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Ethnobotany of wild plants and crop wild relatives in walnut-fruit forests of Kyrgyzstan

Master's Thesis

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Author:

Bc. Linda Vlčková

Supervisor:

doc. Ing. Zbyněk Polesný, Ph.D.

Declaration

I hereby declare that I have written this thesis entitled "Ethnobotany of wild plants and crop wild relatives in walnut-fruit forests of Kyrgyzstan" independently, all texts in this thesis are original, and all the sources have been quoted and acknowledged by means of complete references and according to Citation rules of the FTA.

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Bc. Linda Vlčková

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Abstract

The worldwide unique walnut fruit-forests, situated in the mountains on the southwest of the Kyrgyz Republic, are very important for local communities and for its huge biodiversity. Local people very depend on sources from forests from both economical and ecological sites. The forests are a source of genetic resources such as walnut, apples, pears, plum, and other species. Unfortunately, the forests have been lost due to extensive grazing, the intensive collection of firewood, nuts, and fruits. Consequently, it is important to find out traditional knowledge of local people about plant species, which are important for local communities as the main source of cash income and their prosperity. Data collection was carried out via the free listing method and semi-structured interviews with 146 informants from five villages: Arslanbob, Toskool-Ata, Kyzyl-Unkur, Salam-Alik, and Kara-Alma, between July and September 2018. A total of 88 plant species, among 37 botanical families were documented. The mentioned plant species provide food (39), medicine (51), fuelwood (28), material (14), and feed for animals. Eventually, lists were obtained with botanical and folk names of plants with their used plant parts, their purpose, the plant's habitats and whether or not they are sold. The most commonly represented families were Rosaceae, Asteraceae, Lamiaceae, and Polygonaceae. Differences in knowledge between *leshozes* or generations were not very high, as was knowledge between men and women. Quantitatively, the ethnobotanical data were analyzed by using indices, Use report, Relative frequency of citation, Use value, and Cultural value index. According to the Use Report, the most representative species are *Juglans regia* L., *Malus niedzwetzkyana* Dieck., *Malus sieversii* (Ledeb.) M.Roem., *Prunus divaricata* Ledeb., *Crataegus* spp., *Acer semenovii* Regel et Herder, and *Acer turkestanica* Pojark. The results showed that walnuts, apples, and mushrooms are very important as a source of income for the local communities. Further *Capparis herbacea* Willd. could be explored in more detail as a source of food and cash income for local people.

Key words: Walnut-fruit forests, Kyrgyzstan, quantitative, ethnobotany, wild plants, traditional knowledge

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List of abbreviations

CWR	Crop wild relatives
SAEPF	State Agency on Environment Protection and Forestry
MASL	Metres above sea level
IPPA	Investment promotion and protection agency of the Kyrgyz republic
BIOFOR	(Biodiversity & Sustainable Forestry IQC
UNESCO	United Nations Educational, Scientific and Cultural Organization
CIA	Cental Intelligence Agency
GDP	Gross Domestic Product
IUCN	International Union for Conservation of Nature
NTFP	Non-timber forest products
KGS	Kyrgyz som
PROFOR	Program on Forests
UR	Use report
RFC	Relative frequency of citation
UV	Use value
CV	Cultural value
CAREC	Central Asia Regional Environmental Centre
UNDP	United Nation development programme

1. Introduction

1.1.Ethnobotany

People have been collecting plants and animal products since ancient times. Even today, people gather plants and animal resources for their needs and income. Gathering of high-value products such as mushrooms, nuts, fruits, herbs, spices, gums, fodder, fibers used for the construction of shelter and housing, clothing, and plant products for medicinal, cosmetic or cultural uses also continues in developed countries for cultural and economic reasons (Shippmann et al. 2002). Especially in poorer countries, people depend on wild plants collected for food, construction material, medicine, fuelwood and other purposes (Martin 2004).

The American botanist from the University of Pennsylvania, John William Harshberger first used the term 'ethnobotany' in 1896 in an article entitled "The purposes of ethno-botany", while reporting his discoveries and he was the first who proposed that ethnobotany as a discipline might be developed with its own definition, objectives, scope, and methodologies. His suggestions, such as instituting ethnobotanical garden of culturally important plants, supporting interest in their names and applications, are as relevant today as they were over a century ago, but ethnobotany, as a discipline, dates back long before the term was introduced. Stephen Powers made the first effort by calling the uses of plants by Californian Indians "aboriginal botany" in 1874 and several other scientists used this term (Powers 1874; Davidson-Hunt 2000; Pardo de Santaya et al. 2010; Anderson et al. 2011; Nolan & Turner 2011).

Ethnobotany, term derived from *ethno*-, pertaining to race, people, cultural group, nation, and *botany*, the science of plants. It is a biological discipline that studies the relationship between people and plants, how people use indigenous plants in culture and religion, and involves the dynamics between human populations and plant food and medicines that have historic importance in maintaining human nutrition and health. It investigates the cultural

context of plant use and disburdens understand the ecological and biological traits of useful plants. Also, ethnobotany is very important field because it traces the development of humanity. Even ancient civilization depended on agriculture, the domestication and use of various forage, medical, fiber, and culinary plants (Nolan & Turner 2011; Tondo et al. 2015). As well as now, all people around the world are dependent on plants. Every food, medicine, cloth, fiber, fuels, and many other used materials are obtained from plants. In general, ethnobotanical knowledge can be used for helping to find solutions for global problems, such as increasing food production, developing new medicines and finding environmental conservation or management strategies (Minnis 2000). Overall, ethnobotany shares a holistic and multidisciplinary approach that is necessary for the advancement of human wellbeing on multiple spiritual-levels, nutritional, physical and emotional, what is more, ethnobotanical research helps to collect rapidly disappearing traditional knowledge about useful plants (Davidson-Hunt 2000; Nolan & Turner 2011; Vael 2015).

Ethnoecology

Ethnobotany is linked to ethnoecology that entails interpreting complex resource management strategies (Anderson et al. 2011). According to Minnis (2000), ethnoecology is the area of study which examines the ecological bases of human interactions with and relationships to the ambient environment. Knowledge of ecosystems, when investigated through traditions and customs of use, can revive resource philosophies and practices. The term ethnoecology is used to encompass all individual ethnoscience disciplines such as ethnobotany, ethnobiology, ethnopedology, ethnozoology and etc. This science explores not only how people understand the relationship between humans, animals, and plants as well as ethnobotany does, but also physical elements of a local environment. Ethnoecology evolved an emphasis on local populations with needs and problems and it is important to understand how Indigenous people manage their resources (Davidson-Hunt 2000; Anderson et al. 2011).

1.2. Wild plants and crop wild relatives

Traditional non-domesticated plant sources, shorter ‘wild plants’, are important resources supporting the livelihoods and larger economies of millions of people around the globe, but

at the same time, the harvest of wild plants is a major driver of worldwide ecosystem change. The importance of wild species harvest has declined ever since the invention of agriculture, but nevertheless, it continues to take place all over the world. Wild plants secure food, herbal medicines, low-cost building materials, fuels, a source of income and much more, especially to those people who do not have access to farmland. Wild wood species provide up to 90% of the energy needs of the rural poor in developing countries that is used for cooking and heating. Wild plants have always been used by humans. Furthermore, wild edible foods often help prevent starvation of people living in areas with poor and non-fertile soils (Pimentel et al. 1997; Cunningham 2001; Salo et al. 2014; Rigat et al. 2016). Demand for a wide variety of wild species is increasing with the growth in human needs and commercial trade. Some wild species are being over-exploited with increased awareness. Many agencies recommend wild species to be introduced into cultivation systems, it can have conservation impacts, however, this need to be better understood. For example, medicinal plant production via cultivation can reduce the extent of harvest of populations, but it also may lead to environmental degradation, loss of genetic diversity and loss of incentives to conserve wild populations.

Crop wild relatives are wild plant species genetically related to cultivated crops. Modern varieties of most of the major crops contain genes from their CWRs. Therefore, they are related to socio-economically important species including food, medicinal plants, fodder crops, forestry species, etc., as well as plants used for industrial purposes (e.g. oils, fibres, etc.). The CWRs are the source of genes for resistance to pests, diseases or tolerance to abiotic stresses like extreme temperatures and drought. They should continue to provide a source of genetic material to improve crops, enhance nutritional qualities and modify husbandry requirements under future environmental changes (Bioversity International 2006; Taylor et al. 2017). For example, fruit plants of the Kyrgyzstan such as walnut (*Juglans regia*), apple Sievers (*Malus sieversii*), Sogdian plum (*Prunus Sogdiana* Vass.) and its subspecies *Pyrus korshinskyi, P. regelii, Cerasus mahaleb, C. tianschanica, Pistacia vera, Crataegus* spp., and *Berberis oblonga*, are closely related to the walnut-fruit forests of southern Kyrgyzstan. These relatives of cultivated plants (e.g. *Malus domestica*) are the most valuable material for use in breeding cultivars in general. Unfortunately, supplies of wild plants are increasingly

limited by deforestation from logging and conversion to plantations, agriculture and pastures (Shippmann et al. 2002; SAEPF 2013).

1.3. The Kyrgyz Republic

Kyrgyzstan is a landlocked, mountainous country located in the centre of Eurasia with the capital city of Bishkek on the north. A total area is 199,951 km^2 with neighbouring countries China, Kazakhstan, Tajikistan, and Uzbekistan. Both Kyrgyz and Russian are official languages of the country. The population is around 5.5 mil., mainly Kyrgyz (73.2%), followed by Uzbeks (14.6%), Russians (9%), and others. Although 75% of people living in Kyrgyzstan are Muslims or orthodox (20%), there are still a lot of people, mostly in small villages, who believe in Manas. Manas means in Kyrgyz "God" that is a thousand years old mythical tribal leader. The main philosophical concepts and ideas in believing in Manas are about this world and the next world, about nature, the sun, water, trees, youth and old age. The majority of the population lives in the area classified as comfortable habitation that constitutes only 20% of the territory of Kyrgyzstan. Kyrgyz live nomadic life as herdsmen and horsemen, while Uzbeks are traditionally sedentary and they are rather farmers settled in one place than shepherds who travel from place to place. Around 36% of the population lives in an urban area while the vast majority lives in rural areas (64%), primary on the north and around the capital city of Bishkek, followed by Osh in the west, while the least populated area in the east, southeast in the Tien Shan mountains. More than 60% of the country is occupied by mountains, with an altitude 500-7,000 MASL. The average relief height is 2,750 MASL. Around 90% of the territory is mountainous at more than 1,500 MASL., and 41% of the territory lies in the altitude 3,000 MASL. The highest point is Jengish Chokusu at 7,439m and the lowest Kara-Daryya at 132m. The mountains of the Tien-Shan and Alai ranges dominate the country. Furthermore, these mountains also play an important role by providing fresh water to other Central Asian countries, mainly due to snow and ice which cover the crests of the high mountain ranges. The Kyrgyz Republic is one of the twenty countries with the richest water resources in the world. The Naryn and Chu rivers are of major importance to the country (GEOMIN; IPPA; BIOFOR 2001; Köçümkulkïzï 2005; Orozumbekov et al. 2009; UNESCO 2013; BussinesInfo 2018; CIA 2019; Sinor & Allworth 2019). Kyrgyzstan

is one of the poorest countries in the Europe and Central Asia region with low incomes (GDP per capita, the second poorest country in Central Asia). Among the promising sectors of the Kyrgyz economy are agriculture, energy (the country has considerable energy potential among others in the field of hydropower), the mining industry, and tourism. The economy depends on agriculture, mining and remittances from citizens working abroad. Wool, meat, and cotton are the main agricultural products, but the only cotton is exported. Other major export outputs are mercury, uranium, gold, and natural gas (BussinesInfo 2018).

Climate

Kyrgyzstan has a great distance from the ocean and the sharp elevation from adjacent plains strongly influence the climate of the country. Generally, Kyrgyzstan falls into the dry continental climate with cold winters, often frosty, and warm and sunny summers. Nevertheless, there are a number of different climatic areas on a relatively small area that is affected by altitude and position due to the surrounding large climatic regions. The presence of the non-freezing lake Issyk Kul also has an effect. Climate zones change with height. In lower altitudes, the microclimate is drier, close to the typical continental, with large differences between summer and winter. With higher altitudes, temperatures decrease, humidity increases, and temperature amplitudes decrease during and between seasons. In the west, precipitation is moderate, while the centre-east is arid. The amount of precipitation in the west and north-facing slopes increase with their altitude. The air temperature varies from -40°C in the winter to +40°C in the summer. Plains and deserts surround the country on the north, west, and southeast, making the contrast with the climate and landscape of its mountainous interior. Hot, dry winds from the deserts influence the lower parts of ranges lying in belts of high temperature (GEOMIN; IPPA; Climatetitravel 2010; Sinor & Allworth 2019).

1.3.1. Biodiversity

Kyrgyzstan is located in the southern part of the temperate zone that creates propitious conditions for all types of ecosystems from deserts to mountain tundra and contains a great wealth of biodiversity resources in terms of species, landscapes and ecosystems. In addition,

this country has great differences in altitudes, leading to a wide range of habitats, reflecting unusually high biodiversity levels. There are 20 different classes of ecosystems such as various forest types, bushes, meadows, steppes, deserts and swamps, and represented the range from high mountains to lowland fertile plains and large freshwater systems. Fauna and flora are composed of 4,000 species of vascular plants, 500 vertebrates and threatened species such as snow leopard, argali, brown bear, and etc. (Brylski et al. 2001; BIOFOR 2001). There are about 2,100 species of mushrooms, where 100 species are edible. Among the most commonly collected are *Agaricus* spp., *Lepista saeva*, *Pleurotus eringii*, *P. ostreatus*, in the south of the country, also *Morchella conica* and *Gyromitra esculenta* (Umralina; Moore 2017). The dominant ecosystem is grassland which plays an important role in the protection of mountainsides. Grassland are mainly used for grazing, hay field and for collecting mushrooms and berries, as well as medicinal plants (SAEPF 2013).

1.4. Forest ecosystems

World forests play an important role for people around the world. They maintain environmental balance, strengthen slopes, regulate runoffs and clear the air. About 62% of the total population living in rural regions obtains most of the natural resources from their local environment. Food and other necessities are secured for 200-300 million people annually from wooden and non-timber products, especially for the population in underdeveloped countries that dwell in a rural area and work and live in forest areas (Pimentel et al. 1997; SAEPF 2013). Kyrgyzstan is one of the least forested countries in Asia, but forests play an important role in the development of the economy and improvement of the environment. The forests cover around 5% of the territory but their limited quantity is compensated for by their genetic interest. Despite that small area, forests play an important role in the regulation of ground and surface sources, protecting from soil erosion, preventing from the avalanches, attracting additional and performing other significant ecosystems functions. Forests harbour a wide of genetic resources of ancient and cultivated species such as walnut, apples, pears, grapes, cherry plums, almonds and pistachios needed to breed new varieties. Forest ecosystems also provide a large number of goods and services for local people. The welfare of the majority of these people depends on forests. Main benefits of the

forests are nuts, fruits, herbs, and wood, where wood is the most exploited of these products. Wood and animal manure are important sources of energy. Timber is the main product obtained from woody plants and can be used to supply different needs of local populations, including the construction of houses, fences for land delimitation and the use as fuel. Although forests are classified as protected and harvesting is permitted only for sanitary purposes such as the risk of forest fires or to remove diseased trees, illegal logging, cutting and other types of commercial timber harvesting and cattle grazing impede to natural forests regeneration (BIOFOR 2001; Brylski et al. 2001; Abaihanova et al. 2007; Orozumbekov et al. 2009; Sakbaeva et al. 2013; SAEPF 2013; Rehnus et al. 2013). There are different types of forests, including juniper, fir, spruce-fir, walnut, maple and pistachio low forests and they are essential for the conservation of biological diversity. The spruce-fir forests, which are dominated by *Picea schrenkiana* and *Abies semenovii,* occur in the west, in the centre of the country and at higher altitudes of the ranges from 1,700 to 3,200 MASL. They prevent and reduce the severity of erosive processes, such as landslides, mud, they improve water infiltration into the soil and regulate mountain rivers. Endemic species *Salix tianshanica, Sorbus tiancshanica, S. persica* are mixed with honeysuckle and brambles. Representative animal species are red and roe deer, wolves, and bears. Next type of the forest, Juniper forests, occur on very south of the country or are dispersed in small stands in other parts of the country in very high altitudes up to 3,500m. Juniper forests play an important role in water regulation and water storage in soils and protect the ground from erosion. What more, these forests improve water infiltration and thus protect the numerous brooks and large rivers which are major waterways of Central Asia. The dominant species are *Juniperus semiglobosa, J. seravschanica* and *J. turkestanica*. Bird species are typical of the Himalayan fauna. Other forest ecosystems, dominated by aspens, willows and birches, occur along major rivers in the country. Significant undergrowth plants are *Hippophae rhamnoides* and *Berberis* spp. The last but not least forests are the walnut-fruit forests, which are located on the western and southwestern slopes of the Fergana and Chatkal mountain ridges. Forests are formed primarily by one species of *Juglans regia* L., also other of tree species are mixed with these forests such as apple, hawthorn, plum, rosehip, almond, pistachio and others (BIOFOR 2001; Orozumbekov 2009; Ramos et al. 2014). Two forms of apple population are presented in

forests – *Malus sieversii* and *Malus niedzwetzkyana*, where *M. niedzwetzkyana* is in the Red Book of Kyrgyzstan and the IUCN Red List of threatened species in category Endangered and still decreasing. These species are under threat of disappearance due to the lack of natural seed reproduction, the willful economic activity of people, a pasture of cattle, lack of protective and regeneration measures. In addition, *Malus sieversii* is a major progenitor of domesticated apple, *Malus domestica* Borkh. (BIOFOR 2001; IUCN 2007).

1.4.1. Forestry enterprises - *Leshoz*

Forests are almost all state-owned and from the unified State Forest Fund. Forest management is organized by state forest enterprises or *leshozes*. The *leshoz* were set up in the Soviet era and include both forests as well as land aside for afforestation, which is usually used as pastures for animals. It is a territorial entity and a community of people living and working in the walnut-fruit forests. *Leshoz* is responsible for implementing forest management plans and forest protection. During Soviet times, operations were dictated in a highly top-down manner, with ten-year management plans for the walnut-fruit forests. Afterwards, *Leshoz* staff had to implement them. On the contrary, contemporary *leshoz* has an amount of autonomy in the preparation of own ten-year work plan that is based on a national forest inventory. Besides, *leshozes* have legal responsibility for forest territories and their management. There were 41 *leshozes* in 2001, which employ 5,508 people, and 1,971 of whom were managerial staff financed directly from the state budget (BIOFOR 2001; Brylski et al. 2001; Carter et al. 2003; Undeland 2012). Unfortunately, according to Undeland (2012) forestry sector is inadequately funded. The wages of *leshoz* workers are below the average wages of employees in the public sector, which leads to poor motivation as well as corruption. The budgets are financed from revenues from environmental user fees and from rental agreements.

Grassland

The main sector of agriculture of the republic is livestock farming, the main source of feed in livestock is natural grassland (pastures and hayfields). Pasture ecosystems play an important role in soil formation, controlling water flow, protecting soil erosion, treating

surface pollution and preventing a flood. There are various types of grass ecosystems due to different conditions such as mid-mountain steppes and savannah, alpine and sub-alpine meadows, low mountain steppes and savannah. The high proportion of forests are used as pastures and for grazing livestock. The pasture land can be grouped for management purposes into three zones: summer pastures at elevations above 2,500 MASL, spring and fall pastures at mid-elevation, and winter pastures below 1,500 MASL. Unfortunately, pastures are under pressure and 50-70% of pastureland has already been degraded due to high average population density and excessive unregulated grazing (Brylski et al. 2001; Abaihanova et al. 2007; SAEPF 2013; Alykulova & Kochkarova 2015). Also, more than 200 medicinal herbs growing on pastures are under pressure. Excessive grazing, mowing etc. destroy stocks of valuable medicinal species. Another problem is the exploitation and undermining of stocks of one species and on the other hand, insufficient use of others. Besides, specific measures on stock regrowth are not undertaken in the country (Abaihanova et al. 2007).

1.4.2. Walnut fruit forests

The worldwide unique walnut-fruit forests represent the world's largest naturally occurring walnut forests and are characterized by a huge diversity of herbs, shrubs and trees. The forests occur in the mountains of the Fergana and the Chatkal Ranges on the southwest of the Kyrgyzstan, where they form rich cultural landscapes with a mosaic of natural and planted forest stands, pastures, drier open areas and fields. The total area of fruit trees and walnut cover is not clear, but the estimate is 40,000ha. The relief of the Fergana Range is smoother and these forests consist of Persian walnut (*Juglans regia* L.) admixed with hawthorn (*Crataegus turkestanica* A. Pojark.), apple (*Malus kirghisorum* Al. et An. Theod.), wild cherry (*Prunus mahaleb* L.) and plum (*Prunus Sogdiana* Vass.), found predominantly on north-facing slopes. Pistachio (*Pistacia vera* L.) is found on the driest patches of the lowest and driest sites, while maple (*Acer turkestanicum),* spruce (*Picea schrenkiana*) and fir (*Abies semenovii*) admixed with shrubs (e.g. *Rosa* spp.) and above-mentioned trees are found in the upper belt of the forest complex. Forests are a very important natural resource for local communities and have a long history of human utilization, what more, forests are a source of genetic resources such as wild walnut, apples, pears, grapes, plums, etc., which can

be used to develop new varieties of fruit plants. For centuries, these forests have been used primarily as agroforestry and silvopasture. Nut and firewood collection, cattle grazing and hay production are the most used practices there. Communities living close to forests use them, either as an economic mainstay or as a supplementary source of household income (Blaser et al. 1998; Beer et al 2008; Winter et al. 2009; Undeland 2012; SAEPF 2013; Agrolead 2016).

1.4.2.1. From forests to the market

People use forests for many purposes other than only timber, including for grazing animals, beekeeping, and collecting NTFPs. Nuts and fruit gathering for commercial purposes play a major role for local communities (Undeland 2012). Poor households gain most of the cash income from selling walnuts, rose hips, and apples, only a few households sell other NTFPs (Schmidt 2019). Usually, walnuts are collected from the forests and sold dry and cracked on the local market or fresh immediately after the harvest at the farm or forest gate. Unfortunately, the price at the gate is lower (100-105KGS/kg). Farmers lose the opportunity to store or process nuts and thus get a higher price, but receive compensation from heavy wet nuts. Walnuts stored and sold after 60 to 90 days lose about 25% of their weight, but their price increase. It is common for people to buy walnuts one day, crack them, and return kernels to the market the next day. Around 8,000-10,000 poor people, mostly women, are employed in Bazaar Korgon, Massy, and Jalal-Abad to crack walnuts in years of good harvests. Walnuts from small *lekshozes* are sent directly to the nearest bazaars. Cracking is done by hand and is easier to crack fresh than dry walnuts. From walnut kernels are made oil and husks are used to create a rich yellow-brown dye. The jam is created from the green walnuts. Flour made from the shell is used in the plastic industry. The timber from walnut is used for furniture and dashboards in luxury cars. The market chain of walnuts is shown in Figure 1 (Bourne 2012).

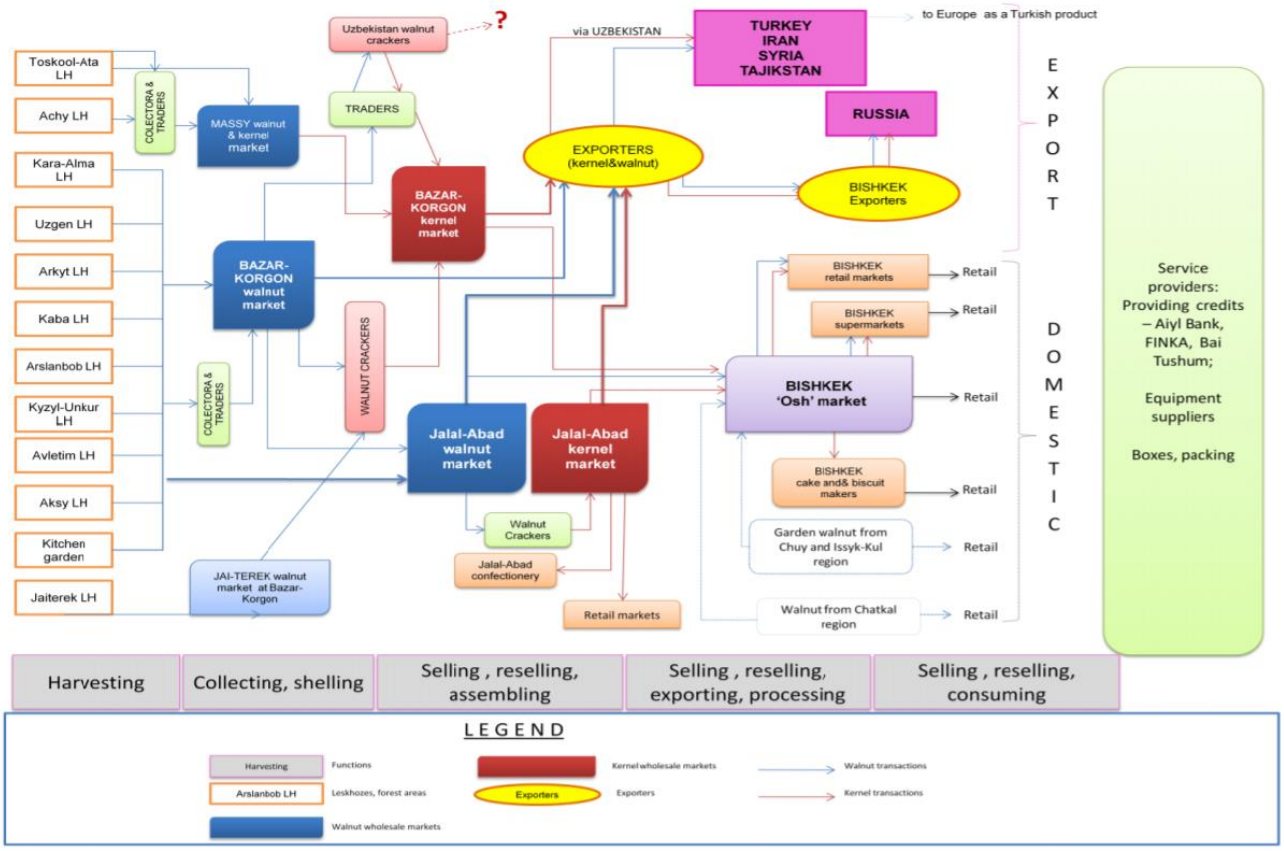

Figure 1: Summary market map for walnut and kernel value chain

(Source: Bourne W. 2012. Analysis of the Walnut Value Chain in the Kyrgyz Republic Working Paper. PROFOR, Washington D.C.)

Apples are usually sold fresh immediately after collecting, or they are cut on small pieces and sun-dried on the floor up to 15 days, or as compot mixes. In addition, dried apples are export to Turkey or Western countries, where are used mostly for fruit teas or compot, by at least two bigger companies and private entrance. In the tourist area such as Arslanbob, wild apples are processed into powder or into apple paper after boiling down and drying apples flat out in the sun (Agrolead 2016).

1.4.2.2. Land and forests degradation

Renewable natural resources are often perceived to be poorly managed and their harvest deficiently coordinated, planned, governed and regulated in many places on Earth. This

causes excessive harvesting and harmful extraction, that leads to damage in the ecological systems of which they form a part. What is then left behind are impoverished environments and exhausting resources (Salo et al. 2014). More than half forests in Kyrgyzstan have been lost in recent years, due to extensive cattle grazing, the intensive collection of firewood, nuts, and fruits. What is more, people have a habit to collect timber repeatedly from the same site in the forest, especially close to their houses, or multiple people gather different forest products on the same forest plot, it causes that the impacts of exploitation are not homogenous. The results are browsing damages, reduced natural regeneration and a loss of biodiversity. In spite of it, plantations and natural reforestation cannot compensate these losses (Abaihanova et al. 2007; Winter et al. 2009; Rehnus et al. 2013). People are not the only ones who are harmful to forests. There are pests that damage the walnut-fruit forests. One of the worst insects is the Gypsy moth (*Lymantria dispar* L.). The population of gypsy moth attacks pistachio, walnut, apple, and hawthorn trees. The larvae are defoliating large areas of the forest stands, annually. Not only forests but also pastures are lost due to intensive use, especially in autumn and spring. Overgrazing led to a significant change in the species composition of grass. The amount of non-forage and weed grasses decreased (Orozumbekov et al. 2009). According to SAEPF (2013), around 1/3 of pasture is heavily covered with toxic, non-forage and harmful plants. Loss of pasture due to weed exceeds 3 million tonnes. Pastures degradation causes the loss of unique mountain landscapes, biodiversity and the depletion of the genetical fund. What is more, erosion contributes to the irreversible process in the mountains, which is water erosion. In the report of Dzunusova (2008), the list of species exposed to the danger of disappearance includes 71 plants, which is around 1% of the total species richness of Kyrgyzstan.

2. Aims of the Thesis

The main objective of the thesis was to document diversity and traditional knowledge of wild plants used by local communities located in proximity of the walnut-fruit forests in the southwest of the Kyrgyz Republic. The specific objectives of the study were: (1) to determine the most culturally important plant species, botanical families and use categories. (2) To analyze cultural importance of crop wild relatives in the local food system (3) to identify promising underutilized plant species.

3. Methodology

3.1. Study area

The study was focused on the part of Walnut-fruit forests, which occur in spatially disconnected areas on the southwest facing slopes of the Fergana Range northeast of Jalal-Abad and on the southeast-facing slopes of the Chatkal Range. These forests lie at an altitude from 700 MASL to 2100 MASL on two isolated large massifs – Arslanbop-Kokart and Hodja-Actynckyi. The total area is not clear, but approximately 40,000 ha. The Walnut and fruit forests are consist of both naturally occurring and human-modified (grafted, planted) Persian walnut (*Juglans regia*), apples (*Malus* species), pears (*Pyrus* species), *Prunus* spp., and other fruit gathering tree species. UNESCO (2013) recognized walnut-fruit forests as a world natural heritage site. In most of regions stands of *Juglans regia* has been growing more than 1,000 years. Around 5,000 species were found, including around 183 various woody species, of which 34 are endemic to Central Asia and 16 of them are endemic to southern Kyrgyzstan. Furthermore, these species are considered to be a global significance for biodiversity conservation. Besides, they are not important only for their species diversity, but also for genetic diversity of economically important species such as walnut, apple, almond, pistachio, pear, and plum. The main source of income for about 100,000 people comes from walnut-fruit forests (BIOFOR 2001; Carter et al. 2003; Beer et al. 2008; Jalilova & Vacik 2012; Sakbaeva et al. 2013). The majority of people depending on the collection and processing of products from forests and their home gardens for their daily food consumption, and they are also the source of the revenue they receive from selling these products (Agrolead 2016). In the walnut forest was selected 5 *leshozes* with the different type of walnut-fruit forests. *Leshozes* were Kyzyl-Unkur, Salam-Alik, Arslanbob, Toskool-Ata, and Kara-Alma. The study was carried out in Kyrgyz or Russian language with mainly Kyrgyz people, next Uzbek, Kazakh, and one woman from Tatarstan.

Kyzyl-Unkur

Kyzyl-Unkur *Leshoz* is located 41°31′ N and 73°08′ E north from the Arslanbob in an elevation between 1250-1300 MASL. The population is around 5,400 in 820 families. The

walnut-fruit forests cover area 3,666 km^2 with dominant species *Juglans regia*. There are two types of forests in this area. The first is a walnut forest mixed with apple and hawthorn-tree, and the second is walnut forest with typical false bromegrass. The climate is cold and temperate. The rain falls mostly in the winter and little rain in the summer. The average temperature is 8.9 °C and the average precipitation is 541 mm (Climate-data 2012).

Salam-Alik

This village lies south of Uzgen and Jalal-Abad on 41°88′ N latitude and 73°78′ E longitude, average 1453 MASL. It is a part of *Leshoz* Uzgen. In 1150 families are around 5750 people. Among the dominant species are *Juglans regia* and *Rosa* spp. The forest is typical for false bromegrass. According to Köppen-Geiger classification, the climate is cold and temperate with the average temperature of 4.8 °C. An average annual rainfall is 550 mm that is stronger in the winter than in the summer (Climate-data 2012).

Arslanbob

The village of Arslanbob is located at the coordinates 41°32′ N and 72°95′ E in an elevation between 1400-1750 MASL. It is one of the most populated villages in *Leshoz* Arstanbab-Ata, and an area of Walnut-fruit forests, with a population around 13,179 in 3056 families. The forest is mostly used as a park, but the most common species are *Malus* spp. and *Juglans regia*, which are the main source of income for local people. According to Köppen-Geiger classification, the climate is temperate and cold. The rain falls mostly in the winter, with relatively little rain in the summer. The average temperature is 7.9 °C and the average annual rainfall is 541 mm (Climate-data 2012).

Toskool-Ata

Toskool-Ata *leshoz* is located 41°15′ N and 72°68′ E in an altitude from 700 to 3,700 MASL. Population create 301 families with 1,885 individuals. The forest of walnut cover around 1,200 ha (Bourne 2012; Turmush 2017). *Pistacia vera* is a predominant species, then *Juglans regia*, and *Malus* spp. The climate is cold and temperate. The winter is rainier than

the summer. The average temperature is 11.8 ℃. About 457 mm of precipitation falls annually (Climate-data 2012).

Kara-Alma

The coordinate systems of both village and *Leshoz* Kara-Alma are 41°22′ N; 73°33′ E and lies an average elevation 1866 MASL. The population is around 500 families and 2,500 people. The total area of the walnut forest is 4,623km^2. The type of forests is-Walnut forest with false brome grass typical. *Malus* spp. and *Juglans regia* are the most extensive species in this area. Generally, it is cold. There is more rainfall in the winter than in the summer. The average temperature is 8.4 ℃ and precipitation here averages 611 mm (Climate-data 2012).

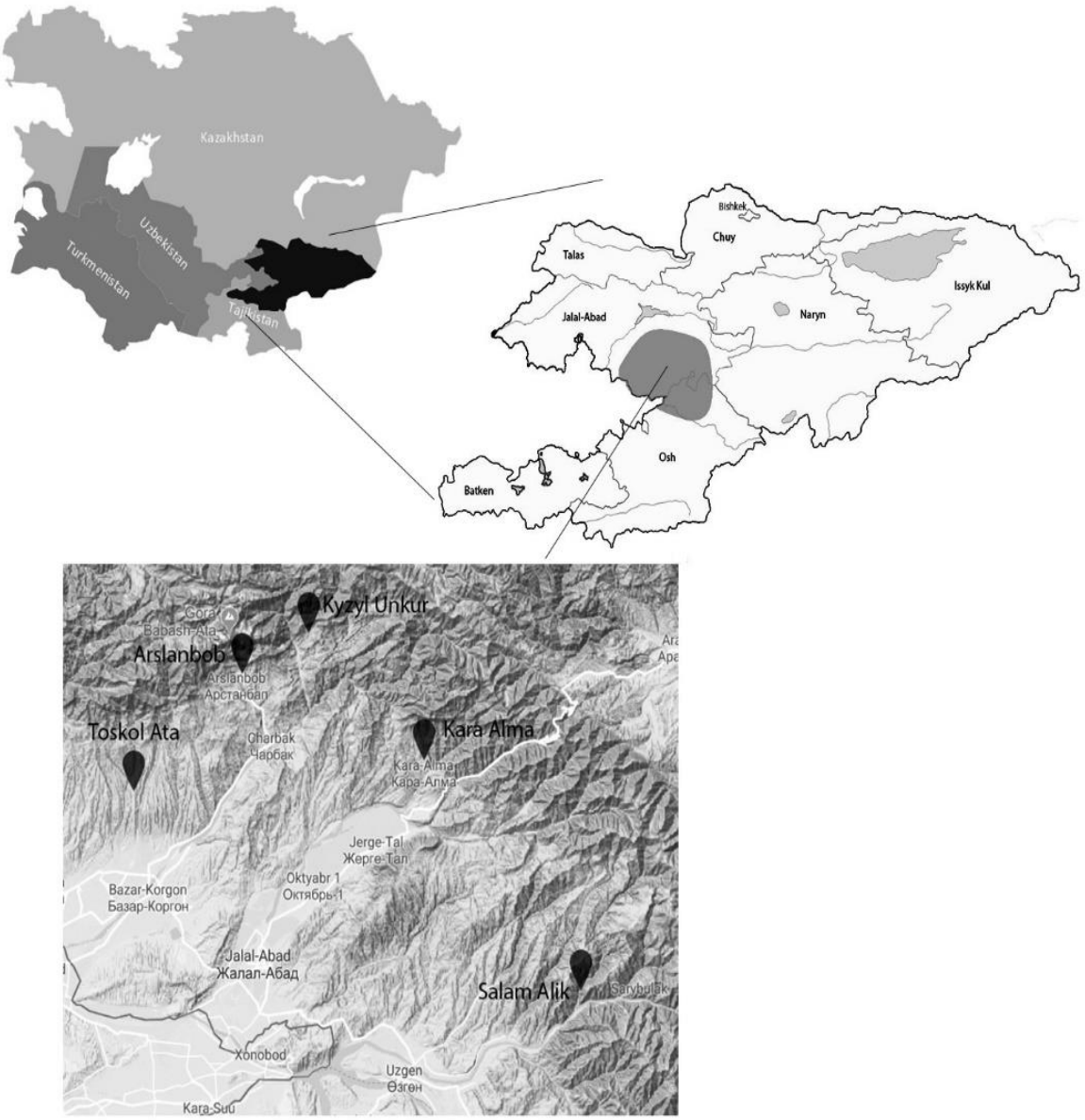

Figure 2: *Leshozes* where the study was conducted

(Source: maps.google.com and edited in Photoshop)

3.2.Data collection

Two main research methods can be distinguished in ethnobotanical research: the qualitative and quantitative method. The qualitative approach allows studying the dynamic relationship between plants and people and quantitative ethnobotany can be defined as the application of quantitative techniques to the direct analysis of contemporary plant use data (Höft et al. 1999; Vael 2015). Both qualitative and quantitative data collecting and analysis tools were used in this study.

3.2.1. Qualitative data collection

Ethnobotanical research was carried out from 26th July 2018 to 8th September 2018 in the walnut-fruit forest of Kyrgyzstan. An exploratory qualitative approach was used for documenting wild plants used as food, medicine, fuelwood, material and other purposes. The data were collected via the free listing method and semi-structured interviews with 146 respondents (61% male, 39% female) from aged 17-84 years in Kyrgyz or Russian language. Predominantly with individuals, but in some cases in a group. Each interview took 40 to 60 minutes to complete. Firstly, randomly selected informants were asked to enumerate all wild plants that they use as food, medicine, fuelwood, material and plants for other purposes, and if they collect hay for animals for winter time. Plant species were recorded in the "folk" names (it refers to how members of a language community name and categorize plants and animals). Mentioned plants were written into the questionnaires that were prepared in English and subsequently translated into Kyrgyz language by local women. The questionnaires included questions focused on information about each individual species (e.g. which part of plants they use, how they prepare them, whether fresh, dry etc., in which month is species gathered, how many kilograms per season they usually collect, how many kilometers they approximately have to go to find the species, if they sell them, where they sell them, which part is sold and what is the price of the product) and personal questions regarding their name, sex, age, education and nation. Multidimensional preference ranking technique was used to investigate the degree of scarcity, species overall importance and species economic value. Each informant was asked to rank plants based on their personal preference. It was repeated for each use category. The most important or preferred species were assigned the highest

score that depends on the number of mentioned plants, while the least preferred species was given the lowest (1). The informants were selected randomly during fieldwork, collecting hay, fruit, nuts, fishing, beekeeping and at their homes or home gardens. Also, specimens of reported species, that were possible to find and collect during this period, were collected twice during field trips and identified by botanist Adilet Usupbaev, who works for Academy of science in Bishkek. The herbal is deposited at Academy of the science of Bishkek. Most of the species were shown during field walk and my staying at 2 families. Local people showed me preparation and preservation of some plant species.

3.2.2. Quantitative analysis of data

Quantitative appraisal of the usefulness of botanical resources is important in ethnobotanical researches. Quantitative ethnobotanical data is complementary to qualitative data (Helida et al. 2015). Another important analytic tool is direct matrix ranking. This technique was used to compare the importance of species between villages from both economical and ecological sites. Besides, the quantitative results of the research were collected translated, tabulated to the Microsoft Excel table and analyzed after data collection. Main uses were sectioned into the five categories: food, medicine, fuelwood, material and feed for animals. Then, all data were analyzed by quantitative ethnobotanical indices and compared by calculating the following indices: Use report (UR), Relative frequency of citation (RFC), Use Value (UV), Cultural value index (CV).

Direct matrix ranking

This method is a variant of free listing, whereby the informants are invited to rank the plants according to their preferences. The data are used to construct a matrix, which allows attributing a score to each species and the subsequent calculation of an index (Albuquerque et al. 2014). The objective was to obtain information, which species are the most preferred by each informant. Participatory preferences ranking data collection was used for documentation these three criteria: species overall importance, species scarcity, and species economic value. The ranking was repeated for each category of use (food, medicine, firewood, material, feed) with the individual respondent.

Use report (UR)

The UR means the number of uses for each plant species. It can be described as an informant (i) mentions the use of species (s) for treatment of a use category (u). The result from the combination of these variables has been defined as a Use report and can reach the value of 1 when a combination exists or 0 when it does not (Shaheen et al. 2017).

Relative frequency of citation (RFC)

Relative frequency of citation (RFC) is a quantitative index that gives us the local importance of a species (Khan et al. 2018). According to Surjawo & Caneva (2016), RFC is the result of the frequency of citation (FC, the number of informants mentioning the use of the species) divided by the total number of informants (N).

$$RFC = FC/N$$

Use Value (UV)

UV evaluates the relative importance of each species based on its relative use among informants. It is calculated by this formula (Vitalini et al. 2013):

$$UV = \sum U_i/N$$

Where U_i is the number of uses mentioned by each informant for a given species, whereas N is the total number of informants.

Cultural value index (CV)

CV index takes into account the use categories. It is defined by the following formula (Surjawo & Caneva 2016):

$$CV = UC \times IC \times \sum IUC$$

Where UC is the total number of uses reported for a species divided by the total number of use categories. IC is the number of informants who listed a species as useful divided by the total number of informants and ∑IUC is the number of informants who mentioned each use of the species divided by the total number of informants.

The economic value of wild plants

Some species have the potential to be sold or traded and thus form part of family income. To find out which plants species are sold and have economic potential, the respondents were asked which from the mentioned species they sell, where and what is the average price.

4. Results

A total number of 146 informants (61% male, 39% female) were interviewed from five *leshozes*: Toskool-Ata (29), Salam-Alik (29), Arslanbob (28), Kyzyl-Unkur (27), Kara-Alma (33). Respondents were predominantly at the age of 46-55 years (23%), followed by 26-35 years (20%), then group 36-45 years (18%), next 56-65 years (16%), after 16-25 years (12%), 66-75 years (10%), and 76 and more years only 1%. Most of the respondents were unemployed, housewives or pensioners. According to the number of mentioned species, Figure 3 shows, the difference in knowledge of plants between *leshozes*. While in Salam-Alik were mentioned 48 species, in Arslanbob 47 species, in Kyzyl-Unkur 39 species, in Kara-Alma 36 species, and Toskool-Ata 32 species. Interviewees also noted the distance between home and places for collecting feed for animals, fuelwood, material, and gathering medicinal plants and food edible species (see Figure 3).

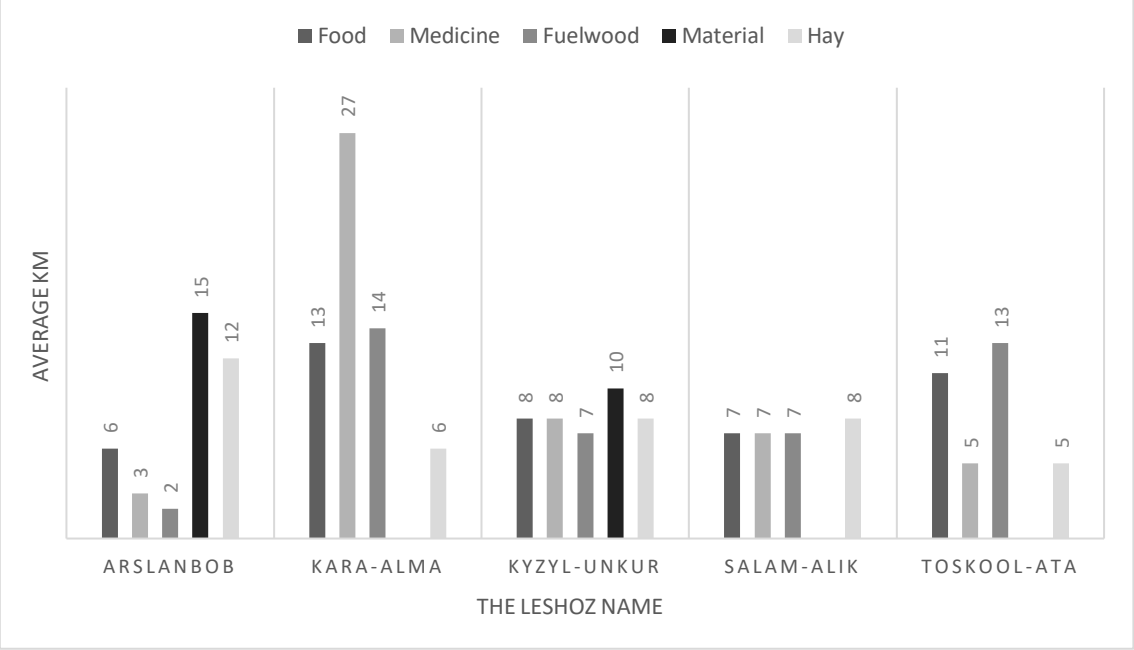

Figure 3: The average distance from home to final product

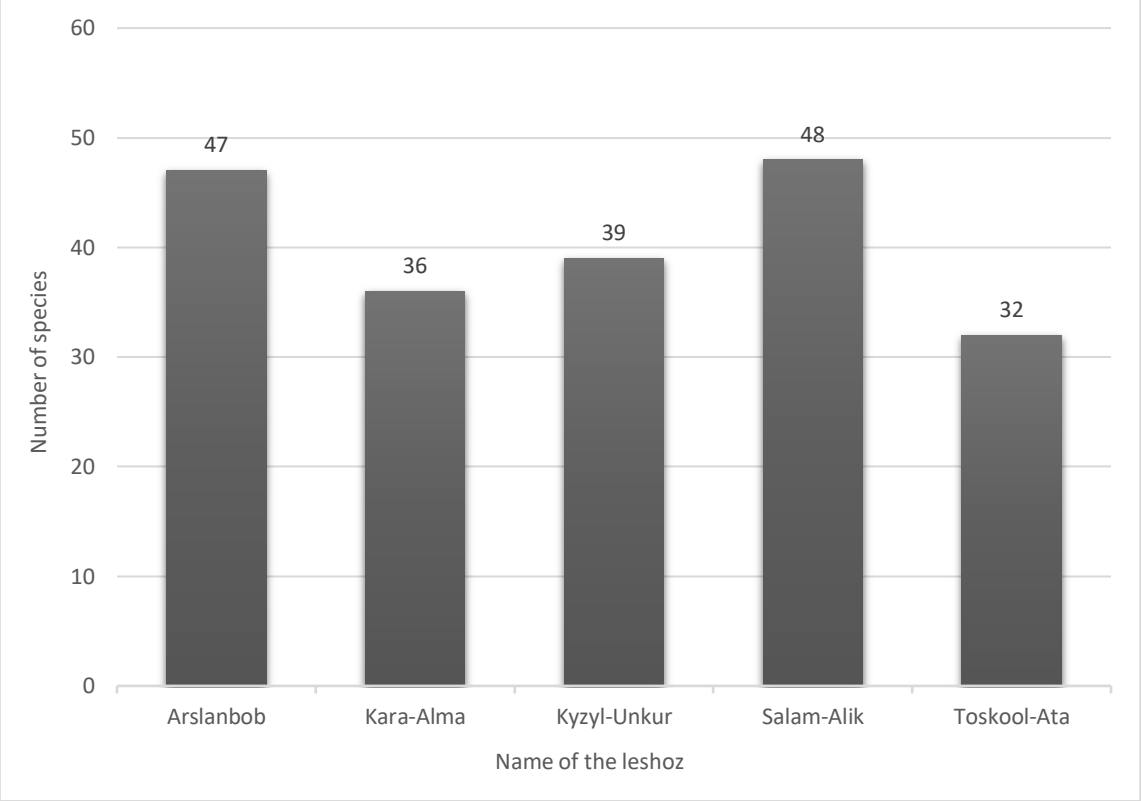

Figure 4: Number of species mentioned in all *leshozes*

A total of 88 different species belonging to 37 families were cited as being used in five categories (food, medicine, fuelwood, material, feed). In most cases, one species was mentioned to more than one use category. The most commonly represented families were Rosaceae (n=22), Asteraceae (n=9), Lamiaceae (n=6), Polygonaceae (n=4), Amaryllidaceae (n=4), Apiaceae (n=3), Salicaceae (n=3), another 30 families (Agaricaceae, Araceae, Araliaceae, Asphodelaceae, Berberidaceae, Betulaceae, Boraginaceae, Cannabaceae, Capparaceae, Caprifoliaceae, Convolvulaceae, Crassulaceae, Cupressaceae, Elaeagnaceae, Equisetaceae, Fabaceae, Fumariaceae, Grossulariadaceae, Hypericaceae, Morchellaceae, Oleaceae, Onagraceae, Pinaceae, Plantaginaceae, Poaceae, Ranunculaceae, Sapindaceae, Ulmaceae, Urticaceae and Xanthorrhoeaceae) not have mentioned more than 2 species. Medicine, food, and fuelwood were the most used categories. Medicine category, with the highest number species (n=51), was the most reported, next was food (n=39) and fuelwood

was the third (n=28). Herbaceous species were documented with the highest frequency, followed by trees and shrubs as shown in Figure 5. Some of the one folk species covered several scientific species, usually, species which are morphologically very similar, for example, Алма can be *Malus niedzwetzkyana* Dieck or *Malus sieversii* (Ledeb.) M.Roem., but local people do not see the difference between species. As well as, several folk species can refer to a single scientific species. Some species have a different name in different *leshoz*, for example, *Origanum tyttanthum* Gontsch. can be Кийик-От, Аш коку and Ак-коку.

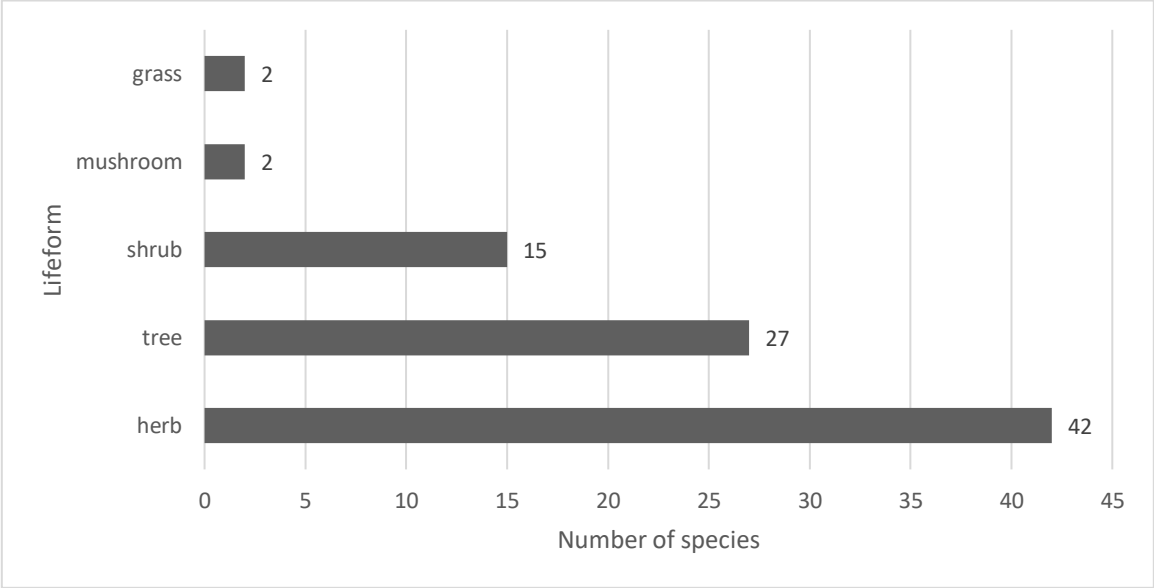

Figure 5: Representation of plant life forms

As shown in Figure 6, any crucial differences were found between the knowledge of men and women about plants and their collection. However, women's awareness of the species used as a material is higher than that of men.

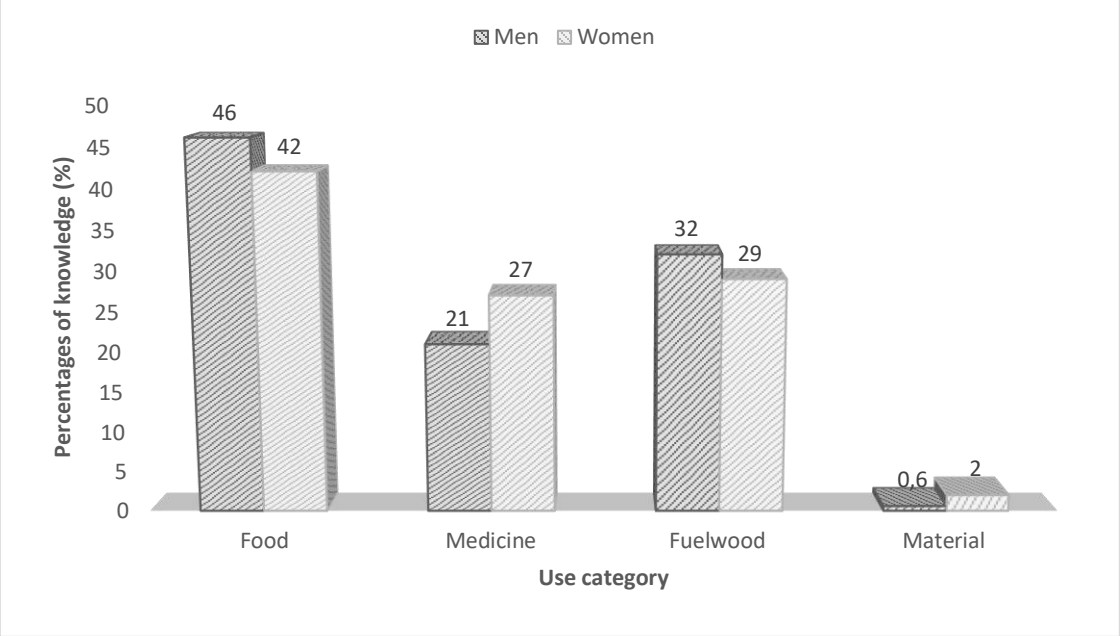

Figure 6: Comparing knowledge between men and women

When comparing knowledge between generations, it was found that the population between 36-65 years had similar results and the highest. The lowest results were observed in the generation between 26-35 years. Overall the highest knowledge had generation between 36-45 years. The young generation had surprisingly high awareness of the species.

Table 1: Demographic factors and knowledge comparison

Factor	Classification	Arslanbob	Salam-Alik	Kara-Alma	Kyzyl-Unkur	Toskool-Ata	Distribution (%)	Number of species (%)
Age	16-25	5	2	5	4	2	18 (12)	56 (16.6)
	26-35	5	8	5	7	4	29 (20)	22 (6.5)
	36-45	6	4	5	1	10	26 (18)	62 (18.4)
	46-55	5	4	12	8	5	34 (23)	60 (17.8)
	56-65	3	5	6	5	5	24 (16)	61 (18.2)
	66-75	3	6		2	2	13 (10)	49 (14.5)
	76-85	1				1	2 (1)	27 (8)
Gender	Male	15	15	18	20	21	89 (61)	78 (50)
	Female	13	14	15	7	8	57 (39)	77 (50)
Ethnicity	Kyrgyz	26	29	32	26	28	141 (97)	
	Uzbek	2	0	1	1	0	4 (2.3)	
	Tatar	0	0	0	0	1	1 (0.7)	

4.1. Quantitative ethnobotanical data

4.1.1. Direct matrix ranking

Appendices 3-7 show the results of the ranking exercises for each village. In the food category, *Juglans regia* L. had the highest ranking in all villages, followed by *Malus* spp. or *Prunus divaricata Ledeb*.. Results in the category of medicinal plants are similar but not the same. Among the best ranking species were *Origanum tyttanthum* Gotsch., *Pyrethrum partheniifolium* Willd., *Hypericum scabrum* L. and *Hypericum perforatum* L.. In the case of firewood, results are different. *Crataegus* spp. can be listed as the most mentioned species with *Acer semenovii* Regel et Herder and *Acer turkestanicum* Pax. Species used as material were mentioned only in two from the five villages. Among these species are *Populus* spp., *Crataegus* spp., *Fraxinus Sogdiana* Bunge, *Juniperus semiglobosa* Regel., *Juglans regia* L., *Malus* spp.

4.1.2. Medicinal plants

51 plant species were listed for medicinal uses. Most of them have different folk names. The herbal species predominate (35), then shrubs (7), trees (8) and grasses (2). The most represented family is Rosaceae and the most mentioned species according to Use report are *Crataegus* spp., *Rosa corymbifera* Borkh., *Origanum tyttanthum* Gontsch., *Pyrethrum partheniifolium* Willd., *Hypericum perforatum* L., *Hypericum scabrum* L., *Rubus* spp., *Mentha asiatica* Boriss., *Urtica dioica* L., *Allium* spp. and *Anaphalis racemifera* Franch. Collecting plants depends on altitude, because at lower altitudes, the growing season is longer, while at higher altitudes it is opposite.

Plant part used and preparation method

Leaves (31%) are the most frequently used parts of plants, followed by all plant parts (22%), where all parts usually mean above ground parts, then fruit (17%), flowers (12%), roots and stems with the same number of representations (8%; 8%) and branches (2%). Drying is the most used method. This method is very practical because dried parts can be used throughout the year. Dried leaves, flowers, fruits and other parts are prepared in most

cases as tea. However, these parts are prepared fresh as well, especially in summer. *Allium* spp., *Morchella esculenta*, *Polygonum aviculare* L., *Rheum maximowiczii* Losinsk., and *Rheum wittockii* Lundst. are used and preserved in salt. From *Hypericum scabrum* L., *Hypericum perforatum* L. and *Allium* spp. are made ointments. In the case of *Juniperus semiglobosa* Regel, the usage can be both medicinal and religious purposes. The cook, spice, jam are other ways of modifying that is practised.

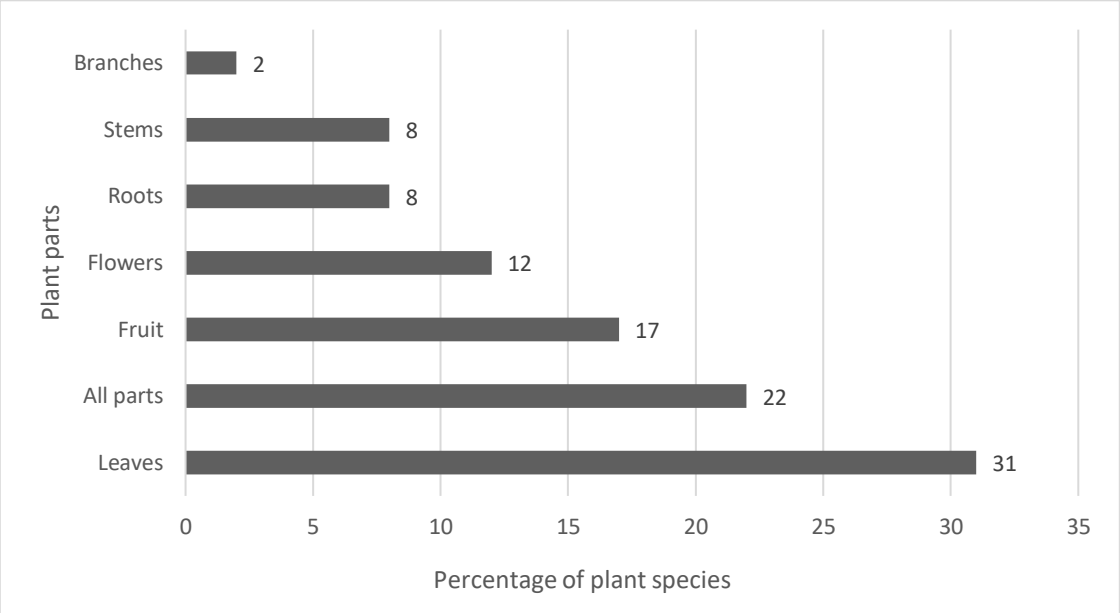

Figure 7: Proportion of plant parts used

Seasonality

Most of the plants are collected in summer months such as June (17%), July (23,5%), and August (24.5%), then May (16%), September (9%), April (7%) and October (3%). Regarding the context plant parts and month, fruits are collected at the end of summer and early autumn, while flowers and leaves are gathered at the end of spring and through the summer.

4.1.3. Species used as a food

38 folk species were identified as 39 scientific plant species used as a food. Trees and herbaceous plants are dominant life form (36%; 36%), followed by shrubs (23%) and

mushroom (5%). Rosaceae was the most common family. Among the most mentioned species are *Juglans regia* L., *Malus* spp., *Prunus divaricata* Ledeb., *Crataegus* spp., *Rosa* spp., *Origanum tyttanthum* Gontsch., *Morchella esculenta*, *Rubus caesius* L., *Berberis oblonga* (Regel) Schneid., *Mentha asiatica* Boriss. Due to poor knowledge of mushroom species, the people use only about ten of mushrooms as food in Kyrgyzstan (Umralina). What is interesting *Capparis herbacea* Willd. grows almost everywhere around *Leshoz* Toskool-Ata and near the *Leshoz* Arslanbob, but this species was mentioned by only one informant.

Plant part used and preparation method

Species are used for their fruits (56%), followed by all parts (26%), stems (9%), nuts (6%) and roots (3%). The most frequent practice of preparation is drying just parts or whole plants (33%), people also use plants fresh immediately after gathering (29%), then plants are cooked, fried, used as sauce etc. (19%), next is salting, that is used mostly for mushroom preservation (11%), fruits are usually compote (6%) and one herb is used as spice (2%).

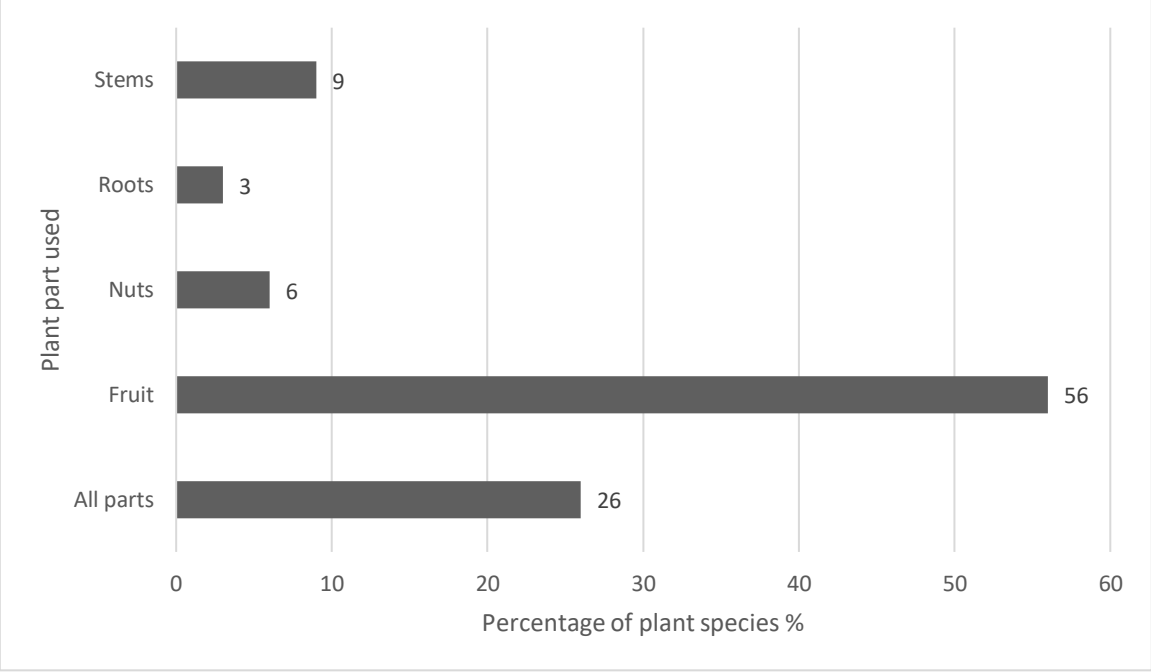

Figure 8: Proportion of plant parts used

Seasonality

Fruits are gathered at the turns of summer and autumn, predominantly in September (36%), then August (31%), October (19%), July (8%), and some late fruits on November (6%). On the contrary, stems and all parts of plants are collected at the turns of spring and summer. Months in which plants are collected the most is April (25%), in which mushrooms are collected the most, then March (19%), June and July (9%; 9%), and March with August (3%).

4.1.4. Fuelwood

Inhabitant use in a total of 28 species, 22 tree species and 6 shrub species as fuelwood. Many of these are used for medicinal or food purposes. Local people mostly collect old shrubs, cut old branches or collect dry branches on the ground, because it is forbidden to cut entire tree. Fuelwood collecting is a household activity and on an average one person visits the forest once a day to collect fuelwood. People usually use donkeys for transport branches from the forests. Fuelwood is used for various activities such as water and room heating and cooking. Fences around the plot are also done from old branches. People put branches around small trees, which prevents the cattle and other animals from biting trees. The Rosaceae family was the most frequent family. The most gather species are *Juglans regia* L., *Malus* spp., *Crataegus* spp., *Acer semenovii* Regel et Herder, *Acer turkestanicum* Pax, *Ribes janczewskii* Pojark., *Pistacia vera* L., *Populus alba* L., *Populus talassica* Kom., *Cerasus mahaleb* (L.) Mill., and *Cerasus tianschanica* Pojark.

Seasonality

Fuelwood is gathered throughout the year, but the busiest season is autumn, when people collect wood for winter. Because of snow, they would not get to the wood and if so, it would be wet.

4.1.5. Fodder

In summer, nomads use to graze their herd on mountain pastures, but in winter, low temperatures and snow forced them to descend to lower altitudes and take herd and horses with them. In the case of villages, cattle and horses are released into the mountains for the summer and in winter the animals return to their owners. Therefore, local people collect hay to feed the animals through the winter. For that reason, all informants were asked if they collect hay for animals. In Arslanbob, 20 from 28 informants collect hay, what more, some of them specify species that are used as animal feed, such as *Trifolium pratense* L., *Urtica dioica* L., *Populus* spp., *Salvia sclarea* L., *Mentha asiatica* Boriss., and *Rumex halacsyi* Rench. 24 from 33 informants collect hay and give *Allium* spp. in *Leshoz* Kara-Alma also. Kyzyl-Unkur is known for stock raising and 22 informants from 27 garner hay. Only 19 informants from 29 gather hay in *Leshoz* Salam-Alik and in Toskool-Ata 21 informants out of 29 collect feed for animals for winter.

Seasonality

Usually, meadows are mown in August and the grass is left in place to dry spontaneously few days. Then the hay is picked up and transported by trucks and stored in the attic, or it is packed into bales and stored or sold.

4.1.6. Materials

Another forest product used by local people is wood, which can be used as fuelwood as well as material such as fences, doors, windows, wall and roof filling, ceiling and roof supports (Ramos et al. 2014). Wood from trees is mostly used as a decorative element on houses, or to make dishes, especially bowls and plates. The walnut wood was used as a dashboard in the Soviet Union for cars, but nowadays, it is prohibited to cut the entire tree (Bourne 2012). 14 species used for material were *Acer* spp., *Hippophae turkestanica* (Rousi) Tzvelev, *Crataegus* spp., *Fraxinus sogdiana* Bunge, *Juglans regia* L., *Juniperus semiglobosa* Regel., *Malus* spp., *Populus* spp., and *Ulmus pumila* L., which are mainly used for construction purposes. The most represented family is Rosaceae.

Seasonality

Collecting timber for building and other non-fuelwood purposes is diverse as needed, but the most mentioned month was September.

4.2. Quantitative analyses of data

Use report (UR)

According to Use Report, the most important species are *Juglans regia* L. (259), followed by *Malus niedzwetzkyana* Dieck and *Malus sieversii* (Ledeb.) M.Roem. (239), *Prunus divaricata* Ledeb (204), *Crataegus knorringiana* Pojark., *Crataegus korolkowii* L.Henry, *Crataegus pontica* C.Koch, *Crataegus turkestanica* Pojark. (171), *Acer semenovii* Regel et Herder and *Acer turkestanicum* Pax (104), *Rosa corymbifera* Borkh and *Rosa kokanica* (Regel) Juz. (85), *Origanum tyttanthum* Gontsch. (74), *Morchella esculenta* (65), *Pyrethrum partheniifolium* Willd. (62), *Hypericum perforatum* L. (46).

Relative frequency of citation (RFC)

Results of Frequency of Citation show that the most commonly reported species are *Malus niedzwetzkyana* Dieck and *Malus sieversii* (Ledeb.) M.Roem., *Juglans regia L., Rosa corymbifera* Borkh., *Rosa kokanica* (Regel) Juz. And *Prunus divaricata* Ledeb.. The most mentioned medicinal plants were *Origanum tyttanthum* Gontsch., *Origanum tyttanthum* Gontsch., *Tripleurospermum inodorum* (L.) Sch. Bip., *Hypericum perforatum L.* and *Hypericum scabrum L.* and for firewood *Juglans regia L., Acer semenovii* Regel et Herder, *Acer turkestanicum* Pax, *Crataegus knorringiana* Pojark., *Crataegus korolkowii* L.Henry, *Crataegus turkestanica* Pojark. Also, local people collect hay for animals in winter time (74%). The field usually has one or more landlords that collect hay together.

Use value (UV)

According to use value results the highest UV scores were found in multipurpose plants species such as *Juglans regia* L., *Prunus divaricate*, *Malus* spp., and *Crataegus* spp. used in the general categories of food, medicine, firewood, and material.

Cultural value index (CV)

Among the species with the highest Cultural value index are *Juglans regia* L., *Malus* spp., *Crataegus* spp., and *Prunus divaricate* Ledeb.

4.2.1. Wild plants on the market

Local people also sell some of the species to improve their income. But only 21 species were mentioned that are sold both from home and on the market. Among these species are *Malus niedzwetzkyana* Dieck, *Malus sieversii* (Ledeb.) M. Roem., *Juglans regia* L., *Rosa corymbifera* Borkh., *Rosa kokanica* (Regel) Juz., *Morchella esculenta*, *Pistacia vera* L. and three informants also sell hay. The Table 2 shows general informations such as which parts, how many kilograms per season are sold, and for how much som (1USD=69,85 KGS; 1EUR=78,46 KGS) (XE 2019). The price depends on whether the product is fresh or dry and on the final product processing method. For example apple species are usually sold fresh at the gate to the forests or farms for price from 3-5KGS per kg, which is the similar price for dried apples as well (3-10 KGS/kg). In contrast, the price of cooked apple is between 5-50 KGS. Apples sold for seeds cultivation of new seedlings is around 8KGS. However, some species that were not mentioned were then found in local markets as shown Figures 23, 26; for example *Hippophae turkestanica* (Rousi) Tzvelev, *Juniperus semiglobosa* Regel, *Pyrus korshinskyi* Litv., *Pyrus turcomanica* Maleev, *Salvia sclarea* L., *Artemisia absinthum* L., *Chamaenerion angustifolium* (L.) Scop. Walnuts, which are considerably higher in value, apples play a smaller but apparently growing economic role (see Figure 9).

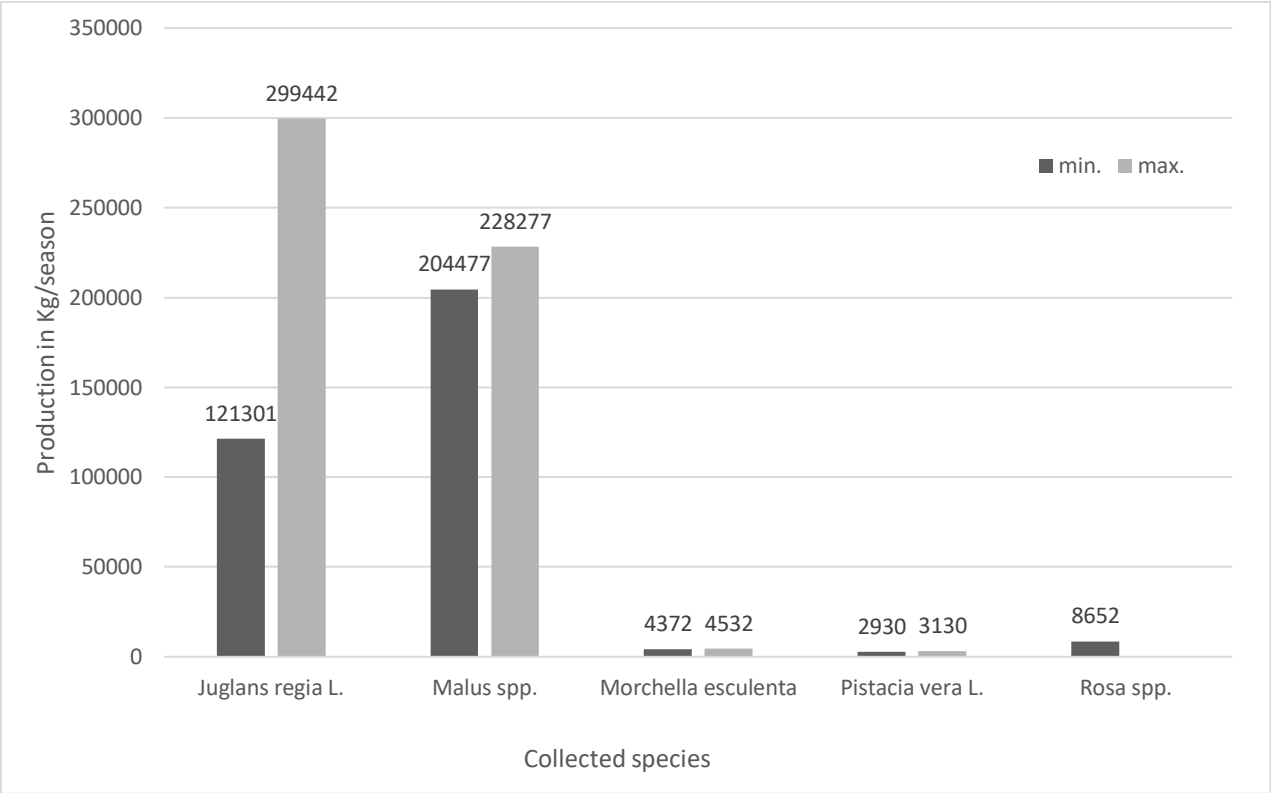

Figure 9: Table of the most collected species

Table 2: Species sold by local people, number of sellers, kilograms per season, mean price, and place

Latin name	Vernacular name	Informants	Part	Kg/season	Som/Kg	Point of sale
Achillea millefolium L.	Минжалбырак	1	Leaves	10	100	Market
Amygdalus bucharica Korsh.	Бадам	3	Fruits	1,003	min. 14	Market
					max. 20	
Berberis oblonga (Regel) Schneid.	Изирик	12	Fruits	min. 726	min. 20	Market
				max. 776	max. 100	
Capparis herbacea Willd.	Гавар	1	Fruits	300	50	Market
Crataegus knorringiana Pojark.	Долоно	10	Fruits	1,515	min. 10	Market
Crataegus korolkowii L.Henry	Сарыайбан		Wood		max. 80	Home
Crataegus pontica C.Koch	Айбансары					
Crataegus turkestanica Pojark.						
Juglans regia L.	Жангак	134	Fruits, nuts	min. 121,301	min. 30	Market
				max. 299,442	max. 200	Home
			Wood		700	
Malus niedzwetzkyana Dieck	Алма	99	Fruits	min. 204,477	min. 3	Market
Malus sieversii (Ledeb.) M.Roem.				max. 228,277	max. 50	Home
			Wood		70	
Morchella esculenta	Козукарын	48	All parts	min. 4,372	min. 80	Market
				max. 4,532	max. 200	Home
Origanum tyttanthum Gontsch.	Кийик-От	1	All parts	5	4	Home
	Ак-коку					
	Аш коку					
Pistacia vera L.	Мисте	14	Nuts	min. 2,930	min. 70	Market
				max. 3,130	max. 150	Home
Polygonum aviculare L.	Кымыздык	1	All parts	min. 15	5	Market
				max. 30		
Prunus divaricata Ledeb.	Алча	4	Fruits	610	min. 5	Market
					max. 90	
Pyrethrum partheniifolium Willd.	Ромашка	1	Leaves	10	80	Home
Rosa corymbifera Borkh.	Ит-Мурун	46	Fruits	8,642.5	min. 15	Market
Rosa kokanica (Regel) Juz.					max. 100	Home
Rubus caesius L.	Бүлдүркөн	3	Fruits	55	min. 70	Market
Rubus idaeus L.	Малина				max. 200	
Hay		3	All parts	20,25	min. 35	Home
					max. 150	

5. Discussion

5.1. Species diversity and traditional knowledge in Kyrgyzstan and neighbouring countries

The walnut-fruit forests are significant with regard to biodiversity conservation not only at the regional level but also at the global level. These forests are characterized by the dominant *Juglans regia* L. and fruit-bearing species such as *Malus* spp., *Pyrus* spp., *Crataegus* spp. and *Prunus* spp., *Rosa* spp, *Acer* spp., *Amygdalus communis*, and *Pistacia vera* L. The plant species diversity of wild plants used in the walnut-fruit forests agreed with other similar studies performed in this area (Beer et al. 2008; Jalilova & Vacik 2012; Sakbaeva et al. 2013). Based on the results of the socio-economic survey conducted by Cantarello (2014), the most important woody species for communities living in the walnut-fruit forests are *Cerasus mahaleb, Crataegus turkestanica, C. pontica, Juglans regia, Malus sieversii, M. niedzwetzkyana, Picea schrenkiana, Prunus sogdiana, Prunus communis, Pyrus communis, P. turkomanica, P. korshinskyi, Abies semenovii, Armeniaca vulgaris,* and *Betula tianschanica*, where species and genera appeared in the results obtained for our study. However, there are five more other species in Cantarello results. Whereas his study dealt with all woody species, not just those collected by local people for their personal use and the study area was northern than ours, differences in results are expected. Even though, walnuts and apples were the most collected species for commercial sale in both studies. Although, the Uzbek are farmers rather herders, the results of Khojimatov et. al. (2015) shows almost the same number of wild species (39) used as food in Uzbekistan, where 14 species and 2 genera of them are also a source of food or fuelwood in the walnut-fruit forests. The way of use and used parts are different in some species. While *Sorbus tianschanica* Rupr. is a source of food in Uzbekistan, in our study was mentioned only as a source of fuelwood. According to Khojimatov et al. (2015), the data represents less than 10% of the plants which are used as food in Uzbekistan. The species diversity of Central Asia is very similar. The following species in our study *Rosa* spp., *Origanum* spp., *Artemisia* spp., *Crataegus* spp., *Hippophae rhamnoides, Urtica dioica, Valeriana* spp., *Berberis* spp., apple, apricot, thyme, almonds are used for wood and non-wood forests products in Uzbekistan, Kazakhstan, Tajikistan,

Turkmenistan, and other parts of Kyrgyzstan according to the thematic study of CAREC (2006). Local communities in the high Pamir Mountains of Tajikistan highly depend on natural resources to sustain their livelihoods. Maintaining traditional knowledge and community-sourced production systems are among the most important actions that can be done for future generations for preserving biodiversity (Foggin et al. 2018). In accordance with Jalilova & Vacik (2012), people have clear and positive intentions for the conservation of biodiversity. Despite their intentions, people will be unable to reduce their impact on forest resources in the future due to the lack of alternative resources for their immediate needs, such as energy for their daily survival.

5.2. NTFPs from the walnut-fruit forests and their commercial use

Collecting nuts and fruits play a major role as the main source of income and consumption (Agrolead 2016). Schmidt (2005) said, walnuts, apples, and rose hips are the most collected species, which corresponds with our results. Economically, the local people collect more rosehips than pistachio per season, but the economic value is lower. While other studies (Dzunusova 2008; SAEPF 2013) were mainly focused on *Juglans regia* L., *Malus* spp., and *Pistacia vera* L. as the most harvested species for the cash income of local communities, according to Uzakbaev (2018) and our study the important species was also *Morchella esculenta*. In walnut-fruit forests are around 66 fungi species. In spite of it, people collect just a few species due to lack of information and poor knowledge (Umralina; Fet 2007). Sale of walnuts in one of the main sources of income for people living near or in the walnut-fruit forests (Cantarello et al. 2014). The population in Tajikistan collects non-wood forest production presented by Persian walnut, a pistachio nut, apples, pears, plum, dog roses, medicinal plants, etc. (CAREC 2006), which are the same plant species as are collected from the walnut-fruit forests in Kyrgyzstan. According to Agrolead (2016) wild apples present a small share of income for forest users, what not corresponded with our results. It has been reported that apples, despite their low price, make up the second largest share of local people's income. The results regarding the price of apples and the processing methods are similar, but not the same. Fresh apples are sold at the gate to the forests or farms for 2KGS, where apples are sold for 3-5KGS under the same conditions in our research. The one reason can be

responsible for this contrast. There is a 2-year range between studies. As a result, price increases can be seen. But the conditions of collecting fruits are the same. Entire families go to the forest area, collect apples and bring them home for storage or sell on markets or farms. On the other side, the study of Agrolead (2016) shows that dried apples are sold for 25-30KGS per kg, but according to our research, dried apples are sold for the similar price as fresh apples (3-10KGS). Besides, The Union for Ethical Bio Trade and UTZ Certified with Agrolead (2016) developed the program, which goal is to build the more sustainable supply chain and focus on biodiversity questions such as the use of pesticides, good agriculture, and long-term survival of biodiversity. But the main problem is biodiversity degradation and forests resources, which are the main source of local people's income, and most of the walnut-fruit studies agree.

5.3.Medicinal plants

There are more than 200 species of medicinal plants in Kyrgyzstan. The most valuable species are *Thalictrum foetidum, A. karacolicum, Inula macrophylla, Leonurus turkestanicus, Thermopsis turkestanica, Hypericum perforatum, Tussilago farfara, Origanum vulgare, Hippophae rhamnoides, Ephedra equisetina, and Veratrum lobelianum* (BIOFOR 2001), where some of these species appeared in this study. We documented 51 species used for medicinal purposes. Five of them exist in the paperwork of BIOFOR (2001) and 21 species are in the study of Pawera (2014), but there was a difference in the folk names, used parts, and in the mode of application in some species. For example, while nuts and fruits of *Juglans regia* L. were mentioned in this study, according to Pawera (2014) parts used as medicine were leaves. These contrast can be due to the different study area. In the Pamir Mountains of Afganistan and Tajikistan, a survey has been done by Kassam (2010) documented 58 different medicinal plant species. The main medicinal plants in the area are *Mentha* spp., *Crataegus* spp., and *Malus* spp. 27 species and genera, including those already mentioned, are also collected in the walnut-fruit forests primary also for medicinal or food purposes. On the contrary, another study in Tajikistan done by Sharopov (2015) shows 18 aromatic plants useful in traditional medicine. Nine of them are also used by our informants, such as *Hypericum* spp., *Melissa officinalis* L., *Origanum tytthantum* Gontsch., *Salvia*

sclarea L., etc. However, traditional use is different. While in Tajikistan they use these plants as aromatic oils, in our study is mostly used as a tea. People in Tajikistan collects the medicinal grasses, for own needs, but the statistics are absent (CAREC 2006). 15 species and 8 genera exist in the study of folk medicine in Uzbekistan conducted by Sezik (2004). There are small differences in case of used part, for example, the root of *Arum korolkowii* Regel. is used in Uzbekistan, while local people from walnut forests use the root but also flowers. The leaves of *Achillea millefolium* L. were mentioned in our study as used part, the flowers have been mentioned by Sezik (2004). The study area, where the data were obtained is located near the borders of Uzbekistan and Kyrgyzstan, where are also located the walnut-fruit forests. People in Tajikistan collects the medicinal grasses, for own needs, but the statistics are absent (CAREC 2006).

5.4.Degradation

Mainly food systems in the mountains are deeply reliant on ecosystem services, and any loss of biodiversity can exacerbate environmental degradation, diminishing nutrition security. Local people may be aware of the benefits of the diversity of crops and livestock. Unfortunately, urban markets from more far distances generally prioritize attributes such as appearance and durability, which can lead to the replacement of traditional wild relative species with introduced varieties (Foggin 2018). The walnut-fruit forests decrease almost by half in the first half of the last century due to unsystematic trees felling, overgrazing, and a mass fruit picking (CAREC 2006). An intensive collection of walnuts for consumption or sale in markets may account for observed regeneration failures of walnut. Other potential factors include haymaking and overgrazing by forest livestock (Cantarello et al. 2014). High level of corruption, illegal logging, and insufficient funding for the forestry sector can cause poor forest management and this can lead to forest degradation due to uncontrolled NTFPs and wood collection and grazing, as mentioned by Undeland (2012). Many studies solve the same problem and that is the forest degradation. The problems are several years old and have an impact on both local people in terms of decreasing sources, above all, on the local ecosystem. The problems, mentioned above, were also observed during the data collection for our study. It was very difficult to find seedling in the forests that we visited for sampling

and data collection. Species that are useful to humans and a source for animals have mostly been replaced by species that neither use. We have also observed major damage to trees, especially pistachios, which were most likely attacked by Gypsy moth. The insect was in the larval phase. Trees were damaged as describe Orozumbekov (2009). According to Uzakbaev (2018) one farmer, who rented a forest plot also mentioned the problem with this insect and take care of trees by collecting the eggs of the Gypsy moths. He mentioned that the insect attack primary apples and walnut trees. According to CAREC (2006) the cooperation between Kyrgyzstan and other countries for the walnut-fruit forests sustainability existed and still exist. For example, successful international projects are the Kyrgyz-swiss program of support of wood, UNDP programs, and project GURTs on the basis of which it was established National Center for testing varieties and genetic resources genetics bank for storage of genetic resources. An expedition to collect wild relatives of cultivated plants such as almonds Petunnikoff, Nedzvetski and Sievers apples, Korzhinskii pears, and species of tulips (SAEPF 2013). Studies conducted in Europe have shown that walnut fruit, timber and intercropping production can be increased by various agroforestry activities and that over time the income of the farmers increased (Magagnotti et al. 2011).

It is important to make some remarks that should keep in mind during further studies. It was very difficult to find and collect some herbaceous species due to the season in which the study was conducted, but on the other hand, most of the fruits species were matured at this time. My recommendation is to go back for a longer period. The best time for collecting data and herbary is from April of August. After trying to explore the resources available for the walnut-fruit forests, we were not able to find a comparable ethnobotanical study. Owing to forest degradation, it is important to map out which species are of great importance to the local population and to focus on these species.

5. Conclusion

This study registered a high dependence on collecting wild fruits, nuts, herbs, and wood, which are an integral everyday part of communities living in or near the walnut-fruit forests. Primarily fruits and nuts are important as a source of income and for the daily needs of the locals. The deadwood and dry branches from the forests are necessary for cooking, cleaning the water, and heating. The study documented traditional uses of 88 plant species reported by 146 informants. Ethnobotanical inventories were performed in five *leshozes* namely Arslanbob, Salam-Alik, Toskool-Ata, Kyzyl-Unkur, and Kara-Alma, lying in the part of Walnut-fruit forests in the Fergana Range. The specimen of documented plant species and families corresponds with studies, that where conducted in the neighbouring countries such as Uzbekistan, Kazakhstan, and Tajikistan, particularly with regard to the type of use. The traditional knowledge between *leshozes* was overall similar, nevertheless the most homogenous was in the *leshoz* Salam-Alik. There was no fundamental difference in knowledge between generations. Rosaceae, Asteraceae, Lamiaceae, and Polygonaceae were the most frequent families, herbaceous species were confirmed as a most common plant life form. Among the most important species from both ecological and economic standpoint are *Juglans regia* L., *Malus niedwetzkyana* Dieck, *Malus sieversii* (Ledeb) M. Roem, *Morchella esculenta*, *Rosa corymbifera* Borkh., *Rosa kokanica* (Regel) Juz., and *Pistacia vera* L. As well as medicine and food categories were the most important use categories. The majority of medicinal plants are also used for food. Distinguishing between the use of plants for food and medicine may be misleading. During the research, it was found that the walnut and apples are important to local people by being important as a main source of income. However, an intensive collection of these products with overgrazing and haymaking cause the degradation of the forests and thus important plant species which are important as source of genetic resources. It has an impact on both decreasing sources for local people and also lost of this unique biodiversity. In addition, the results show one species (*Capparis herbaceae*) which could have a potential economic value and can be used as a source of food for local communities. The study should be performed to evaluate economic value and health benefits of this species.

6. References

Abaihanova Z, et al. 2007. Kyrgyzstan-Environment and Natural Resources for Sustainable Development. Pages 85 in Shkurov E, Makeev T, Koshoev M, editors. UNDP, Bishkek.

Agrolead. 2016. Baseline study on wild apple collectors in Kyrgyzstan UEBT/UTZ Certified Herbal Tea Program. Bishkek.

Albuquerque UP, Cruz da Cunha LVF, Paiva de Lucena RF, Alves RRN. 2014. Methods and Techniques in Ethnobiology and Ethnoecology. Pages 480 in Albuquerque UP, Cruz da Cunha LVF, Paiva de Lucena RF, Alves RRN, editors. Humana Press, New York.

Alykulova K, Kochkarova I. 2015. Community-based Walnut Forest and Pasture Management in Southern Kyrgyzstan. Bishkek.

Anderson EN, Pearsall DM, Hunn ES, Turner NJ, Ford RI. 2011. Ethnobiology. Pages 420 in Anderson EN, Pearsall DM, Hunn ES, Turner NJ, editors. Wiley-Blackwell, New Jersey.

Beer R, Kaiser F, Schmidt K, Ammann B, Carraro G, Grisa E, Tinner W. 2008. Vegetation history of the walnut forests in Kyrgyzstan (Central Asia): natural or anthropogenic origin?. Quaternary Science Reviews **27**:621-632.

BIOFOR (Biodiversity & Sustainable Forestry IQC). 2001. Biodiversity Assessment for Kyrgyzstan. Washington, D.C

Bioversity International. 2006. Crop wild relatives. Bioversity International, Rome.

Blaser J, Carter J, Gilmour DA. 1998. Biodiversity and sustainable use of Kyrgyzstan's walnut-fruit forests: proceedings of the seminar, Arslanbob, Dzalal-abab Oblast, Kyrgyzstan. Pages 182 in Venglovsky B, Yunossova I, Blaser J, Carter J, Gilmour D, editors. IUCN, Switzerland.

Bourne W. 2012. Analysis of the Walnut Value Chain in the Kyrgyz Republic Working Paper. PROFOR, Washington D.C.

Brylski P, Veen TS, Eliste P. 2001. Kyrgyz Republic Mountain Rangeland and Forest Sector Note. ECSSD Environmentally and Socially Sustainable Development Working Paper No: 33. World Bank, Washington, D.C.

BussinesInfo. 2018. BussinesInfo.cz. CzechTrade, Praha. Available from https://www.businessinfo.cz (accessed March 2019).

Cantarello E, Lovegrove A, Orozumbekov A, Birch J, Brouwers N, Newton AC. 2014. Human Impacts on Forest Biodiversity in Protected Walnut-Fruit Forests in Kyrgyzstan. Journal of Sustainable Forestry **33**:454-481.

CAREC. 2006. Non Wood Forest Products in Central Asia and Caucasus. Rome.

Carter J, Steenhof B, Haldimann E, Akenshaev N. 2003. Collaborative Forest Management in Kyrgyzstan: Moving From Top-Down to Bottom-Up Decision-Making. Gatekeeper Series No. 108. Russell Press, Nottingham.

CIA. 2019. Central Asia: Kyrgyzstan. Available from https://www.cia.gov (accessed February 2019).

Climate-data. 2012. Climate: Kyrgyzstan. Available from https://en.climate-data.org (accessed February 2019).

Climatestotravel. 2010. Climate: Kyrgyzstan. Available from https://www.climatestotravel.com (accessed March 2019).

Cunningham AB. 2001. Applied ethnobotany: people, wild plant use, and conservation. Earthscan. London.

Davidson-Hunt I. 2000. Ecological Ethnobotany: Stumbling Toward New Practices and Paradigms. MASA Journal **16**:1-13.

Dzunusova M. 2008. COUNTRY REPORT ON THE STATE OF PLANT GENETIC RESOURCES FOR FOOD AND AGRICULTURE. FAO, Bishkek.

Fet GN. 2007. Satellite Image Processing for Biodiversity Conseration and Environmental Modeling in Kyrgyzstan Republic National Park. [Dissertations and Capstones Theses]. Marshall University, West Virginia.

Foggin M, Emslie-Smith M, Hergarten C. 2018. Food Systems and Agrobiodiversity in the Mountains of Central Asia. Mountain Research and Development **38**:175-179.

GEOMIN s.r.o. Kyrgyzstán. Available from https://www.geominprojects.com (accessed March 2019).

Helida A, Zuhud EAM, Hardjanto H, Purwanto Y, Hikmat A. 2015. Index of Cultural Significance as a Potential Tool for Conservation of Plants Diversity by Communities in the Kerinci Seblat National Park. Journal of Tropical Forest Management **21**:192-201.

Höft M, Barik SK, Lykke AM. 1999. Quantitative Ethnobotany - Applications of multivariate and statistical analyses in ethnobotany. Pages 47 in Höft R, editor. UNESCO, Paris.

IPPA (Investment promotion and protection agency of the Kyrgyz republic). About Kyrgyzstan/general information. Available from: http://invest.gov.kg/en (accessed March 2019).

IUCN. 2007. *Malus niedzwetzkyana*. IUCN Red List of Threatened Species. Version 2007, Bishkek. Available from: https://www.iucnredlist.org (accessed March 2019).

Jalilova G, Vacik H. 2012. Local people's perceptions of forest biodiversity in the walnut fruit forests of Kyrgyzstan. International Journal of Biodiversity Science, Ecosystem Services & Management **8**:204-216.

Kassam KA, Karamkhudoeva M, Ruelle M, Baumflek M. 2010. Medicinal Plant Use and Health Sovereignty. Human Ecology **38**:817-829.

Khan M, Ahmad L, Rashid W. 2018. Ethnobotanical Documentation of Traditional Knowledge about Medicinal Plants used by Indigenous People in Talash Valley of Dir Lower, Northern Pakistan. Journal of Intercultural Ethnopharmacology **7**:8-24.

Khojimatov OK, Abdiniyazova GJ, Pak VV. 2015. Some wild growing plants in traditional foods of Uzbekistan. Journal of Ethnic Foods **2**:25-28.

Köçümkulkïzï E. 2005. The Kyrgyz Epic Manas. Available from http://www.silkroadfoundation.org (accessed March 2019).

Magagnotti N, Nati C, Picchi G, Spinelli R. 2011. Mechanized thinning of walnut plantations established on ex-arable land. Agroforestry Systems **82**:77-86.

Martin GJ. 2004. Ethnobotany: a methods manual. Earthscan. Sterling.

Minnis PE. c2000. Ethnobotany: a reader. University of Oklahoma Press. Norman.

Moore D. 2017. Kyrgyz Express Post: Edible Mushrooms of Kyrgyzstan. Available from http://www.davidmoore.org.uk (accessed April 2019.

Nolan JM, Turner NJ. 2011. Ethnobotany: The Study of People-Plant Relationships. Pages 133-147 in Anderson EN, Pearsall D, Hunn E, Turner N, editors. Ethnobiology. Wiley-Blackwell, New Jersey.

Orozumbekov A, Musuraliev T, Toktoraliev B, Kysanov A, Shamshiev B, Sultangaziev O. 2009. Forest Rehabilitation in Kyrgyzstan. Keep Asia Green **4**:131-182.

Pardo de Santaya M, Pieroni A, Puri RK. 2010. The ethnobotany of Europe, past and present. Pages 1-15 in Pardo de Santayana M, Rajinda K, editors. Ethnobotany in the New Europe. People, Health and Wild Plant Resources. Bergham Books, Oxford.

Pawera L, Verner V, Termote C, Sodombekov I, Kandakov A, Karabaev N, et al. Medical ethnobotany of herbal practitioners in the Turkestan Range, southwestern Kyrgyzstan. Acta Soc Bot Pol. **85**:3483.

Pimentel D, McNair M, Buck L, Pimentel M, Kamil J. 1997. Tha Value of Forests to World Food Security. Human Ecology **25**:91-120

Powers S. 1874. Aboriginal botany. Proc. Calif. Acad. Sci. 1874 **5**:373-379.

Ramos MA, de Medeiros PM, Albuquerque UP, Ramos M, Santos L, Albuquerque U. 2014. Methods and Techniques Applied to Ethnobotanical Studies of Timber Resources. Methods and Techniques in Ethnobiology and Ethnoecology **10**:349-365.

Rehnus M, Mamadzhanov D, Venglovsky BI, Sorg J-P. 2013. The importance of agroforestry hay and walnut production in the walnut-fruit forests of southern Kyrgyzstan. Agroforestry Systems **87**:1-12.

Rigat M, Gras A, D'Ambrosio U, Garnatje T, Parada M, Vallès J. 2016. Wild food plants and minor crops in the Ripollès district (Catalonia, Iberian Peninsula): potentialities for developing a local production, consumption and exchange program. Journal of Ethnobiology and Ethnomedicine **12**:12-49.

SAEPF (State Agency on Environment Protection and Forestry). 2013. FIFTH NATIONAL REPORT ON CONSERVATION OF BIODIVERSITY OF THE KYRGYZ REPUBLIC. UNEP, Bishkek.

Sakbaeva Z, Schroetter S, Karabaev N, Avazov A, Rogasik J, Schnug E. 2013. Soils of nut-fruit forests in southern Kyrgyzstan - important ecosystems worthy of protection. Landbauforschung Volkenrode **63**:93-102.

Salo M, Sirén A, Kalliola R. 2014. Diagnosing wild species harvest: resource use and conservation. Elsevier, Boston.

Shaheen H, Qureshi R, Qaseem MF, Amjad MS, Bruschi P. 2017. The cultural importance of indices: A comparative analysis based on the useful wild plants of Noorpur Thal Punjab, Pakistan. European Journal of Integrative Medicine **12**:27-34.

Sharopov F, Zhang H, Wink M, Setzer W. 2015. Aromatic Medicinal Plants from Tajikistan (Central Asia). Medicines **2**:28-46

Shippmann U, Leaman DJ, Cunningham AB. 2002. Impact of Cultivation and Gathering of Medicinal Plants on Biodiversity: Global Trends and Issues. Pages 142-167 in FAO, editor. Biodiversity and the Ecosystem Approach in Agriculture, Forestry and Fisheries. FAO, Italy.

Schmidt K. 2005. NTFPs and Poverty Alleviation in Kyrgyzstan: Potential and Critical Issues. Pages 28-29 in Pfund JL, Robinson P, Sorg JP, Felber R, Mauderli U, editors. Non-Timber Forest Products between poverty alleviation and market forces. Intercooperation, Bern.

Sinor D, Allworth E. 2019. Kyrgyzstan. Encyclopaedia Britannica. Chicago. Available from https://www.britannica.com (accessed March 2019).

Surjawo W, Caneva G. 2016. Using quantitative indices to evaluate the cultural importance of food and nutraceutical plants: Comparative data from the Island of Bali (Indonesia). Journal of Cultural Heritage **18**:342-348.

Taylor NG, Shelagh PK, Holubec V, Parra-Quijano M, Chobot K, Maxted N, Fischer J. 2017. A systematic conservation strategy for crop wild relatives in the Czech Republic. *Diversity and Distributions* **23**:448-462.

Tondo JE, Silverio ADP, Bawer MC, Evangelista L, Santos L, Albuquerque U. 2015. Ethnobotany of Lubuagan: Household materials and Ornaments. Pacific Science Review B: Humanities and Social Sciences **1**:104-107.

Turmush. 2017. Жалал-Абаддагы Тоскоол-Ата токой чарбасында малак курттар кескин көбөйүп кетти *(фото)*. Available from https://www.turmush.kg/news:319896 (accessed April 2019).

Umralina AR., Prikhodko SL, Mosolova SN, Fet GN. MUSHROOM BIOTECHNOLOGY EDUCATION FOR SUSTAINABLE DEVELOPMENT IN KYRGYZSTAN.

Undeland A. 2012. The Development Potential of Forests in the Kyrgyz Republic. Washington, DC

UNESCO. 2013. UNESCO country programming document: Republic of Kyrgyzstan, 2012-2013. Pages 33 in UNESCO - Relations with Member States, Kazakhstan.

Uzakbaev CH. 2018. Traditional Kyrgyz walnut-apple forests provide map for sustainable future. Available from news.mongabay.com (accessed April 2019).

Vael L. 2015. Ethnobotanical study of the plant use in the natural landscape of two mestizo communities in the Ucayali region of the Peruvian Amazon. [MSc. Thesis]. University Gent, Gent.

Vitalini S, Iriti M, Puricelli C, Ciuchi D, Segale A, Fico G. 2013. Traditional knowledge on medicinal and food plants used in Val San Giacomo (Sondrio, Italy)—An alpine ethnobotanical study. Journal of Ethnopharmacology **145**:517-529.

Winter MB, Wolff B, Gottschling H, Cherubini P. 2009. The impact of climate on radial growth and nut production of Persian walnut (Juglans regia L.) in Southern Kyrgyzstan. European Journal of Forest Research **128**:531-542.

XE. 2019. XE Currency Converter. Available at https://www.xe.com (accessed April 2019).

Annex A

Appendix 1: Quantitative data analysis

Family	Latin name	UR (1)	RFC (2)	UV (3)	CV (4)
Sapindaceae	*Acer semenovii* Regel et Herder	104	0.65	0.712	0.17
Sapindaceae	*Acer turkestanicum* Pax				
Ranunculaceae	*Aconitum rotundifolium* Kar et Kir	6	0.04	0.04	0.00032
Agaricaceae	*Agaricus campestris* L.	4	0.027	0.027	0.0002
Asteraceae	*Achillea millefolium* L.	9	0.062	0.062	0.008
Amaryllidaceae	*Allium caeruleum* Pall.	24	0.144	0.16	0.15
Amaryllidaceae	*Allium longicuspis* Regel				
Amaryllidaceae	*Allium sativum*				
Rosaceae	*Amygdalus bucharica* Korsh.	9	0.062	0.063	0.011
Asteraceae	*Anaphalis racemifera* Franch.	21	0.144	0.14	0.004
Asteraceae	*Arctium tomentosum* Mill.	1	0.007	0.0069	0.00001
Rosaceae	*Armeniaca vulgaris* Lam.	6	0.041	0.041	0.0003
Asteraceae	*Artemisia absinthium* L.	21	0.144	0.14	0.008
Araceae	*Arum korolkowii* Regel	2	0.014	0.014	0.00004
Berberidaceae	*Berberis oblonga* (Regel) Schneid.	39	0.267	0.27	0.03
Betulaceae	*Betula pendula*	8	0.055	0.055	0.001
Capparaceae	*Capparis herbacea* Willd.	2	0.014	0.0137	0.00004
Fabaceae	*Caragana alaica* Pojark.	2	0.014	0.014	0.006
Grossulariadaceae	Ribes janczewskii Pojark.	40	0.274	0.27	0.034
Cannabaceae	*Celtis caucasica* Willd.	8	0.055	0.27	0.0006
Rosaceae	*Cerasus mahaleb* (L.) Mill.	15	0.103	0.1	0.006
Rosaceae	*Cerasus tianschanica* Pojark.				
Crassulaceae	*Clementsia semenovii* (Regel et Herder) Boriss.	13	0.089	0.089	0.0016
Apiaceae	*Conioselinum tataricum* Fisch. ex Hoffin.	1	0.007	0.0069	0.00001
Convolvulaceae	*Convolvulus arvensis* L.	1	0.007	0.0069	0.00001
Fumariaceae	*Corydalis gortschakovii* Schrenk	1	0.007	0.0069	0.00001
Rosaceae	*Cotoneaster integerrimus* Medik.	9	0.062	0.62	0.0007
Rosaceae	*Crataegus knorringiana* Pojark.	171	0.733	1.112	0.96
Rosaceae	*Crataegus korolkowii* L.Henry				
Rosaceae	*Crataegus pontica* C.Koch				
Rosaceae	*Crataegus turkestanica* Pojark.				
Poaceae	*Cynodon dactylon* (L.) Pers.	2	0.014	0.014	0.00008
Lamiaceae	*Dracocephalum imberbe* Bunge	2	0.014	0.0137	0.00004
Boraginaceae	*Echium vulgare* L.	1	0.007	0.0069	0.00001
Equisetaceae	*Equisetum arvense* L.	2	0.017	0.014	0.00004
Xanthorrhoeaceae	*Eremurus fuscus* (O.Fedtsch.)	7	0.048	0.05	0.0005
Asphodelaceae	*Eremurus robustus* (Regel) Regel				
Oleaceae	*Fraxinus sogdiana* Bunge	3	0.014	0.02	0.0001
Apiaceae	*Heracleum lehmannianum* Bunge	2	0.014	0.0137	0.00008
Elaeagnaceae	*Hippophae turkestanica* (Rousi) Tzvelev	14	0.096	0.1	0.002
Hypericaceae	*Hypericum perforatum* L.	46	0.315	0.32	0.01
Hypericaceae	*Hypericum scabrum* L.				
Onagraceae	*Chamaenerion angustifolium* (L.) Scop.	8	0.055	0.055	0.007
Juglandaceae	*Juglans regia* L.	259	0.993	1.782	I.42
Cupressaceae	*Juniperus semiglobosa* Regel	7	0.048	0.05	0.0014

Family	Latin name	UR (1)	RFC (2)	UV (3)	CV (4)
Asteraceae	*Leontopodium ochroleucum* Beauverd	1	0.007	0.00685	0.00001
Caprifoliaceae	*Lonicera microphylla* Willd. ex Schult.	3	0.021	0.021	0.00009
Rosaceae	*Louiseania ulmifolia* (Franch.) Pachom.	1	0.007	0.00685	0.00001
Rosaceae	*Malus niedzwetzkyana* Dieck	239	0.973	I.64	I.28
Rosaceae	*Malus sieversii* (Ledeb.) M.Roem.				
Lamiaceae	*Melissa officinalis* L.	6	0.041	0.04	0.0003
Lamiaceae	*Mentha asiatica* Boriss.	36	0.247	0.25	0.018
Morchellaceae	*Morchella esculenta*	65	0.445	0.45	0.04
Lamiaceae	*Origanum tyttanthum* Gontsch.	74	0.507	0.5	0.103
Araliaceae	*Panax ginseng*	1	0.007	0.0069	0.00001
Poaceae	*Phragmites australis* (Cav.) Trin. ex Steud.	1	0.007	0.0069	0.00001
Pinaceae	*Picea schrenkiana* Fisch. et C.A.Mey.	5	0.034	0.13	0.0002
Amaryllidaceae	*Pistacia vera* L.	24	0.130	0.17	0.009
Plantaginaceae	*Plantago major* L.	21	0.144	0.14	0.004
Polygonaceae	*Polygonum aviculare* L.	19	0.123	0.13	0.006
Salicaceae	*Populus alba* L.	24	0.123	0.54	0.01
Salicaceae	*Populus talassica* Kom.				
Apiaceae	*Prangos pabularia* Lindl.	13	0.089	0.089	0.002
Rosaceae	*Prunus divaricata* Ledeb.	204	0.863	1.396	0.393
Rosaceae	*Prunus spinosa*	8	0.055	0.055	0.0006
Asteraceae	*Pyrethrum partheniifolium* Willd.	62	0.425	0.43	0.04
Rosaceae	*Pyrus korshinskyi* Litv.	15	0.089	0.103	0.004
Rosaceae	*Pyrus turcomanica* Maleev				
Polygonaceae	*Rheum maximowiczii* Losinsk.	20	0.137	0.14	0.011
Polygonaceae	*Rheum wittrockii* Lundst	21	0.144	0.14	0.008
Rosaceae	*Rosa corymbifera* Borkh.	85	0.534	0.58	0.12
Rosaceae	*Rosa kokanica* (Regel) Juz.				
Rosaceae	*Rubus caesius* L.	44	0.295	0.28	0.04
Rosaceae	*Rubus idaeus* L.				
Polygonaceae	*Rumex halacsyi* Rech.	3	0.021	0.021	0.0003
Salicaceae	*Salix wilhelmsiana* Bieb.	10	0.065	0.07	0.002
Lamiaceae	*Salvia sclarea* L.	12	0.075	0.083	0.004
Rosaceae	*Sorbus persica* Hedl.	1	0.007	0.0069	0.00001
Rosaceae	*Sorbus tianschanica* Rupr.				
Asteraceae	*Taraxacum officinale* Wigg.	2	0.014	0.014	0.00004
Ranunculaceae	*Thalictrum foetidum* L.	1	0.007	0.0069	0.00001
Fabaceae	*Trifolium pratense* L.	12	0.082	0.082	0.001
Asteraceae	*Tripleurospermum inodorum* (L.) Sch. Bip.	9	0.062	0.062	0.0008
Asteraceae	*Tussilago farfara* L.	3	0.021	0.021	0.00009
Ulmaceae	*Ulmus pumila* L.	6	0.041	0.04	0.0007
Urticaceae	*Urtica dioica* L.	25	0.171	0.17	0.02
Caprifoliaceae	*Valeriana ficariifolia* Boiss.	1	0.007	0.007	0.00001
Lamiaceae	*Ziziphora clinopodioides* Lam.	3	0.021	0.021	0.00009

(1) Use report, (2) Relative Frequency of citation, (3) Use Value, (4) Cultural value index

Appendix 2: Questionnaire used in this study

Информация

Жанысы: ☐ Аял ☐ Эркек.	Жаш:	Кесип:	
Окуу жай:	Улууту:		

Өсүмдүк жөнүндөгү информация жана анын колдонушу

Өсүмдүк (аталышы)	Ал эмне (дарак, гүл, чөп ж.б.)	Колдонушу	Кайсы түрдө колдонесуз даярдалышы)?	Бүгүнкү күндө канчалык көп өсүмдүк менен колдоносуз?	Өсүмдүктүн чогултүшу жана сактalышы	Кайсы убакытта аны чогултасыз?	Кайсы жерде аны чогултасыз (алыстыгы)?	Сезондо түшүм кандай болот?	Өсүмдүктү же анын бөлүктөрүн сатасызбы?.	Кайсы жерде аны сатасыз?	Анын баасы

Appendix 3: Direct matrix ranking – Arslanbob

Food		Medicine		Firewood		Feed		Material	
Juglans regia L.	149	*Pyrethrum partheniifolium* Willd.	56	*Juglans regia* L.	16	*Trifolium pratense* L.	26	*Populus alba* L.	7
Malus niedzwetzkyana Dieck	125	*Origanum tyttanthum* Gotsch.	41	*Populus alba* L.	7	Feed	20	*Populus talassica* Kom.	
Malus sieversii (Ledeb.) M.Roem.		*Hypericum perforatum* L.	36	*Populus talassica* Kom.		*hay*	8	*Crataegus knorringiana* Pojark.	4
Rosa corymbifera Borkh.	66	*Hypericum scabrum* L.		*Crataegus knorringiana* Pojark.	4	*Urtica dioica* L.	7	*Crataegus korolkowii* L.Henry	
Rosa kokanica (Regel) Juz.		*Artemisia absinthum* L.	34	*Crataegus korolkowii* L.Henry		*Populus alba* L.	5	*Crataegus pontica* C.Koch	
Prunus divaricata Ledeb.	49	*Rosa corymbifera* Borkh.	33	*Crataegus pontica* C.Koch		*Populus talassica* Kom.		*Crataegus turkestanica* Pojark.	
Rubus caesius L.	39	*Rosa kokanica* (Regel) Juz.		*Crataegus turkestanica* Pojark.		*Salvia sclarea* L.	3	*Fraxinus sogdiana* Bunge	3
Rubus idaeus L.		*Mentha asiatica* Boriss.	31	*Malus niedzwetzkyana* Dieck	3	*Mentha asiatica* Boriss.	2	*Juniperus semiglobosa* Regel	2
Berberis oblonga (Regel) Schneid.	38	*Plantago major* L.	28	*Malus sieversii* (Ledeb.) M.Roem.		*Rumex halacsyi* Rech.	1	*Ulmus pumila* L.	2
Morchella esculenta	30	*Crataegus knorringiana* Pojark.	22	*Fraxinus sogdiana* Bunge	3			*Acer semenovii* Regel et Herder	1
Ribes janczewskii Pojark.	29	*Crataegus korolkowii* L.Henry		*Juniperus semiglobosa* Regel	2			*Acer turkestanicum* Pax	
Allium caeruleum Pall.	28	*Crataegus pontica* C.Koch							
Allium longicuspis Regel		*Crataegus turkestanica* Pojark.							
Allium sativum		*Urtica dioica* L.	17						
Crataegus knorringiana Pojark.	22	*Salvia sclarea* L.	12						
Crataegus korolkowii L.Henry		*Melissa officinalis* L.	7						
Crataegus pontica C.Koch		*Prangos pabularia* Lindl.	8						
Crataegus turkestanica Pojark.		*Allium caeruleum* Pall.	6						
Pyrus korshinskyi Litv.	16	*Allium longicuspis* Regel							
Pyrus turcomanica Maleev		*Allium sativum*							
Urtica dioica L.	9	*Anaphalis racemifera* Franch.	5						
Mentha asiatica Boriss.	8	*Equisetum arvense* L.	4						
Salvia sclarea L.	7	*Malus niedzwetzkyana* Dieck	4						
Armeniaca vulgaris Lam.	5	*Malus sieversii* (Ledeb.) M.Roem.							
Origanum tyttanthum Gontsch.	5	*Ziziphora clinopodioides* Lam.	4						
Hippophae turkestanica (Rousi) Tzvelev	4	*Juglans regia* L.	3						
Rumex halacsyi Rech.	4	*Ribes janczewskii* Pojark.	3						
Eremurus fuscus (O.Fedtsch.)	2	*Arctium tomentosum* Mill.	3						
Eremurus robustus (Regel) Regel		*Hippophae turkestanica* (Rousi) Tzvel	2						
Artemisia basinthium L.	2	*Populus talassica* Kom.	2						
Amygdalus bucharica Korsh.	1	*Populus alba* L.							
		Prunus divaricata Ledeb.	1						
		Tussilago farfara L.	1						
		Trifolium pratense L.	1						
		Rubus caesius L.	1						
		Rubus idaeus L.							
		Heracleum lehmannianum Bunge	1						
		Salix wilhelmsiana Bieb.	1						

Appendix 4: Direct matrix ranking for Kara-Alma

Food		Medicine		Firewood		Feed		Material
Juglans regia L.	128	*Origanum tyttanthum* Gontsch.	20	*Acer semenovii* Regel et Herder	80	Feed	24	
Malus niedzwetzkyana Dieck	84	*Pyrethrum partheniifolium* Willd.	18	*Acer turkestanicum* Pax		*Allium caeruleum* Pall.	2	
Malus sieversii (Ledeb.) M.Roem.		*Rosa corymbifera* Borkh.	14	*Malus niedzwetzkyana* Dieck	48	*Allium longicuspis* Regel		
Prunus divaricata Ledeb.	53	*Rosa kokanica* (Regel) Juz.		*Malus sieversii* (Ledeb.) M.Roem.		*Allium sativum*		
Morchella esculenta	44	*Hypericum perforatum* L.	9	*Juglans regia* L.	43			
Rosa corymbifera Borkh.	20	*Hypericum scabrum* L.		*Prunus divaricata* Ledeb.	41			
Rosa kokanica (Regel) Juz.		*Mentha asiatica* Boriss.	7	*Crataegus knorringiana* Pojark.	23			
Rubus caesius L.	14	*Crataegus knorringiana* Pojark.	7	*Crataegus korolkowii* L.Henry				
Rubus idaeus L.		*Crataegus korolkowii* L.Henry		*Crataegus pontica* C.Koch				
Ribes janczewskii Pojark.	13	*Crataegus pontica* C.Koch		*Crataegus turkestanica* Pojark.				
Rheum maximowiczii Losinsk.	9	*Crataegus turkestanica* Pojark.		*Ribes janczewskii* Pojark.	8			
Rheum wittrockii Lundst		*Polygonum aviculare* L.	7	*Betula pendula*	6			
Polygonum aviculare L.	5	*Rheum maximowiczii* Losinsk.	6	*Salix wilhelmsiana* Bieb.	2			
Crataegus knorringiana Pojark.	6	*Rheum wittrockii* Lundst		*Populus alba* L.	1			
Crataegus korolkowii L.Henry		*Clementsia semenovii* Boriss.	5	*Populus talassica* Kom.				
Crataegus pontica C.Koch		*Aconitum rotundifolium* Kar et Kir	4	*Cerasus mahaleb* (L.) Mill.	1			
Crataegus turkestanica Pojark.		*Juniperus semiglobosa* Regel	3	*Cerasus tianschanica* Pojark.				
Mentha asiatica Boriss.	2	*Morchella esculenta*	3	*Lonicera microphylla* Willd. ex Schult.	1			
Allium caeruleum Pall.	1	*Dracocephalum imberbe* Bunge	2	*Chamaenerion angustifolium* (L.) Scop.	1			
Allium longicuspis Regel		*Urtica dioica* L.	1					
Allium sativum		*Salvia sclarea* L.	1					
		Ziziphora clinopodioides Lam.	1					
		Juglans regia L.	1					
		Capparis herbacea Willd.	1					
		Taraxacum officinale Wigg.	1					

Appendix 5: Direct matrix ranking for Kyzyl-Unkur

Food		Medicine		Firewood		Feed		Material	
Juglans regia L.	152	*Origanum tyttanthum* Gontsch.	32	*Acer semenovii* Regel et Herder	53	Feed	22	*Juglans regia* L.	3
Malus niedzwetzkyana Dieck	115	*Anaphalis racemifera* Franch.	26	*Acer turkestanicum* Pax				*Crataegus knorringiana* Pojark.	2
Malus sieversii (Ledeb.) M.Roem.		*Prangos pabularia* Lindl.	25	*Prunus divaricata* Ledeb.	47			*Crataegus korolkowii* L.Henry	
Prunus divaricata Ledeb.	63	*Hypericum perforatum* L.	19	*Malus niedzwetzkyana* Dieck	44			*Crataegus pontica* C.Koch	
Berberis oblonga (Regel) Schneid.	52	*Hypericum scabrum* L.		*Malus sieversii* (Ledeb.) M.Roem.				*Crataegus turkestanica* Pojark.	
Crataegus knorringiana Pojark.	47	*Pyrethrum partheniifolium* Willd.	14	*Juglans regia* L.	43			*Malus niedzwetzkyana* Dieck	1
Crataegus korolkowii L.Henry		*Urtica dioica* L.	13	*Crataegus knorringiana* Pojark.	27			*Malus sieversii* (Ledeb.) M.Roem.	
Crataegus pontica C.Koch		*Plantago major* L.	12	*Crataegus korolkowii* L.Henry					
Crataegus turkestanica Pojark.		*Rosa corymbifera* Borkh.	10	*Crataegus pontica* C.Koch					
Rheum maximowiczii Losinsk.	45	*Rosa kokanica* (Regel) Juz.		*Crataegus turkestanica* Pojark.					
Rheum wittrockii Lundst		*Artemisia absinthium* L.	8	*Cerasus mahaleb* (L.) Mill.	5				
Morchella esculenta	44	*Mentha asiatica* Boriss.	6	*Cerasus tianschanica* Pojark.					
Ribes janczewskii Pojark.	35	*Clementsia semenovii* Boriss.	5	*Picea schrenkiana* Fisch. et C.A.Mey.	4				
Rubus caesius L.	34	*Salvia sclarea* L.	4	*Betula pendula*	2				
Rubus idaeus L.		*Berberis oblonga* (Regel) Schneid.	4	*Populus alba* L.	1				
Polygonum aviculare L.	24	*Prunus divaricata* Ledeb.	4	*Populus talassica* Kom.					
Rosa corymbifera Borkh.	14	*Polygonum aviculare* L.	2	*Lonicera microphylla* Willd. ex Schult.	1				
Rosa kokanica (Regel) Juz.		*Rheum maximowiczii* Losinsk.	2						
Allium caeruleum Pall.	9	*Rheum wittrockii* Lundst							
Allium longicuspis Regel		*Juglans regia* L.	2						
Allium sativum		*Melissa officinalis* L.	2						
Pistacia vera L.	6	*Hippophae turkestanica* (Rousi) Tzvelev	2						
Origanum tyttanthum Gontsch.	5	*Conioselinum tataricum* Fisch. ex Hoffm.	2						
Hippophae turkestanica (Rousi) Tzvelev	5	*Crataegus knorringiana* Pojark.	2						
Hypericum perforatum L.	4	*Crataegus korolkowii* L.Henry							
Hypericum scabrum L.		*Crataegus pontica* C.Koch							
		Crataegus turkestanica Pojark.							

Appendix 6: Direct matrix ranking for Salam-Alik

Food		Medicine		Firewood		Feed		Material
Juglans regia L.	124	*Pyrethrum partheniifolium* Willd.	43	*Crataegus knorringiana* Pojark.	68	Feed	19	
Prunus divaricata Ledeb.	117	*Achillea millefolium* L.	25	*Crataegus korolkowii* L.Henry				
Malus niedzwetzkyana Dieck	95	*Mentha asiatica* Boriss.	22	*Crataegus pontica* C.Koch				
Malus sieversii (Ledeb.) M.Roem.		*Origanum tyttanthum* Gontsch.	22	*Crataegus turkestanica* Pojark.				
Rosa corymbifera Borkh.	75	*Crataegus knorringiana* Pojark.	22	*Malus niedzwetzkyana* Dieck	67			
Rosa kokanica (Regel) Juz.		*Crataegus korolkowii* L.Henry		*Malus sieversii* (Ledeb.) M.Roem.				
Crataegus knorringiana Pojark.	38	*Crataegus pontica* C.Koch		*Prunus divaricata* Ledeb.	62			
Crataegus korolkowii L.Henry		*Crataegus turkestanica* Pojark.		*Juglans regia* L.	61			
Crataegus pontica C.Koch		*Rosa corymbifera* Borkh.	19	*Acer semenovii* Regel et Herder	60			
Crataegus turkestanica Pojark.		*Rosa kokanica* (Regel) Juz.		*Acer turkestanicum* Pax				
Rheum maximowiczii Losinsk.	30	*Hypericum perforatum* L.	19	*Celtis caucasica* Willd.	23			
Rheum wittrockii Lundst		*Hypericum scabrum* L.		*Salix wilhelmsiana* Bieb.	20			
Armeniaca vulgaris Lam.	28	*Chamaenerion angustifolium* (L.) Scop.	18	*Populus alba* L.	16			
Morchella esculenta	18	*Plantago major* L.	12	*Populus talassica* Kom.				
Polygonum aviculare L.	14	*Urtica dioica* L.	12	*Betula pendula*	14			
Origanum tyttanthum Gontsch.	13	*Clementsia semenovii* Boriss.	12	*Cotoneaster integerrimus* Medik.	12			
Ribes janczewskii Pojark.	16	*Aconitum rotundifolium* Kar et Kir	11	*Cerasus mahaleb* (L.) Mill.	11			
Eremurus fuscus (O.Fedtsch.)	12	*Rumex halacsyi* Rech.	9	*Cerasus tianschanica* Pojark.				
Eremurus robustus (Regel) Regel		*Prunus divaricata* Ledeb.	8	*Picea schrenkiana* Fisch. et C.A.Mey.	6			
Hippophae turkestanica (Rousi) Tzvelev	11	*Salvia sclarea* L.	5	*Amygdalus bucharica* Korsh.	3			
Rubus caesius L.	7	*Panax ginseng*	5	*Juniperus semiglobosa* Regel	2			
Rubus idaeus L.		*Valeriana ficariifolia* Boiss.	4					
Berberis oblonga (Regel) Schneid.	3	*Equisetum arvense* L.	3					
Pyrus korshinskyi Litv.	3	*Hippophae turkestanica* (Rousi) Tzvelev	3					
Pyrus turcomanica Maleev		*Juniperus semiglobosa* Regel	3					
Mentha asiatica Boriss.	3	*Rubus caesius* L.	3					
Melissa officinalis L.	3	*Rubus idaeus* L.						
Allium caeruleum Pall.	1	*Arum korolkowii* Regel	3					
Allium longicuspis Regel		*Echium vulgare* L.	3					
Allium sativum		*Melissa officinalis* L.	2					
Amygdalus bucharica Korsh.	1	*Cynodon dactylon* (L.) Pers.	2					
		Leontopodium ochroleucum Beauverd	2					
		Malus niedzwetzkyana Dieck	1					
		Malus sieversii (Ledeb.) M.Roem.						
		Tussilago farfara L.	1					
		Amygdalus bucharica Korsh.	1					
		Phragmites australis (Cav.) Trin. ex Steud.	1					

Appendix 7: Direct matrix ranking for Toskool-Ata

Food		Medicine		Firewood		Feed		Material
Juglans regia L.	130	*Origanum tyttanthum* Gontsch.	27	*Crataegus knorringiana* Pojark.	68	Feed	21	
Malus niedzwetzkyana Dieck	76	*Hypericum perforatum* L.	17	*Crataegus korolkowii* L.Henry				
Malus sieversii (Ledeb.) M.Roem.		*Hypericum scabrum* L.		*Crataegus pontica* C.Koch				
Pistacia vera L.	57	*Pyrethrum partheniifolium* Willd.	13	*Crataegus turkestanica* Pojark.				
Morchella esculenta	53	*Urtica dioica* L.	10	*Acer semenovii* Regel et Herder	41			
Prunus divaricata Ledeb.	30	*Mentha asiatica* Boriss.	7	*Acer turkestanicum* Pax				
Crataegus knorringiana Pojark.	20	*Achillea millefolium* L.	5	*Prunus divaricata* Ledeb.	25			
Crataegus korolkowii L.Henry		*Crataegus knorringiana* Pojark.	5	*Malus niedzwetzkyana* Dieck	22			
Crataegus pontica C.Koch		*Crataegus korolkowii* L.Henry		*Malus sieversii* (Ledeb.) M.Roem.				
Crataegus turkestanica Pojark.		*Crataegus pontica* C.Koch		*Juglans regia* L.	21			
Pyrus korshinskyi Litv.	16	*Crataegus turkestanica* Pojark.		*Pistacia vera* L.	12			
Pyrus turcomanica Maleev		*Artemisia absinthium* L.	5	*Pyrus korshinskyi* Litv.	6			
Mentha asiatica Boriss.	11	*Berberis oblonga* (Regel) Schneid.	4	*Pyrus turcomanica* Maleev				
Allium caeruleum Pall.	10	*Amygdalus bucharica* Korsh.	3	*Amygdalus bucharica* Korsh.	2			
Allium longicuspis Regel		*Rosa corymbifera* Borkh.	2					
Allium sativum		*Rosa kokanica* (Regel) Juz.						
Rubus caesius L.	8	*Plantago major* L.	2					
Rubus idaeus L.		*Clementsia semenovii* Boriss.	2					
Berberis oblonga (Regel) Schneid.	8	*Melissa officinalis* L.	2					
Origanum tyttanthum Gontsch.	6	*Corydalis gortschakovii* Schrenk	2					
Amygdalus bucharica Korsh.	6	*Prangos pabularia* Lindl.	1					
Rosa corymbifera Borkh.	5							
Rosa kokanica (Regel) Juz.								
Rheum maximowiczii Losinsk.	8							
Rheum wittrockii Lundst								
Hippophae turkestanica (Rousi) Tzvelev	3							
Melissa officinalis L.	3							
Polygonum aviculare L.	1							
Capparis herbacea Willd.	1							
Cerasus mahaleb (L.) Mill.	1							
Cerasus tianschanica Pojark.								
Eremurus fuscus (O.Fedtsch.)	1							
Eremurus robustus (Regel) Regel								

Appendix 8: Traditional gathered wild plants

Family	Vernacular name	Herbarium reference	Scientific name	Habit	Part used	Mode of preparation	Use category	Seasonal availability
Sapindaceae	Ак-Чечек	VLC004	*Acer semenovii* Regel et Herder	Tree	Branches	Dry	Fuelwood	September-November
Sapindaceae		VLC073	*Acer turkestanicum* Pax	Tree	Wood	Material	Material	December
Ranunculaceae	Ак-кодол	VLC043	*Aconitum rotundifolium* Kar et Kir	Herb	Fruit, leaf	Dry	Medicine	August-September
Agaricaceae	Чампыш	VLC046	*Agaricus campestris* L.	Mushroom	All parts	Fresh	Food	April
Asteraceae	Минжалбырак	VLC035	*Achillea millefolium* L.	Herb	Leaf	Dry	Medicine	April, July
Amaryllidaceae	Согон	VLC019	*Allium caeruleum* Pall.	Herb	All parts	Dry, fresh, salt	Food	April-July
Amaryllidaceae	Сарымсак	VLC074	*Allium longicuspis* Regel	Herb	All parts	Dry, unguent	Medicine	May, July
Amaryllidaceae	Чырмоок	VLC075	*Allium sativum*	Herb	Fruit	Fresh	Feed	May,June
Rosaceae	Бадам	VLC034	*Amygdalus bucharica* Korsh.	Shrub	Fruit	Fresh, Dry	Food, medicine	July, November
					Branches	Dry	Fuelwood	September-November
Asteraceae	Бозунач	VLC061	*Anaphalis racemifera* Franch.	Herb	All parts	Dry, tea	Medicine	August
Asteraceae	Уйгак	VLC042	*Arctium tomentosum* Mill.	Herb	Root	Dry	Medicine	July
Rosaceae	Өрүк	VLC021	*Armeniaca vulgaris* Lam.	Tree	Fruit	Cook	Food	July
Asteraceae	Эрмен	VLC052	*Artemisia absinthium* L.	Herb	All parts	Dry, tea	Food, medicine	May-August
Araceae	Кучала	VLC013	*Arum korolkowii* Regel	Herb	Flower, root	Dry	Medicine	August
Berberidaceae	Изирик	VLC037	*Berberis oblonga* (Regel) Schneid.	Shrub	Fruit	Dry, jam, fresh, cook	Food	August-September
Betulaceae	Кайын	VLC057	*Betula pendula*	Tree	Fruit	Cook	Food	August, winter
					Branches	Dry	Fuelwood	September
Capparaceae	Гавар	VLC015	*Capparis Herbacea* Willd.	Shrub	Fruit	Salt	Food	August
Fabaceae	Караган	VLC028	*Caragana alaica* Pojark.	Shrub	Fruit	Dry, cook	Food	August-September
Grossulariadaceae	Карагат	VLC076	*Ribes janczewskii* Pojark.	Shrub	Branches	Dry	Fuelwood	August
Cannabaceae	Катранке	VLC030	*Celtis caucasica* Willd.	Tree	Branches	Dry	Fuelwood	October-December
Rosaceae	Саз кайын	VLC062	*Cerasus mahaleb* (L.) Mill.	Tree	Branches	Dry	Fuelwood	September-November
Rosaceae	Чие	VLC063	*Cerasus tianschanica* Pojark.	Tree				
Crassulaceae	Алтын-Тамыр	VLC064	*Clementsia semenovii* Boriss.	Herb	Root	Dry, tea	Medicine	August
Apiaceae	Кереч	VLC005	*Conioselinum tataricum* Fisch. ex Hoffm.	Herb	Leaf	Tea	Medicine	August
Convolvulaceae	Чырмок	VLC003	*Convolvulus arvensis* L.	Herb	Leaf	Dry	Medicine	June-July
Fumariaceae	Ормо кара	VLC077	*Corydalis gortschakovii* Schrenk	Herb	All partss	Dry	Medicine	September

Continue

Family	Vernacular name	Herbarium reference	Scientific name	Habit	Part used	Mode of preparation	Use category	Seasonal availability
Rosaceae	Ыргай	VLC078	*Cotoneaster integerrimus* Medik.	Shrub	Branches	Dry	Fuelwood	September-November
Rosaceae	Долоно	VLC079	*Crataegus knorringiana* Pojark.	Tree	Fruit	Cook, jam	Food	September-October
Rosaceae	Сарыайбан	VLC054	*Crataegus korolkowii* L.Henry	Tree	Flower	Dry, tea	Medicine	May
Rosaceae	Айбансары	VLC058	*Crataegus pontica* C.Koch	Tree	Branches	Dry	Fuelwood	September-November
Rosaceae		VLC065	*Crataegus turkestanica* Pojark.	Tree	Wood	Fresh	Material	September
Poaceae	Ажырык	VLC055	*Cynodon dactylon* (L.) Pers.	Grass	Leaf	Dry	Feed, medicine	July, August
Lamiaceae	аркарот	VLC040	*Dracocephalum imberbe* Bunge	Herb	All parts	Tea	Medicine	August
Boraginaceae	Синяк	VLC080	*Echium vulgare* L.	Herb	All parts	Dry	Medicine	July
Equisetaceae	Кыркмуун	VLC051	*Equisetum arvense* L.	Herb	Stem	Dry	Medicine	Augsut
Xanthorrhoeaceae	Чырыч	VLC059	*Eremurus fuscus* (O.Fedtsch.)	Herb	All parts	Cook, dry	Food	March-April
Asphodelaceae	Чыраш Чырыш	VLC053	*Eremurus robustus* (Regel) Regel	Herb				
Oleaceae	Шун	VLC029	*Fraxinus sogdiana* Bunge	Tree	Branches, wood	Dry	Fuelwood, material	September
Apiaceae	Балтыркан	VLC011	*Heracleum lehmannianum* Bunge	Herb	Stem	Dry, cook	Food	July, September
Elaeagnaceae	Чычырканак облепиха	VLC081	*Hippophae turkestanica* (Rousi) Tzvelev	Shrub	Fruit	Dry, tea, cook	Food, material	August, September
Hypericaceae	Чай чоп	VLC038	*Hypericum perforatum* L.	Herb	All parts	Dry, tea	Medicine	June-August
Hypericaceae	Сарыбаш Тоо чай	VLC001	*Hypericum scabrum* L.	Shrub				
Onagraceae	Иван чай	VLC041	*Chamaenerion angustifolium* (L.) Scop.	Herb	Flower	Dry, tea	Medicine	June-September
Juglandaceae	Жангак	VLC070	*Juglans regia* L.	Tree	Fruit, nuts	Fresh, dry	Food, medicine	September-October
					Branches	Dry	Fuelwood	October-December
					Wood	Fresh	Material	September
Cupressaceae	Арча	VLC047	*Juniperus semiglobosa* Regel	Tree	Branches, wood	Dry, fresh	Material, fuelwood	September-November
					Branches	Smoke	Medicine	All year
Asteraceae	Эдельвейс	VLC071	*Leontopodium ochroleucum* Beauverd	Herb	Leaf	Tea	Medicine	July
Caprifoliaceae	Шилби	VLC072	*Lonicera microphylla* Willd. ex Schult.	Shrub	Branches	Dry	Fuelwood	September-November
Rosaceae	Катын жангак	VLC082	*Louiseania ulmifolia* (Franch.) Pachom.	Tree	Flower	Dry	Medicine	September-November

Continue

Family	Vernacular name	Herbarium reference	Scientific name	Habit	Part used	Mode of preparation	Use category	Seasonal availability
Rosaceae	Алма	VLC044	*Malus niedzwetzkyana* Dieck	Tree	Fruit	Compote, fresh, dry	Food	August-September
Rosaceae		VLC016	*Malus sieversii* (Ledeb.) M.Roem.	Tree	Branches	Dry	Fuelwood, material	September-October
Lamiaceae	Лимон	VLC009	*Melissa officinalis* L.	Herb	Leaf	Tea	Medicine	August
Lamiaceae	Жалбыз	VLC008	*Mentha asiatica* Boriss.	Herb	All parts	Fresh, dry	Food, feed	April-May
					Leaf	Dry, tea	Medicine	April-May
Morchellaceae	Козукарын	VLC066	*Morchella esculenta*	Mushroom	All parts	Fresh, dry, salt	Food	April-May
Lamiaceae	Кийик-От	VLC067	*Origanum tyttanthum* Gontsch.	Herb	All parts, leaf	Dry, tea	Medicine	May-June
	Ак-коку				All parts	Dry, fresh	Food	July-August
	Аш коку							
Araliaceae	Женьшень	VLC020	*Panax ginseng*	Herb	Leaf	Dry	Medicine	December
Poaceae	Камыш	VLC025	*Phragmites australis* (Cav.) Trin. ex Steud.	Grass	All parts	Dry	Medicine	June-July
Pinaceae	Карагай	VLC017	*Picea schrenkiana* Fisch. et C.A.Mey.	Tree	Branches	Dry	Fuelwood	September-November
Amaryllidaceae	Мисте	VLC022	*Pistacia vera* L.	Tree	Nuts	Fresh, dry	Food	September
					Branches	Dry	Fuelwood	September-November
Plantaginaceae	Бака-Жалбырак	VLC026	*Plantago major* L.	Herb	Leaf	Dry, tea	Medicine	April-July
Polygonaceae	Кымыздык	VLC083	*Polygonum aviculare* L.	Herb	Stem	Dry, fresh, salt	Medicine, food	May
Salicaceae	Терек	VLC007	*Populus alba* L.	Tree	Branches	Dry	Fuelwood	All year
Salicaceae		VLC031	*Populus talassica* Kom.	Tree	Wood	Fresh	Material	All year
					Leaves	Fresh	Feed	Summer
Apiaceae	аю чач	VLC002	*Prangos pabularia* Lindl.	Herb	Leaf	Unguent	Medicine	July, August
Rosaceae	Алча	VLC039	*Prunus divaricata* Ledeb.	Tree	Fruit	Fresh, compote, dry	Food	September-October
					Branches	Dry	Fuelwood	September-November
Rosaceae	Кайналы	VLC010	*Prunus spinosa*	Tree	Fruit	Fresh, compote	Food	September-November
Asteraceae	Ромашка	VLC027	*Pyrethrum partheniifolium* Willd.	Herb	All parts, flower	Dry, tea	Medicine	June-August
Rosaceae	Алмурут	VLC084	*Pyrus korshinskyi* Litv.	Tree	Fruit	Dry, cook	Food	September-October
Rosaceae		VLC023	*Pyrus turcomanica* Maleev	Tree	Branches	Dry	Fuelwood	September
Polygonaceae	Чукуру	VLC024	*Rheum maximowiczii* Losinsk.	Herb	Stem	Fresh, salt	Food, Medicine	April-June
Polygonaceae	Ышкын	VLC014	*Rheum wittrockii* Lundst	Herb				

Continue

Family	Vernacular name	Herbarium reference	Scientific name	Habit	Part used	Mode of preparation	Use category	Seasonal availability
Rosaceae	Ит-Мурун	VLC006	*Rosa corymbifera* Borkh.	Shrub	Fruit	Dry, fresh	Food	September-November
Rosaceae		VLC085	*Rosa kokanica* (Regel) Juz.	Shrub	Fruit	Tea	Medicine	September-November
Rosaceae	Бүлдүркөн	VLC012	*Rubus caesius* L.	Shrub	Fruit	Cook, jam	Food	August
Rosaceae	Малина	VLC086	*Rubus idaeus* L.	Shrub	Fruit	Jam	Medicine	May, August
Polygonaceae	Ат кулак	VLC048	*Rumex halacsyi* Rech.	Herb	All parts	Fresh	Food, feed	April
Salicaceae	Тал	VLC087	*Salix wilhelmsiana* Bieb.	Tree	Leaf, stem	Dry	Medicine	August
					Branches	Dry	Fuelwood	May
Lamiaceae	Маро	VLC032	*Salvia sclarea* L.	Herb	All parts	Spice, tea	Food, feed	July, September
					Leaf	Tea	Medicine	July
Rosaceae	Четин	VLC068	*Sorbus persica* Hedl.	Shrub	Branches	Dry	Fuelwood	September
Rosaceae		VLC088	*Sorbus tianschanica* Rupr.	Shrub				
Asteraceae	Какым Ала каакым	VLC056	*Taraxacum officinale* Wigg.	Herb	Leaf	Dry, tea	Medicine	May
Ranunculaceae	Сасык матар	VLC069	*Thalictrum foetidum* L.	Herb	Root	Spice	Food	September
Fabaceae	Беде	VLC033	*Trifolium pratense* L.	Herb	All parts	Fresh	Feed	June-July
Asteraceae		VLC036	*Tripleurospermum inodorum* (L.) Sch. Bip.	Herb	All parts	Fresh	Feed	June-July
Asteraceae	Огой эне гулу	VLC049	*Tussilago farfara* L.	Herb	Leaf, flower	Tea	Medicine	June, August
Ulmaceae	Кара-Жыгач	VLC045	*Ulmus pumila* L.	Tree	Branches	Dry	Fuelwood, material	May-October
Urticaceae	Чалкан	VLC018	*Urtica dioica* L.	Herb	All parts, leaf	Dry, tea	Medicine, feed	May-July
Caprifoliaceae	Валериана	VLC060	*Valeriana ficariifolia* Boiss.	Herb	Root	Tea	Medicine	July
Lamiaceae	Кокомерен	VLC050	*Ziziphora clinopodioides* Lam.	Herb	Leaf	Dry, tea	Medicine	June, August

Annex B

Figure 10: Branches used for fence or as fuelwood

Figure 11: Apple collecting

Figure 12: Insect on *Pistacia vera* L.

Figure 13: *Mentha asiatica* Boriss.

Figure 14: Data collection

Figure 15*: Capparis herbacea* Willd.

Figure 16: *Berberis oblonga* (Regel) Schneid.

Figure 17: Apples collected for seed

Figure 18: Weighing apples

Figure 19: Apples cut and dry on the sun

Figure 20: Walnut kernels

(Author: Yana Chernykh)

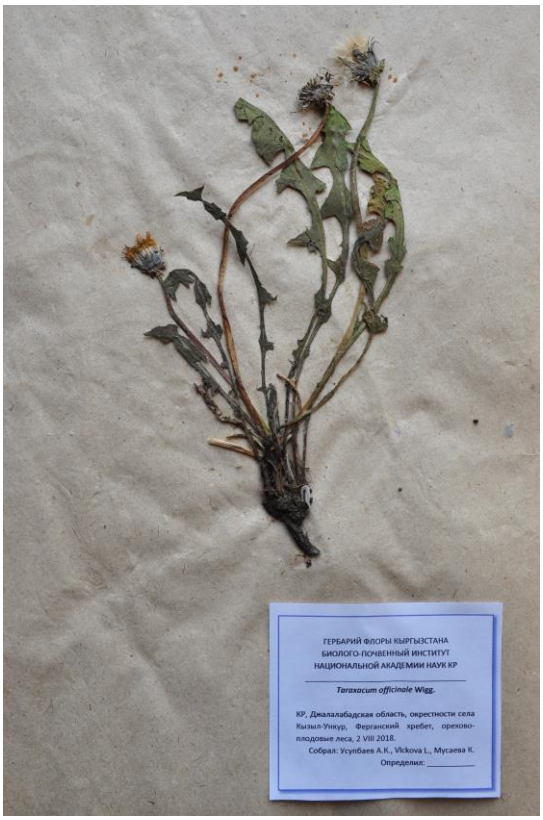

Figure 21: Example in herbary

Figure 22: Apples collected for seeds

Figure 23: *Juniperus semiglobosa* Regel.

Figure 24: Dried apples

Figure 25: Cherries, raspberries, blackberries, plums and currant on the local market

Figure 26: Herbs on the local market

Figure 27: Rosehips on the market

Figure 28: Dried fuits and nuts

Figure 29: Salted mushrooms

Figure 30: Jam and compote from wild fruits

Figure 31: Dried and fresh berberis