Czech University of Life Sciences

Faculty of Environment

Department of LandUse and Improvement

Agroecological Approaches in Land Management

Permaculture Farming in the Czech Republic

Diploma thesis

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Author:

Bc. Zuzana Špaková

Thesis supervisor:

Ing. Vratislava Janovská, PhD.

DECLARATION

I hereby declare that the thesis entitled "Agroecological Approaches to Land Management – Permaculture Farming in Czech Republic" has been carried out in the Faculty of Environmental Sciences, Czech University Of Life Sciences Prague, Czech Republic, under the direction of Ing. Vratislava Janovská, Ph.D. I further declare that all sources has been acknowledged in the thesis.

Bc. Zuzana Špaková
17.4.2017, Prague

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CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

Faculty of Environmental Sciences

DIPLOMA THESIS ASSIGNMENT

Zuzana Špaková

Landscape Planning

Thesis title

Agroecological approaches in Land Management – Permaculture farming in the Czech Republic

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Objectives of thesis

The diploma thesis analyses the agroecological approaches in the Czech Republic, especially focused on the situation of permaculture farming. The main aim is to answer the question: What are the conditions for permaculture farming in the Czech republic? The results will summarise constraints and obstacles of permaculture farming in a larger scale in agricultural landscapes. The knowledge of work is based on an existing research studies and examples of best practices abroad. The results of the thesis will help to disseminate new finding about permaculture farming among farmers and researchers in the Czech republic. It can be also beneficial for land managers and landscape planners in designing agricultural landscapes.

Methodology

Author will analyse conditions of permaculture farming in the Czech republic by online research methods and field visits of selected farms. The findings about farms will be evaluated by PESTLE and SWOT analysis and used to disseminate new finding about permaculture farming among farmers and researchers in the Czech republic. The map of all existing farms will be created in appropriate software (ArcGIS). The appendices will contain photographs of the farms, excel tables and maps.

The proposed extent of the thesis

70 – 80 pp. without appendices

Keywords

sustainable agriculture, rural developlement, local food systems

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Recommended information sources

GLIESSMAN, S. R, 2007: Agroecology: the ecology of sustainable food systems. CRC Press, Boca Raton, FL, USA: 408 p.

HOLMGREN, D., 2001: Permaculture. Principles & Pathways Beyond Sustainability.. Hyden House Ltd, East Meon, Hants, UK: 320 p.

MOLLISON, B., SLAY,R.M., 2016: Úvod do permakultury. Alter Nativa o.z., Brdárka, Slovesko: 244 p.

SHEPARD, M., 2013: Restoration agriculture: real-world permaculture for farmers. Acres, Austin, USA: 339 p

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The Diploma Thesis Supervisor

Ing. Vratislava Janovská, Ph.D.

Supervising department

Department of Land Use and Improvement

Electronic approval: 16. 3. 2017

prof. Ing. Petr Sklenička, CSc.

Head of department

Electronic approval: 17. 3. 2017

prof. RNDr. Vladimír Bejček, CSc.

Dean

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ABSTRACT

The study aims to research and summarise the conditions for permaculture farming in the Czech Republic. It shows the examples of permaculture farming from abroad and describes a farm Jagava in a case study. The thesis brings a proposal for further development of the farm and the general potential for permaculture farming in the Czech Republic. The thesis can serve as a guideline for a new large scale permaculture project in the Czech Republic but also as an inspiration for existing farms. The findings of the thesis can be also used by landscape planners for land management projects.

Permaculture is a sustainable system of principles which can be applied at various scales characterised by a goal to create healthy ecosystem which produces food for humans. It is a design-based conception respecting traditional knowledge and also newest scientific findings in ecology.

KEY WORDS

sustainable agriculture, rural development, local food systems, agroforestry

ABSTRAKT

Studie má za cíl zkoumat a shrnout stávající podmínky pro využití permakultury v zemědělství v České republice. Představuje příklady permakulturního hospodaření ze zahraničí a v případové studii popisuje prvky permafarmy Jagava. Práce nastiňuje další možný vývoj farmy a obecně poukazuje na nevyužitý potenciál, kde by se permakulturní principy mohly uplatnit v zemědělské krajině. Tato diplomová práce může sloužit jako návod pro nové rozsáhlejší permakulturní projekty v ČR, ale také jako inspirace pro již existující zemědělské zařízení. Poznatky práce také mohou být použity krajinnými plánovači pro projekty v péči o krajinu.

Permakultura je systém principů vedoucích k urdžitelnému rozvoji lidské společnosti, které mohou být aplikované v různých měřítcích a mají za cíl vytvořit zdravé ekosystémy produkující potraviny pro lidstvo. Základem koncepce je design, který využívá tradiční praktiky a také nejnovější vědecké poznatky z oblasti ekologie.

KLÍČOVÁ SLOVA

udržitelné zemědělství, vývoj venkova, místní potravinové systémy, agrolesnictví

TABLE OF CONTENTS

1. INTRODUCTION

An increasing number of people see that the current functioning of global system is no longer bearable in terms of healthy environment on which our human life depends. Realising the consequences of poisoning water and soil by conventional farming awakened communities and its people to take action. They came up with a new vision of agriculture. This vision is permaculture. It means "permanent culture" and "permanent agriculture" (MOLLISON 2016) as culture and agriculture go together with each other.

Permaculture is based on practical knowledge so also this diploma thesis emphasises the practice (analyses and case study) and tries to connect them with theory (literature review). There is available foreign literature which is written for different climatic conditions than the one in the Czech Republic. Readers can get better understanding of principles but specific methods are currently being tested. It is why there should be an active platform for sharing this kind of experience. For the past few years, permaculture-themed literature written by Czech authors (e.g. published by Permakultura CS) has appeared. It is mainly focused on private gardens, urban gardening and off-grid style of living. There is almost no literature about permaculture in farming and land management in Czech language. It is the reason why the knowledge of the thesis is mainly based on foreign literature.

Nowadays there are two separate drivers influencing landscape: agriculture practice and nature conservation. Production represents monoculture fields often sprayed with chemicals. Conservation, on the other side, focuses on ecosystems of the species and their protection. This concept bears several problems as pollution of ecosystems and agroecosystems, discontinuity of natural systems, drought and floods, and decreased biodiversity. Permaculture concept brings a new viewpoint for land management. Functions are more interdependent and individual elements fulfil many functions. E.g. windbreak can produce wood and berries for commercial use. It is also helpful in terms of ecosystem services. Applied permaculture practice covers supporting, provisioning, regulating and cultural services.

Permaculture farming is well efficient in the tropic and subtropic landscapes because of easy implementation of its principles of self-regulating ecosystems. But in a moderate climate, especially its continental part with tough winters, it might be quite a task to achieve the goals of permaculture. Luckily there is a growing movement of as referred cold climate permaculture.

2. The Aims of the Thesis

The thesis aims to identify the current situation and conditions influencing the permaculture farming in the Czech Republic. Examples from abroad showcase possible ways to farm in a permaculture way. The output of the thesis is a proposal of potential ways to implement permaculture in a large scale and a case study of farm Jagava, where the author proposes further development of the farm.

The thesis aims to answer these questions:

What are the existing conditions for permaculture farming in the Czech Republic?

What are constrains and obstacles of permaculture farming in the Czech Republic?

How is permaculture applicable on a larger scale?

What is the current situation of permaculture farming in the Czech Republic?

What is the future of permaculture farming in the Czech Republic? Is there a potential to spread this kind of farming?

3. Literature Review

3.1 Sustainable Agriculture

Almost half of the Earth's terrestrial area is occupied by agriculture land (HATHAWAY 2015 ex. SMITH et al., 2007) which makes this land-use unit important factor of a state of environment.

Industrial (conventional) agriculture started after World War II. Because of surplus of ammonium nitrate (from explosive production to chemical fertiliser) and availability of fossil fuels, technology (HATHAWAY, 2015) and a breeding of the new crop varieties. All these reasons caused that it was more convenient to grow crops in monocultures (ALTIERI, NICHOLLS, 2005). Economical and political pressure led farmers to switch to monoculture way of farming because of a need to increase the countries economies ability to export crops abroad. The structure of farms also changed. They are bigger, more specialised and there is less of them (ALTIERI, NICHOLLS, 2005). Industrial agriculture produces almost half of the greenhouse gas emissions of the whole amount released into the atmosphere (HATHAWAY 2015). Rapid population growth required intensive methods which industrial way of farming fulfilled in spite of the fact that the soil in large areas was depleted (GLIESSMAN, 2007).

Large impact occurred on local ecosystems from the beginning of agriculture industrialization. Naturally closed cycles of energy, nutrients and water became open systems in artificial agroecosystem as well as they are prone to pests because of decreased biodiversity which causes the lack of naturally occurring predators. Also the diversity of crop varieties diminished which caused homogenous agricultural landscapes with new varieties on a large areas (ALTIERI, NICHOLLS, 2005).

Sustainable agriculture aims to use manure, organic matter and crop rotation with legumes instead of artificial fertilisers. The management of crop sequence helps to minimise weeds and pests. There is a set of methods for increasing the soil health by putting organic matter in order to enhance water holding capacity and support the soil biota.

The new way of farming bears several names such as sustainable agriculture, biological ag., ecological ag., post-modern ag., organic ag., regenerative, etc. They basically include similar techniques and have just slightly different nuances. Some authors also use new terms such as restoration agriculture which Mark Shepard used for the name of his book and includes the specifics of regenerative agriculture, permaculture, keyline design and permaculture because all of them help to restore damaged land from previous industrial agriculture practice.

The question then is what term is the most precise and general to use for a harmless way of farming? The terms "biological ag." refers only to living organisms and not to inanimate part as water or air. The same problem is with "ecological" as it describes only relationships among parts of ecosystem. "Regenerative ag." definitely includes all the needed aspects but marks just certain period of time when the land is degraded and certain techniques are used to improve and regenerate and once it is done the term "regeneration" looses the meaning. The similar problem arises with an expression "non conventional ag." as it can't be used any longer if it becomes conventional. The term "organic ag." is related to just certified products and brands too much to make it a general term.

For a need of this thesis the most general term for a new way of farming was used "the sustainable agriculture" because of a general definition of sustainability which encompass all the aspects of human's and natural system, defined as "the ability to continue at a particular level for a period of time" (CAMBRIDGE BUSINESS ENGLISH DICTIONARY, 2017) and it is also perceived by public. However, PEARSON (2007) refuses using the term "sustainable" because of ambiguous meaning. He implies that for different authors it means different things. For example, defining the term from the management point view: a sustainable system is able to maintain itself ecologically, socially, or economically (PEARSON, 2007, ex. PEARSON, ISON, 1997). Other authors define it as a goal of "integration of natural processes" (PEARSON 2007 ex. PRETTY, 1998) or in terms of outputs flows (PEARSON 2007 ex. SMITH, McDONALD, 1998).

Even though there are different reasons to turn to sustainable farming the main outputs are the same: to ensure food, to protect natural resources, to create socially equal community and economically viable enterprises (ALTIERI, NICHOLLS 2005). The agriculture of the future has to meet two goals: to be productive enough to feed the population and to be sustainable enough to leave the land fertile for the next generations (GLIESSMAN 2007).

AGROECOLOGY

The term "agroecology" was first described in scientific literature in 1928 by a Russian agronomist Bensin as an ecological method during research of crop plants grown commercially. Until the 1970's, agroecology was examined only as a science. Landscape components (plants, animals, soils and climate) and their interactions with each other within an agroecosystem and also with human's influence on these components was an object of research. Simplistically described as an application of ecology in agroecosystem. The term can be viewed from three perspectives: science, movement and practice (Fig. 1). From the 1970's, agroecology became also seen in movements and from the 1980's was also turned into practical techniques. There is an increased interest in applying ecological principles to agrology (WEZEL et al 2009).

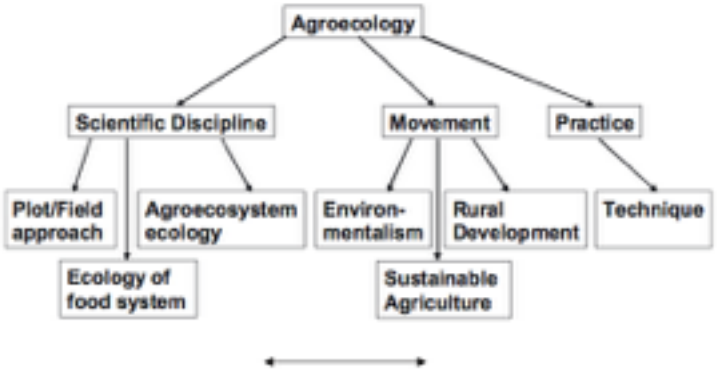

Fig. 1 Approaches in agroecology *(WEZEL et al 2009)*

Agroecology was then defined as “a way to protect natural resources, with guidelines to design and manage sustainable agroecosystems” (WEZEL et al 2009 ex ALTIERI 1989a, GLIESSMAN 2007). Agroecosystems should fulfil four attributes: productivity, sustainability, stability and equity (WEZEL et al 2009 ex CONWAY 1987).

This thesis is focused on practical knowledge therefore the following description contains techniques and practical experience. The biodiversity of agroecosystems can be supported by many ways, GLIESSMAN (2007) describes following list of agricultural techniques:

- Multiple cropping
    - Intercropping: Mixture of two or more crop plants grown in one place at the same time creates polyculture. It brings temporal diversity of structures and functions.
    - Strip cropping: Planting the crops in strips
- Cover cropping: Between two crop cycles, a non crop plant is planted for covering up the bare soil. It enhances soil biological activity and amount of soil organic matter, reduces soil erosion and fixes nitrogen (when plants are legumes).
- Rotations: Growing one crop after another creates rotational effect. Crops grow better because it improves soil fertility and increases an amount of soil organic matter.
- Fallows: In rotation sequence can be planned uncultivated land for a certain period of time. This allows the soil to get recovered.
- Reduced or minimum tillage: Decreasing frequency and intensity of tillage causes more intense activity of earthworms, better soil structure, organic matter content, diversification of organisms.
- High organic matter inputs: It can be done by adding composts, crop residues, cover cropping.
- Reduction in use of chemical inputs: Pesticides eliminate a number of unwanted species but also beneficial ones.
- Hedgerows and buffer vegetation: Woody vegetation planted along pathways and around fields which provide wind protection, boundaries for animals and a production

of timber and fruits. They support biodiversity and when planted in larger strips they can buffer negative potential impact from surroundings.

- Integration of livestock: The complex biodiversity is enhanced by animal integration.

Those methods are the core of sustainable agriculture. In the next chapter there are described several approaches of agriculture which implement agroecology into practice in different ways and scopes.

3.1.2 Different Approaches in Sustainable Agriculture

Many approaches have raised in need to change the food system due to problems with industrial agriculture described above. There is a gradient of sustainable agriculture from organic farming to more natural like ecosystem looking? (agroecosystems). Some of these include sets of agricultural methods as well as ethical principles and philosophical and social aspects. GLIESSMAN (2007) explains sustainability as a continuous harvest with the ability of the system to renew itself. Problem with this definition is that the outcome of sustainable agriculture always lies in the future thus we cannot prove it in the present. However there are some basic aspects which all sustainable farms should meet:

- avoid toxic release into the air, water and soil
- protect and improve soil health and fertility, reduce soil erosion
- implement wise water management
- use local recourses
- preserve biodiversity (GLIESSMAN 2007)

There are many approaches to sustainable farming, they focus on similar goals and the farmers have various reasons why to start or switch to certain way of farming. The types of sustainable agriculture: organic agriculture, regenerative agriculture, biodynamic agriculture, natural farming, agroforestry systems, keyline system and permaculture farming.

ORGANIC AGRICULTURE

The way conventional agriculture has been treating the land has not seem sustainable for a lot of people. Organic farming formatted to reverse long term problems of industrial agriculture. The first impulse was realisation of the need to reestablish the vital soil. Inspiration taken from traditional farming methods with aim to create a small layer of soil called humus (humus farming). This was achieved e.g by composting, animal manure application, rotation crops and managing pH. In 1940's term 'humus' was switched to 'organic', first used by Lord Northbourne in context of agriculture (KUEPPER, 2010).

Organic farming tries to reduce inputs in form of pesticide and artificial fertilisers but the amount of fossil fuels is still quite high (WHITEFIELD, 2005). PEARSON (2007) sees organic systems defined as semiclosed systems, producing food crops certified on national or regional level.

REGENERATIVE AGRICULTURE

Regenerative agriculture emphasises the regeneration ability of a system each year. Example of such system might be permaculture (MASON, 2003). More about permaculture concept is found bellow. RHODES (2012) differentiates permaculture as an initially design-based system and regenerative agriculture sees as more pragmatic and adaptable on techniques of existing farming.

The goal is to create productive system with pattern taken from natural environment which supports human existence and the whole biosphere. The example of regenerative attitude is to plant the annuals in alleys between perennials or at its edge. It is important to grow vegetables (mostly annuals) because they are an important part of one's diet and also a part of natural ecosystem (FRENCH, 2015).

The characteristics of regenerative agriculture include description how much is agronomic system closed. All agro-systems are considered open because there are always crop plants, containing minerals and energy, removed. Regenerative systems are described as semi-closed, where inputs and impacts from outside the farm are

minimised. In contrast, industrial agriculture as an open system use pesticides, fertilisers and fuels from external sources (PEARSON, 2007).

BIODYNAMIC AGRICULTURE

Biodynamic systems (by Rudolf Steiner) aims to establish a farm system which recycles the materials within a farm thus don't need import anything from outside. Biodynamic agriculture fulfil all the requisites of organic farming except of usage of preparations. The preparations are used in a little dose and sprayed on the fields. It also requires at least 10 % of total farm area for biodiversity preservation (DEMETER, 2015).

The difference between organic agriculture is that biodynamic farming uses methods to enhance both biological and metaphysical aspects of soil and harmonises farm management with natural process. (PONZIO et al., 2013 ex. DIVER, 1999)

NATURAL FARMING

Natural farming is considered to be the purest form of agriculture. FUKUOKA (1985), Japanese farmer, set up four rules to follow: No cultivation, no fertiliser, no weeding, no pesticides. His agriculture practice is based on do-nothing philosophy where a farmer observes the natural processes and through them tries to work towards the yield. It is a kind of buddhist concept applied in farming. Fukuoka's natural farming is characterised by growing rice and barley in clover where the symbiosis among plants is established and weeds have no space to grow. He removed all unnecessary steps of growing in compare with "scientific agriculture" which is fossil fuel, machinery and labour intensive.

AGROFORESTRY SYSTEMS (AFS)

The basic principle of agroforestry is a combination of woody species with crops and animals. The result of agricultural and forestry techniques creates diverse and sustainable systems which are productive and also profitable (UMRANI, JAIN, 2010).

The use of trees and shrubs are not primarily for timber production. Such agroforestry land use systems help to prevent soil erosion, provide habitats for organisms, sequester carbon and enhance landscape values. Elements of crop species and tree/shrub species become interrelated physically, environmentally and economically. The science of agroforestry focuses on description of those interactions and applies their benefits into practice (NUBERG et al., 2009).

Agroforestry uses different types varying in time and space. Crop rotation system is the oldest practice. The forest is cut down and in its place is planted annual crop. After the exploiting nutrients, there is a new forest established again. Intercropping system supports beneficial characteristics of both tree and crop species at the same time in one place. The tree component might be planted around borders of agriculture unit, alternate rows or strips (two and more rows) which are basically alleys, hedgerows within the agriculture unit, random mix is spatially not specific layout of the components. Fig. 2 shows terms agrosilviculture, agrosilvipastoral and silvipastoral and as they include three main components: agriculture, forestry and livestock. The graph describes the occurrence of components in the main types of agroecology (UMRANI, JAIN, 2010).

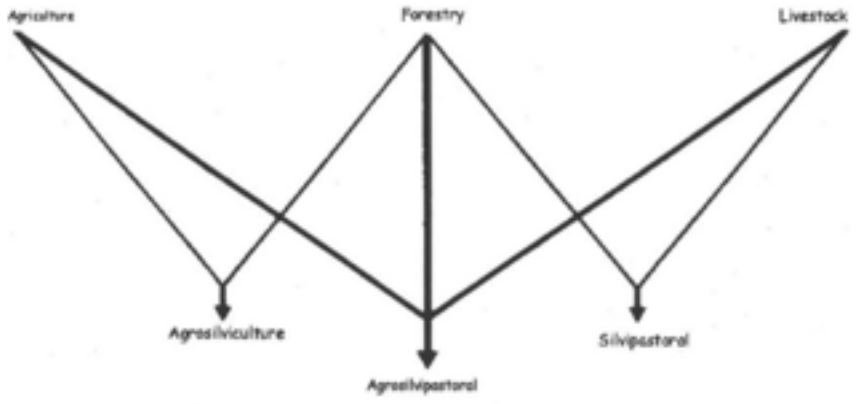

Fig. 2 Three types of agroforestry *(UMRANI, JAIN, 2010)*

KEYLINE SYSTEM

Keyline concept was created by P. A. Yeomans in Australia in the 1950's. The concept aims to improve soil structure, soil fertility and deepen the fertile horizon of soil. It is a complex system of introducing new cultivating methods, water management and layout of farm. The role of key line is to retain stormwater. To identify the keyline, it is necessary to find a key point, which is a point dividing convex and concave parts of a slope. The key line is coming through this point and can be a counter line but it is not a condition. Keyline cultivation is cultivation of lines parallel to the key line (YEOMANS, 1954).

YEOMANS (1954) claims that only fertile soil and correct cultivating is able to stop soil erosion. Fertility is gained by natural processes as absorption, growth and decay.

PERMACULTURE FARMING

Permaculture system is described in next chapter 3.2. Originally, it was defined as a system for gardens and homesteads for establishing self-sufficiency homes. Nowadays there is a movement of farmers who implement permaculture principles on wider scales. If compared with other approaches described above, permaculture concept offers a holistic view on global issues and comes with solutions applicable by individuals from garden to farm scale. The permaculture concept differs from organic farming especially by the design and structure of farm. The design is drafted in the way of biological pest control, optimisation of the human labour and increased productivity by soil management and self-regulation processes.

These types can be sometimes combined and connected into one working system. Organic agriculture is the most common and spread. Biodynamic farming is also spread world-wide and well defined. Regenerative agriculture focuses on regeneration of land after industrial agriculture. Permaculture is sometimes described as regenerative system nevertheless it is more complex and its principles can be implemented on a wider

scope. Natural farming is the purest form of agriculture as well as the most intricate. Agroforestry systems and keyline design can be used in all mentioned ways of farming and both together are compatible. Permaculture can use both agroforestry and keyline design and also be inspired by natural farming.

3.2 PERMACULTURE

Growing awareness of physical limits of Earth in the last century made many people think what to do to create healthy environment by sustainable methods. Permaculture was one of the products of this thinking. The aim is to develop such ecosystem which is able to feed the people (edible ecosystem) (WHITEFIELD, 2005).

The main inspiration source for permaculture is the Nature itself. Observation is one of the permaculture design principles (described bellow). This concept was applied by old civilisations such as inhabitants of Kerala in southern India and people of Chagga in Tanzania. They created gardens, where all layers of trees, vines, bushes and herbs grow the same way as in the natural forest (WHITEFIELD, 2005). In Morocco, berber tribes cultivated terraces in a close to nature way (HOLZER, 2015).

Scientifically permaculture fits into ecology, more precisely systems ecology. The design principles are connected with landscape geography and ethnobiology (HOLMGREN, 2002). Sometimes permaculture is described as “integrated farming”, “ecological engineering” and probably the closest term “cultivated ecology” (DIVER 2002). MOLISSON & SLAY (2016) define permaculture as a design system which is a tool for designing landscapes which are able to provide enough food and shelter for humans as well as other species. There is an emphasis on a smart layout and connections between features. These systems should be economically prosperous but not polluting the environment.

However GLIESSMAN (2007) differentiates permaculture by defining it as a philosophical system which enables humans to design harmonious systems. Beside agroecology analyses ecological principles in agroecosystems, observe mechanisms and

processes within the farm and landscape. He considers both systems as highly complementary.

The main idea of permaculture as such is to take responsibility and do what we want and can do for our closest environment. The attitude of opposing and wanting others to change something does not imply in permaculture (HOLMGREN, 2002).

Permaculture concept is applicable on many aspects of human life (Annex. 1). It started by gardening and agriculture but nowadays there are also overlaps to e.g building and psychology, etc. The conference Permakulturní dům (Permaculture house) organised by Permakultura CS was held in November 2016. Application of permaculture design principles defined by David Holmgren are also useful in couching and personal development (FRONĚK 2012) as well as in water supply and purification and urban planning (WHITEFIELD, 2005).

3.2.1 History and Characters of Permaculture

The term "permaculture" was first used in 1968 at Tasman university in Australia by Bill Mollison and his colleague David Holmgren. They worked on a framework which included principles and species for sustainable agriculture system. In 1978 the results were published in a book Permaculture One, a year later followed by Permaculture Two. Reaction of experts were negative as permaculture concept introduced mixed structures of livestock, forest and agriculture. However, the public got interested and first graduates of design courses started design projects in Australia in 1981 (MOLISSON, SLAY, 2016).

Masanobu Fukuoka (1913 – 2008) was a Japanese farmer and a philosopher who practiced natural farming and wrote a book One Straw Revolution. He didn't use any fossil fuels and machinery. The knowledge of his work based on observing natural processes is also a spiritual practice of removing a compulsive activity from farming. Concept of permaculture was strongly influenced by Fukuoka (KORN, 2003).

Sepp Holzer, similarly to M. Fukuoka, started farming on the farm of his parents in 1962. He created unique edible ecosystem with a system of ponds. The farm is located in high altitude and uses characteristics of microclimate. The knowledge was obtained from observing the landscape and then applied into practice.

Patrick Whitefield was a propagator of permaculture in UK, his findings were for temperate climate permaculture showed practically at his farm. Robert Hart and his follower Martin Crawford focused on creation of forest gardens. In Australia, Goeff Lawton established permaculture farm and dedicates his time for education and video publishing. In the USA, Mark Shepard created a farm with permaculture principles and agroforestry. More detailed description of this farm is in chapter 3.3.2.

3.2.2 PERMACULTURE ETHICS

A. CARE FOR THE EARTH

According to HOLMGREN (2002), this ethical principle can be explained on several levels. The most grounded one is taking care of soil. He emphasises that a good state of the living soil is a base for "future health and well-being of society" but this issue is not so attractive in comparison with other environmental issues, more understandable ones. Globally viewed, there is Gaia hypothesis based on indigenous people's believe in all powerful Mother (Earth). This ethic principle is also possible to see as a respect to diversity of all living forms and meet our own needs as well as to allow the needs of other species.

The main aim is to reduce environmental impact of our behaviour as much as possible as we are not able to recognise all the consequences which our activity leads to. To kill other species is acceptable just in case of real need, wasting is considered disrespectful. All lifeforms must be perceived as part of Earth ecosystem even whether they are not convenient to us or we appreciate them (HOLMGREN, 2002).

B. CARE FOR PEOPLE

Care for people starts with self. It works on the assumption that only healthy and secure person is able to spread goodness in wider circles (self, family, neighbours, community, …). This concept resembles tribal ethical systems. The realisation of global inequities based on unfair distribution of wealth among the people and nations is a starter of thinking about own responsibilities. The solution is to create local economies and households which depend less on global economical system (HOLMGREN, 2002). It emphasises the importance of helping those who have no access to water and food and the need of uniting people for common work (RHODES, 2012).

Another aspect of this principle is to make people realise that well-being does not rely on material resources and can be found in "focus on non-material values" (HOLMGREN, 2002).

C. FAIR SHARE

This ethic principle was also called Set limits to Consumption and Reproduction, and Redistribute Surplus in HOLMGREN (2002). RHODES (2012) also reminds that natural resources have their limits and need to be respected. It requires people's willingness to modify the lifestyles to stay connected with the natural world in order to live sustainably. Permaculture practitioners work on the basis that ecology and economy are not antagonistic (HOLZER, 2015).

3.2.3 PERMACULTURE DESIGN PRINCIPLES

HOLMGREN (2002) set the principles for designing permaculture systems based on ecological and sustainability knowledge:

1. Observe and interact

The base of permaculture lies in a good design, there is a need to get suitable knowledge to achieve this. To obtain information about the property might be an

inspiration for the design. An example of such principle is in Annex. 10, where the farmer observed how to mitigate the power of flow in a river.

2. Catch and store energy

The basics of this principles is to catch energy while it is in surplus, store it and then use it in times of need. The typical example of this principle is to catch solar energy in form of biomass of green plants and also by solar panels for electricity produce.

3. Obtain a yield

The third principle reminds survival instinct of all living organisms. The design of the system must enable to get a yield. In an uncertain future of oil accessibility, only systems ensuring enough food by finding creative and flexible ways will be successful.

On permaculture and traditional farms and homesteads, it is a common thing to find a kitchen garden with vegetables and herbs.

4. Apply self-regulation and accept feedback

The key approach in designing permaculture systems is to identify self-regulatory potential. The feedback can be positive and negative. Positive feedback can be a system's ability to provide energy freely. Negative feedback is able to reduce wasting and misuse of energy.

5. Use and value renewable resources and services

Renewable resources are those which can be renewed by a natural process (e.g. wood). Using them, it does not require to harvest and consume them. It is also called passive functions of plant, animal, soil and water.

6. Produce no waste

In natural systems, the waste produced by one organism is recycled by other one. In human systems we can emphasise timely maintenance to reduce future waste.

7. Design from patterns to details

The permaculture object is designed from complex to detail. First realisation of aspects influencing the system and understanding the pattern, followed by a consideration of individual elements and its place in the system.

8. Integrate rather than segregate

The aim is to create a connected system of elements of design which serve to each other and establish beneficial relationships.

9. Use small and slow solutions

The smallest possible scale and the slowest solution is characterised by the best longevity and functionality.

10. Use and value diversity

Harmonious systems are typically very diverse, it makes them stable and balanced. The diversity can be expressed by amount of species, functions and interactions. This principle can be applied on the design of edible forest (Annex. 9)

11. Use edges and value the marginal

Edges of ecosystems influence the productivity of both sides. Edges, marginal and not visible parts are important and valuable for each system.

12. Creatively use and respond to change

The design should be as stable as prepared to react on change caused by outside influences.

3.2.3 APPLIED PERMACULTURE

Permaculture is sometimes considered as a philosophical system (GLIESSMAN, 2007) but it also offers many practical solutions to a current problem. The emphasis is directed into local and site specific problems which can be solved only on a local scale but influences the larger scale.

The advantages of permaculture in a topic of climate change is that emphasis lays on diversity. E.g. while planting various kinds of trees, there is a big chance some of them will mature despite the climate change during their growth. Another way to preserve climate is no plowing the soil. Such soil is able to absorb the carbon from the atmosphere and mitigate the climate change (GERWIN, 2014).

Mimicing the nature is one of the main features in permaculture. There is almost no bare surface found in nature. On the small scale, mulch is used (usually straw) but on

the larger scale, it is more complicated. In this case, the best ground cover is use of living plants (GERWIN, 2014).

In terms of land management, permaculture brings whole new concept. HOLZER (2015) considers landscape management in a permaculture point of view as a reclamation of the landscape which he defines as a reverse creation of small structured patches in a pattern of natural ecosystems.

A. WATER

Availability of water is related to type of land and depends on rainfall and its distribution throughout the year, capacity of soil to retain the water, soil cover, animals and plants. Except of rainfall, other factors can be changed and designed. The most important thing on land is to identify water resources and design accumulation tanks and ponds with a help of gravitation. Smart design of plantings can solve very wet or very dry locations with suitable vegetation. Swales are long ditches serving for catching water and slowly releasing it into the underground where it can be uptake by vegetation. The essential part of swales are trees and bushes grown along them, wetland species can be grown in the ditch (MOLISSON, SLAY, 2016).

B. SOIL

Permaculture leaves the soil as undisturbed as possible. The main goal is to create well structured soil with plenty of humus and soil life. There are methods of no tillage described also in large scale farms. MOLLISON and SLAY (2016) identify three main attitudes for soil care: afforestation, no till (not turning soil up side down) and for small scale projects to support living organisms (earthworms) by composting and mulching. At larger scale, bicropping can be e.g. used (by P. Whitefield) which is composed by perennial layer of white clover and in between the cereals are annually sown (GERWIN, 2014).

C. VEGETATION

Edible ecosystems work on natural principles. Each plant provides different habitats for insects as well as uptakes different minerals from soil. It is about connection between plants and their useful relationships (WHITEFIELD, 2005). Woody plants are

preferred in permaculture because of several reasons. One of them is their better ability to store water and nutrients than annual plants (HOLMGREN, 2002). Trees also deepen and build the soil by roots and leaf litter (SHEPARD, 2013).

One of the widely discussed issues in permaculture is a production of cereals which cannot be grown at the scale of conventional agriculture. Therefore the common diet must be changed more into products like nuts, berries, vegetables and fruit (RHODES, 2012). However cereals like wheat, barley, rye and oats are traditional and nourishing part of one's diet but growing them in permaculture seems to be problematic. FUKUOKA (1985) mastered growing cereals without use of machinery, manually managed systems with great knowledge of plants and art of observation made himself succesful. The permaculture attitude can be shown on Christian Dalmasso's way of cereal variety planting. On one field he grows several varieties of wheat all together, it helps to slow down the transfer of disease within one variety which is prone to it (LA GUERRE DES GRAINES, 2014).

Approach which goes with permaculture principles is to develop healthy ecosystem where the vegetation is self-regulating and self-reliant in its needs. SHEPARD (2013) came up with a method called STUN (acronym for sheer, total, utter neglect) where fruit tree seedlings are left to its condition and only necessary care is provided (e.g. weed removal in first years). Such trees develop extensive root system and therefore endurance helping the tree to survive extreme conditions. Trees not strong enough die.

In permaculture, there is a phenomenon of forest gardens (edible forests), it is a multilayered and low maintenance system which produces food. The structure might be a mosaic of successional patterns (JACKE, TOENSMEIER, 2005). In large scale farming it is not possible to create such system on large areas but it can be an additional production. It is also a spot with the highest rate of biodiversity (Rod Everett, 7/2017, personal communication).

D. Animals

Livestock plays an important role in permaculture design. SHEPARD (2013) advocates animal polycultures at the farm. It is a mimicry of ecological niches in the natural systems. Livestock occupies one place all together or in a sequence. “The multi species grazing system” allows the grassland regenerate as each species prefers different types of plant. The knowledge of livestock can be implemented to farm management. Pigs can be used for their ability to plow the soil when it is needed, the sheep can be also used for invasive plant control on pastures and goat’s ability to eat even woody plants which is both advantage and disadvantage.

E. Spatial structure

The right design of homestead, farm or garden is a crucial part of permaculture planning. MOLLISON and SLAY (2016) summarises the main design principles. The core of design is a relative location where every element of the land is connected to another so beneficial relationships are created. Each element fulfils many functions and each one of the important function is covered by more elements. The buildings should be planned efficiently in terms of energy use (zones, sectors and slopes). The energy is kept on land and designed in that way it creates cycles (both fuels and human resources).

Zones are defined by placement of elements based on intensity of their usage. Zone 0 is the core of property, a house or a village is usually placed there (large scale design) placed. Zone I is a surrounding of the house, it is the most intensive patch with a kitchen garden, workshops, greenhouses and small livestock (chickens). Zone II is still intensively managed, densely planted and occupied by smaller livestock. There can be orchard and larger shrubs. Zone III contains trees without intensive care and large pastures. Zone IV is a wild zone with some interventions, picking fruits and also for cutting timber. Zone V is totally undesigned and wild, it serves for observation and meditation.

Sector diagram shows prevailing wind directions, sunshine, floods. Identifying sectors helps to understand what to design in terms of vegetation composition etc.

Slopes planning is useful especially for water management and its layout (MOLLISON, SLAY, 2016). Traditionally, those principles were applied in home orchards, a relief determines water accessibility and this can be used for designing an orchard according to water tolerance of certain fruit species (Vojtěch Klusák, 1/2017, personal communication).

3.3 PERMACULTURE FARM

Permaculture farm should meet all aspects of permaculture principles. Basically applying Holmgren's and Mollison's principles helps to understand the holistic attitude of permaculture and its implementation. If we talk about the goals which permaculture farm tries to approach it is important to connect all the aspects of the farm into one holistic system. Basis of the farm productivity is to have healthy soil thus continuously enhancing the soil fertility and prevent soil erosion. Water management should be wise in terms of retaining water, stormwater management and creating new wetlands where it is appropriate. Permaculture farm should have a decent area of perennials and use of beneficial relationships among plant species. There is a need also for sustaining the biodiversity by creating new habitats for species. Animal husbandry is integrated into crop management. The farm must be profitable and aim at economic viability. The farm must be rationally designed and all aspects work together. Renewable energy sources should be preferred and fossil fuel usage reduced or eliminated. Materials are recycled and upcycled, biodegradable matter composed and used again.

The next subchapters describe case studies of permaculture farms in the USA and Sweden. There are shown practical examples of described theory and implementation of Holmgren's design principles.

3.3.2 Case study of permaculture farm I. – New Forest farm

The New Forest Farm (Fig. 3) is located in the USA, Wisconsin, and it covers an area of 43 ha. It was founded by Mark and Jen Shepard in 1994. It is considered to be one of the most ambitious projects of this scale in the USA. It is a perennial farm producing food, fuel and medicines. The form of farm should represent agricultural savannah consisting of trees, bushes, vines, perennial plants and fungi (HORVATH, 2017). The annual average temperature is 8.8 °C and average precipitation is 876 mm per year for the state of Wisconsin (U.S. CLIMATE DATA, 2017)

The ecological model of farm follows oak savannah and successional brushland. The sources of energy are solar and wind power. The types of agriculture practice used are agroforestry systems, alley cropping and silvipasture. Main crops include chestnuts, hazelnuts and apples. The farm also produces walnuts, hickories, pine nuts, pears, cherry trees, asparagus and winter squash. Livestock is represented by cows, pigs, sheep, turkeys and chickens. Other activities of farm are tours, practical workshops and permaculture design courses. Mark Shepard's other businesses are perennial nursery, tree planting and nut processing services. The next source of income is providing consultations and design services (HORVATH, 2017).

The question of fuel is solved by growing the oil-crops which takes less than 3% of crop land of the farm. M. Shepard also practices reduced tillage and using the livestock for grazing of undesirable bush and grass (COULTER, 2017).

3.3.3 Case study of permaculture farm II. – Ridgedale farm

Ridgedale farm is a 10.6 ha property in Sweden. The farm includes systems such as agroforestry, keyline design, holistic management and CSA. As visible on the picture (Fig. 4) there are strips of fruit, berry and nut species among which the livestock is fed. It is designed in a way to minimise inputs in the future. The arable land is utilised by ATV machine which is able to cultivate, seed and pack most of the crops and the good efficient on fuel, it is towed by a quad bike (PERKINS, 2015).

The parts of the farm consist of no dig market garden which supplies farm and its visitors as well as CSA participants (Annex. 4). The income of the farm is based on product sell as well as courses and other educational programmes. Therefore they refuse any kind of a subsidy (PERKINS, 2014).

There are two streams on the farm, accompanied by riparian zones, where the bee hives are located. Also it is undertaken by occasional pasture, timber, nut and fruit harvesting. The keyline pattering and agroforestry was used for multifunction strips (Annex. 2, Annex. 3). There are 1,5 km long tree lines with a common fruit tree and bush species. Among those were planted nitrogen fixers (Sea Buckthorn). One part includes 12 m strips for livestock pastures among them. For the ground cover of tree lines, seed mixture of herbs is collected as a protection of soil, N fixing and accumulation of nutrients, as food for people and bees. The design also includes nuts and edible chestnuts, however, it is difficult to find the varieties for Sweden (PERKINS, 2014).

For the site it is important to keep the preferable climate conditions. It means that wind breaks were a crucial part of the design to protect the land against strong winds. According to permaculture principles, it is the best practice to set up windbreaks with some kind of added value as coppicing willow (PERKINS, 2014).

Fig. 3 Aerial photo of the New forest farm by Mark Shepard, Wisconsin. *There is keyline design system and agroforestry on the photo (*HORVATH, 2017)

Fig. 4 Aerial photo of Ridgedale farm, Sweden (PERKINS, 2015)

4. CHARACTERISTICS OF THE STUDY AREA

4.1 CHARACTERISTICS OF THE CZECH REPUBLIC

NATURAL CONDITIONS

The Czech Republic lies in a temperate deciduous forest biom (also called broadleaf forest biom). The climax stadium is composed of beech (*Fagus sylvatica*) and oak (*Quercus sp.*) mixed with coniferous species (e.g. pine, fir). It covers most of Europe except Scandinavia and Mediterranean area, East of North America and parts of Eastern Asia, on Southern hemisphere in Chile. The climate from oceanic to continental (influences the amount of rainfall and winter temperatures). The forest creates specific microclimate which differs from treeless area. Typical soils are kambisols and luvisols (ULBRICHOVÁ, 2015).

AGRICULTURE CONTEXT

The current state of Czech agriculture is influenced by a process called collectivisation. It was mainly political endeavour for establishing large agriculture cooperatives in the 1950's HRABA (2013). Such influence on Czech landscape was devastating to ecological stability. The clearing of rare ecosystems, homogenisation of landscape structure, disappearing of field roads and vegetation and insensitive water management caused increased soil depletion by water and wind erosion (SKLENIČKA, 2003).

Potential threat of water erosion occurs on 67% of agriculture land and the most threatened soils covers 35% of the area of the Czech Republic. It was counted that 21 million of tonnes per year of top soil is lost due to erosion. The wind erosion threatens 18% of agriculture land. The total area of the Czech Republic is 7 887 thousand of hectars from agriculture land covers 4 216 thousands of hectares (53, 6%). The arable land covers 38% of total country area. Another problem is acidification of soil where 17% of neutral soils changed into acidic in the last 25 years and 43% of soils

are threatened by acidification. The 49% of agriculture land is threatened by a soil compaction (BUDŇÁKOVÁ, 2015).

The solutions for models described above are included in projects as Land consolidation ensuring the appropriate ownership situation, plots accessibility and landscape features. Another tool for improving the state of landscape is Territorial system of ecological stability (TSES) that aims to create a network of biocorridors and biocentres

4.2 Characteristics of Permafarma Jagava

Description of area

The farm is located in region of Mladá Boleslav in a village Veselice in central Bohemia. The landscape is slightly hilly and the farm lies on average altitude in 360 m. above sea level. The prevailing landuse of surrounding landscape is agriculture land with some forested areas.

Geology, Geomorphology and Soils

According to map on GEOLOGY.CZ (2017), the prevailing bedrock is a calcareous mudstone and marlstone, occasionally with calcareous sandstone and in Eastern part of the farm there are loess overlays. The typical soil type is phaeozem (MAPY.GEOLOGY.CZ, 2017).

Geomorphological division is following (GEOPORTAL.GOV.CZ, 2017b):

- Geomorphological system: Hercynian
    - Geomorphological subsystem: Hercynian mountains
        - Geomorphological province: Bohemian massif
            - Geomorphological subprovince: Česká tabule

Climate

The average annual temperature in the area is 8,7 C° and annual precipitation is 579 mm (ČESKÝ HYDROMETEOROLOGICKÝ ÚSTAV, 2017).

Quitt's climatic regions presents warm region but the area lies very close to moderate warm region. Long summer with 40–50 summer days is typical for warm region, average temperature is 15–16 °C. The winters are normally long and with 50–60 frost days, average temperature -2 to -3 °C, the period of snow cover is short 50–60 days (GEOPORTAL.GOV.CZ, 2017).

According to the graph, the distribution of average month precipitation (Fig. 5) is concentrated during the vegetation period the same as average month temperature (Fig. 6).

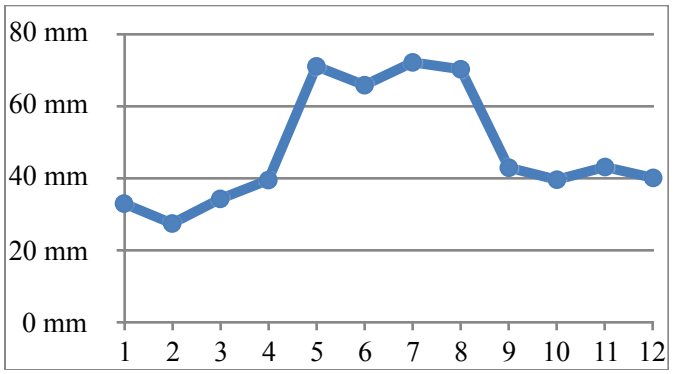

Fig. 5 The distribution of average month precipitation (meteorological station Semčice) *(ČESKÝ HYDROMETEOROLOGICKÝ ÚSTAV, 2017)*

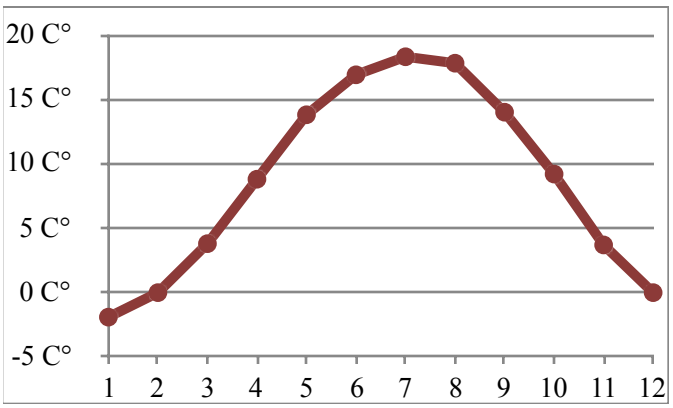

Fig. 6 Average month temperature (meteorological station Semčice) *(ČESKÝ HYDROMETEOROLOGICKÝ ÚSTAV, 2017)*

HYDROLOGY

The farm is located on the hill, there is a stream Hasinský nearby (Fig. 7). All the water on the farm comes from the rainfall. Very close to the farm boundaries there is a drill hole which serves as a water supply for a village Veselice.

Fig. 7 The drainage basin of the stream Hasinský (ČÚZK, 2010)

VEGETATION

Potential vegetation of this farm is an Oak forest with *Luzula luzuloides* and/or *Abies alba* (GEOPORTAL.GOV.CZ, 2017c). According to CHYTRÝ et al. (2010) the area lies in Dry acidophilous oak forest habitat type. There is neither biocentre nor biocorridor of TSES proposed for the farm location.

5. METHODOLOGY

The results consist of two parts, SWOT analysis (7.1) with its output (7.2) and a case study on permaculture farm (7.3) with suggestions for further development of the farm (7.3.2). The data for SWOT analysis are described in a chapter 6.2 PESTLE analysis.

5.1 SELECTION OF STUDY AREA

SWOT analysis summary was drafted on a base of PESTLE analysis in chapter 6.2 for the conditions of the whole Czech Republic. The farms for a chapter 6.1 Current situation of permaculture farming in the Czech republic were chosen with a help of Permakultura (CS) map of permaculture projects and also by author's own online search. Farms fulfil some of permaculture aspects defined in chapter 3.3 Permaculture farm. Due to difficulties to find a fully permaculture farm, the author also mapped permaculture features on biodynamic and other farms and homesteads. The focus area of farm elements description is the way to support the biodiversity and implement permaculture principles.

The case study was on the farm called Permafarma Jagava which lies in a village Veselice at Mladá Boleslav region. There is an abundance of permaculture principles applied thus they can be described for this thesis and also the farm is still in a developing process so in conclusion of the case study, there are suggestions for further development of the farm. The advantage is also a location of the farm and its relatively short distance to Prague. The main study focus of the thesis research is on permaculture elements, especially the agroecology point of view.

5.2 DATA COLLECTION

Common data were received from books (libraries) and scientific papers found on scholar.google.com and mainly used in literature review. For analytical part, various

data from statistics, map servers and personal communication were used. The sources of data were chosen on the basis to fulfil aims of thesis.

5.2.1 STATISTICAL DATA

Analysis of permaculture farming potential in the Czech Republic and especially its part Current situation of permaculture farming in the Czech Republic is based on statistical data from Czech Statistical Office (Český statistický úřad). Statistical Yearbook 2016 (Statistická ročenka 2016) includes information about current situation of Czech agriculture.

The data for import/export of selected fruit was taken from the database of international trade (ČESKÝ STATISTICKÝ ÚŘAD, 2017) and was searched under the codes 080810 for apples and 080231 for walnuts.

5.2.2 MAP SERVERS

For a description of case study characteristics, soil and geology information's source comes from servers as GEOLOGY.CZ (2017) for bedrock type, MAPY.GEOLOGY.CZ, (2017) for soil type, GEOPORTAL.GOV.CZ, (2017a) for climatic regions, GEOPORTAL.GOV.CZ, (2017b) for geomorphology (GEOPORTAL.GOV.CZ, 2017c) for a potential vegetation. The chapter 6.1 Current situation of permaculture farming is based on a map from Permakultura (CS) organisation.

5.2.3 SOFTWARE

Map software QGIS 2.18.2 is used for elaboration of graphical outputs for a use of this thesis. Tools used are WMS connection for creating maps (orthophoto, cadastral maps and ZABAGED) and editor for polygons, points and lines. The final adjustments of maps are made in Adobe photoshop CS6.

5.2.4 INTERVIEWS

Personal communication is undertaken by semi-structural interviews. After permission of respondents, most of the interviews were recorded on dictaphone Sigma DVR 100.

The list of visited farms and consultations:

26/10/2016 Mgr. Tomáš Franěk, Permafarma Jagava

31/1/2017 Mgr. Vojtěch Klusák, Ph.D., BEMAGRO a.s

Ing. Hana Kýbusová, BEMAGRO a.s

6/3/2017 Ing. Anežka Horynová, PlevelDesign

30/3/2017 Mgr. Tomáš Franěk, Permafarma Jagava

9/4/2017 Aleš Heuler, farm Uchované semínko

13/4/2017 Ing. Radim Kotrba, Ph.D., Miskovice (Agroforestry system course)

5.3 PROCESSING DATA

PESTLE is an acronym for political, economical, socio-cultural, technical, legislative, environmental factors. PESTLE analysis helps to identify opportunities and threats in broader context as well as changes of aspects we cannot influence (MINDTOOLS, 2017b).

Obtained information is divided into topics and described in order to be able to create evaluation by SWOT analysis. Fig. 8 shows part of SWOT analysis. SWOT matrix is sometimes called internal/external strategy as strengths and weaknesses refer to internal factors, opportunities and threats to external factors (MINDTOOLS, 2017a). Both analyses were originally developed and used for businesses and economy sphere, nowadays are used in various fields of study.

Strengths	**Weaknesses**
+ internal	– internal
Opportunities	**Threats**
+ external	– external

Fig. 8 SWOT matrix

6. CURRENT STATE OF THE PROBLEM

6.1 CURRENT SITUATION OF PERMACULTURE FARMING IN THE CZ

FARMS WITH PERMACULTURE ASPECTS IN THE CZECH REPUBLIC

There is no fully permaculture farm in the Czech Republic as per the definition of permaculture farm in Chapter 3.3. In a current economical situation it is impossible to hire people for field work as it is much cheaper to use fossil fuels. It can be showed on example of energy slave (147 energy slaves working 24/7 for the need of one person) where human labor power is compared with electricity use (BARKER, 2016). It is a reason why there is no commercial farm which would not use machinery for production of cereals. It is just not financially bearable.

However, it is possible to describe permaculture principles and aspects in Czech landscape. There is a map of permaculture projects on website of Permakultura (CS). Currently (February 2017) there are 35 projects divided into two categories: permaculture sample projects and projects with permaculture aspects. Projects as gardens, homesteads, communities and school gardens are the most occurring on the map. The table (Fig. 9) includes an overview of 8 farms with permaculture aspects found in the Czech republic (Annex. 11). Most of the farms are typical for vegetable and livestock produce.

Another form of farm is a seed farm by Marek Kvapil where he produces mostly vegetables of non hybrid varieties and sells them in an online store. The advantage of such seeds is that a gardener can collect seeds from plant and sow them next year in contrast with commercial seeds which can be resown only with a poor result. The association GENGEL provides similar offers, they also save heirloom varieties of various crop plant and trees.

Farm	Size (ha)	Farm produce	Others
Blahoňov	2	vegetables, fruit	CSA, water reservoirs
Uchované semínko	40	livestock, arable land, orchards, vegetables, fish, eggs	WWOOF (World Wide Opportunities on Organic Farms), community
biostatek Valeč	4	heirloom varieties, livestock	wwoof, education, heirloom orchards
Pístina farm	4	pigs, meadows, edible forest	polycultures, edible forest
Ranč Srbsko	14	livestock, vegetables	agroturism, edible forest, raised veg. beds, zones
Seed farm by M.Kvapil	N/A	vegetables, fruit, flowers	seed sell
Permafarma Jagava	45	vegetables, fruits	CSA, swales
Hobby farm	N/A	livestock, orchards, vegetable	interactions of compounds, compost

Fig. 9 Overview of permaculture farms in the Czech republic

PERMACULTURE ELEMENTS ON CZECH FARMS

Following text includes examples of permaculture aspects found on farms in the Czech Republic. The research focused on permaculture elements which support the biodiversity such as:

- FISHPONDS
- SOIL TILLAGE
- AGROFORESTRY
- EDIBLE FOREST

- FISHPONDS

The traditional way of aquaculture began in the medieval times, especially in southern Bohemia, where establishment of a large system of fishponds was created on a place of former wetlands. This attitude corresponds with permaculture principles of usage wet areas to create production systems with a high rate of biodiversity

- SOIL TILLAGE

Techniques for increasing the soil fertility are known in the Czech Republic. Bemagro farm uses so-called dammkultur developed by Julian Turiel (Annex. 7, Annex. 8). It provides loosen -up for the soil while creating furrows which brings several advantages. E.g. using the slope microclimate of furrows, better capillarity in inner part of furrow securing moisture and optimal aeration. It requires a special plow technology. At Bemagro farm, they appreciate a perfect rate of seed germination sown on furrows, good for beets and potatoes. Cycles of nutrients are closed, the plant and livestock production is connected.

- AGROFORESTRY

Agroforestry has a long tradition in the Czech Republic in the home gardens. Not as much in large scale agriculture anymore. The good example of silvipastoral practice is a private farm of Radim Kotrba in Miskovice (Annex. 13). It is a 1 ha cherry tree orchard with pasturing of sheep, deers and lama guanako. The pasture of livestock was established in 2007 in existing orchard. The advantages of this system is a utilisation of the space, good nutritions from leaves for animals, good microclimate, increased rate of invertebrates (biodiversity). The summer cut of branches serves for deers to feed on the leaves, for humans to pick some cherries and the woody parts for fuel. It is also important to mention that the shade the trees provide is a suitable microclimate in summer for a welfare of livestock. The lama is also able to feed on weed which other animals do not eat.

- EDIBLE FOREST

At farm Uchované semínko in Mšecké Žehrovice, there is a 20-years-old edible forest (Annex. 12). The farmer intuitively planted trees and bushes all together on a degraded slope with no humus layer and south oriented slope which was exposed to extreme summer temperatures. The specie composition is very diverse consisting of: sea buckthorn (*Hippophae rhamnoides*), peach trees (*Prunus persica*), *Pyracantha sp.*, Cornelian cherry (*Cornus mas*), *Sorbus domestica*, apples (*Malus*), pears (*Pyrus*), hazel nut bushes (*Corylus sp.*) and others. The system provides shelter to many organisms. Some of the trees are planted from seeds and adapted to local harsh conditions.

6.2 PESTLE ANALYSIS

PESTLE analysis summarises concrete factors which influence permaculture farming in the Czech Republic. Those are political, economical, socio-cultural, technical, legislative and environmental (incl. ecological). The factors influencing the farm and its establishment are very complex. General factors will be only shortly mentioned over more detailed description of factors which are specific for permaculture farm.

A. POLITICAL FACTORS

Among political factors belong policies and government support, etc. The action plan for Adaptation on climate change is a country's strategy to propose adaptation and mitigation measures towards climate change. The content of this action plan for the Czech Republic is also note for defining and checking the possibilities of implementation of agroforestry concept into conditions in the Czech Republic. Hereby it might ensure expanding the concept also into legislative materials as it is not fully supported (see bellow, chapter 5.1.2 PESTLE analyse, E. Legislative factors). This point of the action plan is identified as a secondary priority (MINISTERSTVO ŽIVOTNÍHO PROSTŘEDÍ, 2015).

Another potential of permaculture farming described in this document is to choose and prepare sample farms and incorporate them into demonstration farm system, which serves as education platform with aim to show soil protection methods (MINISTERSTVO ŽIVOTNÍHO PROSTŘEDÍ, 2015). This farm system could also add example of permaculture farm for better understanding of farming community whose representatives are sometimes not educated about alternatives. Also the diversity of farms and attitudes is important in this time of climate change. There lies opportunity to do research and share the experience on political level.

B. ECONOMICAL FACTORS

Positive economical situation is important for a further development of the farm and financial supportability of the farmers and their employees.

The researches claim that agroforestry methods, especially alley cropping which is increasingly popular in Europe, brings large ecological benefits and financial profitability in a long term. The authors of article see potential in learning from examples from abroad and also research activities of connecting agriculture with forestry (MARTINÍK et al., 2015). From foreign examples, the yield of AFS increases by 40%. However there are not subsidies for agroforestry in the Czech Republic (HAVEL, 2016).

For organic and permaculture farms it is most commonly favourable to orientate on target customer in an economical point of view (Hana Kýbusová, 1/2017, personal communication and Anežka Horynová, 3/2017, personal communication). CSA (Community Supported Agriculture) belongs among those ways. In the Czech Republic there is 23 initiatives of CSA from 2009 feeding approximately 1400 persons. They are located mainly around big cities (JANOVSKÁ, 2016).

Another non productive way to strengthen farm economy are agroturistic activities (Anežka Horynová, 3/2017, personal communication). There is a subsidy title for a rural development provided by the Ministry of Agriculture.

Permaculture authors such as Mark Shepard and Sepp Holzer run their permaculture farms as good examples of permaculture at larger scale. However, their

profit comes very often from workshops and book sells. It is why farms with permaculture aspects create added values as incorporation of the disabled into farm activities or establish a nursery of plants.

C. SOCIO-CULTURAL FACTORS

After collectivisation in the 1950's, most of the people lost their connection with the land. It was a start of industrial agriculture at large scale in the Czech Republic. The situation is slowly changing and more people get involved in farming, especially with a rise of alternative farming.

Demand for local and high quality farm produce increases in the Czech Republic. It can be seen at example of popularity of farmers' markets in Prague. However, the situation is different in the countryside where local people prefer cheap products from supermarket over local organic products from nearby farm (Hana Kýbusová, 1/2017, personal communication).

Aesthetic point of view of permaculture system is not a commonly discussed issue. Such as, it is complete contrast to industrial way of farming (big field blocks, mostly annuals, monotonous field and crop structure). Nevertheless the legacy of traditional agriculture practiced before collectivisation could be considered as aesthetic pattern for a new agriculture concept. At the Annex. 5 there is an example of orthophoto map and a former structure of Czech landscape which correlates with fig. 3 New Forest farm, where is depicted an image of permaculture farm. The Annex. 6 shows old landscape structure in a village of Šardice.

The important problem of alternative innovations is the perception of inhabitants. There are known examples of local people`s disagreement about a proposed vegetation belt planted between orchard and monoculture field (Petr Marada, personal communication, 21/9/2016).

D. TECHNICAL FACTORS

As mentioned above one of the serious obstacles to implement permaculture principles into practice is finding way for alternative energy and fuels in order to avoid fossil fuel use. There is a consensus within permaculture community to use fossil fuels for building new structures as swales, ponds and other earth work. However, regular dependency on them arises to be problematic in environmental terms. The alternatives as biogas seem promising, however, the biomass used for a process is usually grown in monocultures thus impacts the biodiversity and erosion. Permaculture in a narrow definition is able to minimise machinery and instead to use the appropriate design and methods which can substitute machines. Therefore, at large scale, it is still needed to use a machinery.

E. LEGISLATIVE FACTORS

Agroforestry as one of the solution of environmental issues is in the Czech Republic is not supported by law. The practical research of agroforestry practices is not possible according to the Czech law which doesn't support AFS on arable land (HAVEL, 2016). On pursuant Act No. 334/1992 Coll., on conservation of land resources, woody plantation can be grown on arable land only for 10 years, if it is plantation of coppicing trees, it can be used for 30 years but one growth period must last maximally for 10 years.

The size of permaculture farm is crucial for a good design and its functioning. The farms of permaculture authors are usually not bigger than 50 ha (e.g. New forest farm by Mark Shepard: 43 ha, Krameterhof by Sepp Holzer: 45 ha, Zaytuna farm by Goeff Lawton: 27 ha) which indicates manageability of such project.

However, the situation in the Czech Republic is different in terms of average size of agriculture subject. According to a research from 2010, the average size of subject is 14 ha in EU, the Czech Republic has 152 ha per subject (for comparison second and third were Great Britain with 90 ha and Slovakia with 77 ha). It means there are large farms with conventional way of farming. The trend is increasing, in period 2000–2010 it grew from 136 ha to 152 ha per subject. On the other side, only 15,4% of subjects fit to

size max. 5 ha, EU average is 69,2% (MÁCOVÁ, 2014). Farms not bigger than 5 ha can be suitable model for suburban farms, e.g close to Prague and producing food for markets, restaurant supply and CSA.

The solution could be the Soil Foundation (Nadace pro půdu) which is buying the land and rents it to ecological farmers. They are a part of Access to Land organisation. The aim of such organisations are to improve soil conditions, produce the organic food and mainly to make the land accessible for the ecological farmers.

Another restriction is a high rate of land rental by large farming companies. The ownership and usage of own land grew from 7,6% in 2000 to 22% in 2010. EU average gives 51,7% (MÁCOVÁ, 2014).

The cadastre describes land use units, according to regulation no. 357/2013 Coll., they are: arable land, hop field, vineyard, garden, orchard, grassland, forest, wetlands and waterbodies and other categories of built up areas. This can be a problem for the concept of agroforestry, where on one field there is a mixed culture of annual crop and trees, or livestock grazing among the trees. Until 19th century, the cadastral map included units as: field with fruit trees, meadow with fruit trees, meadows for wood harvest, paddocks with fruit trees and paddocks for wood harvest (Jana Krčmářová, personal communication, 31/3/2017).

F. ENVIRONMENTAL FACTORS

As mentioned in literature review, permaculture aims to create edible ecosystem which is inspired by nature. In conditions of central Europe, there is naturally occurring deciduous forest which can be used as mimic pattern in permaculture design. It indicates that suitable form of agriculture would be agroforestry. There are many problems in Czech landscape which argoforestry could treat, e.g. soil erosion. MARTINÍK et al. (2015) shows unused potential of such techniques. Riparian planting at the border of agriculture land, eliminating the nutrient wash out and erosion have advantage of big increment. Poplar and willow biomass forests can be also more used for pasture of livestock or bee keeping.

For permaculture selection of plants in a proposal is preferred the best growing species in a locality. In the Czech Republic there is a traditional species an apple tree but a lot of them are exported from abroad. In the Czech Republic in 2015, it was produced 155 361 tonnes of apples (ČESKÝ STATISTICKÝ ÚŘAD, 2016) and 85 065 tonnes imported from countries like Argentina, India, Chile, New Zealand, Turkey and other 16 European countries and 99 954 tonnes were exported (ČESKÝ STATISTICKÝ ÚŘAD, 2017). The numbers are influenced by the fact of trading and not all produced and imported apples were consumed in the Czech Republic, therefore there is a potential to grow local apples.

In 2015, it was harvested 181 tonnes of walnuts (ČESKÝ STATISTICKÝ ÚŘAD, 2016), 50 tonnes was imported from Brasil, Chile, Germany, France, Hungary, Italy, Moldavia, Slovakia, USA and Vietnam and 20 tonnes was exported to Austria, Germany, Italy and Slovenia (ČESKÝ STATISTICKÝ ÚŘAD, 2017). It means that there are big movements of goods which burden the atmosphere and other environmental issues arises arise as it is the same issue as with apples.

For increased production of permaculture systems are very often used the non-native species and there is a risk of invasive ones spreading into the surrounding. Especially in times of climate change with warm winters they are more likely to survive. Close to protected landscape where there are sensitive threatened species, it is important to respect the decision of nature conservation authority. E.g. for planting of green belt along the fence it was recommended not to plant following species: *Caragana arborescens*, *Colutea arborescens*, *Laburnum anagyroides*, *Eleagnus angustifolia*, *Cornus alba*, *Quercus rubra*, etc. because of nearby Protected landscape area Czech Karst where especially proposed species which fix the nitrogen, are easily spread and potentially threatening dry meadows and rock ecosystems (MUŠKOVÁ, 2012). The known invasive species such as *Robinia pseudoacacia* should be definitely avoided and new species should be examined and collect all possible information to evaluate the risk.

7. RESULTS

For needs of this thesis, following categories were set up: water, soil, vegetation, animals, spatial structure and people. This chapter aims to map examples of permaculture features within the Czech farms and evaluate conditions and potential for permaculture farming.

7.1 SWOT ANALYSIS

SWOT analysis (Fig. 10) of permaculture farming in the Czech Republic is based on described PESTLE analysis. It is a summarisation and evaluation of all factors. The chapter also brings suggestions to improve conditions for permaculture farming.

Threat is a potential uneasy social interaction with local people, especially in small villages. It is important to prevent the misunderstanding by informing the neighbours and others about the farmer's intentions. Potential invasive species must be watched and eliminated if needed.

The reduction of weaknesses of permaculture design process can be done by a selection of experienced designer and appropriate interest and education of the farmer. The cadastral categories might be a restriction to develop agroforestry systems, however, the existing system is still appropriate and there are some suggestions to change the laws on behalf of agroforestry from Czech agroforestry association.

Permaculture farming in the Czech Republic	
Strenghts	**Weaknesses**
• The Czech Republic has got suitable climate and a good soil fund. • National policies supporting the idea of agroforestry and soil conservation. • Increasing trend of healthy cuisine and local products • Working system of CSA	• The knowledge and information demanding design. • The need for long observation of the site, not a fast process of design and development of a farm. • Complicated situation of cadastral categories.
Opportunities	**Threats**
• Implement productive erosion control measures (e.g. alleys on arable land). • Demand for organic product and raising awareness of environmental issues. • For economical viability of a farm, to create diverse subject and added value aspects. • Agroforestry • To grow commercial crop which has suitable natural conditions in the Czech Republic.	• Potential of the invasive species spreading. • Old-fashioned views and misunderstandings of concept by stakeholders and locals.

Fig. 10 SWOT matrix of permaculture farming conditions in the Czech Republic

7.2 POTENTIAL FOR PERMACULTURE FARMING IN THE CZ

SWOT analysis summarised the conditions for permaculture farming in the Czech Republic. The following text describes the potential of permaculture farming in the Czech Republic based on previous analyses.

For a functioning permaculture farm, there is a need for equipment not needed on a typical annual farm. Due to economical situation of small farms, they can't afford buying machines. The system of large farms with a rental service could be established and farmers can come and use the equipment, e.g. hazel nut cracker.

Permaculture principles can be used for sustainable land management. There is a list of examples how to apply it:

- soil erosion control measures
    - swales with a production of fruit trees
    - alley cropping
- water retention
    - wetlands
    - fishponds
- increase of biodiversity
    - edible forests
    - ecotons (ecosystem edges)
    - successional phases

TYPOLOGY OF FARM MODELS

The typology of farm models (Fig. 11) describes four models of permaculture way of farming which can be applied individually or combined together at one farm.

Farm models	Types	Products	Characteristics
Agroforestry farm	Silvipastoral	Meat, milk, fruit, nuts, eggs, wood	Tree rows, tree grid (orchard), livestock
	Agrosilviculture	Vegetables, cereals, wood, fruit	Alley cropping
Cereal farm	Experimental	Cereals	Polyculture, no tillage, clover
Orchard farm	Multi layered orchard	Fruit, nuts, herbs	Tree rows with bushes, herbs
Suburban farm	Market garden	Vegetables	Annual plant polyculture

Fig. 11 Typology of farm models – potential for the Czech Republic

• AGROFORESTRY FARM

Agroforestry farm can be both silvipastoral and agrosilvicultural system. The example of silvipastoral system is a hazelnut orchard combined with chicken pasture among the bushes. The chickens fertilise the ground and eat the pest insects affecting the hazelnut kernels. Agrosilviculture is for example the system of growing vegetables with tree alley.

• CEREAL FARM

The model of cereal farm serves especially for experimental work with cereal polyculture. The output of research would be an evaluation of such growing systems in various natural conditions and a calculation of productivity and income. Fukuoka's methods of wheat or rye sowing into clover growth can be applied. Also, reduced or no tillage would be researched as well as usage of the best varieties of cereals, weed and pest control and humus content.

- ORCHARD FARM

The potential of permaculture farming lies especially in a perennial crop production as it meets the permaculture in its own definition. The orchards have a great potential to supply all year round national consumption, e.g. the apples. The trees can be used as a erosion control measure at slopes plus produce the fruit. It also meets all categories of ecosystem services and can be described as sustainable land management.

- SUBURBAN FARM

Suburban farms are small farms which supply the city with vegetables and common species of fruit. They are also known as market gardens and often use the principles of CSA. They should be located close to the cities and towns due to decreased use of fossil fuels and transport costs. The common problem is a price of land in short distance of cities. The solution could be the Soil Foundation (Nadace pro půdu) which is buying and obtaining the land and rents it to ecological farmers. The principles of permaculture can be implemented by usage of polycultures, swales, zone design, stormwater management and usage of synergistic character of certain species.

METHODOLOGY FOR PERMACULTURE FARM ESTABLISHMENT

There are some specifics for design of a permaculture farm in comparison with a conventional farm. The main difference is that conventional industrial agriculture does not respect the local conditions in most cases. For example, monoculture field where is a small relief depression with accumulation of water, the farmers till all the area. But in permaculture there is an approach to use the wet spot for a wetland or even a fishpond with appropriate plants and perhaps with some economical profit production.

Permaculture prefers perennial plant systems but they require time to reach the fruiting stadium. That's why income should be secured in another way in first years. But even during the time when trees and shrubs already provide yield, appropriate attitude is not to rely on one source of income. It is Mollison's principle, all important functions are covered by several elements.

The system should be designed in aim to create self-regulating ecosystem which produce enough food for people and shelters for wildlife. It should also be stable enough to deal with pests and the soil fertility regenerated after conventional agriculture practices.

Analytical part (Fig. 12), design part (Fig. 13) and establishment and management of the system (Fig. 14) emphasise specifics of permaculture farm development.

Analytical part	
Research for information	Natural conditions
	Cadastral map
	Spatial plan intentions
	TSES
Observations	Rain, snow, sun, wind
	Soil test
Sector diagram	Wind direction, sunshine, floods
Identify the pattern	Ecosystems
Identify species for the area	Ecotypes, local varieties, experiment
Identify the vision for the farm	Goals to achieve it
Time management	Development phases
Business plan	Costs, income, taxes

Fig. 12 Methodology for permaculture farm establishment - Analytical part

Design part	
Identify zones	0. – 5.
Identification of site specifics for design	Wet, dry, fertile, non fertile, erosion, …
Spatial interrelations among elements	Synergism, antagonism
Propose right location for picked species	Wetland, rocks,

Fig. 13 Methodology for permaculture farm establishment - Design part

Establishment and management of the system	
Terrain modeling	Ponds, reservoirs, swales, roads
Planting	Vegetables, trees, bushes
Observation of the system	Smallest interventions
Harvest	

Fig. 14 Methodology for permaculture farm establishment - Establishment and management of the system

7.3 Case study – Permafarma Jagava

The farm Jagava is run by Tomáš Franěk. He owns 30 ha of forests and 50 ha of various plots, however, some of his plots are managed by an agriculture company. The subject of this thesis is about 45 ha which the farmer manages. The farm started in 2012 and was registered into companies register in 2013.

7.3.1 Farm elements

This chapter describes elements of the farm and is especially focused on permaculture principles and ways to increase biodiversity. Although permaculture is about holistic approach so all aspects which, influence farm functioning, are mentioned.

WATER

On the farm, there are several swales helping the water to infiltrate. The long furrows are also in a vegetable part of the field. In Annex. 23 there is visible polder retaining the water. The aim is to keep as much water as possible, however, in a recent few years, the rainfall did not fill even the existing ponds. That is important to have a capacity to catch the water in case of extreme weather events.

SOIL

On arable land there is a management of reduced tillage which minimises a compaction of the soil and organic mater is added by planting the green manure as buckwheat and mustard (Annex. 24). The farmer emphasises the organic matter input and improvement of the soil state. The wheat is grown for straw and sold to farmers as a fodder for cattle. After a change to regenerative soil management, the earthworms appeared in the soil.

One part of the vegetable field was used as an experimental piece of land and there was introduced charcoal into the soil. The comparison of plant growth will be made in the future.

VEGETATION

The vegetation produce is very diverse and composed both from perennial and annual plants. The vegetables (4–5 ha) are grown in long strips (Annex. 19, Annex. 20) among which trees (*Ginko biloba*, *Castanea sativa*) and bushes (currants, buckthorns, roses (Annex. 18) are planted. The composition of species is very diverse. The trees help to regulate microclimate in hot summers, hold water and stop the potential soil particle movement. It also fulfils the function of production of fruits. The farm produces basic types of vegetables: tomato, cabbage, kohlrabi, potato, cucumber, pumpkins, zucchini and herbs (Annex. 21).

The dominant features of the farm are orchards (Annex. 22), where apples, pears, chestnuts, walnuts, hazelnuts, Schizandra and other fruits are grown. The grassland,

covering the area of orchards, composts of mixture (Annex. 16) ensuring the plant diversity and ground cover. In the Annex. 17, there is an example of apple trees, most of them are heirloom varieties. One greenhouse is in use and two more are planned for growing winter vegetables. The breeding of raspberries field patch is also part of the plant production.

ANIMALS

The farm is mostly plant based but there are two pieces of Highland cattle. They serve for a manure provision for the provision to fertilise the soil.

SPATIAL STRUCTURE

On the map of the farm (Annex. 14) there are farm elements seen in their spatial relationships. The zone 0 is composed of buildings which are currently under reconstruction and will serve for storage and processing the fruits, as drying out, fermenting, juicing and packaging. One building is for lectures, seminars and workshops focusing on permaculture and ecological education. The zone 1 is a vegetable garden in intensive management.

Along the whole property is a constructed fence accompanied by *Rosa canina* and *Rosa rugosa*, which serves as a protection against deers and also it is a favourite habitat for wildlife providing them berries as food. The zone 5 is the forest, at the moment it is a neglected piece of land.

The compost heap is located close to livestock and a manure can be manipulated easily for the vegetable production by a tractor.

PEOPLE

As mentioned above, the farm will serve as an educational centre and it is planned to create a trail with descriptions going through the whole farm.

The part of the farm is also a grove composed from of 12 oak trees (*Quercus sp.*) planted into a circle with an alley from linden trees (*Tilia cordata*). During the season

20 boxes a week transported to Prague for CSA needs. Background of the farm also consists of workshops as one for carpentry and black smithery.

7.3.2 SUGGESTIONS FOR A FURTHER DEVELOPMENT OF THE FARM

From a point of view of the land management there is a visible improvement of landscape elements in comparison with the original state (arable land). The addiction of the trees as orchards, tree alleys, grasslands and swale increased and differentiated the biological diversity. There are several suggestions and ideas the farm could aim at as it is still in its development phase.

The important issue for any productive system is a nutrient cycling. By harvesting there is a removal of nutrients which must be added into the soil. The ideal state would be getting the food scraps back from CSA participants but it is practically impossible to transport them back to the farm. The eaters should handle their waste on the local scale and use the compost for urban projects in Prague. As much of the organic material as possible should be composed and put back to the soil to ensure the fertility of land at the farm.

The farm is at the first stage of development and will serve as an educational centre. For that it is needed to diversify the plantings. It would be appropriate to create an “edible forest” as an example for utilisation of the space in vertical direction. The “short version of edible forest” could be placed in a yard of the farm. It can be composed of a few trees, bushes and herbs. The design of it could prove that even highly productive and yielding systems can serve for representative space and have aesthetic value. The proposed examples of plant selection are *Amelanchier sp., Aronia sp., Morus alba* and large fruiting *Crataegus.*

In the woody areas it is possible to grow the mushrooms to diversify the farm production. As well as the willow twigs for creative work as weaving baskets is.

The farm focuses on perennial crop, especially fruit trees. For a newly established orchard, there can be designed also the shrub and herb layer. The proposed

strips of woody vegetation would consist of nitrogen fixing bushes (*Eleagnus angustifolia*) and herbs (*Trifolium pratense)*.

In an original permaculture design plan (Annex. 15) there are proposed many swales and ponds. The question is if there would be their appropriate usage in the future in terms of not enough rainfall to fill it in. Perhaps some of them could be used as a polder for cases of extreme rainfall to catch as much water as possible to prevent floods and ensure slow infiltration.

8. DISCUSSION

Permaculture in the Czech Republic is perceived as an alternative direction and usually is not recognised as a scientific discipline even though the concept of permaculture was defined at university environment by MOLLISON (2016) and HOLMGREN (2011) in Australia. At Mendel University in Brno, there is a subject Permaculture techniques taught by Helena Vlašínová. The Czech University of Life Sciences in Prague offers a subject called Alternative agriculture. The interest among students is expressed by a number of bachelor and master theses from different universities found online. The academic research on permaculture farming practices would classify and evaluate the findings in order to disseminate good examples. The part of the research would be also economic viability of the farm enterprise. Abroad, permaculture is a subject of research papers at universities (e.g. Permaculture and Indigenous Knowledge, at Sussex university by Alex Aisher, anthropologist and Peter Cow, permaculture teacher). There was no finding of a scientific paper with permaculture theme written in Czech environment.

The description of a current situation of permaculture farming in the Czech Republic (chapter 6.1) is created with a map of permaculture projects and by the author's research. It demonstrates the permaculture farming projects within the country. However the identification of all the projects was complicated due to impossibility to search for all of them online. The list is qualitative and shows the types of permaculture larger scale projects in the Czech Republic.

The research should be also done for possibilities to grow cereals in a permaculture way. There are examples of pure natural way of farming by FUKUOKA (1985) who produced e.g. fruit and cereals crop and had enough to sell to the shops in city. Ongoing research in the Czech Republic for no tillage farming was made in Research Institute for Fodder Crops, Ltd. Troubsko where the research on variants of reduced tillage was held and the output claims that it is possible to grow barley with reduced tillage methods but the grower must respect site specific conditions. Marc Bonfils examined Fukuoka's method on European conditions and Ivan Lobík followed

this practice in Slovakia (VLAŠÍNOVÁ et al., 2014). Even though this researches have been made it is still needed to create the new study for larger scale polyculture cereal methods in conditions of the Czech Republic.

Agroforestry offers solution for erosion control and at the same time ensures a production function. The reason for a hard enforcement of agroforestry concept in the Czech Republic is due to existing legislation but also by interruption of traditional agriculture. In the Czech Republic, until the 19th century, the cadastral map included units such as: field with fruit trees, meadow with fruit trees, meadows for wood harvest, paddocks with fruit trees and paddocks for wood harvest (Jana Krčmářová, personal communication, 31/3/2017) which indicates usage of agroforestry practices. MARY et al. (1999) claims that French farmers who inherited land with agroforestry systems are more likely to plant new trees for profit of the next generation.

The third identified potential is the suburban farm (market garden) which is a new trend of sustainability. There are many examples from the USA of such farms, for example 30 years old functioning The Three sister farm in Pennsylvania (2 ha) which has been functioning for 30 years and uses a bioshelter (type of greenhouse) (FRAY, 2011). The example from Europe could be showed on a 6 hectars farm Bec Hellouin in Northern France. The permaculture aims to minimise the dependency on fossil fuels but there are concerns if the farming system would be viable in economic terms. There is a study made on viability of this permaculture farm operating without motorisation for a size of 1, 061 m^2. Monthly net income was 898 € to 1,571 €, the difference depends on gross sales and investments. The labour ensured one market gardener with 43 h work per week, but the emphasis was on short cycle vegetable (e.g. lettuce) and no long cycle crop as potatoes are (MOREL et al., 2016). It means that some profitability is possible however a further research should be done.

Orchard farm model is applied by Stefan Sobkowiak on 2 hectares plot in Canada. The orchard has a pattern of alternating tree species, where is planted nitrogen fixing trees and smaller shrubs among the main trees (HORVATH, 2015). According to

climatic conditions in Canada, it is possible to implement this design in the Czech Republic.

The case study brings an example of farm with permaculture aspects applied in the Czech conditions. The New forest farm and Ridgedale farms are examples (chapters 3.3.2 and 3.3.3) of functioning permaculture farms. However one aspect of the farm Jagava is that there is not renewable resources used neither for buildings nor for tractor fuel although it is one of the permaculture principles defined by HOLMGREN (2002).

9. CONCLUSION

The main aim of this thesis is to answer the question where lies the potential and what are the conditions of permaculture farming in the Czech Republic. The thesis fulfils all the aims stated and comes with proposals of possible solutions. Czech landscape abounds with several problems as soil erosion and complete soil depletion, the water supply extremes and a loss of biodiversity. Permaculture as such can those problems help to solve, however, there are some constraints in existing system to implement its principles in a scale it is needed (legislative, economical).

Permaculture is becoming popular in the Czech Republic and it is applied especially on a scale of home gardens. Originally permaculture was meant for self-sufficiency of families with households. However the need to feed people in cities with no access to land, and sustain the functioning landscape, the question of applicability of permaculture at larger scale arises.

The value of the thesis is that it summarises the conditions for permaculture farming and provides a base for further research. It can be used as an inspiration for the new farmers to find the right intention. There is a list of permaculture specifics during the analytic, design and establishment phases of farm development.

In politics, especially related to climate change, there are policies counting with agroforestry. Currently permaculture is a marginal movement in agriculture and suggested farm models should be slowly introduced into practice. Those aspects could be swales with trees on steep slopes and erosion risk areas. The suburban farms producing vegetables and some fruit might be a whole new concept in the Czech Republic. They would provide a chemical free crop and supply the cities with a healthy local food. The legislation changes would be useful for a new land use unit which would encourage the farmers apply agroforestry systems on arable land. For farm to be financially viable, it is needed to make products with added value, selling the raw products is not economically advantageous.

The case study describing farm Jagava serves as an example of permaculture approach at larger scale in conditions of the Czech Republic. The elements as swales and

alley cropping work on permaculture principles and are a good example how to manage the water and diversify the plant production.

The thesis elaboration opened more questions which could be answered by a further research. Especially in the field of practical methods and system productivity. How much biodiversity we need to create a stable system? What is a yield of permaculture orchard and edible forest, can it be used commercially in the Czech Republic? What agroforestry typology is desirable to apply in the Czech conditions?

During my research I determined the phenomena of people doing permaculture on their own and intuitively creating edible systems. The famous examples would be Masanobu Fukuoka and Sepp Holzer who established their farms not knowing that those principles were described by Bill Mollison and David Holmgren. The permaculture concept is a great source of inspiration and techniques, however, its implementation should be used with a common sense and respect to Nature and people and the concept itself should not become a constraint for new good ideas or rediscovery old traditional farming methods.

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