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Faculty of Tropical AgriSciences

Department of Crop Sciences and Agroforestry


Czech University of Life Sciences Prague

Faculty of Tropical AgriSciences

## Land-use and agricultural systems characterization in rural and peri-urban areas of Osh Province, Kyrgyzstan

Master Thesis

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Supervisor:

doc. Ing. Zbyněk Polesný, Ph.D.

Author:

Bc. Vojtěch Žitný

**Declaration**

I, Vojtěch Žitný, hereby declare that this thesis entitled *Land-use and agricultural systems characterization in rural and peri-urban area of Osh Province, Kyrgyzstan*, is my own work and all the sources have been quoted and acknowledged by means of complete references.

In Prague, April 23rd 2015

Bc. Vojtěch Žitný

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**Abstract**

This thesis aimed to contribute to conservation of traditional knowledge regarding management of land use types in Osh Province, Kyrgyzstan. An effort was to classify land use types, characterize local agricultural systems and describe agricultural practices in rural and peri-urban areas. Home gardens were excluded, because they were the research topic of my colleague from team. Data were gathered through ethnoecological methods as participant observation, participatory rural appraisal and semi-structured interviews combined with field observation. Farming was determined as the only livelihood of 90 % of rural farmers, whereas 48 % of the peri-urban farmers had additionally some off-farm job. Private land ownership dominated in the province. Orchards and fields were determined as the main land use types. The majority of rural farmers owned one field. Most of the peri-urban farmers had a combination of one field and one orchard. While the most abundant woody species occurring in province´s orchards were apple, apricot and common aspen, the most abundant field crop species were cotton, corn and potato in rural; and corn and alfalfa in peri-urban area. Whilst the percentage of households owning cattle was higher in rural area, proportions of households keeping sheep and poultry were higher in peri-urban area. Herd sizes were generally larger in peri-urban area. Staple crops and vegetables were cultivated and sold rather by rural farmers. Milk, mutton, fruits and eggs were produced and sold rather by peri-urban farmers. Rural farming was determined as more intensive regarding input use. Fields were generally more input demanding than orchards, which were determined as more labour consuming and located closer to the households. Irrigation frequencies were higher in peri-urban area. Machinery employment and post-harvest residues retaining on plots were more common in rural area. Water form of erosion was prevailing and occurring mainly in peri-urban area´s orchards. Obtained knowledge can serve as a cornerstone for further detailed agroecological and socio-economic research in Osh Province. It could contribute to higher sustainability of future agricultural systems and practices, which should ideally respect regional specifics and combine traditional knowledge with reasonable amount of modern varieties, technologies and inputs.

**Keywords:** Central Asia, ethnoecology, land use, urban agriculture

**Abstrakt**

Cílem diplomové práce bylo přispět k zachování tradičních vědomostí týkajících se hospodaření na zemědělské půdě v Ošské oblasti Kyrgyzstánu. Snaha byla klasifikovat typy využití půdy (s výjimkou zahrad – předmět výzkumu jiného člena týmu), charakterizovat místní zemědělské systémy a popsat zemědělské praktiky ve venkovské a příměstské oblasti. Data byla získána prostřednictvím etnoekologických metod - přímého pozorování, participativních metod a rozhovorů s místními zemědělci s využitím polo-strukturovaného dotazníku, doplněných o terénní pozorování. Farmaření bylo jediným živobytím 90 % venkovských farmářů, zatímco 48 % příměstských farmářů mělo navíc i zaměstnání mimo farmu. Soukromé vlastnictví půdy v oblasti dominovalo. Sady a pole byly hlavními typy využití půdy. Většina venkovských farmářů vlastnila právě jedno pole. Majorita příměstských farmářů měla kombinaci jednoho pole a jednoho sadu. Zatímco nejhojnějšími dřevinami vyskytujících se v sadech nacházejících se v oblasti byly jabloň domácí, meruňka obecná a topol osika, nejhojnějšími druhy plodin byly bavlník srstnatý, kukuřice setá a lilek brambor ve venkovské; a kukuřice setá a tolice vojtěška v příměstské oblasti. Podíl domácností vlastnících skot byl vyšší ve venkovské oblasti, zatímco v příměstské oblasti převažovaly domácnosti chovající ovce a drůbež. Velikosti stád byly obecně větší v příměstské oblasti. Základní plodiny a zeleninu pěstovali za účelem prodeje spíše venkovští zemědělci. Naopak produkce mléka, jehněčího masa, ovoce a vajec byla charakteristická spíše pro příměstskou oblast. Venkovské farmaření lze charakterizovat jako více intenzivní z hlediska užívání vstupů. Pozemky na orné půdě obecně vyžadovaly více vstupů než sady, které byly dostupnější z hlediska vzdálenosti od domácnosti a na pěstitelské práce časově náročnější. Frekvence závlah byly vyšší v příměstské oblasti. Mechanizace byla častěji využívána ve venkovské oblasti. Vodní forma eroze v oblasti převažovala a to zjm. v příměstských sadech. Více venkovských farmářů zanechávalo posklizňové zbytky na svých parcelách. Výsledky práce mohou být základem pro následný agoekologický a socio-ekonomický výzkum v Ošské oblasti. Mohou také přispět k vyšší udržitelnosti budoucích zemědělských systémů a praktik, které by ideálně měly respektovat oblastní specifika a kombinovat tradiční znalosti a inovativní technologie.

**Klíčová slova:** Centrální Asie, etnoekologie, využití půdy, městské zemědělství

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## List of abbreviations

CAREC - Central Asian Regional Economic Cooperation

e.g. - for example

FAO - Food and Agricultural Organization of United Nations

GDP - Gross domestic product

GPS - geographical positioning system

HDI - Human development index

i.e. - it means

m.a.s.l. - Metres above sea level

P – Peri-urban

PA – Peri-urban agriculture

R - Rural

RA - Rural agriculture

$S^2$ - Variance

SD - Standard deviation

U - Urban

UA - Urban agriculture

# 1. Introduction

## 1.1. Central Asia - geography and ecological conditions

Central Asia is a region comprising five states (Kazakhstan, Kyrgyzstan, Tajikistan, Uzbekistan and Turkmenistan), which emerged after the fall of Soviet Union in the beginning of 1990´s. This region of an area of approximately 4 million km$^2$ is situated between 35 - 55° N and 48 - 87° E (De Pauw, 2007).

Central Asia lies in moderate and subtropical climatic zones. Climate is continental, which means that there are significant diurnal and annual temperature fluctuations (Fig. 1).

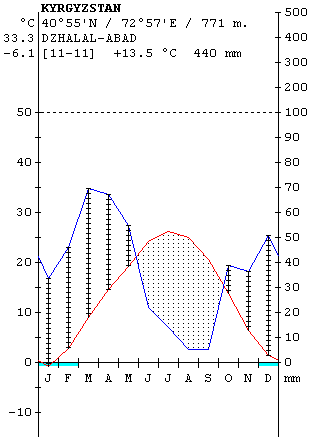


Figure 1: Continental climate of Central Asia demonstrated on climograph of Jalal-Abad, Southern Kyrgyzstan (adopted from www.globalbioclimatics.org)

Soils of Central Asia are diverse. In general, Northern Kazakhstan lies on fertile chernozems, central Kazakhstan on fertile kastanozems, southern Kazakhstan and western Kyrgyzstan on xerosols poor in organic material, often saline. The rest of Kyrgyzstan is, with a few exceptions such as fertile Fergana valley, situated on yermosols – dry soils poor on humus. Uzbekistan is typical by shifting sands and rock debris. Whole territory of Central Asia is interlaced by patches of solonetz – salty soils with high sodium content (FAO, 1992).

Region´s ecosystems are represented by deserts, steppes and dry hilly areas in lower altitudes; and forests, subalpine and alpine meadows and permanently snow-covered

mountains in higher altitudes (Kreutzman, 2005). The highest mountain ranges are Pamir-Alai and Tian-Shan with the highest peaks over 7,000 m.a.s.l.. These biomes situated in the mountains are extremely rich in plant and animal species. They are considered as the place of origin of several crops, woody plants and animals (CAREC, 2004). Mountainous areas are also diverse from the point of view of land use types, which are largely determined by microclimate, local topography and local natural vegetation (De Pauw, 2007). High precipitation and melting glaciers occurring in mountainous areas feed the rivers, which spring there. They are on some places used for hydropower generation (Curtis, 1996), but most of the water is used for agricultural irrigation in the valley of Fergana, situated in the western part of the Central Asia, and in Turkmenistan (Gareeva et al., 2008).

## 1.2. Central Asia - primary sector and related environmental problems

Central Asia´s population is from 65 % rural (Frenken, 2013). While pastoralism is the main life strategy in the mountains, crop cultivation is concentrated on the plain of northern Kazakhstan and in the valleys between mountain ranges. In general, both mountain and lowland agricultural systems can be described as mixed systems combining cultivation of plants and animal husbandry.

Fergana valley is the main agricultural area of the Central Asia. It lies at the borders between Kyrgyzstan, Uzbekistan and Tajikistan. Main cultivated crops in the area are: cotton (*Gossypium hirsutum* L.), wheat (*Triticum* spp.), various rice varieties (*Oryza sativa* L.), barley (*Hordeum vulgare* L.), alfalfa (*Medicago sativa* L.), tobacco (*Nicotiana* spp.), millet (*Panicum miliaceum* L.), grapevine (*Vitis vinifera* L.), corn (*Zea mays* L.), fruits and vegetables. Agricultural production is supported by surface irrigation. Population of 14 million people with their agricultural plots is concentrated on area of 22,000 $km^2$. Ethnic composition is varied, which together with high population density result in frequent conflicts in this area (De Martino et al., 2005).

In general, mountainous areas of the Central Asia are not favourable for arable agriculture due to harsh ecological and climatic conditions. Predominantly pastoralism is practiced there. Past human made land use changes related to agriculture, pastoralism and logging in Pamir-Alai led to deforestation, erosion, landslides, overgrazing, soil fatigue

resulting in decreasing yields and desertification (Breu and Hurni, 2005). These negative impacts result in gradual biodiversity loss and decreasing efficiency of ecosystem roles fulfilling (Förster et al., 2011).

Natural resources in both highlands and lowlands of the Central Asia are exploited unsustainably. Population´s living standard is poor and its demands on natural resources gradually increase. Most of the Central Asian countries are not wealthy and cannot support people in other way than turn a blind eye to overexploitation of natural resources which will eventually lead to even more pronounced population impoverishment in the future (CAREC, 2004).

## 1.3. Kyrgyzstan - geography and introduction to land use

Kyrgyzstan is a mountainous country located in the Central Asia and bordering with Tajikistan, China, Kazakhstan and Uzbekistan (Fig. 2).


Figure 2: Kyrgyz Republic location (shapefiles for maps downloaded from www.naturalearthdata.com and www.arcgis.com)

It has an area 199,951 km$^2$. Forty percent of the country´s area is situated over 3,000 m.a.s.l., usually under permanent snow and ice. Parallel mountain ranges running in west - east direction divide the country into three zones differing in ecological conditions. The northern zone comprises the Talas and Chuy river valleys, the southern fringe of the

Kazakh steppe, and the upland tectonic basin. The central zone includes mountain ranges, high river valleys, upland steppes, and alpine and sub-alpine pastures and meadows. The southern zone consists of fertile Fergana Valley and agricultural lowlands (FAO, 1997).

Fifty-six percent of Kyrgyzstan´s area is classified as agricultural land, from which 75 % is used as a pasture and approximately 13 % as arable land. Only 0.4 % of total land is under permanent crops. Roughly 4 % of country´s area is occupied by water bodies. More than 70 % of the arable land depends on irrigation for its productivity (USAID, 2012).

## 1.4. Kyrgyzstan - socio-economic facts

Kyrgyzstan has a population about 5.72 million inhabitants. Thirty five percent of the population lives in the cities (World Bank, 2015). It is known for its diverse ethnic composition (e.g. Uzbeks, Russians, Kazakhs, Tajiks). Most of the residents are Muslims (75 %).

There are 65.5 % of inhabitants in a productive age (World Bank, 2015). Approximately 53 % of people work in agriculture, 8 % in industry and 39 % in services (World Bank, 2007). Thirty-eight percent of inhabitants live under poverty line. Nominal GDP is 6.473 billion USD per year (World Bank, 2015). Agriculture makes 24.6 % of GDP, industry 25 % and services 50.4 %.

Kyrgyzstan with the HDI 0.628 belongs between medium developed countries. Life expectancy is 70.1 years. Nearly 100 % of population is literate (World Bank, 2015). The country is egregiously known for its high rate of corruption, which negatively affects economic growth (Gyimah-Brempong, 2002). Corruption perception index reaches 27. It is one of the forty worst countries in the world (Transparency International, 2014).

## 1.5. Kyrgyzstan - a land use related history

Value of natural resources, their demand and utilization change over time. Groundbreaking events often lead to increase or decrease in natural resources exploitation. Russian conquest in 19$^{th}$ century, Russian October Revolution in 1917 and the fall of Soviet Union were by Schmidt (2005) determined as these groundbreaking events for Central Asia.

Pre-Russian period was dominated by evolution of rangelands and pastoral systems. Nomads were migrating in order to cope with climate variability (Chuluun and Ojima, 2002; USAID, 2012). Pastoralists were having mixed herds (cattle, sheep, goats) (USAID, 2012), with which they were herding especially in mountainous areas. They were crossing trade routes, collecting non-timber forest products and bartering their livestock derived products with lowland merchants for staple crops and textile. Forests were exploited by local people as a source of timber, fuelwood, nuts and fruits (Schmidt, 2005).

In the last quarter of 19$^{th}$ century the area of today´s Kyrgyzstan was occupied by Russian Empire. Forests were nationalized. However Russian colonists, when they came, found already degraded forests. Extraction and burning of wood in order to extend nomadic pastures were identified as the causes of this degradation. The ecological role of the forest in terms of water cycle regulation, erosion control and climatic regime became known in this period and thus Russian colonists put a ban on detrimental grazing in the forests. Extraction of natural resources was not running in organized way in this period. It was a subsistence activity (Schmidt, 2005).

October Revolution in 1917 started a chain of events leading to sovietization and collectivization in 1930´s (Chuluun and Ojima, 2002; Schmidt, 2005). All farmers were expropriated and their land and domestic animals nationalized or collectivized. The State Farms (sovkhozes) and the Collective Farms (kolkhozes) were established. Almost each countryside household got 3 to 5 ha of forested land for hay collection. These lands were awarded to people only orally, but people considered them their own. Nowadays people still exploit these areas and pay a small fee to the State Forest Enterprise (leshoze) as a rent. Many walnut trees were felled during World War Second in order to support Soviet war efforts before nature reserves were established after the end of the war. However bans on felling in protected areas were and are under the pretext of sanitation felling circumvented frequently. People were obliged to harvest certain amounts of non-timber forest products and give them to state forest enterprises for symbolic redemption prices. Population growth and Soviet state policy led to gradual transformation of traditional nomadism to more sedentary agriculture. Soviet experts considered this step in Central Asia as a step towards rural development (Schmidt, 2005). They introduced a centrally

controlled intensive livestock production system based mainly on sheep (USAID, 2012) and forced people to convert grasslands into croplands. Thus they reduced space for grazing, while the number of livestock and population were gradually growing and exerting enormous pressure on pastures and fields (Chuluun and Ojima, 2002).

Kyrgyzstan, as a part of Soviet Union, played tiny but integrated role. Kyrgyzstan provided agricultural products such as grapevine, tobacco, sugar beet (*Beta vulgaris* L.), animal fats, meat, vegetables, oilseeds and plant fibres. Until the fall of Soviet Union Kyrgyz Republic had also several industrial enterprises. Its industry was providing among others products derived from agriculture such as shoes (leather) and clothes (cotton) (Curtis, 1996).

The fall of Soviet Union in 1991 resulted in gradual transformation of a state-managed economy to market economy. State enterprises except forestry were privatized (Curtis, 1996). Sheep and other livestock from state or collective enterprises were distributed between households (USAID, 2012). Probably the most damaging impact of transformation for both society and nature was the onset of unemployment resulting in hunger and poverty and thus also stronger pressure on natural resources, which started to be even more unsustainably exploited.

## 1.6. Specifics of contemporary Kyrgyz primary sector

Pastoralism based on sheep, goats and cattle is nowadays the main use of agricultural land in Kyrgyzstan. Mutton, beef, eggs, milk, wool, silk and bred horses are the main domestic animals derived products (Curtis, 1996). However the loss of a guaranteed market for wool combined with low wool prices and high meat prices after the Soviet Union´s disintegration resulted in significant reduce of the Kyrgyzstan‘s sheep number (about 75 %) and other livestock numbers (about 30 %). Livestock Census in 2003 registered circa two million sheep, three million cows and one million horses. Domestic animals are from 96 % owned by households and small farms. Such enterprises or households usually own small number of domestic animals (on average 15 pcs). Mistrust in professional herd management and fragmented administrative control over pastures resulted in overgrazing of easily accessible pastures, while the remote pastures became underutilized. Roughly 33 % of the pasture near farms and settlements is degraded, 19 % is negatively affected by erosion and 33 % by expansion of inedible weeds. However

contemporary animal numbers are considered to be below the pastures´ carrying capacity, which means that the livestock number can potentially grow and contribute to better livelihoods of the farmers, if the land will be used sustainably (USAID, 2012).

Three types of farms can be distinguished in today´s Kyrgyzstan: household plots, peasant farms and collective farms. Household plots are the smallest often based purely on subsistence. Peasant farms are bigger and more market-oriented. These two categories overlap in terms of some of their characteristics. Collective farms are the largest, but their share is in all aspects rather negligible (Tab. 1).

Table 1: Kyrgyz farm types characteristics, adopted from Akramov and Omuraliev (2009)

| | **Household plots** | **Peasant farms** | **State and collective farms** |
|---|---|---|---|
| **Number** | 924,100 | 323,600 | 1,300 |
| **Average size of arable land (ha)** | 0.1 | 2.9 | 58.9 |
| **Total sown area per year (1000 ha)** | 101.2 | 951.5 | 76.1 |
| **Share in total sown area per year** | 9.0% | 84.3% | 6.7% |
| **Overall annual financial output (million USD)** | 526.9 | 852.4 | 38.9 |
| **Share in annual financial output** | 37.2% | 60.1% | 2.7% |
| **Annual financial output per hectare (USD)** | 5 206.0 | 896.0 | 510.0 |

Note: Data related to year 2007

Fodder crops, wheat, barley, cotton, sugar beets, potatoes (*Solanum tuberosum* L.), tobacco, fruit, vegetables represent Kyrgyz plant production (Curtis, 1996). Crop yields are rather low due to lack or bad availability of high quality seeds, fertilizers, equipment, machinery and processing plants; inadequate maintenance of machinery; decreasing soil fertility; decreasing public investments into agriculture and limited availability of agricultural services (USAID, 2012). Moreover Kyrgyzstan is vulnerable to water scarcity, which is a serious problem if the fact that significant proportion of its contemporary produce comes from irrigated agriculture is taken into account. Irrigation and drainage systems are of poor quality (maladaptive irrigation infrastructures after the post-Soviet land reforms, insufficient and unequal water distribution between users, deteriorated infrastructure, low efficiency of used furrow irrigation, poor management). These difficulties also contribute to gradual growth of soil salinity (Aleksandrova, 2014).

Non-timber forest products repurchase and export are in some cases carried on by foreign investors from Turkey [walnuts (*Juglans regia* L.)] and France (mushrooms).

Importance of fuelwood gradually grows. Although the state forest enterprise allow people to cut a certain volume of wood in the forests, these limits are often exceeded and wood overharvesting goes on especially around inhabited areas (Schmidt, 2005).

Kyrgyz industry is in poor condition. Majority of big industrial enterprises were theft during privatization. Manufacturing, which includes textile industry processing cotton from Fergana, is the main branch of the secondary sector. Importance of mining and logging is still high (Curtis, 1996). There are Canadian investments into gold mining and British investments to logging (Schmidt, 2005).

## 1.7. Specifics of urban and peri-urban agriculture and its comparison with rural agriculture with focus on developing countries

While RA takes place in the countryside; growing poverty, starvation, unemployment and opportunities provided by the city (e.g. growing demand for food, proximity of markets and availability of cheap resources such as organic waste and wastewater) have supported the onset of UA and PA. They are defined as an intentional growing of plants and breeding of animals for food and other uses in the cities (UA) and in their surroundings (PA) and related activities such as the production and delivery of inputs, processing and marketing of products (FAO, 2007).

Population in P area grows due to high natality and influx of immigrants from both R and U areas. Growing population density results in land scarcity, growing land prices and also the onset of multiple land use types. UA and PA tend to be small-scale and intensive – farmers try to maximize an output from a limited space, which involves inputs, technologies and labour (Prain, 2006). While farming is primary and often only livelihood of R farmers, U and P farmers usually have off-farm employment. Production of staple crops, beef and mutton is common in R areas. UA and PA systems are often based on perishable products, such as green leafy vegetables, fruits, dairy products, poultry-derived products and mushrooms (FAO, 2007; Nugent and Egal, 2000). On irrigation dependent vegetable production dominates in PA. Cultivation of aromatic, medicinal and ornamental plants and various woody plants also play non-negligible role in UA and PA (FAO, 2007). Crop and livestock production are usually separated in UA and PA, i.e. some

households do the crop cultivation and others do the animal husbandry. Mixed systems combining livestock and crop production are not common, but can be found between small-scale P enterprises (Prain, 2006).

Developing countries´ cities and suburbs are characterized by important share of their agricultural production for subsistence. Only surpluses are usually traded. P farmers are more market-oriented than ordinarily purely subsistence U farmers. Products are sold directly on the farm, delivered by lorry, in local shops, on local farmers' markets or to intermediaries and supermarkets (FAO, 2007).

Each world region has its own specifics of UA and PA (FAO, 2001).

- Thirteen percent of **Sub-Saharan** region´s agricultural population practice UA and PA, which is characterized by producing of fruits and vegetables and breeding of dairy cattle, goats and poultry. People tend to have some off-farm job.
- Over six percent of **Middle East´s and North Africa´s** agricultural population practice horticulture and poultry breeding in and around cities. These people tend to have some off-farm employment and sell part of their fruits and vegetables in order to have some extra income.
- These special kinds of agriculture were not so much adopted in **South Asia**. UA and PA agriculture is practiced by approximately 1 % percent of local agriculturalists. They usually combine horticulture and husbandry of dairy cattle and poultry. In addition to that they have some off-farm work.
- A proportion of people practicing UA and PA and their main livelihoods in **East and South East Asia** are more or less the same as in South Asia, however produced milk and vegetables are more often sold on the market.
- The principal livelihoods in **the Caribbean and South America** are more or less the same as it is in East and South East Asia, but the percentage of engaged agricultural population is somewhat higher (about 3 %).
- An importance of UA and PA in **Eastern Europe and Central Asia** grows. Circa 7 % of agriculturalists are involved in UA and PA in East Europe and Central Asia. Their produce is mainly for subsistence and is based on vegetables, poultry and pigs. U and P farmers sell their produce rather sporadically in these regions.

The key differences between RA, UA and PA were summed up by FAO (2007) and presented in the Table 2.

Table 2: Comparison of rural, peri-urban and urban agriculture; adopted from FAO (2007)

| | AGRICULTURE TYPE | |
|---|---|---|
| | **Rural** | **Urban and Peri-urban** |
| **Farm type** | Conventional; Farms consisting of interdependent subunits | Unconventional; Partly mobile; Partly without a soil; More specialized independent units acting in cluster/chains |
| **Livelihood** | Farming = primary livelihood; Full-time farming<br><br>Usually 'born farmers'; Traditional knowledge | Farming usually secondary livelihood; Off-farm employment common<br><br>'Beginners': urban citizens engaged in agriculture by necessity or by choice; Recent migrants with weak traditional knowledge |
| **Products** | Mainly staple crops; Cattle; Sheep | Perishable products: esp. vegetables dairy products, poultry and pigs, mushrooms, ornamental plants, herbs, fishes etc. |
| **Cropping calendar** | Seasonal periods | Whole year cultivation (irrigation) |
| **Production factors** | Low land price; Lower costs of labour; High costs of commercial inputs; Variable cost of water | High land price (land scarcity); Higher costs of labour; Lower costs of commercial inputs; High cost of clean water; Availability of low-cost organic wastes and wastewater |
| **Farmer organization** | Often existing and more easy to establish since farmers share the same social background | Often lacking and more difficult to establish, because farmers dispersed and coming from greatly varied social backgrounds |
| **Social context** | Community; Most families engaged in farming and share a common social background; More homogeneous; Relatively stable; A few external stakeholders; Farmers more organized | No activities outside their neighbourhood; The percentage of households engaged in farming in a neighbourhood variable; Urban farmers with varying socio-cultural backgrounds. Highly dynamic environment with strong fluctuations; Many external stakeholders with different interests and contrasting views on agriculture; Farmers hardly organized |
| **Environmental context** | Relatively stable; Land and water resources rarely polluted | Fragile; Land and water resources often polluted |
| **Availability of research and extension services** | More likely (although declining) | Hardly available, but possible gaining of direct access to libraries, research organizations, market information, etc. |
| **Availability of credit services** | More likely (although possibly for larger farmers and mainly men) | Hardly available, but credit services for the informal sector available and might assist farmers too, including women |
| **Market** | Distant markets; Marketing through chain; Low degree of local processing | Closeness to markets; Direct marketing to customers possible; Higher degree of local processing |
| **Land security** | Relatively high | Insecure; Often informal use of public land; Competitive land uses |

UA and PA have a lot of advantages, such as food security enhancement, increased availability of food for low income groups (Nugent and Egal, 2000), meaningful use of city´s organic waste, sound food composition provision, employment enhancement, income generation, social development (FAO, 2007), contribution to city´s resilience against climatic change (Aubry et al., 2012) and reduce of the vulnerability to macroeconomic changes (Lange et al., 2013). However there are several risks related to it. Crop contamination caused by pathogenic organisms due to irrigation by polluted streams, inadequately treated wastewater and/or insanitary handling of fresh products during transportation, processing and marketing can occur. Crops and drinking water can be polluted by the residues of chemicals used for agriculture and/or heavy metals, which are in the U areas in higher concentrations due to city traffic and industry. Human disease vectors (e.g. infected mosquitoes) are often attracted by agricultural activity. Transmission of diseases carried by domestic animals to people can occur too. Moreover occupational health risks (e.g. improper handling with agricultural chemicals, untreated wastewater) can threaten U and P farmers. Water streams´ siltation due to insensitive irrigation water management and clearing of natural vegetation for agricultural purposes are other frequently occurring consequences of UA and PA (FAO, 2007).

## 1.8. Statement of the problem

The issue of land use is very complicated due to lot of interrelated aspects resulting in final features of its management. The key roles are played by the presence of infrastructure; possibility of agricultural expansion and wood extraction; demographic trends; economy (e.g. market presence, urbanization, industrialization); available technology; policy (e.g. corruption, land tenure system); culture (e.g. public attitude and beliefs) and environment (Geist and Lambin, 2002). The circumstances for the final decision-making regarding land use, employed agricultural practices, agricultural production structure, principal and possible secondary livelihoods thus vary between RA, UA and PA (FAO, 2007), because above mentioned factors differ in between R, U and P areas.

R population in developing countries tend to migrate to the cities or suburbs in order to find a job outside agricultural sector (Lambin et al., 2001; Lipton, 1980). Elder farmers in

the countryside have no descendants for sharing their experiences and traditional knowledge regarding land use types (United Nations, 2009[a]). Practices occurring in R areas often cannot be applied in U and P setting due to limited land area and other constraints. Traditional knowledge in Kyrgyzstan is already limited due to suppression of such knowledge by practices implemented by Soviet agricultural decision-makers (Pawera, 2014) and transformation of centrally planned economy to market economy (Marten, 1990), which brought the onset of unemployment; growing demands for a cash; pronounced migration; and elements of modern agriculture such as improved varieties, inputs and technologies from western countries, which are often considered as the new role models for post-Soviet countries (Schmitt, 1997). However the performance of modern varieties, inputs and technologies are often not that outstanding as expected. Moreover these modern agricultural solutions are more costly due to dependence on fossil fuels and imported materials and additionally less sustainable and less resilient to environmental extremes (Guttmann-Bond, 2010).

Unlike R population, P and U population in Kyrgyzstan grow much faster (United Nations, 2015). Limited land has to feed growing amount of inhabitants. Land is gradually getting fragmented. New marginal and for cultivation unsuitable lands are nowadays starting to be cultivated or grazed. Agricultural intensification is underway. Growing dosages of inputs in order to sustain or increase the yields result in environmental degradation (Marten, 1990), often with detrimental effect on human health (FAO, 2007). Moreover UA and PA can be in conflict with urban plans, which results in land tenure insecurity (FAO, 2007) and thus in decreasing willingness for investments into long-term sustainable agricultural solutions (Timberlake, 1985).

RA and PA practices in Kyrgyzstan have in common that often result in unsustainable use of natural resources. Population and livestock put a pressure on agricultural and forested land (Schmidt, 2005). Predictions of climate change forecast warming leading to increased availability of irrigation water in a short or mid time frame, however insufficient water supplies and deterioration of its quality in a long term perspective (Aleksandrova et al., 2014). Deforestation in order to get firewood or extend agricultural/pasture areas; overgrazing; erosion (Schmidt, 2005); excessive water withdrawals for irrigation and poor

irrigation infrastructure resulting in unequal water distribution, waterlogging and soil salinity (Kazbekov et al., 2009); removal of crop/logging residues (thus also nutrients) from fields and forests (Jaleta et al., 2013); agricultural intensification resulting in growing amounts of inputs, growing share of monocropping and abandonment of traditional crop landraces lead to environmental degradation, decreased profitability (Marten, 1990) and higher vulnerability to climate change (Aleksandrova et al., 2014) and macroeconomic changes (Lange et al., 2013).

These numerous and often related problems occurring in Kyrgyzstan call for designing of sustainable land use management guidelines applicable (with modifications) in all R, U and P areas, but at the first, contemporary and past land use types, their management and problems have to be analyzed. Secondarily, findings from this analysis and findings from the recent science should be combined for identifying the main pros of farmers´ practices and finding out the opportunities for improvements. Finally, sustainable and at the same time profitable agricultural practices respecting regional specifics should be designed for R, U and P areas. This could be achieved by combining traditional knowledge and practices with reasonable amount of modern inputs, technologies and varieties (Marten, 1990).

## 2. Objectives and hypotheses

The main objective of this master thesis is to contribute to conservation of traditional knowledge regarding management of various land use types in Osh Province, Kyrgyzstan. An effort is to classify land use types, characterize local agricultural systems and describe agricultural practices in R and P areas. An aim is to compare RA and PA by answering specific questions such as: Do farmers have some off-farm employment? How much time farmers, their families and hired employees spend by working on agricultural plots? Which kind of land tenure prevails? What are the sizes of agricultural plots? What are the main land use types? How broad is the range of cultivated crops, shrubs and trees? What are the differences between herd sizes and species composition of domestic animals in R and P areas? What are the differences in management of land use in terms of labour time and employed agricultural inputs, machinery and irrigation? Do low input agricultural

plots tend to be more distant from the household than high input? Which plant derived products and domestic animal derived products are sold? How farmers use post-harvest residues? Which type of land use is more vulnerable to various erosion types and in which area? I, based on the literature, hypothesize that:

- PA in Central Asia is rather subsistence activity compared to the farming in R areas and thus the marketing of agricultural products by P farmers is rather occasional compared to the R farmers (Aubry et. al, 2012; FAO, 2007; Nugent and Egal, 2000).
- While the farming is a primary livelihood of farmers in R areas, farmers in P areas tend to have off-farm employment (FAO, 2007; Lange et al., 2013; Nugent and Egal, 2000) and thus P farmers spend less time on their agricultural plots.
- While the farmers in R areas produce staple crops and breed cattle and sheep, P farmers´ agricultural production is based on perishable products such as green vegetables, fruits, dairy products and poultry-derived products (FAO, 2007; Nugent and Egal, 2000).
- Low input land use systems tend to be more distant from household (Marten, 1990).
- Retention of crop residues on the field is not a common practice in the areas with high population pressure (Jaleta et al., 2013), i.e. P area.

# 3. Materials and methods

## 3.1. Osh Province characterization

The research was conducted on two localities situated in Osh Province on the south of Kyrgyzstan (Fig. 3). The first locality was Aravan District situated on the borders between Kyrgyzstan and Uzbekistan, concretely Aravan (40°30´54´´ N 72°29´57´´ E) and the villages in its neighbourhood – the R area. The second research area was the southern suburbs of Osh City (40°31´48´´ N 72°48´00´´ E) called Tölöyken – P area.

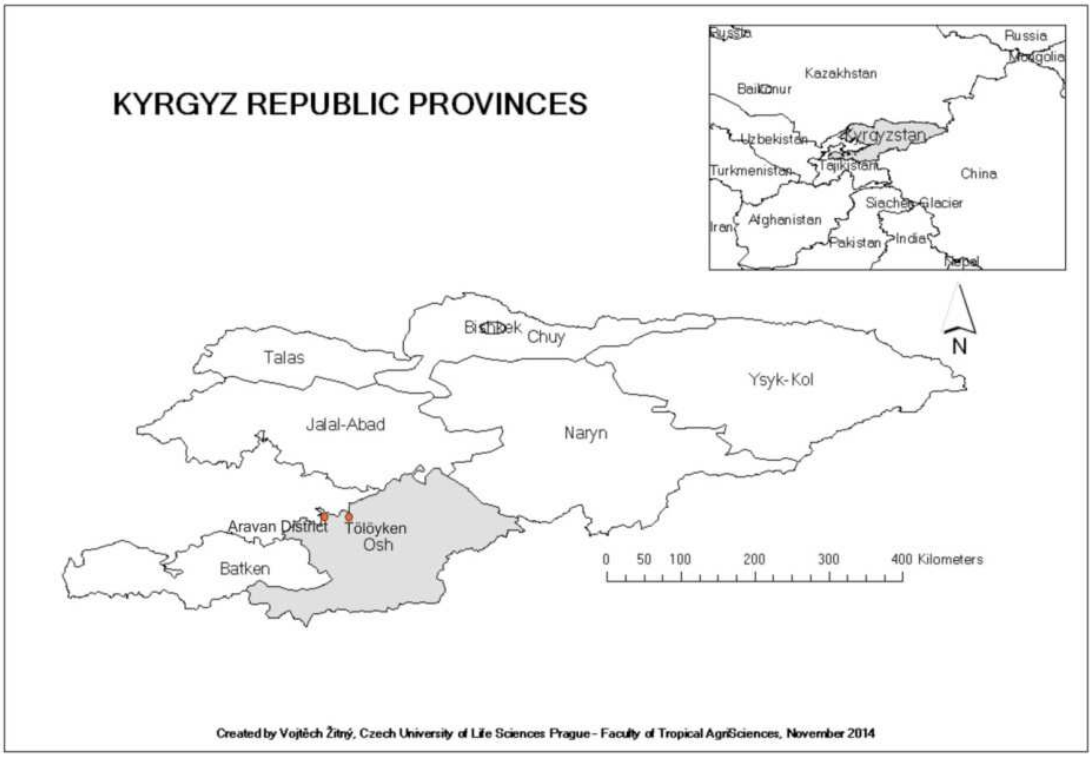


Figure 3: Kyrgyz Republic provinces with highlighted research areas in Osh Province (shapefiles for maps downloaded from www.naturalearthdata.com and www.arcgis.com)

### 3.1.1. Topography and soils

Osh Province´s topography can be characterized by mountainous areas with Alay Range, whose highest peak is 5,544 m.a.s.l., on the south and flat landscape on the north where the eastern tip of Fergana Valley is situated. Both research localities were situated in the northern flatlands of Osh Province. Elevation of research areas varied between 600 m.a. s.l. in Aravan district and 1,130 m.a.s.l. in Töloyken. Soils in research areas were determined by Agakhanyants (1986) as fine alluvial chernozems and chernozem-like soils with a high humic content and expressed carbonate layer. However favourable soil conditions mars soil salinity (Kazbekov et al., 2009) caused by improper irrigation practices and poor irrigation and drainage infrastructure (Aleksandrova et al., 2014).

### 3.1.2. Climate and hydrography

Northern part of Osh Province has a continental climate with hot and dry summers and cold winters. The winter average temperature varies from – 30 °C to 20° C. The summer average temperature ranges from 25 °C to 37 °C. Average annual rainfall in Osh Province is approximately 150 mm. Reference evapotranspiration is 1,034 mm (Kazbekov et al.,

2009). Agriculture is thus strongly dependent on irrigation by rivers (Naryn, Ak-Buura, Aravan, Kara-Darya), which spring in Alay Range, Tian Shan Range and Fergana Range. Detailed meteorological data for Osh and its surroundings are presented in Tab. 3.

Table 3: Detailed meteorological data measured in Osh Meteorological Station adopted from Kazbekov et al. (2009)

| METEOROLOGICAL DATA GATHERED IN OSH METEOROLOGICAL STATION BETWEEN YEARS 2003-2007 | | | | | | | |
|---|---|---|---|---|---|---|---|
| Month | Mean air temperature (°C) | Max air temperature (°C) | Min air temperature (°C) | Relative humidity (%) | Windspeed (m/s) | Precipitation (mm) | Sunshine duration (hrs/day) |
| January | 0.3 | 4.1 | -2.3 | 76.7 | 83.5 | 12.3 | 3.8 |
| February | 2.3 | 6.2 | -0.6 | 73.7 | 103.7 | 19.6 | 4.9 |
| March | 8.2 | 12 | 5.2 | 70.3 | 115.2 | 25.3 | 4.3 |
| April | 15.5 | 19.8 | 11.5 | 62.3 | 126.7 | 28.2 | 6.3 |
| May | 20.1 | 25.2 | 15.2 | 54 | 129.6 | 22 | 8.8 |
| June | 25.5 | 31 | 20.4 | 47.3 | 129.6 | 11.5 | 9.7 |
| July | 27.7 | 33.5 | 22.2 | 45.3 | 112.3 | 3.4 | 11.2 |
| August | 25.3 | 31.3 | 19.8 | 47.3 | 106.6 | 2.2 | 10.1 |
| September | 21 | 27.4 | 15.5 | 53.3 | 89.3 | 4.2 | 9.6 |
| October | 14.3 | 20.1 | 9.9 | 62.7 | 83.5 | 8.6 | 7.8 |
| November | 5.8 | 10.4 | 2.8 | 77 | 74.9 | 12.1 | 4.6 |
| December | 2.2 | 6.1 | -0.2 | 80 | 69.1 | 13.4 | 3.4 |

### 3.1.3. Natural vegetation types

Natural vegetation types in Osh Province are suppressed by grazing, agro-ecosystems (fields, orchards and home gardens) and residential areas. Patches of riparian forest composed of willows (*Salix* spp.), birches (*Betula* spp.), white poplars (*Populus alba* L.), common aspens (*Populus tremula* L.), tamarisks (*Tamarix* spp.) and sea buckthorns (*Hippophae rhamnoides* L.) (United Nations, 2009[b]) can be found along the rivers and irrigation canals. Other vegetation types, which can be found in the study area, are dry steppes composed of tall forbs and meadow steppes dominated by umbellates such as *Ferula* spp. and *Prangos pabularia* Lindl.. Plants tend to end their growth in late July. Meadow plants die off with growing moisture deficit. Shrubby vegetation can occur on more shaded sites (Agakhanyants, 1986).

### 3.1.4. Agriculture

Cropland occupies approximately 7 % of Kyrgyz landscape (Curtis, 1996) and it is situated mainly in the valleys such as Fergana Valley (Osh Province), Chuy Valley (Chuy Province) and Talas River Valley (Talas Province), where rivers provide water for typical furrow or

basin irrigation. That means that one of the few areas in Kyrgyzstan suitable for agriculture is situated in the study area – Fergana Valley. Most of the farms can be according to Akramov and Omuraliev (2009) classified as household plots or peasant farms. Local agriculture is generally based on corn, potatoes, cotton, alfalfa, rice, wheat, cabbage (*Brassica oleracea* L.), tomatoes (*Solanum lycopersicum* L.), carrots (*Daucus carota* L.) and bell peppers (*Capsicum* spp.). Almond (*Prunus* amygdalus Batsch), apricot (*Prunus armeniaca* L.), apple (*Malus domestica* Borkh.), peach (*Prunus persica* Batsch), cherry (*Prunus avium* L.), sour cherry (*Prunus cerasus* L.), pear (*Pyrus communis* L.) and mulberries (*Morus* spp.) trees are typical for province´s fruit production. Vegetation belts dominated by common aspens often create border between different land use types or plots of different owners.

Domestic animals (cattle, sheep, horses, donkeys, goats, poultry) are usually kept rather in small quantities (up to 20 pieces). They are fed by both fresh and dried fodder obtained from fields, orchards and home gardens. They are sometimes also allowed to graze the field borders; crop residues left on the field after harvest; tree leaves, weeds and undergrowth in the orchards and home gardens; and less fertile remote areas.

### 3.1.5. Socio-economy

Osh Province of an area nearly 30,000 $km^2$ is based on malnutrition incidence and poverty incidence one of the less developed provinces in Kyrgyzstan. Province is known for its significant Uzbek minority counting 28 % of its total population 1.1 million. Nearly 83 % of province´s population live in R areas (National Committee on Statistics, 2009).

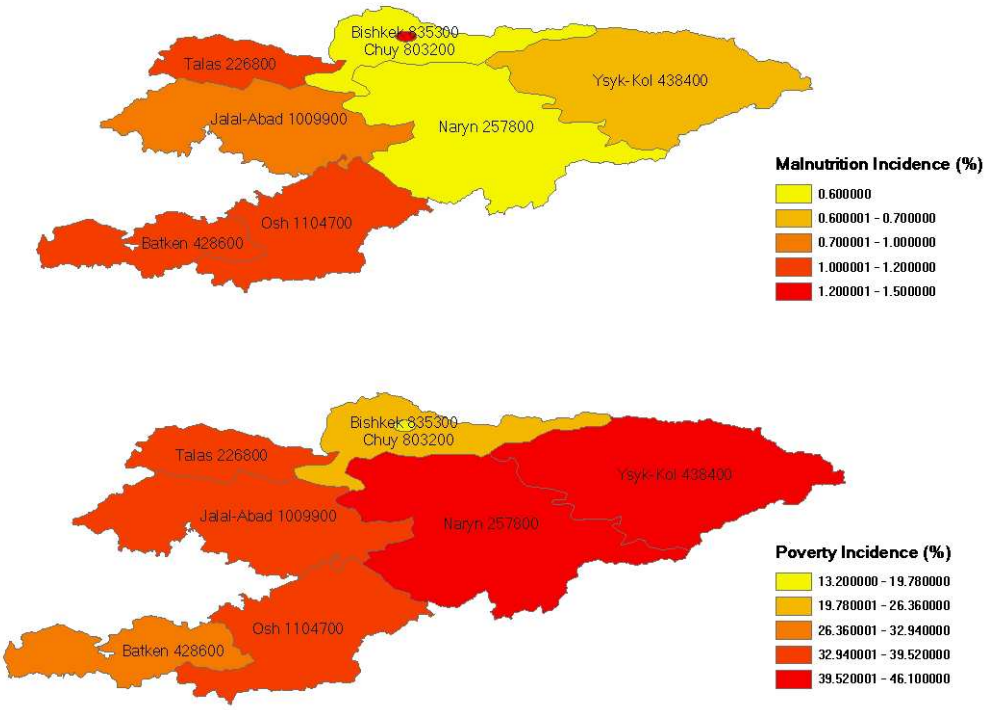


Figure 4: Kyrgyzstan´s provinces population (2009), malnutrition incidence (2012) and poverty incidence (2011) (shapefiles and data for map creating downloaded from arcgis.com)

NOTE: Osh province is in some references divided on Osh City (105 000 inhabitants) and Osh Province (999 576 inhabitants). Osh Province is here assessed as one entity.

Whilst the Uzbek minority holds economic power in the region, Kyrgyz people hold the political and executive power characterized by nationalism, which is probably the main reason for past and recent inter-ethnic conflicts taking place in the province (McGlinchey, 2014).

### 3.1.6. Aravan - rural area

Aravan (Араван) in Kyrgyz language means fresh air. The district of Aravan comprises several villages (айыл) (Fig. 5). It creates eastern tip of Fergana valley and borders with Uzbekistan. It is interlaced by Aravan River (Араван сай) and surrounded by Chil-Ustun Mountains and Kekelik Mountains. There is a big cave system in Chil-Ustun Mountains. The name of whole mountain range (тоо) is derived from forty pillars supporting ceiling of one of the caves. Chil-Ustun namely means forty pillars in Kyrgyz.

Mountain ranges are not suitable for cultivation due to their slope, erosion and dryness. Irrigated agriculture is thus concentrated in the lowlands, where agroecosystems almost suppress natural vegetation.

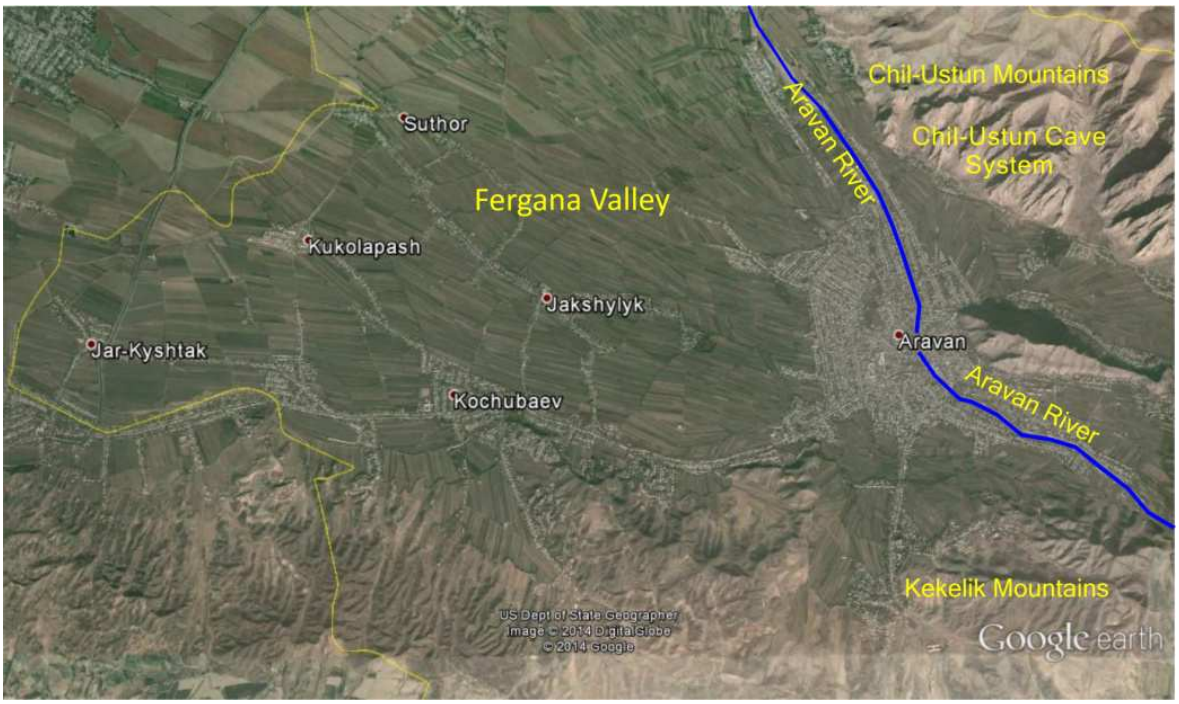


Figure 5: Aravan District detailed map (acquired in Google Earth software and modified in Corel Draw X5, imagery date: 12th March 2013)

Population of the district is predominantly R with significant share of Uzbek families. Twenty one farmers were interviewed there from that 11 Uzbeks, 9 Kyrgyz and 1 Turk; 19 men and 2 women. The average farmer owns 6 pieces of livestock (usually cattle and sheep), shares the household with four other people and has annual income 4145 USD.

Aravan farmers tend to have polycultural fields in order to: get food for themselves (potatoes, vegetables, rice, wheat); get feed for their livestock (corn); and produce cash crop (usually cotton) in order to earn money. Typical crop rotations are mentioned in Fig. 7. All of the interviewed farmers sell at least part of their plant produce. Orchards are not common land use type there – only two interviewed farmers own it. Animal production is rather for subsistence.

### 3.1.8. Tölöyken - peri-urban area

Tölöyken is named after ancient ancestor of today´s area residents, who settled it before thirteen or fifteen generations (this detail varied between different informants). Töloyken lies in the valley between two nameless hill ranges (чоку). Its area is interlaced by Ak-Buura River. Ak-Buura in Kyrgyz means white camel. River name is derived from the legend about rich man, which owned rare white camel. One day the camel drowned in this river. People named this river in honour of this camel.

Agriculture is partly practiced at the valley´s bottom (зн чукур жер) and partly above residential area at the foothill (тоонун тугу). Agriculture is supplied by the water from irrigation canal (арык) in both zones. *Rosa* spp., *Cirsium* spp., *Verbascum* spp., *Cynodon* spp., *Taraxacum* spp., *Rumex* spp., *Crataegus* spp., *Convolvulus arvensis* L., *Mentha asiatica* Boriss., *Plantago lanceolata* L., *Plantago major* L., *Sisymbrium loeselii* L. are species, which can be found in the valley. Hilly areas above valley bottom are very dry, eroded and overgrazed. Patches of *Cousinia* spp., *Artemisia* spp. and shrublets occur there. Grazing is practiced there mainly in the spring after two rainy months (March and April). However it is desert-like in the middle of the summer.

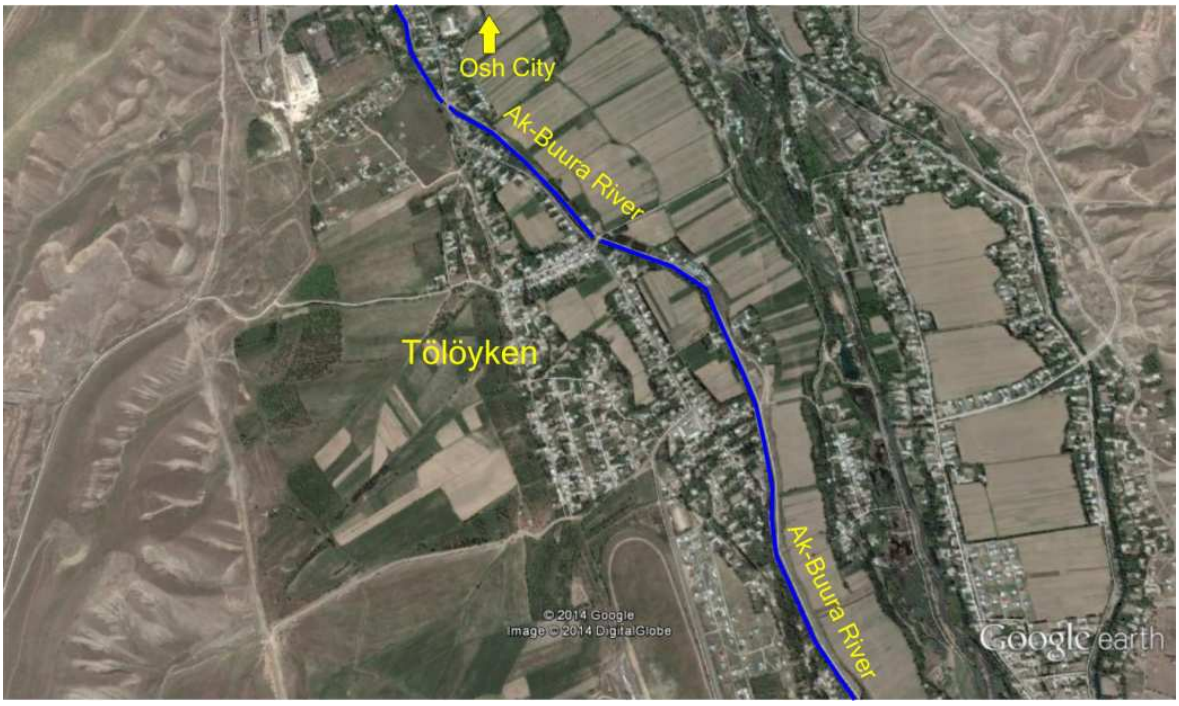


Figure 6: Tölöyken detailed map (acquired in Google Earth software and modified in Corel Draw X5, imagery date: 22nd May 2014)

A part of Tölöyken´s residents commute to work to city and farming is their additional employment. Twenty-three farmers were interviewed. All of them were Kyrgyz nationality; 13 men and 10 women. The average farmer owns 16 pieces of livestock, shares the household with four other people and has annual income 2024 USD.

Tölöyken farmers tend to have fields producing especially fodder (corn, alfalfa) and orchards producing fruits (apple, apricot, cherry). Whilst crop production is rather for subsistence, marketing of domestic animal products is practiced by non-negligible proportion of farmers. Typical crop rotations are mentioned in Fig. 7.

| CROP ROTATIONS | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Rural area** | | | | | | | | | | | | | | | |
| | **YEAR 1** | | | | | **YEAR 2** | | | | | **YEAR 3** | | | | |
| **Field part no.** | **1** | **2** | **3** | **4** | | **1** | **2** | **3** | **4** | | **1** | **2** | **3** | **4** | |
| | Potato>Rice | Corn | | | | Corn | Potato>Rice | | | | Potato>Rice | Corn | | | |
| | Cotton | Potato>Rice | Corn | | | Corn | Cotton | Potato>Rice | | | Potato>Rice | Corn | Cotton | | |
| | Cotton | Rice | Corn | Wheat | | Wheat | Cotton | Rice | Corn | | Corn | Wheat | Cotton | Rice | |
| | Potato>Corn | Cotton | | | | Cotton | Potato>Corn | | | | Potato>Corn | Cotton | | | |
| **Peri-urban area** | | | | | | | | | | | | | | | |
| | **1** | **2** | **3** | **4** | **5** | **1** | **2** | **3** | **4** | **5** | **1** | **2** | **3** | **4** | **5** |
| | Alfaalfa | | | | | Alfaalfa | | | | | Alfaalfa | | | | |
| | Corn | | | | | Corn | | | | | Corn | | | | |
| | Corn | Alfaalfa | | | | Alfaalfa | Corn | | | | Corn | Alfaalfa | | | |
| | Corn | Tomato | Bell pepper | Potato | Cabbage | Cabbage | Corn | Tomato | Bell pepper | Potato | Potato | Cabbage | Corn | Tomato | Bell pepper |

Figure 7: Typical crop rotations in rural and peri-urban areas of Osh Province, Southern Kyrgyzstan

## 3.2. Data collection

Field research was conducted during period lasting from July to August 2014. In total 45 fields and 22 orchards were surveyed. Meetings with the informants in Aravan District were arranged by our main informant there – local agronomist Khamid. The first interviews in Tölöyken were arranged by agronomy professor from Osh University - Dooronbek. Subsequently modified snowball method (Goodman, 1961) was used. Twenty-one farmers owning 2 orchards and 21 fields participated on the interviews in Aravan District and twenty-three farmers owning 24 fields and 20 orchards in Tölöyken. Gender composition was thirty-two men and twelve women. Thirty-two informants were of Kyrgyz nationality, eleven farmers were Uzbeks and one Turk. Informants´ age ranged from 31 to 68 years. Most of the farmers were attending school for 10 years. Household inhabitants´ number varied between 2 and 9 and annual household income ranged between 157 and 8874 USD.

A method called participant observation previously described by Martin (2004) was used during initial week of the research, while our research team were staying at the

household of local agronomy professor in Tölöyken. Information regarding province´s terrain, agricultural practices, irrigation systems, cultivated crops, natural vegetation, household functioning and home garden works were gathered by active participation.

Ethnobotanical method called participatory rural appraisal (Martin, 2004) was used for data collection. Whole process comprised following steps. At first, each informant was orally apprised with the research purpose. Official languages of Kyrgyz Republic are Kyrgyz and Russian. Skilled Russian, Kyrgyz and English speaking interpreter was used for exact translation in order to avoid any misunderstandings. Then informant decided whether he/she wants to participate or not. Permits to use obtained information were gained from farmers orally in order to not put a pressure on them by signing any official document. Then farmer was asked, whether he/she can accompany me to his/her orchard and/or field. If the answer was positive, field visit combined with semi-structured interview (Martin, 2004) was implemented, if not farmer only orally answered interview questions.

Questions regarding basic socio-economic factors such as age, number of household inhabitants, education, ethnicity and annual incomes were asked initially. Secondarily the distance from household to plot was measured by GPS device. Coordinates, elevation and slope of plot were also gauged by GPS device. Plot orientation was determined using compass. Subsequently questions regarding land use types were asked. Questions concerned ownership, soil quality, livestock ownership, grazing, crops or/and trees cultivated, machinery use, inputs use, irrigation frequency, labour intensity, uses of produce, crop residues utilization, crop and fruit marketing, yield estimation, way of trading, seeds/seedlings sources and prices were asked. Above mentioned questions were determined as appropriate for studying folk ecological knowledge in Martin (2004).

## 3.3. Data processing

Study combines approaches from utilitarian ethnobotany, ecology and cultural ecology. Traditional technical, ecological and botanical data was gathered and written down to the field notebook (Cotton, 1996). Data were subsequently organized into one huge excel data sheet comprising all of the gathered knowledge. Basic descriptive statistics were used for gathered data evaluation. Seasonalities of crops were added into agricultural

calendars similar to that one occurring in Marten (1990) and Ribeiro and Kenhiri (1989). Pie charts, bar charts and tables were used for data visualization and easy understanding.

# 4. Results

## 4.1. Livelihood analysis

Although there are some possibilities of off-farm working in Aravan district, they are not that frequent as in the nearest large city - Osh. A distance to Osh´s city centre, which offers more education and off-farm job opportunities, is higher from R areas of Aravan (30 km and more) than from suburban Tölöyken (6 km). Moreover public transportation is faster and more frequent from suburbs. These reasons contribute to the fact that 90 % of farmers living in R area do farming as their only livelihood and 10 % have some off-farm employment. The situation is different in P area, where 48 % of farmers do some off-farm job (Fig. 8).

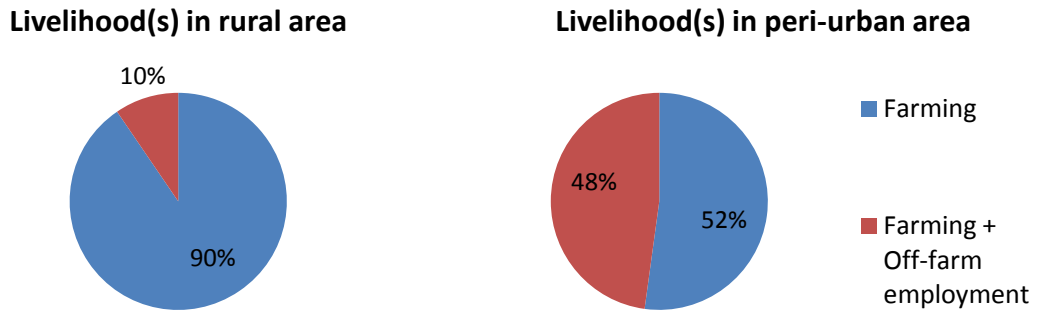


Figure 8: Comparison of farmers´ livelihoods in rural and peri-urban areas of Osh Province, Southern Kyrgyzstan

Off-farm jobs consume non-negligible amount of time, which results in lower time availability for farming. R farmers, their families and hired workers spend on average more time by practicing agriculture than P farmers´ families and their hired employees (Tab. 4).

Table 4: Comparison of time consumed by agricultural activities in rural and peri-urban areas of Osh Province, Southern Kyrgyzstan

| | Mean man hours per household and hired workers | Median man hours per household and hired workers | SD | $S^2$ |
|---|---|---|---|---|
| **Rural area** | 98 | 72 | 4 | 16 |
| **Periurban area** | 82 | 56 | 2 | 4 |

## 4.2. Research plots´ characteristics

### 4.2.1. Basic characteristics

Although the flatlands of R area logically offer more possible plot orientation variants than narrow valley of P Tölöyken, the second mentioned is more diverse in terms of plot orientation (Fig. 9), probably due to the fact that even tiny marginal areas are used for cultivation.

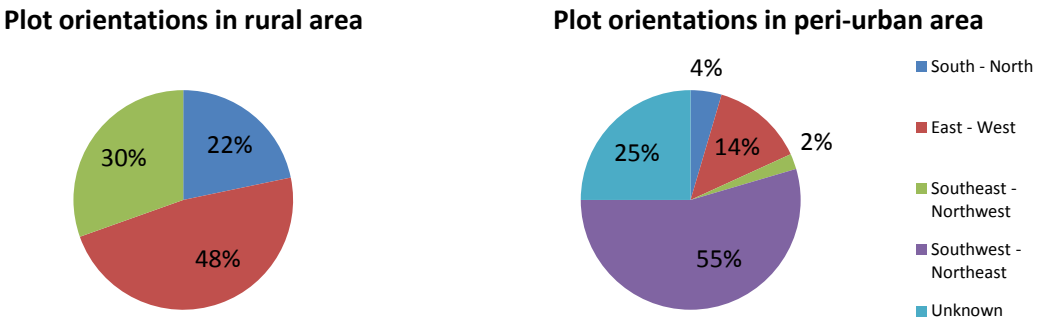


Figure 9: Comparison of plot orientations in rural and peri-urban areas of Osh Province, Southern Kyrgyzstan

Most of the research plots´ soils are perceived by farmers on both localities as medium fertile (87.88 %). The scale of the answers is more diverse in R area indicating that R farmers are more perceptive to soil quality due to their dependence on it for their commonly only livelihood – farming (Fig. 10).

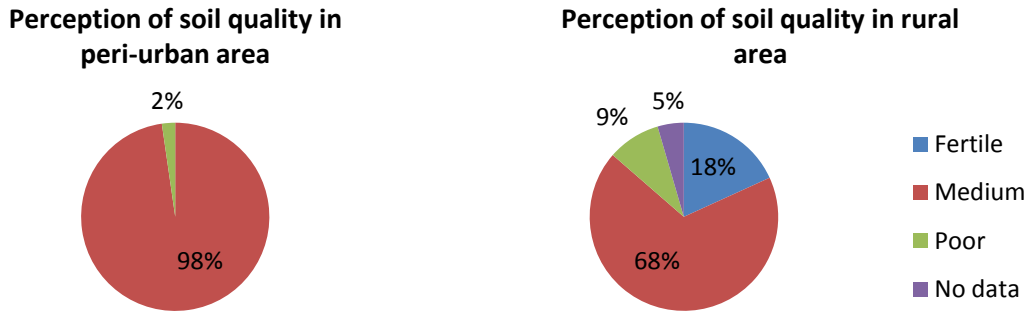


Figure 10: Comparison of soil quality perception in peri-urban and rural areas of Osh Province, Southern Kyrgyzstan

Plots in the R area of Aravan are more flat due to the nature of the landscape. While Aravan lies in the flatlands, suburban Tölöyken is situated in undulating area of narrow valley – plots are often located at the foothill or even in the areas with strong inclination (Fig. 11).

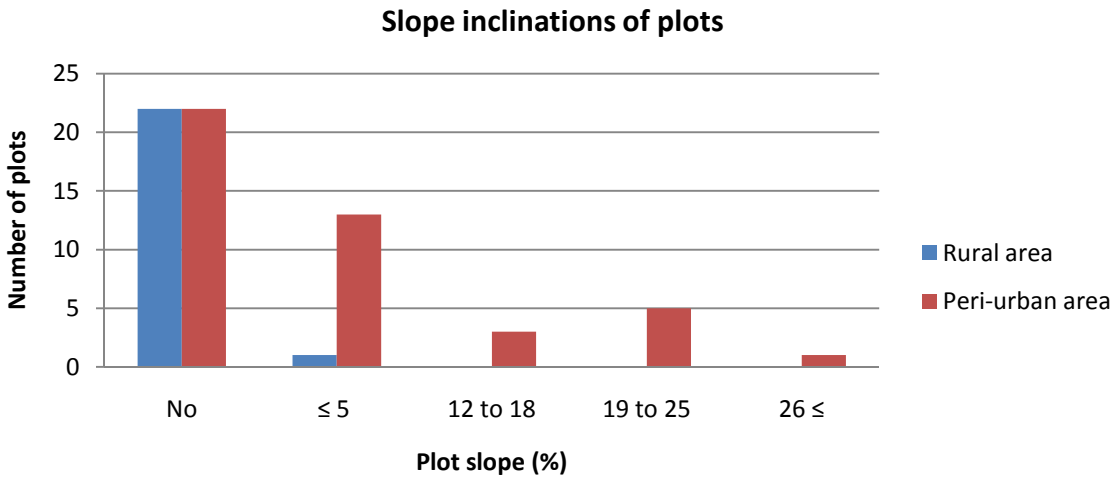


Figure 11: Comparison of plot slope inclinations (%) in rural and peri-urban areas of Osh Province, Southern Kyrgyzstan

Orchards were generally more diverse in terms of slope inclination, which was mainly due to the fact, that the vast majority of them were situated in undulating areas of P Tölöyken (Fig. 12).

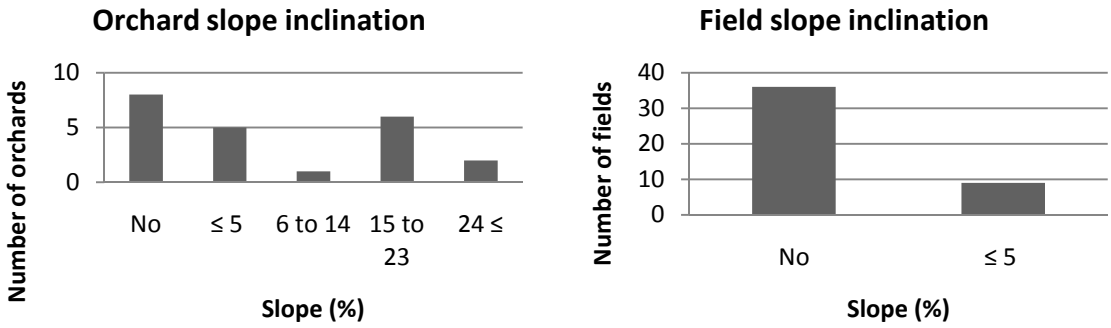


Figure 12: Overview of slope inclinations according to land use type occurring in Osh Province, Southern Kyrgyzstan

### 4.2.2. Plot ownership

Most of the plots on both localities are privately owned (91.04 %). Only 8.96 % plots are rented or partly rented. Although P areas are known by their frequent influxes of people from both cities and countryside, farmers in Osh Province tend to be settled in these areas for longer time, which can be partly caused by the fact that Kyrgyz borders, where the Aravan District is located, were not stable after the disintegration of Soviet Union. An analysis of ownership period length revealed that R farmers in Aravan own their plots roughly for 16 years, median 17 years; whereas their P counterparts in Tölöyken for 22 years, median 22 years. While an average price for renting 0.1 ha area of orchard in P Tölöyken is 56 USD per year, median 61 USD per year, a mean price for renting 0.1 ha of field for one year in R Aravan is 18 USD, median 18 USD, which makes sense since perishable products, such as fruit provided by orchard, are on the market more expensive than staples and the prices in the countryside tend to be lower.

### 4.2.3. Plots´ areas and typical land use types

Sampled plots´ areas are generally smaller in P area (Fig. 13) due to the land fragmentation caused by faster population growth. However their smaller areas are compensated by the fact that 78.26 % of households own more than one plot, whereas the share of such farmers in R areas is only 9.52 %.

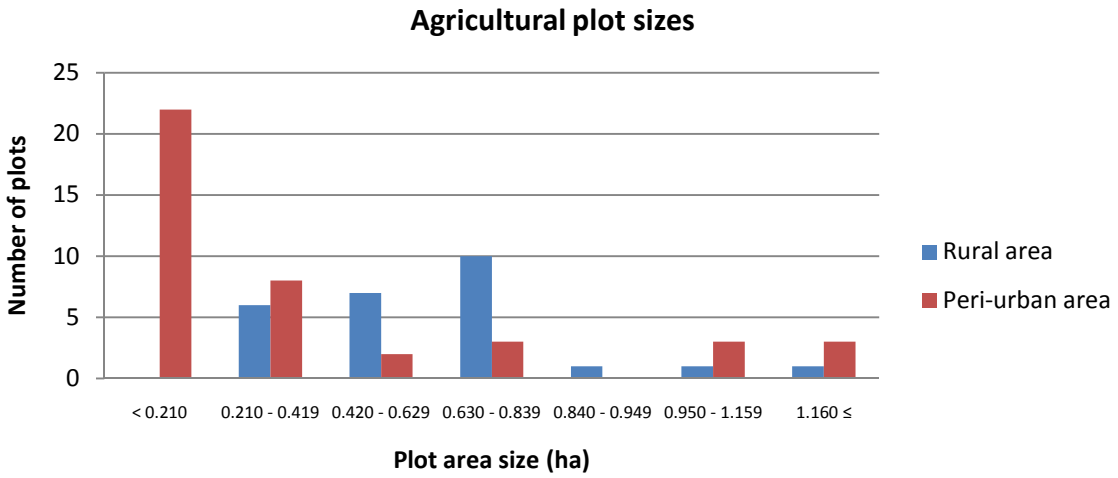


Figure 13: Comparison of plot sizes in rural and peri-urban areas of Osh Province, Southern Kyrgyzstan

R farmers in 80.25 % of cases have only one field. The average field area is 0.67 ha, median 0.70 ha. Only 9.52 % of them own orchard, which is on average 0.51 ha large. P farmers commonly (60.87 %) have a combination of one field and one orchard. Mean field size is 0.37 ha, median 0.25 ha. Orchard sizes are very diverse with mean on 0.51 ha, median 0.15 ha, maybe due to the fact that some of them call “orchard” their home gardens, maybe because of distortion caused by one orchard of an area 3.5 ha. Home garden is the third main kind of land use in Osh Province. However home gardens were not the subjects of research.

While cultivated area per household in R area is homogenous – 0.72 ha and median 0.72 ha, informants in P area cultivate on diverse plot sizes with an average on 0.83 ha and median 0.50 ha. If the emphasis is put on agricultural land per household member, numbers are more or less similar, with the highest share of households cultivating up to 0.14 ha per capita (Tab. 5).

Table 5: Comparison of cultivated land per household member in rural and peri-urban areas of Osh Province, Southern Kyrgyzstan

| Ha per person | Number of households in rural area | Number of households in Peri-urban area |
|---|---|---|
| **< 0.08** | 1 | 8 |
| **0.08 to 0.14** | 12 | 6 |
| **0.15 to 0.21** | 3 | 2 |
| **0.22 to 0.28** | 2 | 1 |
| **0.29 ≤** | 2 | 6 |
| **No data** | 1 | 0 |

The total share of **orchards** in sampled plots is roughly 33 %. This number is also valid for the percentage of the total area, which they cover on both localities together. Orchard is not very common type of land use in R area. Only two orchards were sampled in Aravan (9 % of sampled plots, 7 % of sampled area). The first one comprises four woody species (cherry 200 pcs, peach 3 pcs, apple 10 pcs, willow 48 pcs) and the second one is one year old monocultural persimmon (*Diospyros* spp.) orchard (400 pcs). Woody plant densities are 816 respectively 571 trees per hectare. Row intercropping is used in both cases - in the first with potatoes and in the second with water melon [*Citrullus lanatus* (Thunb.) Matsum. & Nakai] and Gallia melon (*Cucumis melo* L.).

Orchards are more common in P area. Forty-five percent of sampled plots there were orchards. They cover more than 53 % of Tölöyken´s sampled plots´ area. The number of cultivated species per orchard is highly variable, but most of the orchards are composed of 5 to 6 species (Fig. 14).

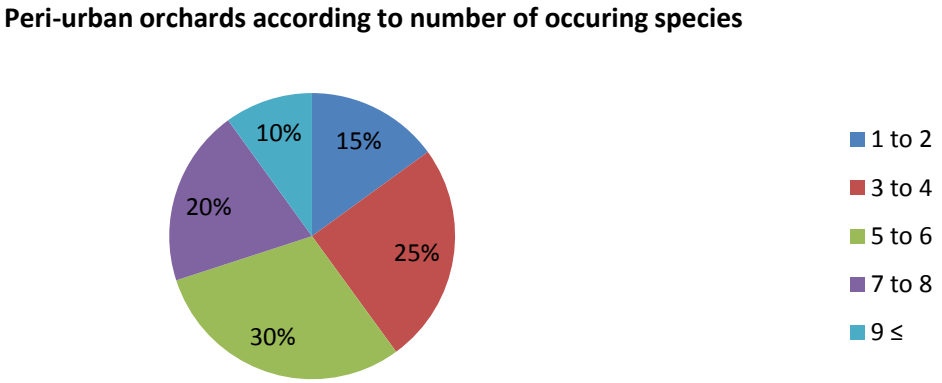


Figure 14: Peri-urban orchards of Osh Province, Southern Kyrgyzstan according to number of occuring species

Most of the P orchards have woody plant density ranging from 100 to 466 trees per hectare (Fig. 15), which is less than in R area, where both sampled orchards belong to the woody plant density interval 467 to 833 trees per hectare.

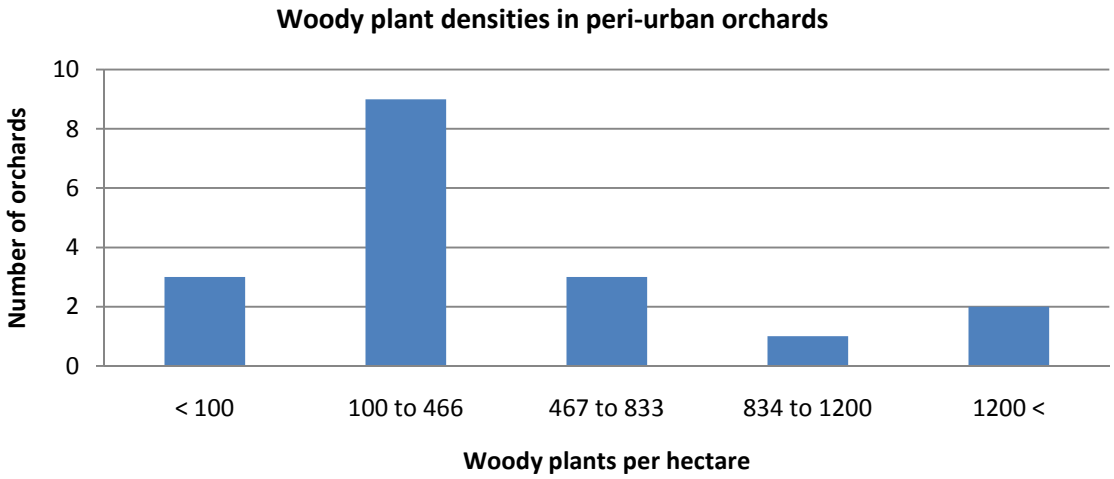


Figure 15: Woody plant density in peri-urban orchards situated in Osh Province, Southern Kyrgyzstan

In total, two thousand four hundred and ninety trees were sampled in P Tölöyken. Apple is the most abundant species creating more than 50 % of all sampled woody species (Fig. 16).

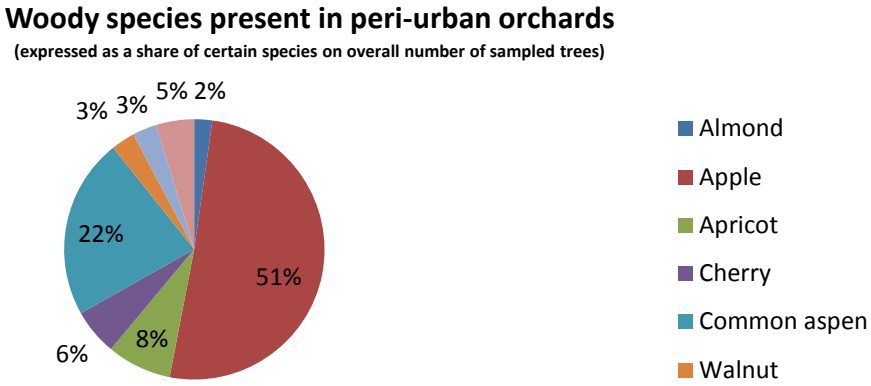


Figure 16: Share of various woody species occurring in peri-urban orchards situated in Osh Province, Southern Kyrgyzstan

The most important tree species (determined by number of orchards, where these species are present) in P areas are apple, apricot, cherry, white mulberry and common aspen (Fig. 17).

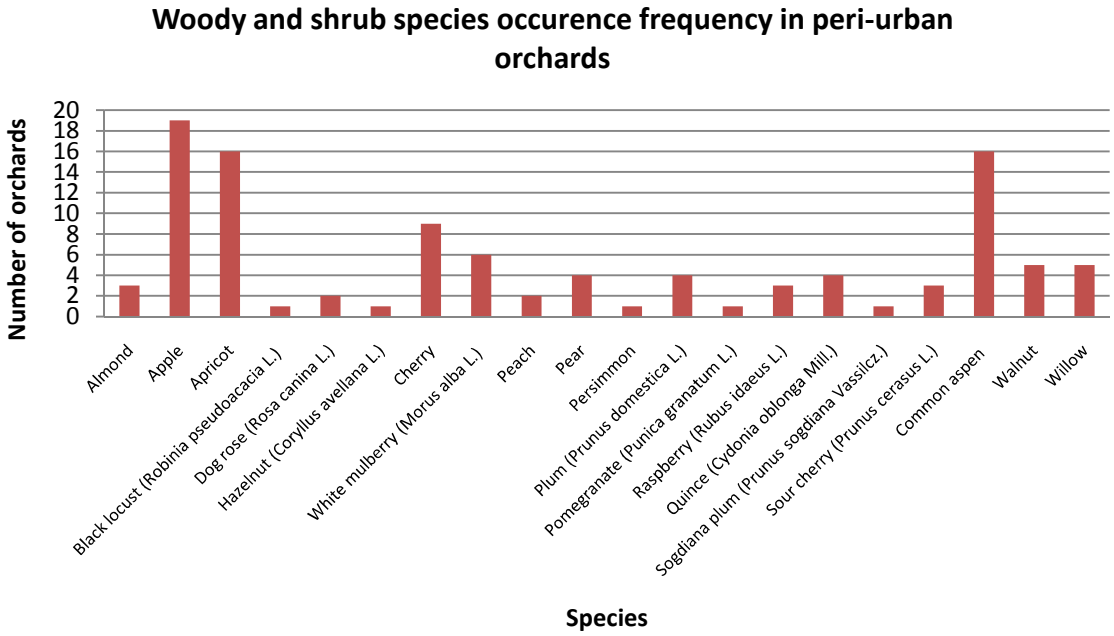


Figure 17: Importance of woody and shrub species for peri-urban agriculture in Osh Province, Southern Kyrgyzstan, expressed by their representation in peri-urban orchards

Orchards are predominantly used as a source of fruit. However deadwood of fruit trees is being used as fuelwood. Wood from trees such as common aspen and willow is used for both construction wood and fuelwood. Common aspens are cut by manual saw, debarked by hoe and let to dry on the sun (Fig. 18).

Figure 18: Drying of common aspens (*Populus tremula* L.) in rural Aravan District, Osh Province, Southern Kyrgyzstan

Pollarding once a year/once per two years/once per three years takes place usually in autumn. It is used for obtaining firewood from willows. Wood is dried, tied into bundles and transported to the household (Fig. 19). Wood, leaves and defected fruits are sometimes used as a feedstuff.

Figure 19: Pollarding of willows (*Salix* spp.) in Aravan District, Osh Province, Southern Kyrgyzstan

**Fields**, creating approximately 67 % of all sampled plots and overall sampled area in Osh Province, are the most frequent kind of land use occurring there. While the fields are clearly the most common land use type in R Aravan (91 % of sampled plots; 93 % of sampled area), their dominance in P Tölöyken is not that significant (55 % of sampled plots; 47 % of sampled area). Three to four species are commonly annually cultivated per field in R Aravan and one to two in P Tölöyken (Fig. 20).

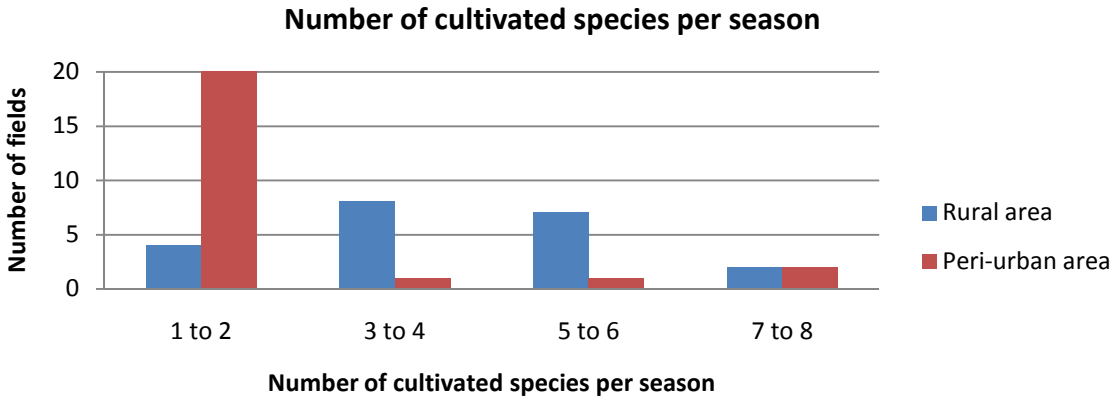


Figure 20: Number of field crops cultivated in rural and peri-urban areas of Osh Province per season, Southern Kyrgyzstan

In total, most of the farmers cultivating field (73.68 %) practice crop rotation in order to mitigate soil exhaustion and soil fatigue. Double cropping – cultivating two crops successively on the same piece of land during one growing season is practiced by 34.21 % of all informants. Both phenomena are more frequent in R area (100 %, respectively 63.16 %). Practices such as mixed intercropping occur rather sporadically. Crop rotations are sometimes based on more species than those ones present on the field during the timescale of one year. They are perennial and that is why the number of species per crop rotation is in some cases higher than number of cultivated species per season. It is commonly 3 to 4 species in Aravan and 1 to 2 in Tölöyken (Fig. 21). In general, R farmers tend to have more complicated crop rotations. They utilize the field potential in maximum possible way due to the nature of their livelihoods.

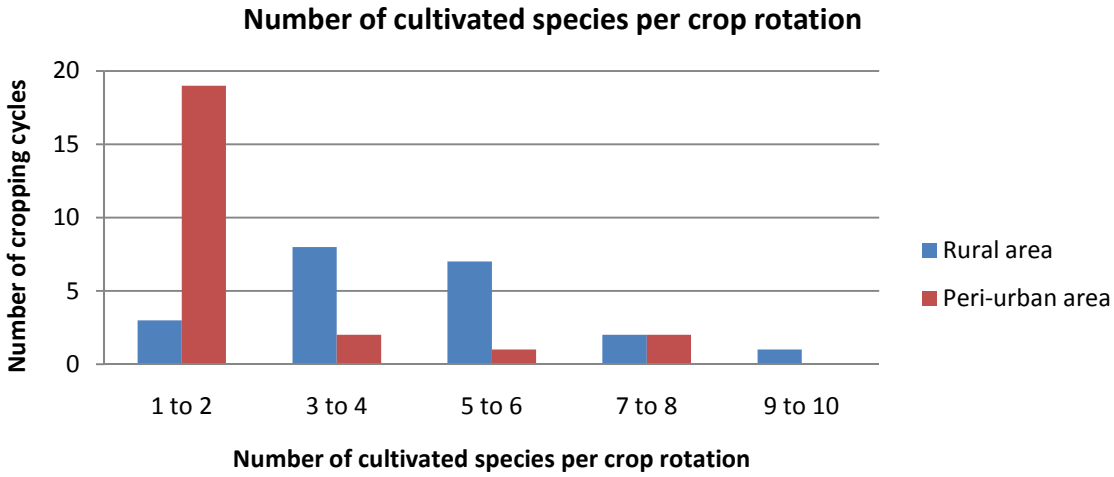


Figure 21: Number of cultivated species per crop rotation in rural and peri-urban areas of Osh Province, Southern Kyrgyzstan

Main cultivated crops (Fig. 22), respectively crop mixtures (Tab. 6) in RA and PA differ due to different livelihoods of farmers in both R and P areas. Whilst the most important crops determined by number of crop rotations, where is the species employed in RA are corn, cotton and potato (fodder crop, cash crop and subsistence/surplus-sold crop); the most important crops for P farmers are crops predominantly used as a feed for own livestock - corn and alfalfa.

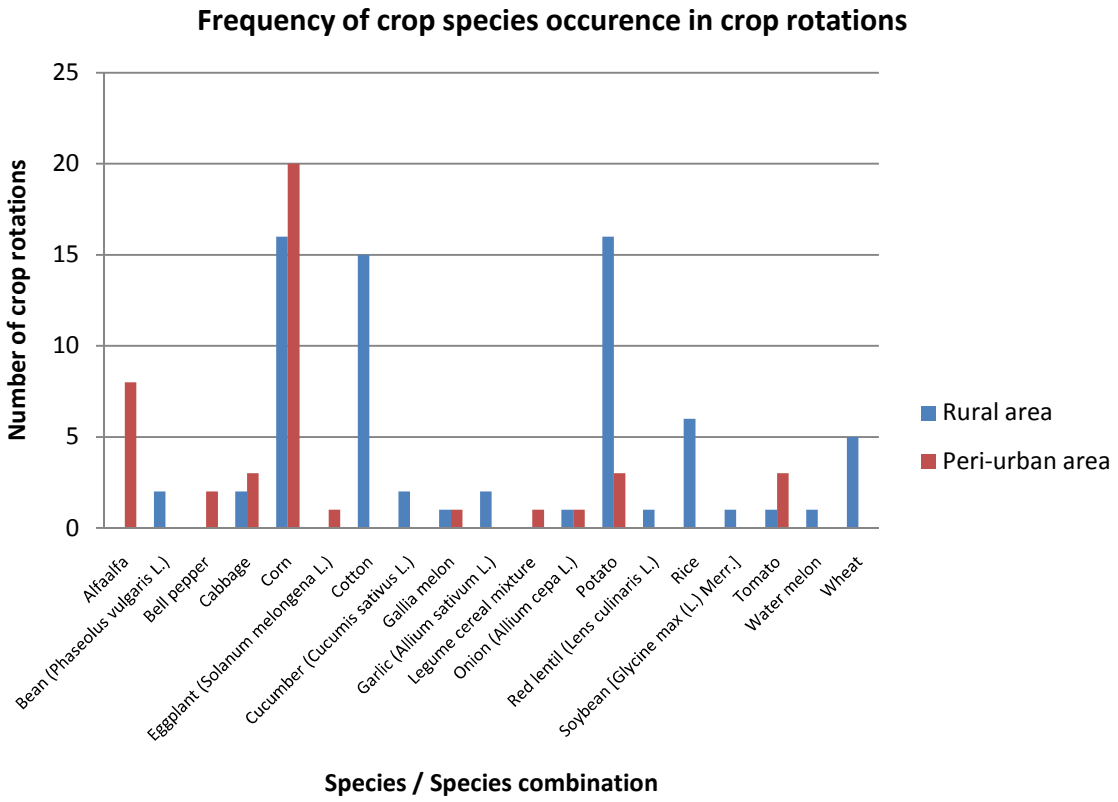


Figure 22: Importance of various crops/crop mixtures for rural and peri-urban agriculture expressed by their representation in cropping cycles in Osh Province, Southern Kyrgyzstan

Table 6: Percentages of rural and peri-urban households cultivating certain group of crops in Osh Province, Southern Kyrgyzstan

| | PERCENTAGE OF HOUSEHOLDS CULTIVATING GROUP OF CROPS | |
|---|---|---|
| | **Rural area** | **Peri-urban area** |
| **Staples** | 100.00% | 78.26% |
| **Vegetables** | 15.00% | 13.04% |
| **Fruits** | 42.86% | 86.96% |

Trees are sometimes cultivated or kept on the field borders or even in the middles in both R and P areas, but it is more common phenomenon in Osh Province´s RA (Fig. 23). Although they are usually kept in small quantities, common aspens on the field borders are in this aspect exceptional. Their number can reach tens or even hundreds. They are used in the same ways as it is in orchards.

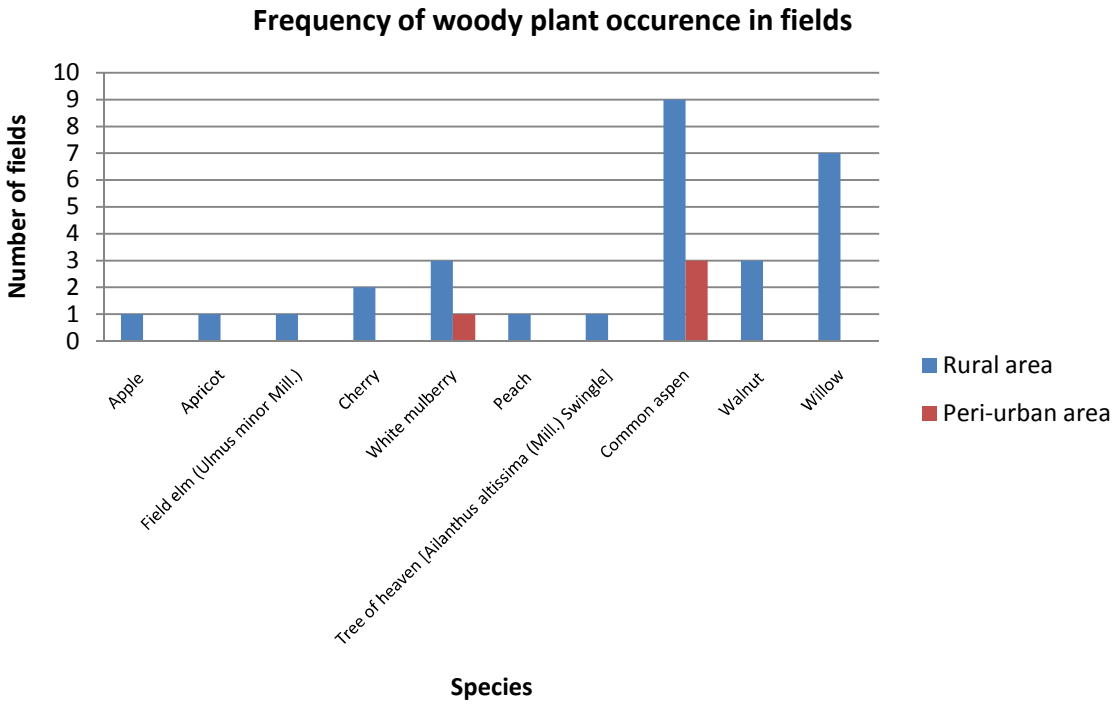


Figure 23: Representation of woody plants on rural and peri-urban arable lands of Osh Province, Southern Kyrgyzstan

Seasonality of crops and time of fruit harvesting are depicted in agricultural calendars (Fig. 24 and Fig. 25). Some crops (cabbage, potatoes) tend to be established and harvested earlier in R Aravan. Such result can be caused by different employed varieties of these crops. Depicted harvest months of fruit trees are more diverse in P Tölöyken probably due to incomparable higher number of interviewees owning orchard and also by high diversity of fruit trees´ varieties with different time of ripeness.

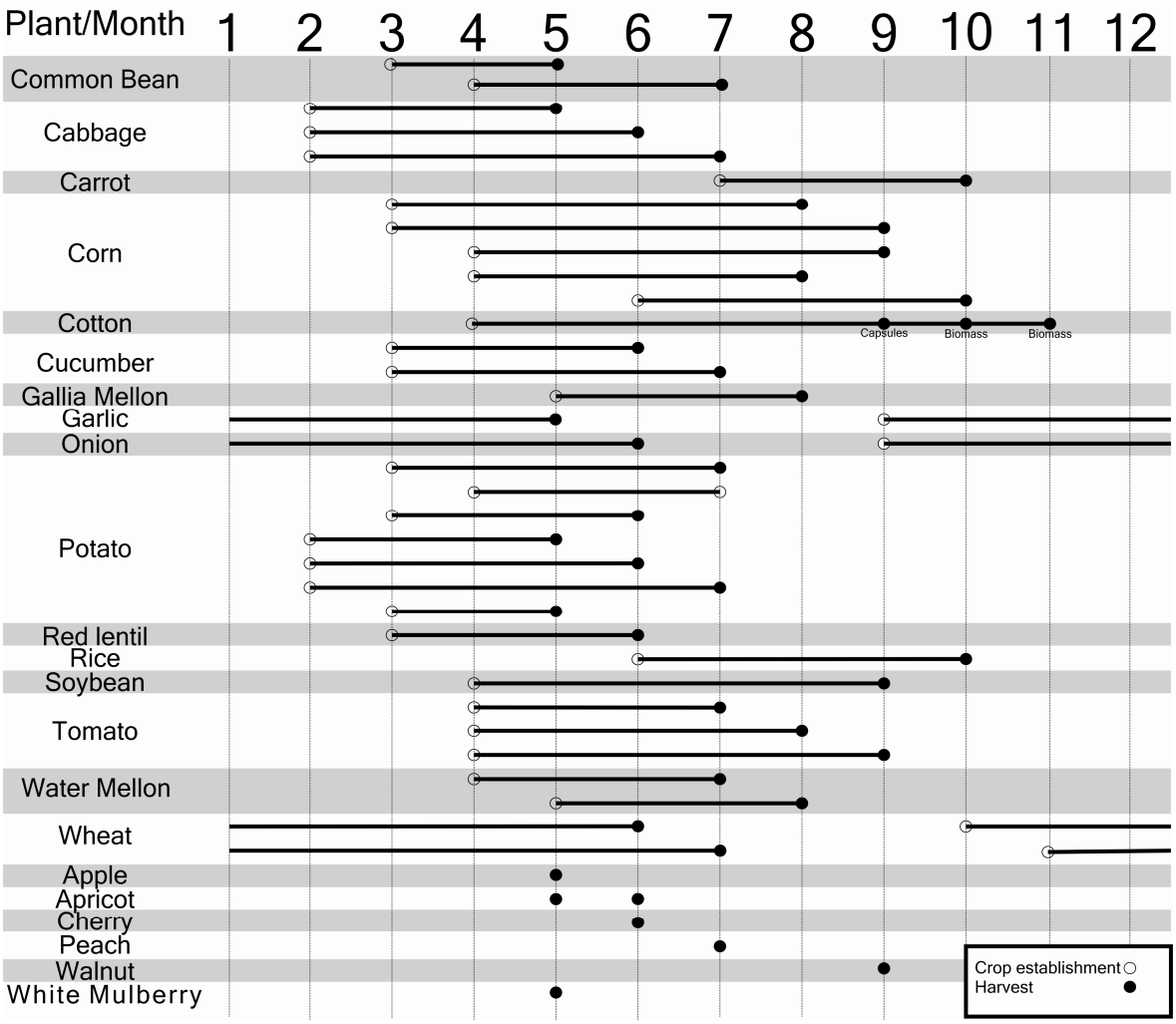


Figure 24: Agricultural calendar of rural area, Osh Province, Southern Kyrgyzstan

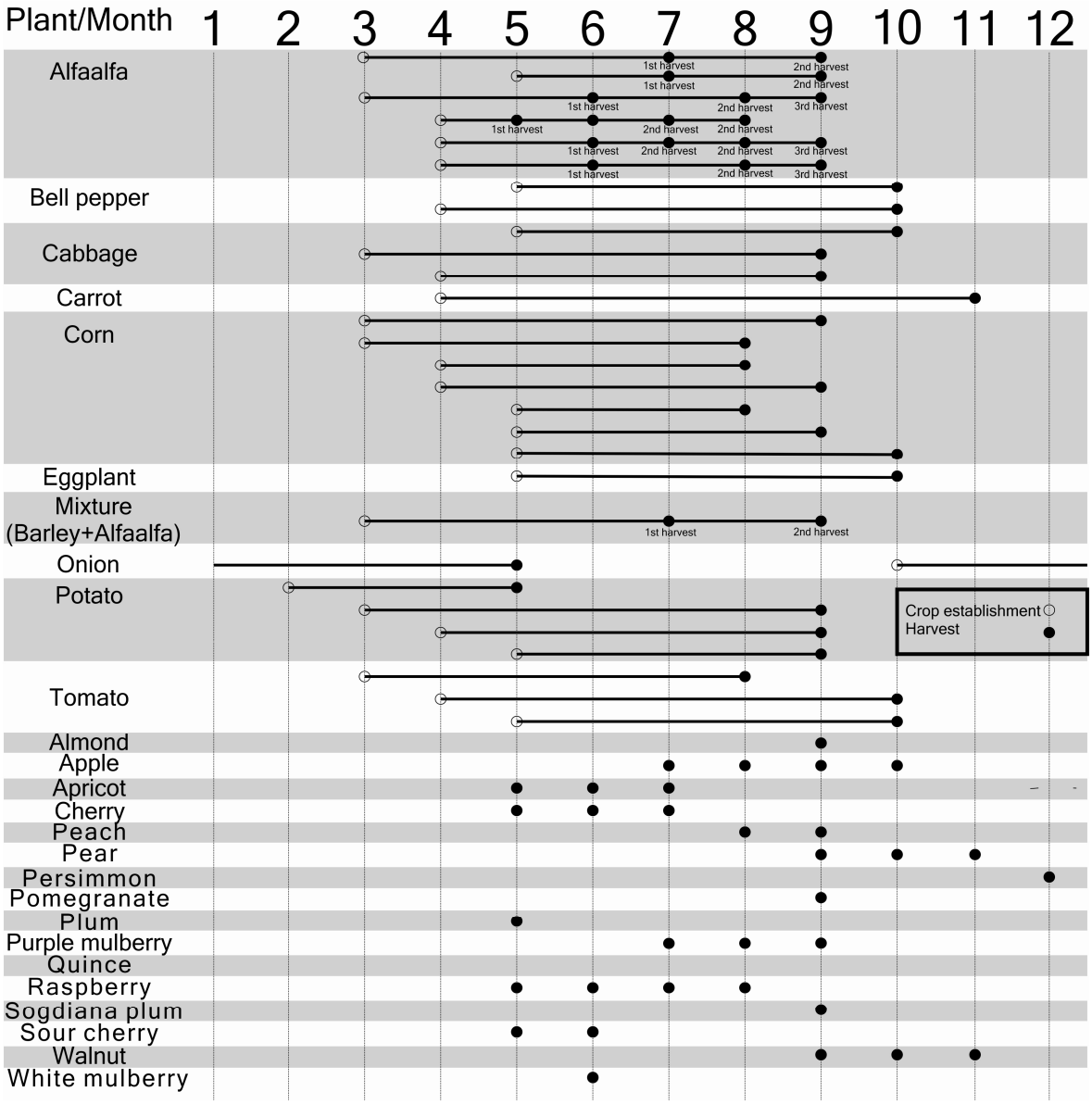


Figure 25: Agricultural calendar of peri-urban area, Osh Province, Southern Kyrgyzstan

## 4.3. Livestock

A scale of bred animals is more diverse in P area. Livestock number per household is also higher there. Although lower number of cattle is owned by R farmers, the percentage of households owning it is higher. On the contrary higher percentage of P households owns sheep, poultry, donkeys, horses and goats and even the herds of all domestic animals are on average larger in P area (Tab. 7). The reason for such results can be more subsistence nature of animal husbandry in R area and moreover different national composition and thus also food habits of informants.

Table 7: Comparison of rural and peri-urban farmers of Osh Province, Southern Kyrgyzstan, with the respect to livestock

| | AVERAGE NUMBER OF ANIMALS PER HOUSEHOLD | | PERCENTAGE OF HOUSEHOLDS OWNING ANIMAL | |
|---|---|---|---|---|
| | Rural area | Peri-urban area | Rural area | Peri-urban area |
| **Cattle** | 2 | 3 | 95.00% | 82.61% |
| **Sheep** | 4 | 9 | 40.00% | 69.57% |
| **Poultry** | 0 | 3 | 0.00% | 13.04% |
| **Horse** | 0 | 4 | 0.00% | 26.09% |
| **Donkey** | 0 | 2 | 0.00% | 17.39% |
| **Goat** | 0 | 4 | 0.00% | 26.09% |

Cattle is bred for milk, meat and draft; sheep and goat for meat; horse and donkey for draft; and poultry for eggs. Farmers in P area cultivate on fields mainly fodder crops for animals, they let their domestic animals graze understorey in orchards and weedy vegetation on field borders. R farmers cultivate food crops, fodder crops and cash crop. The areas devoted to fodder crops are thus smaller and that is why higher proportion of R farmers let their livestock graze on arable land after harvest and its borders. Higher percentage of R farmers let animals graze on arable and orchard lands (Fig. 26).

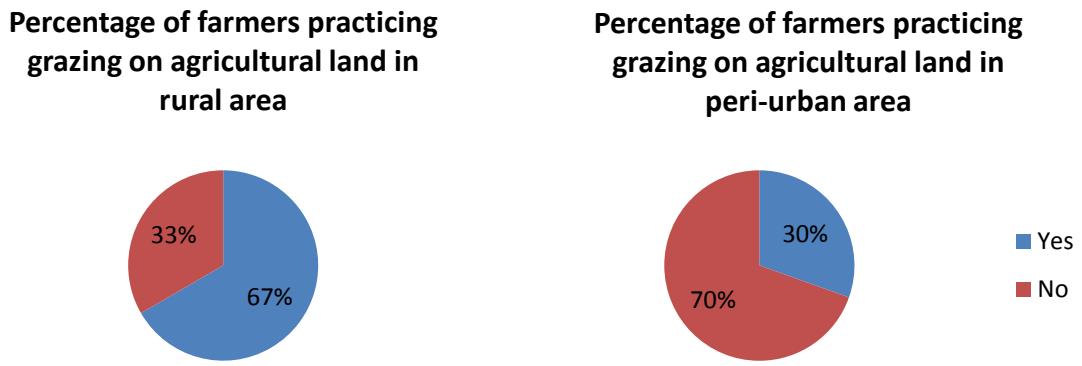


Figure 26: A percentage of farmers allowing their domestic animals graze on crop residues, field borders and in orchards in Osh Province, Southern Kyrgyzstan

## 4.4. Inputs and technologies

A sufficient quantity and adequate quality of agricultural and arboricultural produce are except time spent by field works influenced by applied agricultural inputs (fertilizers, pesticides), machinery and irrigation.

### 4.4.1. Labour

An analysis of time spent by working per plot revealed trend - it decreases with growing distance, which indicates that low labour input plots are more distant from household than those ones situated in its proximity (Fig. 27). This trend was more pronounced in P area indicating that the farmers have to balance between time investments into off-farm job and farming thus the transport to more distant plots and work there are not that frequent.

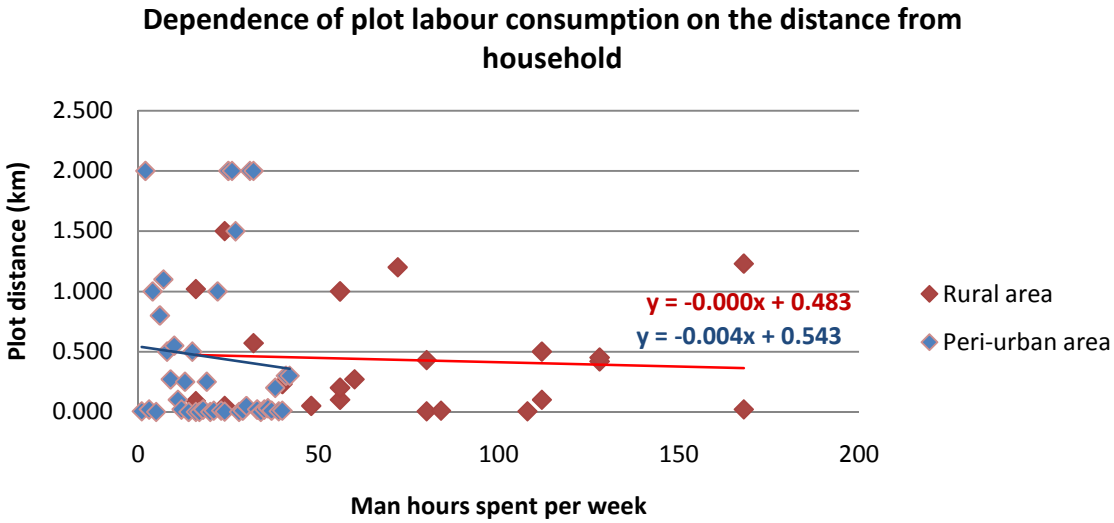


Figure 27: Dependence of plot labour consumption on the plot distance from household in rural and peri-urban area of Osh Province, Southern Kyrgyzstan

### 4.4.2. Agricultural inputs

Farmers on both R and P localities ordinarily use various combinations of inputs in order to protect plants, increase yields and improve soil properties. These activities are more intensive in R area (Fig. 28 and Fig. 29), which is caused especially by higher share of agricultural products consumed by people in its produce. Cultivation of fodder for livestock is not that input (esp. pesticides) demanding because weed occurrence does not represent such serious problem, as it is usually consumable biomass.

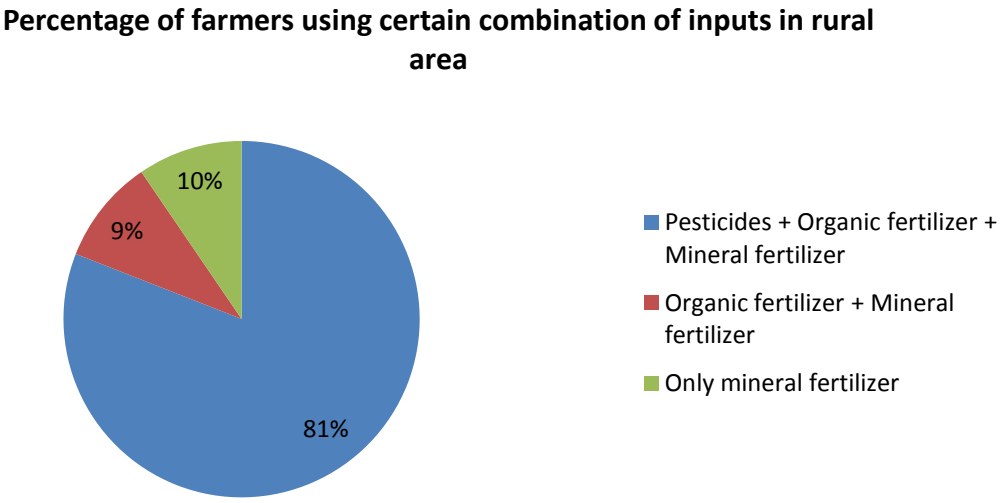


Figure 28: Percentage of rural farmers in Osh Province, Southern Kyrgyzstan, using certain combination of inputs

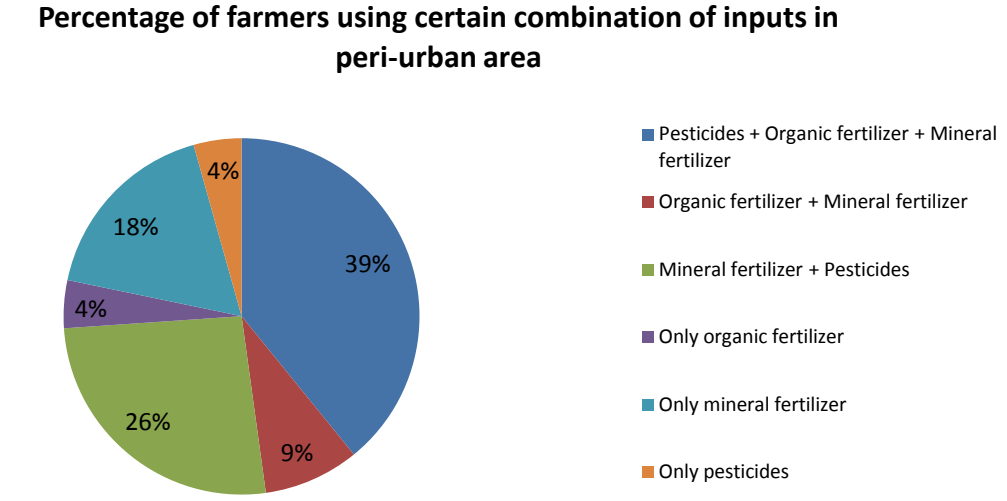


Figure 29: Percentage of peri-urban farmers in Osh Province, Southern Kyrgyzstan, using certain combination of inputs

Based on gathered knowledge orchards seem less input demanding and more input diverse compared to fields (Fig. 30). The fact that trees are better capable of nutrient recycling through litter and can access nutrients from deeper soil layers may play a role.

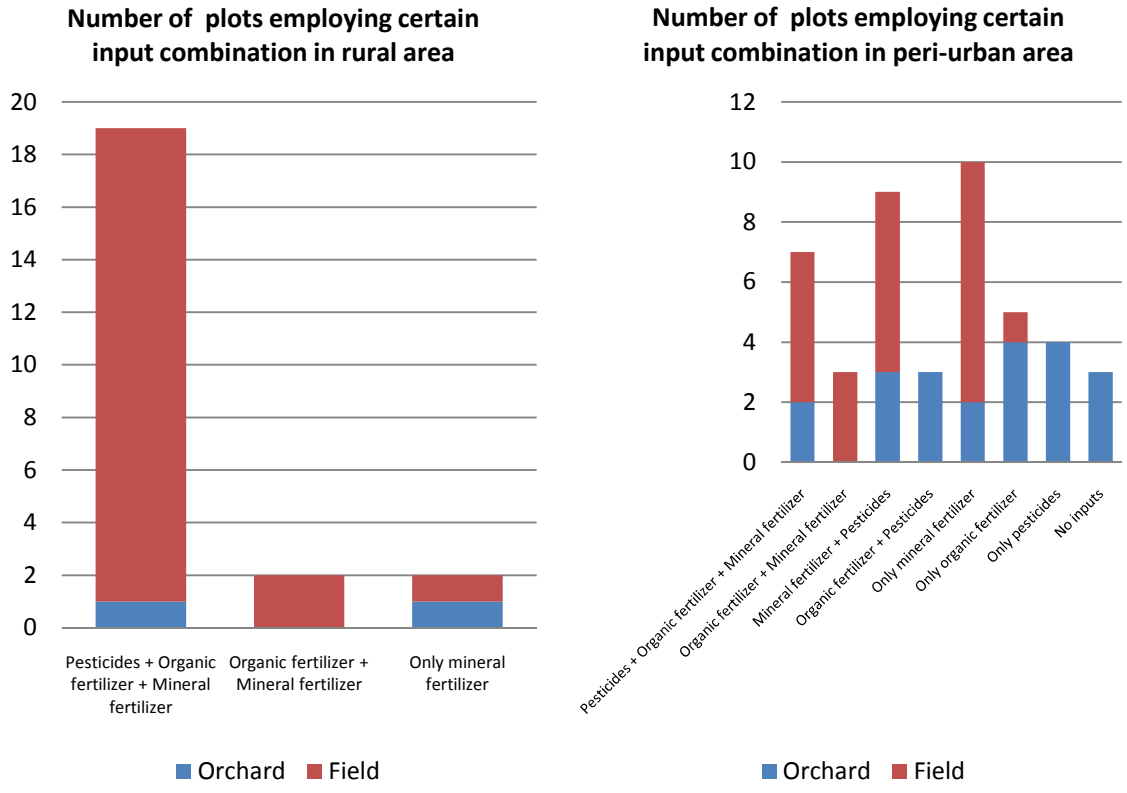


Figure 30: Input combination according to different land use systems in rural and peri-urban areas of Osh Province, Southern Kyrgyzstan

In general, orchard was determined as more labour intensive land use type compared to field (Fig. 31). That could be the reason why the orchards are closer to the household in order to not waste a time and money by commuting or walking. That was confirmed by our results (Fig. 32), if one orchard distant 12 km from household was excluded in order to not distort the results.

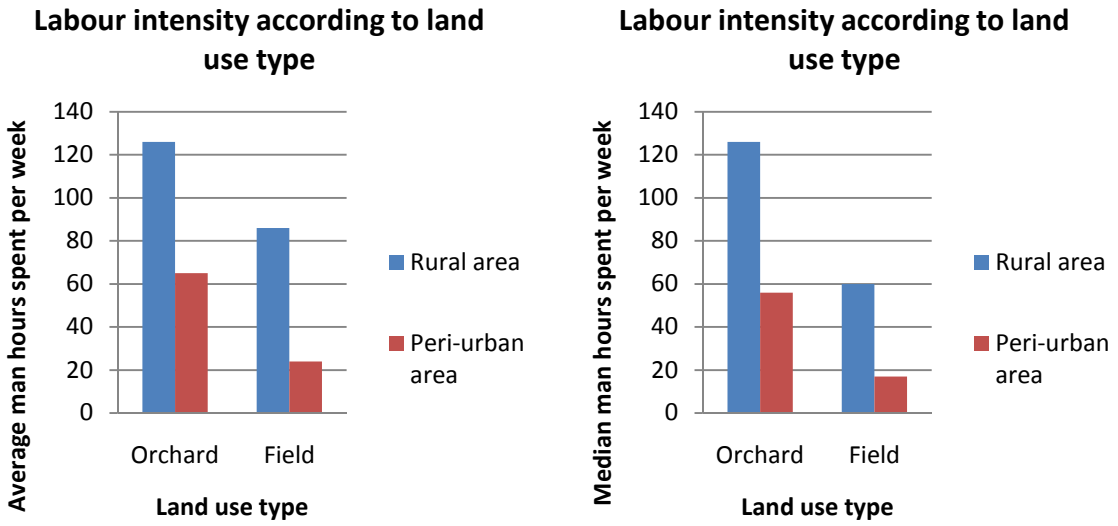


Figure 31: Time consumption comparison of various land use types occurring in rural and peri-urban area of Osh Province, Southern Kyrgyzstan

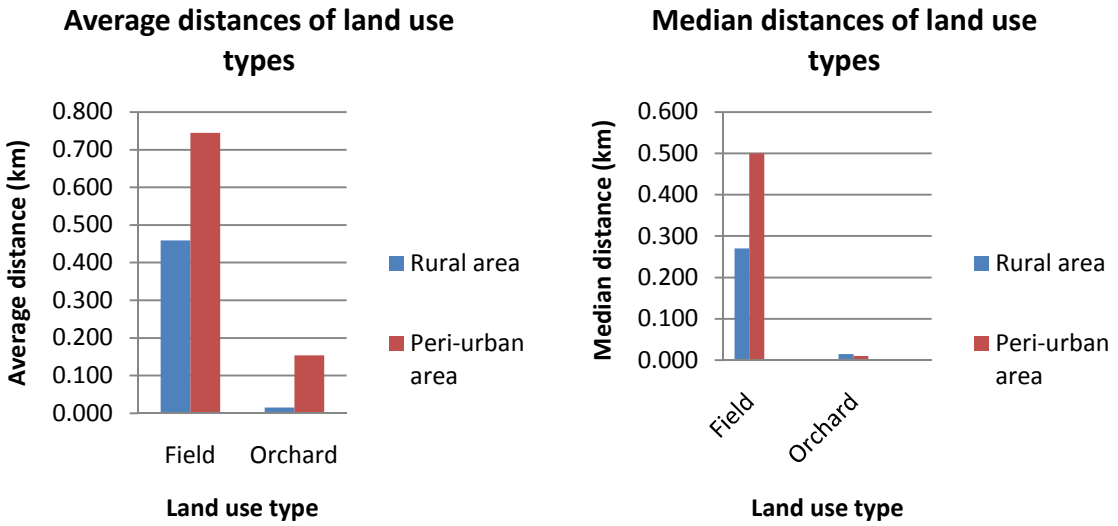


Figure 32: Field and orchard distances comparison in rural and peri-urban area of Osh Province, Southern Kyrgyzstan

Number of inputs common for RA and PA (mineral fertilizer, organic fertilizer, pesticides) should be according to created hypothesis decreasing with growing distance of the plot from household. However this was not confirmed by the results and there was no apparent explanatory trend in data.

### 4.4.2. Irrigation

Furrow irrigation is used on both localities. Irrigation infrastructure is very poor, drainage infrastructure often lacks. A proportion of farmers do not get enough water in order to water their orchards and fields. Ideal frequencies of irrigation of the most abundant woody plants and crops are mentioned in the Tables 8 and 9. Farmers of P Tölöyken generally irrigate more often, however difficulties with the lack of water are, based on interviews, more frequent there.

Table 8: Number of irrigations used for woody plant species in rural and peri-urban areas of Osh Province, Southern Kyrgyzstan

| IRRIGATION OF THE MOST ABUNDANT TREES (TIMES PER MONTH) | | |
|---|---|---|
| | **Rural area** | **Peri-urban area** |
| **Almond** | No data | 3 |
| **Apple** | 2 | 2 to 3 (also permanent) |
| **Apricot** | 2 | 3 (also permanent) |
| **Cherry** | 4 | 3 (also permanent) |
| **Persimmon** | 3 | 4 |
| **Common aspen** | 2 | 3 (also permanent) |
| **Walnut** | 2 | 3 |
| **Willow** | 2 | 3 |

Table 9: Number of irrigations used for crops in rural and peri-urban areas of Osh Province, Southern Kyrgyzstan

| IRRIGATION OF THE MOST ABUNDANT CROPS (TIMES PER MONTH) | | |
|---|---|---|
| | **Rural area** | **Peri-urban area** |
| **Alfalfa** | No data | 3 to 4 |
| **Cabbage** | 2 | 4 |
| **Corn** | 2 | 3 |
| **Cotton** | 1 to 2 | No data |
| **Potato** | 2 | 4 |
| **Rice** | 4 | No data |
| **Tomato** | 2 to 3 | 4 |
| **Wheat** | 1 | No data |

Irrigation is a very important kind of input for Osh Province´s agriculture, which depends on it. Number of irrigations common for RA and PA should be according to created hypothesis decreasing with growing distance of the plot from household. While the number of irrigations per month grows with growing distance in R area, the situation is opposite in P area indicating that the P farmers have to balance their available time

between off-farm job and farming thus the transport to more distant plots and works there are not that frequent (Fig. 33).

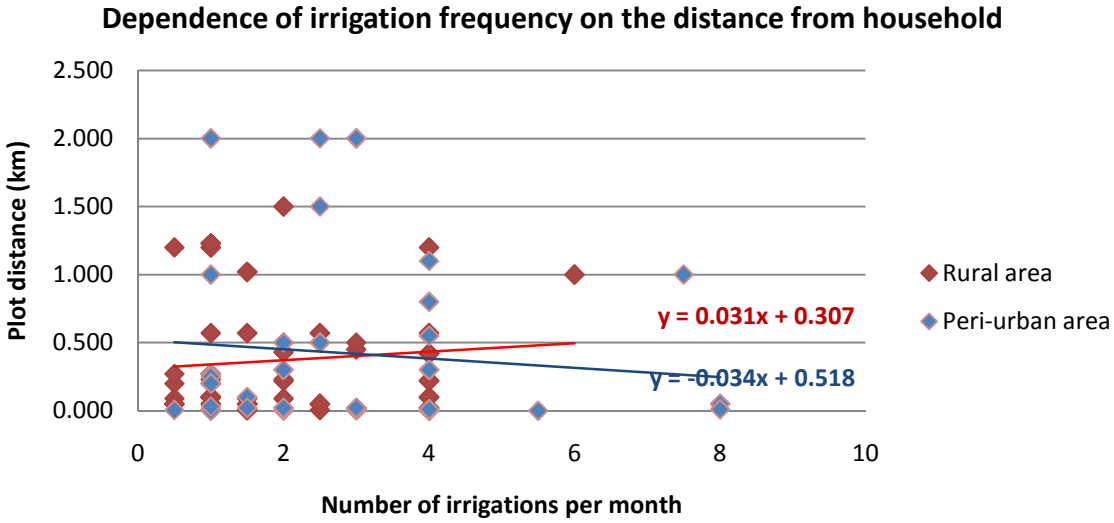


Figure 33: Dependence of irrigation number on plot distance in rural and peri-urban areas of Osh Province, Southern Kyrgyzstan

### 4.4.3. Machinery

Agriculture is in many cases partly mechanized. Machinery is usually hired from dayboy for a fee. Ninety-five percent of R Aravan´s and 78 percent of P Tölöyken´s farmers use machinery for some agricultural purposes. Such results can be caused by the fact that it is more profitable to use machinery on larger plots than on smaller ones. Moreover orchards, creating significant share of agricultural land in P area and sometimes even the only agricultural land owned by P farmer, are commonly only manually tended. Machinery is sometimes used only for irrigation furrow preparing there. Purposes of machinery use in a field are more diverse. Overview of machinery uses in the most abundant woody species and crops on both localities is provided in Tables 10 and 11. Weeding is always done manually.

Table 10: Overview of machinery use for woody plants commonly occurring in both rural and peri-urban area of Osh Province, Southern Kyrgyzstan

| IRRIGATION OF THE MOST ABUNDANT TREES (TIMES PER MONTH) | | |
|---|---|---|
| | **Rural area** | **Peri-urban area** |
| **Almond** | No data | 3 |
| **Apple** | 2 | 2 to 3 (also permanent) |
| **Apricot** | 2 | 3 (also permanent) |
| **Cherry** | 4 | 3 (also permanent) |
| **Persimmon** | 3 | 4 |
| **Common aspen** | 2 | 3 (also permanent) |
| **Walnut** | 2 | 3 |
| **Willow** | 2 | 3 |

Table 11: Overview of machinery use for crops commonly occurring in both rural and peri-urban area of Osh Province, Southern Kyrgyzstan

| IRRIGATION OF THE MOST ABUNDANT CROPS (TIMES PER MONTH) | | |
|---|---|---|
| | **Rural area** | **Peri-urban area** |
| **Alfaalfa** | No data | 3 to 4 |
| **Cabbage** | 2 | 4 |
| **Corn** | 2 | 3 |
| **Cotton** | 1 to 2 | No data |
| **Potato** | 2 | 4 |
| **Rice** | 4 | No data |
| **Tomato** | 2 to 3 | 4 |
| **Wheat** | 1 | No data |

## 4.5. Marketing

Livelihoods of R farmers of Aravan are based on mixture of commercial and subsistence agriculture. All of the farmers there sell a part of their plant derived produce or whole produce. Cotton, in the form of capsule or in the form of fibre (more valuable), is usually sold to local cotton enterprises or to middle man. Other crops, fruit and wood are sold on local market or market in Osh. Exceptions such as selling of beans through middle man to Bishkek market can occur too.

Only twenty percent of farmers cultivating fields and forty percent of farmers cultivating orchards sell some of their produce – most of the P plant production is thus for subsistence. Producer prices of the most abundant agricultural and arboricultural products on both localities are provided in Tables 12 and 13.

Table 12: Producer prices of common arboricultural products in rural and peri-urban areas of Osh Province, Southern Kyrgyzstan

| AVERAGE PRODUCER PRICES FOR FRUITS AND WOOD (USD/kg) | | |
|---|---|---|
| | **Rural area** | **Peri-urban area** |
| **Apple** | 0.56 | 0.56 |
| **Apricot** | No | 0.40 |
| **Cherry** | 1.28 | 0.80 |
| **Peach** | 0.56 | No |
| **Raspberry** | No | 1.20 |
| **Sour cherry** | No | 0.24 |
| **Trunk of common aspen** | 80.00 | 16 to 48 |
| **Walnut** | No | 0.70 |

Table 13: Producer prices of agricultural products in rural and peri-urban areas of Osh Province, Southern Kyrgyzstan

| AVERAGE PRODUCER PRICES FOR CROPS (USD/kg) | | |
|---|---|---|
| | **Rural area** | **Peri-urban area** |
| **Bean** | 1.60 | No |
| **Cabbage** | 0.26 | 0.21 |
| **Carrot** | No | 0.24 |
| **Corn** | 0.26 | 0.27 |
| **Corn biomass** | No | 0.11 |
| **Cotton capsules** | 0.67 | No |
| **Cotton fiber** | 1.73 | No |
| **Cotton seeds** | 0.80 | No |
| **Cucumber** | 0.16 | No |
| **Gallia melon** | 1.60/pc | No |
| **Garlic** | 0.02/pc | No |
| **Onion** | 0.16 | No |
| **Potato** | 0.43 | 0.24 |
| **Red lentil** | 1.20 | No |
| **Rice** | 1.50 | No |
| **Soybean** | 0.45 | No |
| **Tomato** | No | 0.24 |
| **Water melon** | 1.04/pc | No |
| **Wheat** | 0.19 | No |

Nearly 35 % of P farmers sell cow milk, whereas this percentage is only 15 % in R areas. While 10 % of farmers sell mutton in R area, 47.8 % of farmers do that in P area. Only four percent of P farmers sell eggs. However nobody practices the poultry husbandry in R area. A share of farmers selling certain agricultural products is depicted in Fig. 34.

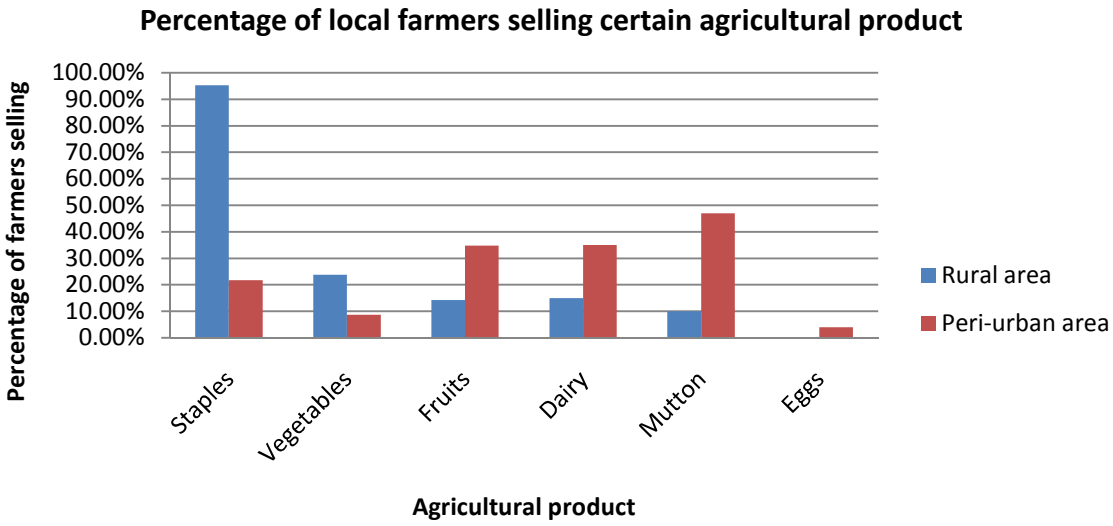


Figure 34: A percentage of farmers selling certain agricultural product in Osh Province, Southern Kyrgyzstan

## 4.6. Post-harvest residues utilization

Retention of post-harvest residues in the field, which is one of the principles of conservation agriculture, is not a common practice in the areas with high population pressure, i.e. U and P areas. There is a limited land for practicing livestock grazing. Farmers have to feed domestic animals by cultivated or bought fodder crops and post-harvest residues from trees, vegetables and staples. Farmers in R areas are in Osh Province more conscious in terms of crop residue retaining in the fields and orchards (Fig. 35). However these fields with crop residues are subsequently in some cases grazed. Moreover land availability is generally not that low in the countryside and livestock number is lower than in P area.

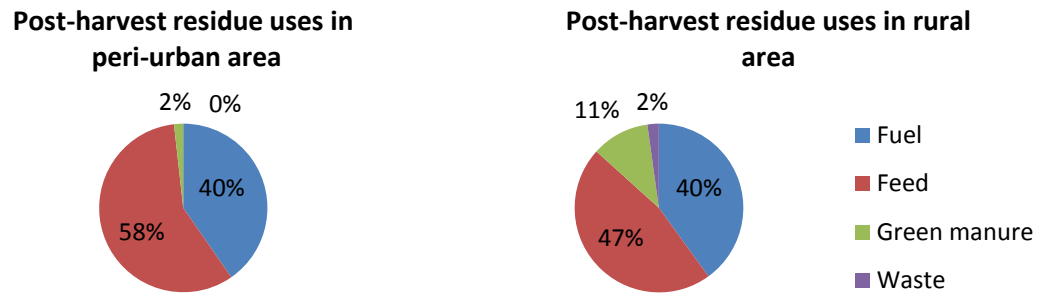


Figure 35: Comparison of post-harvest residues uses in peri-urban and rural areas of Osh Province, Southern Kyrgyzstan

### 4.7. Erosion

Osh Province is negatively affected by erosion (Fig. 36). It is more common phenomenon in P area of Tölöyken (79 % of all recorded erosion events). Water form of erosion prevails (87 % of all recorded erosion events) and occurs predominantly in orchards (70 % of all recorded water erosion events). This can be caused by the fact that P Tölöyken landscape is more undulating and orchard, as a land use type, is more often situated in sloping areas than field. Other reasons for such results are insensitive irrigation and grazing in orchards.

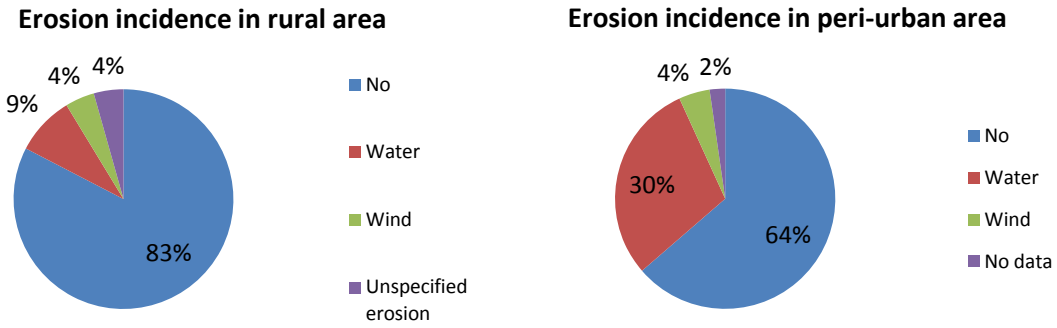


Figure 36: Erosion incidence on rural and peri-urban plots in Osh Province, Southern Kyrgyzstan, expressed as a percentage of all affected plots in the concrete area

## 5. Discussion

### 5.1. Livelihood analysis

Cities, as Osh, offer more off-farm job positions in various branches compared to villages (Evenson and Pingali, 2007). P areas, as Tölöyken, are closer to the city and thus more suitable for daily commuting to work due to cheaper and faster transportation compared to the R areas, as Aravan (Wiggins and Proctor, 2001). Moreover population of cities and their close surroundings tend to be better educated and thus more suitable for off-farm working (Evenson and Pingali, 2007). These are the reasons why R farmers in Osh Province tend to have farming as their only livelihood. On the contrary significant proportion of P farmers have some off-farm employment as it is stated in FAO (2007) and Madaleno and Gurovich (2004). These facts result in higher time investment of R households into agriculture compared to P households.

## 5.2. Plots´ characteristics

### 5.2.1. Basic characteristics

Recommended plot orientation is south-north, because then the sunlight distribution is uniform and amount of the incident energy on plants is higher (Kohout et al., 2002). Such orientation is not commonly used by farmers in both R and P areas of Osh Province. However it is more common in R areas (22 % of all sampled plots) indicating that R farmers are more knowledgeable traditional farmers compared to P farmers frequently with weaker knowledge; and have more options to choose due to higher availability of land (FAO, 2007).

It is not unusual that farmers perceive soil on their plots as medium fertile throughout the world. The scale of the answers is more diverse in R areas indicating that R farmers are more perceptive to soil quality due to their dependence on incomes and subsistence produce from farming (FAO, 2007).

Fields ideally occur on flatlands or in the areas with small slope inclination. Orchards occur on places with various slope inclinations (Špulerová et al., 2014). Both were confirmed by the results reached on R and P study locality. However, fields can occur on inclined terrain too (McCord et al., 2015).

### 5.2.2. Land ownership

Private ownership of land is not the only way of land owning in developing countries, where various customary rights occur (De Zeeuw, 1997; Kalabamu, 2000; Kalabamu, 2014). Private ownership in Central Asian countries became common during the transformation of centrally planned economy to more market-oriented economy, but not in all countries (USAID, 2007). Renting is usually used for increasing operational size of farm, improving of agricultural produce and increasing household income (Rahman, 2010). Renting of agricultural land is common phenomenon occurring in developing countries such as Sudan (Kevane, 1997), Guatemala (Macours, 2014) and Bangladesh (Rahman, 2010). However, only few rentals were reported in Osh Province. They were more ordinary in P area, which is vastly different from the situation, which occurs in Vietnam (Anh et. al., 2004) and China (Garcia, 2011), but more or less the same as the

situation in Cameroon, where the renting of land in both R and P areas is common (USAID, 2012). While P areas of developing countries are known by their frequent influxes of people from both cities and countryside (FAO, 2007), which is valid for Kyrgyzstan too (United Nations, 2015), R areas suffer from outmigration, which among others results in higher prices of land in P and U areas compared to the R. In general, people tend to be settled in R areas for longer time than in P areas (FAO, 2007). However exceptions occur, mainly on the localities, where is unstable political situation as it was on the borders between Kyrgyzstan and Uzbekistan in the beginning of 1990´s (Megoran, 2006). Prices of land with woody plants are higher than prices of common treeless cropland (Peluso, 1992). Moreover price of land in the cities or nearby cities is higher (FAO, 2007). These two facts explain higher price of renting permanent cropland situated in P area.

### 5.2.3. Common land use types and smallholders´ plot sizes

Plot areas are generally smaller in P areas than in R areas due to the land fragmentation caused by population growth and influx of newcomers demanding land (FAO, 2007). Their smaller areas can be compensated by owning more plots there (Gough and Yankson, 2000). Both phenomena occur in the study area.

Farmers living in both R and P areas of various developing countries throughout the world have different ways of land use. The most of the farmers from Central Asia own or rent at least one of the most frequent land use types – pasture (Curtis, 1996); annual cropland - field, permanently cultivated land – home gardens and orchards (USAID, 2012). However detailed studies aimed on land use types in Central Asia lack.

R farmers of Ethiopian regions such as Rift Valley have to cope with semi-arid climate. They have these land use types: dense acacia (*Acacia* spp.) woodlands, parkland systems based on acacia, grasslands and rainfed fields (Biazin and Steerk, 2013). Southeast Asian smallholders farm in wetter climate. Countryside farmers of Cordillera on Philippines have five distinctive land use types: rice paddies, swidden fields, grazing areas, managed forests and home gardens. RA on Java Island in Indonesia can be characterized by following land use types: home garden, upland rainfed field and paddy field. R farmers living in floodplain valley of Northern Thailand cultivate rice fields and home gardens. Cultivated area per household is on average between 0.5 and 1.0 ha on Java Island and

slightly less than 1 ha in Northern Thailand (Marten, 1990). Sizes of R farms´ plots in Osh Province thus correspond with plot sizes occurring in Southeast Asia.

While the most common land use types occurring in the suburbs of Hanoi are: annual croplands, home gardens, perennial croplands, pastures, aquaculture ponds, managed forests and nurseries (Vien et al., 2005), vegetable farming dominates the Yangtze River Delta Region in China (Huang et al., 2006). P farms in Vietnam usually manage 0.3 to 1.3 ha. These areas are fragmented into small plots of approximately 500 $m^2$ (Böhme, 2011). P farmers from Ghana cultivate 0.4 to 1.3 ha (Danso et al., 2002). The sizes of P farms´ plots in Vietnam and Ghana are more or less the same as in P areas of Osh Province, whereas such strong land fragmentation is not common there probably due to lower population pressure compared to above mentioned countries. In general, it can be concluded that the sizes of R and P agricultural plots do not differ from the sizes of plots occurring in the developing world. However the scale of land use types looks more diverse in other developing countries, which can be caused by more favourable ecological conditions in these countries.

Overall area of permanent cropland, where orchards belong, is only 0.4 % of total land in Kyrgyzstan (USAID, 2012), whereas 0.7 % in Myanmar, 2.9 % in Indonesia, 0.8 % in Cambodia, 0.1 % in Laos, 10.1 % in Malaysia, 9.6 % on Philippines, 3.4 % in Thailand, 1.4 % in Vietnam (Marten, 1990), 2.3 % in Armenia, 2.8 % in Azerbaijan, 3.9 % in Georgia, 0.2 % in Kazakhstan, 0.9 % in Tajikistan, 0.1 % in Turkmenistan and 0.8 % in Uzbekistan (Osepashvili, 2006). Orchards commonly occur in both R and P areas around Mexico City (Losada et al., 1998), which was confirmed by reached results for Osh City too. However the share of plots producing woody plants derived products is generally higher in P area (FAO, 2007), which makes sense since it is multistrata system, which efficiently uses limited land and thus it is suitable for the places with higher population pressure such as areas around cities (Nair, 1993). This was confirmed by study results. Optimum woody plant density in orchard differs according to species and area. Developed countries use much higher number of woody plants per hectare than in developing countries (Hampson et al., 2002; Marini and Sowers, 2000). Tree densities are generally higher in western countries due to stronger intensification of agriculture. Intercropping of orchards, which

occurs in Southern Kyrgyzstan, is on retreat in developed European agricultural systems (Eichhorn et al., 2006), however still ordinary in developing countries such as Thailand (Withrow-Robinson et al., 1998). Monoculture orchards prevail in developed world (Moriana et al., 2003; Nesme et al., 2003). Orchard is not a common land use type in developing countries, but occur for example in South Africa (Molebatsi et al., 2010) and Northern Thailand (Withrow-Robinson et al., 1998), where it is polycultural. Orchard as a land use type is partly substituted by home gardens, which are polycultural in Asia [Vietnam, Srí Lanka, Indonesia (Mohri et al., 2013) and India (Pandey et al., 2007)], South America [Peru (Lamont et al., 1999)] and Eastern Africa [Ethiopia (Tolera et al., 2008)]. Woody plant species commonly occurring in developing countries´ orchards and home gardens are determined by local ecological conditions, farmers´ preferences, cultural and religious beliefs. Typical species for humid climate of Southeast Asia are: jackfruit (*Artocarpus heterophyllus* Lam.), coconut palm (*Cocos nucifera* L.), areca palm (*Areca catechu* L.), fishtail palm (*Caryota urens* L.), *Gliricidia* spp., mango (*Mangifera indica* L.), clove [*Syzygium aromaticum* (L.) Merill and Perry] and coffee (*Coffea arabica* L.) in Vietnam and Indonesia (Mohri et al., 2013); respectively peach (*Prunus persica* L.), jackfruit, litchi (*Litchi sinensis* Sonn.), Japanese apricot (*Prunus mume* Siebold and Zucc), and mango in Thailand (Withrow-Robinson et al., 1998). Woody species such as coconut palm, areca palm, cashew tree (*Anacardium occidentale* L.), papaya (*Carica papaya* L.), curry tree [Murraya koenigii (L.) Sprenge)] and silk-cotton tree (*Bombax* spp.) ordinarily occur in humid South Asia (Pandey et al., 2007). South American home gardens consists of woody species like cashew tree, sugar apple (*Annona squamosa* L.), *Jatropha mollissima* (Pohl.) Baill, *Prosopis juliflora* (Sw.) DC., common guava (*Psidium guajava* L.) in semi-arid Brazil (Albuquerque et al., 2005) respectively mango, peach palm (*Bactris gasipaes* Kunth, moriche palm (*Mauritia flexuosa* L.f.), South American sapote (*Quararibea cordata* Vischer), ice cream bean (*Inga edulis* Mart.), common guava, grapefruit (*Citrus paradisi* Macfad.) and abiu (*Pouteria caimito* Radlk.) in humid areas of Peru (Lamont et al., 1999). Egyptian R and P home gardens situated in the arid climate, the similar type of climate as Osh Province, comprises among others woody species occurring in small quantities in Kyrgyz home gardens and orchards such as pomegranate, grapevine, apricot, pear and white mulberry (Norfolk et al., 2013). R orchards in semi-arid

South Africa are usually composed of four woody species, periurban of two. Some of frequently occurring species such as peach, grapevine, white mulberry and pomegranate occurring in more than 20 % of orchards in northwest South Africa (Molebatsi et al., 2010) occur in both R and P areas of Osh Province too. Study results indicate that R orchards occurring in arid Southern Kyrgyzstan are usually composed of two to three woody species, whereas periurban five to six. The most common species are apple, apricot, common aspen, cherry, white mulberry, walnut and willow. Whilst incorporation of timber trees into orchards and home gardens is not common on the northeast of South Africa (Molebatsi et al., 2010) and India (Pandey et al., 2007), because timber is extracted from nature, they occur in home gardens in such as Brazil (Albuquerque et al., 2005), Peru (Lamont et al., 1999), Egypt (Norfolk et al., 2013), Indonesia, Srí Lanka and Vietnam (Mohri et al., 2013).

Timber, fuelwood and fruit trees incorporation to the fields is common in semi-arid Zimbabwe (Chivaura-Mususa et al., 2000) and Malawi (Dewees, 1995); humid Central American Honduras (Barrance et al., 2003) and humid Southeast Asian Thailand (Pham et al., 2015) and Indonesia (Marten, 1990). Mobola plum (*Parinari curatellifolia* Planch. ex Benth.), *Acacia sieberiana* (DC.) and mango commonly occur in Zimbabwean fields (Chivaura-Mususa, 2000). Mango, *Bauhinnia thoningii* (Schumach. And Thonn.), *Faidherbia albida* (Delile) A. Chev., eucalypts (*Eucalyptus* spp.), pines (*Pinus* spp.), beechwood (*Gmelina arborea* Roxb.), Toon (*Toona ciliate* M. Roem.), common guava, *Citrus sp.,* sugar plum (*Uapaca kirkiana* Müll. Arg.), Mobola plum *and Sesbania* ssp. ordinarily occur in Malawi (Dewees, 1995). Spanish elm [*Cordia alliodora* (Ruiz and Pav.) Oken], little-leaf mahogany (*Cercocarpus* spp.), *Lysiloma ssp.*, guanacaste [*Enterolobium cyclocarpum* (Jacq.) Griseb] and *Albizia saman* (F. Muell) frequently occur on the fields in Honduras (Barrance et al., 2003). Various woody plants such as mango, oil palm (*Elaeis guineensis* Jacq.), *Dipterocarpus spp.*, *Shorea spp*., *Mitragina diversifolia* (Wall. ex G.Don) Havil., champak (*Michelia champaca* L.), neem (Azadirachta indica A. Juss.) and teak (*Tectona grandis* L.f.) can be found in rice fields in Thailand (Pham et al., 2015). Fruit trees and *Albizia* sp. occur in Indonesian fields (Marten, 1990). Common aspens and willows, which are considered as timber and fuelwood species occur most frequently in Osh Province. However fruit trees occur too. Selling of timber trees occurring in fields is

practiced by both R and P farmers of Osh Province. This practice is ordinary with cream albizia (*Albizia adinocephala* Donn. Sm.), *Albizia saman,* Spanish cedar (*Cedrela odorata* L.), Spanish elm*,* guanacaste*, Guazuma ulmifolia* Lam.*,* Paradise tree (*Simarouba glauca* DC.)*,* and Pacific Coast mahogany (*Swietenia humilis* Zucc.) is ordinary in Honduras (Barrance et al., 2003). Eucalypts grown in paddy fields of Thailand are sold too (Pham et al., 2015). Fruits of mango are collected mainly for subsistence in the Zimbabwean fields (Musvoto and Campbell, 1995). Fruit picking is practiced in both P and R areas of Southern Kyrgyzstan and its main purpose is subsistence too since the quantities of fruits are rather low. Pollarding in order to reduce shade on paddies and obtain fuelwood is practiced once per three years on *Mitragyna diversifolia* in Thailand´s rice fields (Pham et al., 2015). Pollarding is also common in the pastures of Honduras in order to reduce shade conditions in understorey (Barrance et al., 2003). Pollarding is practiced in Southern Kyrgyzstan too and only in willows. The purpose is to obtain fuelwood. Occurence of woody plants in fields can be considered as a common phenomenon in Southern Kyrgyzstan and developing countries throughout the world. However species composition varies in between different countries or even state districts due to different ecological conditions, farmers´ preferences, cultural and religious beliefs.

Overall area of annual cropland, where fields belong, is 6.7 % of total land in Kyrgyzstan (USAID, 2012), whereas 14.6 % in Myanmar, 7.8 % in Indonesia, 16.4 % in Cambodia, 3.7 % in Laos, 3 % in Malaysia, 23.6 % on Philippines, 31.8 % in Thailand, 17.2 % in Vietnam (Marten, 1990), 17.4 % in Armenia, 20.4 % in Azerbaijan, 11.4 % in Georgia, 8.1 % in Kazakhstan, 6.5 % in Tajikistan, 3.8 % in Turkmenistan and 10.5 % in Uzbekistan (Osepashvili, 2006). Fields occur in both R and P areas. The difference between them lies in cropping patterns. Whilst R farmers cultivate predominantly staples, P farmers grow vegetables (FAO, 2007). Three crop species are usually cultivated per season in humid R Honduras (Barrance et al., 2003), two to four in semi-arid R Ethiopia (Biazin and Steerk, 2013), one in R semi-arid Zimbabwe (Chivaura-Mususa, 2000), one to several in R humid Thailand (Marten, 1990; Pham et al., 2015; Withrow-Robinson et al., 1998), three in R semi-arid Malawi (Dewees, 2005), two to three in R humid Indonesia (Marten, 1990). Such numbers correspond with numbers of crops cultivated in both R (3 to 4) and P (1 to 2) areas of Southern Kyrgzystan. Total number of species employed in crop rotations is

sometimes higher than number of crops occurring on one field per season since some of these cycles are perennial, i.e. do not employ one certain crop each year. For example Indonesian R farmers´ crop rotations comprise even nine species (Marten, 1990). Crops employed in crop rotations are determined by local ecological conditions, farmers´ preferences, cultural and religious beliefs. Crop rotations in following developing countries are composed of these species. Dominating crop species occurring on Philippines are rice, millet, sweet potatoes (*Ipomoea* spp.), beans, squash (*Cucurbita* spp.), corn, bananas (*Musa* spp.), eggplant, potatoes and cabbage. Species such as corn, tobacco, cassava (*Manihot* spp.), various kinds of beans, bitter melon (*Momordica* charantia L.), bananas, sweet potatoes, peanuts (*Arachis hypogaea* L.), cucumber (*Cucumis sativus* L.) and chilli peppers (*Capsicum* spp.) are common crop species in Indonesia. Typical crops for humid Northern Thailand are rice, garlic, soybean, tobacco, shallot (*Allium cepa var. aggregatum* L.), chilli peppers and various kinds of vegetables (Marten, 1990). Corn, tobacco and peanuts are grown in semi-arid Malawi (Dewees, 2005). Corn, sorghum [*Sorghum bicolor* (L.) Moench] and beans are cultivated on fields in humid Honduras (Barrance et al., 2003). Corn, beans, teff [*Eragrostis teff* (Zucc.) Trotter] and barley occur on semi-arid Ethiopian fields (Biazin and Steerk, 2013). Crops as rice, corn, eggplant, potatoes, cabbage, garlic, soybeans and barley occur in cropping patterns of Osh Province´s farmers too. Corn (both PA and RA) together with cotton (only in RA) and alfalfa (only in PA) form a backbone of province´s farmer produce. Corn intercropped by trees is commonly cultivated in Zimbabwe (Chivaura-Mususa, 2000). Row intercropping has not been observed in Osh Province. However trees are cultivated at the field borders there. Double or tripple cropping commonly occurs in Chiang Mai, Thailand, where rice is cultivated in wet season and rice, garlic, soybean, mungbean [*Vigna radiata* (L.) R. Wilczek], tobacco or vegetables in cool season and hot season (Marten, 1990). Double cropping, which based on study results occur mainly in R areas of Osh Province, also occurs in neighbouring China. Combinations such as wheat and corn (Huang et al., 2015); and wheat and cotton (Du et al., 2014) or two rice crops (Cheng et al., 2013; Li et al., 2011). Obtained results indicate that frequently occurring crop combinations in Southern Kyrgyzstan are potato and rice; and potato and corn. Intercropping crop - woody plant as written above is a common practice throughout developing countries

Crop-crop intercropping is in developing world ordinary too (Barrance et al., 2003; Marten, 1990). Milpa system comprising species such as sorghum, bean and corn is practiced in Honduras (Barrance et al., 2003). Indonesian farmers use multilayer intercropping with four strata: the lowest - soybeans, cucumbers, and water melon; the middle - chilli peppers and eggplant; the highest – corn, cassava and beans; and tree layer composed of various tree species (Marten, 1990). Kyrgyz farmers in PA practice mixed crop-crop intercropping. They employ barley and alfalfa. They use this mixture as nutritionally balanced fodder.

Agricultural calendars differ according to world´s region. Agricultural calendars depicting crop seasonality in neighbouring countries or countries with similar natural conditions lack. Crop seasonality in R Northern Thailand is depicted in Fig. 36. The climate there is vastly different from Kyrgyz climate, which is the reason why crops occurring in both countries differ in seasonality.

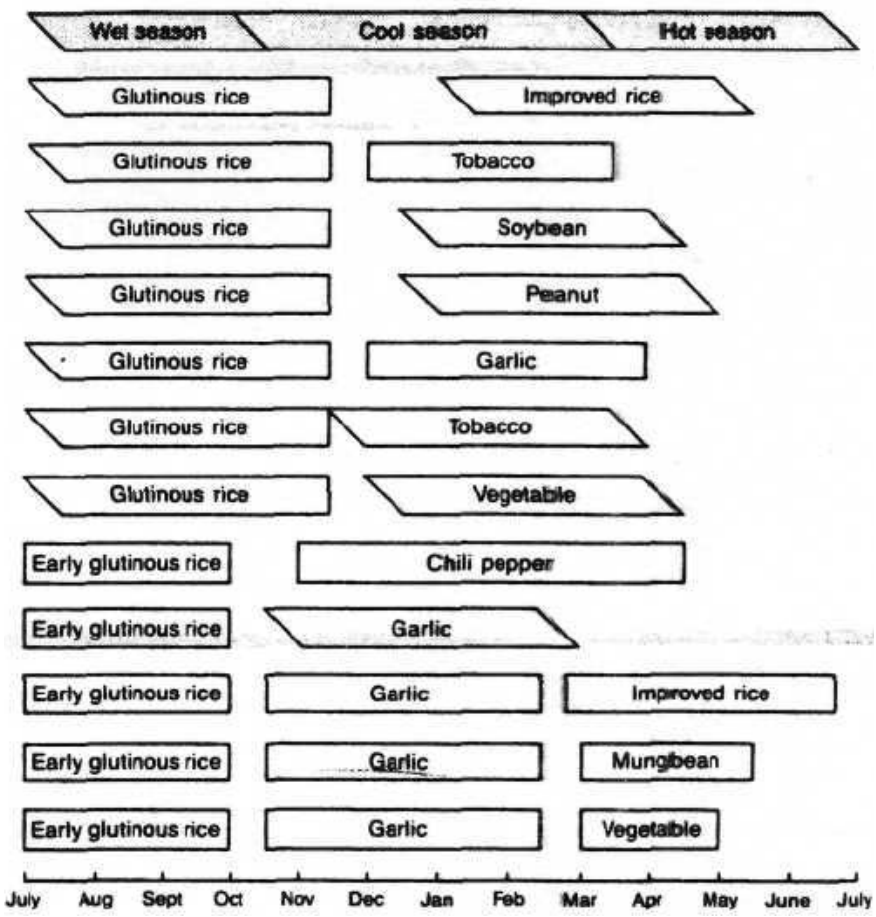


Figure 37: Agricultural calendar of Chiang Mai, Northern Thailand (adopted from Marten, 1990)

## 5.3. Livestock

In general, RA is characterized by cattle and sheep husbandry, whereas suburbs are typical by breeding of poultry, pigs and fish (FAO, 2007). The study results indicate that average number of cattle per household is lower in R areas of Southern Kyrgyzstan. However the percentage of households owning it is higher there. Both sheep number per household and percentage owning them is higher in P area. It may be caused by different ethnic composition of informants and thus different food habits or easily different livelihood strategy. Percentage of households owning poultry is higher in P area and the average number of poultry per household is higher there too, which fully confirms FAO (2007) statement. Aquaculture and breeding of pigs do not have a tradition in Osh Province due to the environmental, cultural and religious reasons.

The research results show that P farmers in the study area cultivate fodder for their domestic animals. This trend occurs also in India (Buechler and Devi, 2006) or Tunisia (FAO, 2007). They let their livestock graze understorey (time to time sown by alfalfa) in orchards and weeds on field borders in order to supplement their diet. The proportion of land devoted to fodder crops is smaller in R area due to the cash and subsistence crop cultivation and that is why R farmers let their livestock graze on crop residues and field borders. Grazing on crop residues is also practiced in R Northern Thailand (Marten, 1990). Field borders are grazed even in developed United Kingdom, concretely Essex County, whose landscape can be included into both R and P zone (Marshall and Moonen, 2002).

## 5.4. Inputs and technologies

### 5.4.1. Labour

Orchards on the south of Kyrgyzstan were determined as more labour intensive and fields as less labour intensive. Orchards tend to be closer to the households, which confirms the theory uttered by Marten (1990) that the low input plots can be situated more far away from house, because the value of crops cultivated there is lower.

### 5.4.2. Inputs

Farmers on both R and P research locality ordinarily use various combinations of inputs in order to protect plants, increase yields and improve soil properties. Inputs are commonly

used in PA in Cameroon (FAO, 2007) or Vietnam (Jansen et al., 1995) especially for the production of vegetables. Moreover farmers in P zone tend to utilize U organic wastes, which is not the case of Southern Kyrgyzstan. In general, PA employs fertilizers for vegetable cultivation. Staples are usually supported by organic wastes (FAO, 2007), which is not valid for Southern Kyrgyzstan. R farmers in Thailand usually employ inputs if they have money for making such investment and if cultivated crop requires it for satisfactory yield. Otherwise they turn to low input crops ideally nitrogen fixing such as peanut. They commonly spread a risk and cultivate 25 % of their land by high input crops and 75 % by low input crops (Marten, 1990), which is partly valid for R areas of Osh Province, where cotton represents this high input crop. However the share on cultivated crops is usually higher than 25 % of farmer´s land there.

### 5.4.3. Irrigation

Furrow irrigation is rather primitive and very common type of irrigation system occurring in R (Berehe et al., 2013) and P environments (Hide et al., 2001) of developing countries; and developed countries´ R (Luquet et al., 2005) and P areas too (Pedrero et al., 2010). Thus the problems regarding irrigation in Osh Province are more or less the same as in other countries using this system, some of them more pronounced, some of them less. Constraints such as an accumulation of salinity between furrows, an increased level of tail-water losses, the difficulty of moving farm equipment across the furrows; the added expense and time to make extra tillage practice; an increase in the erosive potential of the flow; a higher commitment of labour to operate efficiently; and ensurance of equal discharge in each furrow belong between them (Walker, 1989). PA usually uses wastewater for irrigation (FAO, 2007). However this practice was not seen on the south of Kyrgyz Republic.

### 5.4.4. Machinery

Farm machinery is used in both developed and developing countries on large scale plantations or large monocrop fields. Smallholders can reach it especially by contract farming (Kirsten and Sartorius, 2002). However there are smallholders, which does not use it at all (van Eijck et al., 2014). Machinery is used by R smallholders in India (Singh et al., 2002), Thailand (Pham et al., 2015) and Kenya (McCord et al., 2015) and it is being

spread by extension programmes in several countries in Western Africa (Nygaard, 2010), but it usually still plays minor role (Singh et al., 2002). Machinery is also employed in PA such as around Bogota, Colombia (Bojacá and Schrevens, 2010) and Toluca, Mexico (Lerner et al., 2013). Precise regional studies regarding percentage of farmers employing machinery in developing countries and purposes of its use lack.

## 5.5. Marketing

Whilst R farmers generally tend to sell staples and products derived from sheep and cattle; P farmers sell perishable products such as fruits, vegetables, milk, poultry derived products, fish, ornamental plants and woody plant derived products (FAO, 2007). Danso et al. (2002) stressed that R Ghanyan farmers consume non-negligible part of their staples and P farmers sell considerable part of their irrigated vegetables. With growing proximity of city centres farmers tend to cultivate crops rather for subsistence. U and P systems aimed only on marketing or on both subsistence and marketing, which was common in Osh Province P areas, can occur too (FAO, 2007).

Cotton as a typical cash crop frequently occurs, except Southern Kyrgyzstan, in arid and semi-arid countries as Uzbekistan, Benin, Burkina Faso, Chad, Mali (Baffes, 2004). Other cash crops of arid and semi-arid areas occurring in developing countries are: safflower (*Carthamus tinctorius* L.), castor (*Ricinus communis* L.), mungbean, grapevine, pigeon pea [Cajanus cajan (L.) Millsp.] (Walker and Ryan, 1990) and corn (Campbell et al., 2002). While cotton was traded on world market for more than 4 USD per kilogram in 2011, farmers of Western Africa got 1.1 USD per kg cotton fibre (Bassett, 2014) and in Zimbabwe on average 0.85 USD per kg (Manyani et al., 2014). Redemption price in the countryside of Kyrgyz south was 1.7 USD per kg in 2013. Corn is time to time sold on Kyrgyz south by both R and P farmers too. Prices of crops produced by Kyrgyz farmers are higher than those of African smallholders´.

The results of study confirm that P farmers tend to sell milk, poultry derived products, fruits and eggs; and R farmers tend to sell staples, which confirms information from FAO (2007). However mutton selling prevails in P area and vegetable selling in R area, which differs from information obtained from FAO (2007). Differences can be caused by

different ethnic composition of R and P area and thus different food habits and agricultural product preferences.

## 5.6. Post-harvest residues utilization

Retention of post-harvest residues in the field is one of the principles of conservation agriculture. It is not a common practice in the areas with high population pressure, which are mainly U and P areas, due to direct competition between using residues as a feed, firewood, construction material, source of income through sale and leaving it as mulch or green fertilizer in field (Jaleta et al., 2013). However R areas of Fergana valley are generally considered as a region with high population density too.

Farmers in Kenya are knowledgeable in terms of crop residue retention especially on sloping areas, which contributes to erosion mitigation. Nearly all Kenyan farmers use corn residue at least for one other purpose than feed. Approximately one third of Kenyan farmers use corn residue partly for feed and partly as a mulch. However predominant use of corn post-harvest residues (usually more than two thirds of produced biomass) is only feed in Kenya (Jaleta et al., 2013). The use of crop residues as a mulch is not a common practice in Osh Province R and P areas due to high population densitiy. Study results have shown that farmers in Kyrgyz R areas are more conscious in terms of crop residues retaining in the fields and orchards (11 % vs. 2 % of farmers). Land availability is not that low in the countryside and livestock consuming post-harvest residues is not that numerous as in P area. R farmers thus can afford to leave post-harvest residues on their plots. However some farmers let their livestock feed on crop residues, which is not common in P area.

## 5.7. Erosion

Perennial vegetation cover (orchards) is more efficient in terms of erosion mitigation than annual vegetation cover (fields) (Glover, 2003). This was not confirmed by reached results, because orchards in Southern Kyrgyzstan frequently occur on sloping land, which is more susceptible to erosion than flat land (Ray and Yusuf, 2011), where most of the fields were located. Moreover main advantage of permanent vegetation cover is constant covering of ground by litter, which reduce erosive power of rainfall (Nair, 1993), but if this

litter is in Osh Province collected and dried for livestock or directly consumed by livestock, the advantage disappear. Moreover water erosion in Osh Province is rather related to insensitive surface irrigation.

Otherwise wind and water erosion occur everywhere in the world, but wind erosion tend to affect rather arid or semi-arid areas (Pierre et al., 2014; Li et al., 2014; Wu et al., 2014) and water erosion takes place in more humid areas (Chambers et al., 2000; Quine et al., 1994).

# 6. Conclusion

The study brought insight into the land use types, agricultural systems and practices occurring in R and P areas of Osh Province, Kyrgyzstan. While farming was determined as nearly only livelihood of R farmers, a significant proportion of P farmers was commuting to off-farm jobs in the city, which is the reason why P farmers were on average spending less time on their agricultural plots than their R counterparts.

The vast majority of all agricultural plots were privately owned. Renting of land was not ordinary. If occurred, it was more expensive in P than in R area. Plots with trees were more expensive to rent than treeless arable land. Plot sizes tended to be smaller in P area. However the vast majority of P households had more than only one plot, which was uncommon in R area. Field and orchard were determined as the main land use types. Orchards were more common in P area, where they were occupying larger area, but slightly less sampled plots than fields. Their occurrence in R area was rare. Most of the orchards in both RA and PA were composed of three to six species. Dominant woody species in P area were apple, apricot, cherry, common aspen and willow. Such brief statement was not possible to make in R area, where only two orchards were sampled. Fields were occupying the vast majority of both sampled area and sampled plots in R area. Field was creating smaller proportion of sampled area, but higher number of sampled plots in P area. While R farmers were commonly cultivating three to four species per season, P farmers were growing one to two. Crop rotation was practiced in both RA and PA. However, it was more common and more species employing phenomenon in R area. The most important crops in RA were corn, cotton and potato in R; and corn and

alfalfa in P area. Trees were standing on the borders or in the middles of fields, usually in small quantities. However numerous stands of common aspens on the field borders were in this aspect exceptional. Retention of post-harvest residues was not a common practice in the province. P farmers were practicing it less frequently than their R counterparts. Erosion was more common phenomenon in P areas. Water form of erosion was prevailing and it was most frequent in P orchards.

The scale of bred animals was wider in P area. Livestock number per household was also higher there. Although on average lower number of cattle was owned by R farmers, the percentage of households owning it was higher. On the contrary higher percentages of P households were owning sheep, poultry, donkeys, horses and goats. P households´ herds of all domestic animals were on average larger.

Use of agricultural inputs was more intensive in R area. Orchards were less input demanding and more input diverse compared to the fields. They were also determined as more labour intensive than fields. Low labour input demanding plots tended to be situated in higher distance from households. Field crops and woody plants were irrigated more frequently in P area. Ninety-five percent of R and 78 % of P farmers were using machinery for some agricultural purpose. However manual labour was still prevailing in both RA and PA.

P farming was determined as more commercially based in terms of animal production, however less commercial regarding plant production than R. Cotton was cultivated as cash crop in R area and sold to middle man or directly to local cotton enterprise. Other agricultural goods produced in both P and R areas were commercialized on local or Osh market. Farmers in R area were selling staples and vegetables, whereas P farmers were commercializing milk, mutton and eggs.

Documented traditional agricultural knowledge and the findings of contemporary science could inspire future farmers how to do farming sustainably and profitably, i.e. combine traditional practices with reasonable amount of innovative technologies for yield improving and soil fertility maintenance. New sustainable agricultural practices respecting

regional specifics could be based on conservation agriculture, agroforestry, crop diversification, deficit irrigation and farmers should be instructed about their benefits.

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