potting and weaning of pygeum cuttings has been developed and reported [10]. Avoid getting leafy stem cuttings from woody seedlings.

Processing seed before planting
Seed for planting is extracted from the mature fruit by rubbing the fruit with sand to remove the pulp. Air-dry seed under shade to a moisture content of around 15%. This seed can then be stored in an open-weave bag or in a well-aired box, protected against insects and rodents, for a maximum of six weeks while maintaining viability of 80-90% (10). Seed stored in a refrigerator at 3^{o} to 5^{o}C should retain viability for several months. Expect between 30 and 90% germination rates using these methods (13). The best results are generally obtained from fresh seed (14).

Establishing and managing seedlings
Germinate seed in a seedbed [10] of sand or sawdust, or use a sand and sawdust mixture (in equal parts). Place seed at around 2 cm depth in the bed. The seedbed may be located in a shade house (10) or otherwise placed under partial shade, and should be regularly watered (but not flooded). Germination will likely take from 10 to 50 days (11, 13). Lift seedlings from the seedbed when they have 2 leaves, and transplant into 1-litre polythene bags containing moist substrate of 3 parts of soil and 1 part of river sand or 2 parts of soil, 1 part of river sand and 1 part of compost. If the roots of lifted seedlings are more than 5 cm long, trim them to about 3 cm with scissors or a sharp knife while transplanting (10). Water potted seedlings regularly and keep them under partial shade. Around 2 weeks before field planting, move seedlings into full sunlight to facilitate their acclimatisation.

Plant out seedlings into the field when they are about 30 cm tall (normally, this is around 6 months after the sowing of seed or after a cutting has rooted). Dig a hole that is around 30 cm wide and 30 cm deep. Use topsoil mixed with compost to fill back the hole. Transplanting into the field is best undertaken at the beginning of the rainy season when the soil is well watered. Plant trees at a density of around 5 m by 5 m for pure stands and around 10 m by 10 m when establishing with crops. Planting with annual crops in the first years eases weeding and enhances the establishment of young trees. Pygeum can also be planted in hedges and on farm boundaries to minimise competition with food crops. To stimulate growth, if possible, apply 50 g of fertiliser (NPK 20-20-10) to the soil around the tree a month after planting. Pygeum grows well in diverse

cropping systems containing various annual and perennial crops without being unduly competitive (16-18).

Pruning the lower branches from the trunk of saplings can facilitate later bark harvesting by creating a 'clean' bole (10).To treat pests, such as caterpillars, snails, borers aphids and ants, curative treatments can be used when an attack starts, and preventative treatments at regular intervals (e.g., monthly) (10).

Farmers can expect a 30 to 60% survival rate for trees 15 years after planting in mixed agroforestry plots. At elevations less than 800 m tree may grow faster, but in such conditions trees are more susceptible to pests and diseases. Young trees are sensitive to fire and to grazing by livestock, and require appropriate protection (13, 16, 19).

Support to nurseries and growers
Nurseries in bark-producing areas can provide a local source of plant material to enrich wild stands and to provide stock for farm cultivation. Nurseries, and small demonstration plots associated with them or placed on local growers' farms, can be excellent places to demonstrate and introduce new cultivation techniques. Networks of nurseries, growers and harvesters who are in contact with bark buyers can share information and experiences about available stocks and prices of seedlings and bark. Networks can also share information about good production, management and harvesting techniques. This can contribute to tree owners growing trees with the most desirable characteristics and to bark sellers having more control over bark prices and demand (20, 21).

Information and planting campaigns can be effective at stimulating cultivation when they are accompanied with policies which influence improved prices, the supply of seed and seedlings, and address land tenure issues (23). Experiences in Cameroon and DR Congo indicate that it is important to promote policies that support the commercialisation of bark specifically from cultivated trees. Different ways to reach farmers, harvesters and traders with information and other inputs are needed. A focus on the practices and conditions specific to the areas where the trees are grown is essential to enable well-designed and effective interventions (21, 22).

Best harvesting practice

Generally, harvest of a large quantity of bark from a tree will lead to disease and mortality. Pygeum however, can withstand limited bark stripping over a period of time. The tree's survival and health depends on the proportion of bark harvested and the interval between harvests. It also depends on environment and harvest season, with trees at lower altitudes harvested in the dry season more susceptible to pests and diseases (19).

The 'two quarters' method appears to be a sustainable harvesting technique for wild trees. In this approach, bark from trees with at least 30 cm diameter at breast height is peeled gently from the cambium between breast height and the first branch from two opposite panels of the circumference, removing one-half of the bark over this part of the tree, once every seven years. Repeat harvesting should be done only if the bark has re-grown since the previous harvest (harvesting from the alternate quarters from any previous stripping) and the tree is otherwise healthy. A healthy tree has a full crown of leaves, no dead branches and no pests or diseases.

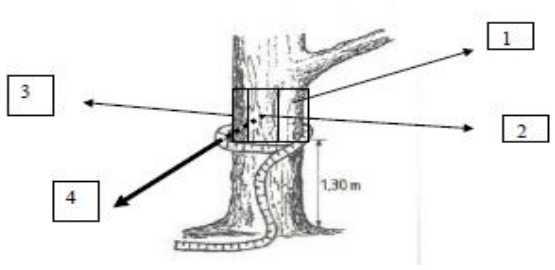

Figure 2 *The 'two quarters' technique for harvesting pygeum bark* (10)

In Uganda after harvesting, the debarked portion is smeared with a mixture of soil and cow dung, which can help prevent insect attacks (24). A record should be kept of harvesting activities (25).

Harvesting can result in significant reductions in crown size and high post-harvest mortality rates. These risks can occur even when using the 'two quarters' method, but appear to increase when a greater proportion of the bark is removed (19, 26-28). The application of poor harvesting methods is lower when trees are privately owned rather than a 'common property' resource (26). Bark harvest may not be the only cause of tree mortality: heavy undergrowth, disease, insect attack, nutrient deficiency, and/or climatic fluctuations can also be important (29).

A harvesting method that can be practised for planted trees is to fell and completely strip them. Bark, leaves and twigs all contain the active ingredients and all are or could be used in pharmaceutical production (13, 30). The wood can also then be sold for timber and other purposes. Since this approach kills the tree, it should only be used as part of a continual planting and harvesting rotation (31).

The economics of cultivation

While wild harvest may often be less expensive, the cultivation of pygeum trees brings economic, social and environmental benefits as well as costs.

Environmental benefits include reducing soil erosion and landslides by planting pygeum on steep slopes (13, 22). The tree is also an important source of pollen and nectar for bees and other insects (11, 20), and the fruits are eaten by rodents, birds and mammals, many of which are only found in mountain forests (29, 32-34). Planting can therefore support biodiversity and honey production. The environmental costs of wild harvesting include the damage to trees and the reduction of numbers of pygeum trees in local areas, due to the mortality caused by unsustainable harvesting (19, 20, 35-38), the loss of vegetation and lianas cleared from and around harvested trees in natural forests, and hunting while carrying out harvesting (35).

The social benefits received from both commercial wild harvest and cultivation include the local use of roots, bark, leaves and seeds for medicines for human and veterinary remedies (32, 39-43). In some countries, such as Cameroon, communities benefit from commercial harvest because some proceeds from pygeum harvested on community-owned and/or managed forest and lands are used to construct infrastructure and provide services (20, 44, 45). Knowledge on pygeum cultivation, sustainable harvesting and conservation is also disseminated for the wider benefit of community members (44, 46-49).

Other costs include monitoring and enforcement to prevent unsustainable and illegal harvest, and income loss due to theft and illegal exploitation (20, 50). Harvesters who had previously benefited from harvesting revenue, but who do not own land to cultivate trees, may be marginalised if cultivation means the market for wild bark is reduced.

The main economic benefit from wild and cultivated trees is the sale of bark for its use in the pharmaceutical and health supplement industry, mainly in Europe, the USA and Asia. The price of fresh 'wet' bark to harvesters varies widely, from the equivalent of €76 to €839 per tonne. The highest prices in Cameroon were paid to harvesters organised into unions and community forest associations (20, 51). Export prices for dry bark (on average 50% of the weight of fresh bark) are around €2,000 a tonne. The timber is also sold locally in some counties for charcoal, carving, to make tools and for construction. Governments are a beneficiary of bark export through permit revenues (20, 35, 51).

Cultivating pygeum can be economically viable (52). Pygeum's growth rate can make it at least as attractive as trees such as eucalyptus in providing good economic returns for farmers (18).

The economic costs of cultivation include the long timescales between planting and profit from harvest (around 15-35 years depending on growth rates and diameter (13, 19). Setting up a full nursery to produce 900 seedlings a year costs around €3,050. This can generate an income of €3,740 each year for five years, if seedlings are sold for €1.00 each (51). Based on the total cost of inventories, management, training, harvesting, monitoring and enforcement in Cameroon, and a five year rotation period in which around 600 tons is harvested from around 12,000 healthy trees (assuming on average 55 kg of fresh bark is harvested from each tree), these costs vary from €1,017 to €1,080 (51).

Demand for bark

Although accurate predictions are difficult, it appears that there will be continued demand for pygeum bark. The most recent market study, although some time ago in the year 2000 (53), predicted a growing market for bark extract, due to an aging male population. The popularity of herbal treatments continues to grow, and the global market for pygeum-based complementary medicines is increasing (54, 55). The opportunities for selling pygeum-based pharmaceuticals are increasingly recognised in Asia (56-59). The stable market for pharmaceuticals prescribed for benign prostatic hyperplasia in at least four European countries continues (60).

The worldwide trade trebled from 2003 to 2005 to 2,815 tons. From 1995 to 2013, 52% of exports have originated in Cameroon. Many of the main exporting countries in the past twenty years, such as Cameroon, Madagascar, Uganda, Tanzania, Kenya and Equatorial Guinea, have found it difficult to comply with international requirements for trade from trees in the wild, leading to 191 tons being exported in 2013. In 2014 quotas were granted by CITES to Cameroon, the DR Congo and Uganda, to export 1,253 tons in total.

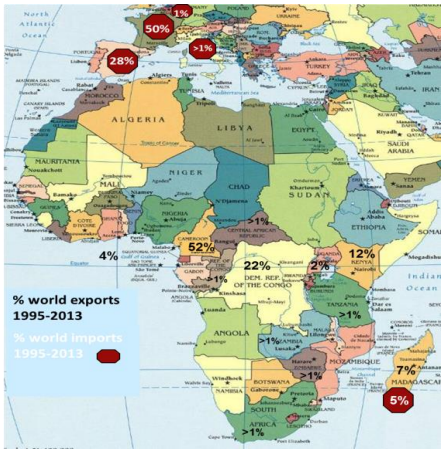

Figure 3 *Global pygeum exports and imports 1995 to 2013*
Source: UNEP & WCMC CITES Trade Database

Ways Forward

Farmed pygeum appears to be an important and a sustainable way to meet current and future demand. Some of the key issues to support cultivation include:

1. Supportive policy and regulatory frameworks that allow cultivated pygeum to be sold internationally.
2. Empowering farmers by training on vegetative propagation, as a more efficient way to produce good quality, fast-growing trees.
3. Promoting registration and inventories of pygeum currently cultivated in all producing countries, so that more information about the current extent of cultivation becomes available.
4. Introducing traceability and monitoring systems in the international bark trade that distinguish between cultivated and wild sourced bark.
5. Enabling farmers and owners to register and certify cultivated trees.
6. Tax and policy incentives to support the cultivation of pygeum trees and the trade in bark from cultivated trees, and make this more attractive compared to wild harvesting.
7. Support for the trade in cultivated bark from importers, governments and organisations such as CITES in countries where pygeum is consumed.
8. Developing national and Africa-wide policies and mechanisms, such as seed banks, to ensure the supply of bark from cultivated materials in the long term.

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