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Traditional and alternative techniques of Chilgoza Pine (*Pinus gerardiana* Wall.ex D. Don) nut harvesting and processing in Afghanistan.

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Abstract: Chilgoza pine nut is an important non-timber forest product (NTFP) of Afghanistan. Chilgoza pine cones reach at maturity in August and cone collection continues until the end of September. Local communities and or contractors harvest pine cones from chilgoza trees every year. Usually, chilgoza pine cones are harvested unsustainably in Afghanistan. People harvest cones from chilgoza trees without considering tree health and natural regeneration. The extraction process of pine nut is also unsustainable and time consuming. In this study, we investigated traditional chilgoza pine cone harvesting and pine nut extraction techniques across the chilgoza pine range in Afghanistan. Our study revealed that mostly chilgoza pine cones are collected by contractors however, this trend is region dependent. In the eastern provinces, cones are predominantly harvested by villagers; while in southern provinces cones are usually harvested by contractors. Cones of chilgoza pine is collected with a sharp hook attached to the end of a long stick and or small axes. The most common method of cone drying is sun and air dry. Once dried, scales of the cones open naturally and pine nuts are extracted by beating the cones with a stick or over a hard surface. Traditional methods can be replaced by use of better harvesting equipment and extraction techniques. With the use of better equipment, damages can be reduced to trees during cone harvesting.

Key words: Chilgoza pine; Communities; Cone harvesting; Pine nuts

Introduction

Chilgoza pine forests are important natural resources of Afghanistan. Pine nut is one of the main source of income of the local communities living near the chilgoza pine forests. In Afghanistan, chilgoza pine forest stands are usually controlled by local tribes (Shalizi and Khurram 2016). Tribes are controlled by tribal elders and leaders. They are responsible to distribute forest stands between villages and village members (Kuhn *et al.,* 2006). In some areas villagers harvest and process nuts in groups and then revenue is divided among families based on their contribution during collection and processing. While in other areas, each family is designated a patch of forest before harvesting and they collect, process and sell the nuts independently (MAIL 2012). In India, all community members participate in nut collection and harvesting. The income generated is then equally divided between households based on level of participation of individuals (Peltier and Dauffy 2009).

In chilgoza pine forests, local people often harvest pine cones from tree branches using a sharp metal blade attached to the end of a long pole (Kuhn *et al.,* 2006, Harrison 1951, Said 1959). Cones of lower branches are removed with the long pole from the ground, while cones of upper branches are removed by climbing the tree. During cone collection, the branches, crown and even bark of trees is damaged by collectors (Akbar *et al.,* 2014, Lakhanpal and Kumar 1996, Urooj and Jabeen 2015). Severe tree damage during cone collection in Afghanistan is reported by Groninger (2012). Most of the time cone bearing branches are broken due to beating, pulling and cutting. Unsustainable harvesting methods may impact chilgoza pine forest health. Traditional harvesting methods is not only time consuming and less effective, but also reduce nut quality and tree health.

Chilgoza pine cone collection and extraction methods have not been studied in Afghanistan. It is important to study current practices applied during chilgoza pine nut harvesting and extraction. This study was part of a complementary research investigated various aspects of chilgoza pine forests of Afghanistan. The objective of this study was to assess traditional methods of chilgoza pine cone harvesting and extraction practices used in

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Afghanistan. Also, to devise alternative equipment and methods in order to reduce tree damage during collection and improve nut quality via introduction of better extraction techniques.

Materials and Methods

This study was based on interviews, questionnaires and review of literature. A questionnaire was prepared for local villagers and community members living in the chilgoza range. Target population were individuals living in the eastern forest complex (EFC) close to chilgoza pine forest stands. A total of 56 subjects were surveyed in Kapisa, Laghman, Kunar, Nuristan, Nangarhar, Paktia, Khost, and Paktika provinces. Number of subjects per province was unbalanced and related to the area of chilgoza forest of each province and security conditions. A preliminary goal was set to interview at least one subject in each district of these provinces. The number of subjects varied from a low of 1 subject/province to a high of 23 subjects/provinces with a total of 29 districts across the above 8 provinces. Since many of the subjects were illiterate and were not familiar with reading and writing, the majority of questionnaires were completed through use of in-person or phone-based interviews. Local villagers and community members were inquired for common chilgoza pine cone harvesting and pine nuts processing techniques.

Results and Discussion

Cones are harvested by villagers and by outside contractors. Most of the communities or villages (43%) contract their chilgoza forests to outside contractors (Figure 1). Cone collection is a difficult process because chilgoza trees usually grow on steep rocky slopes and climbing trees is somewhat dangerous and time consuming (Peltier and Dauffy 2009). Thus, local villagers tend to lease their forest to outside private contractors to harvest the cones from trees during nut harvesting season (Singh 1989). These private contractors bring their own equipment and labor. Unfortunately, most of the time the contractors collect every single cone and do more harm and damage than local collectors (Peltier and Dauffy 2009).

The contract system is most common in Paktia, Paktika and Khost provinces while in Nangahar, Laghman, Nuristan, Kunar and Kapisa provinces it is more common for local villagers to directly harvest chilgoza pine cones (Figure 2). In the contract system, chilgoza forest stands are given to the contractors for a short period of time during the harvest season. These contractors bring their own workers and equipment and harvest the cones. The other reason that villagers or communities give for contracting out their chilgoza forests to outsiders is that they are performing other jobs or are busy with agriculture. In some cases, the forest area is so large that villagers are not able to harvest all of the cones and they therefore lease out part of their forest to contractors. In other cases, some years the harvest is done by villagers and some years they contract it to outsiders. In some communities, tribal leaders are responsible for contracting out chilgoza forests to contractors.

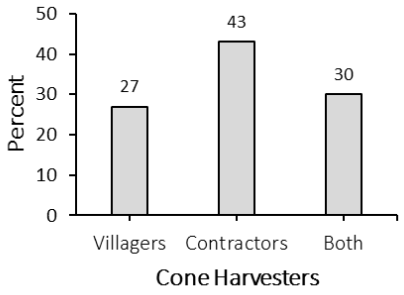

Figure 1: Percent of chilgoza pine cone harvesters in EFC.

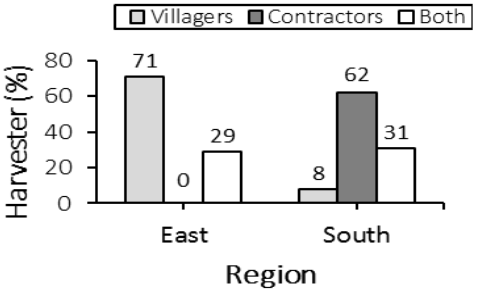

Figure 2: Percent of chilgoza pine cone harvesters by region in EFC.

Cone collection methods and tools

Cones of pine trees are collected by climbing the tree with rope or ladder, ground-based, and/or through use of a tree-tong (Murray 2007). Ground-based or use of a ladder does not harm the tree during cone collection, however climbing the tree with a rope or free climbing may damage branches (Murray 2007).

In Afghanistan, cones of chilgoza pine are commonly collected with a sharp hook attached to the end of a long stick (Figure 3) and in some areas, small axes are used as well (Table 1). Local villagers and/or contractors use these hooks to detach cones from tree branches. Although these hooks ease cone collection, they can also be used to cut or break off the meristematic tips and ends of branches in order to down multiple cones. This type of incidental pruning can significantly impact seasonal growth patterns and affect the natural growth habit of the tree. The long-term effect of this type of harvesting on lifetime cone productivity is not well understood.

Figure 3. Chilgoza pine cone removal hook, b) hook attached to pole and, c) cone collection with hook.

There is some alternative equipment that may increase time efficiency and reduce damages to branches during cone collection. Pole pruners (Figure 4) are designed to prune upper branches of trees. These can be used to prune pine cones from branches instead of breaking branches with common hooks. With this equipment cones can be pruned and detached from branches easily. Also, the efficiency of common hooks may be enhanced if another blade with a pulley is attached below the hook. Harvesting cones with pruners can decrease damages and injuries to the tree if used correctly, however they must be used with care as they are also capable of cutting off the tips and ends of branches. Modifications to traditional tree pruners have been suggested to reduce damage to trees. For example, it may be possible to sheath the cutting blades with a plastic cover or resin so that individual branches can be gripped and shaken to drop the cones as opposed to cutting.

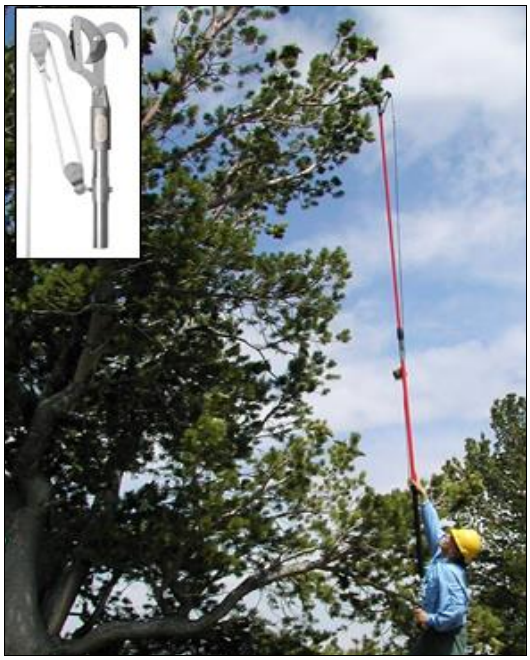

Figure 4: Cone removal with pole pruner.

Another tool that may have significant potential to reduce tree damage during harvesting is the tree tong (Figure 5). This device attaches to the end of a long pole and plucks cones from the tree with a set of hands that are opened and closed by pulling on a cord attached to the tongs (Davies and Murray, 2006). Using the tree tong, no cutting or breaking of branches is incurred as individual cones are removed from the tree, or branches are shaken. While this tool has not been field tested in Afghanistan, it is recommended that trial tests be conducted to determine its effectiveness compared with traditional methods.

Climbing ladders can also enhance time and cone collection efficiency. If ladders are used carefully, cones of upper branches can be easily pruned without exerting any damage to the branches. Other protective equipment such as safety harnesses, ropes, gloves, helmets and goggles may also bring significant safety improvements for those climbing trees to collect cones.

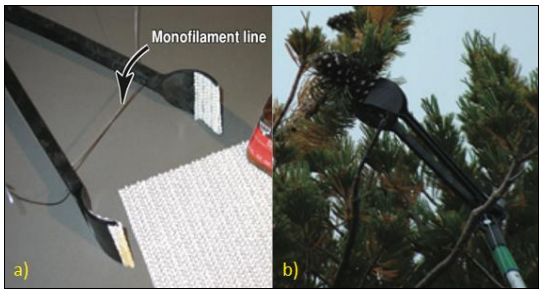

Figure 5: Tree tong with cord for opening and closing; and, b) tree tong being used to remove pine cone from branch (Davies and Murray 2006).

Cone Harvesting Time

Cones of chilgoza pine reach maturity in September (Said 1959) and they should be collected before the outer scales open or loosen (Chandy 2002). At the time of maturity, cones first turn into green and then to brown colors (Krugman and Jenkinson 1974). Cone collection begins in August and September and continues for two months (Said 1959). Both collection and preliminary processing (extraction) continue until February of the following year (Kuhn *et al.,* 2006). In some areas, local harvesters collect the cones too early or sometimes too late, which results in low quality nuts (Kuhn *et al.,* 2006).

As the quality and price commanded for pine nuts are partially dependent upon harvesting cones at the correct stage of maturity, training harvesters on cone development and proper harvesting time can increase value for villagers, traders and exporters. Additional research on optimum harvesting time is recommended.

Cone Drying and Nut Extraction Methods

Once cones are collected, they are generally transported to the village in large jute or burlap sacks and piled together. After some time, cones

are spread over the ground and exposed to the sun to air dry (Khan and Khan 1992, Krugman and Jenkinson 1974). The harvesters try to dry the cones immediately in order to prevent mold development that results in seed deterioration (Khan and Khan 1992).

Sun/air drying is the most common method of cone drying in Afghanistan (Table 1), however use of fire or coals to aid in drying has been reported. In some areas, cones are piled on rooftops to dry naturally in the sun. Some villagers bury the cones in meter-deep pits for some time and then move them to the open-air for drying. Similar method of cone drying is used in Gilgit, Pakistan as well (Urooj and Jabeen 2015). Alternatively, some people store the cones inside a room and then expose them to the sun for drying. Some believe that cones stored in soil and/or shade for a period of time will cause resin to ooze out and allow the scales to open more quickly in the sun. The drying process is completed between 2 – 60 days by spreading the cones on dried ground exposed to air and sunlight (Khan and Khan 1992, Krugman and Jenkinson 1974). This drying process is slow and depends on the climatic situation. On average it takes 15 days for cones to dry in open air (Krugman and Jenkinson 1974, Troup 1921, Young and Young 1992). In Afghanistan, under traditional drying procedures it takes about 20 days for the cones to open (Kuhn *et al.,* 2006). Some harvesters heat the cones with fire in order to accelerate scale opening and seed release (Harrison 1951).

Table 1. Cone collection equipment, methods of cone drying and seed extraction used in Afghanistan.

Cone collection equipment	Count (N)	%
Hook attached to a long stick	53	94
Small axe and hook	2	4
Small axe	1	2
Method of cone drying		
Naturally in the sun	56	100
Roasting with fire	0	0
Method of seed extraction		
By cutting the cones open	0	0
By beating on a hard surface	48	86
Both	8	14

The modern, improved method of cone drying and nut extraction is through the use of cabinet driers, wherein the duration of time until seed extraction can be reduced and the quality of the nut is improved by reducing its moisture content (Thakur *et al.,* 2009, 2014). Cabinet driers expose the cones to a controlled amount of heat, while in traditional methods, cones are exposed to the sun or fire heat and the temperature is not controlled. Once cones are heated and dried, scales completely or partially open and nuts are extracted manually (Kuhn *et al.,* 2006). Nuts are extracted by placing the cones in a sack and beating with a stick or over a hard surface (Urooj and Jabeen 2015, Table 1). Cones that do not open their scales after the drying process are cut open with shears or clippers. During the extraction process, some seeds are damaged and wasted by striking and beating. In India, a sharp-edged saw is used to cut the cones for nut extraction, which damage the seeds (Thakur *et al.,* 2009).

In some regions, local traders buy the cones from villagers and take care of manual processing (Kuhn *et al.,* 2006). After seed extraction, nuts are roasted in their shell in order to improve flavor and shelf life (Kuhn *et al.,* 2006, Urooj and Jabeen 2015). Roasting in Afghanistan is done manually using gas or wood as a heating source, while in Pakistan it is done with sophisticated machinery (Kuhn *et al.,* 2006). In domestic markets nuts are sold with shells and deshelling is usually done by hand (Kuhn *et al.,* 2006).

Based on scientific research, advanced methods of nut extraction have been introduced. The pinyon pine nuts in the US are extracted and deshelled using mechanized machinery (Harrison 1951). Although expensive, use of a cabinet drier is one of the best methods of nut extraction, wherein the seeds are extracted quickly and the quality of the nut is improved by reducing moisture content (Thakur *et al.,* 2009, 2014). Cabinet driers extract seeds by exposing the cones to a controlled amount of heat. While, in traditional methods, cones are exposed to sun or fire heat and the temperature is not controlled. Thakur *et al.* (2014, 2009) observed quick cone opening at 55 - 60^{o} C temperature in cabinet driers. Cabinet drying is considered the best drying mode based on time efficiency and consistency, however use of solar polyethylene drying tunnels may be suitable in achieving the required moisture content and significantly more resourceful and cost effective (Thakur *et al.,* 2009, 2012).

Conclusions

Chilgoza pine play an important role in livelihood of local communities in the EFC. People harvest pine cones and sell pine nuts in local and international markets. Mostly, cones are unsustainably collected by local villagers and or outside contractors. During cone collection trees are damaged and natural regeneration is suppressed. Use of traditional techniques and equipment is not very effective during cone collection. Most of the time, tree branches and bark is damaged with the use of locally made equipment. In order to avoid tree damage, cones have to be collected by trained individuals. In addition, use of better equipment such as pole pruners, tree tong, ladders and safety equipment can reduce tree damage.

The traditional cone drying and nut extraction method, is ineffective and time consuming as well. Traditional cone drying and extraction not only reduces yield but also decrease quality of nuts. Likewise, nut extraction process is also not standard as well. The most common cone drying method is sun and air drying which is not very effective. Furthermore, manual seed extraction results in reduced yield. Cabinet drier is an effective method of cone drying and seed extraction. With the use of cabinet drier not only seeds are extracted quickly, but quality is improved by controlling seed moister as well.

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