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Structure, function and management of rural and peri-urban homegardens in Osh Province, Kyrgyzstan

Master´s thesis

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Declaration

I, Kateřina Šimková, hereby declare that this thesis, submitted in partial fulfilment of requirements for the MSc. degree at the Faculty of Tropical AgriSciences of the Czech University of Life Sciences Prague, is wholly my own work unless otherwise referenced or acknowledged.

In Prague April 21 2016

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ABSTRACT

This survey was conducted in 40 homegardens in Aravan and Tuleyken in Osh province, situated in the southern Kyrgyzstan. The aims of the thesis were to document structure, crop diversity and gardening practices of rural and peri-urban gardens. Data were collected during July to August 2014, through semi-structured questionnaires and direct observation. The surveyed homegardens ranged from 51.2m^2 to 3,600m^2 in size, with an average of 639 m^2. The total number of species encountered in homegardens was 52, belonging to the 24 botanical families, most represented by Rosaceae, Solanaceae, Brassicaceae and Cucurbitaceae. The most important species were *Prunus avium* L., *Prunus persica* (L.) Batsch, *Vitis vinifera* and *Malus domestica* Borkh. Aspects documented during the survey were following: the botanical and vernacular names, plant parts used and purposes of use. Plants were categorized into 7 use categories (food, medicines, fodder, construction material, environmental uses, fuel and materials). The mean Margalef index, providing an understanding of the species richness of the surveyed sites, with values 2.02 in Aravan and 1.59 in Tuleyken did not show any significant differences between rural and peri-urban area. The Shannon-Wiener index, representing both evenness and abundance of species varied from 0.007 to 2.59. The biodiversity indices indicated the fact that the species richness and number of species per homegarden were affected by homegarden sizes. The results showed the fact that despite dry and hot climate Kyrgyz homegardens could be diverse as some tropical gardens. They could be a valuable tool in conservation, maintain species diversity and play an important role in food production and income accretion of local people. This thesis could be a commencement for further detailed research in Central Asian homegardens as they generally lack of relevant, empirical and precisely investigated studies focused on land use management and traditonal knowledge.

Keywords:

Agrobiodiversity, ethnobotany, homegardens, Kyrgyzstan, useful plants

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ABBREVIATIONS AND TERMS

ADB - Asian Development Bank

CAREC - Central Asian Regional Economic Cooperation

Chernozem - Black-coloured soil containing a high percentage of humus and high percentages of phosphoric acids, phosphorus and ammonia

CDCS - Country Development Cooperation Strategy

FAO - Food and Agricultural Organization of United Nations

GDP - Gross Domestic Product

GKR - Government of the Kyrgyz Republic

HDI - Human Development Index

Kolkhozes - a form of collective farm in the Soviet Union

Langman: noodle topped with lamb vegetable stew

Lepjoshka - traditional bread

Manta - traditional dumplings filled with vegetable or meat

MASL - Metres above sea level

MEA - Milleniumosystem Assessment

MEP - Ministry of Environment of Kyrgyzstan

NSC - National Statistical Committee

Pelmeni - traditional dumplings filled with vegetable or meat

Plov - one-pot rice dish cooked in lamb fat with onions and carrots

RDF - Rural Development Fund

Samsa - a fried or baked dish with a savoury filling as vegetable or meat

SIC - Scientific Information Centre

Topchan - wooden base with upholstered benches about 50-60 centimetres above the ground, with or without a roof.

Toshyok - kind of local cushion

UN - United Nations

UNDP - United Nations Development Program

USAID - United States Agency for International Development

1 Introduction

1.1 Kyrgyzstan- natural conditions, population and economy

The Kyrgyz Republic is situated in Central Asia and it is relatively new state formed after the break of Soviet Union in 1991. The neighbouring countries are Republic of Kazakhstan, Republic of Tajikistan, Republic of Uzbekistan, Turkmenistan and China. The total area of the country is 198,500 km². The land is highly mountainous and systems of Pamir-Alai and Tien Shan belongs to highest and most aged mountains on the Earth. Their altitudes in range from 132-7,439 MASL and almost half of the area is over 3,000 MASL (UN, 2000). The life in mountains developed extreme biodiversity at the ecosystems and it is considered as place of origin of many crops and animal breed (CAREC, 2004). In spite of that the country area occupy only 0.13 % of all land area of the planet, Kyrgyzstan biodiversity reaches 1 % of the world biodiversity which exceeds the average world level (MEP, 1998). Thanks to the glaciers and precipitation, the high mountains are a unique source of fresh water and nourish many rivers in the region (CAREC, 2004). Nevertheless, Kyrgyzstan often suffer by lack of water, which is caused by high usage of water by neighbouring countries Uzbekistan and Turkmenistan (Gareeva et al., 2008).

Kyrgyzstan's population is estimated at 5.6 million in 2013. The nation's largest ethnic group are the Kyrgyz, who comprise 72 % of the population. Historically Kyrgyz people have been semi-nomadic herders, living in round tents called yurts and tending sheep, horses and yaks. Other ethnic groups include Russians concentrated in the north and Uzbeks living in the south. Additionally, the country has over 80 ethnic groups. The language is closely related to Kazakhs but some differences between the regions are evident as the southern Kyrgyz use many words from Uzbek language. Except the language, there is also social difference. On the south, people are more conservative because of the stronger influence of Islam religion due to greater distance from Russia (Farrington, 2005). The population of Kyrgyzstan is well educated, the adult literacy rate is 99.3% (ADB, 2008). The

unemployment was approximately 8.3 % in 2006, which is the highest number in the former Soviet countries of Central Asia (ADB, 2008).

Kyrgyzstan´s economy cannot rely on economic advantages in terms of natural resources that its neighbours have. Twelve percent Gross Domestic Product (GDP) depended on gold mining, and 26% of tax revenues. Almost half of GDP rely on largely subsistence agriculture. Nevertheless, in country are missing value-added food processing chains which could improve product quality and create value-added employment in the agricultural sector (CDCS, 2014). Nowadays the living conditions for people are often very low. The population is predominantly rural (65 %) and general poverty in rural as well as urban areas is one of the limiting features. This situation strongly influences people livelihood strategies, how to sustainably work on income generating activities and how to manage and use assets (Shimizu, 2006). Many people solve the situation by migration and almost one million of citizens work abroad, mostly 20-29 aged. Except few positives as building professional capability, job training and sending back significant portions of salaries in remittance, emigration has negative effects in terms separation of families. Subsequently it leads to women hazing by overtaking farm duties, although they are already burned with the task of raising children and taking care for elder family members (CDCS, 2000). On the other hand, women, in particular, could play important role in the country's economic development, with an emphasis on the agricultural development anticipated in the south.

1.1.1 Local agriculture and land use system

Kyrgyz agriculture is specific by 2 factors. First one is that Kyrgyz people have been traditionally nomadic pastors mostly specialized in animal herding that requires movement for grazing (Crawford and Leonard, 2002) and people were never fully self-sufficient and depended on their neighbors. They practiced agriculture only occasionally so they do not have a strong agricultural tradition (Bacon, 1966). The second factor is related to the process of collectivization during Soviet era which forced people to conversion from pastoralists to sedentary agriculturalists and caused establishment of household plots (Lerman et al., 1994). The problem occurred after the breakdown of Union when people employed in collective farms *(kolkhozes*) with very narrow specialization suddenly became individuals with little or

no experience in planning crops, caring for the farm or marketing and selling excess production (Messerli et al., 2006)

From the total area of the country, 7 % is suitable for agriculture, including arable land, fallows and hayfields (Shkurov et al., 2007) and 40% is degraded (Kyrgyzstan delegation, 2007). The agricultural sector contributed with 22 percent of value added in GDP (FAO, 2010) and the sector employs 65% of total workers (GKR, 2006). As the main agricultural area is considered the Fergana valley, which lies at southern Kyrgyzstan. The valley is nowadays separated between 2 other states, Tajikistan and Uzbekistan. It often leads to ethnic conflicts mostly cause by overpopulation, and limited land and natural resources (De Martino et al., 2005). Our faculty have conducted already 2 case studies in that place, one focused on fruits orchards development (Wurstová, 2011) and second one on land use and agricultural systems (Žitný, 2015).

According to Shimizu (2006), the situation of living standards in Kyrgyzstan is one of the worst in the world. People totally depend on natural resources as livestock keeping, haymaking, firewood and non-timber forest products as nuts and absence any other source of income. Moreover, the lack of work opportunities is leading to huge male outmigration to national urban areas or other countries as Kazakhstan or Russia as was already mention above (Schmidt and Sagynbekova, 2008). For these reasons, the government is relatively tolerant to the fact, that people are overusing natural resources without any sustainability (CAREC, 2004; SIC, 2007). However, it is necessary to invent new agricultural experience inspirited by former traditional life and old practices to stabilise situation of rural farmers (UNDP, 2002). There is some progress in the agricultural sector as United States Agency for International Development (USAID) wants to invest to local agricultural sector and to help to prioritize agricultural research activities by developing practical links to farmers and agribusinesses. They want to focus especially to women and ethnic minority farmers, helping them obtain training and education in improved production technologies. Moreover, the organisation wants to look for expand markets because nowadays agriculture is not competitive with imports, neither it is typically able to export. Only 7% of agricultural output is reported as exported, while 23% of food is imported (Mogilevskii, 2012)

1.2 Homegardens

Homegardens basically differ from large scale agriculture by fewer amounts of chemical inputs, no mechanization and higher level of plant as well as animal diversity (Raheem et al., 2008; Hylander and Nemomissa, 2008). They are one of the most important study areas for ethnobotanist. One of the definitions describe homegarden as an agro-socio-ecological system nearby the gardener´s house, basically comprising of domesticated plants and/or animals. Homegardening ensures variety of fruits, vegetables, medicinal plants and useful materials fulfilling subsistence needs and often generating an additional income for the agricultural societies (Soemarwoto and Conway, 1992; Nair and Kumar, 2006). Homegarden can have other functions except nutrition and food availability. As it is usually part of the house and work there in not so manually difficult as in the field they could help with improving the role of women in agriculture. Women appreciate continuous availability of products as spices, vegetable and fruits to family kitchen and moreover it could help them the express the autonomy and worth within the village setting. Other important function is aesthetic and ecological. Families often consider homegarden as a place to relax and gather together in the shadow surrounded by flowering plants and other ornamental decorations (Okigbo, 1990; Moreno-Black et al., 1996). They could be also connected with cultural use when represent place for religious activities (Huyin and Hamilton, 2009). Last but not least is that it works as place for domestication of wild plants.

The main advantage of interview in homegarden is that it favours local people participate in research nearby their home. It allows them alternate interview sessions with household tasks and they are more willing to take part in the research (Thomas et al., 2007). The investigations on homegardens usually lead to interesting results and new insights into the composition, management, and importance of these agroecosystems for subsistence and cash income, the application of traditional knowledge in community development and the conservation of agrobiodiversity (Fernandes and Nair, 1986; Padoch and de Jong, 1991; Leiva et al., 2002).

Homegardens in arid or semi-arid conditions are rather specific and sometimes they do not fit in classical definition of homegarden. It is cause by hardier conditions as land

scarcity and water shortage. Therefore, in these areas, the garden is not necessarily around the gardener's house and the presence of perennials could be limited (Ceccolini, 2002; Wiersum, 2006; Thaman et al., 2006). Unfortunately, homegardens as a functioning agroecosystems has been investigated predominantly in the humid areas of the tropics (Albuquerque et al., 2005; Mohan et al., 2007; Thomas and Van Damme, 2010; Vlková et al., 2011), whereas information from arid and semi-arid regions are very scarce (Huai and Hamilton, 2009). This give us an impression, that homegardens are principally a tropical phenomenon (Nair and Kumar, 2006). There are few studies from Africa (Bernholt et al., 2009; Thompson et al., 2010; Norfolk et al., 2013), America (Blanckaert et al., 2004; Eyssartier et al.,2011) and Asia (Ceccolini, 2002) with limited number of studies from Central Asia (Khasbagan, 2010; Khasbagan, 2015; Currey, 2009). However, more detailed research is necessary as one third of the world population live in the arid areas (MEA, 2005) and could suffer with decreasing availability of food sources caused by water scarcity, frequent drought, climatic variability, land degradation, desertification and widespread poverty (Buchmann, 2009). These constrains are expected to increase as a result of population growth and urbanization and they will probably deepen the problem of food insecurity in areas which are already vulnerable to hunger and malnutrition (Thompson and Amoroso, 2014). Clear understanding of food production, consumption systems and the functionalities of agrobiodiversity is necessary to allow formulation of sustainable intensification strategies for future agricultural systems (Drescher et al., 2006).

1.2.1 Homegardens in Kyrgyzstan

Homegardens in Kyrgyzstan are living artefacts of Soviet collectivisation. They were mostly established during communist era, when locals were being allocated similar sized plots thus there is certain uniformity within communities in whole country (Lerman and Stanchin, 2004; Sharashkin, 2008). Generally, in the former Soviet Union countries, homegardens provide the majority of significant part of agriculture production and are important contribution to national GDP. In 2007, homegardens in Kyrgyzstan contributed 22% of the total agriculture production (NSC, 2008). It is less percentage in comparison to Uzbekistan where it contributed 60% (Lerman and Stanchin, 2004) but still it is a significant

source of income. Despite small size of homegardens in Kyrgyzstan (average 0.1 ha) these agroecosystems contribute provide households relevant proportion of their revenues (World Bank Kyrgyz Republic, 2005) even higher than from large scale agriculture. For example, in Issyk-Kul region, income from the sale of apples provided households with 33% more income than gardeners earned from larger agriculture (Currey, 2009). Despite their importance, Kyrgyz homegardens have not been well researched. Unfortunately, the research will always suffer because absence of attention to the field in the Soviet period and the lack of differentiation among ethnicities which is crucial in case of investigation of traditional knowledge (Moldogazieva and Spoor, 1997; Tchoroev, 2002). The sustainability of local homegardens lies in targeting them for agricultural development represented by marketing and improving access for people to credit to improve technology management practices which could lead to increasing household income (Currey, 2009)

1.3 Ethnobotany

Ethnobotany is a science of people´s interactions with plants based on indigenous knowledge (Turner, 1995). The discipline involves botany, anthropology, ecology, linguistics and in some cases economy (Martin, 2004). Nowadays it is considered as a way to conservation biology, environmental education and resource management (Bennet, 1995) as researches considered plants and people who use them to be integral part of local ecosystems. Due to the adoption of the quantitative methods the research has moved from writings inventories merely listing plant species to more practical approaches focused on sustainable use and the plant resources conservation. Moreover, there is an effort to understand local community via cultural perspective and livelihood strategies (Phillips, 1996; Albuquerque et al. 2009). According to Pieroni and Giusti (2009) ethnobotanical surveys could be applied for long-term management and conservation strategies and contribute to livelihood and plant conservation status. The type of research depends on the study objective and research question and it could vary from evaluation of traditional knowledge to laboratory analysis of biologically active compounds of used plants. (Khan et al., 2013). One of the basic tools for obtaining ethnobotanical information is the interview. During interviews

in situ, living plants are used as a reference and respondents are asked about plant growth and use (Thomas et al., 2007).

In Kyrgyzstan, more than seventy years long period under the Soviet Union rule caused unsustainable use of natural resources and ignorance of local beliefs, traditions and practices which resulted in significant loss of traditional knowledge (RDF, 2013). There are few research focusing on traditional knowledge, e.g. livestock production (Baibagushev, 2011), traditional medicine (Pawera et al., 2016) and homegardens (Currey, 2009) however the number is very limited and more scientific research should be done until the knowledge disappear forever.

1.4 Definition of peri-urban areas

World-wide, urban and peri-urban agriculture is estimated to provide as much as one-seventh of the total food supply (Drescher, 1998) Borders between rural and urban environment in many parts of the world are not clear and cannot be easily defined (WinklerPrins, 2003). Therefore, the term peri-urban was introduced and it represents the area immediately surrounding a city which is neither entirely urban nor purely rural. It is located somewhere in-between the urban core and the rural landscape characterized by three following components: demographic (i.e. increasing population size and density); economic (i.e. a primarily non-agricultural labour force) and social-psychological (i.e. consciousness of what does it mean to be urban) (FAO, 2000). In the developing world peri-urban agriculture is an important part of livelihood strategy ensuring the regional food security (Ellis and Sumberg, 1998; Ali and Porciuncula, 2001), where poor infrastructure development could result in unreliable food supplies from distant rural areas (Ellis and Sumberg, 1998; Maxwell, 1999). They also provide opportunities for recycling organic waste and provide jobs. Nevertheless, Ali and Porciuncula (2001) warned that all these benefits are threatened by heavy competition for urban land use and excessive use of water or agricultural chemicals. According to Molebatsi et al. (2010), rural and peri-urban homegardens often differ in cultivated species. While peri-urban residents grow predominantly ornamental species, rural homegardens tend to be self-sufficient in

providing food for members of family and therefore cultivate more species with wider range of uses as food, medicine or energy. Another difference lays in attitude to the farming, whereas for rural people farming is often primary and only livehood, people in peri-urban area usually have additional employment (FAO, 2007).

1.5 The importance of agrobiodiversity

Biodiversity is the variability among living organisms and ecosystems they compose (UNCED, 1992). In the past, the biodiversity present in agricultural land was overlooked with respect to that present in natural ecosystems. This has caused the wrong idea that the wild species are genetically more diverse than the domesticated ones (Caballero et al., 2007). In 1993, when Banham (1993) defined the term "biodiversity," he thought in terms in wild species and totally excluded agricultural plants. For this reason, it was lately introduced the term "agrobiodiversity" for defining the diversity presents in the crops (FAO, 1995). According to Heywood (1999) it is a subset and extension of biodiversity that embraces units (such as cultivars, pure lines, and strains) and habitats (agroecosystems as farmers' fields, homegarden, etc.) that are not normally considered or even accepted as properly part of biological diversity. It includes all plant species that are used directly or indirectly for food and agriculture, both as human nutrition and as feed (including grazing) for domesticated and semi-domesticated animals; and the range of environments in which agriculture is practiced. Agrobiodiversity represent the biological support of agriculture (Fowler and Hodgin, 2004). Research have proved that biodiversity in the area increase productivity (Tilman et al., 1997) and stability (McNaughton, 1977) resulting in sustainability of agricultural systems (Love and Spaner, 2007). In fact, this challenge to provide enough food for the increasing population and consequently preserve natural resources is more important in arid and semi-arid areas, where persistent water scarcity, land degradation, widespread poverty is more significant and make the area more vulnerable to hunger or under-nutrition (Buchmann, 2009; Cabalda et al., 2011).

Homegardens are also considered as an important area for *in situ* conservation of plant genetic resources (Trinh et al., 2003; Eyzaguirre and Linares, 2004), especially of local

species which could be better adapted to local agroecological conditions (Drescher, 1998). However, the cultural and socioeconomic changes in the world could lead to decreasing plant diversity of local species due to commercialization of products or loss of indigenous knowledge (Soemarwoto and Conway, 1992; Tesfaye, 2005). In Kyrgyzstan, the conservation of indigenous plants has high importance. In 1995, the Central Asian mountains were defined as a 'hotspot' for global diversity as many of more than 300 fruit and nuts such as apple, apricot, pear, cherry plum, almonds, pistachio etc. which grow wild are ancestors of important crop species (Davis et al., 1995; Eastwood et al., 2009). According to Currey (2009), the role of homegardens in conservation of agrobiodiversity in Kyrgyzstan is unknown. But due to high diversity of crop wild relatives providing inhabitants opportunity to introduce these species into the gardens, could be significant.

The diversity could be measured in many different ways. In agriculture, the study area is defined by the boundaries of farmer´s field or homegarden, in contrast with ecological studies where boundaries between plant communities or populations are difficult to define (Whittaker, 1965). The simplest measure of diversity is species richness, total number of species or varieties in a specific place at a point in time (Hubbell, 2001). It means total number of crops species sampled within a farmer´s field. The other index, species evenness which shows how many individuals belong to each species in a community, should be always considered as well (Margalef, 1958). Shannon-Wiener´s or Simpson index combine richness and evenness values to produce a numerical output (McCune and Grace, 2002). The calculation is not always simple to make in case of high planting densities and difficulty to count individuals (Whittaker, 1965).

2 Objectives

Despite the fact that Central Asian countries became independent more than 20 years ago, they still suffer from the previous legacy. The cooperation between scientists, environmental managers from different countries and local politics is negligible (Kreutzmann, 2005). According to Dear el al. (2013), who reviewed and evaluated the research on sustainable land management in mountain societies in Kyrgyzstan and Tajikistan, there is a significant shortage of relevant, empirical and precisely investigated scientific knowledge

Considering this kind of scarcity of data from Central Asia and particularly Kyrgyzstan this study aimed to document structure, crop diversity and gardening practices of rural and peri-urban gardens in Osh province in southern Kyrgyzstan. The specific objectives of the study were: (1) to examine useful plant species diversity (2) to determine prioritized and culturally important species (3) to compare rural and peri-urban homegardens (4) to analyse functions and management of the local homegardens and (5) to determine traditional knowledge on wild useful species.

3 Methodology

3.1 Background research

A systematic literature review was performed using an electronic search of scientific papers and abstracts. Used databases for screening of literature were Web of Knowledge; Google Scholar and Scopus. Latin plant names and authority were adjusted according to the 'Tropicos' – botanical information system of the Missouri Botanical Garden (www.tropicos.org).

3.2 Study area

The fieldwork was performed in two districts of Osh Province, i.e. Kara Suu and Aravan. The Osh province covers area of 2,900 km^2 and has the population about 1.2 million (20% of the population of Kyrgyzstan). Approximately 92% of the local population live in a rural area, which is the lowest urbanization rate at the national level (NSC, 2009). Osh province is the least developed part of the whole country measuring via human development index (HDI), which represents 0.594, ranking the province to the same level as Zambia, Laos, Congo or Bangladesh (UNDP, 2013).

Generally, the Osh province is characterized by diverse topographical conditions. Mountainous areas with Alay Range (highest peak 5,544 MASL) lie on the south along the border with Tajikistan, while for the northern part is typical flat or gently undulating landscape of Fergana valley. Both study sites were situated into the northern flatlands. Climate is continental with temperature in summer ranging from 15°C to 30°C and in the winter from –5°C to + 15°C. The average annual rainfall is 336 mm. According to Kazbekov et al. (2009), the whole country is affected by high evapotranspiration (1,034 mm), therefore agricultural sector strongly depends on additional irrigation from local water resources – particularly rivers. Soils are predominantly fine alluvial *chernozems* and *chernozem*-like soil with a high humid content (Agakhanyants, 1986). However, due to inappropriate agricultural practices especially unsuitable irrigation methods and drainage infrastructure represented by

open channels, soils nowadays suffer from salinity. Additionally, uncontrolled storage and usage of animal dung cause pollution of surface and ground waters with nitrates and bacteria (MEP, 1998).

Osh province is one of few areas in Kyrgyzstan which is suitable for agriculture. Maize, cotton, rice, wheat and vegetables (tomatoes, carrots, and peppers) are prevalent agriculture crops. Unfortunately, agricultural practices strongly influence natural vegetation. The remains can be found predominantly along the rivers and irrigation channels and it is represented by riparian forest composed of willows (*Salix* spp.), birches (*Betula* spp.), poplars (*Populus alba* L., *Populus. tremula* L.), tamarisks (*Tamarix* spp.) and sea buckthorns (*Hippophae rhamnoides* L.) (UN, 2009). Other vegetation types in the study area are dry meadow steppes generally represented by family Apiaceae, specifically by species *Ferula* spp. and *Prangos pabularia* Lindl. (Agakhanyants, 1986).

3.2.1 Aravan study site

Rural area was represented by villages around the city Aravan, the administrative centre of the district Aravan (40°30′54′′ N 72°29′57′′ E). They were situated on the border with Uzbekistan, surrounded by Chil-Ustun Mountains. Due to their slope, erosion and dryness, agriculture was practiced in the lowlands. The altitude ranges from 618 MASL to 714 MASL. The Aravan River which flows throughout the villages was the main local water resource. Majority of the households had higher living standard (UNDP, 2013) although farming was their main occupation. Due to immediate proximity of the border with Uzbekistan, the population of the district was culturally heterogeneous. Among the twenty owners of homegardens who participated in our study, 10 were ethnic Uzbeks, 9 Kyrgyz and 1 Turk. The sample consisted of 18 men and 2 women and the average age of respondents was 41.5 years.

3.2.2 Tuleyken study site

Tuleyken (40°31′48′′ N 72°48′00′′ E; 1,079-1,149 MASL) is located in the southern suburbs of Osh city and it was considered as a peri-urban area. It lies in a valley with the Ak-Buura River, surrounded by two mountain hills. Agriculture was mainly practiced at the

valley's edge and partly above the residential area at the foothills. Crop cultivation is intensified by the water from irrigation canal in both areas. People from the area mostly commuted to regular work in the Osh city and therefore farming and gardening was just their additional occupation. Majority of the households had middle or lower living standard (UNDP, 2013) and are thus less developed compare to households from Aravan. In this location 10 men and 10 women farmers were interviewed. All of them were Kyrgyz nationality with average age 38.6 years.

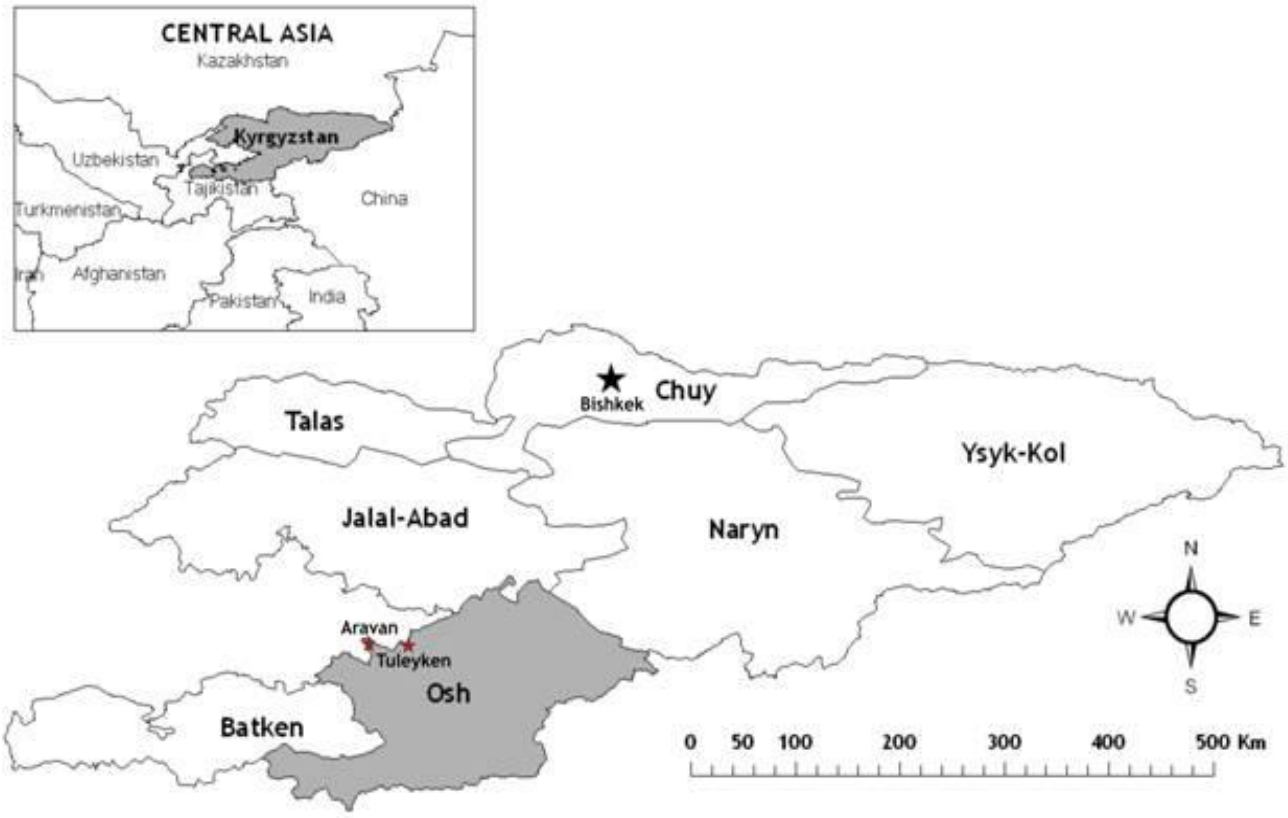

Figure 1. Location of Aravan and Tuleyken where the study was conducted (by Vojtěch Žitný)

3.3 Data collection

Data were collected over the period from July to August 2014. In both study areas we were interviewing farmers with homegardens based on snowball sampling method described in Tongco (2007). The total number of respondents reaches 40, equally distributed among Aravan and Tuleyken study sites. All interviewees were involved in homegarden activities and in the elaboration of derived products, food consumption and eventual commercialization. These activities were documented using field methods of Vogl et al. (2004) through direct observation and semi-structured interviews with the household member. Since all of the interviewees speak Kyrgyz or Russian, the interviews were conducted with the help of local bilingual assistant and subsequently translated into English. First of all, we collected basic socioeconomic data (ethnicity, education, occupation, income) and garden-related information (garden size, livestock presence, motivations for production and use of external inputs such as fertilisers, pesticides and plant genetic material). Afterwards, ethnobotanical data by interviewing respondents about their knowledge of cultivated plants, useful weeds and plants collected from the wild nature (name of the plant, plant parts used, purpose, genetic material acquisition, commercialization, marketing channels etc.), were gathered. All collected data were registered into the field notebook immediately. Plant uses were grouped into use categories according to Economic Botany Data Collection Standard (Cook, 2005). However, analogous to the study of Thomas et al. (2009) construction materials were classified separately from materials. The seven resulting use categories were: food (including beverages); medicines; fodder; construction material; environmental uses (including shadow and wind protection); fuel; and materials (including handicrafts, dyes and tools). The same plant could fall into more than one use category. All data were grouped into alphabetically sorted botanical families in Table 2, where Latin name, vernacular name, plant part(s) used, use category, way of consumption or utilization; commercialization and % occurrence in each locality were provided.

According to Van den Eynden (2004) cultivated plants were species which are managed and cared for by humans during their entire life cycle. In contrast to managed plants wild plants were classified as species which are not manipulated genotypically or phenotypically by people in any way (Dufour and Wilson, 1994). Ornamental plants and

weeds were not included in the study, except those, which were listed by respondents with additional specific use. Plant material of species that we did not know was collected by author. Species identification was made by Dr. Georgy A. Lazkov, Laboratory of Flora, Institute of Biology and Soil Science, Kyrgyz Academy of Sciences, Bishkek, Kyrgyzstan). In the case of very common crop species (e.g. *Malus domestica* Borkh., *Daucus carota* L., *Zea Mays* L.) the voucher specimens were not collected.

3.4 Data analysis

Homegardens were categorized according to i) the villages, Aravan (rural area) and Tuleyken (peri-urban area) and ii) into three size classes according to the area of the homegarden and following median calculation (Mohan et al. 2007). The standard statistic methods were used to calculate data using MS *Excel*. For most of homegardens number of species, number of tree species and abundance were calculated. One homegarden in Tuleyken was not included in calculations as the garden had very untypical characteristics, 3,600 m^2 in size with cultivation of 2 species. Species richness, diversity and evenness were estimated using biodiversity indices i) Margalef index (Magurran, 1988), ii) Shannon-Wiener index (Magurran, 1988) and iii) Sorenson index of similarity (Sorenson, 1948). Species diversity is a function of the number of species present (species richness or species abundance) and the evenness with which the individuals are distributed among these species (species evenness or species equitability) (Hurlbert, 1971). Each method is explained in the following sections. By simple statistical methods we were analysing correlation between homegarden size and various factors. Patterns of agrobiodiversity were calculated based on homegarden size which were categorized into the three size classes: small (≤0.045 ha), medium (0.045-0.089 ha) and large (≥0.089 ha). Boxplot graphs were made to depict graphically through quartiles in which area is higher number of species per homegarden and how homegarden size influence the species diversity.

3.4.1 Number of species

Number of species (S) is a sample of a specified size and it is an instantly comprehensible expression of species diversity (Magurran, 1988). S is related to the total number of individuals (N) summed over all S species recorded (Williams et al., 2005).

$$S = \sum S_d$$

S_d – total number of species in given homegarden

3.4.2 Abundance

Abundance (A) represents the number of all individuals of all species in given homegarden. Accuracy of abundance depends on the monitored site and selection of the homegarden (Spellerberg, 1995).

$$A = \sum N$$

N – total number of individuals

3.4.3 Margalef index

Margalef index (D_{Mg}) is used to provide an understanding of the species richness of the surveyed homegarden. The higher the index, the richer would be the species diversity of the population. The Margalef index have been cited as being inadequate by several authors (e.g. Magurran, 1988; Williams et al., 2005) because the index lacks the ability to differentiate the species richness of samples having similar S and N.

$$D_{Mg} = \frac{S - 1}{\ln(N)}$$

S – the number of species, N – total number of individuals in the sample

3.4.4 Shannon-Wiener index

Shannon-Wiener index (H) is derived from information theory, based on the rationale that diversity in a natural system may be measured in a similar way to information contained in a code or message. The advantage of Shannon-Wiener index is its simplicity of calculation and it has led to the widespread acceptability as an index (Magurran, 1988). Mohan et al. (2007) similarly refer that Shannon-Wiener is the most commonly used diversity indicator in plant communities, and it takes a value of zero when there is only one species in a community, and a maximum value when all species are present in equal abundance. The Shannon-Wiener index, while representing both evenness and abundance of species, is relatively insensitive to the presence of rare species (Mohan et al., 2007) and sensitive to sample size (Magurran, 1988). Shannon-Wiener index can be also called Shannon index or Shannon-Weaver index (Spellerberg and Fedor, 2003).

$$H = -\sum_{i=1}^{S} p_i \ln(p_i)$$

p_i – proportion of the species relative to the total number of plants

3.4.5 Sorenson index of similarity

Sorenson index of similarity (S_S) represents the number of common species between two sites (e.g. homegardens). All similarity indices are expressed in percentages in order to make the comparisons easier to read (Mohan et al., 2007). The equation for this measure is as follows:

$$S_S = \frac{\text{number of common species}}{\frac{S_a + S_b}{2}} \times 100$$

S_a – the number of species in homegarden A, S_b - the number of species in homegarden B

4 Results

4.1 Homegardens and household characteristics

The survey covered a total garden area of 25,559 m^2, comprising 12,587m^2 at Aravan, and 12,972 m2 at Tuleyken. The mean size of the gardens at both localities was very similar, the average was 639 m^2 and size ranged from 51.2m^2 to 3,600m^2 (Table 1). The socio-economic profiles were comparable as well. The number of household member varied from 2 to 9, with an average of five members per family. All respondents had the minimum 10 years of education.

Table 1. Characteristics of the surveyed households by site

Site	n[a]	HGD[b] size (m2)		Annual income ($)		Mean no. of people/HH[c]
		Mean	Range	Mean	Range	
Aravan	20	629,341	51.68-2282	4145,202	165,3-8874	5.4
Tuleyken	20	648,617	75-3600	1896,8871	157-5742	5

[a] *n* number of surveyed households [b] *HGD* - homegarden[c] *HH* - household

Usually all members were involved in household tasks, however some gender differences could be observed. While sowing, harvest and other tasks connected with the cultivation were performed mainly by men, women were in charge of post-harvest processing and meal preparation. All homegardens were located close to the house and besides widespread vegetable crops, people also cultivated fruit trees usually dispersed all around the garden. Irrigation was carried out by hand from a bucket or from a pipe connected to the communal source of water. Around whole Tuleyken area communal rudimentary channels for distributing water had been constructed. Soil was defined by farmers by medium quality in both areas however recently people have started having problems with erosion. At all household outdoor kitchen for preparing all kind of dishes was employed, nevertheless common indoor kitchen was also present and used for food processing. The specific feature common to nearly all homegardens was so called *topchan* which is a wooden base with

upholstered benches about 50-60 centimetres above the ground, with or without a roof. People sit on the carpet and *toshyok* (kind of local cushion) and lean back to the pillows. It is popular for serving tea, food or recreation. Food is served on the low tables standing in the middle. Typical feature in Aravan was shaded area like a terrace in front on the house, which was composed of iron structure and climbing plant of *Vitis vinifera* L. In Tuleyken these areas were not so common, they were presented only in 8 homegardens.

According to our results, the main function of the homegarden was to provide fresh food and traditions custodianship of such a place (Fig. 2).

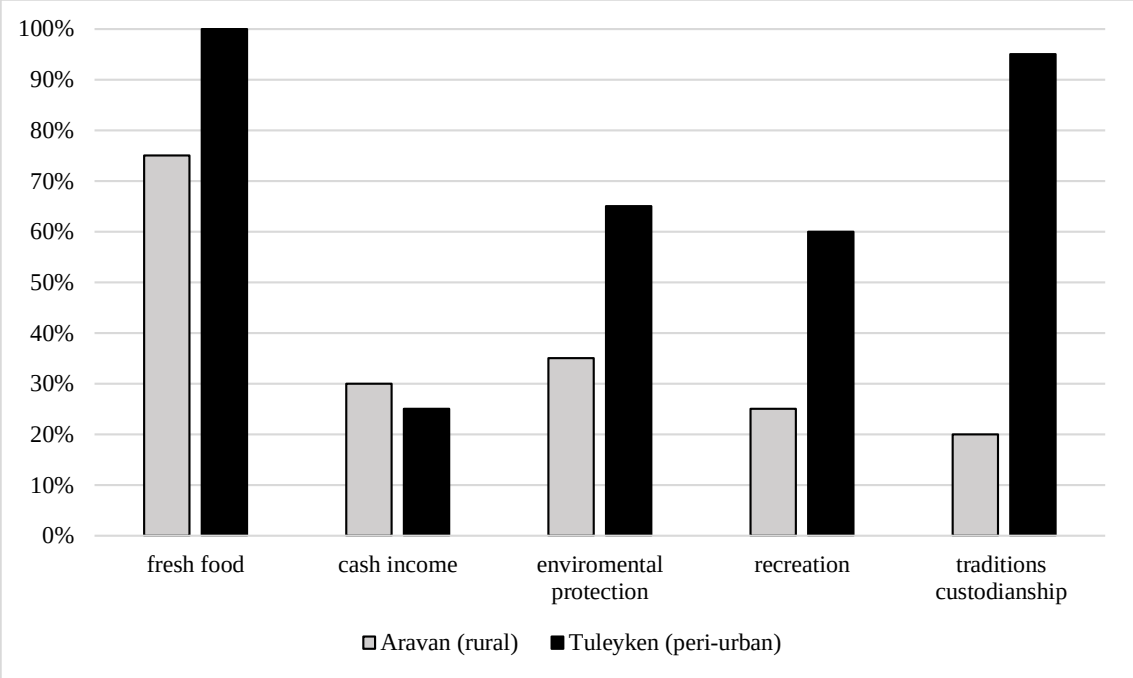

Figure 2. Functions of homegardens

The external purchase of fertilisers was the main source of inputs in both localities, however farmers were mostly using organic manure. In the Aravan, seeds and seedlings were predominantly obtained from own production, contrasting to the Tuleyken where most of the propagation material was bought from the market. Acquisition of the genetic material from neighbourhood was not very popular, nor its collection from the wild. Only one respondent answered that seeds of *Morus nigra* L. were regularly collected from the wild stands. The production was predominantly destined to household consumption, nevertheless, in the case

of good harvest, people commonly sold the surplus products. This trend was much more significant in the Aravan where agriculture was the main source of income. In the Tuleyken, commercial focus had minor importance, half of the households did not sell their production at all, while in the Aravan only 3 homegardens did not commercialized the production. Important points of sales of fruits and vegetable are shown in Fig. 3. In the Tuleyken, 3 households sold part of their production directly from the house, where buyers harvest the fruits on their own. Some surpluses were also processed to homemade jams and compotes, but these products always served primarily as a supplies for winter, when there was lack of fresh food, and never being sold on the markets.

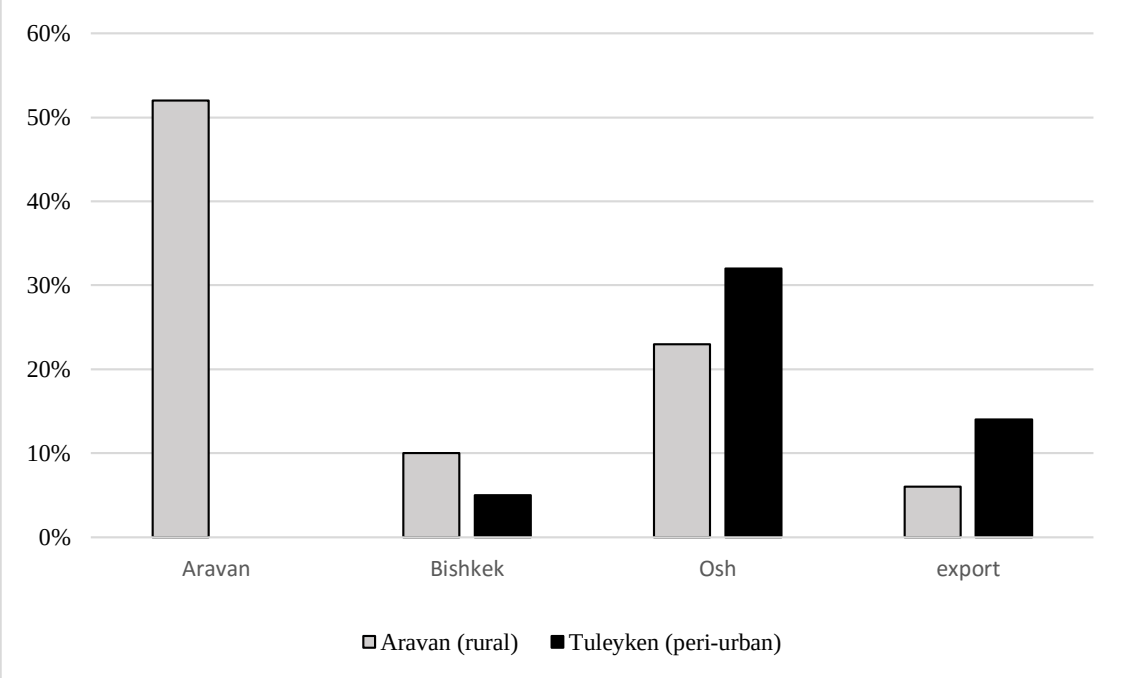

Figure 3. Important points of sales of fruits and vegetable

All interviewed farmers kept domestic animals in their gardens. In the Aravan the number of animals varied from 1 to 21 (on average 6 heads), while in the Tuleyken varied from 2 to 49 (on average 14). In the Aravan, animals like cow, calf, sheep, ram, bull and goat were kept. Tuleyken was characterized by higher variability. Besides above mentions animals, also horses, donkeys and hens were tended. They were usually fed by the fresh or

dried fodder purposively cultivated in the fields, or spontaneously collected from orchards and homegardens (rests of crops, weeds). The kitchen waste was also effectively used as an animal feed. In many cases, animals were allowed to graze on the field margins.

4.2 Species composition

In total, 52 different plant species were cultivated in the 40 surveyed homegardens. From the total number, 49 plants were identified down to species level. Three plants could only be identified down to genus level (*Pelargonium* sp., *Salix* sp. and *Capsicum* sp.). All species belong to the 24 botanical families, most represented by Rosaceae (11 species), Solanaceae (5 species), Brassicaceae (4) and Cucurbitaceae (4). All the documented data are presented in descending alphabetical order of plant families in the Table 2. The majority of plants managed in homegardens were annual herbs (28 species), followed by trees (17 species), 4 perennial herbs, 2 shrubs and 1 climber species. A total of 31 crops were present at both locations, 10 were specific to the Aravan and 11 were found exclusively at the Tuleyken. Overall, the most important use category was food and beverages, including 86% of the total number of species (Fig. 4).

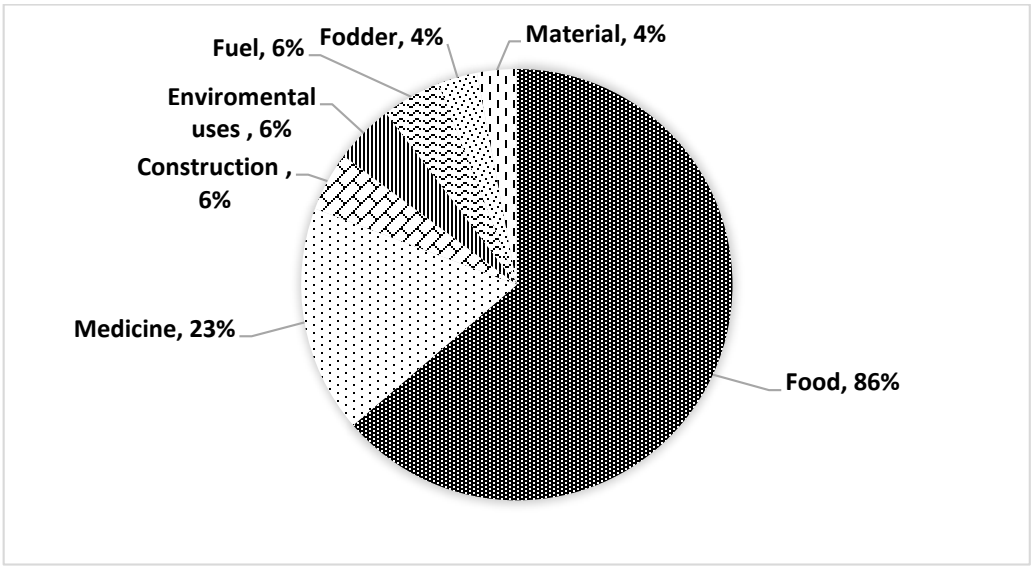

Figure 4. Use categories of cultivated species

4.2.1 Categories of useful plants

The category of food and beverages was represented by 45 species. Most of them were fruits and vegetables (17 species each), seasonings (4), staple crops (3) and 3 were cultivated for nuts and seeds. Fruits were generally eaten fresh, dry or processed into jams or compotes and served as a food supplies during winter season. Based on the number of use reports, the most important species were *Prunus avium* L. (34 reports), *Prunus persica* (L.) Batsch (32), *Vitis vinifera* (27) and *Malus domestica* (26). Among those, part of the production was sold and represented income for the households. Each locality had some typical species commercialized. In Aravan it was *Diospyros kaki* Thunb. and *Ficus carica* L. However, in case of *F. carica,* even though Aravan has hot climate during the summer, it did not produce many fruits because of the hard winter period. This obstacle was also affecting the cultivation of *Punica granatum* L., which fruits were eaten fresh or pressed into juice. *P. granatum* had also medicinal use. Tea from pomegranate fruit exocarp was drunk against diarrhoea and stomach ache, or the bandage was soaked in decoction and applied to a place with an allergic rash. One farmer was even trying to grow banana in his garden but without any relevant success. Looking at the typical species in the Tuleyken, *Ribes aureum* Pursh and *Rubus idaeaus* L. were specifically popular. Fruits of *R. aureum* were eaten as a medicinal food for prevention of flu as it has high content of vitamin C (Moyer et al., 2002). During winter the fruits of *Cydonia oblonga* Mill. were added to the traditional dish *plov* (one-pot rice dish cooked in lamb fat with onions and carrots). Considering vegetable crops, the most important species were *Solanum lycopersicum* L. (27 reports), *Cucurbita pepo* L. (11) and *Capsicum annum* L. (10). *C. pepo* was frequently added to traditional food as *manta, pelmeni*, or *samsa*. Other species had very low importance and the number of reports did not exceed 5, except of *Brassica olearacea* L. var. *capitata*, *Solanum melongena* L. and *Daucus carota*. Part of the vegetable production was usually salted and preserved for winter. As a seasoning, main cultivated plant for this purpose was *Ocimum basilicum* L., used for salads or soups. Other species were *Anethum graveolens* L., which was added to salted vegetable, *Satureja hortensis* L., serving for good digestion, and *Nigella sativa* L. *Nigella* seeds were used as a condiment or chewed for improving digestion, against tooth ache, periodontitis, and vomiting. Surprisingly, even though that *Nigella* was widely used for sprinkling traditional

bread (*lepjoshka*) at both localities, the garden cultivation was reported only once at the Aravan. The staple crops were mostly cultivated in the field, however sometimes were cultivated also in the garden. *Solanum tuberosum* L. (16 reports), except one report at the Aravan, was planted only in the Tuleyken. Widespread staple crop was *Zea mays* (12 reports), which was typical for both localities. Maize had also some additional uses. Frequently, its leaves were dried and used as a feed for cows and seeds were used as a feed for hen. Furthermore, at the Aravan, medicinal tea used as profylacticum or against hepatitis was prepared from the prolonged stigmas (hairs). Moreover, one report was with the environmental use as it was planted around vegetable beds to provide partial shade for the cultivation of vegetable. In the category of nuts and seeds, the most common crops were *Juglans regia* L. (12 reports), *Amygdalus communis* L. (6), *Pistacia vera* L. (2) and *Helianthus annuus* L. (1).

The category of medicinal plants was represented by 12 species. Most of them had very low relative frequency of citations, as they were mentioned by 1 or 2 informants. Interesting was use of *Pelargonium* sp. which was generally grown in a pot as an ornamental plant and it leaves was plucked off and sniffed for improving heart function. Other useful ornamental plant was *Calendula officinalis* L. which infusion was used to treat skin problems. Salad made from fresh tubers of *Helianthus tuberosus* L. was considered as beneficial for kidneys. Important medicinal as well as material plant was *Impatiens balsamina* L. The plant was cut into small pieces, then squeezed and the juice was mixed with a bit of salt and once a day put on the skin with some rash problems or on the feet as an antiperspirant and against fungal infections. The juice had also cosmetic-decorative use. It was being dried for 5 hours, then applied on the women nails and let it there to take effect for 10 hours. At final, the natural colour would stay for 1 months. Other plant used as material was *Kochia scoparia* (L.) Schrad. Mostly at the Aravan's gardens it covered quite big part of the area and practically it was dried and used as a broom. As a fodder species, only 2 plants were documented in homegardens (*Zea mays* and *Medicago sativa* L.), however most of the fodder was produced further in the fields. *Medicago sativa* was usually harvested 4 times per year, in May, July, August, and September. The most important construction species was *Populus alba*, mainly used as deposit for building purposes of the new parts of the house. This species was occasionally sold and traded among the neighbours. It had also important environmental

use as it was grown around the gardens and function as a wind breaker or fence. Other trees used for construction purposes were *Morus nigra* and *Salix* sp. which were additionally used as a fuel.

Table 2. Cultivated plant species at Aravan and Tuleyken

Family/Species	Vernacular name	Parts used	Use categories[a]	Way of consumption or utilization	Commercialization	Occurrence % of gardens	
						Aravan	Tuleyken
AMARYLLIDACEAE							
Allium cepa L.	piyaz	bulb	F	fresh, dry	no	-	15
Allium sativum L.	sarimsak	bulb	F	fresh, dry	no	5	-
AMARANTHACEAE							
Beta vulgaris L.	kyzylcha	root	F	fresh, soup	no	-	5
Kochia scoparia (L.) Schrad.	shipyrgy	herb	Ma	dry- broom	no	65	5
ANACARDIACEAE							
Pistacia vera L.	badam	seed	F	fresh, dry	no	10	-
APIACEAE							
Anethum graveolens L.	ukrop	herb	F	fresh, dry, seasoning, added to salted vegetable	no	25	10
Daucus carota L.	sabiz	root	F	fresh, salted	no	10	25
ASTERACEAE							
Calendula officinalis L.	kalendula	flower	Me	tea	no	-	5
Helianthus annuus L.	kun karama	seed	F	dry	no	-	5
Helianthus tuberosus L.	topinambur	tuber	F	salad	no	-	5
			Me	salad	no		

Table 2. (continued)

Family/Species	Vernacular name	Parts used	Use categories[a]	Way of consumption or utilization	Commercialization	Occurrence % of gardens	
						Aravan	Tuleyken
BALSAMINACEAE							
Impatiens balsamina L.	khna	herb	Me	juice mix with salt, put on feet, once a day	no	20	5
			Ma	juice, dry 5 hours, put on nail for 10 hours (stay will 1 months)	no		
BRASSICACEAE							
Armoracia rusticana P.Gaertn., B.Mey. & Scherb.	khren	leaf	F	salad	no	5	-
		root	F	with cucumber	no		
Brassica oleracea L. var. *capitata*	kapusta	leaf	F	fresh, salads, boiled, *manta*, salads	yes	15	30
Brassica oleracea var. gongylodes	kapusta	bulb	F	fresh	no	5	-
Raphanus sativus L. var. s*ativus*	turp	root	F	fresh, soups, salads, *langman*, salted	no	-	15
CARICACEAE							
Ficus carica L.	inzhir	fruit	F	fresh, jam, compote, dry	yes	30	-
			Me	fresh, jam	no		

Table 2. (continued)

Family/Species	Vernacular name	Parts used	Use categories[a]	Way of consumption or utilization	Commercialization	Occurrence % of gardens	
						Aravan	Tuleyken
CUCURBITACEAE							
Citrullus lanatus (Thunb.) Matsum. & Nakai var. l*anatus*	darbuz	fruit	F	fresh	no	-	10
Cucumis melo L.	dynya	fruit	F	fresh	no	10	-
Cucumis sativus L.	badirang	fruit	F	fresh, salted	no	5	15
Cucurbita pepo L.	ashkabak	fruit	F	fresh, boiled, soup, traditional food (*manta*, *samsa*)	no	25	30
EBENACEAE							
Diospyros kaki Thunb.	khurma	fruit	F	fresh, jam, dry	yes	60	5
			Me	fresh	no		
FABACEAE							
Phaseolus vulgaris L.	fazol	fruit	F	fresh, boiled	no	10	5
		seed	F	fresh, boiled, dry	no		
Medicago sativa L.	bede	herb	Fo	dry, hay	no	5	15
GERANIACEAE							
Pelargonium sp.	kaz tamak	leaf	Me	sniff fresh leaf	no	-	5
GROSSULARIACEAE							
Ribes aureum Pursh	karagat	fruit	F	fresh, jam	no	-	5
			Me	fresh, jam	no		

Table 2. (continued)

Family/Species	Vernacular name	Parts used	Use categories[a]	Way of consumption or utilization	Commercialization	Occurrence % of gardens	
						Aravan	Tuleyken
JUGLANDACEAE							
Juglans regia L.	jangak	seed	F	fresh, dry	yes	45	15
LAMIACEAE							
Ocimum basilicum L.	raykan	leaf	F	fresh, dry, seasoning	yes	30	10
Satureja hortensis L.	oregano	leaf	F	fresh, dry, seasoning	no	20	-
			Me	tea	no		
LYTHRACEAE							
Punica granatum L.	anar	exocarp	Me	decoction	no	30	5
		seed	F	fresh	no		
MORACEAE							
Morus nigra L.	tyt	fruit	F	fresh, juice, jam, dry	no	40	20
		wood	Co		no		
			Fu		no		
MUSACEAE							
Musa acuminata Colla	banan	fruit	F	fresh	no	5	-
POACEAE							
Zea mays L.	jugoru	aerial parts	En		no	35	40

Table 2. (continued)

Family/Species	Vernacular name	Parts used	Use categories[a]	Way of consumption or utilization	Commercialization	Occurrence % of gardens	
						Aravan	Tuleyken
		leaf	Fo	dry	no		
		seed	F	fresh, dry and boiled	no		
			Fo	dry	no		
		stigma	Me	tea	no		
RANUNCULACEAE							
Nigella sativa L.	zire	seed	F	fresh, dry, on *lepjoshka*	no	5	-
			Me	dry	no		
ROSACEAE							
Amygdalus communis L.	badam	seed	F	fresh, dry	no	10	20
Cydonia oblonga Mill	ayva	fruit	F	fresh, jam, compote, dry, added to plov	yes	35	40
Fragaria x ananassa Duchesne	klubnika	fruit	F	fresh, jam	no	5	10
Malus domestica Borkh.	alma	fruit	F	fresh, dry, juice, compote, jam	yes	65	65
Prunus armeniaca L.	uruk	fruit	F	fresh, juice, dry, jam, compote	yes	85	75
			M	fresh, jam, compote	no		
		seed	F	fresh, dry	no		
Prunus avium L.	gilaz	fruit	F	fresh, juice, jam, compote, dry	yes	90	80
Prunus cerasifera Ehrh.	alcha	fruit	F	fresh, jam, compote, dry	no	25	-

Table 2. (continued)

Family/Species	Vernacular name	Parts used	Use categories[a]	Way of consumption or utilization	Commercialization	Occurrence % of gardens	
						Aravan	Tuleyken
Prunus domestica L.	sliva	fruit	F	fresh, jam, compote	yes	10	20
Prunus persica (L.) Batsch	shabdaliy	fruit	F	fresh, juice, dry, compote, jam,	yes	75	25
Pyrus communis L.	almurut	fruit	F	fresh, juice, jam, compote, dry	no	15	15
Rubus idaeus L.	maleena	fruit	F	fresh, jam, compote	no	-	35
SALICACEAE							
Populus alba L.	terek	aerial parts	En		no	20	45
		wood	Co		yes		
			Fu		no		
Salix spp.	tal	wood	Co		no	-	15
			Fu		no		
SOLANACEAE							
Capsicum annuum L.	kalempir	fruit	F	fresh, dry, salted with tomatoes and eggplants	no	20	30
Capsicum sp.	achu kalempir	fruit	F	fresh, dry, salted	no	10	10
Solanum lycopersicum L.	pomidor	fruit	F	fresh, juice, dry, salted	yes	60	75
Solanum melongena L.	baklazhan	fruit	F	fresh, boiled, dry, salted	yes	25	15
Solanum tuberosum L.	kartoshka	tuber	F	boiled, fried	yes	5	75

Table 2. (continued)

Family/Species	Vernacular name	Parts used	Use categories[a]	Way of consumption or utilization	Commercialization	Occurrence % of gardens	
						Aravan	Tuleyken
VITACEAE							
Vitis vinifera L.	juzum	aerial parts	En		no	95	40
		fruit	F	fresh, juice, jam, compote, dry	yes		

[a] *use categories:* F - food, Me - medicine, Fo - fodder, Co - construction, En - environmental use, Fu- fuel, Ma - materials[b]

4.2.2 Wild useful plants in homegardens and their surroundings

Collecting wild plants seemed that have almost disappeared. Respondents usually stated that their parents were collecting various plants from the wild, however nowadays very few people are able to recognize these plants and their usage. Moreover, they do not have time to collect them. At both localities, we found some remnants of the traditional knowledge, nevertheless most of the species were mentioned by very low number of informants. At the Aravan, 11 wild plants were collected and 8 at the Tuleyken. The most important plant family was family Asteraceae (4 species), the other families include 1 species alone, except family Brassicaceae which was represented by 2 species. Most of the species were collected from the garden area and few species from the field surroundings.

The most important use category was medicine. We would like to mention *Plantago major* L. leaves used against pain in knees, and *Rosa canina* L. dried fruits used as tea as profylacticum. Both of them had commercial utilization. The category materials was interesting by plants *Isatis tinctoria* L. and *Elaeagnus angustifolia* L. *I. tinctoria* was utilized as cosmetic dye. The juice was pressed from the leaf and then applied on eyebrows. Fruits of *E. angustifolia* were used for making necklaces, bracelets, or curtains which were placed to the doors. All collected wild plants are documented in Table 3.

Table 3. Non-cultivated species at Aravan and Tuleyken

Family/Species	Vernacular name	Parts used	Use categories[a]	Way of consumption or utilization	Commercialization	Citations
AMARANTHACEAE						
Atriplex spp.	alabata	leaf	F	fresh, added to traditional dishes	no	1
			Me	tea from dry leaves	no	
ASTERACEAE						
Achillea filipendulina Lam.	salybash	flower	Me	tea	no	4
Arctium leiospermum Juz. et C.Serg	lopukh	leaf	Me	put the leave on knee for 5-10 minutes	no	2
		root	Me	tea	no	
Chamomilla recutita (L.) Rauschert	romashka	flower	Me	tea	no	2
Cichorium intybus L.	cikorij	stem	Me	tea	no	2
BRASSICACEAE						
Descurainia sophia (L.) Webb ex Prantl		herb	Ma	dry	no	1
Isatis tinctoria L.	osmo	leaf	Ma	squeeze juice from leaf, apply on eyebrow	no	1
CAPPARACEAE						
Capparis herbacea Willd.	koorgu	fruit	Me		yes	1
ELEAGNACEAE						
Elaeagnus angustifolia L.		seed	Ma	making curtains and jewellery	no	1
LAMIACEAE						
Mentha asiatica Boriss.	jalbuz	leaf	Me	tea	no	2

Table 3. (continued)

Family/Species	Vernacular name	Parts used	Use categories[a]	Way of consumption or utilization	Commercialization	Citations
MALVACEAE						
Abutilon theophrasti Medik.	dikogo chlopka	herb	En	shadow for tomatoes	no	1
PLANTAGINACEAE						
Plantago major L.	podorozhnik	leaf	Me	fresh, tea, put on painful spot	yes	4
POLYGONACEAE						
Polygonum persicaria L.	kymyzdyk	leaf	Me	tea	no	1
ROSACEAE						
Rosa canina L.	it murun	fruit	Me	tea	yes	5

[a] *use categories:* F - food, Me - medicine, En - environmental use, Ma - materials

4.3 Plants species diversity

Species diversity, richness and evenness were calculated for 39 homegardens. The richest homegardens contained 20 species, whereas the poorest garden held just 3 species.

Table 4. Plant species diversity in homegardens within study sites

Observed characteristics	**Aravan (n=20)**	**Tuleyken (n=19)**
Total number of observed species	40	42
Mean no. of species/HGD[a]	11.6	10.3
Average no of species/m^2	1.84	2.09
Total abundance	22,204	51,514
Mean abundance/HGD	1,110.2	2,711.3
Total number of tree species	16	14
Mean no of tree species/HGD	6.4	4.7
Mean Margalef index/HGD	2.02	1.59
Mean Shannon-Wiener index/HGD	1.6	1.46

[a] *HGD* – homegarden

Table 4 shows data according to species diversity. Mean number of species per homegarden (11.6) and mean number of tree species (6.4) was higher in Aravan. For better visualisation the boxplot graph was made (Fig.5). Other criteria as average number of species per m^2 (2.09) and mean abundance per homegarden (2711.3) was higher in the Tuleyken. High abundance in both localities is caused by high number of individuals of some cultivated species, i.e. *Medicago sativa*, *Zea mays* or *Solanum tuberosum*.

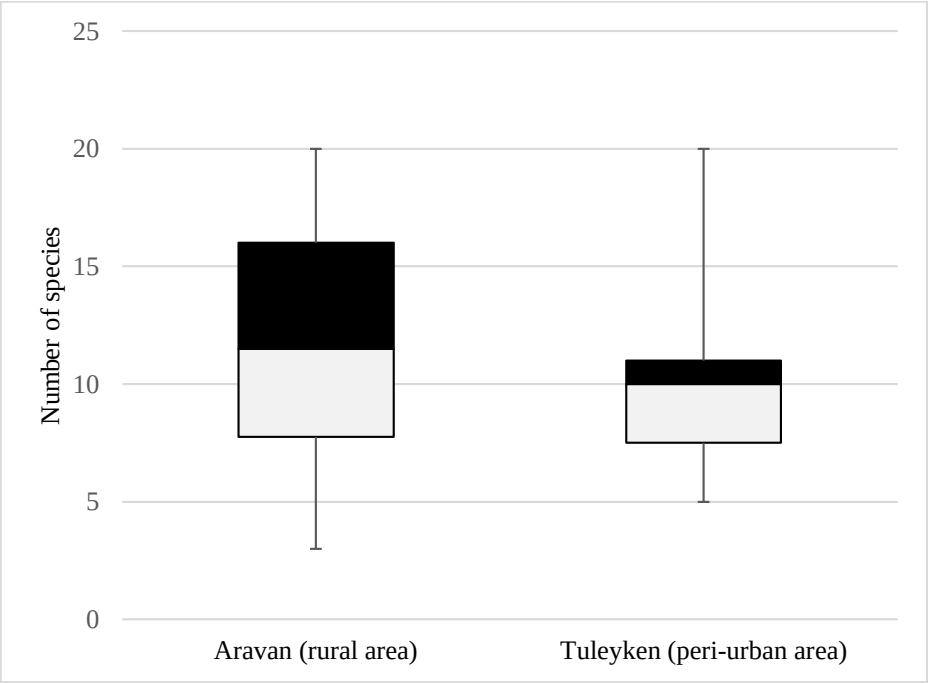

Figure 5. Boxplot of number of species for both localities

The mean Margalef index, providing an understanding of the species richness of the surveyed sites, with values 2.02 in Aravan and 1.59 in Tuleyken did not show any significant differences between the study sites. The Shannon-Wiener index, representing both evenness and abundance of species varied from 0.007 to 2.59. The low values of Shannon-Wiener index (under 1) showed in 5 gardens was caused by high number of individuals of cultivated species *Medicago sativa*. The level of similarity for species compared in the study sites was determined using Sorenson´s index at 51.2%. The highest similarity was found between category of fodder and materials and there was no concordance in the category of medicinal species (Tab. 5)

4.3.1 Size of homegardens and patterns of agrobiodiversity

All homegardens were categorized into the three size classes according to the area of the homegarden and following median calculation; small (≤0.045 ha), medium (0.045-0.089 ha) and large (≥0.089 ha). Considering particular homegarden size classes, the mean number of 9.2, 12.3 and 13.8 species per small, medium and large homegardens has been obtained, respectively (Table 6).

Table 5. Sorenson´s index of similarity (%) for crop categories among surveyed sites

Construction	50
Fodder	100
Food	75
Fuel	80
Materials	100
Environmental uses	50
Medicine	0
Total number of crop species	51.2

Table 6. Plant species diversity in different homegarden's size classes

Observed characteristics	**Small (n[a]=20)**	**Medium (n=11)**	**Large (n=8)**
Total number of observed species	42	40	37
Mean no. Of species/HGD[b]	9.2	12.3	13.8
Average no of species/m^2	4.2	1.8	1.1
Total number of tree species	16	16	15
Mean no of tree species/HGD	4.3	6.5	7.7
Mean Margalef index/HGD	1.58	1.9	2.19
Mean Shannon-Wiener index/HGD	1.5	1.46	1.7

[a] *n* - number of homegardens
[b] *HGD* - homegarden

The difference in the mean Margalef index and mean Shannon-Wiener index implied further the fact, that the species richness is affected by homegarden size. Accordingly, higher diversity was represented in larger homegardens (Fig. 6). Nevertheless, small homegardens had significantly higher number of species per m^2, almost 4 times more than large homegardens.

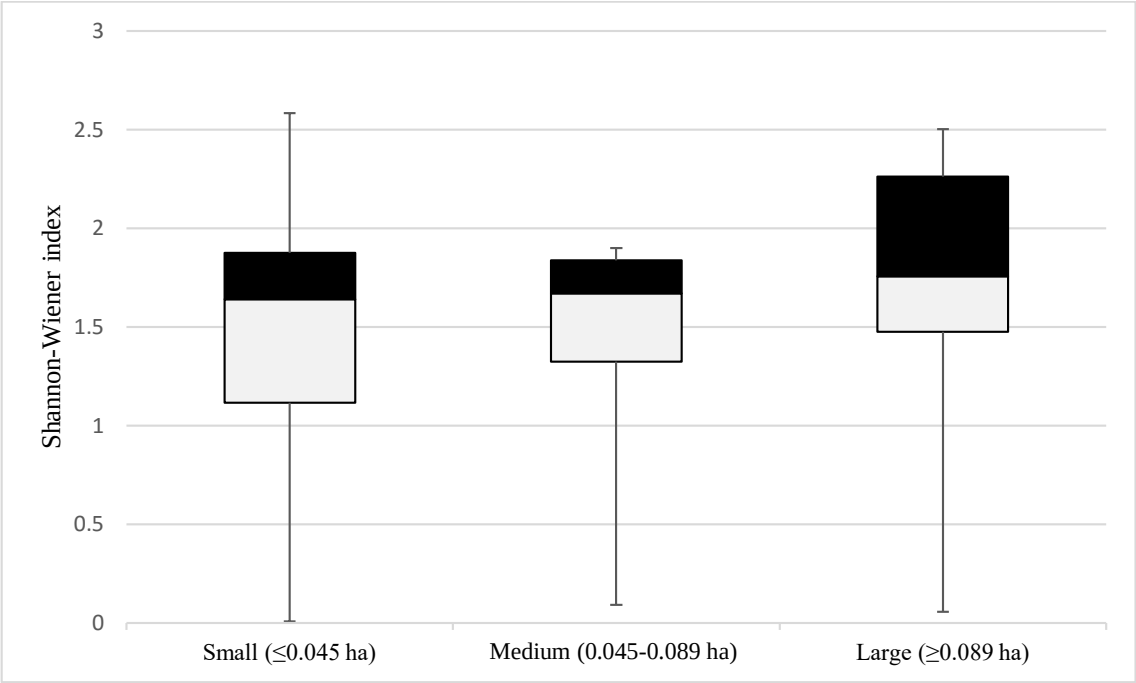

Figure 6. Boxplot of Shannon-Wiener index for different size categories of homegardens

Our results showed, that homegarden size affects the number of species (Fig. 7), with reliability 25.79% as well as abundance of tree species 31.1% shown in Figure 8.

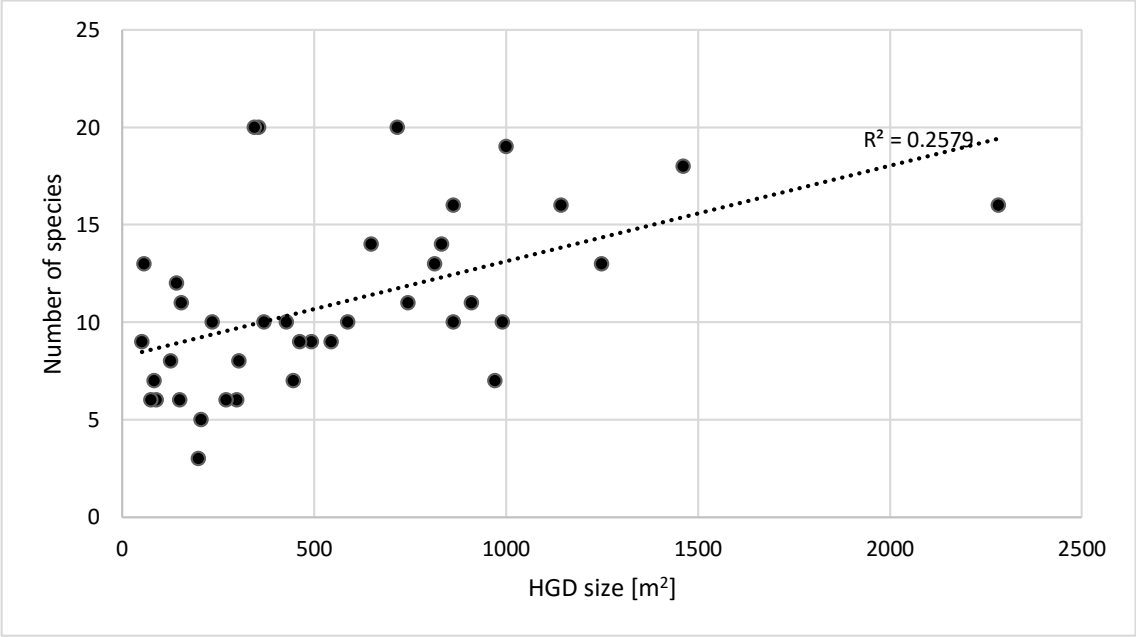

Figure 7. The influence of homegarden size on the number of cultivated species

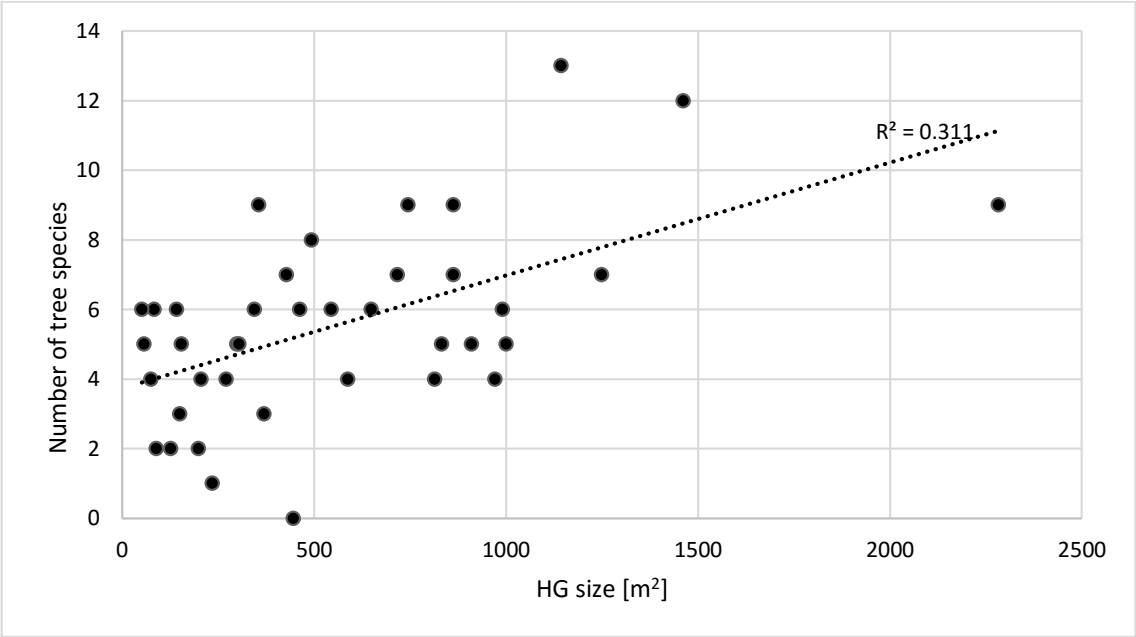

Figure 8. The influence of homegarden size on the number of tree species

5 Discussion

5.1 Household and homegardens characteristics

5.1.1 Size of the homegarden

Although there is no standard or optimal size which classify typical homegarden, studies from different ecological and geographical areas showed that average size of homegarden varies from 1,000 to 5,000m^2 worldwide (Brierley, 1985; Danoesastro, 1985; Fernandes and Nair, 1986; Kumar et al., 1994). According to NSC (2008) average size of Kyrgyz homegardens is 1,000 m^2. In our study the mean size of the gardens at both localities was very similar (639 m^2) and it ranged from 51.2m^2 to 3,600m^2. Thus there was no significant difference between rural and peri-urban area. In the northern part of the country in Issyk-Kul state, homegardens tend to be larger as their size varied from 1,700m^2 to 3,000 m^2 (Currey, 2009). It was confirmed that gardens in arid areas used to be smaller than in tropics as it was declared in study from arid parts of Brazil (Albuquerque, 2005) or from Inner Mongolia (Khasbagan, 2010). In tropics they could be even four times larger. For example, in the study from Vietnam homegardens size ranged from 450 to 12,500m^2 (Vlkova, 2011).

5.1.2 Homegardens' function

Homegardens in Kyrgyzstan, like in other post-Soviet Republics are not just for subsistence. According to NSC (2008), homegardens production is very important for the country economy. In 2007, they provided 27 % of the total market value of agricultural production although they represented only 9% of the country´s arable land. In Aravan, where agriculture is the main source of income, people are selling important part of their production. It is in contrast with Tuleyken, where people has additional jobs and they do not have so much time to sell products at the market. Consequently, the main function of homegardens is to provide fresh food. The additional occupation of peri-urban people is probably due the fact that suburbs of cities as Osh offer more off-farm jobs compared to the rural areas and

easier transportation to the city (Evenson and Pingali; 2007, Žitný, 2015). Interestingly, although almost all rural people sell their production, the commercial function was mention with the minor importance. However, none of gardens was fully oriented only for subsistence production or for market orientation. It proves the statement of Kabir and Webb (2009) that Kyrgyz homegardens are not in transitional phase between subsistence and commercialization. Generally, homegardens in Kyrgyzstan provide supplemental food production for household members and in case good harvest option for market selling. The other functions as provision of environmental services like reducing wind and shade areas, quality food, recreation and improving life in general correspond with similar studies from Ethiopia (Hailu and Asfaw, 2011) and Spain (Calvet-Mir et al., 2012). Other important function of homegarden lays in improving role of women in Kyrgyz society. In our study women were in charge of post-harvest processing and meal preparation similarly as in study from Argentina (Pochettino et al., 2012). In study of Vlkova (2011) most of the women were also in charge of marketing the products what is in accordance with Marsh (1998). Such role might be an important source of independent income for women. Thus it is good opportunity to increase confidence of women as generally in Central Asia they carry the principal role of family, care of children and household and on the other hand they have few rights as members of society.

5.1.3 Inputs for the homegardens

Generally, homegardens are typical by using less amount of chemical fertilisers and no mechanisation (Raheem et al., 2008; Hylander and Nemomissa, 2008). Nevertheless, some additional inputs are always needed. At both localities the main source of inputs was purchase of fertilisers. However, it was primary intended for fertilising fields and on homegardens people were used just the rest of it. It means that in case that there would not be additional larger plots the fertilisers would not be even purchased. At all homegardens it was common to use organic manure which was usually produced by their own animals. However, Currey (2009) warned that people in Kyrgyzstan use manure in a fresh stage and it could bring harmful bacteria or weeds to the soil. Moreover, people are overusing and it leads to water contamination. Thus developing projects focused on agriculture should always provide

trainings how to handle with these materials. The way of acquisition of genetic material was different between localities. In Aravan, people mostly produced their own material in contrast to Tuleyken where most of the propagation material was bought from the market. The cause might be that peri-urban gardeners usually have additional occupation so they do not have time to plant their own seedling so it is easier for them to buy it at the market. In the north, people often buy propagation material on market as well but there is also popular to get seeds or seedling from neighbours or relatives which support plant diversity.

5.1.4 Domestic animals in homegardens

According to FAO (2007) people in rural homegardens are used to keep animals as cows or sheep, whereas in peri-urban areas people have poultry, pigs and fish. However, it is always influenced by cultural or environmental conditions. As in Kyrgyzstan the prevalent religion is Islam, people do not keep pigs as a household animal and due dry conditions breeding fish is not popular as well. In our study all interviewed farmers kept domestic animals but there were some differences between study sites. In the Aravan (rural area), number of animals varied from 1 to 21 (on average 6 heads) and animals like cow, calf, sheep, ram, bull and goat were kept. In Tuleyken (peri-urban area) they kept more heads, 2 to 49 (14 on average), with even higher variability. Except those animals from Aravan, people had horses, donkeys and hens. The higher percentage of households owning poultry in Tuleyken confirms FAO (2007) statement mentioned above. Animals were usually fed with rests from the garden or kitchen and cows were grazed in weeds and range plants at the field margins as it was in case of study from Sudan (Thompson et al., 2010)

5.2 Plant species composition compared to rural and peri-homegardens and the rest of the world

According to Currey (2009), who conducted similar study at the north of the country, Kyrgyz homegardens are usually represented by *Malus domestica*, *Prunus armeniaca* L., *Pyrus communis* L., fruit shrubs as currants and raspberry and variety of vegetables, herbs and grasses which was proved by our study as well. Most of the other crops were similar as

well. The statement of Molebatsi et al. (2010), that peri-urban gardeners predominantly grow ornamental species whereas rural homegardens tend to be self-sufficient in subsistence needs of family, was not proved. However, some differences between study sites could be observed. Thirty-one crops were presented at both location (51.2% Sorenson´s index of similarity), 10 were specific to the Aravan and 11 were found exclusively in Tuleyken. It could be caused by different ethnic or slightly different environmental conditions as Aravan tend to have warmer climate. If we compare species composition with studies from different climatic zones like Ethiopia (Mekonen et al, 2015), Niger (Bernholt et al., 2009) or Vietnam (Vlkova, 2011) we can find strong correspondence in cultivation of vegetable species (carrot, potatoes, beans, pumpkin, onion etc). Ethiopia is centre of origin and diversity of agricultural crops as Kyrgyzstan and homegardens there suffer by loss of traditional knowledge and lack of documentation of homegardens as well. If we check studies from similar climate and closer to our study site e.g. from Inner Mongolia (Khasbagan 2010; Khasbagan, 2015) we could even find correspondence in less familiar species, however with different use. *Impatiens balsamina* is used as ornamental plant and *Kochia scoparia* used as fodder. The same fruit tree species as pomegranate, grapevine, apricot and pear can be found in Egyptian homegardens (Norfolk et al., 2013).

5.3 Collection of wild useful plants

According to our best knowledge from Kyrgyzstan, there has not been conducted proper ethnobotanical study focused on collection of wild species except study of Pawera (2016) from Leylek district in Fergana valley. For our study it was not the main topic but we considered this knowledge crucial for household management as well. According to Segnon and Achigan-Dako (2014), in dry areas the availability of wild plants could secure at least part of the food security and as Pieroni and Giusti (2009) stated. These ethnobotanical surveys could help with long-term management and plant conservation status together with contribution to people livelihood. In areas where our study was conducted it seemed that collecting of wild plants was not generally widespread. One could say that collecting wild plants has never been popular in that area. However, respondents mostly provided the fact

that parents were collecting wild plants and nowadays people do not have time for it. These findings could have more aspects. One of the aspects might be that Kyrgyzstan was under the Soviet Union rule for more than seven decades and it caused disrespecting of local beliefs and traditions and let to subsequent loss of the traditional knowledge (RDF, 2013). On the other hand, only one of 10 interviewed healers in Pawera's study (Pawera, 2016) confirmed this kind of suppression by Soviet authorities. Thus it is possible that regular people do not collect wild plants as it is specialisation of local healers who kept collection sites of plants in secret. However also in the study of Pawera (2016), significant part of medicinal plants was collected from anthropic environments such as orchards and homegardens so they should be known by other people as well. Some species correspond with our study, *Capparis herbaceae* Willd., *Mentha asiatica* Boriss. and *Plantago major*.

We may hope that in the future we would be able to observe revival of traditional knowledge. As in other former Soviet republic´s or communist countries, this traditional knowledge could skip a generation of people who did not practise wild plants during that time (Kassam, 2009). This phenomenon was slightly observed by Pawera in Kyrgyzstan (Pawera, 2016), by Kassam et al. (2010) in Afghan-Tajik Pamir mountains and by Sezik et al. (2014) and Egamberdieva et al. (2013) in Uzbekistan and also by Simkova and Polesny (2014) in Czech Republic. Thus there is a chance that traditional botanical knowledge is not disappearing and people all over the world will keep it in dynamic process by actual practicing as they will consider it as important and functional biocultural heritage.

5.4 Plant species diversity

According to Currey (2009), the role of homegardens in conservation of agrobiodiversity in Kyrgyzstan is almost unknown. Our study researched 40 of homegardens and found 52 useful crop (excluding ornamentals and weeds), which is similar number as in the study conducted in the north of the country (Currey, 2009). This number shows the fact that despite dry and hot climate they can compete with tropical homegardens which are supposed to be more diverse. Few studies from tropics noted even lower numbers as it was in study of Coomes and Ban (2004), Perrault-Archambault and Coomes (2008), Kabir and

Webb (2009) and Zaldivar et al. (2002). However, there are many studies from tropics where the amount of useful homegarden species is over 100 pieces as in Ethiopia (Hailu and Asfaw, 2011), Benin (Salako et al., 2014), Bolivia (Thomas and Van Damme, 2010) and Indonesia (Kehlenbeck and Maass, 2004).

There are two ways of looking at rural and peri-urban diversity. Molebatsi et al. (2010) say that rural homegardens usually contain more individuals of useful species than high diversity. This statement was not proved by our study. It was probably due to the fact that rural people had also additional plot for more intensive cultivation so gardens could stay diverse. The second opinion, that diversity does not decline from rural to peri-urban areas was in accordance with our study (Poot-Pool et al., 2015)

Size of the homegardens influenced species richness and larger gardens were more diverse as it was in study from Niger (Bernholt et al, 2009)). However, it was in contrast with the study from the Issyk-Kul state (Currey, 2009) were size did not influence diversity. There are concerns that the commercialization of products and subsequent cultural and socioeconomic changes could lead to decreasing plant diversity (Soemarwoto and Conway 1992; Tesfaye, 2005). Fortunately, our study did not prove this statement.

5.5 Future and development of homegardens in Kyrgyzstan

As it was already mentioned above, homegardens in Kyrgyzstan play an import role in agricultural production. Nevertheless, there are missing value-added food processing chains which could improve product quality and create value-added employment in the agricultural sector (CDCS, 2014). However, we must be aware that increasing agricultural production could lead to loss of biodiversity as many gardeners with increasing market orientation remove local species from their garden and then contribution of homegarden to in-situ conservation of traditional species could be questioned (Soemarwoto and Conway, 1992).

Till summer 2015, World Bank runs Agricultural Productivity Assistance Project in Kyrgyzstan (World Bank, 2016). Mainly they were focused on innovative technologies,

practices and processing and export of the products. The other scope of improving was the role of women in agriculture. Many households are female headed due to the men emigration for better work (CDCS, 2014) so they needed support in their new role. The project helped to secure professional background, trainings, weather information, etc. The project also assisted women during start their own productive agriculture. At the end of season women were able to earn money for education of their children and for deposit for another season. However, the most important was the fact that they built their own confidence and improved their social life. Another example of a successful project is project supporting the movement of rural women 'For a Healthy Lifestyle' oriented to landscaping, water supply, sanitation and rational use of household plots. It was conducted by organisation Gender and Water Network with a minor support from the Asian Development Bank. They have already proved that women can lead a farm successfully (Stulina, 2015).

New projects should be implemented very carefully and they should be based on respect of traditional and local knowledge. However, it is needed to take into account the fact that not all traditional techniques are effective and necessary to keep (Reenberg et al., 2008).

6 Conclusion

The study brought insight view of the household management, gardens practices and plant diversity of homegardens in Osh province, southern Kyrgyzstan. The survey was conducted in 40 homegardens in rural area of Aravan and peri-urban area of Tuleyken. The evaluation of agrobiodiversity in homegardens was based mainly on two indicators, Shannon-Wiener index and Margalef index. Both indices were used in conjunction with each other in order to establish a satisfactory estimate of the diversity. The results showed the fact that despite dry and hot climate Kyrgyz homegardens can be diverse as some tropical gardens. The indices indicated the fact that the species richness and number of species per homegarden is affected by homegarden size. Sorenson index was used to evaluate similarity among urban and peri-urban area. None diversity indices did not prove any significant differences between study areas. Generally, it is assumed that diversity decline from rural to peri-urban area and that peri-urban homegardens serve only for ornamental purposes. Our study did not prove such fact and we found out that peri-urban homegardens could be valuable tool in conservation and maintaining species diversity at the same level as rural homegardens. Consequently they play an important role in ensuring food security and income accretion of Kyrgyz people. More or less we could not find any crucial differences between rural and peri-urban homegardens neither in size of homegardens, management practices, species composition or collection of wild plants. There were some minor differences between the scale of bred animals and commercialization of the products from homegardens. Both aspects were connected to the fact that people in peri-urban area had another jobs and homegarden production was intended for subsistence needs of family whereas in rural area agriculture was the main occupation of local people therefore should generate income for the farmers.

Post-soviet union countries as Kyrgyztan have generally lack of documentation regarding traditional knowledge about homegarden practices or collection of wild plants. During our observation we found out that people in homegardens did not use significant traditional approaches but neither modern effective ones which shows that Kyrgyz people are not historicaly gardenes and in the present situation there is lack of education focusing at

this topic. how they could do it effectively. We found some remnants of wisdom focusing on collection of wild plant, however it was not popular in our study areas. We recommend more detailed study in the entire country since there is still a chance that traditional botanical knowledge will not disappear and it is necessary to keep the knowledge because it is an important and functional biocultural heritage. For the same reason, the equal interest should be given to cultivation of traditional varieties and landraces of fruit species. They are usually more resistend against pests and disease and provide more stabile production in local climatic conditions together with lower need of inputs. Clear understanding of traditional behaviour of local people, food production, consumption systems and the functionalities of agrobiodiversity are necessary for formulation of sustainable intensification strategies and are crucial for determining of educational goals to stabilise situation of rural farmers.

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Appendix A. Photos - Field phase

Figure I. Field surrounding around Aravan

Figure II. Field surrounding around Tuleyken

Figure III. Outdoor kitchen in Tuleyken household

Figure IV. Preparation of fried potatoes

Figure V. Shaded terraces with Vitis vinifera

Figure IV. Multistrata homegarden with vegetable, spices and fruit trees

Figure V. Plants of *Kochia scoparia* (dried used as a broom)

Figure VI. Preserving tomatoes in salt for winter

Figure VII. Relaxing place called *topchan*

Figure VIII. Drying fruits of *Prunus armeniaca* in front of the house

Figure IX. Dye preparation from *Isatis tinctoria* and its application