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Forest dependency of local communities and management for nut and fuelwood production in Jalalabad oblast, Kyrgyzstan

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ABSTRACT

Jalalabad *oblast* (region) in the Kyrgyz Republic is a home for the world's largest natural walnut (*Juglans regia*) forest (1,000 - 2,200 meters a.s.l) and Pistachio (*Pistacia vera*) natural forests (800 - 1,000 meters a.s.l.). Walnut and pistachio are the main income source for local people. However, those nut-fruit forests has been decreased. Wood is an important energy source for cooking and heating. Although, walnut forest is under the special state protection, local people collect fuelwood from those natural forest due to lack of alternative energy sources. This study aimed to explore solutions to restore nut-fruit forests, while providing fuelwood source and improve income of local people. For this study qualitative approach was used through semi-structured interview (SSI) and survey questionnaires with farmers in Toskool-Ata, Jalalabad *oblast* in Kyrgyzstan, central and local government officials and 1) Identified willingness of local people to plant fast-growing tree species in order to meet demand for fuelwood and income; 2) Investigated that local people see forest degradation as the main environmental problem 3) Investigated that livestock and complicated lease arrangements are challenges in forest management; and 4) Determined the possible support/incentives the government can provide for local communities for their participation in the forest rehabilitation such as planting instead of lease fee payment. This study found out that tree-based farming approach can be an important alternative land use with potential solution. Findings indicated that the 74.1% of local farmers are ready to plant fruit-trees and fast-growing tree species in order to meet their demand for fuel wood and more income to improve their livelihoods, if the government can support with temporary fencing. It was also found that capacity building is required for farmers to learn proper planting, managing and harvesting towards more sustainable practices. Moreover, it was observed that there is a need for policy makers to modify policies/legislations through simplified and incentive-based forest lease arrangements and other stakeholders like NGOs, international organizations may take into consideration supporting farmers with fencing.

Key words: wood, fuel, fast-growing tree species, forest rehabilitation, walnut forest, Kyrgyzstan

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Chapter 1. INTRODUCTION

1.1. About the Kyrgyz Republic

The Kyrgyz Republic, a mountainous, landlocked country in the eastern part of Central Asia, bordered with Kazakhstan, China, Uzbekistan and Tajikistan is one forest dependent country. The total area of the country is about 200,000 square kilometers whereas mountainous terrain accounts for more than 95% of the land that sits at or above 1,500 meters above sea level (a.s.l.), among which 50% is over 3,000 meters a.s.l. which means only 45% of Kyrgyz territory is suitable for human habitation. The country's population lives mostly on 20% of the habitable land area, though some reside on 30% of habitable, but not ideal land.

The country's varied terrain from 142 meters to 7,439 meters a.s.l. results a dry continental climate, with temperate zones in the foothills, a subtropical zone in the Fergana Valley, and an almost polar zone in high mountainous areas (Undeland, 2012). The climate of the country is sharply continental with significant changes in different regions. The average total annual precipitation in all climatic regions are quite similar: north-western region – 456 mm, north-eastern region – 421 mm and south-western region – 521 mm (UNDP, 2009). Given Kyrgyzstan's continental climate with cold and long winters, access to reliable and affordable heating is critical for the wellbeing of its population.

There are about 8,200 glaciers in the country with more than 30,000 rivers flowing from them and only 13-17% of surface water is used for the country's own needs (Undeland, 2012). The Kyrgyz Republic plays an important role in Central Asia as a source of glacier water, which affects regional climate, food security through nourishing agriculture as well as gives potable water, and produces hydropower. However, over-exploitation of natural resources, unsustainable land practices, and deficiencies in forest management, including Central Asia's fast warming than the global average (The Third Pole, 2022), causing melting of glaciers threatening food security, energy, livelihoods of Central Asia including Afghanistan.

Population of Kyrgyzstan is about 6.6 million (2021), whereas in Jalalabad *oblast* population is 1,260 thousand (18.9% of the country) (**Table 1**) and this number will continue to increase since young aged population under 14 years are 50.64% of total population of Jalalabad (National Statistic Committee, 2021).

Table 1. Total number of populations of Kyrgyzstan and Jalalabad oblast (as of 2021)

Name	Population (thousand)	%
Kyrgyzstan	**6,636**	
Women	3,342	50.4
Men	3,294	49.6
Urban	2,229	33.6
Rural	4,406	66.4
Jalal-Abad	**1,260**	**18.9**
Women	626	49.7
Men	634	50.3
Urban	**251.3**	**19,9**
Rural	**1,009**	**80.06**

Source: National Statistic Committee, 2021

There are about 25 cities and towns that are home to 33% of the total population, with the remaining 67% living in approximately 1,800 villages clustered into 472 rural municipalities known as *aiyl aimak* (National Statistic Committee, 2021) spread across lowlands and mountainous valleys along rivers and streams.

The Kyrgyz Republic has considerable economic potential based on its rich endowments (World Bank, 2021) including significant unexploited natural endowments in the form of minerals, agriculture sector, hydropower production and exports as well as its tourism industry (World Bank, 2019). Despite country's potential for growth, a large share of Kyrgyz households is clustered just above the poverty line, making them extremely vulnerable to poverty in the face of macroeconomic

shocks such as food price increases and of households' shocks such as loose of employment, illness, death of the head of a household. Kyrgyzstan's population income per capita remains low as USD 1,173.6 (World Bank, 2020).

In the Kyrgyz Republic, 25.3% (World Bank, 2020) of the population lived below the national poverty line in 2021 (**Figure 1**), especially in the mountainous and remote areas (Asia Development Bank, 2020). For 2015, the Human Development Index in the country was 0.697 (UNDP, 2020), ranking 120th (out of 188) in the world. 74% of the poor living in rural areas and 60% residing in southern Kyrgyzstan where the study area is located.

Figure 1. Poverty Indicators of the Kyrgyz Republic

1.2 Roles of forests in the Kyrgyz Republic

Land covered by forest, as well as not covered by forest but assigned for forestry is recognized as State Forest Fund (SFF) land. This includes forests, plantations, nursery forests, felling areas, clearings as well as not forest lands etc. (Fisher et al., 2004).

The Kyrgyz Republic has 4,088,872.4 hectares of land in the SFF, among which only 1,206,705.7 hectares are covered with trees (**Table 2**), which is equivalent to 6.03% of land area

according to the Forest Service under the Ministry of Agriculture, Water Resources and Regional Development of the Kyrgyz Republic (Forest Service, 2019).

Table 2. Distribution of the forest fund by regions

Unit: thousand hectares

Region	Forest Fund	Forest Cover	% of forest fund
Chuy	253,821.8	88,779.3	35
Osh	673,219.2	195,038.5	29
Talas	200,071.5	63,340.9	31
Jalalabad	1,036,289.2	396,024.3	38.2
Narun	525,499.4	134,816.7	25.6
Issukkul	830,661.3	160,286.6	19.3
Batken	569,310	168,419.4	29.5

Source: Forest Service, 2021

90% of forests in the Kyrgyz Republic can be found at altitudes from 700 meters to 3,600 meters a.s.l. About 130 species of trees and shrubs grow in the forests of the Kyrgyz Republic. The Kyrgyz Republic is continuously working on increasing its forest cover (**Table 3**).

Table 3. Changes in forest area of the State Forest Fund of Kyrgyzstan

Unit: hectares

No.	State Forest Fund	1993	1998	2003	2013	2019
1	Total area (Under management of the Forest Fund)	2,861,300	3,163,200	3,321,500	3,474,100	4,088,872.4
2	Area covered with forests	843,000	849,500	864,900	858,4	1,206,705.7

Source: Forest Service, 2021

Despite its small area, forests in the Kyrgyz Republic play an important economic, environmental, and social role. The country's walnut fruit relict forests are the largest remaining of

this forest type in the world (Shigaeva and Darr, 2020) and together with sea buckthorn (*Hippophae rhamnoides*) are under special state protection including a large range of fruit trees and wild species (e.g. pistachio (*P. vera*), pear (*Pyrus asiae mediae* and *Pyrus korshinskyi*), grapevine (*Vitus usunachmatica*), cherry (*Prunus sodgiana),* apple (*Malus niedzwetzkyana* and *sievercii),* apricot (*Prunus armeniaca*), plum (*Prunus domestica*), peach (*Prunus persica*), almond (*Amygdalus petunnikowii*), pomegranate (*Punica granatum*) etc.) within nine state nature reserves, seven national parks, state forests and botanical wildlife reserves, which comprise about 412,132 hectares belonging to IUCN Category I; 235,646 hectares to IUCN Category II and 41,341 hectares to Category III ((Lapeña, Turdieva, Noriega et al., 2014)). Particularly, these forests contribute not only to income generation, but also to the nutrition of rural people.

For instance, nuts are very rich in vitamins, minerals, amino acids and fatty acids, fibers, and carbohydrates. Especially, walnut (*J. regia*) contain minerals (2%), fibers (2%), carbohydrates (12–16%), proteins (~ 24%), and fat (60–67%) (Ozyigit, Uras, Yalcin et al., 2019). However, they are threatened by over-exploitation, livestock grazing and other anthropogenic pressures. Deforestation imposes environmental problems, decline in the productivity of the land and increases food insecurity, which subsequently lead to socio-economic problems (Fan and Chan-Kang, 2005). Furthermore, in the event of forest degradation, the ability of forests to function as an environmental regulator decreases, the risk of flooding and soil erosion increases, soil fertility is deteriorating (Norris, 2008) which negatively affects the flora and fauna.

The Forest Code (FC) approved in 1999 serves as the main legal act for the forest agencies ensuring a legal base for sustainable forest development, conservation and protection, afforestation, ecological and resource capacity of the forests in the Kyrgyz Republic. All forests of the Kyrgyz Republic are in state property and prohibited to cut for commercial purpose of obtaining wood. In accordance with the ecological, economic and social significance of the forest fund, depending on functions it performs, the SFF is divided into categories of protection as stated in the Article 30 (**Table 4**) of the FC.

Table 4. Categories of forest protection distinguished in the Kyrgyz Republic

Category	Description
Water Protection	Forbidden forest belts along the banks of rivers, lakes, reservoirs and other reservoirs
Protective	Anti-erosion forests, protective forest belts of transport routes, forests in desert and sparsely wooded mountain areas, which are important for environmental protection
Sanitary, Hygienic and Health-Improving	Urban forests, forest parks, forests of green zones around settlements, forests of the first and second zones of sanitary protection zones of water supply sources, forests of sanitary protection territories of resorts
Forests of Specially Protected Natural Areas	Reserves and protected areas, national natural parks, reserves, especially valuable forests, forests of scientific importance, including genetic reserves and natural monuments, walnut-fruit forests, juniper forests, pistachio forests

Source: Forest Code of the Kyrgyz Republic

Provincial forest administration units or State Forest Enterprises (*leshoz* or *leskhoz*) are in charge for forest management at the level of each region (*oblast*). Locally, more than forty *leshozes* are responsible for the protection and management of the forest and non-forested land located on *leshoz* territory, mainly pastures but sometimes also arable land. A *leshoz* is typically made up of a central office with technical and administrative staff and several forest rangers. Timber production is restricted to *leshoz* operations and involves only sanitation cuttings.

In the case of forest lands inside of *leshozes*, use rights are granted in the form of leases, for which fees are collected by the *leshoz*, who is responsible for its management including access to lease. Local communities do use forests for other purposes, including grazing animals, beekeeping, and collecting fruits, berries, nuts, and medicinal herbs and plants (Fisher et al., 2004). There are several different types of lease arrangements. For the forest lands lease periods start from 5 to 49 years depending on nature of activity (Forest Service, 2021). Leasing permits to collect firewood

(dead trees only) to use for cooking and heating. However, many of the forest users without official permission, also collect medicinal plants in small quantities for own consumption.

Forests with Non-timber forest products (NTFPs) cover a small area (less than 100,000 ha), but they play a crucial role in the life and economy of local communities for either subsistence products or sources of income (Undeland, 2012).

1.3 Fuelwood consumption in the Kyrgyz Republic

Wood and coal are the main cooking and heating fuel for the majority of Kyrgyz households and its importance increased significantly (Gottschling, Amatov, Lazkov, 2015). Wood fuel is not only an important source of energy, but its use relates to public sector interests such as environment, public health, rural development, employment and even foreign exchange (Githiomi, 2011).

During the Soviet era, between 400,000 m^3 and 500,000 m^3 of roundwood and 2 million m^3 of fuelwood were imported annually from the Russian Federation. In the early 1990s, imports fell sharply and with no alternative source of energy and raw material. The result was that people exploited timber and fuelwood from Kyrgyzstan's forests. However, a ban on domestic logging, introduced in 2007 resulted in an increase in timber imports from the Russian Federation (FAO, 2019).

In Kyrgyzstan annual wood demand for fuel is approximately 2 million m^3 and for timber approximately 160,000-500,000 m^3 (**Figure 2**). In order to meet domestic demand, the country import approximately 100,000 m^3 from Russia and SFF produces approximately 20,000-45,000 m^3 annually. Moreover, despite its 6.03% of forests, approximately 540,000 m^3 of wood are illegally logged annually (Undeland, 2012).

Today firewood is the most important energy source for the population (Schmidt, 2007) living in rural areas for cooking and heating, often the only available in rural areas (Arnold and Jongma, 1978). Out of all kyrgyz households, only about 17% have an access to modern district heating services, mainly in Bishkek and other urban centers.

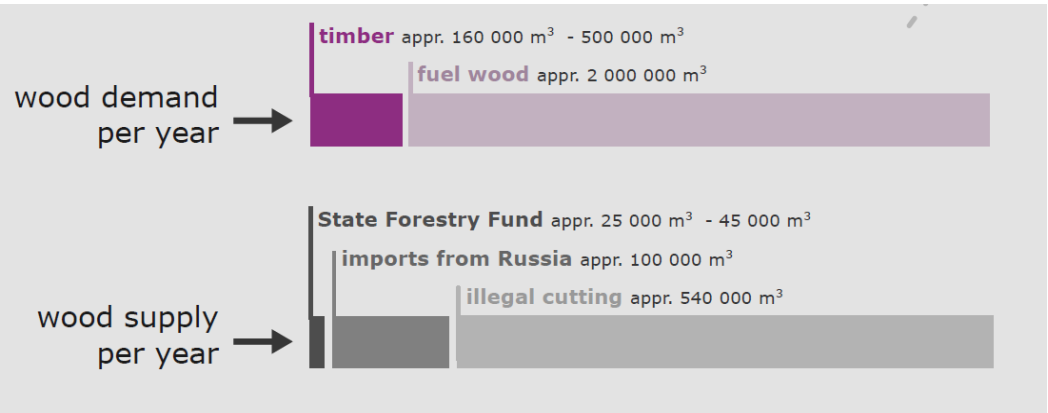

Figure 2. Wood demand and supply in Kyrgyzstan (World Agroforestry Organization (ICRAF))

The remaining households have to resort to individual heating solutions, primarily fueled by coal (60% of all households), electricity (15%), wood and dung (5%) or gas (1%) (World Bank, 2020). Alternatives sources of energy (**Table 5**) could help reducing firewood consumption in the region. However, they are very limited, especially for low-income households not only because of affordability issues but also infrastructure limitations (Balabanyan et al., 2015). The lower the income, the higher the reliance on solid fuels (coal, dung, wood): 97% in the lowest income tertile rely on solid fuels from wood to rubber to meet heating needs. Overuse of natural forests can lead to an overuse of the resources and a decrease of the genetic diversity of the species (Mamadzhanov, 2013)

Alarming losses of forests have had far reaching negative effects on the country's economy and welfare that pose a threat to the future sustainable development of the country, mainly due to the depletion of natural resources without creating effective alternatives, the loss of basic natural ecosystems and the stagnation of human capital (UN CBD, 2019)[1]. Some of the consequences include inadequate supply of wood fuel and timber that lead to illegal logging of trees causing environmental degradation. As a result, the stable reproduction of forest products is under threat.

[1] https://chm.cbd.int/database/record?documentID=243111

Table 5. Alternative sources of energy in the Kyrgyz Republic

Alternatives	Limitations
Electricity Supply	The capacity of the power network in Kyrgyzstan is already strained, causing recurrent winter power shortages and necessitating the rationing of electricity by means of yearly government plans with consumption limits for each region (The Government of the Kyrgyz Republic, 2019). A large-scale switch to electric heating solutions is not a viable alternative until significantly more generation capacity is added. Rough estimates indicate that a switch to electricity by households currently using solid fuel would increase winter peak load by up to 50%.
District Heating	An expansion of the district heating network is not an economically viable option in peri-urban and rural areas characterized by low heat load density and limited affordability. Access to district heating will likely remain limited to households located in major urban centers.
Gas and others	The gasification of the country is constrained by geography and income considerations, and access to gas remains limited to wealthier households in Bishkek and other cities. At the household level, renewable energy resources (e.g., solar or geothermal) are not yet financially viable for space heating applications, and woody biomass resources are limited.

It is indicated that with current trend of government policies and no major technologies, the use of fuelwood and other energy sources will increase (IEA, 2019). In the case of the Kyrgyz Republic's domestic energy demand, it is expected to increase (Colfer et al, 2005), as the country's 6.6 million (as of 2021) population is increasing and expected to increase since one third of the population is under the age of 14 years (National Statistic Committee, 2021), particularly the most intense exploitation occurs near the settlements (Schmidt, 2005). This needs to be assessed and subsequently addressed to avoid environmental degradation (Lindquist et al., 2016).

1.4 Problems in forestry in the Kyrgyz Republic

Before Russian Revolution in 1917, historically, people of the Kyrgyz Republic lived nomadic lifestyle mainly depending on pasturelands and forests. However, after incorporation by the Soviet Union until independence in 1991, Soviet Union's plan was to increase agriculture lands, which shaped current environmental conditions. There were massive timber harvests. The annual timber harvest from 1925 to 1950 was 3.7 times higher than the annual forest growth (Chebotarev, 1960). Through this unsustainable practice, the Kyrgyz Republic lost about half of its forest cover by 1966 (Undeland, 2012) and about 20 million hectares of land were designated for arable farming (Fisher et al., 2004).

After collapse of Soviet Union, along with the timber, fuelwood and other important resources from the former center stopped. Hence, people had to cope with this situation by creating new livelihood sources. In this regard, the access to nature-based resources became essential for survival, especially for people in rural areas (Steimann, 2011; Borchardt et al., 2011). Forests of the Kyrgyz Republic are continuously being degraded due to uncontrolled logging (Orozumbekov et al., 2009) as well as poor management. Overgrazing of pasturelands (Ammann, 2008) and agricultural intensification resulted in substantial amount of degraded lands (Mirzabaev et al., 2015). As a result, 36 % (about 160,000 ha) of juniper forests and walnut forests have been lost since 1968.

Harvesting timber for wood products and grazing remains major drivers of the forest degradation even these days. Particularly, forests which are comprised of spruce (*Picea schrenkiana*), juniper (*Juníperus*), walnut, fruit trees and pistachio are suffering significant degradation. Whereas coniferous forests were predominantly utilized for construction timber, pistachio wood was the main raw material for charcoal production. Walnut stands were exploited for their valuable burrs, and also for firewood. In recent years, illegal cutting of firewood has increased due to the energy crisis and high fuel prices (Musuraliev, 1998). A combination of factors including the cessation of subsidized timber from the former Soviet Union, rural poverty, a lack of alternative energy sources and the lack

of institutional capacity to protect and regulate forests have all added to the pressure on vulnerable forests of the region (Djanybekov, Dzhakypbekova, Chamberlain et al., 2015).

Today around 200,000 hectares within the SFF are considered as degraded and dry lands, which is approximately 1% of total territory of the country (Forest Service, 2021). Hence, the protection and rational use of forest resources is one of the most urgent problems in the country, on the correct solution of which the development of the economy, the improvement of the environment, and the well-being of the people largely depend.

In the Kyrgyz Republic pastureland is the dominant land use occupying about 85% of agricultural land, highlighting the vital role of livestock production for livelihoods (Djanybekov, Dzhakypbekova, Chamberlain et al., 2015). The number of livestock has been increasing rapidly during the past decade. Increasing livestock numbers put more pressure on natural ecosystems, leading to the degradation of grassland areas, especially near or close to villages (UNECE, 2019). The lack of assets due to the economic crisis and the disruption of seasonal migration patterns led to an overexploitation of easily, and accessible pastures that were located close to settlements (Kasymov, Undeland, Dörre et al., 2015).

Previous studies have shown that Jalalabad region has natural walnut and other fruit forest, which considered as a biodiversity hotspot (Fisher and Christopher, 2007) of international significance due to the diversity of woods (Venglovskii, 2015). However, as firewood becomes increasingly scarce around settlements, villagers have to go further and deeper into the forest to satisfy their daily fuel needs. Likewise, although an important source of income for local communities, unsustainable harvesting of NTFPs or Non-wood forest products (NWFP) such as walnuts, or wild crafted medicinal plants for export, poses a major threat to the conservation of the region's unique fruit and nut forests. In addition, trees are over aging, walnut yields are decreasing and regrowth of young trees is largely inhibited by over-grazing. A report by Conservation International (2008) on biodiversity hotspots estimates that some 90% of fruit and nut forest habitats have been lost across the region in the last 50 years (Eastwood et al., 2009).

Moreover, the expected climate change will have a significant impact on the living conditions and health of the population, but the water resources of the republic will be the most vulnerable, which will lead to a reduction in the development of hydropower, which is the main source of energy around country. People depend on tree resources for the provision of quality water, as well as of timber, wood-fuel, and food provided by the forests (Global Forest Resources Assessment, 2020). It is crucial to find alternative energy sources as well as reduce dependency on the natural forest as the primary source of fuelwood. Tackling this issue will not only provide a sustainable solution, but also prevent desertification and land degradation, thus mitigating the adverse impacts of climate change. However, this vital resource is underestimated (only 44% of actual forest uses are captured in formal agreements) and often mismanaged, to the detriment of the more than 2 million people who live near or on state forest land (Undeland, 2012).

Afforestation of walnut forests only has not been successful, because people cannot wait until the trees bear fruits. Therefore, planting walnut trees through agroforestry system was promoted by several donor projects, including GIZ's project "Community-based management of walnut forests and pasture in South of Kyrgyzstan (WALNUT)" which allows local farmers to plant and protect nut-fruit trees while getting immediate income.

1.5 Research Question and Objectives

This study identified willingness of local people to participate in forest rehabilitation through planting fast-growing tree species for fuelwood production in order to meet demand for fuelwood, investigated perception of local forest users on local environmental problems and agroforestry. In addition, this study identified issues among stakeholders related to the long-term forest land leases/tenure. The study focused on the following questions:

- Does the local people have willingness to grow fast-growing tree species for fuel-wood and income?
- What is the impact of walnut forests on the economy of local people?

- What is the perception of local people on local environmental problems?
- What are the challenges in participatory forest land management?
- What are the possible support/incentives the government can provide for local communities?

Global demand for nutritional crops such walnut and pistachio is expected to grow, which are dominant in the research area. Although walnuts and pistachios have been widely domesticated, maintaining wild populations is critically important for health of forests in the future. Particularly in the research area, this can be only done through participatory approach of communities living near or in the forests. Sustainable use of forests and forest resources can prevent land degradation and sequester large amounts of carbon to mitigate the climate crisis.

Taking into account people's need both in fuelwood, livestock as well as NTFPs, agroforestry may well offer opportunities to expand forest areas. Sustainable forest management offers unique opportunities to generate income of local families in the rural areas. Modernizing the fuelwood production sector can help improve rural livelihood and contribute to a better and sustainable forest management through more tree planting and more incomes. This study investigated the benefits associated to a range of potential mixed tree management. In order to achieve aims of this study, the following questions were established to address:

- Identify willingness to grow fast-growing tree species in order to meet demand of fuel-wood
- Investigate the impact of forests to the economy of local people
- Investigate the perception of local people on local environmental problems
- Identify the challenges in participatory forest land management
- Determine the possible support/incentives the government can provide for local communities for their participation in forest rehabilitation

Chapter 2. LITERATURE REVIEW

2.1. Benefits of planting fast-growing tree species

Transition to sustainable use of forest resources and land is an urgent need, since the Kyrgyz Republic's socio-economic development is largely based on the consumption of natural resources. Economic opportunities in mountainous and remote areas are mostly limited to livestock and subsistence farming (Undeland, 2012). Given the lack of other work opportunities in rural areas, the majority of rural people must turn to agriculture, putting pressure on arable land and increasing crop land at the expense of pastures and forests.

According to the analysis done by Djanibekov and Khamzina (2014) farm forestry was a viable option to manage agricultural production risks by diversifying land use activities in Uzbekistan (Djanybekov, Dzhakypbekova, Chamberlain et al., 2015). Experiments in Tajikistan showed that an agroforestry system with 12% trees, 30% alfalfa and 58% in traditional agriculture can improve drainage while decreasing salt accumulation at the root zone. Agroforestry on marginal croplands with *Elaeagnus angustifolia*, *Ulmus pumila* and *Populus euphratica* in irrigated area of Uzbekistan helped to rehabilitate such lands and to generate higher financial benefits than major crops. Households can save USD 50 annually by producing fuelwood for domestic energy instead of purchasing fossil fuels (Djanibekov et al., 2013). Agroforestry with *Robinia pseudoacacia*, and *Gleditsia triacanthos* can provide nutritious tree-based fodder that can help to reduce grazing pressure on forests. Estimated carbon sequestration potential ranges from under 100 Mt CO2 per year by 2030 to over 2000 Mt CO2 per year over a 30-year period. Afforestation using *Echinacea angustifolia* and *Populus euphratica* can store 17 and 23 tCO2 ha−1, respectively, over a five-year period. In addition, Djanibekov et al. (2015) showed that in northwest Uzbekistan, fuelwood from agroforestry can substitute for domestic energy sources and reduce the CO2 emissions of rural households.

Establishment of fast-growing plantations could reduce pressure on forests by helping to meet demand for fuelwood and timber (FAO, 2019). Many degraded pastures in Kyrgyzstan provide little

biomass. Farmers could apply agroforestry techniques to convert such plots to more valuable land if the location and status of such lands were publicly known (Djanybekov, Dzhakypbekova, Chamberlain et al., 2015).

Extending *Populus spp.* plantings in 250 m × 250 m gridded windbreaks to all the croplands of the Kyrgyz Republic would meet the local demand for timber and fuelwood in a country with limited forest resources (Aliev et al., 2017; Razhapbaev, 2017). Also combining production with conservation objectives can provide biodiversity and multiple ecosystem services (Brockerhoff et al. , 2008).

The effect of tree wind breaks on crop water consumption resulted in a reduction of water consumption of corn by 6.6% compared with open field condition as measured in Northern China (Liu et al., 2018). Water productivities, expressed as biomass increment per unit of water consumed, were investigated by Thomas et al. (2006) on poplars and other riparian plants in Xinjiang, China, by (Khamzina et al., 2012) for riparian trees in Khorezm, Uzbekistan, and by (Baier et al., 2021) on Paulownia (*Paulownia tomentosa* x *fortunei* Shan Tong) at Issyk Kul, Kyrgyzstan.

Measures to combat further degradation and support forest restoration could include, establishing plantations of fast-growing trees that would supply fuel and timber, together with controlling grazing pressure in forested areas (Forest Service, 2019; World Bank, 2019). Plantations of fast-growing trees would contribute to meeting fuelwood and timber demand, thus reducing the pressure on native forests (UNECE, 2019).

Forest restoration can also be accomplished with fast-growing native species under less-degraded conditions (Stanturf et al., 2019). Integrating forest landscape restoration (FLR) principles and improved environmental standards into the entire value chain for goods and services can contribute to long-term FLR success. For example, in Central Kalimantan (Indonesia), green rural development and financial incentives created through timber production are achieved using fast-growing native species (*Anthocephalus spp.* and *Azadirachta excelsa*) and developing markets for innovative products (Schwegler, 2017). Market analyses and product innovation for fast-growing

timber species have proven crucial to safeguard high returns over a relatively short time (Stanturf et al., 2019).

Forests defined in very different ways, from numerous perspectives, by different actors: as a specific type of ecosystem; as an area producing a diversity of wood and NTFPs (Meybeck et al., 2020). Forests and trees also provide numerous materials used for building, furniture, tools, handicraft as well as numerous substances used in both traditional and occidental medicine (Meybeck et al., 2020). Given the multiple roles of forests in providing income, nutritious foods and cooking wood, and as providers of support functions for agriculture (HLPE, 2017) it is important to sustainably manage forests. The explicit role of afforestation in moving towards carbon neutrality and greenhouse gas mitigation and policy makers are now looking at ways to mitigate greenhouse gas production as agricultural production is increased in response to increasing global demands for food (Ryan et al., 2016).

Because of poverty and other social problems, people who live around the country's forests experience difficulties in covering the increased cost of principal energy sources such as electricity, gas, coal, and firewood. Especially for the rural population fuelwood is the primary source of energy. As a result, people in the remote areas illegally harvest firewood (Orozumbekov et al., 2009)

In the case of forest lands inside of *leshozes*, use rights are granted in the form of leases, for which fees are collected by the *leshoz*, who is responsible for its management including access to lease. For the forest lands lease periods start from 5 to 50 years depending on nature of activety (Forest Service, 2021). There are several different types of lease arrangements. In addition to leases which allow collection of forest products, lease arrangements are also made which allow use of *leshoz* land for haymaking or tilling (Fisher et al., 2004). Leasing permits to collect firewood to use for cooking and heating. However, many of the forest users without official permission, also collect medicinal plants in small quantities for own consumption or selling as well as firewood.

Tree planting helps to increase the number of trees in the landscape where people live and need wood or other tree products (Aliev et al., 2017). So people have less demand to use wood from

forests and forest degradation can be avoided. For the tree shelterbelts *Poplars* are mainly used In Central Asia (Aliev et al., 2017).

Due to an increasing population, demand for firewood is going to increase (Colfer et al, 2005), particularly the most intense exploitation occurs near the settlements (Schmidt, 2005). This needs to be assessed and subsequently addressed to avoid environmental degradation (Lindquist et al., 2016).

A strategy to increase the adoption of shelterbelts (in order to take advantage of their ecosystem services) is to put stronger emphasis in argumentation on those benefits that are ranked highest by the farmers. These include the provision of construction material, firewood and fences. This requires perception of the farmers and support from the government, international organizations, NGOs and donors that have so far been promoting SFM, CBFM.

One of the main features of the new regulations was that CFM leases were to be issued for five years in the first instance and then would extended for an additional 49 years where tenant receives 100 % of all income and products harvested under the lease. Another form of lease (issued under Decree No 226) is a long term lease in which people pay a percentage of the value of the harvest in cash. These long term leases sometimes cover very big areas and are not limited to forest plots (Fisher et al., 2004).

2.2. Importance of willingness of local people in forest rehabilitation

Even in the context of preservation, the source of pressure on forests is mostly from local communities, so an understanding of community interests and usage patterns is critical to having a full picture of forest management issues in the country (Undeland, 2012). Patterns of forest usage by nearby communities also affects downstream communities, which do not have direct access to forest resources but depend on them for grazing livestock, obtaining fuelwood and timber, and accessing irrigation and drinking water (Undeland, 2012).

There are many synergies between the provisioning and regulating ecosystem services of shelterbelts, which can be best communicated at community level managed by local farmers under

supervision and support of experts from the forestry agencies. This requires willingness from the side of the farmers and support from organizations in the promotion of tree planting. Because, human behaviors on the environment are based on complex physiological and social values (Clayton and Myers, 2015) comprising beliefs, affective responses, and intentions that people hold toward environmental issues and activities (McIntyre and Milfont, 2016)

Chen et al. (2006) observed that better-educated households consume less fuelwood. The better educated are more aware of the health issues related to indoor pollution caused by fuelwood and other types of sources for heating and cooking (Chen et al., 2006). Yang et.al.2017 says that in their study it was observed that the change in tenure is estimated to increase the fuelwood consumption from own-plots. (Yang et al., 2017).

The results of study of Buhari Abdulkarim et.al (2017) also showed that in Malaysia the farmers' perception and behavior toward conserving ecological functions were significantly positively affected by their perception toward conserving hydrological functions of the watershed. If the farmers' awareness and perception about the environmental conservation are remarkable, they influence a lot to the farmers' attitude toward conservation. Moreover, the result shows a positive response to define perception toward forest watershed conservation (Abdukarim et al., 2017).

A proper study and understanding of farmers' attitudes are essential when creating CBFM, SFM related programs that encourage stakeholders' participation (Milfont and Duckitt, 2004). Successful environmental outcomes cannot be achieved without understanding mindset and attitudes of people towards forest conservation. One of the most popular measures of ecological worldview, predicting environmental attitudes and behaviors, is the New Ecological Paradigm (NEP) Scale, developed by Dunlap and Van Liere, which has been applied to measure children's environmental attitudes (Kopnina, 2011; Thomson, 2013). NEP focuses on beliefs about humanity's ability to upset nature, the existence of limits to human economic growth and development, and humanity's right to rule the nature (Dunlap and Van Liere, 1978; Dunlap et al., 2000). Since its inception, the NEP scale has been used to measure environmental attitudes, beliefs in several countries from different social categories, including farmers, students, and nationally representative samples (Johnson and

Onwuegbuzie, 2004; Pahl et al., 2005). Multiple studies have shown that the new pro-ecological paradigm is significantly related to behavioral intentions (Casey and Scott, 2006; Rauwald and Moore, 2002).

2.3. Importance of incentives for forest users

Incentive-based land tenure can help achieve conservation of forests and improve livelihood jointly (Huberman, 2008). If sufficient incentives are provided, through collection of NTFPs, local households can diversify incomes, while at the same time increasing household's adaptation to climate change through increasing forest cover.

In Kazakhstan in 2009, financial support was introduced for fruit plantations. Under the program, farmers had to plant a minimum of 5 ha, use drip irrigation, install fruit frames, and assess technical sustainable production. Such support excludes small-scale farms that use ancestral varieties with low-input and traditional practices, as well as orchards and vineyards inherited from *kolkhozes* and *sovkhozes*.

According to Quy Khuc et al. (2021) in Vietnam, despite awareness and perception and a high dependency on forests, it is not confirmed whether forest landholders will participate in new forest practices. The only possible way is higher the financial incentives, the higher the willingness to participate in SFM. In Bhutan's recent embrace of markets in community forestry models can dually fund community activities and increase rural livelihoods through permitting the sale of community forest products (Belsky, 2014).

The expansion of non-industrial private forests (NIPF) in Ireland is unique in which the almost doubling of forest cover within the last thirty years has taken place largely on farmland. In addition, the expansion was facilitated by a series of Irish and European Union subsidies which incentivized the afforestation of agricultural land (Ryan et al., 2016). Such studies within western sociocultural contexts strongly suggest that positive attitudes are important for environmental behavior (Ajzen and Driver, 1992; Ajzen and Fishbein, 1980; Fielding and Louis, 2008) of farmers.

In Uganda, when farmers were paid the value of the timber (USD 28 per hectare per year) for not felling timber trees, deforestation rates were reduced by up to 9 % (Jayachandran et al., 2017). While in Nepal, varying degree of household's fuel-wood dependence on the forests is primarily driven by their socio-economic conditions (Sapkota et.al, 2008). The study of Zhang (2007) showed that secured rights to land and market factors influence positively on farmers forest plantation activities and investment in Ghana. Nonetheless, to the extent that Ghana can be considered representative of the tropics, the Ghanaian experience in forest plantations may be informative to other countries. Ghana has generally been one of the most stable countries with one of the better economies in Africa.

2.4. Enhancement of participatory forest rehabilitation

During the Soviet, there was no need for multifunctional forest management, since forest products such as timber were provided from other parts of Soviet (FAO, 2014). Sustainable use of forest resources for the benefit of the national economy and local population started to be discussed since independence (Fisher et al., 2004) in 1991.

At global level there are increasing demands on forests for conservation, for more wood and NWFP (FAO, 2021). Kyrgyzstan, became the first reform state in Central Asia in terms of privatization and the commodification of land titles, agricultural infrastructure, and services (Dekker, 2017). The government's resolution 'On the procedure of providing pastures for lease and use' introduced in 2002 based the advice of the World Bank can be seen as a consequential attempt to fill a perceived legal gap (Kasymov, Undeland, Dörre et al., 2015).

Since 2001 when CBFM first started in Kyrgyzstan, the model has spread throughout the regions through people's trading markets near the roads, cafes etc. There are fewer cases of CBFM arrangements when households lease land for planting trees. However, this is because people are not aware of the fast-growing species. The most vulnerable communities can find a source of income through wood fuel and NWFP collection and sale (Angelsen and Wunder, 2003; Mulenga et al., 2012).

Modernizing the traditional wood energy sector has the potential to improve livelihoods, create sustainable value chains and unlock resources for investments in sustainable forest management (FAO, 2021)

Tenure regimes revolve primarily around use arrangements with *leshoz*. Several types of formal and informal arrangements allow access to forests and use of their various resources. Forest According to the resolution of the Government of the Kyrgyz Republic dated April 10, 2018 No. 192 On approval of the Procedure for the use and disposition of the SFF, the following types of forest uses can be carried out on the lands of the SFF:

1. farming, haymaking, grazing, placement of apiaries, collection of wild food resources, medicinal plants, technical raw materials;
2. harvesting of secondary forest resources;
3. reproduction of forest resources;
4. use of the forest for research, cultural, recreational and tourism purposes, as well as for the needs of the hunting economy;
5. performance of works for the development of mineral deposits (geological study of subsoil, development of mineral deposits);
6. use of water reservoirs;
7. community forest management;
8. performance of works for the construction of power plants using renewable energy sources[2]

Local communities use forests for many purposes other than timber, including for grazing animals; beekeeping; and collecting fruits, nuts, berries, mushrooms, food, and medicinal herbs and plants (**Table 6**). NTFPs play a crucial role in the life and economy of local communities, either for subsistence or as source of major or supplemental income. In fact, using forest land as pasture for grazing livestock is seen as the most significant use for communities. In the fruit and nut forests in

[2] http://cbd.minjust.gov.kg/act/view/ru-ru/11731?cl=ru-ru

the southern part of the country, collecting nuts for commercial purposes plays a major role for local communities.

Table 6. Area of major non-timber forest products in Kyrgyzstan

NTFP	Area (in hectares)
Walnut trees	35,000
Pistachio trees	33,000
Almond trees	1,600
Apple trees	16,700
Apricot trees	1,000
Cherry plum trees	400
Hawthorn bushes	2,500
Sea buckthorn bushes	3,600

Source: Forest Service (2010)

CBFM was formally introduced in 2001 with the support of the Kyrgyz-Swiss Forestry Program (KIRFOR). It was introduced as one of the tools of Joint Forest Management, which aimed to establish partnerships between local governments, forestry management, and the population for sustainable forest management. It was designed to empower a group of households or (ideally) a whole community to manage large patches of forest land to better preserve the forests while improving their livelihoods. The KIRFOR started piloting this type of forest use in walnut and other fruit-bearing-tree forests in the southern part of the country because these forests are extremely important for biodiversity preservation. They are under heavy pressure from local communities, and it was hoped that the benefits of CBFM to the local population would be significant and immediate. However, this model has started to spread on its own in other areas as well, when people have entered into CBFM to lease areas near roads to organize trading markets or cafes in places where tourists frequent. There are fewer cases of CBFM arrangements when households lease land for planting trees (A. Undeland, 2012)

In the past, the experiences have shown that rapid spread of Community Forest Management (CFM) leases to areas with different types of forests and quite different linkages between settlements and forests were problematic due to the development based on very limited field experience and unanticipated effects have occurred (Fisher et al., 2004). Another challenge was and still existing is the communication between the state, local authorities and local individuals.

The approach to forest management in Kyrgyzstan (Collaborative Forest Management (CFM)), started to be used since September 1995 (Blaser et al. 1998) and a subsequently elaborated action plan for walnut and pistachio forests (Goslesagentsvo, 1996). Based on discussion of participatory approaches to forest management, several projects were implemented to explore collaborative management of NTFPs in the forests where study area is located in 1998 (Fisher et al., 2004). For example, the Kyrgyz-Swiss Forest Support Programme (KyrLes Programme) supported by Switzerland and realized by the Swiss Agency for Development and Cooperation "Intercooperation" aimed to support the country's forest sector focusing on people, trees and forests. Sustainable utilization of forest resources brings significant input in satisfaction of vital needs of local population, increasing their interest in protection and preservation of forests (Fisher et al., 2004). Through this programme, the *leshozes* developed a lease model which rapidly expanded into a national programme, ultimately supported by National CFM Regulations, signed on 7 July 2001 (Decree Number 377) (Fisher et al., 2004).

Deforestation from shifting agriculture, grazing, and fire created a highly degraded landscape in Denmark centuries ago (Madsen et al., 2005) and people needed wood for construction and fuel. Overgrazing and fire also destroyed the heather, exposing sandy soil to wind erosion. Because of harsh growing conditions, survival and growth of planted seedlings were low and only non-native conifers such as mountain pine (*Pinus mugo* Turra) could survive. One lesson to draw from the Danish experience is the importance of citizen support (Stanturf et.al., 2017).

Similarly, Charles E. Owubah et.al. states that the probability of a farmer engaging in sustainable forestry practices is applicable to Ghana and may be applicable to similarly situated countries. They also say that if sustainable management of forests is a desired goal, then their results

suggest incremental changes in tenure variables transferability, comprehensiveness, economic compensation, and duration which would facilitate achievement. Economic compensation is the most significant tenure variable affecting adoption and implementation of sustainable forestry practices. However, Holmes-Watts and Watts (2008) stated in their assessment of participatory natural resource management in Southern Cape forests in South Africa that organizing meetings appears to be the only activity that forestry officials seem to understand well when implementing participatory forest, although these meetings often turn out to be empty talks, without yielding local benefits (Chirwa et.al, 2012).

Melak et al. (2021) said that forest conservation initiatives should promote education, alternative livelihoods, and intensive land management in Ethiopia for a more positive perception of farmers towards conservation of forests (Melak et al., 2021). In Kenya engaging local community members during the research process shows the ways in which local knowledge and geographic analyses complement learning about the opportunities viewed critical in any resource management plan (Slocum et al. 1998). Moreover, communities living further from the forest reserve can propagate fast-growing trees in their farmlands (Kaburi et al., 2011). Furthermore, GregHiemstra-van der Horst et al. (2009) said in their work that rather than creating degradation and hardship, fuelwood vending provides an important source of low-cost energy to urbanites who find collection difficult or undesirable and a key income generating opportunity for hinterland residents.

2.5. Advantages of application of planting mixed tree species

Depending on restoration goals and objectives, planted forests may include planting of mixed tree species to meet food and nutrition security; short- or long-rotation plantations or mixed-species plantings for timber, fuelwood, and livelihood diversification; or silvicultural treatments to restore species and structure to native forests (Kleine et al., 2019). In the areas like Arimzhan, agroforestry can be applied since agroforestry is reported to have a positive impact on livelihoods (Nyaruai, 2016).

The *leshoz* land and the forests upon them must therefore be considered in the context not only of national objectives to preserve forests, but also of their de facto role in the communities around them. About 2.4 million people live in proximity to forests with about 1.8 million, or 31% of the country's population reliant, to some extent, on forest resources: for example, the walnut and wild fruit forests in Jalal-Abad province and the surrounding area are home to 1.2 million people (UNECE, 2020). However, people who live around the country's forests usually do not have many economic opportunities. Their villages are often high in the mountains, far from *rayon* centers and towns, with poor infrastructure and limited jobs.

Previous studies on the factors impacting the adoption of planting mixed trees or agroforestry systems found land tenure to affect adoption significantly (Steimann, 2011). A further strategy is to broaden the focus of agroforestry extension to include not only shelterbelts but to integrate more prominently the planting of fruit trees into extension strategies as a way to generate additional income and to diversify the basis of livelihoods (Ruppert et.al 2020). Some of the major agroforestry type practices found within the CAC, each with associated benefits and functions such as silvopasture, which combines trees and livestock, which could involve planting of fodder trees, tree-based understory fodder production-hay-making, and/or grazing and cover-crops for orchard floor management. Forest grazing, which is similar, consists of grazing of animals under the forest canopy (Djanybekov, Dzhakypbekova, Chamberlain et al., 2015).

Although nut and fruit collection is mainly undertaken in the south of the country, berries and medicinal herbs are collected everywhere (Forest Service, 2021). In the *leshozes* with walnut and pistachio forests, leases allow people to collect a certain amount of fuelwood, to obtain agricultural plots, to collect hay or to harvest walnuts or fruits for sale (FAO, 2004). Forest users in exchange for access to forest resources pay a share of the walnut harvest (40-70%), a set amount of walnuts depending on the size of the family (100-400 kg), payment in cash, or carry out certain task for the *leshoz*, such as collecting seeds or preparing and planting of seedlings. In some cases, in exchange for labour implemented for the leshoz, a person can use forest resources free of charge (Fisher et al., 2004).

By integrating crop/livestock production and tree planting, agroforestry has the potential to diversify and increase farmers' production through the provision of food, wood, fibre and medicines, while providing environmental and social benefits, such as enhanced soil fertility, erosion control, water regulation, carbon sequestration, biodiversity and resilience to natural hazards (Garrity, 1995; Catacutan et al., 2017).

Planting mixed tree species offers the potential to diversify household income sources through the production of fruits, fodder, wood for fuel and construction, medical substances, fibres and waxes (FAO 2020). According to the recommendations of the UN Convention to Combat Desertification (UNCCD), agroforestry is recognized as one of the areas that combat land degradation (UNECE, 2020).

The results of the study done by Thevs et al. (2018) show that starting new tree – crop plantations does barely yield an income. In contrast, cutting some older trees, selling the timber, and start with young walnut trees plus crops does yield an income. Cutting some trees for their timber allows farmers to start off with some money, which allows them to cover fencing costs in order to protect leased lands from livestock and bridge low income period before the walnut trees bear fruits. (Thevs et al., 2018) Through the same study Thevs et al. (2018) selected suitable mother trees against the expected impact of climate change. (Thevs et al., 2018).

Thevs and Aliev (2021) did a sensitivity analysis for tree wind breaks combined with cotton, in which a range of increasing and decreasing cotton and tree revenues were assumed. The range for the revenue by cotton was 20 % above and below the interview results, while the range for the tree revenues (15 years old trees) was from KGS 2000 to KGS 3000 per tree. The absolute values of water productivity changed drastically, in particular with changing cotton revenues, but never rendered the water productivity of the tree wind break system lower than cotton under open field conditions.

In the context of the Fergana Valley, it is recommended to establish tree wind breaks along field boundaries or irrigation ditches, in order not to cut through field plots and impede farm operations, with an average distance of 200 m between tree wind breaks. Furthermore, simple tree

lines are put forward, as larger belts of multiple tree rows have been shown not to attain financial gains and save less water than the single tree lines (Thevs, Aliev, Lleshi, 2021).

In Thailand shrub species such as *W. tinctorial (WETI), M. rotundifolia (MIRO), B. retusa* and *Z. oenoplia (ZIOE)* are often used for firewood and construction. Utilization by communities have an impact on the natural restoration of forest ecosystems in the community forest (Thammanu et al., 2021).

In Eastern Kenya the maize planted on the same plots as woody plants had 30 % less yield than when planted in fields without trees (Ndlovu, 2013). Nevertheless, woody species provided substantial returns for farmers (between USD 50-80 depending on size and quality) when harvested after 8 years; consequently, this income can offset the annual income losses due to a reduced yield by generating a positive incremental benefit for the farmers, as well as a range of environmental benefits for society at large (FAO, 2020).

A recent study showed that local people in all parishes around Budongo Forest, Uganda use wood fuel, poles, timber, and Luti (wood for tobacco curing) regularly (Kasolo 2005) Buffer zone agroforestry can be practiced in a delineated external buffer zone around the Budongo Forest resource base, to supply products such as poles, firewood and timber which are ordinarily harvested from the protected forest area by local communities. Woodlots, boundary planting, scattering on farms and home gardens were nevertheless, indicated as the most suitable technologies by all parishes. Buffer zone agroforestry has a potential for enhancing the protection status of natural forests which are threatened by high extractive activities by dependent communities. Species which are commonly harvested from the forest can be integrated into farming systems around the forest, to provide alternative sources for the associated products and services (W.K. Kasolo et.al. 2008).

Promotion of Multiple-use Forest Management in the timber concessions of Congo is possible based on studies of Lescuyer et al. (2015) through the presence of agriculture within logging concessions would justify a reduction in their area and it could improve local development in agroforestry, tree plantations and animal breeding. Also, local population would reduce several illegal practices such as selling land or commercial hunting and curb the expansion of shifting cultivation.

These would be reasonable for the State to accept a reduction in forest tax revenues in anticipation of an increase in economic activity at the local level (Lescuyer et al. 2015).

Chapter 3. MATERIALS AND METHODS

3.1. Research framework

Nowadays when carbon pricing development is one of the main topics in the world, conservation of a forest is a form of investment for each country. Hence, role of communities living near the forests is crucial. A farmer's willingness to sustainably use forests is largely influenced by the income they get from the forest (Chirwa et al, 2012).

While the value of a forest depends on its meaning to the society, its value in present arises from the viewing of its value in the future. If the farmer's perception of the future value of the forest is high, the forest will most likely be conserved and sustainably used (Melak et al., 2021). In other words, the farmer's value for the forest is positive and they would be willing to pay for the sustainable forestry practices (SFP) for their near future. Nonetheless, the achievement to SFP and CBFM by local people will not be reached until an answer can be given to the main question, 'Is there perception of individuals to be engaged in tree growing?' This question can be answered through simplified forest land lease arrangement, policy reforms and capacity building of households living nearby forest.

The research process began from development of analytical framework. Details are presented in (**Figure 3**) below.

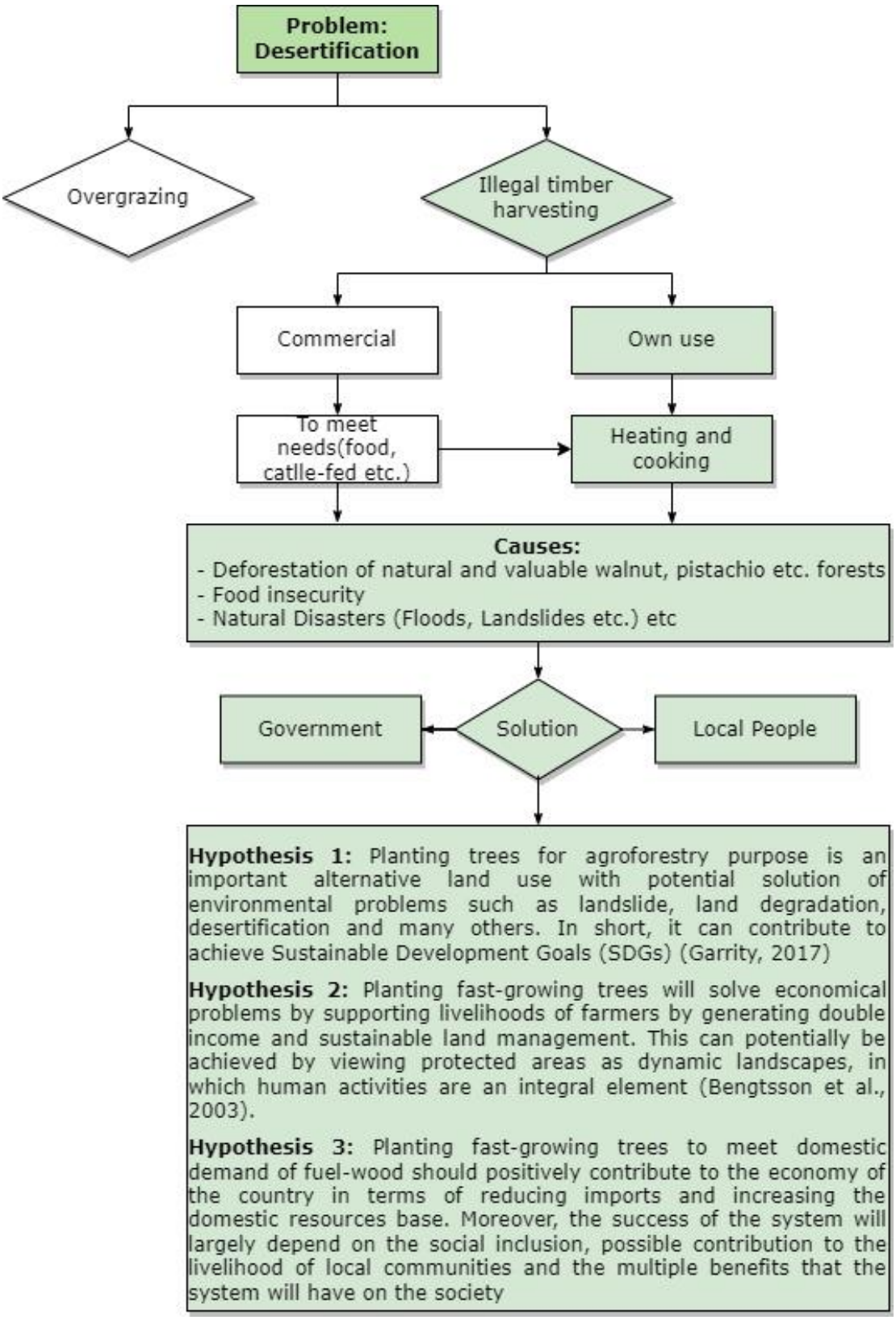

Figure 3. The research framework

After identification of major research questions and analytical methods (**Figure 4**), the actual research work has begun. Observation was done on existing problems related to forest loss due to illegal harvesting for fuelwood through a review of literature about the recent forest sector in the Kyrgyz Republic, as well as an assessment of legislation and policy documents related to the forestry sector, including national policies, national plans/programmes, and official reports produced by state forestry bodies, NGOs and international organization.

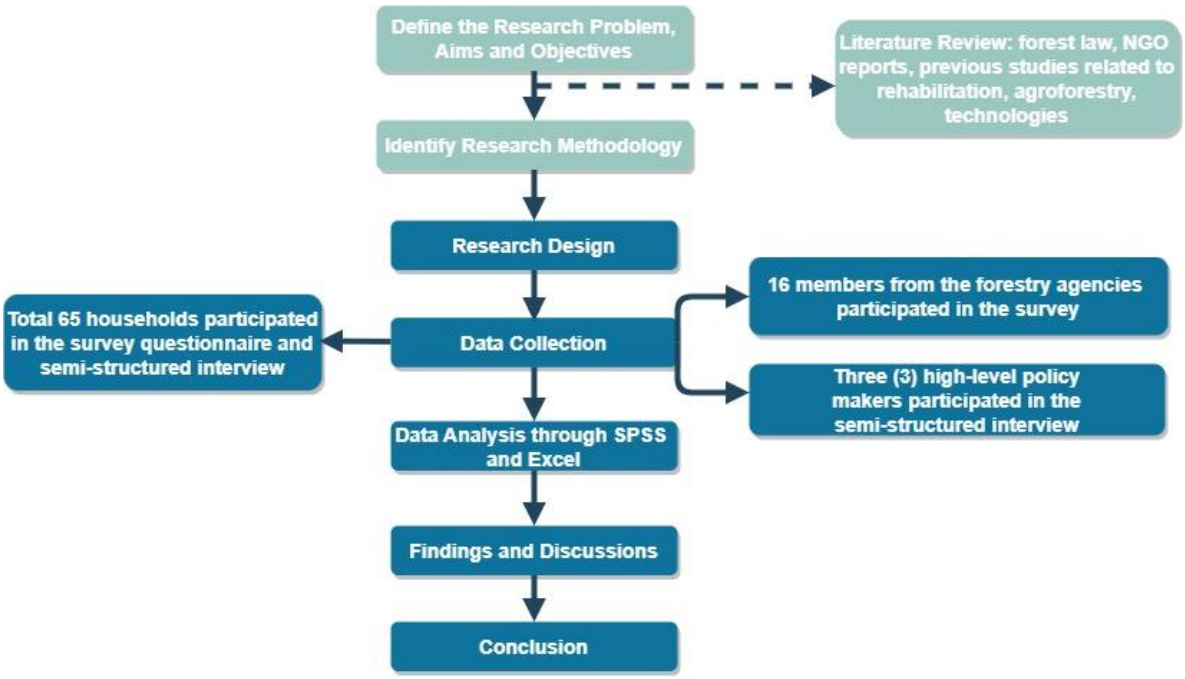

Figure 4. Flowchart and steps of the study

Based on secondary data, next stage was design of survey questionnaires which were used to gather the data required to meet the research questions. Due to different nature of respondents, the research covered forest-user households, non-forest user households as well as central and local government officials working in the forestry sector. Separate questionnaires were developed for each four different respondents. After translation into local Kyrgyz and Russian languages for a better participation of respondents, the survey questionnaires were pre-tested at field level for verification and modifications.

Field survey was implemented from August to November 2021 and finished processing the data in February 2022. All semi-structured interviews and focus group discussions with experts and stakeholders were conducted the same period.

The field interviews and survey focused on Toskool-Ata *leshoz* area, which the Forest Service proposed for the study. The aim of the field survey was to understand the core issues of access to forest resources, resource use, and recommendations for improving resource governance. Sixty-five heads of households were interviewed with a combination of two methods for sampling respondents: a snowball method for identifying users and non-users of forest resources, as well as simple random sampling based on annual *leshoz* logs of lease agreements using logs from the past year. The combination of the two methods produced a selection of users who have official permits for the use of forest resources and users who do not have official permits but nonetheless continue to use and consume these resources.

The three sustainable forestry practices - namely preservation of endemic, economically valuable nut trees (walnut and pistachio), conservation of natural forests, and establishment of forest plantations for fuelwood consumption through application of planting mixed tree species are the dependent variables in this research. Responses to all dependent variables are binary.

3.2. Study area

In Jalalabad *oblast* (region) where the study site is located, total forest fund is 1,036,289.2 hectares, of which only 396,024.3 hectares are covered with trees. There are 1,279,081 people living within and around forests in the *oblast*. Walnut and wild fruit forests cover 631,000 hectares and are distributed mainly in southern Kyrgyzstan with the largest contiguous areas on the slopes of the provinces Jalal-Abad (Chatkal district) and Fergana ranges between 1,000 meters and 2,200 meters a.s.l. (USAID, 2001). These forests are a mixture of walnut (*J. regia*) and a number of wild and ancient species of apple, pear, cherry, plum, almond and other fruits mainly belonging to the family Rosaceae. At lower elevations, pistachio dominates parts of these forests. Riparian forests (*tugai*

forests) form narrow strips along most of the rivers, with willow (*Salix alba*), birch (*Betula*), Euphrates poplar (*Populus euphratica*) and sea buckthorn as the main species (Forest Service, 2019).

The study area is located within the boundaries of the Nooken district (**Figure 5**) of the Jalal-Abad region. Forests in the Nooken district which covers an area of about 247,342 hectares (27 %) are unevenly distributed. They are located in the form of a ribbon up to 20 kilometers wide in the north - eastern part of the region, below the belt of alpine and subalpine meadows. The elevation of the district steadily climbs up from the southern parts lying lower than 1,000 meters to high peaks of over 4,000 meters.

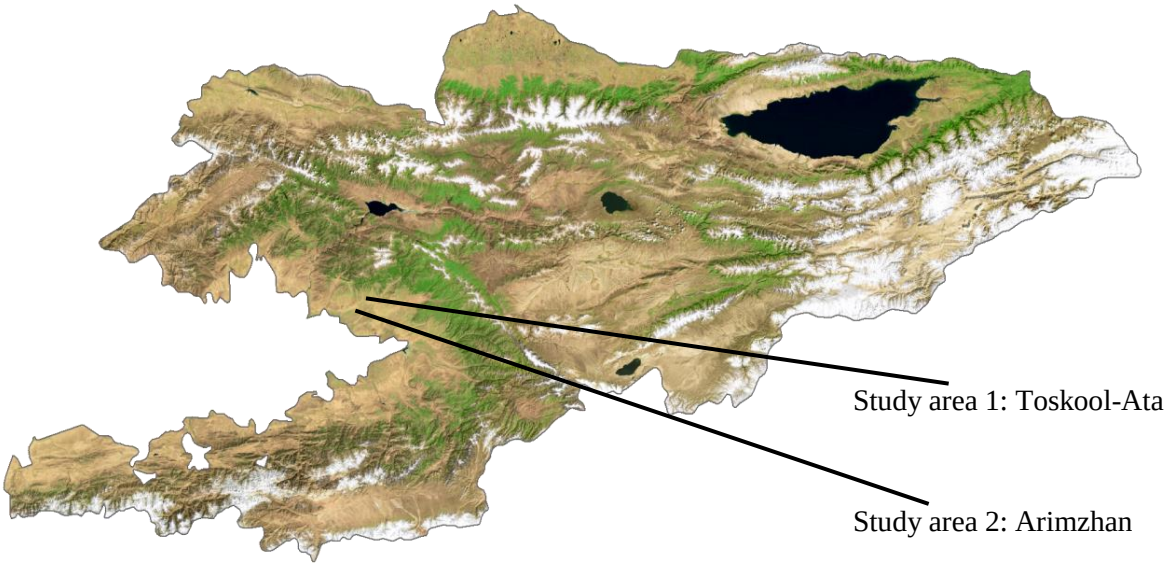

Figure 5. Location of study area (Jalalabad, Kyrgyzstan)

The study was conducted in Toskool-Ata (41°12′10″N, 72°41′30″E) (**Figure 6**). As seen in the **Figure 6**, areas closer to the settlements are degraded due to illegal logging and overgrazing (Beer et al., 2008; Frohardt, 2010).

Figure 6. Toskool-Ata landscape

Figure 7. Arimzhan landscape

In Toskool-Ata, there are 2,180 populations (National Statistic Committee, 2021), which occupy the lower mountain slopes at an altitude of roughly 1,300 meters to 1,800 meters a.s.l. Forests in Toksool-Ata comprise both naturally occurring and human-modified walnut, pistachio, apple and other fruit-bearing tree species (**Table 7**).

Table 7. Distribution of species in the study area

S/N	Tree species	Frequency (ha)	Percent (%)
1	Walnut (*Juglans regia*)	1887.4	5.86
2	Pistachio (*Pistacia vera*)	6131.7	19.05
3	Almond	27.6	0.09
4	Apple	417.8	1.30
5	Maple	5672.3	17.62
6	Hawthorn (*Crataegus*)	8468.2	26.31
7	Juniper (*Junípérus*)	5964.2	18.53
8	Spruce (*Pícea*)	62.6	0.19
9	Populus (*Pópulus*)	14.5	0.05
10	Riparian (*Tugai*) vegetation	31.1	0.10
11	Other shrubs	3500.9	10.88
12	Other trees	5.6	0.02

Source: Toskool-Ata leshoz

Toskool-Ata *leshoz* was organized in 1997 on March 12 on the basis of Decree No. 142 of the Government of the Kyrgyz Republic. The territory of the Toskool-Ata *leshoz* consists of one

massif. The length of the forestry territory from north to south is 37 km, from west to east - 21 km. The total territory of the Toskool-Ata *leshoz* is 71,723.3 hectares, whereas 33,673.7 hectares are forest land (47%). Among 47% of forest land, 29,214.2 hectares are covered with trees (**Table 8**). As a state body, the *leshoz* pursues a forest policy on its territory in accordance with the FC and at the same time has the following goals: to protect the forest fund, to carry out reforestation and afforestation, to improve the standard of living of the population (Forest Service, 2021).

Table 8. Distribution of forest land category in the study area

Land category	Hectares	Tenured land	% of used land	Number of renters (tenure)
Forest land covered with tree	29,538.5	2,066.38	7	550
Forest culture	5,690.5			
Unclosed forest crops	655			
Nursery	3.3			
Resin	552.3			
Clearings and wastelands	3150			
Irrigated arable land	19.1	6.45	33.7	21
Rainfed arable land	277.1	101	36	85
Hayfield	297.03	122.5	41	23
Pasture land	29,759.1	12,019.5		159
Garden	93.1	11.9	12.7	10
Homestead	367.1			
Swamp	4.8			
Water	62.3			
Other type of land	6,805.8			

Source: Toskool-Ata leshoz

Until 1917, forests in Toskool-Ata *leshoz*, were declared state-owned and were under the administrative subordination of the local bodies of the resettlement department of the Ministry of Agriculture and State Property. Despite the fact that these forests were state-owned, they were exploited by various entrepreneurs. After 1917, the forests repeatedly passed from one department to another, which negatively affected the conditions of forests. Some departments were engaged only in logging, others in the harvesting of fruits, and none was involved in protection and restoration. The

forests suffered enormous damage in the period preceding the establishment of their final ownership. Arborist A.E. Dyachenko (1964) emphasized that the areas of walnut forests with such management are doomed to decrease. Forests suffered enormous damage during the World War II.

In order to better understand which factors promote farmers' environmental behavior, in this study case, application of planting fast-growing tree species and the planting and maintenance of protective tree shelterbelts, we selected two case study regions to identify similarities and differences in two geographical locations. Comparative approach through survey for people living nearby forests and people living far from forests was conducted in Arimzhan (41°02'07.0"N, 72°34'55.5"E) (**Figure 7**) with 2,141 populations mostly doing agricultural activities.

Whole Southern Kyrgyzstan, belongs to the vast botanical-geographical region of the ancient Middle Earth, its Western Asian sub region and, according to plant zoning, is included in the district of the western Tien Shan. In Southern Kyrgyzstan, Professor P.A. Gan identified four forest-growing regions: Chatkal, Fergana, Fergana-Alai and Turkestan-Alai. The territory of the Toskool-Ata *leshoz* is located in the northern part of the Fergana forest region with five forest belts namely belt of desert pistachio woodlands and small shrubs, belt of steppe pistachio woodlands, forest belt, subalpine belt, alpine belt.

On the territory of the Toskool-Ata *leshoz* there are all five forest belts. This forest region ranks first in Kyrgyzstan in terms of forest cover. This is due to the extremely favorable thermal and humid climatic conditions in the mountains, which create preconditions for the development of the most valuable nut plantations here. The walnut-fruit and pistachio forests of Kyrgyzstan represent a peculiar feature not just of the country but also of the whole Central Asian region (Kasymov, Undeland, Dörre et al., 2015). Taking into account the special value and important national economic importance, walnut forests have the status of the State Forestry Reserve with a special regime of use. Because they are considered as a biodiversity hotspot of international importance (Rehnus, 2011). The forests of the walnut zone are characterized by a wide variety of tree and shrub species, comprising over 120 species, of which 20 of tree species and about the same number of shrubs are forest-forming species.

Located within a vast desert region, this mountainous region is dominated by dry continental air. However, the penetrating masses of the sea air of the Atlantic in the spring and autumn periods leave a significant amount of precipitation here. Therefore, the area is sharply distinguished by very favorable agro-climatic conditions against the background of a sharply continental and mostly arid area. These climate features are determined mainly by the geomorphological structure of the region, the location of the surrounding ranges, their absolute height and exposure to humid air.

Mountain ranges, located perpendicular to the main direction of moist winds, create conditions for up to 850-1200 mm of precipitation per year and average temperature in July is 20.5 °C and an average January temperature of 3.1 °C (Grisa et. al. 2008). A solid wall of high mountains from the west, north and east protects the area in the winter season from the direct entry of cold air. In general, the climatic conditions of the forestry have a positive effect on the growth of tree and shrub species here, their most important representatives - real pistachio and walnut. Only spring frosts, which often occur during the flowering period of the walnut, negatively affect, therefore, the yield in these cases is almost absent.

On the southern slopes of the Fergana and Chatkal ridges at an altitude of 1500-2300 meters a.s.l., there are tracts of walnut plantations, Kyrgyz and Siversii apple trees, cherry plum, Turkestan maple on a total area of 630.9 thousand hectares, including 35 thousand hectares of pure walnut forests, pistachio on an area of 33 thousand hectares. A recent study by Rehnus et al. (2013) highlights importance of walnut production for farmer income and hay-making (**Table 9**).

Table 9. Categories of leased forest land use in the study area

Category of land use	Hectares	Number of renters (tenure)
Agriculture	107.45	106
Hayfield	122.5	23
Collection of berries	11.9	10
Collection of walnut	1045.2	423
Collection of pistachio	1020.8	125
Recreation, tourism	1.08	3

Source: Toskool-Ata leshoz

On the territory of the *leshoz* there are 4 settlements: Toskool, Karabulak, Shyngyma and Shaidan. In these settlements, the population lives very densely, except for the village of Shyngyma and Shaydan. Only in the village of Toskool live more than 300 households with a population of over 1100 people, in the village of Karabulak 170 households with a population of 850 people, in the village of Shaydan 26 households with a population of 110 people, and in the village of Shyngyma about 35 people. Such a dense location of the population, negatively affects the forests of the forestry, given that the population in the heating season solves the problem of fuels only at the expense of the forest. The population does not use other sources for heating (electricity, coal, etc.) because of the high cost and inaccessibility.

Agriculture and collection of walnuts are the most important natural resource-related income source for many local households in the region, pasture-based livestock and agriculture is also important economically for individual households, as well as for the regional economy (Schmidt, 2005; Dörre, 2014). Since natural resources usability and pasture depends on the availability of water and edible plants for the animals, specific spatial features have a significant influence on the pasture's seasonal usability, in particular altitude, exposure, and the existence of water sources. Spring and autumn pastures, *jazdoo* and *kyzdoo* (Kyrgyz), respectively, are found predominantly in the district's south, below the forest belt, and at shorter distances from settlements than the summer pastures. Most of them are communal or 'national land reserve' lands (Dörre, 2015). Wood is an important energy source, used by over 90% of the households for cooking and heating (Ruppert et al., 2020). Another main source of energy for heating is coal (Jones et al., 2003).

3.3. Data collection

Secondary and primary data were collected in order to address the objectives of this study. Secondary sources comprised of published research papers; reports of international organizations, internet search and other sources. Secondary information was used to supplement the data collected

through primary sources. Primary data collected were both quantitative and qualitative. The methods used in primary data collection involved key-informant interviews, focus group discussions, household interviews and direct field observations. Two focus group discussions were conducted in each of the two villages.

All data for this study gathered was based on key informant interviews, qualitative interviews, field visits, and review of the secondary literature. For the rapid rural appraisal, semi-structured interviews with rural people were conducted both for local forest users, non-forest users, local timber sellers and government officials, who have important knowledge regarding issues that affect their lives and forestry sector. In most instances, the team attended interviews as a whole group, although information was also gathered on a one-to-one basis. Field interviews were conducted with groups of rural forest users and donors working in the area. The interviews were held with representatives of the following groups:

- *Leshoz* workers of Toskool-Ata (**Figure 8**)
- Forest users in Toskool-Ata (**Figure 9**)
- Farmers of Arimzhan (**Figure 10**)
- Policy makers from the Ministry of Agriculture, Water Resources and Regional Development of the Kyrgyz Republic
- Government officials from the Forest Service

Figure 8. Interview of forestry workers in Toskool-Ata leshoz

Figure 9. Interview of Toskool-Ata leshoz forest users

Source: Field visit, 2021

Figure 10. Farmers in Arimzhan responding to the survey questionnaire

Figure 11. Traditional stove for cooking in one of the households in the study area

Source: Field visit, 2021

Following preliminary review of forest and land related policies, national laws including related literature available in Russian, Kyrgyz and English, the survey and semi-structured interview was conducted. The data for this study was collected during several field visits to southwestern Kyrgyzstan between August and November 2021. The data used for this research come from a household survey conducted in August 2021. The survey was designed to investigate challenges in long-term forest land tenure, evaluate readiness of communities to plant trees for fuel-wood consumption through planting fast-growing tree species or mixed trees and determine possible

support from the government in terms of providing incentives for forest users etc. The investigated households were selected based on the principle of simple random sampling. In particular, the survey covered randomly selected two villages. **Figure 5** depicts the distribution of surveyed villages.

Total of sixty five households were randomly selected from villages near the forest and near the agricultural land. The households, both local and central government officials were interviewed face to face. Households were interviewed about their household and individual income sources, pasture and forestry related activities, fuelwood and other energy consumption, including limitations in leasing forest lands etc.

For this research a combination of different methods was applied. More than 30 interviews with representatives of governmental and non-governmental organizations delivered diverse assessments of the forest management, access, and utilization including over 65 different survey respondents among farmers.

The selection was based on the existing data that these participants were directly involved in relevant issues comprising the conceptualization of the regulations and their implementation or that they could deliver a substantial assessment of the forest management situation in Kyrgyzstan. The selection included national organizations like the Forest Service, Ministry of Agriculture, Water Resources and Regional Development; the Association of Forest Users etc.

The forest and land related legislation were reviewed, particularly regulations of management including utilization, tenure/lease, and conservation, as well as ownership and allocation of usage rights. Additionally, group interviews with members of the local and district authorities in the study region were conducted. These interviews were especially important to obtain official opinions about the implementation of the forest land tenure legislation, resulting problems, and the specifics of the CBFM in the research area.

The knowledge gained through these interviews helped to prepare extended visits to several settlements and forests, where resource management and utilization practices were systematically explored utilizing diverse empirical methods. Over twenty interviews and survey questionnaires with forest users and representatives of the identified management authorities such as central and local

forestry enterprises delivered important primary data, as well as contextual background from diverse perspectives. These key informants were identified directly during excursions to the forests and settlements, as well as on the recommendation of previously interviewed respondents. The interview guidelines covered topics such as entitlements and their allocation, utilization forms, the negotiation of regulations and their implementation, management responsibilities and practices, and conflict resolution. The aim of mixed approach was to gain variegated data for the comparison of the CBFM-related legal requirements with the reality on the ground.

This study focused on perception of local communities to produce fuelwood in the leased forestlands in order to meet own demand. Hence, the target population was people residing in the study area both men and women. For forest user respondents, heads of households were interviewed in this study. Households interviewed were selected from the list available at the village's *leshoz* responsible for overall forest management. The other households were selected systemically among employees of local school, kindergarten, administrative office and others.

A simple random sampling procedure was used in selecting sample used in this study. Since it allows more equal participation of all villagers (Kothari, 2004). In total, 65 heads of households were selected and interviewed in Toskool-Ata and Arimzhan (**Table 10**).

Table 10. Total number of respondents (excluding interview respondents)

Division	N	% among respondents
Central government	10	12.3
Local government	6	7.4
Forest users	31	38.2
Non-forest users	34	41.9
Total	**81**	

Source: Field-survey, 2021

3.4. Data analysis

In order to gather and analyze stakeholders' values, a structured questionnaire survey was conducted with the Theory of Planned Behavior (TPB). TPB, developed by Ajzen (1991) is a commonly used behavioral approach, which was regarded as an important tool for explaining and predicting farmers' behaviors with regard to environmental conservation and livestock welfare (Beedell and Rehman, 2000). TPB is an extension of the "theory of the reasoned action model", which offers greater insight into predicting farmers' behavior than other socioeconomic variables (Lam, 2006).

This study employs the TPB to analyze the factors affecting the perceptions and behaviors of farmers toward tree planting. A hypothetical model of the farmers' behavior toward tree planting was developed based on the questionnaire results: 12 questions assessed perception and 12 assessed attitudes, mostly using "Yes" or "No" scale. The questionnaires included some warm-up questions, representing various social psychology constructs to determine farmers' perception, attitude, and satisfaction.

Both quantitative and qualitative data were edited, numbered and entered in a Statistical Package for Social Sciences (SPSS) software. Multiple response questions were analyzed for frequencies and percentages. Tables and bar charts/graphs were used to present different variables and facilitate results of the analysis and interpretation of data.

For the primary data collection, this research was targeted to the respondents such as government officials from the central and local government agencies/institutions, forest users and non-forest users to conduct survey. Discourse analysis were used for 16 respondents among government officials in order to study what kind of incentives the government can provide for local forest users for their participation in forest restoration. In addition, local timber shop owners and other stakeholders from the NGOs and international organizations participated in the semi-structured interview for individual interviews with a small number of respondents to explore their perspectives on a particular idea, program, or situation.

Chapter 4. RESULTS

4.1. Demographic characteristics of the respondents

4.1.1. Respondents among forest users

A total of surveyed forest users was 31, consisting of 17 (54.9%) male and 14 (45.1%) female (**Table 11**). The user's age groups were recorded as: 25.8% 40-49 years old, 19.3% for both 30-39 and over 60 years old, and 16.1% 50-59 years old. Although off forest users, 54.8% were government employees, 100% of them engagement in the forest land lease and have income from the forests. Their occupations were reported as: public official / teacher and administrative officer. Respondents income ranged from 5000 som over 20000 som. As anticipated, the majority of households living near the forest areas are clustered in a large group of low income (receiving 15,000 KGS or less (equivalent to USD 156[3])). While in Kyrgyzstan income per capita is USD 1,323 (World Bank, 2020). The household heads are on average < 45.7 years old, with high-school education. 71% of forest users graduated only high-school and 29% graduated from the university. The average distance from the village to the closest county center Jalalabad city is > 90 km, which indicates that the sampled village is quite remote. 45.1% of respondents had 5-6 family members living together and 22.5% had 7-8 people living together as shown in **Table 11**.

About the 100% reported to have fully involved in forest related activities as means of supporting their livelihood. The overall average landholding of the respondents was reported to be about 2.8ha/HH as described in the (**Table 11**).

[3] Based on the website: akchabar.kg

Table 11. Socioeconomic characteristics of the respondents (Forest users)

Variables (n = 31)	Frequency	Percent (%)	Mean	SD	Min.	Max.
Gender						
Male	17	54.9				
Female	14	45.1				
Age group			**45.7**	**10.9**	**28**	**63**
20-29	2	6.5				
30-39	6	19.4				
40-49	10	32.3				
50-59	7	22.6				
≥ 60	6	19.4				
Level of education						
High school	22	71				
≥ University	9	29				
Household size			**5.36**	**1.6**	**1**	**8**
1-2	1	3.2				
3-4	3	9.7				
5-6	14	45.2				
7-8	7	22.6				
N/A	6	19.4				
Income Level (RM)			**14417.2**	**12981.5**	**3800**	**75000**
1000-5000 som	4	12.9				
5001-10000 som	7	22.6				
10001-15000 som	10	32.3				
15001-20000 som	5	16.1				
20001-25000 som	2	6.5				
75000 and over	1	3.2				
N/A	2	6.5				
Farm size category			**2.8**	**1.4**	**1**	**5**
≤ 1 ha	11	35.5				
2 ha	5	16.1				
3 ha	5	16.1				
≥ 4 ha	10	32.3				
Lease period			**21.7**	**18.8**	**5**	**50**
≤ 5 yr	15	48				
≤ 25 yr	8	26				
≤ 50 yr	8	26				

Source: Field survey, 2021

4.1.2 Respondents among non-forest users

The gender of the non-forest users was recorded as 61.7% female and 38.3% male (**Table 12**). The user's age groups were recorded as: 20.5% for 40-49 years old, 23.5% for 30-39 and 17.6% over 60 years old, and 26.4% 50-59 years old. Among non-forest users, 47% were government employees, however all of them had agricultural lands and have income from those lands. Their occupations were

reported as: public official / teacher and hospital workers. Respondents income ranged from 10,000 som over 100,000 som. 38.2% of non-forest users graduated only high-school and 58.8% graduated from the university. 55.8% of respondents had 5-6 family members living together while 22.5% had 3-4 people living together and 17.6% had 7-8 family members.

Table 12. Socioeconomic characteristics of the respondents for (Non-forest users)

Variables (n = 34)	Frequency	Percent (%)	Mean	SD	Min.	Max.
Gender						
Male	13	38.3				
Female	21	61.7				
Age group			**47.3**	**13.3**	**27**	**68**
20-29	4	11.8				
30-39	8	23.5				
40-49	7	20.6				
50-59	9	26.5				
≥ 60	6	17.6				
Level of education						
High school	13	38.2				
≥ University	20	58.8				
Household size			**5.05**	**1.4**	**2**	**8**
1-2	2	5.9				
3-4	7	20.6				
5-6	19	55.9				
7-8	6	17.6				
≥ 9	0	0.0				
Income Level (RM)			**48789.2**	**39437.8**	**6000**	**140000**
N/A	6	17.6				
5000-10000 som	4	11.8				
10000-15000 som	6	17.6				
15000-20000 som	3	8.8				
50000-100000 som	11	2.9				
≥120000 som	2	35.3				

Source: Field survey, 2021

4.1.3. Respondents among central government officials

The gender of the central government officials was recorded as 30% female and 70% male (**Table 13**). Working period was recorder as 40% worked for 5-10 years and 30% worked more than 10 years and 30% worked one or less year.

Table 13. Gender, periods of working and residence of interviewees in central government

Variables (n = 10)	Frequency	Percent (%)	Mean	SD	Min.	Max.
Gender						
Male	7	70				
Female	3	30				
Working period			**16.1**	**17.3**	**1**	29
≤ 1 yr	3	30				
5-10 yr	4	40				
≥ 10 yr	3	30				

Source: Field survey, 2021

d) The gender of the local government officials was recorded as 100% male (**Table 14**). Working period was recorder as 50% worked for over 10 years and 33.3% worked more 5-10 years and 16.6% worked one or less year.

Table 14. Gender, periods of working and residence of interviewees in local government

Variables (n = 6)	Frequency	Percent (%)	Mean	SD	Min.	Max.
Gender						
Male	6	100				
Female	0	0				
Working period			**31.5**	**15.5**	**6**	**44**
≤ 1 yr	1	16.7				
5-10 yr	2	33.3				
≥ 10 yr	3	50				
Years lived in the area			**58.1**	**11.2**	**36**	**68**
36 yr	1	16.7				
≥ 60 yr	5	83.3				

Source: Field survey, 2021

This study also determined that 100% of people living near the forests use forest land lease system and get benefits from forests, particularly NTFP products and fuelwood. Almost every rural household has a kitchen garden, while windbreaks, live fences and woodlands managed for NTFPs are rarely practiced.

4.2. Forest use of local communities for economy and fuelwood

The main economic activity in Toskool-Ata was collection of nut fruits from the forests whereas 100% main economic activity was agriculture in Arimzhan. All households in both villages grew at least one head of livestock at home. Through survey questionnaire it was investigated that 100% of local communities involved in the forest related activities through lease of forest land (**Table 15**). Investigation results of this study are given as below:

Table 15. Categories of leased forest land use in the study area

S/N	Category	Total area	Frequency (ha)	Percent (%)
1	Walnut collection	1887.4	1045.2	55.38
2	Pistachio collection	6131.7	1020.8	16.65
3	Pasture	29759	12019.5	40.39
4	Irrigated area	21.1	6.45	30.57
5	Non-irrigated area	460	101	21.96
6	Hay making	485	122.5	25.26
7	Gardening	84.5	11.9	14.8
8	Tourism		0.93	
9	Recreation		0.15	

Source: Field survey, 2021

Among them 74.2% of respondents indicated that walnut (**Figure 12**) or pistachio (**Figure 13**) collection is their main income source (**Figure 14**), which shows high dependency on forest products in the study area.

Figure 12. Walnut forest and walnut fruit (Source: Field visit, 2021)

Figure 13. Pistachio tree and fruit (Source: Field visit, 2021)

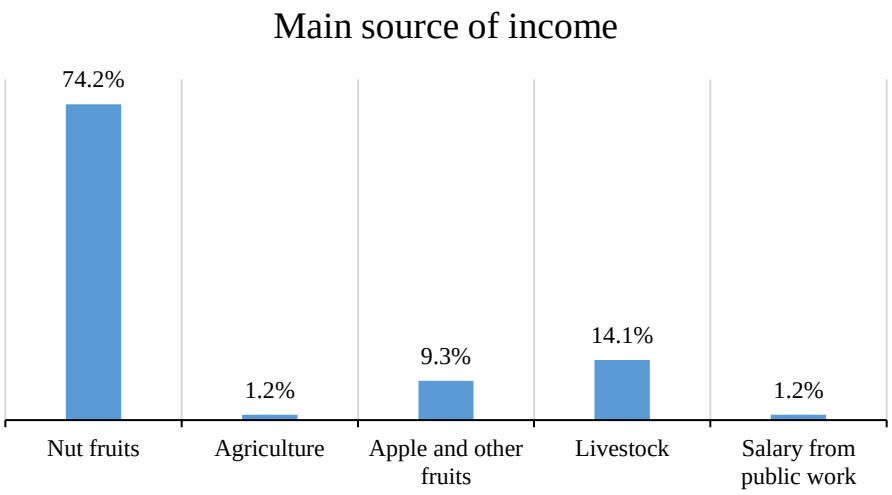

Figure 14. Main source of income of forest users

In Toskool-Ata it was also observed that 90.3% of respondents use wood for heating and cooking (**Figure 15**) whereas 53.5% said they take wood from the nearest state forests while 42.8% said that they collect wood from their leased forest lands and remaining from the market. It was also observed that 22.5% of respondents spend ≤ 50 of their income for heating sources. **Figure 15** summarizes the data that the forest users' fuelwood usage for cooking. It is higher than the households in Arimzhan, which is about 20.5%. The majority of the households in both villages use the traditional cook stove (**Figure 11**), especially among lower income segments. These traditional stoves are characterized by a low thermal efficiency (20-40%) and high ambient and indoor air pollution.

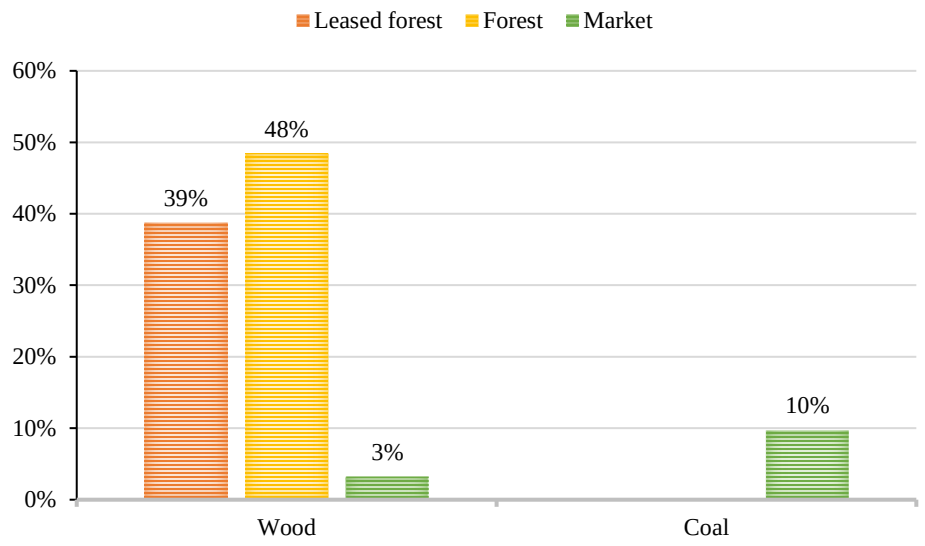

Figure 15. Main source of heat of households in Toskool-Ata

Respondents in Arimzhan indicated that they mix wood with coal and cotton stem. About 100% of farmers in the survey area said that due to the deforestation, less fuelwood collection is available in the area through time. According to the farmers, deforestation is happening due to overgrazing and poor management of livestock. This result indicated that the fuelwood collection and overgrazing have been causing degradation of the forest resources in the state forests.

Based on the survey it was analyzed that the majority of fuelwood consumption was from people's leased forest lands or nearby forests which they collect among dead shrubs or nut-fruit trees. However, the amount of available dead wood decreasing (Gottschling et al., 2005) and people cannot get dead wood every year. Comparing to the wood, among households in our survey area only 9.7% use coal for heating and cooking purchased from the local market (**Figure 15**). The reason for using the fuelwood rather than alternative energy sources as respondents indicated is the lack of alternative energy sources (World Bank, 2019).

4.3. Perception of local people on challenges and capacity building in forest use

4.3.1. Perception of environmental problems

Respondents also showed their awareness that the deforestation as the main ecological problem in the area. Most respondents among forest users (48.8%) believed that the forest degradation is the main problem (**Figure 16**) while 52.9% of the non-forest user farmers think that water shortage is the main ecological problem. This is due to their main activity – agriculture. During the interview out of all respondents, 27 (87.1%) of them pointed out that the overgrazing is the major reason for deforestation. While only 4 (12.9%) believe that fuelwood collection is the second main cause for the deforestation in the study area.

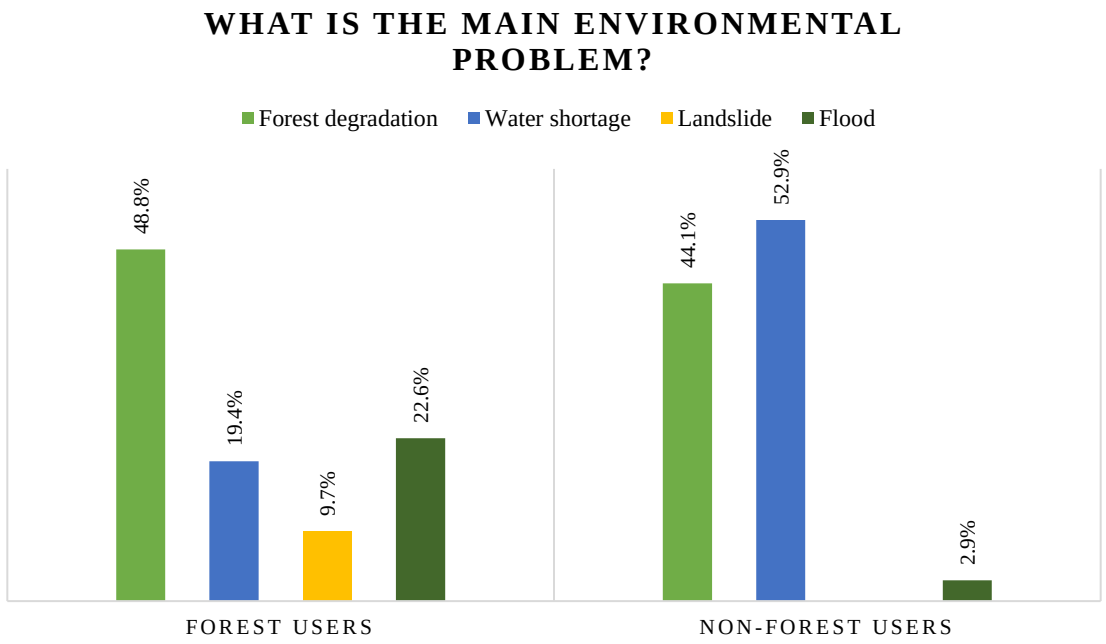

Figure 16. Perception of local environmental problems

4.3.2. Fuelwood production for market

None of our households reported selling in the market the wood from their leased forest lands. However, some interviewers in the local market said that there are local people illegally selling fuelwood as well. According to Hyde and Kohlin (2000) this is common throughout the all fuelwood related literature. During the field visit to the local market, any local was selling fuelwood produced from their lands. There was only one local timber shop (**Figure 18**) which sell pine wood mainly imported from Russia, Belorussia and Kazakhstan and a small amount of local poplar wood. A decade ago in the market 80% of wood was local poplar wood (Aliev et al., 2017).

4.3.3. Growing livestock in the study area

Interviewees emphasized on the need of fences in their leased forest land. Because, cattle and other livestock of other households enter the forest land and eat all the young vegetation (**Figure 17**). This is one reason why households do not want plant trees in their lands.

Figure 17. Cattle on the unfenced pistachio forest land

Figure 18. Local wood selling shop

Source: Field visit, 2021

4.3.4. Willingness of local people to increase forest land and capacity building

Messerli et al. (2000) identified a major challenge impeding agroforestry adoption in Kyrgyzstan as the perception by farmers that it would lead to the loss of valuable arable land and deprive the farmers of other subsistence agricultural opportunities (Messerli et al., 2000). However, it was identified through the interview that that 74.1% of households willing to plant trees in their land in order to meet their own fuelwood demand if the government can support with a temporary fencing. Through the survey it was also identified that local people are not aware of management through planting mixed tree species (**Table 16**). Most local communities during the interview showed their interest in learning if the government can provide capacity building activities in order for enhancing the protection status of natural forests and increase income of dependent communities. Walnut and pistachio are commonly harvested from the forest, however planting fast-growing tree species like popular can be integrated into farming systems around the forest, to provide alternative sources for fuelwood. Furthermore, fast growing poplar trees mitigate negative effects of droughts by absorbing groundwater with their deep roots (Djanibekov et al., 2013). There is already existing value chain (**Figure 19**) to incorporate in the marketing of fast-growing poplar trees if farmers wish to sell wood. This could reduce loss of forests due to fuelwood cut.

Table 16. Questions and responses of interview questions from forest user household

S/N	Interview Question	Yes	No
1	Do you want to increase forest land through lease/tenure?	74.10	25.90
2	Do you know well borders of your leased land?	90.32	9.68
3	Do you collect wood from your leased land?	83.87	16.13
4	Do you use irrigation in your leased land?	35.48	64.52
5	Are you planning continuously lease land?	83.87	16.13
6	Do you know agroforestry/agrosilvopasture?	16.13	83.87

4.3.5 Satisfaction on forest lease policy

In order to understand the challenges, through satisfactory interview questions it was identified that 61.3% of respondents are satisfied while 38.7% had various challenges including change in the forest lease policy **(Table 17**). 62% of respondents indicated that forest lease process became complicated and 61.3% answered that they are not satisfied with the support from the government.

Table 17. Satisfactory interview questions

S/N	Interview Question	Yes	No
1	Are you satisfied with the forestland lease process?	61.3	38.7
2	Does forestland lease process simple?	38	62
3	Are you satisfied with the support from the government?	42	58
4	Are you satisfied with your land use rights?	38.7	61.3
5	Is forestland fee expensive?	71	29

On the extent of forest rights devolution, it was observed that in study area, the government had transferred only 7% of its state forests to individual household management by 2021.

Through the literature review and interviews of government officials, it was observed that there is only one type of acquired forest land under current jurisdiction: forest with open access which can be acquired through either inheritance or outright purchase. After the series of interview with the local forest users, it was identified that most local people in general are aware of the arrangements available to access forest resources. However, recent change in the policy, made local households unaware about their rights, legislations including financial, and physical assets including management of forestlands. Furthermore, during the interview several respondents complained that the *leshoz* gave forest lands to other people, who even do not live in study area and even do not do any activity in the leased forest land while most people need resources from those forests for their livelihood. In general, interviewees noted that *leshoz* management has significant latitude to simplify procedures of leases.

Same, 70% of respondents among central government officials agreed on the need of new or modified policy on forest land tenure. All these observations from the prior literature are consistent with general economic expectations. We anticipate similar observations from research in Toskool-Ata, with further insight into the effect of improved forest tenure.

Traditionally, besides livestock production, haymaking and walnut harvesting are the main sources of income in these walnut forests (Rehnus et al., 2013). Investigation through interviews has shown that the economic performance of haymaking surpasses that of agricultural crops due to lower inputs such as labor costs. However, both lucerne and hay plots generated less than the plots comprising tree or berry products, which sell for a higher value and have fewer costs. Farmers typically do not sell hay; they use it for their livestock, which gives hay significantly more value than its actual selling price. And the price for hay is growing in Kyrgyzstan every year due to increased drought seasons with very less precipitation.

Due to the lack of budget in the government, only 6.3% of all government officials indicated possibility for fencing from the government (**Table 18**).

Table 18. Percentage of response for possible incentives from the government

What are the possible incentives? (n=16)	Frequency	Percent (%)
Planting trees instead of lease fee	11	68.8
Provide loan for planting	1	6.3
Fencing	1	6.3
None	3	18.8

Chapter 5. DISCUSSION

5.1. Benefits and impacts of forests to the economy of local people

Forest resources considered as a readily available and valuable asset that could be deployed in the fight against rural poverty (Fischman, 2012). The unique nut-fruit forests in Toskool-Ata are a good example of the multifunctional use of forests in temperate zones. Not only are NTFPs collected but the land in and around the forests is used for grazing and haymaking, as well as for arable cropping through land lease. Apart from sustaining the lives of the local mountain people.

The simultaneous dependence of the population on both agriculture and forest offers ideal conditions for the extension and improvement of mixed tree species planting. However, solutions must be found concerning the practice of uncontrolled grazing, the insecure land and tree tenure situation, the low productivity of the existing land use systems, the lack of agricultural advice and training and the serious impact of firewood collection on the forests in order to safeguard the Walnut Fruit Forest's biodiversity while integrating the needs of the local population into forest management (Rehnus, 2011).

Planting mixed tree species offers a variety of approaches that can provide beneficial effects for conservation and for livelihoods. It can also help to provide products and services that were supplied during Soviet Union through coordinated regional distribution. Benefits of planting fast-growing tree species include diversification of income, food and energy security, provision of fodder, and other ecosystem services. For example, managing NTFPs can yield honey, mushrooms and nuts for household consumption, and protect natural resources and help to sequester carbon to mitigate climate change.

Planting mixed tree species can be practiced at the household level and extended to a larger area. Accordingly, as most of Kyrgyzstan is mountainous, the slopes could be planted with contour rows of trees such as *Ailanthus altissima* and *Fraxinus pennsivanica* while the alleys between these

trees could be planted with barley or lucerne, which improves soil fertility and protects against erosion. The trees' wide root system protects from water erosion and decreases runoff. Windbreaks, buffer strips and other tree-based practices ameliorate the spread and impact of dust, particularly for farmers. Vegetative buffers filter air borne particulates harmful to human health and agricultural production. Planting mixed trees also has potential for supporting biodiversity conservation, particularly through in-situ conservation of important genetic resources, such as fruits and nut bearing trees. Encouraging the economic cultivation of local and endemic cultivars provides viable in-situ conservation options for conserving genetic diversity.

Forests in the study area contribute significantly to income generation, providing the most benefits requiring less labor, highlighting the importance of nut crops due to their high market value (FAO, 2016), walnut trees can help to significantly reduce poverty, although the full reward will not typically be felt for 20 years (Hardy et al., 2018) if not plant fast-growing trees together. The results from the literature review show that afforestation plots, which include hay and tree crops as well as apple, almond have significant economic benefits. This is partly due to the notable differences in inputs required compared with other farming systems (Wilson, 2009), that is, less labor needed and no fertilizers or pesticides required.

The region has an estimated 500–600 arborescent species, of which 100–150 are trees. They are home to not only of walnut-fruits, but also wild fruit species such as apple, pear (*Pyrus spp.),* plum (*Prunus spp.*), pomegranate (*Punica granatum spp.*), almond (*Amygdalus spp.*), and grape (*Vitis spp.*) etc.

5.2. Investigation of the perception of local people on local forest related problems

In spite of the many advantages of mixed tree species planting, it has not been widely adopted in Kyrgyzstan. In addition, farmers are not familiar with the range of ecosystem services provided and thus have a low perceived value of this land use. Currently, agroforestry practices such as alley

cropping, silvopasture, windbreaks, live fences, fruit-based kitchen gardens, managed woodlands for timber and NTFPs and riparian buffers are practiced in Kyrgyzstan to different degrees of intensity. These practices have many purposes including commercial and subsistence production, and protection of natural resources. The extent of these practices ranges from 1 ha at the household level to regions along walnut-fruit forest zones.

The crucial role of forests is mainly recognized by local farmers living nearby forests (**Figure 16**), 48.8% of all respondents indicated that the main ecological problem in the area is deforestation. However, due to the luck of alternative energy sources, households have no choice except for going to the forest to collect fuelwood. In addition, cattle and other livestock enters forest lands and eat all vegetation. This is one reason that could cause the forest degradation in the area. It is also evident that the local people totally depend on harvested shelter from the natural vegetation (Feyisa, 2017). This implies that households cannot fence their leased land due to the limitations of budget.

The lack of perception about various managements possibilities in Kyrgyzstan can be explained by the fact that policies were shaped by Soviet Union strategies. Institutional structure from the Soviet Union and absence of proper secured land tenure as well as lack of capacity locked farmers into traditional grazing, fruit and crop production.

5.2.1. Willingness to grow fast-growing tree species in order to meet demand of fuel-wood and income

Providing goods and ecosystem services, planting trees has a number of advantages not only on a household level, but also on village, country, regional and global levels. Such positive impacts are full-value public goods, contributing to food security and income of the rural population, and need to be regarded as such. Internalizing the added value of goods and services of such land use may increase its financial value. Rewarding the providers accordingly through different (i.e., compliance or regulatory) markets could give a boost to mixed tree species planting (Djanybekov, Dzhakypbekova, Chamberlain et al., 2015), and compensate for farmers' start-up time during which no income is generated from tree products.

5.2.2. Investigation of the challenges in long-term forest land lease/tenure

"Law on use of forest lands" which entered into force in 10 April 2018 allow communities to use all types of lands in the SFF, except for nature reserves and national parks. According to the collected data, 14329.36 hectares are leased forest lands (Forest Service, 2021)

The majority of the people interviewed indicated that not only they feel insecure leasing the forest lands, but also there were no monetary benefits accruing to them as a result of their involvement in the forest protection or restoration. For locals it is important, because many people in the area have low income. Furthermore, according to the survey conducted, over 68% of respondents agree that current newly adopted law made it even harder for local people to lease forestlands. There are more and more cases when rich people who do not use forests or live nearby lease forests for a long term. However, they do not do any activities on those lands. Hence, when providing forest lands for lease, it is important to consider clear plan of forest users and monitoring of accomplishment of those plans. Conducted survey also have shown that monitoring by government officials are not being conducted regularly and properly. This tells that the government should regularly monitor forest users' activities in order to avoid illegal activities within the SFF.

Although time is passing and regulations are changing, one thing remaining the same both pasture and forest users is the organizations and respective decision-making processes were dominated by older and wealthier users (Kasymov, Undeland, Dörre et al., 2015). Providing tenure security requires consideration of an array of different rights to resources, including tenure rights (**Table 19**) to land where planting is situated, to woody perennials, to crops and animals, and to the products generated by all that is grown and raised on the land (Borelli et al., 2019).

When farmers are certain about their land possession, they will be more willing to make long-term investments, such as agroforestry (Djanybekov, Dzhakypbekova, Chamberlain et al., 2015). Insecure land tenure can discourage local people in long-term forest land use (Holden et al., 2014). Especially, when activities related to tree planting. 70% of respondents among central government

officials agreed on the need of new policy on forest land tenure and/or need to improve the forest policy.

Table 19. Types of right to land, trees, and their products

Types of rights
• Right to own, or use land
• Right to own, transfer rights and inherit trees
• Right to plant trees
• Right to use trees for subsistence and commercial purposes - *to harvest (e.g. fruits, nuts, pods)* - *to use the standing tree (e.g. beekeeping)* - *to cut part of a living tree (e.g. leaves, branches, roots, bark)*
• Right to dispose of trees - *to uproot or cut down a tree* - *to lend the use of a tree to someone else* - *to lease, mortgage, or pledge a tree* - *to give away or sell a tree, either together with, or separate from, the land.*

Source: Adapted from Boffa, 2000

Fencing around the seedling within pastures would prevent livestock from damaging it and increase its chances to grow. However, protecting saplings within pastures was not considered conceivable as it is time-consuming, would use more fence material and would reduce the pasture area: Live fences can be an option for low-cost establishment of trees in pasture landscapes as they work as a protective barrier for seedlings and young trees from cattle damages (Love et al., 2009). This lack of natural regeneration within pastures might cause a decrease in the overall tree cover in the future and thus should come to the attention of local authorities and organizations (Chamayou, 2011).

5.3. Possible support/incentives from the government

Since the government's plan is to increase forest lands, involvement of local communities in sustainable forest management can give more positive results like in Europe or Ghana's cases if local people can get economic compensation and enough secured time for their achievement. Yet, economic compensation is the most significant in implementation of sustainable forest management. Through agroforestry can be supplied products such as firewood and timber which are originally harvested from the leased forest area by local communities. Not only, but also planting around leased forest lands like boundary instead of fences could stop livestock to enter leased lands. Since this was also indicated as the most suitable technologies by all parishes in Ghana.

National and local incentives are essential to realize the environmental and economic potential of agroforestry and its contribution to sustainable development in the CAC. Legal recognition is therefore necessary to allow agroforestry practices to flourish. The institutional design needs to take into the account the enabling options of agroforestry, the actors involved in agroforestry practices, resources required for agroforestry, as well as agroforestry's feedback to these actors and resources. Flexibility in land use so farmers can decide what and where to cultivate could be equally decisive to initiate agroforestry practices.

One of the key aspects of CFM is the role of local people as stakeholders in the decision making process around the implementation of CFM as well as to be a transparent and democratic process, where the vision, needs and expectations of the local population are incorporated at all stages of forest management (Fisher et al., 2004). However, current new policy made it harder for local forest users. The presence or absence of security the conservation actions (Robinson, Masuda, Kelly et al.).

The role of the population in the management of forests should strongly promoted through local and national level knowledge sharing. The role of the state is important towards development of multifunctional forest management (Fisher et al., 2004) in Kyrgyzstan. In particular, a change in the legal status of land rights is essential. Land and income tax exemptions may be considered to raise

the financial attractiveness of agroforestry in the beginning (Kan et al., 2008). Local support is required to cover initial investments and attract farmers for such land use (Djanybekov, Dzhakypbekova, Chamberlain et al., 2015). In order to make forestry healthy and sustainable, technical, financial, organizational, educational and promotional activities are required.

As social marginalization is cross-cutting issue in land tenure, related policy and legislation interventions must have a dedicated focus on removing legal impediments that discriminate and on supporting policy and programs that strengthen rights awareness and broaden access to markets and services (USAID, 2005). Strengthening capacity is the next important issue – the capacity of government to create and implement forest land tenure related policy, the capacity of forest land users on sustainable forest management including capacity of knowing and understanding rights and act upon them (Fischman, 2012).

This study assumes that if incentive-based policy will be developed or the existing policy will be improved and include incentives for forest land users even like planting trees instead of lease fee payment, it can increase public goods in forest (Bruce, Manber, Shapiro et al., 2010). Due to the budget limitations, the government cannot provide additional payment as an incentive for the local forest land users. However, planting trees instead of paying lease/tenure fee could be a good option both for local people and the government.

Providing farmers agriculture subsidies, production inputs, and low interest credit for strategically important trees biases planting of economically valuable fast-growing tree species. The lack of adoption of agroforestry in Kyrgyzstan where farmers own land, however, do not know ways of sustainable use illustrates that land lease alone does not lead to the adoption of agroforestry, capacity building and knowledge sharing should be followed.

In Arimzhan, where local people mostly do agricultural activities, current infrastructure (e.g., irrigation networks, agricultural machinery etc.) was designed to sustain agricultural production like wheat and cotton. However, it is possible to plant fruit trees around the irrigated lands as shelterbelts. The deficit of water can be the main reason for poor diversification of fruit tree production in regions with main agriculture activities.

Limited provision of machinery to manage agroforestry, and the lack of processing equipment and access to credit complicates adoption of agroforestry. At the same time, agroforestry practices usually require higher investments during initial years and may take years. Most farmers are inclined to invest their time and resources for short-term returns because of insecure land tenure and the inherited perception of the lack of benefits of agroforestry. The transitional nature of policies with frequent changes creates uncertainty for farmers. As a result, they refrain from long-term investments and continue known practices of growing annual crops. The adoption of agroforestry will be slow or nonexistent without government support and progressive policy reforms.

There is a need to influence peoples' understanding of agroforestry and its advantages through national legislation. Such policies need to be accompanied by more secure land tenure that would allow farmers to make more flexible decisions and more investments into a new and long-term land uses. Djanibekov et al. (2015) showed that giving farmers flexibility in land use can lead to afforestation on degraded croplands and a shift of cotton cultivation to more productive lands. Furthermore, state subsidies can support and encourage agroforestry adoption. For example, subsidies by Kazakhstan's government for no-till practices have accelerated its adoption, and similar approaches could be used to encourage agroforestry adoption.

To develop a simple model of land use over time, which determines the optimum timing of tree planting under different land tenure rules. This might include simplifying the rules around agroforestry arrangements, to allow farmers more flexibility to change their species and configuration arrangements—as long as they replace trees they remove (Fleming, O'Grady, Mendham et al., 2019). Along with development of favorable policies, establishment of institutional and physical infrastructure and increasing the flow of production inputs for agroforestry could provide incentives to adopt agroforestry. Storage and processing facilities and better markets for agroforestry products would boost the economic value of this land use practice. In addition, internalizing the value of ecosystem services (e.g., carbon sequestration, biodiversity increase, and land rehabilitation) of agroforestry and providing farmers the markets to sell such services can reduce the time until farmers can break-even from investments needed to adopt agroforestry.

Flexibility in allowing farmers to decide what type of crop and where to cultivate can improve the potential for adoption of agroforestry. Because of the importance of cotton and wheat production, it may be more effective to retain current crop production practices and instead identify suitable areas for diversification with agroforestry. Silvopasture in sloping areas of Kyrgyzstan may be more suitable than annual crop production.

New ways to collaborate, by integrating and forging new partnerships at organizational and policy levels, may emerge from openly responding and reflecting on past arrangements. To support cohesion and a collective culture across all of the primary industries, new government authorities could be established to facilitate and/or support collaborative working arrangements between agencies, tertiary institutions, industry, NGOs and farmers.

The multi-dimensional character and multi-level scale of agroforestry (i.e. provision of various ecosystem services at various scales) suggests the establishment of a particular institution, focusing on agroforestry management regulating all interrelations among the named fields and fostering sustainable management, scientific research and dissemination of knowledge. Sharing knowledge from research institutions with farmers about agroforestry practices, ecosystem services and management strategies is essential for wide-spread adoption. Knowledge can be disseminated through capacity building activities of NGOs, farmers' associations, village centers and local state administrations. For example, the Kyrgyz Association of Forest and Land Users works directly with farmers who use forest resources and work on arable lands. This institution could bridge gaps between farmers and national governments, advocate for agroforestry policies, develop and disseminate technical materials, and help to market products (Djanibekov, Villamor, Dzhakypbekova et al., 2016). It is also crucial to introduce information-and-communication technologies, conduct the workshops and seminars involving public and local communities. Particularly on their rights and sustainable use of forest lands and natural resources. As mentioned in Mela et al. (2021) study in Ethiopia for a more positive perception of farmers towards conservation of forests it is also very urgent to organize special courses to increase capacity and qualifications of forestry sector specialists.

I assume that a farmer acquires a plot of land at time 0 and grows food crops alone until time T when he intercrops commercial trees with annual crops. I further assume that acquired land is immediately used for cultivation of food crops or tree-cum-food crops, because land is scarce and, hence, yields positive return from cultivation. While timing of land acquisition is exogenously determined in the case of inheritance, it can be chosen in the case of opening forest or purchasing land. In this study, we focus on the choice of T with a view to deriving the testable hypotheses. Given the common practice that trees are planted in the whole plot in a short period of time, we do not consider partial planting of trees (Otsuka, Suyanto Tomich, 1997).

Livestock contributes to both income and food security: during bad harvests, livestock is a good buffer to overcome times of economic difficulty. Furthermore, it is common for farmers to use the corn they grow to feed their livestock, giving corn, and the farm systems that grow corn, a higher value than the market value. This highlights a key synergy between crop production and livestock rearing for income and food security, demonstrating the importance of both livelihood strategies for poverty reduction. However, it is important to note that agriculture production often erodes the soil. It is therefore not sustainable in the long term without significant crop rotation (Falk, 2013). This suggests that there are trade-offs between accepting the negative impact of corn production and opting for other crop systems.

Potato, corn, and multi cropping systems, which have higher labor requirements, do not generate benefits as high as those of plots based on tree crops and come with other disadvantages, such as ecological damage, including soil degradation, which could be avoided by intercropping where farm plot size allows it. Furthermore, the berry plots, especially like sea buckthorn, due to its lower labor requirements combined with higher sale price, resulted in one of the highest NTFPs after the tree cropping systems.

Due to the initial fencing costs, most plots do not generate income until walnut trees yield nuts, making farming for subsistence imperative until the trees begin to yield. Use of the forests and their resources can be accomplished through the use of SFF land for production purposes and through the harvesting of forest resources. Two formal arrangements govern the use of forest resources

according to the FC: leases and special permits (FC Art. 53). In addition, CBFM was introduced in 2001 and has been applied to *leshoz* around the country. Using land for production purposes is formalized through a lease agreement. People use forest land to grow cereals, vegetables, and fruits, to graze livestock, and to make hay. Lease agreements can be for one use or for multiple uses within the allocated area (FC Art. 43).[4]

Appropriate markets need to be developed where farmers can easily sell products to boost the economic value. Processing adds value to strategically important NTFPs along the market chain. Markets for tree products are less efficient and less developed than for annual crop products, and thus demand for tree products is less. Abandoning previous policies, processing and infrastructure and investing in new policies, processing and infrastructure may lead to substantial changes in the economic sector. K. Aliev et al. (2017) gave example (**Figure 19**) for a value chain in their study of potentials for fast-growing poplar trees.

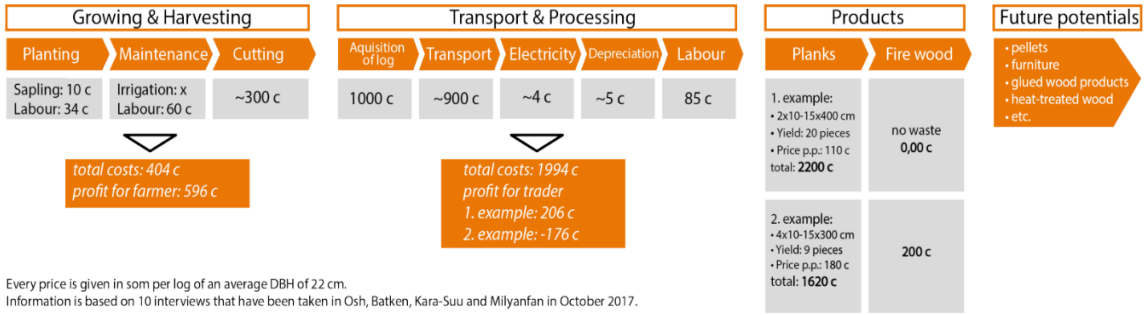

Figure 19. Value chain example (Aliev et al., 2017)

This could also be applied to the households in the study area. Because, in the future imports of wood from Russia might decrease, and people will be more dependent on national resources than ever before, which means forests will be more under threat. Hence, it is crucial to prepare alternative energy resources for the country.

[4] http://cbd.minjust.gov.kg/act/view/ru-ru/10?cl=ru-ru

Chapter 6. CONCLUSION

This study analyzed constraints and options to adopt agroforestry practice in the Kyrgyz Republic. For this analysis, I used the co-evolutionary socio-ecological systems framework. By using this framework, the results showed that agroforestry was being practiced in the Kyrgyz Republic and there were opportunities to address socio-ecological issues, however, legacies of the Soviet Union constrained the extent of adoption of such land use. Existing agricultural production systems are locked-in and hinder adoption of alternative land uses. Moving towards agroforestry may be expensive during the transition to a market economy, as state priority crops contribute substantially to the national economies.

Several incentives and systematic changes are essential in fully realizing the potential of agroforestry. Selecting areas less suitable for monoculture crop cultivation and integrating with trees might mitigate competition between the state strategic crops and diversified land use systems, and avoid high economic costs of changing agricultural production. Internalizing potential benefits, creating markets, processing industries, infrastructure and institutions are needed to drive adoption of agroforestry.

The conceptual framework of the study, which focused on showing the linkages and interaction between extrinsic and intrinsic variables as well as the missing influence of the intervening variable of extension in the decision-making process of farmers was helpful to understand the conditions for adoption in a more holistic way. The framework provided a useful lens for the development of guiding questions, semi-structured interviews, and observations during field visits. The results on household characteristics showed a high dependency on local natural resources, in particular on fruits from trees. Under changing climatic conditions, productivity will be decisive for the resilience of the walnut forests.

Currently, however, the windbreak effect and potentials for more efficient use of water are not a major concern of farmers. A strategy to increase the adoption of shelterbelts is to put stronger

emphasis in argumentation on those benefits that are ranked highest by the farmers. These include the provision of construction material, firewood, fences, and the like.

The interpretations and knowledge of the national legal framework varied considerably from village to village. Therefore, working together and with the support of local governments is important. Since the usefulness of shelterbelts was clearly demonstrated for the large-scale cooperative farms during Soviet times, one way to overcome the obstacle of small field sizes would be to promote the adoption of cooperative arrangements to set up joint shelterbelt systems covering larger areas of land. This would also require institutional support to show how modern cooperative arrangements can function in the Kyrgyz context.

The results of this study are relevant in the broader global context, where adopting an ecosystem approach to rehabilitation, ecosystem restoration, and more specifically planting trees is getting increasing attention and support from many sides. Besides providing new insights into the adoption of CBFM in Kyrgyzstan, this research highlights the need to study and take farmers' concerns seriously when developing strategies to promote environmentally friendly behavior. The promotion of sustainable land use systems requires the right institutional frameworks, proper communication, and extension work e.g., through demonstration sites, best practice examples, but also a serious engagement with farmer concerns (Ruppert, Welp, Spies et al., 2020).

The farmers' "awareness and perception for planting trees" and "their satisfaction on the forest land lease policy" were the factors that most influenced the farmers' perception. Both the drivers of attitudes and perceived behavioral control can be used by policymakers to direct farmers' intentions and behaviors toward tree planting for forest restoration. Planting trees as a shelterbelt could also prevent from entering livestock to the forestlands. Since both forest land users and policy makers agree, these results suggest that farmers are willing to participate in planting trees and preventing desertification. Implementation of a CBFM program in this area may provide important tool for the conservation and restoration of nut fruit trees of Toskool-Ata, which is the main source of income for the livelihoods of local people and nearby locations which have the same situation.

This study provides some empirical evidence to the fact that secured rights to land influence positively on farmers forest plantation activities and investment. Government's incentives do motivate households to invest more in silviculture. The results of the present study also revealed the negative impacts of fuelwood consumption on forest resources thereby biodiversity and human livelihoods in the study area. The most preferred incentive by the government in order to plant trees was fencing the forestlands.

Majority of the community in the study area have been using biomass energy sources without tree planting. This is one of the causes for the forest degradation in the study area. Though fuelwood is a renewable resource, its overuse can lead forest degradation. As many households continue to use fuelwood, especially in the rural areas of the country like Toskool-Ata. This can negatively impact the economy of the households, for example, through deforestation, and declining of productivity and increased natural disasters as landslides and floods. The implications of this on the environment are obvious: deforestation, soil erosion and declining soil productivity, and destruction of the ecological system leading to loss in the natural habitat for the wildlife.

In the regions with the same activity like Arimzhan, if planting poplar trees, the tree heights of 11 m can be reached within three years like in a planting experiment near Bishkek (Thevs, Aliev, Lleshi, 2021), beyond the sheer economic perspective, tree wind breaks can quickly provide benefits like improved micro climate and reduced water consumption of agriculture (Thevs, Aliev, Lleshi, 2021).

For any intervention to encourage the planting of shelterbelts by the state, NGOs or other actors, a sound understanding of both intrinsic and extrinsic factors and their interlinkages is needed. While the extrinsic factors are usually better known and more obvious, the intrinsic factors (knowledge, perceptions, and attitudes) frequently remain unclear. In our particular case, the interplay between past experiences, lack of knowledge, the lack of encouragement of local administrative bodies and non-consistent interpretation of legal rules creates a situation that does not promote environmentally friendly behavior of farmers. To overcome these barriers, this paper outlined a novel contribution to understanding the underlying values that create different perceptions of agroforestry.

Providing more incentives for people across these groups to work together and to prioritise trees on farms as a productive way to achieve multiple outcomes that fit with individual farmer objectives offers a clear way forward.

In conclusion, this study suggests that tree wind breaks can be inserted into the irrigated agriculture as an additional source of farm income, to deliver domestic wood resources, and help reduce overall water consumption in irrigated agriculture. In a more global view, such tree wind breaks with the wood they deliver on top of ongoing agricultural benefits may constitute a renewable biological resource. Agroforestry holds a great deal of promise for addressing the nexus of sustainability issues facing farmers—environmental, social and financial.

The policy implications of this study are that increased amount of freehold land tenure would stimulate forest plantation establishment by farmers. Because numerous interests exist in communally owned lands, these lands are prone to conflicts, making it insecure for would-be farmers/investors to invest in long-term projects such as forest plantations on these lands. If secured rights in land conducive for plantation establishment can be granted, more farmers would be motivated to participate in plantation establishment. Should the Government of the Kyrgyz Republic implement measures to ensure improved capacity building and security of land rights, investment in forest plantations would increase in the future. This will also help to an increasing demand on timber and thereby reducing the pressure on the natural forest resources. The Kyrgyz Republic's legal regulations urgently need reform (Kasymov, Undeland, Dörre et al., 2015).

Finally, recognizing the values that drive behavior is the first, most fundamental step, in tailoring any further approaches to increasing adoption of agroforestry. This reflective starting point is the critical contribution of this paper in establishing future programs (Fleming, O'Grady, Mendham et al., 2019).

The study suggests that under these conditions, market development for forest plantations can be successful, and provide commodity benefits to landowners, consumers, and the country. Expansion of such analyses to other countries with poorer political and economic situations would be useful as well to see and determine how robust findings of this study are.

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SUMMARY IN KOREAN

키르기스스탄의 잘랄라바드 주는 세계 최대의 천연 호두나무(*Juglans regia*) 산림(해발 1,000~2,200m)과 피스타치오(*Pistacia vera*) 천연림(해발 800~1,000m)이 있는 지역이다. 호두와 피스타치오는 지역 주민들의 주요 수입원이다. 그러나 이러한 그 유실수(견과일) 산림은 계속 줄어들고 있다. 나무는 요리와 난방을 위한 중요한 에너지원이다. 호두나무 산림은 국가의 특별 보호를 받고 있지만 대체 에너지원이 없기 때문에 지역 주민들은 천연림에서 목재를 채취하고 있다. 본 연구는 땔감 자원을 제공하고 지역 주민들의 소득을 향상시키면서 유실수 수종의 산림을 복원하기 위한 솔루션을 모색하는 것을 목표로 하였다. 본 연구에서는 키르기스스탄의 잘랄라바드주 토스쿨아타의 농부들과 중앙 및 지방 정부 공무원을 대상으로 반구조화 인터뷰(SSI) 및 설문조사를 통해 질적 접근을 하였으며, 1) 지역 주민들이 목재 연료에 대한 수요를 충족시키기 위하여 산림 복원에 참여할 의지가 있는지 확인하고, 2) 지역 환경 문제에 대한 지역 주민들의 인식을 조사하였으며, 3) 참여형 산림복원에 대한 문제점 및 현안을 조사하여, 4) 산림 복원에 참여하는 지역 사회에 정부가 제공할 수 있는 가능한 지원방안 및 인센티브를 제시하고자 하였다. 이번 연구에서는 목재생산 기반의 다목적 농업을 통해 토지이용에 있어 잠재적인 해결책이 될 수 있음을 발견하였다. 조사 결과에 따르면 지역 농부의 74.1%는 정부가 경계 울타리를 지원해 준다면 생계를 위하여 다목적 농업을 통해 목재에 대한 수요를 충족하면서 더 많은 혜택을 충족하기 위해 속성수와 유실수 등을 식재할 의사가 있는 것으로 나타났다. 또한 농부들이 더 지속 가능한 경영을 위해 적절한 식재와 관리 기술 및 수확 기법 등 역량 배양이 필요하다는 것으로 밝혀졌다. 더욱이, 정책 입안자들이 간소하면서 인센티브 기반의 산림 임대 계약을 통해 정책/법률을 수정할 필요가 있음이 밝혀졌다. 또한 정부 및 NGO, 국제기구와 같은 기타 이해 관계자는 울타리 조성 및 기타 인센티브로 농부를 지원해야 할 것으로 사료되었다.

중요어: 목재, 연료, 임농복합경영, 산림복구, 호두나무, 피스타치오, 키르기스스탄

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