

**CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE**

FACULTY OF ECONOMICS AND MANAGEMENT

DEPARTMENT OF ECONOMICS



**Economic analysis of potato production in the CR**

DIPLOMA THESIS

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**CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE**

Department of Economics  
Faculty of Economics and Management

# **DIPLOMA THESIS ASSIGNMENT**

Pokorný Pavel

Economics and Management

Thesis title

**Economic analysis of potato production in the CR**

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## **Objectives of thesis**

Examine the development of the Czech potato industry  
Identify the current situation in the Czech potato industry  
Measure the growing costs of potatoes under different conditions on the basis of the field study in company Družstvo Bramko CZ  
Compare the growing costs of potatoes with other products of Czech agriculture  
Estimate the production function for potatoes

## **Methodology**

Analysis  
Synthesis  
Methods of text study  
Induction  
Deduction  
Analysis of documents  
Regression analysis  
Qualitative analysis of time series

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potatoes, costs analysis, Czech Republic, Družstvo Bramko CZ, subsidies

**Recommended information sources**

The Common Agricultural Policy after 2013 - Environment, Food and Rural Affairs Committee. (15. 4 2011). Retrieved 11. 11 2011, from Parliament UK: <http://www.publications.parliament.uk/pa/cm201011/cmselect/cmenvfru/671/67104.htm#n16>

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Prague March 7. 2012

**DECLARATION:**

I declare I have worked on the diploma “Economic analysis of potato production in the CR” thesis on my own with using the referenced literature and other resources.

Prague, 25<sup>th</sup> March 2012

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# **Ekonomická analýza pěstování brambor v ČR**

## **Economic analysis of potato production in the CR**

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### **SOUHRN**

Tato diplomová práce se zabývá tématem ekonomiky pěstování brambor v České republice. Na tuto problematiku je nahlíženo jak z obecného úhlu pohledu, tak z pohledu praxe. Tato diplomová práce zkoumá příčiny snižující se produkce brambor v České Republice. Analyzuje nejen historickou situaci, ale zahrnuje i velmi aktuální problémy ovlivňující trh brambor v České republice. Porovnává produkci brambor v České republice nejen se světovou produkcí ale i s produkcí pouze v rámci Evropské Unie. Tato diplomová práce varuje před možnými budoucími hrozbami pro konzumenty brambor v České republice a navrhuje adekvátní právní kroky.

### **KLÍČOVÁ SLOVA**

Brambory, Společná zemědělská politika, Česká republika, Družstvo Bramko CZ, Integrovaná produkce brambor, analýza nákladů

### **SUMMARY**

The subject matter of this diploma thesis is the issue of economics of growing potatoes in the Czech Republic. This issue is described and approached not only from the theoretical point of view but it is mostly focused the findings of practical experimental research. This diploma thesis researches the reasons for the decreasing production of potatoes in the Czech Republic. Analyses not only the historical situation but includes also most up to date issues influencing potato production in the Czech Republic. The production of potatoes is compared not only with the World production but also with the production of potatoes in Europe. This diploma thesis warns against possible future threads for customers and states recommendations of suitable legal actions.

### **KEY WORDS**

Potatoes, Common Agriculture Policy, Czech Republic, Družstvo Bramko CZ, Integrated production of potatoes, cost analysis

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# Introduction

Agriculture is one of the oldest human activities. Agriculture is the process of intentional growing of crops and breeding of animals in order to serve human needs. Agriculture can be understood just as a process of production of foodstuffs. Agriculture is not only the activity that produces food for human nutrition. It provides renewable energy resources and absorbs negative externalities of industrial production. Agriculture shapes the countryside, maintains biodiversity on Earth and generally an essential role in our lives. Although the human nutrition is strongly dependent on agricultural products the scale of agriculture is in the Czech Republic continuously decreasing.<sup>1 2</sup>

Even though potatoes are world's number one<sup>3</sup> non-grain food commodity the agricultural production in the Czech Republic in the last 20 years significantly decreased. *The potato produces more nutritious food more quickly, on less land, and in harsher climates than any other major crop - up to 85 percent of the plant is edible human food, compared to around 50% in cereals.*<sup>4</sup> Potatoes are a cheap ingredient with many possibilities of usage. Potatoes are rich on many vitamins – especially vitamin C, minerals and contain also very important fibre.<sup>5</sup> Potatoes are not used only in the gastronomy, but also in pharmaceuticals, health care, and other industries.

I have chosen the Economic analysis of potato production in the Czech Republic as a topic of my diploma thesis because of my deep personal interest in the researched issue. I have a personal stake in the potatoes production in the Czech Republic. Our family has deep roots in farming. The tradition of farming in our family dates back to the 18<sup>th</sup> century. From my early childhood potatoes were one of the most reoccurring conversation topics in our family. From the writing of this diploma thesis I expected to provide me further information that I did not know and that I will later share with the readers of this diploma thesis.

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<sup>1</sup> Various Eurostat databases

<sup>2</sup> (Anderton, 1997)

<sup>3</sup> (FAO, 2008)

<sup>4</sup> (FAO, 2008)

<sup>5</sup> (Černá, 1997)

This diploma thesis provides the general background to the potato production in the Czech Republic with a relation to the production of potatoes within the global perspective and also to production of potatoes in Eurocentric point of view. The historical influences of potato production are researched and their present implications are analysed. On the basis of the production development examination and production functions construction, the reasons of decreasing production of potatoes in the Czech Republic are revealed.

The diploma thesis decides whether production of potatoes in the Czech Republic under current economic, political and social conditions is further sustainable for the future practice or not. The warning concerning the possible negative development on the Czech potato market is presented. The recommendations of suitable legal actions for the future are stated.

# Aim

The main aim of this diploma thesis is to give a simplified analysis the Czech potato market in the context of the international competition within the European Union.

Firstly, the long term development of Czech potato primary industry will be examined. There will be used historical time series and there will be observed if there are any implications and influences of the history on the present situation. There will be researched if these historical influences may continue also in the future. Their possible effect will be estimated.

Secondly, there will be analysed current situation on the potato market within the Czech Republic. There will be analysed current trends in the production and the influence of foreign trade. The main trade partners of the Czech Republic in terms of import and export will be identified. There will be also analysed the influence of accession of the Czech Republic into the European Union.

Thirdly, the growing costs of potatoes will be determined. There will be performed an experimental measurement of the growing costs of potatoes under different conditions based on the experimental field study of the potato growing companies united in Družstvo Bramko CZ. These costs will be compared with growing costs of selected vegetables and wheat, which will be determined also on the basis of experimental measurement in the growing companies of Družstvo Bramko CZ.

Finally, there will be estimated production functions for potatoes. The major factors that influence yield will be determined. The production functions will be estimated for very early potatoes, early potatoes and late potatoes. The production functions of potatoes will be compared with the production functions of selected vegetables and wheat which will be also estimated on the basis of the experimental measurement.

# Methodology

Without systematic approach to the topic I would be never reach the aims of this diploma thesis. Mainly, I followed a saying of Franklin D. Roosevelt: *"Take a method and try it. If it fails, admit it frankly, and try another. But by all means, try something."*<sup>6</sup>

Firstly, there will be made a literature review where will be analysed what was already written in Czech and also international literature about analysed topic. Findings and attitudes of other researchers which had already tried to approach this problem of potato industry will be presented. On the basis of new knowledge gained from Czech and international literature will be chosen and used particular methods that will lead to successful achievement of the aims of this bachelor thesis.

Method is: *"Established, habitual, logical, or prescribed practice or systematic process of achieving certain ends with accuracy and efficiency, usually in an ordered sequence of fixed steps."*<sup>7</sup> And methodology is: *"a system of methods used in a particular area of study or activity"*<sup>8</sup> In the case of this diploma thesis the individual methods will create the whole methodology that will serve to the achievement of the aim of diploma thesis. There are going to be used two types of possible research methods: qualitative methods and quantitative methods as well. Qualitative methods will be used in the first part of the research, but quantitative methods will replace it in the second part. Methods used in this diploma thesis are:

## Method of analysis and synthesis

The origin of these two methods is in the ancient (classical) Greek. The original meaning of these two methods in the ancient Greek was: "to loosen up" for analysis and "to put together" for synthesis. These two methods are the very basic methods of text exploring. The procedure by which is broken down an intellectual or substantial whole into parts or components is known as analysis. Synthesis is defined as the opposite

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<sup>6</sup> (Method Quotes)

<sup>7</sup> (businessdictionary.com)

<sup>8</sup> (Oxford Dictionaries)

procedure: *to combine separate elements or components in order to form a coherent whole.*<sup>9</sup> These two methods are usually used together. Each synthesis usually foregone by analysis and each synthesis is usually connected with analysis.

These methods are going to be used in this diploma thesis mainly in the literature review. Competitive background of Czech potato market and of European agriculture is going to be analysed and then synthesis will be used in order to get significant conclusions.

### **Method of abstraction and concretization**

These two methods are also members of the very basic methods of the text handling. They are also called pair methods as analysis and synthesis because they occur in the academic texts very often together. In the abstraction method there are some details are intentionally omitted in order to make data more general. This provides better overall general insight into a researched problem. Then comparative methods are very often used in order to compare such generalized data. These methods will be used in this diploma thesis also when comparing import and exports of potatoes in the Czech Republic. Furthermore these methods will be used when comparing individual cost groups in the production of potatoes. There will be compared just groups of costs and not the individual costs. Some details will be omitted in order to make data comparable.<sup>10</sup>

The opposite method of abstraction is concretization. It is used when there is an amount of data and we are trying to identify and justify the differences between particular pieces of data. This method will be used in this diploma thesis mainly for the purposes of identification of differences between the costs of production between several crops e.g. early potatoes, late potatoes and vegetables.<sup>11</sup>

### **Comparative analysis**

Comparative analysis deals with confrontation of data. Comparative analysis is used to determine and quantify relationships between two or more variables by observing different groups that either by choice or circumstance are exposed to different

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<sup>9</sup> (Ritchey, 1996)

<sup>10</sup> (Stepanov)

<sup>11</sup> (Hindriks)

treatments. This method will be used in the last section of this thesis where will be compared the production functions of several crops and where will be also compared the production costs of individual European countries. <sup>12</sup>

### **Descriptive analysis of time series data**

A time series is a collection of observations of well-defined data items obtained through repeated measurements over time. Time series analysis deals with analysing this kind of data. It tries to identify and interpret some regular and irregular behaviour of data. This method will be used also in practical part of my diploma thesis when the analysis of graphs from data, that will be gathered, will be done. <sup>13</sup>

### **Correlation analysis**

Correlation is: *A causal, complementary, parallel, or reciprocal relationship, especially a structural, functional, or qualitative correspondence between two comparable entities.*<sup>14</sup> Correlation analysis will be used in this diploma thesis mainly in order to gain the coefficient of correlation between the data gained by experimental measurement in the growing companies united in the Družstvo Bramko CZ. *Coefficient of correlation is a tool used to evaluate the similarity of two sets of measurements (i.e. two dependent variables) obtained on the same observations. The coefficient of correlation indicates how much information is shared by two variables, or in other words, how much these two variables have in common.*<sup>1516</sup>

### **Regression analysis**

*Regression analysis is a statistical tool for the investigation of relationships between variables. Usually, the investigator seeks to ascertain the causal effect of one variable upon another.*<sup>17</sup> This method will be used when the production functions will be constructed. On the basis of experimental field study will be gathered data in the growing companies united in Družstvo Bramko CZ. Then the economic model and econometric

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<sup>12</sup> (Walk, 1998)

<sup>13</sup> (Time Series Analysis: The Basics, 2005)

<sup>14</sup> (Definition of correlation)

<sup>15</sup> (Correlation)

<sup>16</sup> (Svatošová & Kába, 2010)

<sup>17</sup> (Sykes)



model will be constructed. The linear relationship among explanatory variables will be expected. The parameters of the production functions will be estimated by the use of ordinary least squares method (OLSM).<sup>18,19</sup>

## Literature review

### Brief history of potatoes in the World

Potatoes (*Solanum*) belong to the kingdom of Plantae (Plants), subkingdom Tracheobionta (Vascular plants), superdivision Spermatophyta (Seed plants), division Magnoliophyta (Flowering plants), Class Magnoliopsida (Dicotyledons), Subclass Asteridae, Order Solanales Solanaceae family and genus *Solanum*.<sup>20</sup> *Solanum is the largest genus in the Solanaceae Family with an estimated 1,400 species*<sup>21</sup> It is estimated that potatoes have been grown already for 8000 years. Home of potatoes is said to be South America. Potatoes were grown by Inks in two climatic regions. They grew them in the highlands of Peru and Bolivia where were present distinct differences of day and night temperatures. In this region were born long red skin tubers known as *Solanum andigenum*. With the movement of the tribe of Inks were potatoes brought to the coast of Chile where is said to be the origin of the round yellow skin tubers *Solanum tuberosum*.<sup>22</sup>

Some researchers had declared that potatoes had brought to Europe from his journeys Christophe Colomb. Later on was found that he did not bring to Europe potatoes but sweet potaotes which do not have biologically very much in common with potatoes because sweet potatoes are fruits of moonflowers (*Ipomoea batatas*). Potatoes (*Solanum tuberosum*) are from the family Solanacea and are closely related with tomatoes, peppers or tobacco.

### Brief history of potatoes in Europe

First person who is known that has mentioned in Europe true potatoes is Pedro Cieza de Leon around 1553. He posted a printed paper about Peru where he mentioned red tuber that were called by the Inks papas. *Solanum tuberosum* were first brought to

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<sup>18</sup> (Tvrdoň, 2008)

<sup>19</sup> (Čechura, Malý, Hálová, Kroupová, Peterová, & Šobrová, 2011)

<sup>20</sup> (PLANTS Profile - *Solanum tuberosum*)

<sup>21</sup> (Bradley, 2009)

<sup>22</sup> (Surverying Czech Agriculture)

Europe by Francis Drake from England. He sent few tubers to his friend and recommended him to organize a degustation of them. Unfortunately cooks prepared just the upper leafy part of the plant. The taste of them was disgusting. The leaves of potatoes contain glykaloid solanin which is in larger doses poisonous. The consumers stated that the potatoes are in climatic conditions of Europe not able to mature.

Potatoes were spreading around Europe in 16<sup>th</sup> and 17<sup>th</sup> century as an herb or a precious plant. People did not know how to eat it and they did not found out that the eatable part of potatoes are the tubers. When the conquerors were in Latin America, they cared more about gold and not so much about the technology of planting, growing and storing of potatoes. <sup>23</sup>

First declared successful consummation of potatoes was mentioned in the year 1616. It was organized by Louis the XIII. Their taste was said to be fabulous and potatoes became to spread across Europe as a precious delicacy. Some of them were grown also by monks in Ireland. These monks have given seed potatoes to people in the time of large famine. That is why it Ireland was the first country, where the potatoes were grown on a larger scale. <sup>24</sup>

### **Brief history of potatoes in the Czech Republic**

Into the area of the Czech Republic were potatoes first brought by Jiří Agricola. Marie Terezie and Joseph the II. tried to spread the growing of potatoes but in the beginning they were not very much successful. People did not want to plant potatoes because it was given to them as a command from their rulers. Marie Terezie then imported larger volumes of potatoes from Prussia and sent priests to help her with convincing people to grow them. Few very bad seasons helped her. There were few very hard winters and bad seasons for cereal crops, people had nothing to eat and they were forced to start growing potatoes. The consumption per capita was rapidly increasing. In the year 1800 was consumption 50 kilograms per capita. The maximum amount of potatoes consumed per

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<sup>23</sup> (Houba, 2007)

<sup>24</sup> (Houba, 2007)

capita in the Czech Republic was in the year 1850. In that time each Czech consumed in average 170kg of potatoes per year.<sup>25</sup>

The blight on potatoes caused in the half of 19<sup>th</sup> century a serious famine in Ireland and in the middle of the First World War caused the potato blight famine in Germany. That underlines the importance of potatoes for human nutrition.<sup>26</sup>

Before the First World War belonged Czechoslovakia between the most developed countries in the World. The economics was focused mainly on industry production and agriculture did not play important role in economics. Agriculture was based on the purposes of private ownership. The technologies used in agriculture were on very high level and the yields were comparable with countries of Western Europe. Already in that period of Czech history was Czechoslovakia net importer of agricultural products.<sup>27</sup> But the technologies used in the production of potatoes in Czechoslovakia were after First World War on the top world level.

After the Second World War the system of government in Czechoslovakia changed. The share of agricultural sector was very much smaller than in other socialist countries. The production was based on governmental central planning and not on the needs of customers or opinions of farmers. Also in the socialist era was Czechoslovakia quite well developed country in terms of technologies in agriculture in comparison with other socialist countries. But Czechoslovakia was not able to reach the yields and the technological standards that were common in the West Europe or USA.<sup>28</sup> In the production of potatoes the situation was in that time very similar as in the whole agricultural sector. The technological development was almost stopped. *In contrast to other socialist countries (for example Hungary and Poland), Czechoslovakia exhibited an almost fully nationalized or collectivized agricultural sector.*<sup>29</sup> In Czechoslovakia majority of land was managed through 174 state farms and 1024 farm cooperatives. The discontinuity of private ownership led to the destroying the link between the land and farmers.

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<sup>25</sup> (Rybáček, 1988)

<sup>26</sup> (Čepl)

<sup>27</sup> (Csaki, Debatisse, & Honisch, 1999)

<sup>28</sup> (Noble)

<sup>29</sup> (Baun, Kouba, & Marek, 2009)

## **Agricultural production in the Czech Republic after 1989**

In the 1989 the socialist governmental system collapsed and the change of political regime came. New government has issued high number of economic reforms. The political program of the new government included also many changes in agriculture. The reform of agriculture was based on the principles of private ownership of land and other agricultural property. The aim of the reform was to create trade oriented and internationally competitive sector. Potato growers gained a hope that they will get their confiscated property back.

In the first years after Velvet revolution Czechoslovakia focused on the implementation of this ambitious plan. Csaki divides this reform into three parts:

- Creation of macroeconomic trade framework for the producers, processors and traders
- Privatization of main agricultural facilities both in primary agricultural production as well as in processing industry
- Changes in the institutional framework, law and state regulations in order to support the function of a free trade.<sup>30</sup>

Unfortunately according to Baun, Kouba and Marek the period after the year 1989 is characteristic by a drastic decline of agricultural production, fragmentation of ownership of agricultural companies and a continuous decline of animal production. According to them the main reasons were the restructuralisation of ownership, loss of previous markets in socialistic countries, reduction of state subsidies and increasing indebtedness of agricultural enterprises. Although the total agricultural production was decreasing, the productivity started to increase. This trend can be found also in the production of potatoes. The yields have since the 1989 continuous increasing trend.<sup>31</sup> The Czech Republic had among all post communistic countries the lowest share of population employed in

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<sup>30</sup> (Csaki, Debatisse, & Honisch, 1999)

<sup>31</sup> Based on various statistics of Czech Statistical Office

agriculture. Czech Republic had also the lowest number of workers in agriculture per hectare. It was just 0,112 compare for example with Poland which had 0,258.<sup>32</sup>

All the business relationships of the production chain were interrupted. The farmers suddenly did not know from whom they should buy seeds and fertilizers and to whom they should sell their production. The potato production became a very hard competition. The links between farmers and land were interrupted and the business connections as well. The prices of agricultural producers were very slowly increasing but the prices of inputs were for farmers increasing much faster. The Czech Republic opened its borders very quickly so there were new products and technologies flooding Czech agribusiness. Due to increasing import has changed also the consumption manners. People did not consume just the seasonal products and started to buy agricultural products also out of the usual season. Import duties were in the Czech Republic very much lower than in the neighbouring countries. Czech producers were not defended against imports from the western countries where the farmers had several advantages:<sup>33</sup>

- Experience with the principles of trade economy
- Better access to new technologies
- Farms equipped on higher level of technology
- Sometimes also export subsidies from government
- Solved soil ownership issues

Western markets were for Czech farmers very strongly defended by the individual western governments. The quality of the final products and the level of the presentation of the final product were in the 90's also on very much lower level than in the Western Europe. Based on the above mentioned influencing factors is understandable complete collapse not only of the potato production in the Czech Republic but also collapse of the whole agricultural sector. Financing of the potato production became to be tough. To get a loan for the agriculture production in 1990's was in the Czech Republic very hard because

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<sup>32</sup> (Rozelle & Swinnen, 2004)

<sup>33</sup> (Rozelle & Swinnen, 2004)

the bank sector had to go through the restructuralisation as well. Farmers were in the 90's in banks not very welcome customers.

The Czech Republic opened its agricultural market with the intention to start the cooperation with foreign countries and to initiate gain foreign trade. The import duties in the Czech Republic for imported agricultural products were significantly lower than in neighbouring countries.<sup>34</sup> The cooperation with the foreign countries had to lead to the accession of the Czech Republic into NATO and European Union. Unfortunately Czech growers not only of potatoes were not defended against high competition from abroad.

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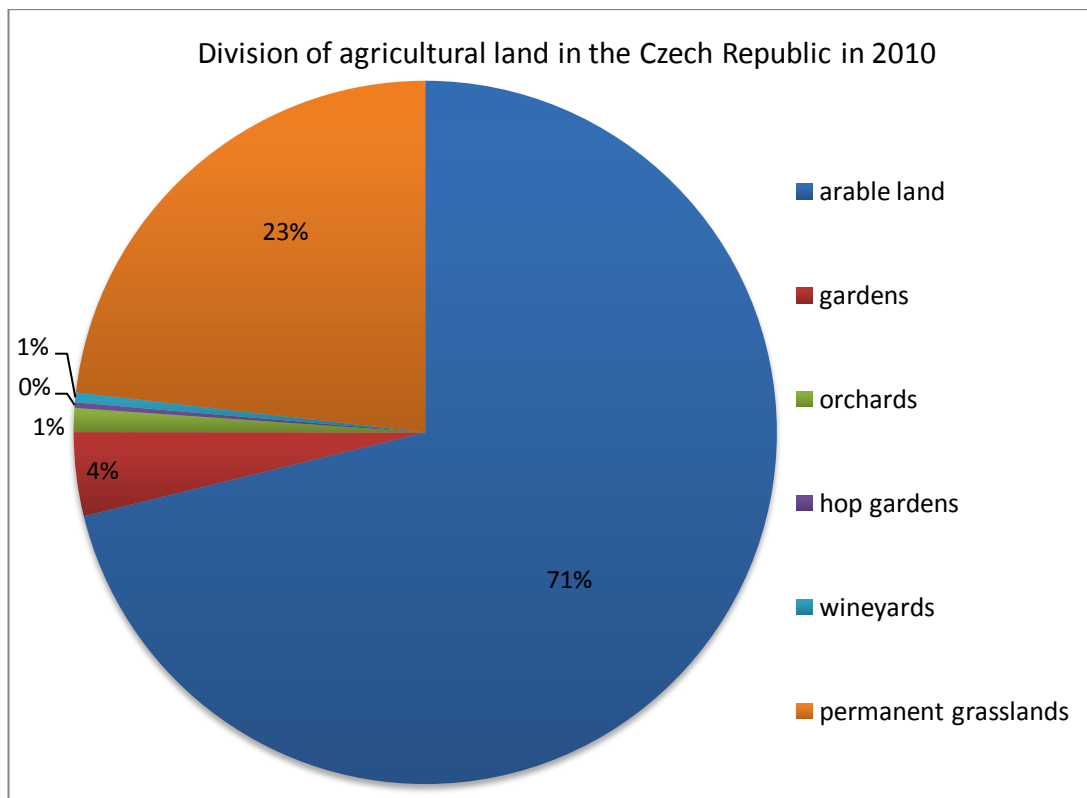
<sup>34</sup> (Dobrylovský)

# Analytical part

## Current situation in the potato industry

According to data of Czech statistical office 31.12.2010 total area of the Czech Republic was 7 886 492 hectares. From that were 4 238 975 hectares of agricultural land and 3 647 517 hectares of non-agricultural land. Based on the **Table -1** was created **Graph - 1**, that clearly shows the structure of agricultural land in the Czech Republic. The highest percentage of agricultural land of course belongs to arable land. Permanent grasslands are present in the Czech Republic on 23% of agricultural land; gardens are present on 4% of agricultural land. Finally hop gardens and vineyards and are present on less than 1% of agricultural land.

**Graph – 1: Division of agricultural land in the Czech Republic in 2010**

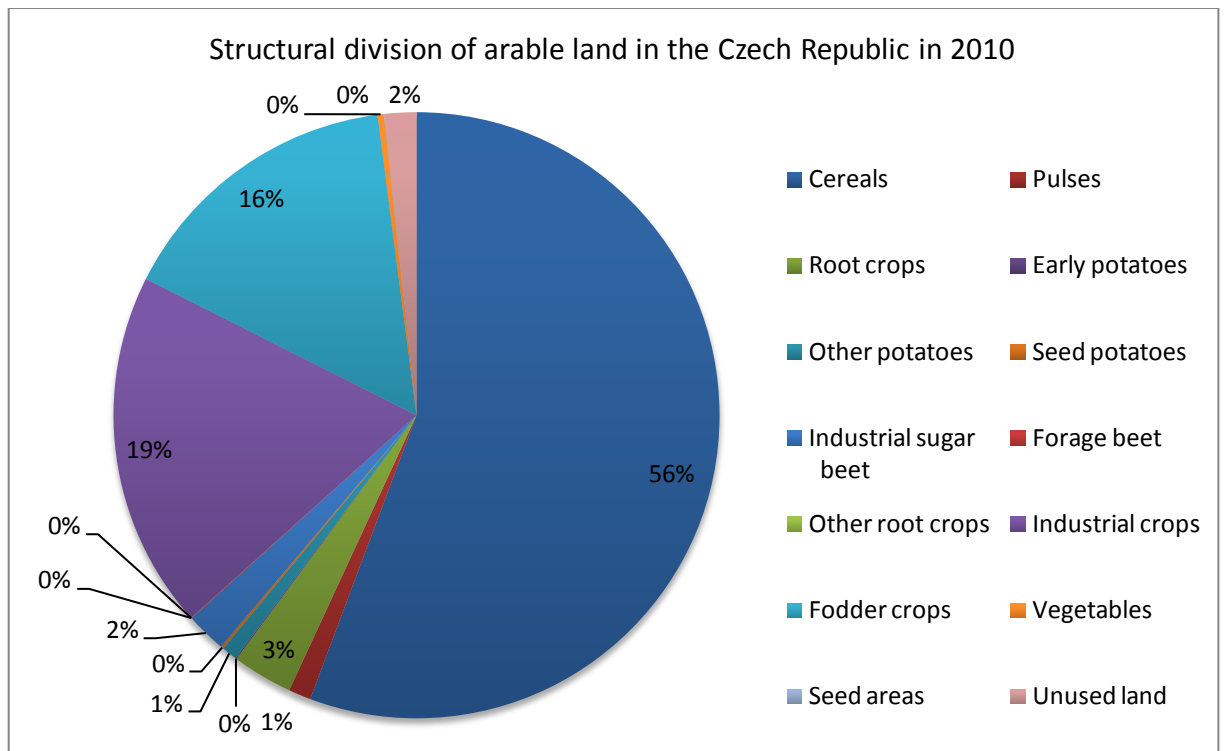


*Source: Own work of an author based on data from Czech Statistical Office*

Based on the **Table-2** was created a **Graph - 2** that shows structural division of arable land in the Czech Republic. It can be recognized that majority of arable land is used in the Czech Republic for growing of cereals. Cereals are grown in the Czech Republic on

58% of arable land, industrial crops are grown on 20% of arable land, fodder crops are grown on 16% of arable land and finally on 3% of arable land are grown root crops. Potatoes in this statistics belong between root crops.

**Graph – 2: Structural division of arable land in the Czech Republic in 2010**



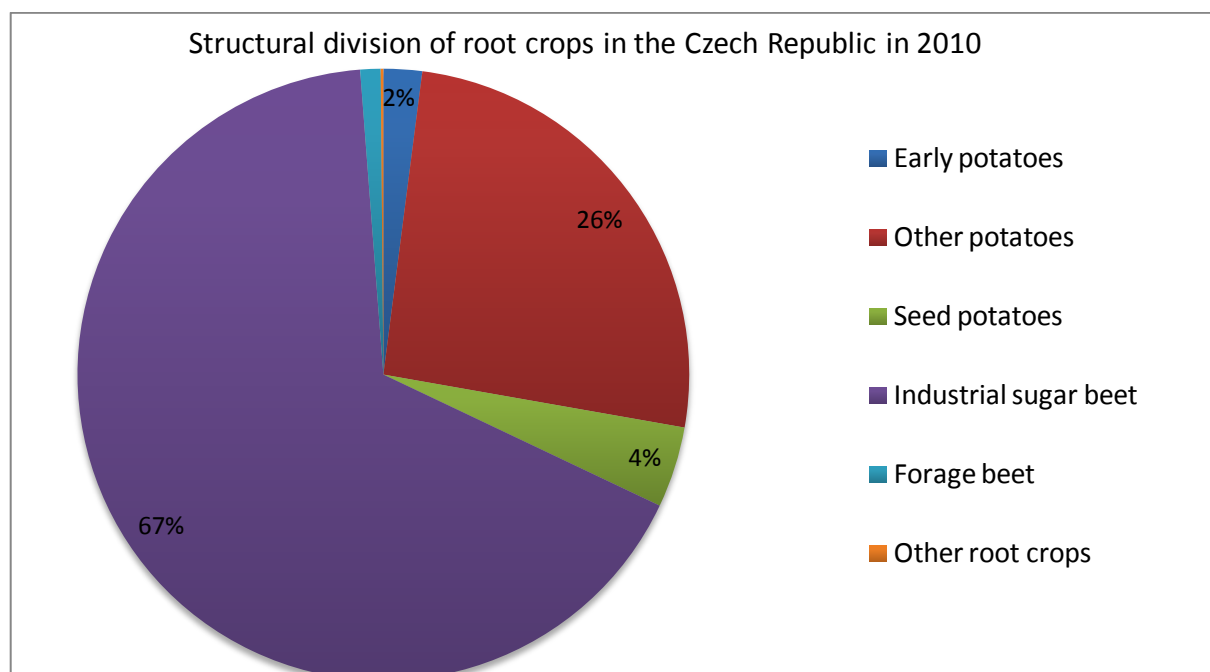
*Source: Own work of an author based on data from Czech Statistical Office*

Based on **Table-3** was created **Graph-3** which shows the structure of root crops in the Czech Republic. Sugar beet has the highest share – almost on two thirds of fields, where are grown root crops, is grown sugar beet. Share of potatoes on root crops was in 2010 slightly over 32% which was just about 1% from the total area of arable land of the Czech Republic. Czech statistical office divides potatoes just into four groups – new potatoes, early potatoes, seed potatoes and other potatoes. As it can be seen from **Table-4** majority of potatoes grown in Czech Republic are by Czech Statistical Office qualified as other potatoes that contain potatoes for direct consumption and potatoes for industry that means mainly for the starch extraction. Seed potatoes are grown on about 13% of all potato fields. Early potatoes are grown on slightly more than 6% of potato fields. In the Czech Republic are as early potatoes qualified all potatoes that are harvested until 31. August.



New potatoes are not grown within the Czech Republic and the number in statistics represents the imported new crop from states such as Egypt, Cyprus or Morocco.

**Graph -3: Structural division of root crops in the Czech Republic in 2010**

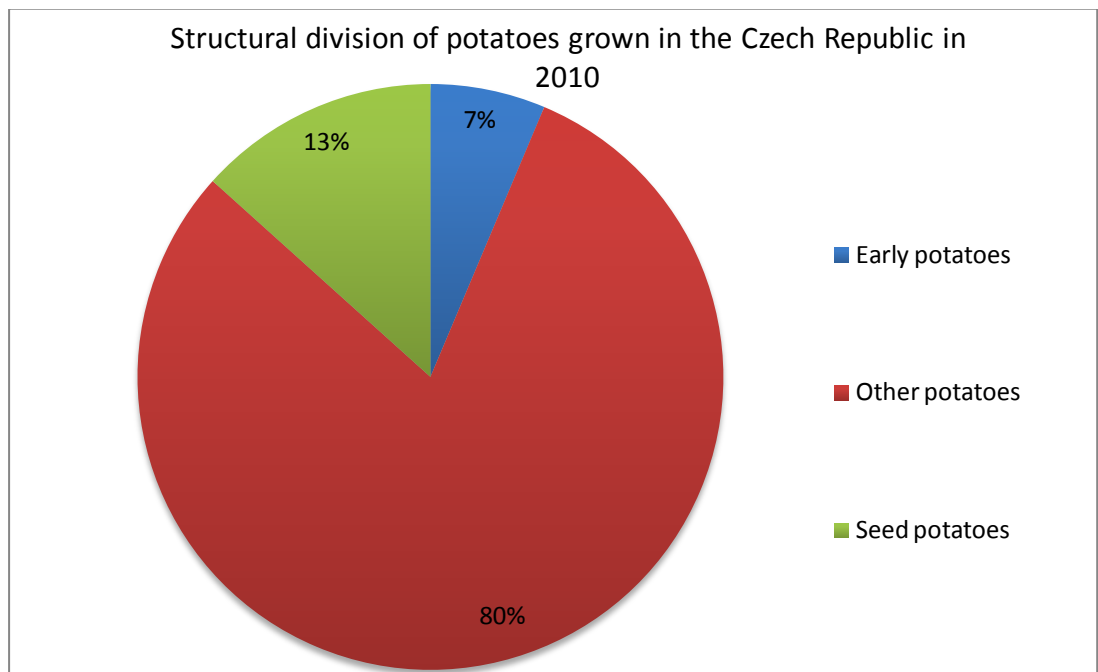


*Source: Own work of an author based on data from Czech Statistical Office*

Potatoes can be also classified according many other aspects. Basic division is according to the type of usage of potatoes. Varieties grown for industry purposes are very different from the varieties of potatoes that are dedicated to the direct consumption. All varieties can be further classified according to vegetation period as very early, early, half early, half late and late. Potato varieties that are intended for direct consumption can be further divided according to the cooking type. There exist three very basic cooking types A, B and C. Waxy potatoes that are recommended to be used for potato salads are known as type A. Floury potatoes are known as type C and are used mainly for roasting, frying and mashing. Between these two cooking types are potatoes that are mid-way and mid-floury – cooking type B. These potatoes should be mainly for frying, roasting, boiling and they can be also prepared in microwave.<sup>35</sup>

<sup>35</sup> (Potato variety classification )

**Graph -4: Structural division of potatoes grown in the Czech Republic in 2010**



*Source: Own work of an author based on data from Czech Statistical Office*

**Graph - 4** is based on **Table – 4** and shows the structure of potato fields in the Czech Republic. On the majority of fields are grown so called Other potatoes that include potato for direct consumption that are harvested after 31<sup>st</sup> of August and potato that are used for industry purposes. Seed potatoes are grown on 13 percent of all potato fields of the Czech Republic.<sup>36</sup>

Late potatoes, potatoes for industry and also seed potatoes are traditionally grown in the area of Czech highlands. Potatoes need well drained and loose soil. Potatoes need also enough moisture. PH of the soil should be between 5.5 and 6.8. Potatoes are one of the crops with high adaptability to growing conditions that are not ideal.<sup>37</sup>

Early potatoes are grown just on 7 percent of all potato fields in the Czech Republic. Early potatoes are grown in the parts of Czech Republic with the highest average temperatures. This means that these potatoes are grown mainly in Central Bohemia and South Moravia. Early potatoes are grown usually on light sandy soils or light brown soils. These soils have usually low humus content and slightly acidic PH. Potatoes are grown

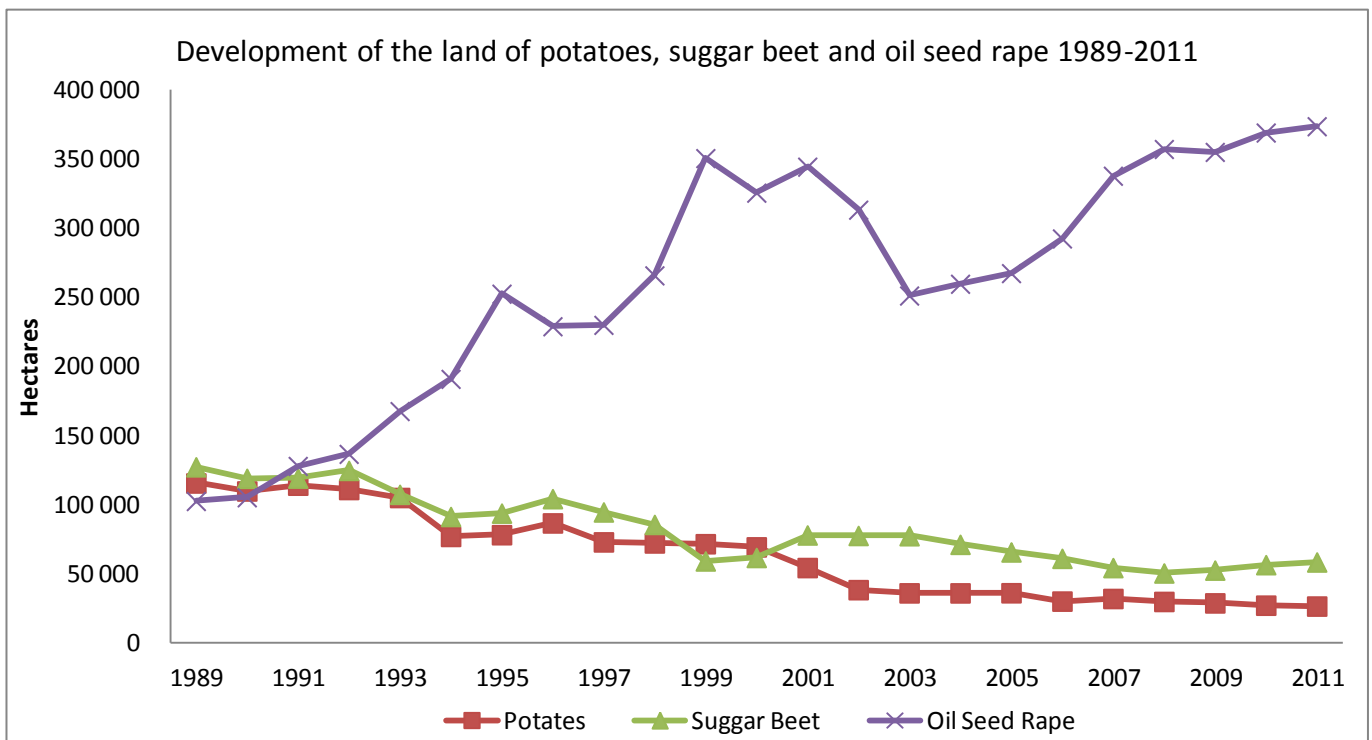
<sup>36</sup> (BRAMBORY, ZLATO VYSOČINY)

<sup>37</sup> (Soil Conditions For Potato Growing, 2011)

usually under irrigation and sometimes also under fleece cover in order to ensure as early harvest as possible.<sup>38</sup>

**Graph-5** shows the historical development of potato areas in the Czech Republic. This **Graph - 5** was created on the basis of **Table -5**. Into **Table – 5** were also included areas of other selected important crops in the Czech Republic. As the crops to be compared with potatoes were chosen cereals, oil seed rape and sugar beet. Into **Graph – 5** were the cereals not included because they are in the Czech Republic grown on very much larger scale than the other crops and inclusion of cereals into **Grap-5** would spoil the scale of the **Graph-5**. But the development of production of cereals can be clearly seen from the **Table-5**. From **Table-5** and **Graph-5** can be recognized that the land areas of sugar beet, cereals and potatoes are slowly but continuously decreasing.

**Graph – 5: Development of the land of potatoes, suggar beet and oil seed rape 1989-2011**



*Source: Own work of an author based on data from Czech Statistical Office*

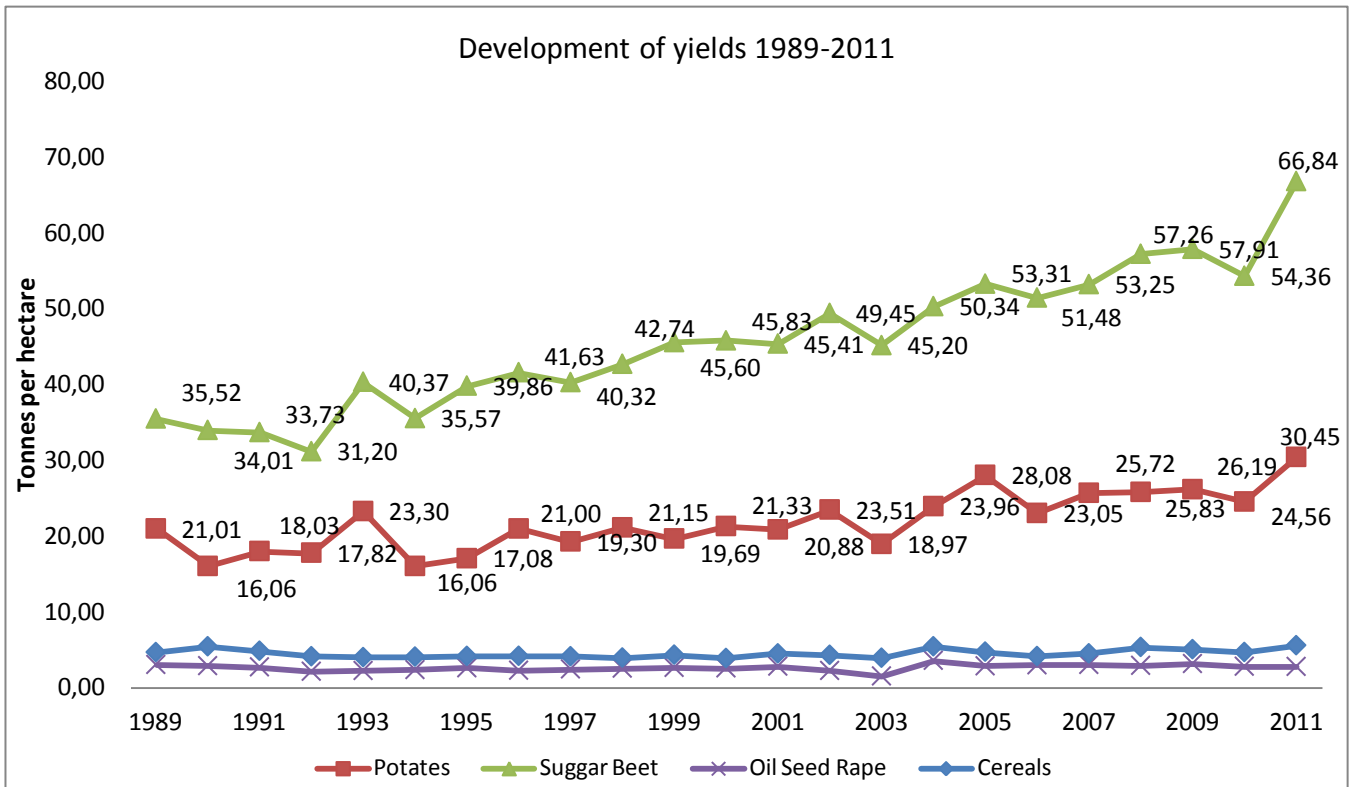
The lowest decrease can be found in cereals. Surface of cereals decreased from the Velvet revolution by 11, 5%. Since 1989 the surface of cereals has increased several times for one year period but the overall result in 22 years is a decrease in surface. In case of

<sup>38</sup> (Vašát, Jarolím, & Šantrůček, 2005)

sugar beet there can be found 54% decrease in the surface since the Velvet revolution. The worst situation is in potatoes. The surface of potato fields decreased from the Velvet revolution by over 77%. Just the surface of Oil Seed Rape has increase. In the last 22 years the increase was enormous. The increase in the surface was over 360%.

This situation may have several reasons. It can be caused by improvements in technology and increasing yields. It can be also influenced by increase of some costs in the production of certain crops. Eating habits may have changed over last 20 years, so people may intend to consume different products now than before. Furthermore the international trade can play a certain role. Some farmers may be influenced also by the Common agricultural policy.

**Graph – 6: Development of yields 1989-2011**



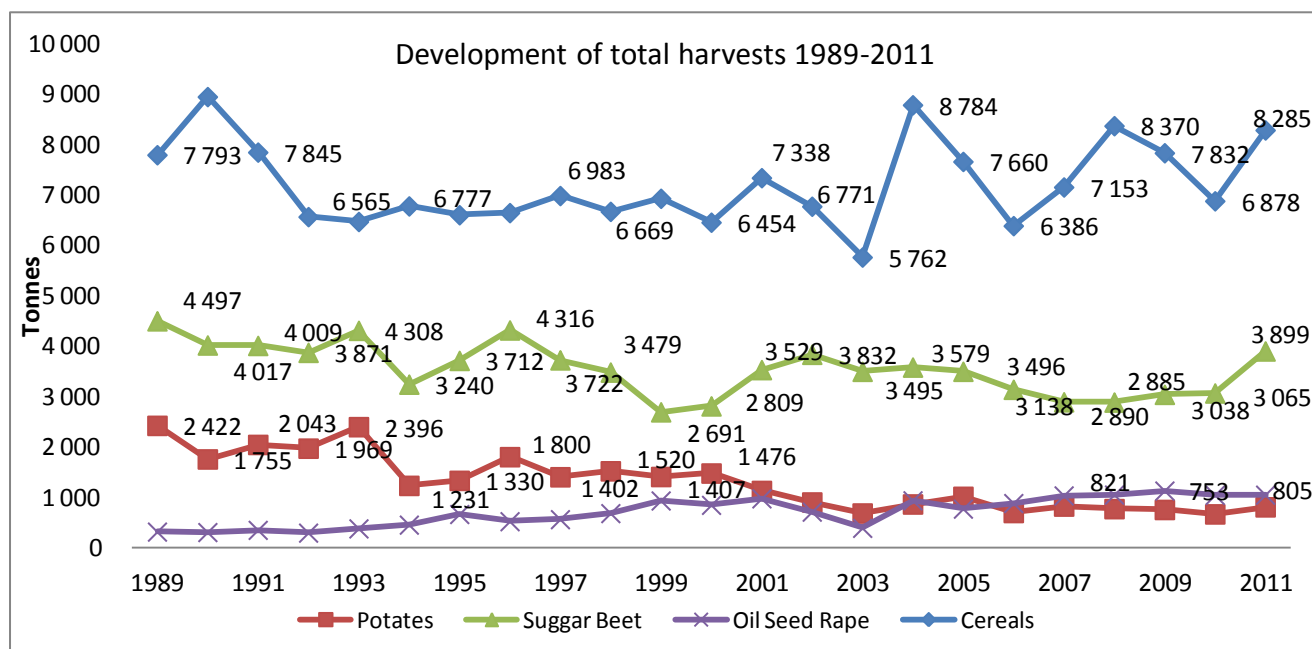
*Source: Own work of an author based on data from Czech Statistical Office*

On the basis of **Table-5** was created a **Graph-6** that shows changes in the yields of oil seed rape, sugar beet, potatoes and cereals. After Velvet revolution Czech Republic became open to new technologies and entrepreneurs started to search how to gain an advantage over the others. The innovators have brought new technologies from abroad to

The Czech Republic, increased their yields or lowered costs with the same yields and gained an advantage over the others.<sup>39</sup> But they had to face quite a decent amount of risk. When it showed up, that the technology works, then it was copied by others. Mainly the old LPGs were laggards in accepting new technologies, and that is why many of them went bankrupt. The improvements can be made in the soil preparation, plants nutrition, pests control, harvest, storage or management. The increases in yields can be seen in all compared crops except oil seed rape. The yields of oilseed rape decreased over last 22 years by about 8%. The technology of growing of oil seed rape is relatively simple and the yield probably depends more on other factor such as weather etc. than on technology. The lowest increases are found in the production of cereals – about 19%. The biggest increase in yields was in sugar beet – about 88%. New technologies had certainly also an effect on the yield of potatoes. The average yield is nowadays about 44% higher than it was in the year 1989.

**Graph – 7**, that was created also on the basis of **Table – 5** shows the effect of the changes in surfaces of individual crops and the changes of yields on the total production.

**Graph – 7: Development of total harvests 1989-2011**

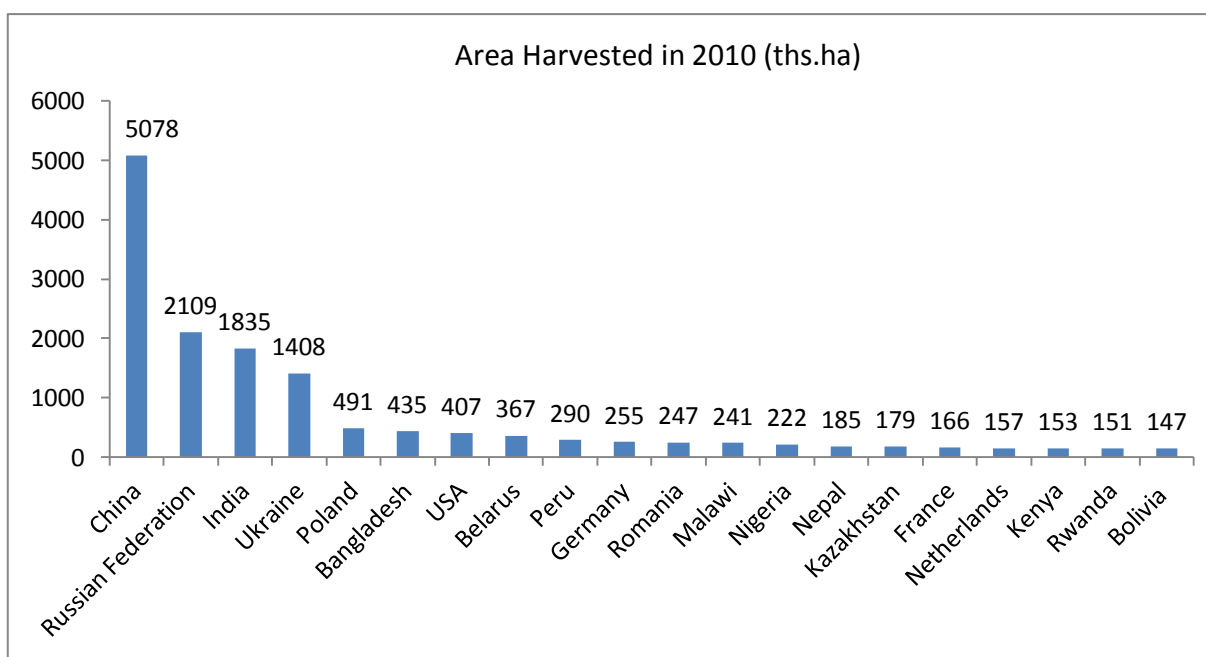


Source: Own work of an author based on data from Czech Statistical Office

<sup>39</sup> (Macáková, 2007)

In case of cereals the total production has increased even if the total surface has decreased. The total production of sugar beet decreased even if the yields have increased a lot. Total production of oil seed rape increased mainly due to the increased surface. The decrease of surface of potatoes grown had a huge effect also on the total production of potatoes in the Czech Republic. The total production of potatoes in The Czech Republic has in the last 22 years decreased by 66%. If the time series is decomposed, then it can be recognized that the major decrease in production was between the years 1993 and 1994 when total production fell by almost 50% in one year period. It might be connected with the split of Czechoslovak Republic. Another fall in total production of potatoes came in the years before Czech accession into European Union. That was caused by the fear of farmers about future in the European Union.<sup>40</sup>

**Graph-8: Area Harvested in 2010**



*Source: Own work of an author based on data from Faostat*

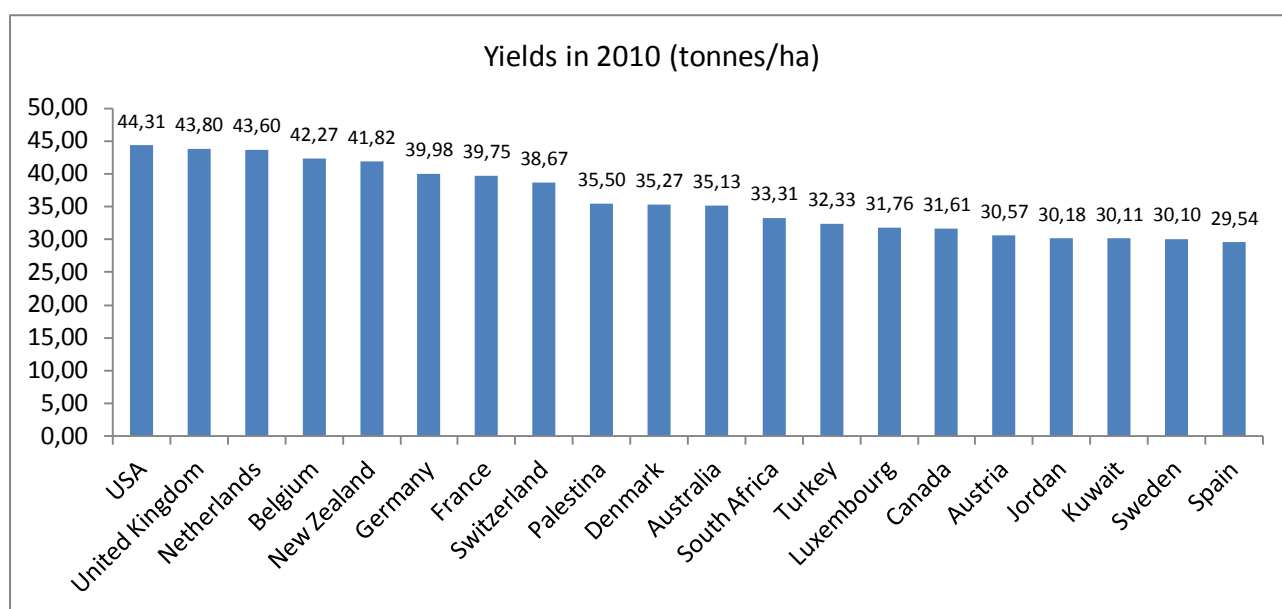
**Graph-8** was created on the basis of **Table-6** and illustrates the production of potatoes in the whole World. There were selected twenty countries that produced in 2010 the most of the potatoes from the land point of view. The number of hectares does not say anything about the yield per hectare. It is possible that the countries with fewer hectares

<sup>40</sup> (Rousková, 2006)

than China will have higher yield and comparable total production. In the production of potatoes China produces far most potatoes from the land point of view. Russia on the second place grows potatoes on less than half of the surface in the comparison with China. China grows more than ten times more hectares of potatoes than Poland which is leader in the EU from the land point of view.

On the **Graph-9**, that was created on the basis of **Table-7**, can be seen that China has very low yields per hectare and certainly does not belong to twenty top countries in the world from yield point of view.

**Graph-9: Yields in 2010**



*Source: Own work of an author based on data from Faostat*

In China the average yield in production of potatoes is about 14 tons per hectare which is in comparison with the worst countries from top twenty countries is less than one half. If China is compared with USA, that has the highest average yield in the world, the yields in China are less than one third. Yield of potato is very much influenced by the growing technology. There are many factors that influence potato yield for example: quality of soil, volume of irrigation, the volume of fertilizers, technology of application of herbicides<sup>41</sup>, fungicides, pesticides, technology of harvest etc.<sup>42</sup> In top twenty countries

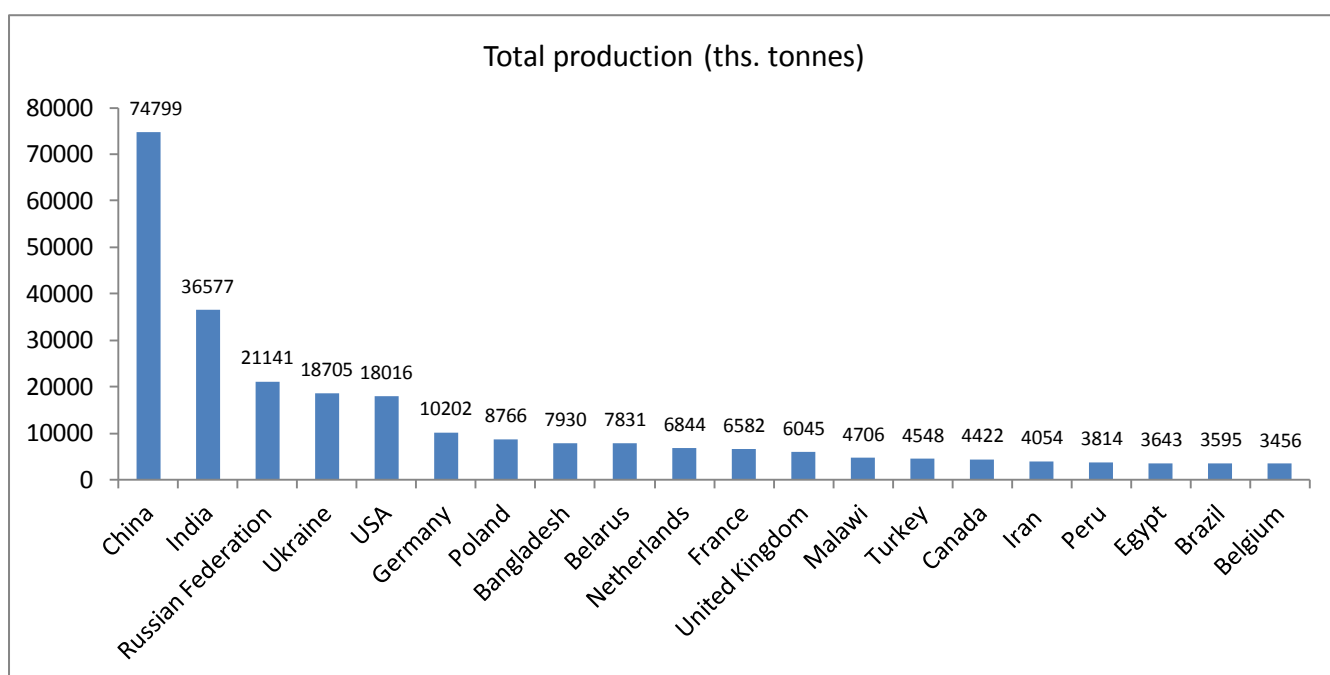
<sup>41</sup> (Essah, Holm, & Delgado, 2004)

<sup>42</sup> (Ojala, Stark, & Kleinkopf, 2007)

which have the highest yield in the world belong quite many countries from Europe which confirms quite high standard of growing potatoes especially in the Western Europe.

**Graph-10** that was created on the basis of **Table-8** shows twenty countries with the highest total production of potatoes. The highest production has again China even though the average yield in China is quite low. On the second place is India which has lower surface of potatoes grown than Russia and still has higher total production because it has higher average yields. First EU country from the point of view of the total production is Germany which has much higher yields than Poland that has much bigger surface of potatoes grown.

**Graph-10: Total production**

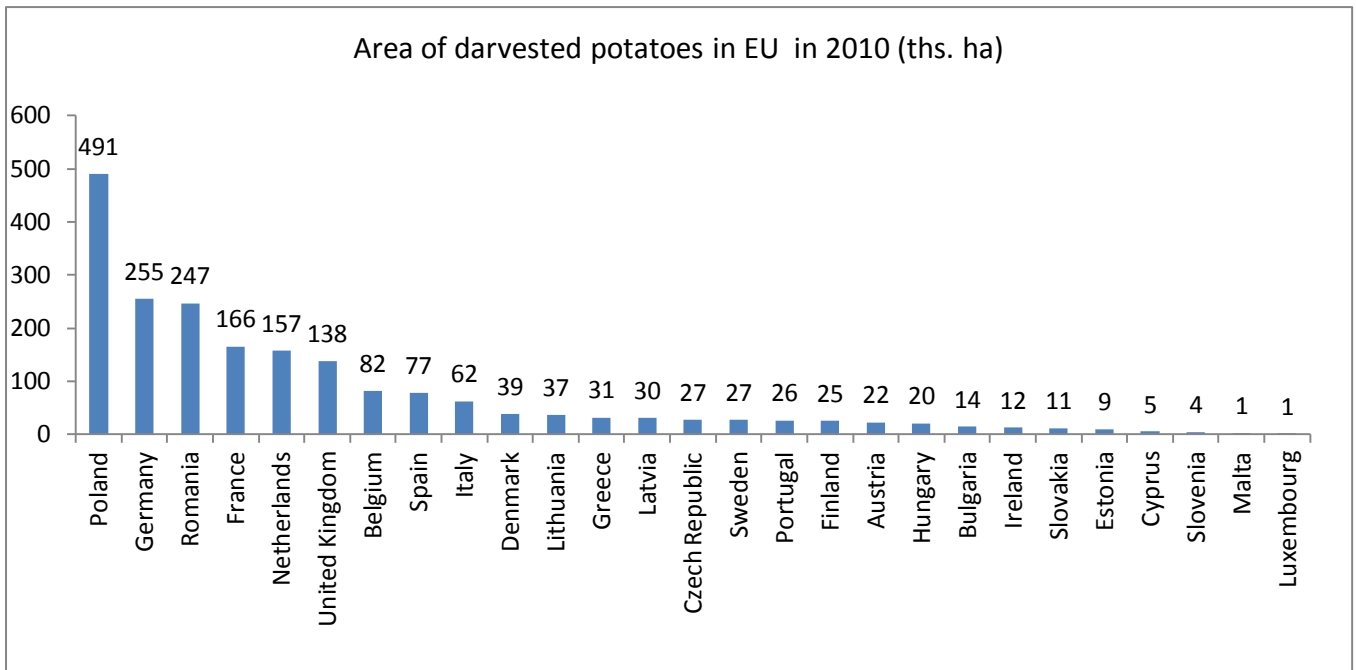


*Source: Own work of an author based on data from Faostat*

The situation in the European Union is compared in **Tables 9-11**. **Table-9** shows the total land of potatoes that had every country of EU in 2010. On the basis of **Table -9** was created **Graph-11**. There can be recognized that in top three countries from the point of view of total land of potatoes grown belong two new members of the EU – Poland and Romania. This could be a threat for the old EU countries in the future.



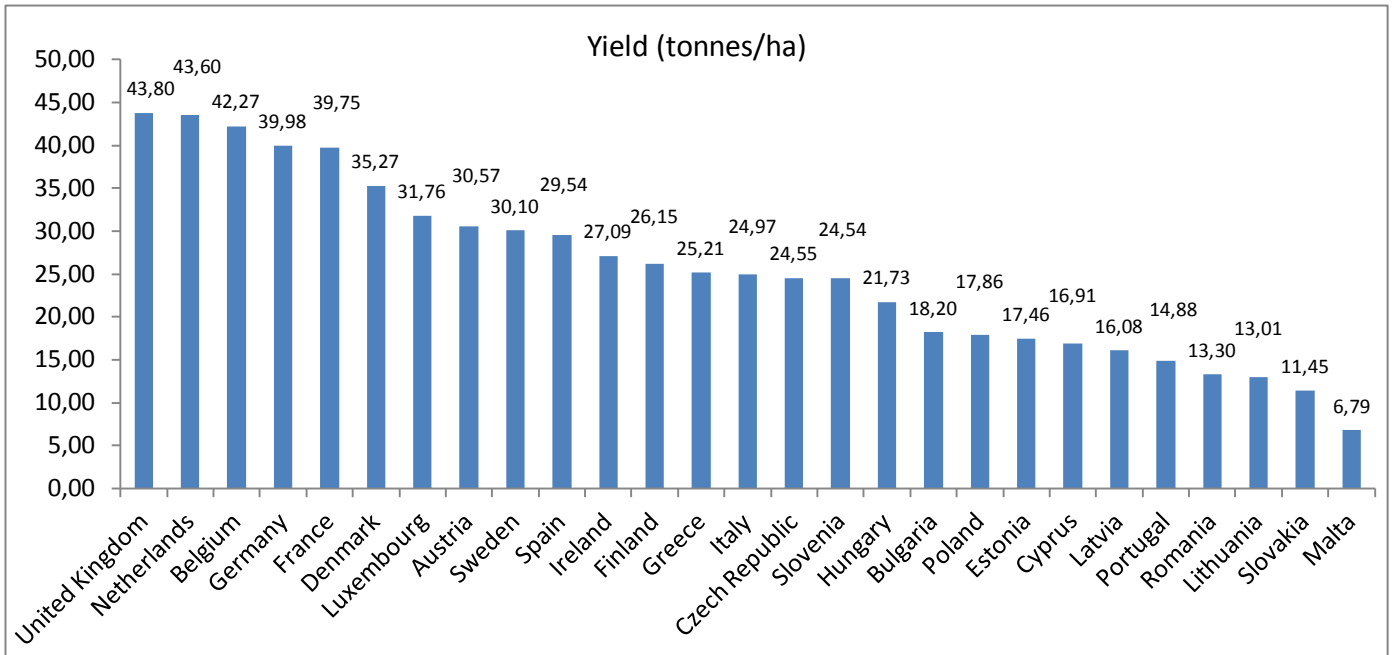
**Graph-11: Area of darvested potatoes in EU in 2010**



*Source: Own work of an author based on data from Faostat*

Currently Poland and Romania do not generate very high yields in the potato production which is probably caused by lower level of technology in these two countries. From the Faostat data can be seen that the yield in these countries have been increasing in the last few years which implies that the growing conditions in these countries are improving and Poland and Romania may become to be big players on the European potato market in the future. The Czech Republic is the land of potatoes in the European Union on the 14<sup>th</sup> place. From the new member countries have more hectares than the Czech Republic Poland, Romania and Lithuania. The yields of all countries of the European Union are compared in the **Table - 11**. The Czech Republic is on the 15<sup>th</sup> place with the highest average yields of potatoes from the new member countries which is not bad. Unfortunately, as it can be seen on the **Graph – 12**, which was created from the **Table -11**, the difference between average yields in the Czech Republic and United Kingdom is more than 19 tons per hectare.

**Graph – 12: Yields by country**

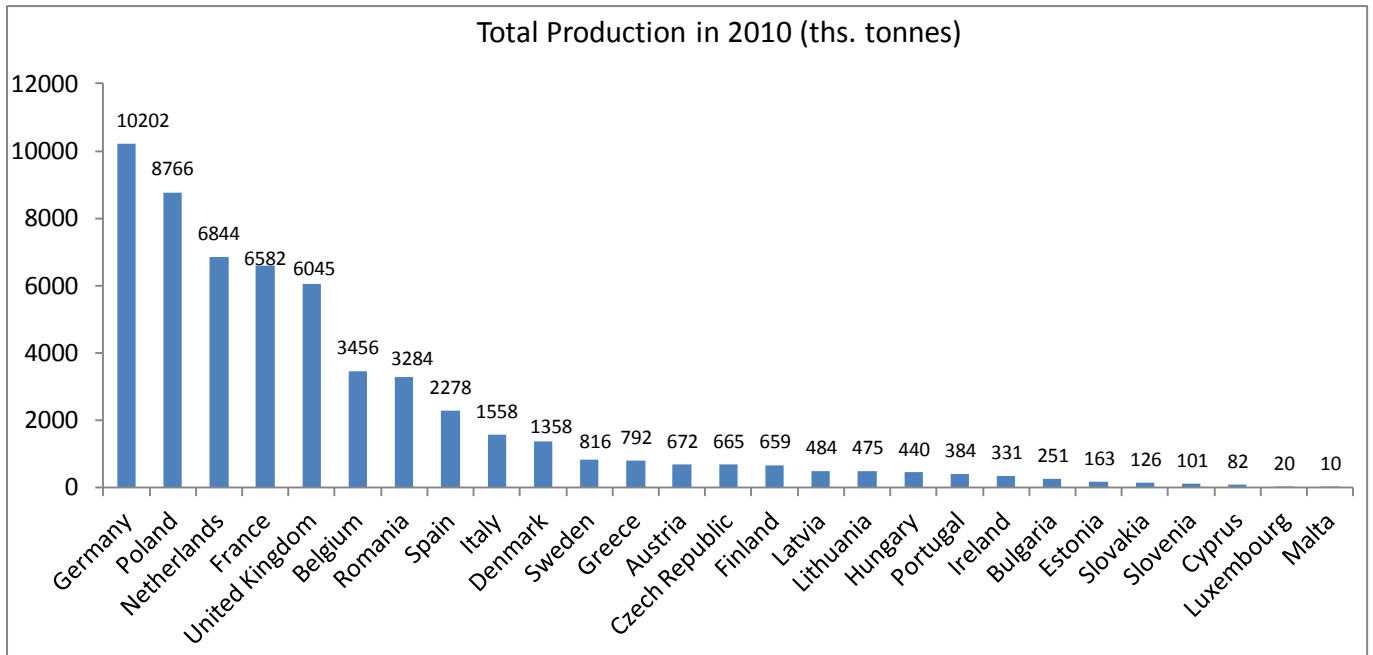


*Source: Own work of an author based on data from Faostat*

The average yields in Slovakia are the second lowest in the whole European Union – just about eleven and half tons per hectare and it is shocking that it is four times less than in United Kingdom or The Netherlands or Belgium. The differences between the old member countries and new member countries are huge if we consider that the potatoes are sold on one common market. The major question is who is more efficient if the old member countries with high yields and probably higher total costs or new member countries with lower costs but also lower yields.

Total production of individual countries of the European Union is shown on the **Graph – 13** which was created on the basis of **Table-10**.

**Graph – 13: Total Production in 2010**



*Source: Own work of an author based on data from Faostat*

There can be seen that the countries with a lot of hectares of potatoes like Poland or Romania due to low average yields are not on the very first position. Poland has fallen on the 2nd place and Romania is on the 7th place. Germany has just about one half of hectares compared to Poland and still the production in Germany is bigger.

**Graph – 14**, which was created on the basis of **Table – 12** shows the development of consumption of potatoes per capita in the Czech Republic from the year 1949. Into this graph were added also consumptions of vegetables, cereals and meat. Cereals were included in terms of flour weight in order to get longer time series. Meat was included as a total of pig meat, veal meat, beef meat and chicken meat, game, rabbits, goats and muttons in terms of carcass weight.

In the consumption of potatoes can be recognized the biggest decrease in consumption from all of these products compared. The consumption of potatoes was with some exceptions decreasing continuously since the 1920s. There was an increase in the consumption of potatoes just in 1960s.

The consumption of cereals has decreased as well over last half century. The decrease of the consumption of cereals was not as dramatic as the decrease of consumption

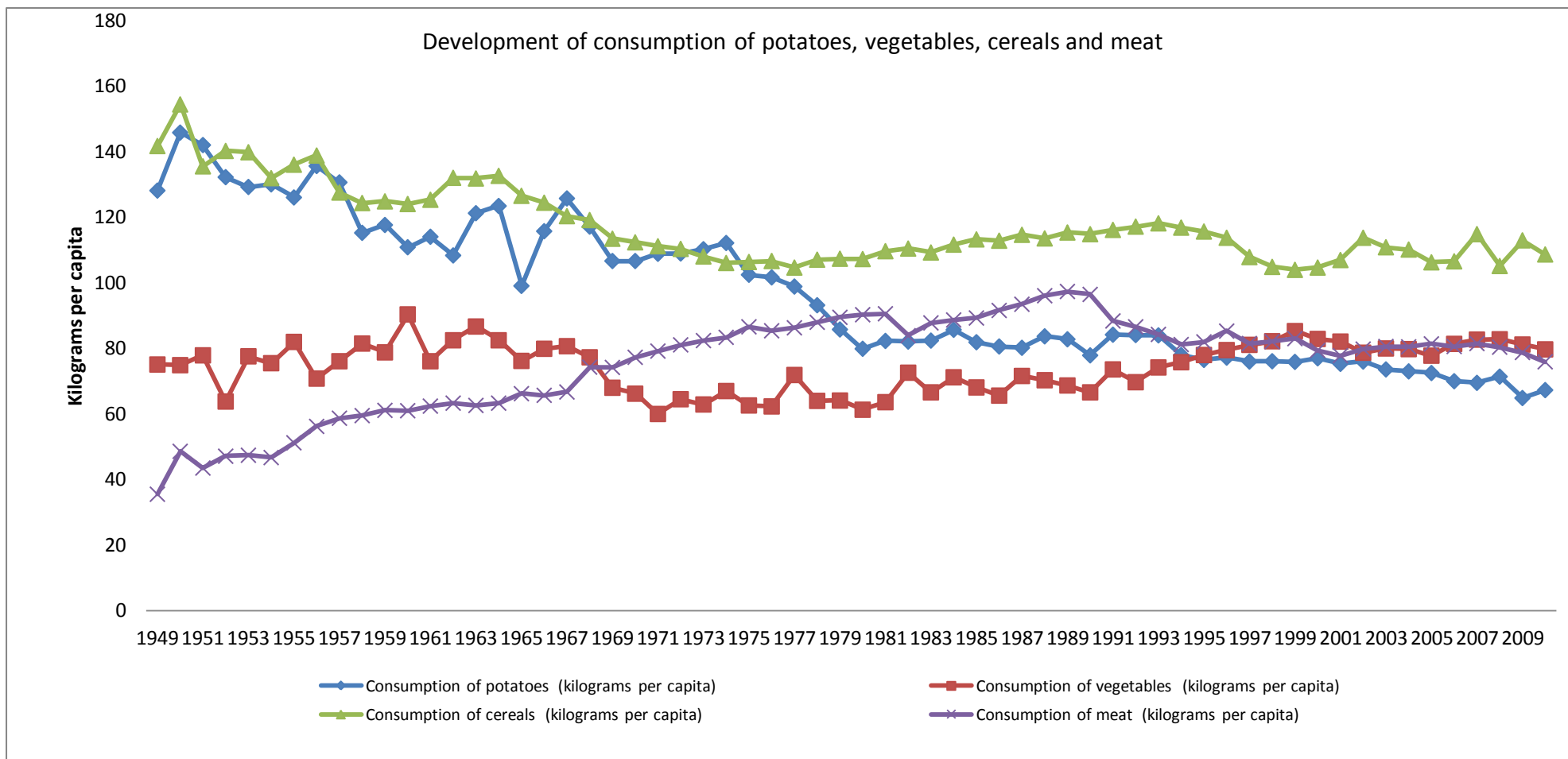
of potatoes. The consumption of meat was increasing until the 1990s. Since the year 1990 the consumption of meat has been also decreasing. The only foodstuff where the production increased and was included into this comparison is vegetables. It has been increasing since the 1990s. These changes are very much influenced by the changes of lifestyle. In the communist era people had different eating habits than today. Traditional Czech cuisine in the communist era used more potatoes, meat and the dishes were quite fat and heavy. The major change came right after opening of Czech market for products from abroad. According to survey of Institute of Agricultural Economics and Information was there was a rapid change of eating habits in the 1990s which continues until the present time but in the last 10 is slower. Today people try to care more about their eating habits. The variety of products in the Czech Republic has increased a lot. The choice in the supermarkets is not as limited as it was in the communistic period.<sup>4344</sup>

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<sup>43</sup> (Jídlo ovlivňuje zdraví víc než zdravotní péče a geny, 2006)

<sup>44</sup> (Boučková, a další, 2001)

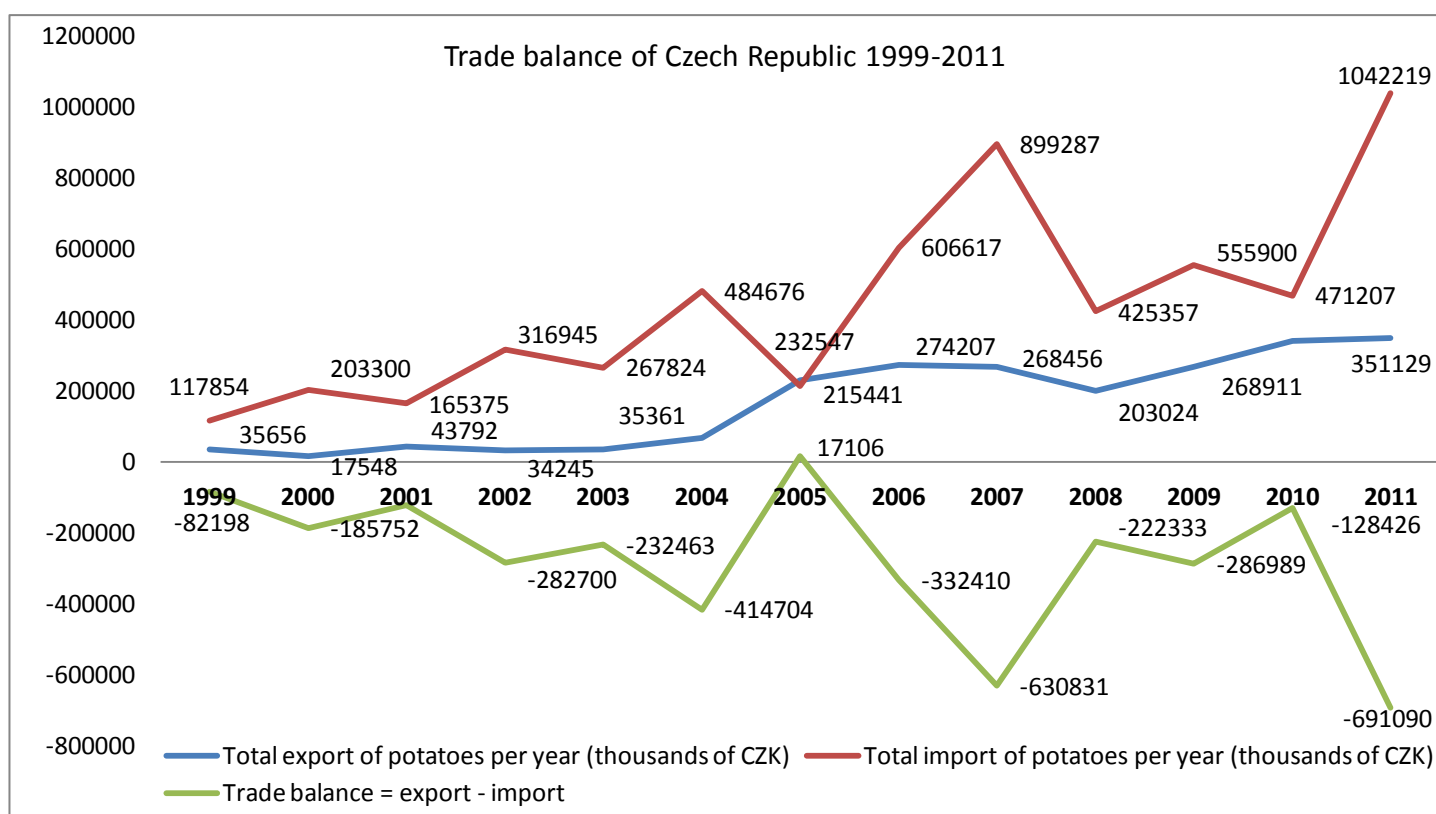
**Graph – 14: Development of consumption of potatoes, vegetables, cereals and meat**



Source: Own work of an author based on data from Czech Statistical Office

The surface of potato fields in the Czech Republic decreased hugely and the consumption of potatoes decreased a lot as well. The production of potatoes was decreasing faster than consumption which led to the fact that since 2006 Czech Republic is not self-sufficient in the production of potatoes.<sup>45</sup> **Table – 13** shows the imports of potatoes by country and year since the 1999. There can be found all countries that exported potatoes into the Czech Republic and there can be also found for how much money each year. The data are not in natural units but in Czech Crowns because the Czech Statistical Office does not provide the statistics of imports and exports in the natural units since 2006. In the **Table – 14** can be found all exports that the Czech Republic has made. This table again contains information about all locations where the exports went and amounts for all years since 1999. **Table – 13** and **Table – 14** are colored where green indicates the high amounts, yellow indicates the middle values and finally red shows the lowest values.

**Graph – 15: Trade balance of the Czech Republic 1999-2011**



*Source: Own work of an author based on data from Czech Statistical Office*

<sup>45</sup> (ČR poprvé v historii nebude soběstačná v produkci brambor, 2006)

**Graph – 15** was created on the basis of **Table – 13** and **Table – 14**. It shows the trade balance of the Czech Republic with potatoes since the 1999. There can be seen that both exports and imports were with some exception continuously increasing. The imports grew much faster than exports and that caused that the Czech Republic is in long run in trade deficit with potatoes. Only in the year 2005 the Czech Republic generated trade surplus which was caused by huge decrease of imports in 2005. This decrease of imports during the year was caused by quotas that were applied on imports on potatoes before accession of the Czech Republic into European Union. There can be seen that the increase in trade were much lower before the entrance of the Czech Republic into European Union. After the accession of the Czech Republic to European Union, the foreign trade with potatoes grew much faster than before. Especially the imports were increasing a lot. As the imports were significantly increasing and the exports grew slower, the trade deficit of the Czech Republic was increasing. There are several reasons for that:

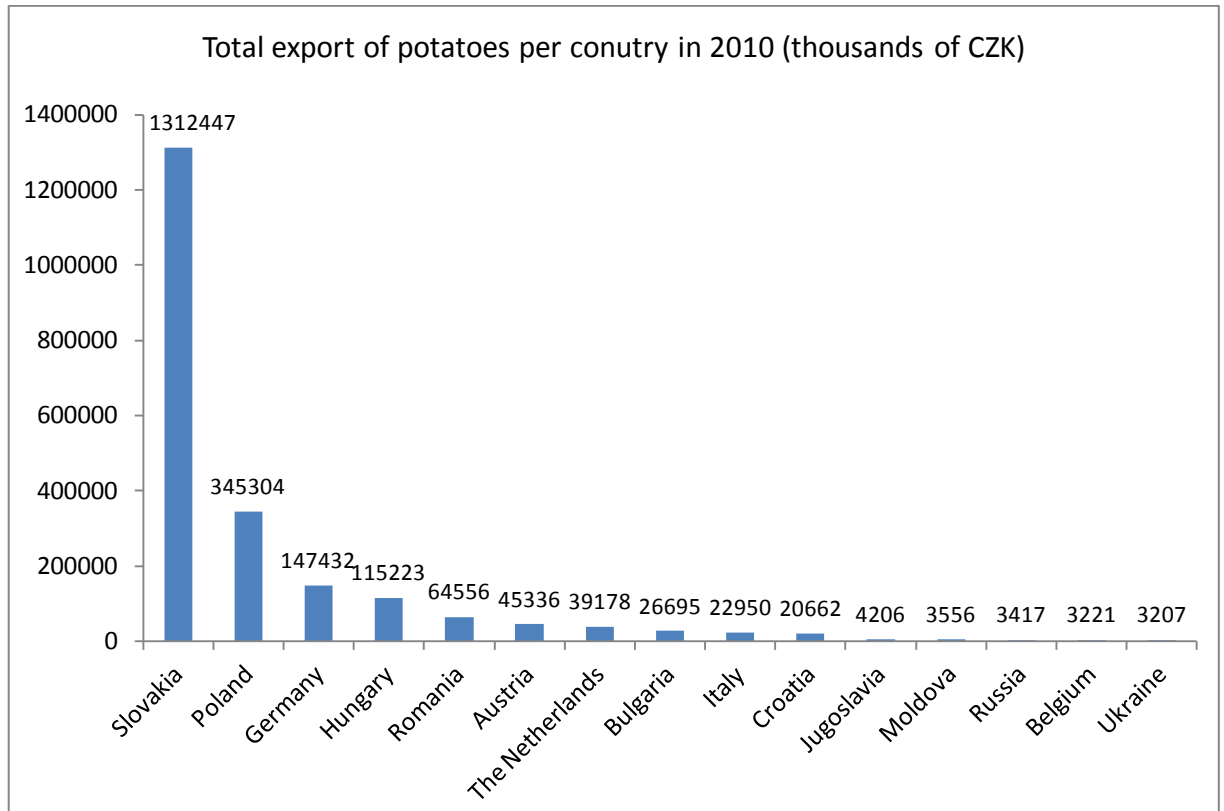
- In some periods of the year are our farmers not able to produce
- There is low storage capacity in the Czech Republic
- Czech potatoes are of low quality
- The producers from the exporting countries have lower costs of production
- The producers in exporting countries produce in more subsidized environment

All these cases will be researched further more in this diploma thesis, but firstly there will be decomposed the foreign trade. That should reveal the structure of imports and exports. It might give better insight into a researched problem. Based on the **Table – 13** and **Table – 14** were created **Tables 9-14**. **Tables 9-14** reveal the main trading partners of the Czech Republic in the trade with potatoes.

**Graph – 16**, which is based on the **Table – 20** shows the exports from the Czech Republic for the period 1999-2011. There are compared all countries where the Czech Republic has exported its potatoes. Slovakia is on the first place with a great margin. It can be said that the Czech Republic exports to Slovakia more than to all countries together. If the exports of all other countries are summed then the difference between exports to all

other countries versus exports to Slovakia is 467 504 000 CZK which is more than exports from Czech Republic to Poland which is our 2<sup>nd</sup> biggest export partner.

**Graph – 16: Total export of potatoes per country in 2010 (thousands of CZK)**



*Source: Own work of an author based on data from Czech Statistical Office*

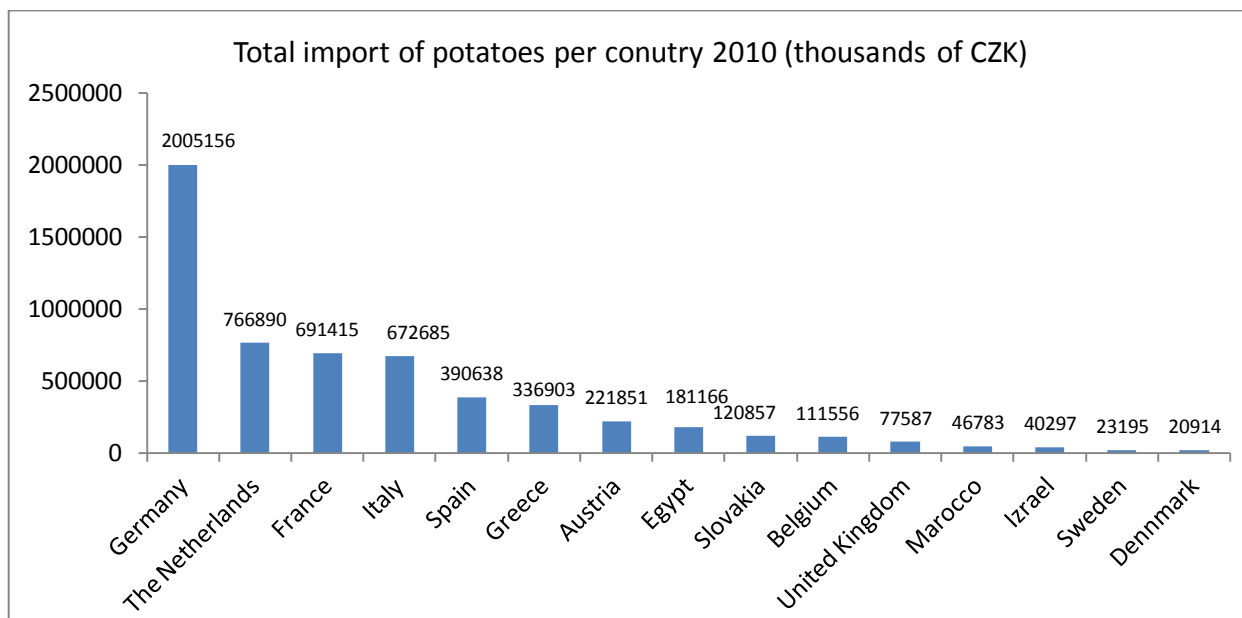
Also before the accession of the Czech Republic into the European Union was Slovakia main partner for the Czech exports. The reason is pretty straightforward. With Slovak people we have a very similar language and there are still remaining business connections from the former Czechoslovakia. The Slovakian customers are also very near to Czech producers especially those from South Moravia. The second most important partner in terms of exports has been always Poland – before and also after the Czech accession to the European Union. The reasons for such a strong partnership with Poland are very similar to the reasons of trade with Slovakia. Before accession to the European Union the Czech Republic has exported significant amounts of potatoes into Croatia, but after the Czech accession to the European Union these exports disappeared. After Czech accession to the European Union, Czech Republic remained oriented in



exports mainly on the neighboring countries. Good relationships are maintained also with Hungary and Romania.

From the **Table -13** was created a **Graph – 17** that shows main trading partners in terms of import of potatoes. The potatoes were imported into the Czech Republic over the last twelve years mainly from Germany, The Netherlands, France and Italy. The structure of importers was little bit different before and after Czech accession to the European Union. As it can be seen from **Table – 15**, before the entrance to the European Union, Czech Republic imported potatoes mainly from Germany (28%), Italy (22%) and The Netherlands (20%). From the **Table-17** can be recognized, that after the accession of the Czech republic to the European union the imports were made mainly from Germany (37,5%), France (15%) and The Netherlands (10%). From Italy there was imported after the Czech accession to the European Union just about 7% of total potato imports. Countries like Germany, France or The Netherlands have majority of their production of potatoes placed in the areas with similar climate to the Czech climate. The weather in the Netherlands has more influence from the ocean. The temperatures are comparable with the Czech Republic.

**Graph – 17: Total import of potatoes per country 2010**



*Source: Own work of an author based on data from Czech Statistical Office*

The climate in the Netherlands because of the short distance to the ocean is more suitable for seed potato production than in Czech Republic.

The production of potatoes in Italy is placed in several locations. The very early potatoes are grown on Sicily and in Puglia and Calabria.<sup>46</sup> That the regions of Italy with the highest temperatures where the harvest is very much earlier than in the majority of Europe. The rest of the Italian production of potatoes is located mainly around the city Bologna, where the climate conditions are comparable with the Czech Republic or Germany.<sup>47</sup>

In France potatoes produced are also produced in several areas. The most important and famous is the area around the city Blois which is about 180 kilometers south-west from Paris. Another very important area for the potatoes used and for storing for direct consumption is Picardy.<sup>48</sup> The very early potatoes are grown in France in the area of Bretagne.<sup>49</sup>

In 2011 there were imported potatoes into the Czech Republic for 792 387 000 CZK. From that were imported so called new potatoes just for 29 162 000 which is just about 3,7%. 3,7% is the portion of potatoes imported that are Czech farmers not able to produce because of weather conditions. There are some varieties that cannot be multiplied in the Czech Republic so some the seed potatoes have to be imported as well. The share of seed potatoes on total imports was 4 849 000kg. Unfortunately there was not available monetary value of total imports of seed potatoes. If the weight is multiplied by 8 CZK, which is a normal price for seed potatoes then the total imports of seed potatoes was worth approximately 38 792 000 CZK. That is about 4,8% of total potato imports. That means that less than 10% of total imports would not be possible to produce in the Czech Republic.

### **Analysis of subsidies in the European Union**

Another reason why the production of potatoes is decreasing in the Czech Republic is increasing competition in the European potato market. As it was proven in the bachelor thesis Subsidization under common agricultural policy (CAP) as a factor of

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<sup>46</sup> (Foti, 1999)

<sup>47</sup> (Dove nasce la Patata di Bologna DOP)

<sup>48</sup> (TRADITIONAL AND ORIGINAL POTATOES)

<sup>49</sup> (Brittany - regional and general information)

competitiveness of the European agricultural producers the subsidization of European farmers is not even. Some countries such as Greece or Ireland get from the European budget much more than they give into it. Then the free rider effect occurs. The farmers in some countries get more subsidies per hectare or per capita than the others which significantly influences the potato trade. Unfortunately they all can sell their production on a common European potato market. There are several reasons for such inequalities.<sup>50</sup> The most important ones are:

*1) Model of subsidies is based on the referential periods so each state has its own (= different) referential value. The model is based on historical data that is why the differences continue until the present time.*

*2) The new states still do not receive the full amount of subsidies. This is connected with Phasing in Model.*

*3) There are premium subsidies for certain commodities.*

*4) Less favourable areas play role in the total amount of subsidies received. On the less favourable areas are paid extra subsidies.*

*5) Each country might discuss some exceptions.*<sup>51</sup>

The Czech Republic entered to the European Union without any protection of Czech potato growers who did not have sufficient support from the home government.<sup>52</sup> According to Petr Tuček the entrance of the Czech Republic into the European Union had direct impact on the decrease of the production of potatoes in the Czech Republic.<sup>53</sup> In the time when Czech producers were not equipped enough there was applied phasing in model on them which means that they received less direct payments than the western competitors. Furthermore on the production of starch there were applied production quotas. It caused to Czech producers serious problems.<sup>54</sup> Whole situation has led to the fact that the Czech Republic is not self-sufficient in the production of potatoes anymore and is becoming more and more dependent on imports.<sup>55</sup> The production of potatoes is being replaced by other

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<sup>50</sup> (Pokorný, 2010)

<sup>51</sup> (Pokorný, 2010)

<sup>52</sup> (Bartík)

<sup>53</sup> (Po vstupu do EU asi vlivem dovozu poklesne produkce brambor, 2004)

<sup>54</sup> (Smrčka, 2002)

<sup>55</sup> (Tuzemská produkce brambor klesá a Česko už není soběstačné, 2011)

crops such as oil seed rape and cereals.<sup>56</sup> This situation may lead to serious problems in the potato supply in the Czech Republic in the future. By such a problem might be affected many customers within the Czech Republic.<sup>57</sup>

### **Cost analysis of potatoes**

In this chapter there will be analyzed the costs of production of potatoes in the Czech Republic. The costs will be structured into groups and will be compared with the growing costs of other crops common in the Czech agriculture. *Cost is the price paid to acquire, produce, accomplish, or maintain anything.*<sup>58</sup> During authors diploma practice was made an experimental measurement of growing costs of potatoes. In order to gain a better perspective over the production costs were measured also production cost of selected vegetables and cereals. The measurement was done in the companies united under the market cooperative Družstvo Bramko CZ.<sup>59</sup>

Družstvo Bramko CZ was founded in 2006 but the roots of the company dates back to the early 1990s. Bramko – Pavel Pokorný was the predecessor of Družstvo Bramko CZ and nowadays is Bramko – Pavel Pokorný one of the members and owners of Družstvo Bramko CZ. Bramko – Pavel Pokorný was founded in 1992 in Semice about 30km from Prague. The initial production consisted already in 1992 from potatoes, onions and cauliflower. All these products were grown in total on about 30 hectares of land. Since the very beginning was all the production traded directly without any intermediators. Today is all the trade managed by the cooperative Družstvo Bramko CZ which is owned Pavel Pokorný – Bramko, Agáta spol. s.r.o., Bramko s.r.o., J+N Semice s.r.o., Bruinsma Czech s.r.o, Strudo and ZD Dřísy. All these companies together produce vegetables, potatoes and cereals on about 4000 hectares.

Družstvo Bramko CZ is a market organisation focused mainly on trading with vegetables and potatoes. Družstvo Bramko is the biggest market organisation specialising on the trade with vegetables and potatoes in the Czech Republic. The member companies of Družstvo Bramko CZ grow all together more than 950 hectares of potatoes, 140 hectares

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<sup>56</sup> (Česko se z bývalé bramborové velmoci stává trpaslíkem. Je odkázáno na dovoz, 2011)

<sup>57</sup> (Bumba, 2011)

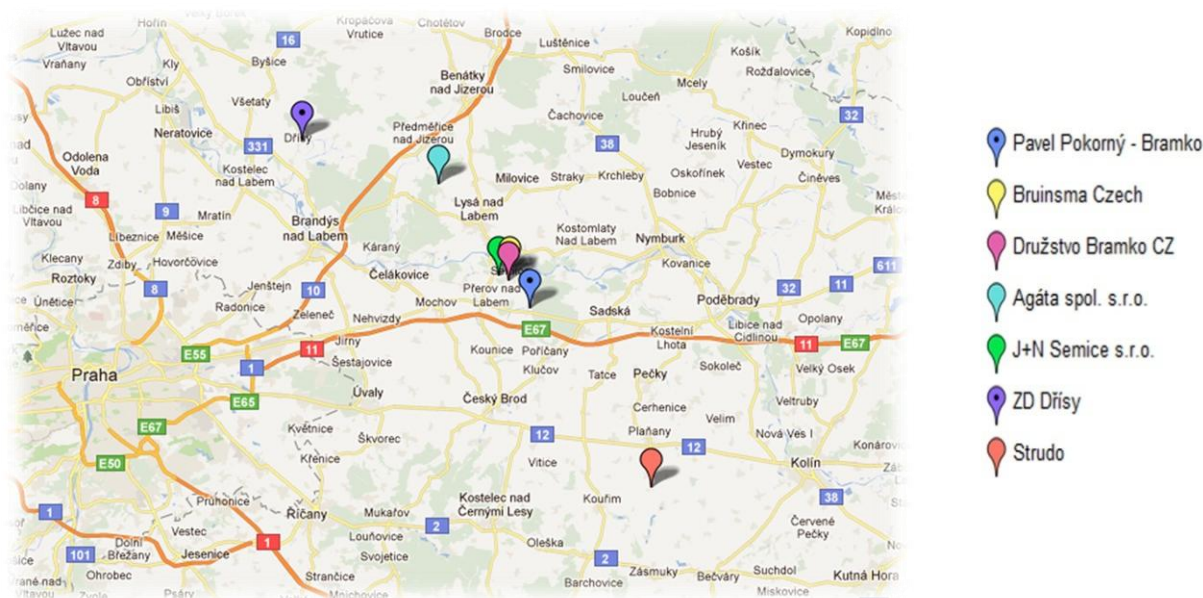
<sup>58</sup> (Definition of costs)

<sup>59</sup> (Samuelson & Nordhaus, 1991)

of salads, 70 hectares of cabbages, 200 hectares of radishes, 250 hectares of onions, 80 hectares of kohlrabies, 80 hectares of parsley, 10 hectares of chives and 30 hectares of garlic. On the rest of the fields of members of Družstvo Bramko CZ are grown cereals.

The author of this diploma theses had unlimited access to all production companies of the trade cooperative Družstvo Bramko CZ. The cooperative Družstvo Bramko CZ has its base in Semice. The seats of all members of Družstvo Bramko CZ can be seen on Picture-1, which was created by the use of Google Maps.

**Picture -1**



*Source: Own work of an author based on (Google Maps)*

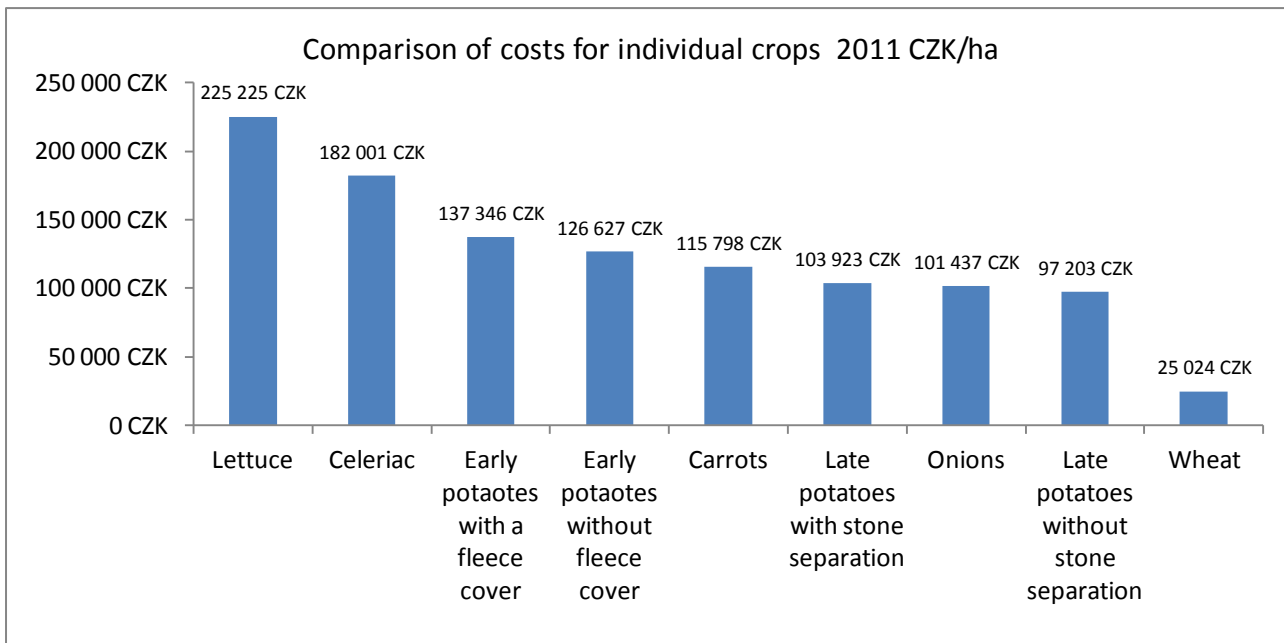
Fields of Družstvo Bramko CZ members are placed in the region of Poděbrady and Všetaty. In these regions were built widespread irrigation systems in the era of communism. These irrigation systems are nowadays still working and provide great competitive advantage to its users. The catchment areas of rivers Jizera and Labe are together with the South Moravia the earliest areas in the Czech Republic. In the catchment areas of rivers Jizera are located company ZD Dřisy and partly also Agáta spol. s.r.o. In the catchment area of river Labe are located companies Bramko s.r.o., J+N Semice s.r.o. and Pavel Pokorný – Bramko. The companies Strudo and Bruinsma Czech s.r.o have their fields located in the Kolín area. In the Kolín area the soils perform one of the best scores of

Czech bonity system. Unfortunately the irrigation in the Kolín area is very difficult and almost impossible.

The experimental measurement for the purposes of this diploma thesis was made in the summer of the year 2011. The results were put into tables for individual crops. The costs were divided into two very basic groups – field operations and material costs. Into field operations were included soil preparation, application of fertilizers, planting, application of pesticides, application of fungicides, irrigation, harvest costs, transport cost and eventually other costs. The material costs include seeds or plants, fertilizers, cost of water, rent and eventually other costs. All the costs were always measured or recalculated per one hectare. Usually there was made a measurement for one field block and then the costs were recalculated per hectare. The costs of all fertilizers were summed up into one digit. The same has been done with all the fungicides, herbicides and pesticides. The overhead costs were calculated as 12% of all the other costs.

The costs for each crop are organized in **Tables 21-29**. Into comparison were include onions, carrots, wheat, very early potatoes and late potatoes. The early potatoes were grown under irrigation in two modifications. The potatoes that were intended to very early harvest were grown under fleece cover. The member companies of Družstvo Bramko CZ grow all together about 200 hectares of potatoes under fleece cover. The rest of potatoes are grown without fleece cover. The potatoes for very early harvest and early harvest are grown in the region of Semice, Všetaty and Stará Lysá where the irrigation is available. The potatoes grown for the late harvest are grown mainly in the area of Bošice, Plaňany and Přebozy by the companies Strudo and Bruinsma Czech. Based on **Tables 21-29** were created **Tables 30-39** that compare the individual cost factors, that influence the production. On the **Table – 40** is based **Graph -18** which shows the difference in total costs of the compared crops.

**Graph -18: Comparison of costs for individual crops 2011**



Source: Own work of an author based on field experimental study in Družstvo Bramko CZ

Based on **Graph -18** can be recognised significant differences in the total growing costs of individual crops. Potatoes are much more costly to be grown than cereals that are represented in this comparison by wheat. The growing costs of potatoes are comparable with the production of onions and carrots. The growing costs of celeriac and lettuce are significantly higher than the growing costs of potatoes. There can be recognised that growing of early potatoes is more costly than growing late potatoes

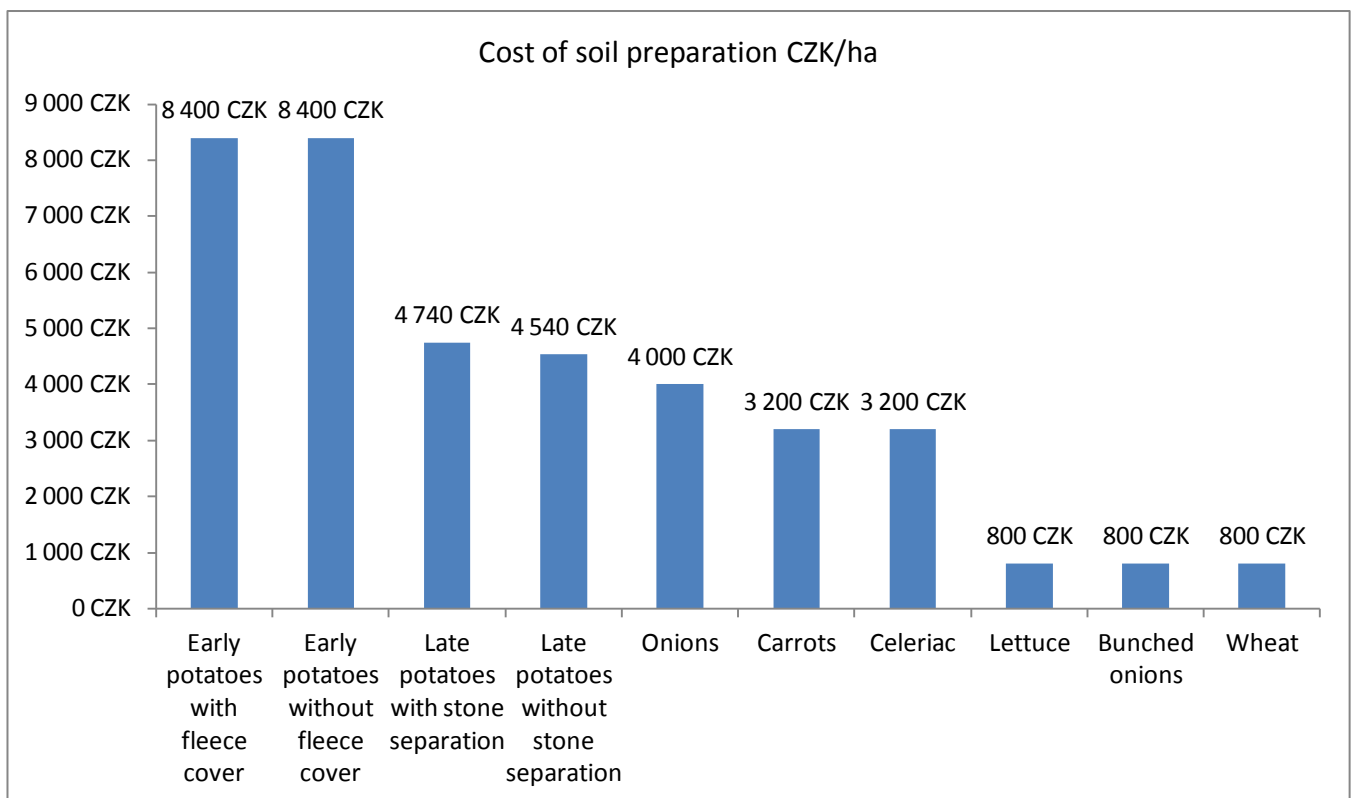
Into the comparison of total costs were not included transport cost of final product, final cleaning of the final product, washing and packing of the final product. It is pretty straightforward that all these things have to be done in the practice and that all these factors play a significant role. In the real world different products are transported from various locations and require different post-harvest treatment. All the member companies have usually stores and post-harvest treatment capacities for vegetables in the neighbourhood of their fields. Družstvo Bramko CZ has a central store in Semice. Into this store are usually transported final products that are in the central store prepared for the final customers. The crops from various growing companies are combined here for particular customers into a single shipment and then they are transported to the customer. The post crop treatment of

potatoes in Družstvo Bramko CZ is little bit extraordinary from the other crops produced within the cooperative.

The individual production companies share the harvesting technology. There is a disponibility of 6 two row harvesters either from the company Grimme or from the company WM. The raw harvested potatoes are either transported to one of the stores or in case of potatoes for direct sale they are transported into the central store of Družstvo Bramko CZ in Semice. There is located a complete post-harvest treatment line that includes washing, sorting, polishing, drying, calibration and packing.

In order to see the structure of cost differences the total costs will be decomposed.

**Graph – 19: Cost of soil preparation 2011**



*Source: Own work of an author based on field experimental study in Družstvo Bramko CZ*

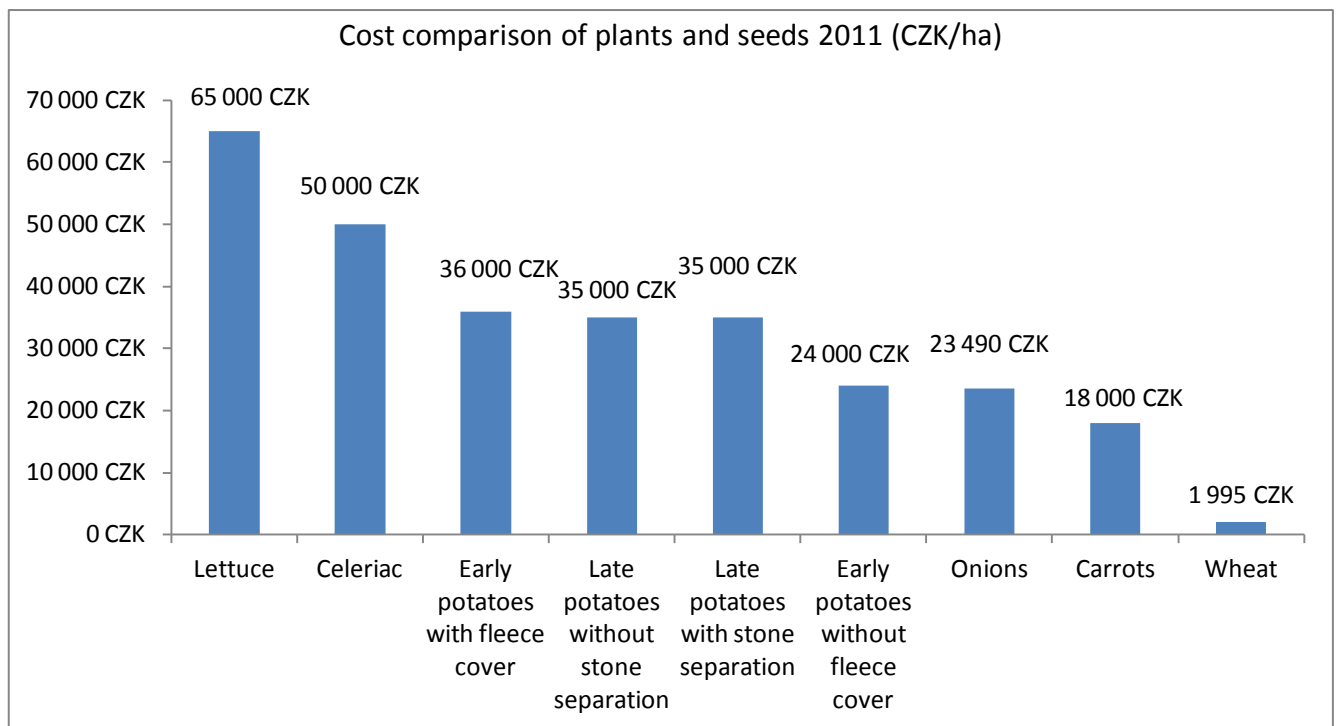
**Graph – 19** was created on the basis of **Table – 32** and shows the difference in costs for the soil preparation among all the compared crops. The soil preparation for potatoes is more costly than for the other products. It is mainly because it is done in the very early spring and need the soil to be prepared quite deep. That means that there has to be used heavy machinery that operates in quite humid soil. That needs powerful tractors



that have to drive quite slowly and that cost a lot of more money than the soil preparation for example for weeds where even the conventional tillage is not done.

The cost of seed potatoes is shown on the **Graph – 20**, which was created on the basis of the **Table – 34**. There can be recognised that there has been used different varieties. The variety plays role in determination of the price of the seed potatoes which is the reason of seed potatoes per hectare is different among early and late potatoes.

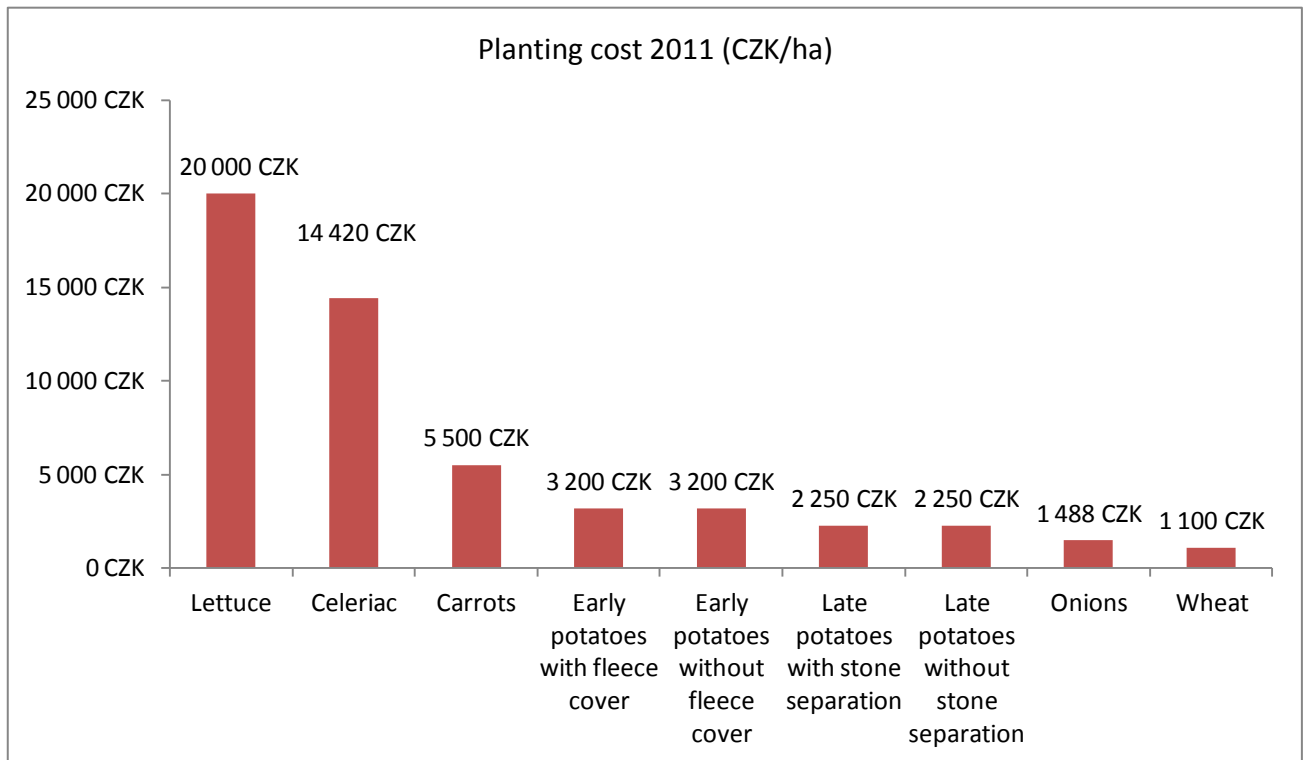
**Graph – 20: Cost comparison of plants and seeds 2011**



*Source: Own work of an author based on field experimental study in Družstvo Bramko CZ*

Each variety of potatoes also requires different spacing between individual potato plants. Although the early potato varieties are sometimes more costly than the others they usually have bigger spacing among individual plants so there are less of them needed per hectare. If the cost of seed potatoes is compared with young plants of lettuce and celeriac then the seed potatoes are less expensive per hectare. Apart from that the seed of onions or carrots are less expensive than seed potatoes. The cost of seed of wheat is about 15 times lower than seed potatoes.

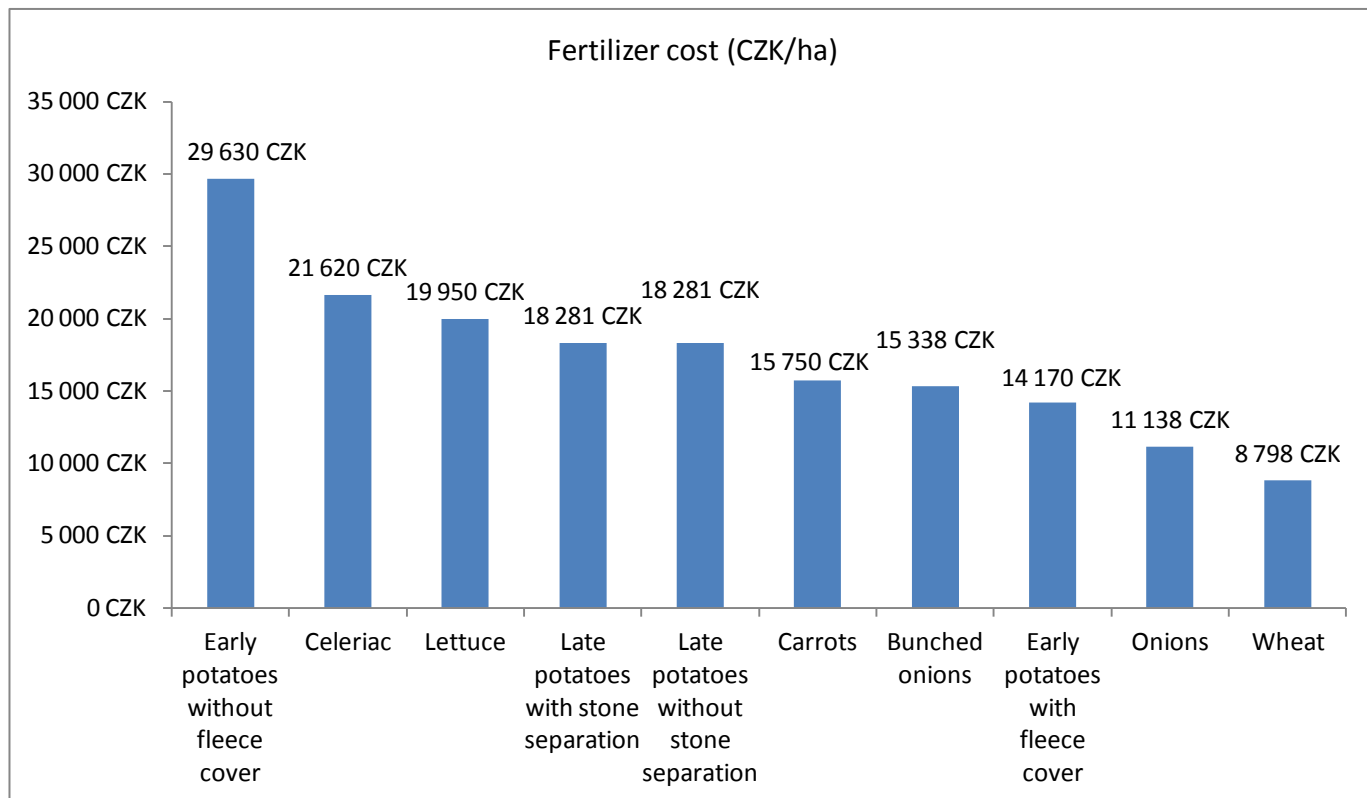
**Graph-21: Planting cost 2011**



*Source: Own work of an author based on field experimental study in Družstvo Bramko CZ*

On the **Graph-21** are compared the planting costs of individual crops. **Graph -21** was created on the basis of **Table -33**. It is obvious that the cultures of crops that are sown and not planted are cheaper to be started than the planted crops. The cost of early potatoes planting is higher because the machine had to go slower due to high humidity of the soil. Later on the planting was faster, so the per hectare cost decreased. In this comparison there was calculated in early potatoes as well as in late potatoes with the planting with automatic machine. There is also another possibility to plant the potatoes with semi-automatic machines. The planting with a semi-automatic machine is more costly because it requires more workers and goes slower but provides one significant advantage. The planting with a semi-automatic machine is more sensitive to the seed potato which stimulates its growth and the harvest of the potato in comparison with the automatic planted *ceteris paribus* done few days earlier. On one hand earlier harvest can have a significant effect on the price of potatoes but not always. On the other hand the planting with the semi-automatic machine significantly increases the costs. So it is quite risky to plant with the semi-automatic machine but there are still each year some hectares planted with the semi-automatic planters.

**Graph-22: Fertilizer cost 2011**

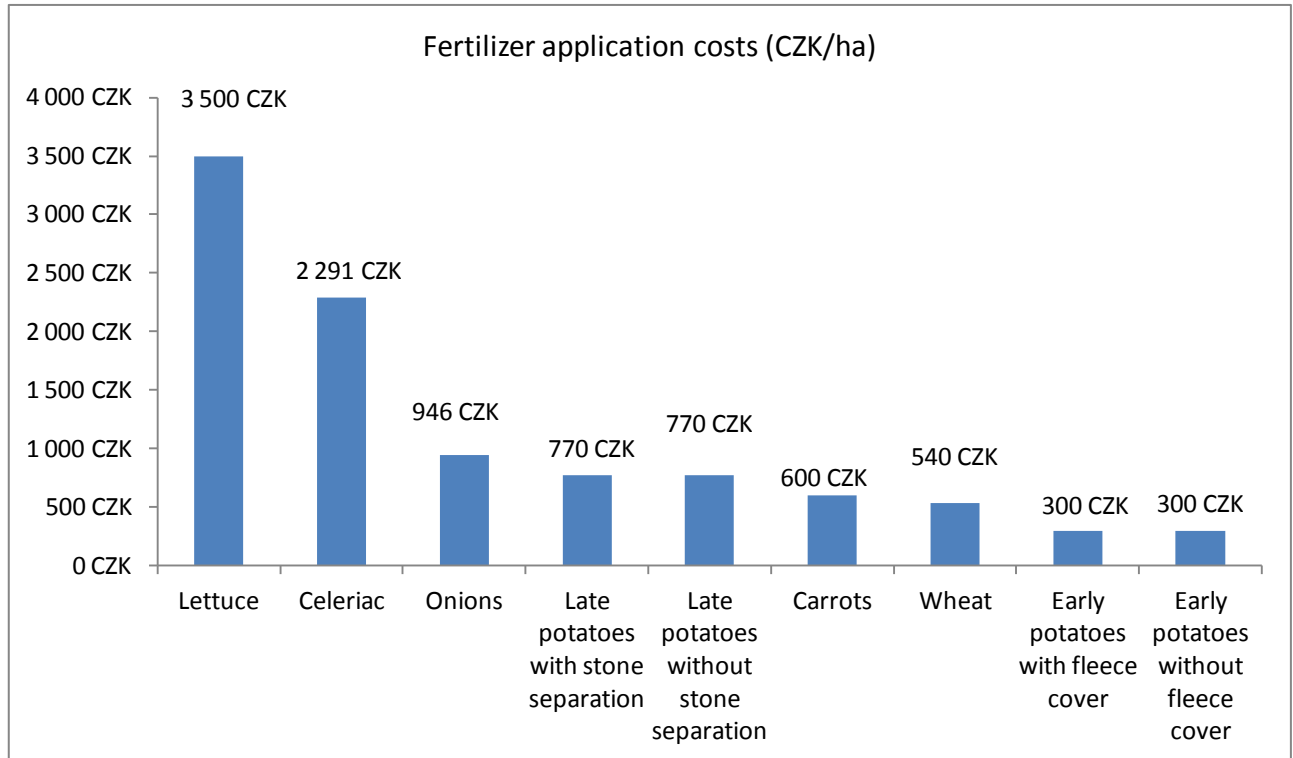


Source: Own work of an author based on field experimental study in Družstvo Bramko CZ

Fertilizer costs used per each crop are shown on the **Graph-22** which is based on **Table-30**. There can be seen that although in the production of potatoes there were used similar doses of fertilizers on all fields the costs were absolutely different. The reason is that there are various fertilizers on the market. The cheapest way is to buy the NPK mix as the nitrogen, phosphorus and potassium separated in several capsules with fast release into the soil. The more expensive products such as Compo Nitrophoska have all three substances nitrogen, phosphorus and potassium integrated into one capsule and emerges into the soil slowly. It has several advantages. The individual capsules of nitrogen, phosphorus and potassium have usually different size and weight which means that during the application they fly from the machine different distances. The usage of one uniform capsule has the effect of more uniform fertilization which has significant effect on the yield and revenue. The other advantage that the one uniform capsule emerges slower into the soil and that is why there is less of them needed.

In the comparison with the other crops the costs of fertilizers needed for the production of potatoes are on the similar level with lettuce. The costs are little bit lower than the costs of fertilizers used for the production of celeriac but much higher than fertilizers needed for the production of wheat or onions.

**Graph-23: Fertilizer application costs 2011**

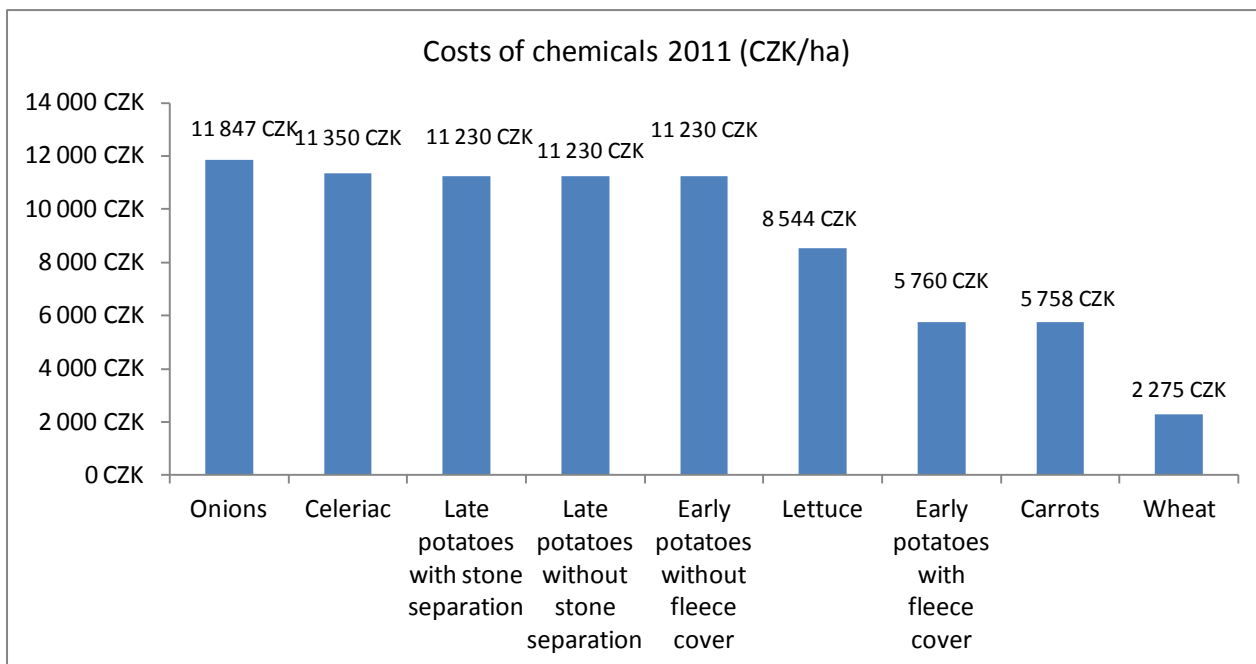


*Source: Own work of an author based on field experimental study in Družstvo Bramko CZ*

The cost of application of these fertilizers is in the production of potatoes quite low. This situation is shown on **Graph-23** which was created on the basis of **Table – 31**. The highest cost of fertilizers application is in the production of lettuce and celeriac because these products need supply of fertilizers in very low doses and very frequently. The early potatoes get usually all the fertilizers at once and the late potatoes get them in two or three applications. This is done because the late potatoes remain on the field longer time.

The costs of chemicals are compared in the **Graph-24** which is based on the primary data that were structured in the **Table – 38**.

**Graph-24: Costs of chemicals 2011**



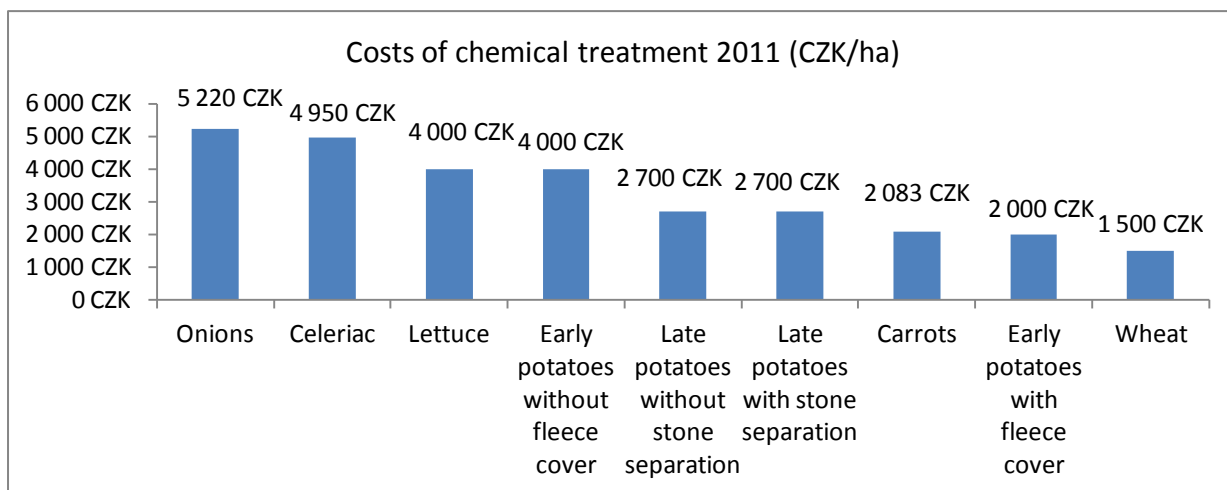
Source: Own work of an author based on field experimental study in Društvo Bramko CZ

There can be recognised that the costs of chemicals satisfy the maximum allowed amounts and are almost comparable among wide range of crops. Just lettuce and early potatoes required this season less applications of chemicals and that is why the cost of chemicals for these crops was lower. The maximum doses are prescribed for all crops in the Czech Republic and it is strongly forbidden to exceed these limits. The amount of residuals of chemicals is regularly tested by the official institutions and Društvo Bramko CZ also makes its internal test for residuals in order to supply its customers with residual free products. There are much less chemicals used in the production of wheat and these chemicals are also significantly cheaper than those used for the production of potatoes and vegetables. This explains why there were found lowest costs for chemicals in the production of wheat in the experimental study.

**Graph-25** shows the costs of chemical treatment. This **Graph -25** is based on **Table – 35**. The price of chemical treatment depends on the doses that individual crops require, number of applications and the length of the vegetation period of a particular crop. As it can be seen on **Graph-25** the lowest costs for chemical treatment are in the production of wheat. Early potatoes exhibit the second lowest cost for chemical treatment.

That is caused by the facts that the vegetation is quite short and significant portion of the vegetation spend early potatoes under fleece cover.

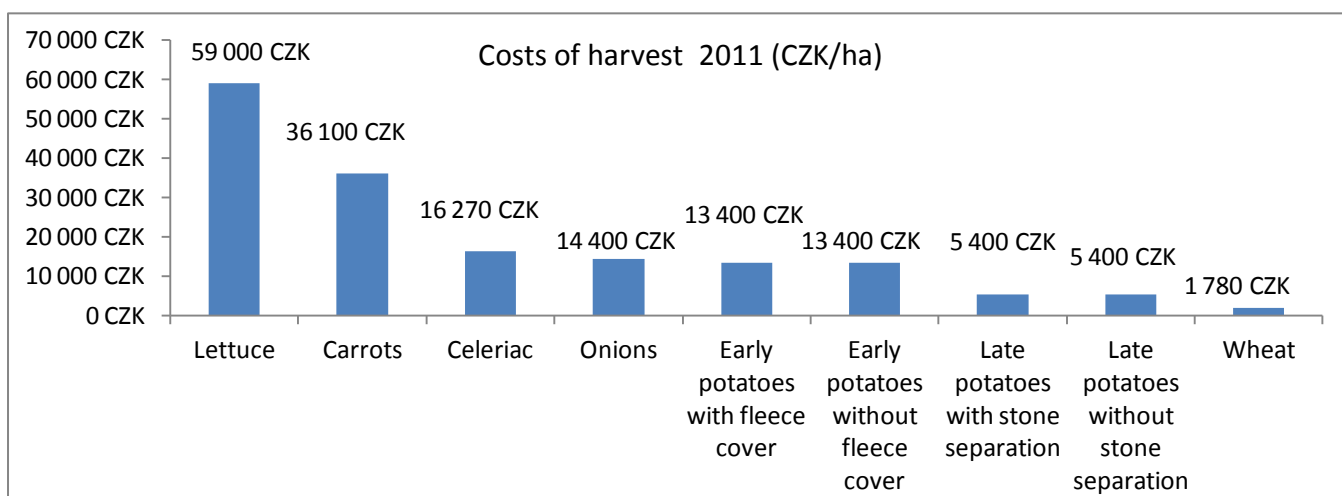
**Graph -25: Costs of chemical treatment 2011**



*Source: Own work of an author based on field experimental study in Družstvo Bramko CZ*

When the potatoes are under fleece cover they are not treated by chemicals. Late potatoes have longer vegetation period, require spreading of chemicals over whole vegetation period which increases the costs for application. The potatoes without fleece cover were little bit special this year because on that field was tested different (more costly) technology.

**Graph -26: Costs of harvest 2011**



*Source: Own work of an author based on field experimental study in Družstvo Bramko CZ*

The onions are on the field quite long period and require the chemicals in small doses which imply the highest costs from the examined crops.

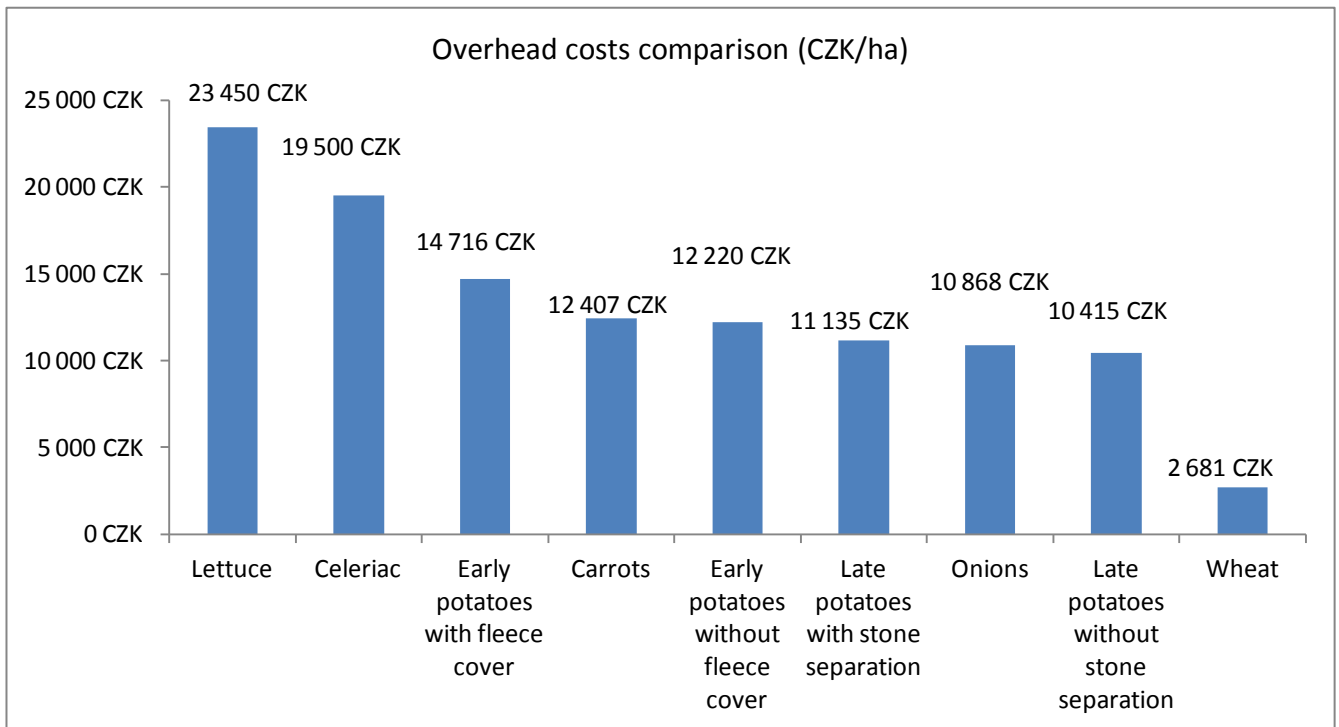
**Graph-26** compares the costs of harvest of all analysed crops. **Graph – 26** is based on the **Table-36** from the appendix. The costs of the harvest are highest for crops where is required a lot of labour for harvest. It means that lettuce and carrots are very much dependent on the availability of labour. The harvest of celeriac is dependent on the labour as well because there is needed a post – crop cleaning where is used a lot of labour and that is not calculated in the harvest cost but in the other costs.

The harvest costs of potatoes are very much similar to the harvest costs of onions because both crops are harvested with a similar machine. The potato harvester needs a modification which makes it usable for the harvest of onion as well. The cost of harvest of onions compared to the cost of potato harvest is higher because the harvest of onions requires one more extra operation. The tractor holds two special devices. By the first one the dry leaves of onions are cut and by the second one is the onions turned up. Such a onions is left on field for some time (depends on the weather conditions – usually about one week) to get dry. Later on the onions is collected by the modified potato harvester.

The cutting of leaves and turning up makes the additional costs in the comparison to potatoes where all those operations are done at once and potatoes don't lie on the field for one week. The harvest of early potatoes was higher because they were harvested during June where the humidity of the soil was not ideal. The humidity of the soil was little bit too high which caused that the tractor had to go slower and that increased the harvest costs of the early potatoes.

The harvest costs of wheat are much lower than for potatoes because there is no any unskilled labour needed during the harvest of weeds. Wheat is harvested by completely different type of harvesters that makes the cost per hectare much lower because the harvest goes very quickly and there are no unskilled workers needed.

**Graph-27: Overhead costs comparison 2011**



*Source: Own work of an author based on field experimental study in Družstvo Bramko CZ*

**Graph-27** is based on the **Table – 37** and shows the comparison of overhead costs. *Overhead is synonymous with indirect costs in that it cannot be assigned to a specific contract without some method of allocation. Conceivably, there can be an all-inclusive overhead designed to include all indirect costs into a single expense pool. The danger of this broad designation is that there are several more defined types of overhead, each requiring a finer understanding of their specific characteristics.*<sup>60</sup> In the cooperative are the overhead costs assigned to several groups. Unfortunately every member have slightly different style of assigning costs into these groups which causes that individual groups of overhead costs are not comparable. In the experimental field study were overhead costs calculated just as the percentage share of total costs. It is straightforward that the distribution of crops is the same as in the case of total costs and does not need any further comments.

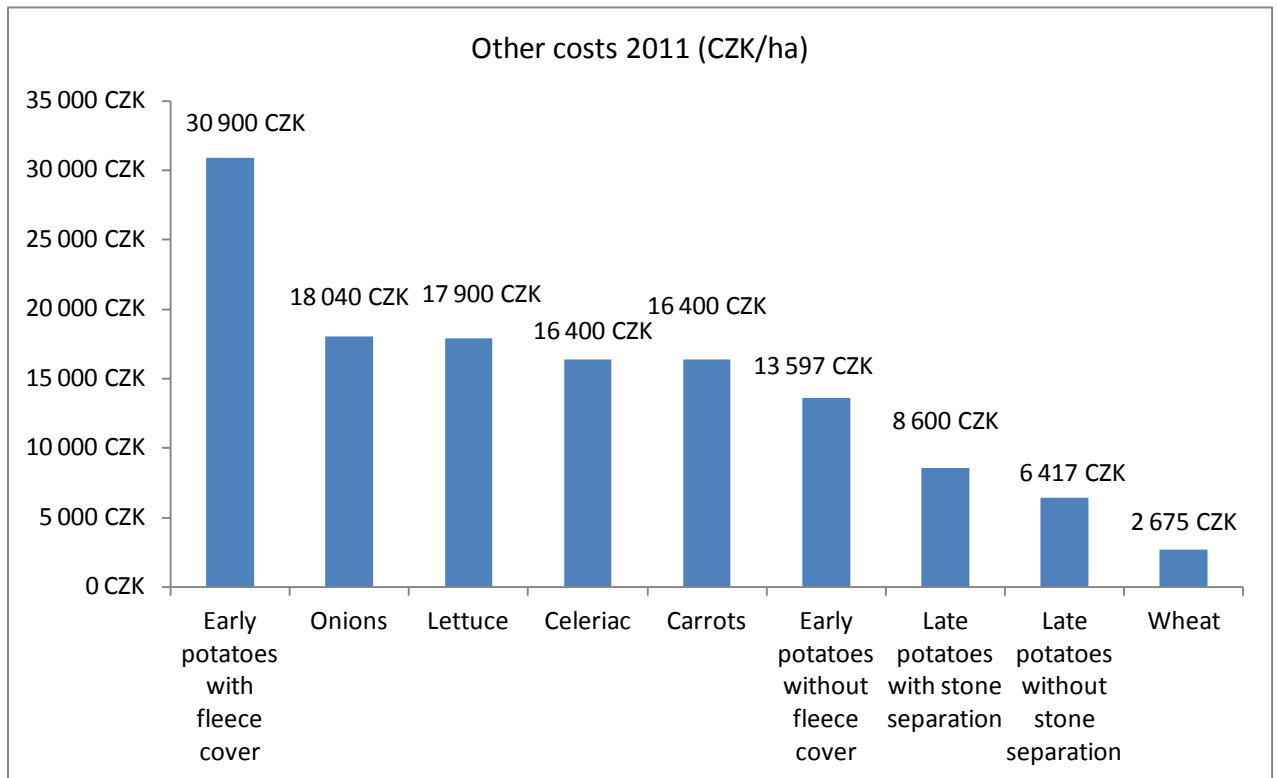
There were other costs associated with the production of individual crops. These crops were put into a **Table-39** and from this **Table -39** were made a **Graph-28**. Into other costs of all crops were included costs for rent which is 2400 CZK per hectare in the region

<sup>60</sup> (Norfleet, 2007)



of Semice and Stará Lysá. In the region of Všetaty the cost of rent is 2000 CZK per hectare and in the region of Kolín, in the neighbourhood of Bošice there is the most expensive – 2600 CZK per hectare.

**Graph-28: Other costs 2011**



*Source: Own work of an author based on field experimental study in Družstvo Bramko CZ*

For all the vegetables and early potatoes was into other costs included also irrigation. Irrigation was not used during the production of wheat and late potatoes therefore it was not calculated into other costs. The early potatoes grown under fleece cover has the higher other costs because into the other costs were included the fleece covers and manipulation with the fleece which makes all together 14500 CZK per hectare extra. In order to have the harvest as early as possible there were used also pre-sprouted seed potatoes in the production of potatoes under fleece cover. The cost of pre-sprouting per hectare of potatoes is also quite high – 4500 CZK per hectare. In the case of late potatoes with the stone separation was the cost of stone separation also included into other costs.

The comparison of the costs in the international scale would be rather difficult because there many are exceptions that again influence free trade and create comparative advantage to some farmers in some countries.<sup>61</sup> According to basic values and rules of the European Union there should be free trade among its members. Free trade should be with all production factors.<sup>62</sup> That should mean that the production costs should be in all countries very similar and should differ just by the amount of transport cost. Unfortunately the free trade with the production factors is distorted by many exceptions. One of the examples might be that the farmers in Poland do not have to pay income tax and any social insurance as it is common in majority of EU countries. This fact decreases the costs of potato farmers in Poland and they are then more competitive in the international potato market. This has negative implications on the production of potatoes within Czech Republic.<sup>63</sup> Another example of negative factors that influences hugely Czech potato growers are the unequal regulations for the use of chemicals and fertilizers. For example in France and Poland are more of the chemicals allowed that of course affects the cost of growing.<sup>64</sup> In the following chapter will be researched which factors have the most important role on the yield of potatoes.

### **Estimation of potato production functions**

This chapter of diploma reveals analyses and quantifies various aspects that might have an effect on the yield of potatoes. There will be constructed a very simplified econometric model. On the basis of data gathered in the member companies of cooperative Družstvo Bramko CZ will be, by the use of regression analyses, researched influences of chemicals, labour, fertilizers and machinery on the yield of potatoes. In this very simple econometric model will be pretended that all these data explain fully the conditions in the real world, which is of course not true. There are many other influences that have an impact on the yield of potatoes. The data were gathered on diverse locations which had different soil and climatic conditions. This also decreases explanatory value of the model but there will be expected that all the crops were grown under similar conditions.

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<sup>61</sup> (Pindick & Rubinfeld, 2005)

<sup>62</sup> (DOHODA O VOLNÉM OBCHODU, 2011)

<sup>63</sup> (Vavrouška, 2011)

<sup>64</sup> (Králová, České zelinářství v Evropské unii: soutěž v nestejných podmínkách, 2005)

During summer 2011 there were gathered data on 15 diverse locations. There was measured yield, labour, and consumption of chemicals, use of machinery and use of fertilizers for early potatoes grown under fleece cover, early potatoes grown without fleece cover and late potatoes. To have a comparison with other crops there were gathered data also for wheat and lettuce. The data were always measured for a whole field block and then they were recalculated per one hectare. Fertilizers represent the consumption of fertilizers in kilograms per hectare. The usage of chemicals was measured in litres per one hectare. Machinery was measured as sum of hours of operations of all machines present on the field block during the vegetation and then it was recalculated per hectare. Labour was calculated as the sum of all work hours of all workers present on the particular field block during the vegetation and then it was recalculated per one hectare. All the values were rounded after recalculation per one hectare.

Early potatoes under fleece cover were grown from the pre-sprouted seed potatoes, planted with a semi-automatic planting machine and irrigated. That is why the hours per hectare are usually higher in the comparison with early potatoes and late potatoes. The early potatoes were not pre-sprouted, were planted with an automatic planting machine and were not grown under fleece cover. The yield of potatoes and wheat was measured in tonnes per hectare. The yield of lettuce was measured as a number of harvested lettuces per hectare. The yield of early potatoes was lower than of the late potatoes which were caused by two reasons. Firstly it was caused by the differences among varieties where the varieties of late potatoes usually provide higher yields. Secondly it was caused by intentional early harvest of early potatoes. It was done in order to be on the market faster than competitors with the view of better prices.

Based on the information provided above there will be constructed 4 production functions. All the functions will be computed as one equation models which do not have any relation between each other. The first production function will be constructed for very early potatoes. The explained variable ( $Y_{1t}$ ) will be yield of very early potatoes which will be explained by explanatory variables that are fertilizer consumption per hectare ( $X_{4t}$ ), consumption of chemicals ( $X_{5t}$ ), usage of labour ( $X_{2t}$ ) and usage of machinery ( $X_{3t}$ ). In order to receive the intercept, there will be included also unit vector into our model ( $X_{1t}$ ).

In order to simplify the model there is expected linear relationship between variables. The equation for economic model looks like:

$$\beta_{11}y_{1t} = \gamma_{11}x_{1t} + \gamma_{12}x_{2t} + \gamma_{13}x_{3t} + \gamma_{14}x_{4t} + \gamma_{15}x_{5t}$$

The economic model is just a deterministic relationship. We know that with one equation and so low number of variables we are not able to model real world. So we will add into our economic model stochastic variable – the error term and by that we will transform our economic model into econometric model. The stochastic variable can be found in our model as  $u_{1t}$  and contains three substances:

- Factors which influence our dependent variable but they are not included in the model
- Mistakes of measurement
- Errors connected with analytical type of function – we use simpler function than reality

The equation of the econometric model is then:

#### **Formula-1**

$$\beta_{11}y_{1t} = \gamma_{11}x_{1t} + \gamma_{12}x_{2t} + \gamma_{13}x_{3t} + \gamma_{14}x_{4t} + \gamma_{15}x_{5t} + u_{1t}$$

Based on the data provided in the company Družstvo Bramko CZ was made an estimation of parameters for our econometric model. Based on the request of the representatives of company Družstvo Bramko CZ will be shared in this diploma thesis just the basic information about the data set. For each time series there will be given just the maximum value, minimal value and the average value. These data about first estimated equation can be found in the appendix as a **Table-41**. Before the estimation of the coefficients on individual parameters there has to be controlled if there is not any correlation between the explanatory variables. All the computations were made by the usage of a special Plug-in for the programme Microsoft Excel. The results were further confirmed also by recalculation in the software Gretl. There was computed correlation matrix that can be found in the appendix as a **Table-42**. From the **Table-42** is obvious that in our model is

not present critical correlation between explanatory variables and that the parameters of explanatory variables can be estimated.

Based on the Microsoft Excel calculation was created a **Table-38** that includes the estimated coefficients, coefficient of determination and the t-value. Based on **Table-38** was created **Formula-2** of production function for early potatoes.

### **Formula-2**

$$\beta_{11}y_{1t} = -17,93 + 0,25x_{2t} + 0,17x_{3t} + 0,008x_{4t} + 0,24x_{5t} + u_{1t}$$

From the **Table-43** can be read that the coefficient of determination is 0,7161 which means that 71,61% of reality is explained by our model. The statistical significance of variables will be determined according to p-value. If the p-value is equal or lower than 0,025 then the variable is statistically significant for 95% or even more. Based on **Table-43** can be said that all the variables present in the econometric model for early potatoes are statistically significant.

From the **Formula-2** can be read that the major influence on the yield of early potatoes has  $X_{2t}$  which are the hours of labour. If the input of labour into production increases by 1 hour per hectare then the yield increases by 0,25 ton per hectare which is quite a lot. Variable with the second strongest influence on the yield of potatoes is  $X_{5t}$  which is consumption of chemicals. When the input of chemicals increases by one litre per hectare then the yield according to our econometric model increases by 0,24 ton per hectare. The lowest influence on the yield of early potatoes according to our model has the input of  $X_{4t}$  which are fertilizers. The increased input of fertilizers by one kilogram increases the yield of potatoes by just about 8 kilograms. From the **Table-43** and **Formula-2** it is pretty obvious that in the real world the production function is not a linear relationship. The coefficients in Formula-2 are with the plus sign which implies that the function has increasing trend. If the inputs were increasing for ever the yield of early potatoes should also increase forever which in reality is definitely not true. If compared with the reality the function should represent diminishing returns to scale. In the beginning the yield of early potatoes should react on increased inputs positively and later, the increments of the yield should be decreasing. When there were added too high doses of

inputs the yield should even decrease. The quadratic form of function should be probably more suitable our model.

There will be estimated parameters also for the early potatoes that were planted by an automatic planting machine and grown also under irrigation. Furthermore there will be computed the coefficients also for the late potatoes that were planted also by an automatic planting machine and grown without irrigation. The production functions will be compared also with the production functions of vegetables and wheat that will be also estimated.

All the estimations will be based on identical methodology in order to receive comparable results. All the production functions will be based on one equation linear relationship with five explanatory variables. The explained variable ( $Y_{1t}$ ) will be yield always the yield of particular crop which was measured in tons per hectare. Just in case of lettuce it was measured in the number of harvested salad heads per hectare. The explanatory variables will be in all production functions identical. There was measured fertilizer consumption per hectare ( $X_{4t}$ ), consumption of chemicals ( $X_{5t}$ ), usage of labour ( $X_{2t}$ ) and usage of machinery ( $X_{3t}$ ). In order to receive the intercept, there will be included also unit vector into our model ( $X_{1t}$ ). Just in case of wheat there will not be included the influence of labour ( $X_{2t}$ ) because there is not used any unskilled labour during the production of cereals. The general formula for all production functions will be then:

**Formula-3**

$$\beta_{11}y_{1t} = \gamma_{11}x_{1t} + \gamma_{12}x_{2t} + \gamma_{13}x_{3t} + \gamma_{14}x_{4t} + \gamma_{15}x_{5t} + u_{1t}$$

Just for the production of wheat it will look like:

**Formula-4**

$$\beta_{11}y_{1t} = \gamma_{11}x_{1t} + \gamma_{13}x_{3t} + \gamma_{14}x_{4t} + \gamma_{15}x_{5t} + u_{1t}$$

All the models were tested if the explanatory variables are not correlated. The table with the basic information about the data measured for early potatoes is in the **Table-44**. In the comparison with the very early potatoes can be recognized higher average yield which is not a surprise. In the **Table-45** can be seen that there is no significant correlation between explanatory variables in the model for early potatoes planted with automatic

machine. The basic information about the data set for the late potatoes is included in the appendix as a **Table-46**. Again there can be seen increase in the yield in comparison with the early and very early potatoes even if the late potatoes were grown without any irrigation. The reason for that are the variety characteristics and the type of soil. Late potatoes were grown in companies Bruinsma Czech and Strudo in and the measurements were made in the area of Bošice where the quality of soil is unique. **Table-47** is the correlation matrix for the model of late potatoes. Also in this model there was not found any significant correlation of explanatory variables.

The overall information about the measurements that were taken in wheat can be found in **Table-48**. There can be realise quite high variability among yields within Družstvo Bramko wheat fields and also the average yields does not reach very high values. The reason is that wheat is not grown as a main crop in Družstvo Bramko CZ and it is used just as one of the components for the crop rotation. Wheat is sometimes sown on fields that are not very suitable for that and that is why the yields do not reach the best companies in the Czech Republic. On the other hand the yields of potatoes in Družstvo Bramko CZ are very much higher than is the average of the Czech Republic. The correlation matrix for the explanatory variables for the production function of wheat can be found in the appendix as a **Table-49**. Also between explanatory variables of the yield of wheat there was not found any significant correlation.

Into the comparison of the production functions will be included also a production function for carrots. The basic data about the field experimental measurement can be found in the **Table-50**. The correlation matrix for the explanatory variables of yield of carrots is listed in the appendix as a **Table-51**. Based on **Table-51** can be said that even between explanatory variables of carrot yield is not a significant correlation, so the estimation of all production functions can be performed.

The results of the estimation of parameters of for the early potatoes are in the appendix as **Table-52**. From that can be read the production function for early potatoes which is:

**Formula-5**

$$y_{1t} = -0,53 + 0,4x_{2t} + 0,35x_{3t} + 0,01x_{4t} + 0,4x_{5t} + u_{1t}$$

The coefficient of determination tells us that reality is explained by our model just from 67%. Calculated P-values show that all variables are statistically significant for 95% or more except the intercept. It is obvious that even if there were not given any inputs the yield cannot be negative. This mistake of the model is most probably caused by wrong functional form of the model. In reality we would have to recalculate the model and the quadratic function would be used. In this diploma thesis this insignificance will be ignored. The highest influence on the production of early potatoes have again labour and chemicals. The influence of these two variables is even stronger than in the case of very early potatoes. As there is researched the same crop just under different growing conditions it is acceptable that it is influenced by the same factors.

The results for the late potatoes can be found in the **Table-53**. Based on the **Table-53** was created following production function for late potatoes:

**Formula-6**

$$y_{1t} = -1,88 + 0,54x_{2t} + 0,4x_{3t} + 0,03x_{4t} + 0,27x_{5t} + u_{1t}$$

Apart from the very early and early potatoes the usage of machinery has shown up to be important for the production of late potatoes. The most important is again the labour within the production of late potatoes. Addition of one hour of labour according to **Formula-6** adds 0,54 tonnes per hectare on yield. The usage of chemicals is in the comparison with other explanatory variables also quite significant. The addition of one litre of chemicals per hectare increases the yield of late potatoes by 0,27 tonnes per hectare. The coefficient of determination says that the reality is explained by this production function by 61,56%. The P value shows that all our explanatory variables are significant again except the error term which is most probably connected again with the linear type of function. There would be more suitable to use quadratic function for our estimation but as there was already stated – these production functions were simplified a lot.

**Formula-7**

$$y_{1t} = -0,27 + 0,33x_{3t} + 0,013x_{4t} + 0,29x_{5t} + u_{1t}$$



The production function of wheat is constructed on the basis of results from the Table-49. The production of wheat and the yield of wheat is explained by the production function by 81,07% which is quite strong dependence. The variable with the highest influence on the yield of wheat is  $X_{3t}$  and  $X_{5t}$  which is machinery and chemicals. If there is added one hour more of machinery per hectare into the production then, according to **Fomula-7**, the yield of wheat increases by 0,33t per hectare. If there is added one litre of chemicals per hectare, then the yield according to our production function increases by 0,29 tonnes per hectare. The linear form of function again caused that all the explanatory variables are according to the P-value from **Table-54** significant except the P-value for the intercept.

Finally there was constructed a production function for carrots. The results of the estimation can be found in the appendix as a **Table-55**. Based on that the production function for carrots is:

**Formula-8**

$$y_{1t} = -10,35 + 0,2x_{2t} + 0,21x_{3t} + 0,03x_{4t} + 0,3x_{5t} + u_{1t}$$

All the variables in this production function were found to be significant even the intercept, which was quite a problem in the previous production functions. The explanatory variables with the highest influence on the yield of carrots are chemicals, machinery and labour. Again according to the production function for carrots the use of fertilizers is not so important. According to the coefficient of correlation, the estimated production function explains the reality by 69%.

If the production functions are compared it is clear that the quadratic function would be more suitable for the estimation. The linear relationship implies that if the inputs were added to the production forever then the yields of all crops would raise which is definitely not true. It is connected with the law of diminishing returns to scale. There was found quite surprising conclusion that the effect of fertilizers on yield is very low. On the other hand there was found that labour and chemicals are very important for the production because these two explanatory variables usually have the major effect on yield.

There has to be again mentioned negative influence of Czech government to the Czech growers. As it was proven with by the constructed production functions is strongly dependent on the factor of labour. In the Czech Republic in the potato and vegetable production often work foreigners as an unskilled labour force. As it can be seen on **Graph -30** which was created on the basis of **Table – 52** the highest number of foreigners is from Ukraine. The new regulation of Czech government wants to prohibit the submission of work permits to foreign workers from third countries. This should serve as a tool that should be used in the battle with unemployment.<sup>65 66</sup>

Unfortunately this new tool might have a serious effect on the Czech potato growers. It might happen that Czech growers will be this year without labour during season. There will be no one who would plant the potatoes and no one who would harvest them. This confirms the article on Czech server aktuálně.cz which states that the ban of work permits for foreigners would even increase the unemployment. The Ukrainians are used as an unskilled labour and there are also employed people who manage them. These people will have no one to manage and will be redundant.<sup>67</sup> As it can be seen in **Table-56** and **Table -57** it recognised that the number of workers from the foreign countries is decreasing and as is decreasing the number of foreign workers in the Czech Republic the number of unemployed people is growing. Furthermore the seasonal workers come to work into Czech Republic in the summer when the unemployment is the lowest during the year and leave the Czech Republic for winter when the unemployment is high.

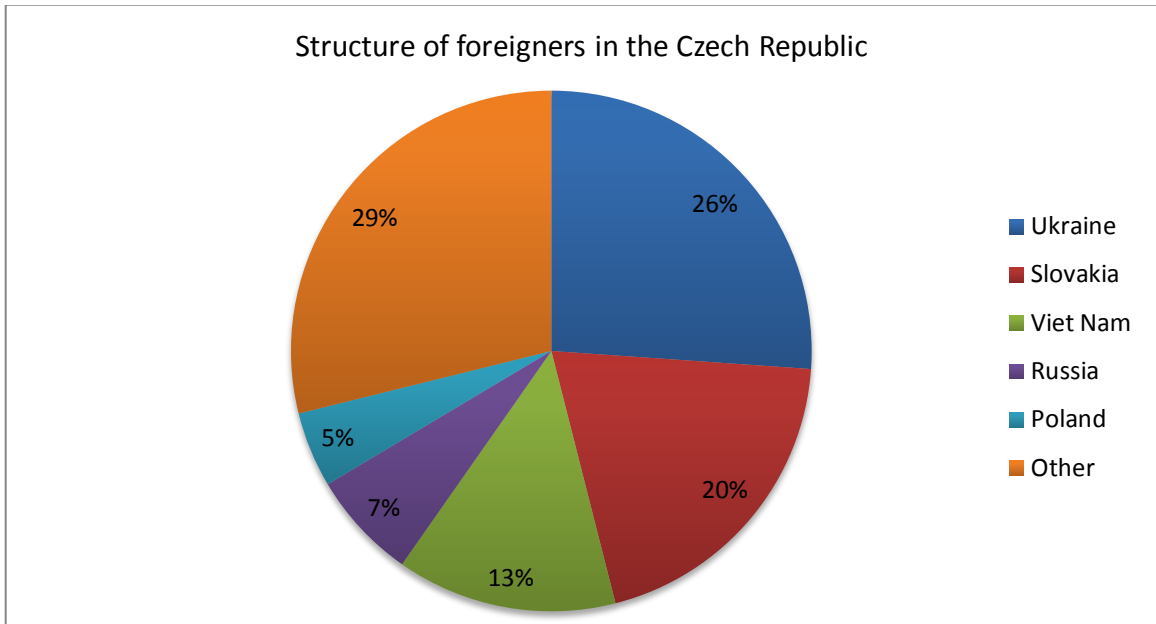
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<sup>65</sup> (SOUHLASÍTE?, 2012)

<sup>66</sup> (Synek, 2006)

<sup>67</sup> (Toman, Drábek bere práci Ukrajincům, o místa ale přijdou Češi, 2012)

**Graph-29: Structure of foreigners in the Czech Republic 2011**



*Source: Own work of an author based on data from Czech Statistical Office*

That there is no relationship between the number of foreign workers and unemployment declares also the study of Czech Ministry of Finance that was posted in the year 2007. The study also confirms everything that was stated above. The Czech government should probably first read the analysis that was paid from the pockets of Czech citizens and then issue the regulations.<sup>68</sup> Such regulations harm Czech regulations Czech farmers and just create corruption opportunities.<sup>69</sup>

Company Bramko organised a recruitment of a new staff two times. First of March and seventh of March were invited 240 applicants from the Czech labour office. Company Bramko was ready to accept 150 of them. Unfortunately just 93 of these applicants came to the recruitment day of company Bramko. All of them were offered to work but just 33 of them wanted to work. They were given labour contracts and were invited to join the staff of company Bramko. Unfortunately just three of these workers came the first day to work.

<sup>68</sup> (Pavel & Turková , 2007)

<sup>69</sup> (Cunningham, 2009)

Until 25<sup>th</sup> of March when this diploma this is being finished just one of these three workers remained in work.<sup>70</sup>

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<sup>70</sup> (Kučera, 2012)

## Conclusion

This diploma thesis has researched the potato market situation not only within the Czech Republic, but has also compared the industry with European and World standards. The history of growing potatoes was revealed. Some interesting details about the origin of potatoes were found. Based on historical context was analysed the current structure of Czech potato market. There was performed comparative analysis of time series where was found out that the production of potatoes in the Czech republic is decreasing in long term and that Czech Republic is not self-sufficient in the production of potatoes anymore. The main reason for that is the change in consumption manners of Czech population in the 1990s. Another reason was that Czech farmers were not ready in the early 1990s to compete with the competitors from the Western Europe who were on much higher technological level. Czech government cared more in that time more about the development of Czech foreign trade with industrial products and services and did not defend Czech farmers by any legislation or subsidies.

The structure of Czech potato market was identified and the possible influences were mentioned and further researched. In the early nineties there was significant change of the food chain in the Czech Republic. The market chains entered Czech retail market. The supply of potatoes to the final consumer changed dramatically those changes again negatively affected Czech producers. Significant pressure on price evolved, which in the short term it seemed to be a beneficial for the consumers, but it negatively affected quality supplied on the market. It has caused that many farmers were forced to leave the market because on their fields they did not reach the yields needed to become profitable. Yields were in the 1990s far under the average of the European Union which Czech Republic entered on 1<sup>st</sup> May 2004.

The Czech farmers did not receive equal subsidy conditions upon their entering the open European market. There were given reasons why the conditions in the current European potato market are not even. Within European Union were identified countries that benefit from the current subsidy conditions and countries that are handicapped by the current subsidy situation in Europe. There is a question if the Europe will be able to finance the Common agricultural policy in the future. It would definitely be worth

consideration the way of New Zealand where the subsidies were in 1984 cancelled and the only effect it had was the positive development of New Zealand's agriculture sector.<sup>71</sup>

Currently, Czech Republic is not self-sufficient in the production of potatoes any more. Czech Republic is heavily dependent on the imports from foreign countries. For Czech consumers it might be a future threat. On one hand the costs of energies and fuels are increasing and on the other hand subsidies will have the tendency to decrease.<sup>72</sup>

The estimated production functions have shown that the production of the potatoes is very much dependent on the usage of unskilled labour. There was also found out that the production of potatoes is not very much dependent on the usage of fertilizers. That might be an opportunity to implement the concept of an integrated production of potatoes that is currently discussed.<sup>73</sup> That would bring to the farmers the needed funds and to the consumers guarantee of safe food. The marketing brands such as Klasa or the label of regional speciality might also help to promote the Czech potato producers.

Although the current situation of the potato industry does not seem very encouraging author of this diploma thesis believes in the bright future of Czech potato industry and plans to join the team of Družstvo Bramko CZ in the very near future.

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<sup>71</sup> (Sayre, 2003)

<sup>72</sup> (Antrobus, 2010)

<sup>73</sup> (Čížek, 2009)

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# Supplements

**Table -1: Division of land in Czech Republic 2010**

Division of land in Czech Republic	2010
agricultural land	4 238 975
non-agricultural land	3 647 517

arable land	3 016 858
gardens	162 877
orchards	46 511
hop gardens	10 661
wineyards	19 292
permanent grasslands	982 776

*Source: Own work of an author based on data from Czech Statistical Office*

**Table -2: Division of arable land in the Czech Republic 2010**

Division of arable land in the Czech Republic
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Crop	Hectares (2010)	Percentage
Cereals	1459505	57,56%
Pulses	31318	1,24%
Root crops	84492	3,33%
Industrial crops	499792	19,71%
Fodder crops	406450,29	16,03%
Vegetables	8582,67	0,34%
Seed areas	265,69	0,01%
Unused land	45047,26	1,78%
Total	2 535 571	

*Source: Own work of an author based on data from Czech Statistical Office*

**Table -3: Division of root crops grown in the Czech Republic**

Division of root crops grown in the Czech Republic
--

Crop	Hectares (2010)	Percentage
Early potatoes	1721	2,04%
Other potatoes	21745	25,74%
Seed potatoes	3613	4,28%
Industrial sugar beet	56388	66,74%
Forage beet	908	1,07%
Other root crops	118	0,14%
Total	84 493	

*Source: Own work of an author based on data from Czech Statistical Office*

**Table -4: Division of potatoes grown in the Czech Republic**

Division of potatoes grown in the Czech Republic
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Crop	Hectares (2010)	Percentage
Early potatoes	1721	6,36%
Other potatoes	21745	80,30%
Seed potatoes	3613	13,34%
Total	27 079	

Source: Own work of an author based on data from Czech Statistical Office

**Table – 5: Development of land, yields and total harvests 1989-2011**

Year	Land				Yield				Harvest			
	Cereals	Potates	Suggar Beet	Oil Seed Rape	Cereals	Potates	Suggar Beet	Oil Seed Rape	Cereals	Potates	Suggar Beet	Oil Seed Rape
	Hectares				Tonnes				Thousands of Tonnes			
1989	1 669 850	115 446	127 124	102 376	4,69	21,01	35,52	3,06	7 793	2 422	4 497	313
1990	1 652 169	109 664	118 813	105 102	5,46	16,06	34,01	2,90	8 947	1 755	4 017	305
1991	1 620 585	113 858	118 988	127 773	4,87	18,03	33,73	2,74	7 845	2 043	4 009	348
1992	1 586 262	110 726	124 536	136 473	4,15	17,82	31,20	2,16	6 565	1 969	3 871	293
1993	1 606 911	104 931	107 243	167 423	4,03	23,30	40,37	2,26	6 468	2 396	4 308	377
1994	1 660 338	76 789	91 205	190 721	4,10	16,06	35,57	2,38	6 777	1 231	3 240	452
1995	1 581 341	78 045	93 654	252 285	4,19	17,08	39,86	2,62	6 602	1 330	3 712	662
1996	1 586 491	86 548	104 115	228 775	4,20	21,00	41,63	2,30	6 644	1 800	4 316	521
1997	1 696 325	72 839	94 498	229 767	4,14	19,30	40,32	2,47	6 983	1 402	3 722	561
1998	1 680 760	72 087	85 471	265 560	3,97	21,15	42,74	2,57	6 669	1 520	3 479	680
1999	1 586 592	71 505	59 078	350 353	4,35	19,69	45,60	2,67	6 928	1 407	2 691	931
2000	1 647 508	69 236	61 574	325 338	3,91	21,33	45,83	2,61	6 454	1 476	2 809	844
2001	1 626 785	54 296	77 849	344 117	4,52	20,88	45,41	2,84	7 338	1 130	3 529	973
2002	1 562 117	38 311	77 498	313 024	4,33	23,51	49,45	2,27	6 771	901	3 832	710
2003	1 452 349	35 984	77 326	250 959	3,95	18,97	45,20	1,55	5 762	683	3 495	388
2004	1 607 251	35 973	71 095	259 460	5,46	23,96	50,34	3,60	8 784	862	3 579	935
2005	1 593 487	36 073	65 570	267 160	4,75	28,08	53,31	2,88	7 660	1 013	3 496	769
2006	1 527 104	30 024	60 959	292 246	4,17	23,05	51,48	3,01	6 386	692	3 138	880
2007	1 561 191	31 913	54 272	337 570	4,53	25,72	53,25	3,06	7 153	821	2 890	1 032
2008	1 552 717	29 788	50 380	356 924	5,37	25,83	57,26	2,94	8 370	770	2 885	1 049
2009	1 528 020	28 734	52 465	354 826	5,08	26,19	57,91	3,18	7 832	753	3 038	1 128
2010	1 462 836	27 079	56 388	368 824	4,70	24,56	54,36	2,83	6 878	665	3 065	1 042
2011	1 479 484	26 450	58 328	373 386	5,60	30,45	66,84	2,80	8 285	805	3 899	1 046

Source: Own work of an author based on data from Czech Statistical Office

**Table – 6: World comparison -area harvested**

	<b>Countries</b>	Area Harvested (ths. Ha)
1	China	5078
2	Russian Federation	2109
3	India	1835
4	Ukraine	1408
5	Poland	491
6	Bangladesh	435
7	United States of America	407
8	Belarus	367
9	Peru	290
10	Germany	255
11	Romania	247
12	Malawi	241
13	Nigeria	222
14	Nepal	185
15	Kazakhstan	179
16	France	166
17	Netherlands	157
18	Kenya	153
19	Rwanda	151
20	Bolivia	147

**Table –7: World comparison - Yield**

	<b>Countries</b>	Yield (tonnes/Ha)
1	United States of America	44,31
2	United Kingdom	43,80
3	Netherlands	43,60
4	Belgium	42,27
5	New Zealand	41,82
6	Germany	39,98
7	France	39,75
8	Switzerland	38,67
9	Palestina	35,50
10	Denmark	35,27
11	Australia	35,13
12	South Africa	33,31
13	Turkey	32,33
14	Luxembourg	31,76
15	Canada	31,61
16	Austria	30,57
17	Jordan	30,18
18	Kuwait	30,11
19	Sweden	30,10
20	Spain	29,54

**Table – 8: World comparison -Total Production**

	<b>Countries</b>	Production (ths. tonnes)
1	China	74799
2	India	36577
3	Russian Federation	21141
4	Ukraine	18705
5	United States of America	18016
6	Germany	10202
7	Poland	8766
8	Bangladesh	7930
9	Belarus	7831
10	Netherlands	6844
11	France	6582
12	United Kingdom	6045
13	Malawi	4706
14	Turkey	4548
15	Canada	4422
16	Iran	4054
17	Peru	3814
18	Egypt	3643
19	Brazil	3595
20	Belgium	3456

*Source: Own work of an author based on data from Faostat*



**Table – 9: Europe comparison -area harvested**

	<b>Countries</b>	<b>Area Harvested (ths. Ha)</b>
1	Poland	491
2	Germany	255
3	Romania	247
4	France	166
5	Netherlands	157
6	United Kingdom	138
7	Belgium	82
8	Spain	77
9	Italy	62
10	Denmark	39
11	Lithuania	37
12	Greece	31
13	Latvia	30
14	Czech Republic	27
15	Sweden	27
16	Portugal	26
17	Finland	25
18	Austria	22
19	Hungary	20
20	Bulgaria	14
21	Ireland	12
22	Slovakia	11
23	Estonia	9
24	Cyprus	5
25	Slovenia	4
26	Malta	1
27	Luxembourg	1

**Table – 10: Europe comparison- Total Production**

	<b>Countries</b>	<b>Production (ths. tonnes)</b>
1	Germany	10202
2	Poland	8766
3	Netherlands	6844
4	France	6582
5	United Kingdom	6045
6	Belgium	3456
7	Romania	3284
8	Spain	2278
9	Italy	1558
10	Denmark	1358
11	Sweden	816
12	Greece	792
13	Austria	672
14	Czech Republic	665
15	Finland	659
16	Latvia	484
17	Lithuania	475
18	Hungary	440
19	Portugal	384
20	Ireland	331
21	Bulgaria	251
22	Estonia	163
23	Slovakia	126
24	Slovenia	101
25	Cyprus	82
26	Luxembourg	20
27	Malta	10

**Table – 11: Europe comparison-Yield**

	<b>Countries</b>	<b>Yield (tonnes/ha)</b>
1	United Kingdom	43,80
2	Netherlands	43,60
3	Belgium	42,27
4	Germany	39,98
5	France	39,75
6	Denmark	35,27
7	Luxembourg	31,76
8	Austria	30,57
9	Sweden	30,10
10	Spain	29,54
11	Ireland	27,09
12	Finland	26,15
13	Greece	25,21
14	Italy	24,97
15	Czech Republic	24,55
16	Slovenia	24,54
17	Hungary	21,73
18	Bulgaria	18,20
19	Poland	17,86
20	Estonia	17,46
21	Cyprus	16,91
22	Latvia	16,08
23	Portugal	14,88
24	Romania	13,30
25	Lithuania	13,01
26	Slovakia	11,45
27	Malta	6,79

Source: Own work of an author based on data from Faostat

**Table – 12: Development of consumption 1949-2010**

Year	Consumption of potatoes (kilograms per capita)	Consumption of vegetables (kilograms per capita)	Consumption of cereals (kilograms per capita)	Consumption of meat (kilograms per capita)
1949	128,2	75,1	141,8	35,5
1950	145,9	74,9	154,5	48,6
1951	142,1	77,9	135,6	43,5
1952	132,3	63,8	140,3	47,1
1953	129,3	77,6	139,9	47,4
1954	130,1	75,5	132	46,7
1955	126,1	82	136,1	51,2
1956	135,7	70,8	138,9	56,2
1957	130,7	76,1	127,6	58,7
1958	115,3	81,5	124,4	59,5
1959	117,7	78,8	124,9	61,1
1960	110,9	90,4	124,1	61
1961	114,1	76,1	125,4	62,4
1962	108,4	82,5	132,1	63,3
1963	121,3	86,7	131,9	62,6
1964	123,5	82,5	132,7	63,3
1965	99,1	76,2	126,6	66,2
1966	115,8	79,9	124,5	65,7
1967	125,8	80,7	120,4	66,7
1968	117,2	77,3	119,2	74,3
1969	106,7	68	113,5	74,2
1970	106,7	66,2	112,4	77,3
1971	108,9	60	111,2	79,2
1972	109	64,5	110,4	81,1
1973	110,3	62,9	108,1	82,4
1974	112,2	67	106,1	83,4
1975	102,5	62,6	106,4	86,6
1976	101,7	62,3	106,7	85,4
1977	98,9	71,9	104,7	86,3
1978	93,2	64	107,1	88
1979	85,8	64,1	107,4	89,5
1980	79,9	61,3	107,3	90,3
1981	82,3	63,6	109,7	90,6
1982	82,1	72,6	110,5	83,9
1983	82,4	66,6	109,3	87,8
1984	85,7	71,2	111,7	88,7
1985	81,9	68,1	113,3	89,3
1986	80,6	65,6	112,9	91,6
1987	80,2	71,6	114,7	93,5
1988	83,7	70,3	113,6	96,1
1989	82,8	68,7	115,4	97,4
1990	77,9	66,6	114,9	96,5
1991	84,2	73,6	116,2	88,4
1992	84,1	69,7	117,2	86,6

1993	84	74,2	118,2	84,3
1994	78	75,8	116,9	81,2
1995	76,5	78	115,7	82
1996	77,2	79,5	113,8	85,3
1997	76	81,1	107,9	81,5
1998	76,1	82,2	104,9	82,1
1999	75,9	85,3	104	83
2000	77	82,9	104,7	79,4
2001	75,3	82,1	107	77,8
2002	76	78,7	113,8	79,8
2003	73,6	80	110,9	80,6
2004	73	79,8	110,2	80,5
2005	72,5	77,8	106,3	81,4
2006	70	81,4	106,6	80,6
2007	69,5	82,7	114,9	81,5
2008	71,4	82,8	105,18	80,4
2009	64,87	81,2	113	78,77
2010	67,29	79,72	108,7	75,93

*Source: Own work of an author based on data from Czech Statistical Office*

**Table – 13: Total imports of potatoes by country 1999-2011**

Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Total import of potatoes by country (thousands of CZK)
Austria	1189	371	332	3279	11661	5316	5460	25804	48859	23635	28011	39416	28518	221851
Belgium		24315	1004	21840	14352	10879	706	2830	2778	739	6143	12250	13720	111556
Brazil								11						11
Bulgaria	77		122			213					394		325	1131
Columbia											1			1
Croatia			90	1927			140							2157
Cyprus	308	49				762	2859	1083	3347	593	2	270	409	9682
China												1		1
Denmark		193			568		238	2722	762		2681	760	12990	20914
Egypt					2		10751	28947	79355	14681	11108	21210	15112	181166
France	571	10158	5528	25945	13473	5785	2156	7796	89255	71356	142926		316466	691415
Germany	18199	41760	22178	76202	75426	206610	73223	296460	389207	133640	165294	212925	294032	2005156
Greece	7165	622	7847	13712	5455	54051	1260	76471	56328	46759	25644	25730	15859	336903
Honduras									38	13	27	2	0	80
Hungary							1118	1518	3015	1003	3200	1808	8551	20213
Italy	35435	53880	84670	99604	22985	46519	38081	58837	81158	32924	30576	38852	49164	672685
Ireland					231	1810	3	5	0				3557	5606
Izrael				693	3212	11512	36	717	7335	6406	8048	2338		40297
Jugoslavia				121										121
Malta									10					10

Marocco	7803	6055	535	1899	60	73	4280	7289	6550	6542	1227	1949	2521	46783
Poland	99	1		144		4021	297	2522	3216	183	661	177	1272	12593
Portugal						225	776	1333	253	90			428	3105
Romania											17	17	97	131
Senegal			11							0				11
Slovakia	0	64	365	1899	10913	12494	15750	26494	10961	9850	7805	12579	11683	120857
Slovenia						35								35
South Africa											1			1
Spain	13486	25046	12579	20693	51551	7774	32566	9083	37125	25645	60155	24526	70409	390638
Syria	15													15
Sweden								13890	9012		293			23195
The Faroe Islands							2	22		3	3			30
The Netherlands	33128	40272	26896	47282	56915	114288	23702	32772	57682	48951	61547	74307	149148	766890
Thailand			37											37
Tunisia			2565	502		700	892	188	1003	490		101	1179	7620
Turkey	373					398	224	39	88	88				1210
United Kingdom	6	513	616	1203	1020	1211	919	9776	11950	1764	126	1949	46534	77587
USA							2	8	0	2	9	40	245	306
Vietnam		1									1			2
Total import of potatoes per year (thousands of CZK)	117854	203300	165375	316945	267824	484676	215441	606617	899287	425357	555900	471207	1042219	

Source: Own work of an author based on data from Czech Statistical Office

**Table – 14: Total exports of potatoes by country 1999-2011**

Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Total exports of potatoes by country (thousands of CZK)
Armenia													164	164
Austria				58	318	3261	3194	4783	15417	2791	5601	6808	3105	45336
Belarus													1174	1174
Belgium						579	2642							3221
Bosnia and Herzegovina	80	73	1700		22	97						427		2399
Bulgaria	125	304	2686					331	2200	884	2793	15122	2250	26695
Costa Rica			48											48
Croatia	307	885	13618		3025		1062	675		1090				20662
Cyprus								46						46
Denmark							136	415		70				621
Estonia							1143	889	516					2548
France					1442				237	15	232	535	518	2979
Germany	0					17256	16469	19607	6123	21973	22302	37632	6070	147432
Greece							282				711			993
Gruzia							1289							1289
Hungary	763	53	7828	469	4392	774	6794	25907	15228	5560	18990	20546	7919	115223
Italy						683	4471	1046	2338	1474	698	223	12017	22950
Izrael										288				288
Jugoslavia	169	180	1504	1577	776									4206

Latvia							893	1245	298	1	144			2581
Macedonia	1197	0												1197
Moldova						4		711			552	2164	125	3556
Mongolia									2					2
Pakistan													46	46
Poland	365	683	9385	19364	5781	5431	58440	70246	63875	30906	32379	29497	18952	345304
Romania	553	484	903	206			6488	14455		4563	2715	18514	15675	64556
Russia							205	1937				207	1068	3417
Serbia										80		1206	309	1595
Slovakia	31164	13810	5966	11913	13251	41233	126640	129394	161809	112433	177729	209840	277265	1312447
Slovenia	0			543	220			107					1020	1890
Spain							44			3	8			55
Sweden							23							23
The Netherlands	904				5993	654	2280	777	108	20893	4057	60	3452	39178
Togo				115										115
Ukraine	29	1076	62		141		52	1542	305					3207
United Kingdom								94						94
Uruguay			92											92
Total export of potatoes per year (thousands of CZK)	35656	17548	43792	34245	35361	69972	232547	274207	268456	203024	268911	342781	351129	

Source: Own work of an author based on data from Czech Statistical Office

**Table – 15: Import of potatoes by country 1999-2004**

		Import of potatoes by country 1999-2004 (thousands of CZK)
1	Germany	440375
2	Italy	343093
3	The Netherlands	318781
4	Spain	131129
5	Greece	88852
6	Belgium	72390
7	France	61460
8	Slovakia	25735
9	Austria	22148
10	Marocco	16425
11	Izrael	15417
12	United Kingdom	4569
13	Poland	4265
14	Tunisia	3767
15	Ireland	2041

**Table – 16: Export of potatoes by country 1999-2004**

		Export of potatoes by country 1999-2004 (thousands of CZK)
1	Slovakia	117337
2	Poland	41009
3	Croatia	17835
4	Germany	17256
5	Hungary	14279
6	The Netherlands	7551
7	Jugoslavia	4206
8	Austria	3637
9	Bulgaria	3115
10	Romania	2146
11	Bosnia and Herzegovina	1972
12	France	1442
13	Ukraine	1308
14	Macedonia	1197
15	Slovenia	763

Source: Own work of an author based on data from Czech Statistical Office

**Table – 17: Import of potatoes by country 2005-2011**

		Import of potatoes by country 2005-2011 (thousands of CZK)
1	Germany	1564781
2	France	629955
3	The Netherlands	448109
4	Italy	329592
5	Spain	259509
6	Greece	248051
7	Austria	199703
8	Egypt	181164
9	Slovakia	95122
10	United Kingdom	73018
11	Belgium	39166
12	Marocco	30358
13	Izrael	24880
14	Sweden	23195
15	Hungary	20213

**Table – 18: Export of potatoes by country 2005-2011**

		Export of potatoes by country 2005-2011 (thousands of CZK)
1	Slovakia	1195110
2	Poland	304295
3	Germany	130176
4	Hungary	100944
5	Romania	62410
6	Austria	41699
7	The Netherlands	31627
8	Bulgaria	23580
9	Italy	22267
10	Moldova	3552
11	Russia	3417
12	Croatia	2827
13	Belgium	2642
14	Latvia	2581
15	Estonia	2548

Source: Own work of an author based on data from Czech Statistical Office



**Table – 19: Total imports of potatoes by country**

		Total imports of potatoes per country (thousands of CZK)
1	Germany	2005156
2	The Netherlands	766890
3	France	691415
4	Italy	672685
5	Spain	390638
6	Greece	336903
7	Austria	221851
8	Egypt	181166
9	Slovakia	120857
10	Belgium	111556
11	United Kingdom	77587
12	Marocco	46783
13	Izrael	40297
14	Sweden	23195
15	Denmark	20914

**Table – 20: Total exports of potatoes by country**

		Total exports of potatoes by country (thousands of CZK)
1	Slovakia	1312447
2	Poland	345304
3	Germany	147432
4	Hungary	115223
5	Romania	64556
6	Austria	45336
7	The Netherlands	39178
8	Bulgaria	26695
9	Italy	22950
10	Croatia	20662
11	Jugoslavia	4206
12	Moldova	3556
13	Russia	3417
14	Belgium	3221
15	Ukraine	3207

Source: Own work of an author based on data from Czech Statistical Office

**Table – 21: Costs-Early potatoes without fleece cover**

**Table – 22: Costs- Early potatoes with a fleece cover**

**Early potatoes without fleece cover**

operation	cost CZK per hectare
soil preparation	8 400 CZK
fertilizer application	300 CZK
planting / sowing	3 200 CZK
chemical treatment	4 000 CZK
irrigation	8 000 CZK
harvest	13 400 CZK
movement of material	1 500 CZK
seeds / plants	24 000 CZK
chemicals	11 230 CZK
fertilizer	29 630 CZK
water	7 000 CZK
rent	2 400 CZK
overhead costs	13 567 CZK
<b>total costs</b>	<b>126 627 CZK</b>

**Early potatoes with a fleece cover**

operation	cost CZK per hectare
soil preparation	8 400 CZK
fertilizer application	300 CZK
planting / sowing	7 200 CZK
chemical treatment	2 000 CZK
irrigation	7 000 CZK
manipulation with fleece	4 500 CZK
presprouting of seed potatoes + heating	4 500 CZK
harvest, transport	13 400 CZK
seeds	36 000 CZK
fertilizer	14 170 CZK
chemicals	5 760 CZK
fleece covers	10 000 CZK
water	7 000 CZK
rent	2 400 CZK
overhead costs	14 716 CZK
<b>total costs</b>	<b>137 346 CZK</b>

Source: Own work of an author based on field experimental study in Družstvo Bramko CZ

Table – 23: Cost- Late potatoes with stone separation      Table – 24: Late potatoes without stone separation

<b>Late potatoes with stone separation</b>	
<b>operation</b>	<b>cost CZK per hectare</b>
soil preparation	4 740 CZK
fertilizer application	770 CZK
cleavage	3 000 CZK
stone separation	3 000 CZK
planting	2 250 CZK
chemical treatment	2 700 CZK
harvest	5 400 CZK
doprava	3 817 CZK
seed potatoes	35 000 CZK
fertilizer	18 281 CZK
chemicals	11 230 CZK
rent	2 600 CZK
overhead costs	11 135 CZK
<b>total costs</b>	<b>103 923 CZK</b>

<b>Late potatoes without stone separation</b>	
<b>operation</b>	<b>cost CZK per hectare</b>
soil preparation	4 740 CZK
fertilizer application	770 CZK
planting	2 250 CZK
chemical treatment	2 700 CZK
harvest	5 400 CZK
transport	3 817 CZK
seed potatoes	35 000 CZK
fertilizer	18 281 CZK
chemicals	11 230 CZK
rent	2 600 CZK
overhead costs	10 415 CZK
<b>total costs</b>	<b>97 203 CZK</b>

Source: Own work of an author based on field experimental study in Družstvo Bramko CZ

Table – 25: Costs-Celeriac

<b>Celeriac</b>	
<b>operation</b>	<b>cost CZK per hectare</b>
soil preparation	3 200 CZK
fertilizer application	2 291 CZK
planting	14 420 CZK
chemical treatment	4 950 CZK
irrigation	7 000 CZK
harvest	16 270 CZK
post-harvest cleaning	22 000 CZK
plants	50 000 CZK
fertilizer	21 620 CZK
chemicals	11 350 CZK
water	7 000 CZK
rent	2 400 CZK
overhead costs	19 500 CZK
<b>total costs</b>	<b>182 001 CZK</b>

Table – 26: Costs-Onions

<b>Onions</b>	
<b>operation</b>	<b>cost CZK per hectare</b>
soil preparation	4 000 CZK
fertilizer application	946 CZK
sowing	1 488 CZK
chemical treatment	5 220 CZK
irrigation	8 640 CZK
harvest	14 400 CZK
seeds	23 490 CZK
fertilizer	11 138 CZK
chemicals	11 847 CZK
water	7 000 CZK
rent	2 400 CZK
overhead costs	10 868 CZK
<b>total costs</b>	<b>101 437 CZK</b>

Source: Own work of an author based on field experimental study in Družstvo Bramko CZ

**Table – 27: Costs- Carrots**

<b>Carrots</b>	
<b>operation</b>	<b>cost CZK per hectare</b>
soil preparation	3 200 CZK
fertilizer application	600 CZK
planting	5 500 CZK
chemical treatment	2 083 CZK
irrigation	7 000 CZK
harvest	36 100 CZK
seeds	18 000 CZK
chemicals	5 758 CZK
fertilizer	15 750 CZK
water	7 000 CZK
rent	2 400 CZK
overhead costs	12 407 CZK
<b>total costs</b>	<b>115 798 CZK</b>

**Table – 28: Costs-Lettuce**

<b>Lettuce</b>	
<b>operation</b>	<b>cost CZK per hectare</b>
soil preparation	3 200 CZK
fertilizer application	3 500 CZK
planting	20 000 CZK
chemical treatment	4 000 CZK
irrigation	7 000 CZK
harvest	59 000 CZK
plants	65 000 CZK
fertilizer	19 950 CZK
chemicals	8 544 CZK
water	7 000 CZK
rent	2 400 CZK
overhead costs	24 131 CZK
fence	1 500 CZK
<b>total costs</b>	<b>225 225 CZK</b>

*Source: Own work of an author based on field experimental study in Društvo Bramko CZ*

**Table – 29: Costs-Wheat**

<b>Wheat</b>	
<b>operation</b>	<b>cost CZK per hectare</b>
soil preparation	800 CZK
sowing+fertilizer application	1 100 CZK
transport	75 CZK
fertilizer application	540 CZK
chemical treatment	1500 CZK
harvest	1 780 CZK
transport	880 CZK
seeds	1 995 CZK
fertilizer	8 798 CZK
chemicals	2 275 CZK
rent	2 600 CZK
overhead costs	2 681 CZK
<b>total costs</b>	<b>25 024 CZK</b>

*Source: Own work of an author based on field experimental study in Društvo Bramko CZ*

**Table – 30: Fertilizer cost**

	Fertilizer cost (CZK/ha)
Early potatoes without fleece cover	29 630 CZK
Celeriac	21 620 CZK
Lettuce	19 950 CZK
Late potatoes with stone separation	18 281 CZK
Late potatoes without stone separation	18 281 CZK
Carrots	15 750 CZK
Bunched onions	15 338 CZK
Early potatoes with fleece cover	14 170 CZK
Onions	11 138 CZK
Wheat	8 798 CZK

**Table – 31: Fertilizer application costs**

	Fertilizer application costs (CZK/ha)
Lettuce	3 500 CZK
Bunched onions	2 540 CZK
Celeriac	2 291 CZK
Onions	946 CZK
Late potatoes with stone separation	770 CZK
Late potatoes without stone separation	770 CZK
Carrots	600 CZK
Wheat	540 CZK
Early potatoes with fleece cover	300 CZK
Early potatoes without fleece cover	300 CZK

Source: Own work of an author based on field experimental study in Družstvo Bramko CZ

**Table – 32: Cost of soil preparation**

	Cost of soil preparation CZK/ha
Early potatoes with fleece cover	8 400 CZK
Early potatoes without fleece cover	8 400 CZK
Late potatoes with stone separation	4 740 CZK
Late potatoes without stone separation	4 540 CZK
Onions	4 000 CZK
Carrots	3 200 CZK
Celeriac	3 200 CZK
Lettuce	800 CZK
Bunched onions	800 CZK
Wheat	800 CZK

**Table – 33: Cost of planting or sowing**

	Cost of planting or sowing (CZK/ha)
Lettuce	20 000 CZK
Celeriac	14 420 CZK
Carrots	5 500 CZK
Early potatoes with fleece cover	3 200 CZK
Early potatoes without fleece cover	3 200 CZK
Bunched onions	3 120 CZK
Late potatoes with stone separation	2 250 CZK
Late potatoes without stone separation	2 250 CZK
Onions	1 488 CZK
Wheat	1 100 CZK

Source: Own work of an author based on field experimental study in Družstvo Bramko CZ

**Table – 34: Cost of seeds or plants**

	Cost of seeds or plants (CZK/ha)
Lettuce	65 000 CZK
Celeriac	50 000 CZK
Early potatoes with fleece cover	36 000 CZK
Late potatoes without stone separation	35 000 CZK
Late potatoes with stone separation	35 000 CZK
Early potatoes without fleece cover	24 000 CZK
Onions	23 490 CZK
Carrots	18 000 CZK
Wheat	1 995 CZK

Source: Own work of an author based on field experimental study in Društvo Bramko CZ

**Table – 35: Cost of chemical treatment**

	Cost of chemical treatment (CZK/ha)
Onions	5 220 CZK
Celeriac	4 950 CZK
Lettuce	4 000 CZK
Early potatoes without fleece cover	4 000 CZK
Late potatoes without stone separation	2 700 CZK
Late potatoes with stone separation	2 700 CZK
Carrots	2 083 CZK
Early potatoes with fleece cover	2 000 CZK
Wheat	1 500 CZK

**Table – 36: Harvest costs**

	Harvest costs (CZK/ha)
Lettuce	59 000 CZK
Carrots	36 100 CZK
Celeriac	16 270 CZK
Onions	14 400 CZK
Early potatoes with fleece cover	13 400 CZK
Early potatoes without fleece cover	13 400 CZK
Late potatoes with stone separation	5 400 CZK
Late potatoes without stone separation	5 400 CZK
Wheat	1 780 CZK

Source: Own work of an author based on field experimental study in Društvo Bramko CZ

**Table – 37: Overhead costs comparison**

	Overhead costs comparison (CZK/ha)
Lettuce	23 450 CZK
Celeriac	19 500 CZK
Early potatoes with fleece cover	14 716 CZK
Carrots	12 407 CZK
Early potatoes without fleece cover	12 220 CZK
Late potatoes with stone separation	11 135 CZK
Onions	10 868 CZK
Late potatoes without stone separation	10 415 CZK
Wheat	2 681 CZK

**Table – 38: Chemicals**

	Chemicals (CZK/ha)
Onions	11 847 CZK
Celeriac	11 350 CZK
Late potatoes with stone separation	11 230 CZK
Late potatoes without stone separation	11 230 CZK
Early potatoes without fleece cover	11 230 CZK
Lettuce	8 544 CZK
Early potatoes with fleece cover	5 760 CZK
Carrots	5 758 CZK
Wheat	2 275 CZK

Source: Own work of an author based on field experimental study in Društvo Bramko CZ

**Table – 39: Other costs**

	Other costs (CZK/ha)
Early potatoes with fleece cover	30 900 CZK
Onions	18 040 CZK
Lettuce	17 900 CZK
Celeriac	16 400 CZK
Carrots	16 400 CZK
Early potatoes without fleece cover	13 597 CZK
Late potatoes with stone separation	8 600 CZK
Late potatoes without stone separation	6 417 CZK
Wheat	2 675 CZK

Source: Own work of an author based on field experimental study in Društvo Bramko CZ

**Table – 40: Total production costs**

Crop	Total production costs 2011
Lettuce	225 225 CZK
Celeriac	182 001 CZK
Early potatoes with a fleece cover	137 346 CZK
Early potatoes without fleece cover	126 627 CZK
Carrots	115 798 CZK
Late potatoes with stone separation	103 923 CZK
Onions	101 437 CZK
Late potatoes without stone separation	97 203 CZK
Wheat	25 024 CZK

Source: Own work of an author based on field experimental study in Družstvo Bramko CZ

**Table-41: Production factors – very early potatoes**

	Y1	X2	X3	X4	X5
	Yield (tons per hectare)	Labour (hours per hectare)	Machinery (hours per hectare)	Fertilizer (kilograms per hectare)	Chemicals (litres per hectare)
Maximum	21	75	33	900	45
Minimum	15	59	55	1380	21
Average	17	63	37	950	27

Source: Own work of an author based on field experimental study in Družstvo Bramko CZ and further computation in Microsoft Excel

**Table-42: Correlation matrix - very early potatoes**

	Y1	X2	X3	X4	X5
Y1	1				
X2	0,263955	1			
X3	0,331105	-0,14331	1		
X4	0,150587	-0,18651	-0,09867	1	
X5	0,25111	-0,24777	-0,13109	-0,19671	1

Source: Own work of an author based on field experimental study in Družstvo Bramko CZ and further computation in Microsoft Excel

**Table-43: Coefficients - very early potatoes**

R squared	0,71614073	
	Coefficient	P value
Intercept	-17,930676	0,0005804
X2	0,25157795	1,942E-06
X3	0,17140675	2,133E-06
X4	0,00797289	0,0001552
X5	0,23803525	2,976E-06

Source: Own work of an author based on field experimental study in Društvo Bramko CZ and further computation in Microsoft Excel

**Table-44: Production factors – early potatoes**

	Y1	X2	X3	X4	X5
	Yield (pieces per hectare)	Labour (hours per hectare)	Machinery (hours per hectare)	Fertilizer (kilograms per hectare)	Chemicals (litres per hectare)
Maximum	32	34	33	840	35
Minimum	23	19	19	1260	21
Average	27	21	21	950	23

Source: Own work of an author based on field experimental study in Društvo Bramko CZ and further computation in Microsoft Excel

**Table-45: Correlation matrix - early potatoes**

	Y1	X2	X3	X4	X5
Y1	1				
X2	0,278687	1			
X3	0,075025	-0,28978	1		
X4	0,115868	-0,11732	-0,23305	1	
X5	0,165145	-0,28123	-0,23489	-0,27974	1

Source: Own work of an author based on field experimental study in Društvo Bramko CZ and further computation in Microsoft Excel



**Table-46: Production factors – late potatoes**

	Y1	X1	X2	X3	X4
	Yield (pieces per hectare)	Labour (hours per hectare)	Machinery (hours per hectare)	Fertilizer (kilograms per hectare)	Chemicals (litres per hectare)
Maximum	73	30	63	900	69
Minimum	47	24	21	1400	30
Average	61	28	28	973	39

Source: Own work of an author based on field experimental study in Družstvo Bramko CZ and further computation in Microsoft Excel

**Table-47: Correlation matrix – late potatoes**

	Y1	X2	X3	X4	X5
Y1	1				
X2	0,278687	1			
X3	0,075025	-0,28978	1		
X4	0,115868	-0,11732	-0,23305	1	
X5	0,165145	-0,28123	-0,23489	-0,27974	1

Source: Own work of an author based on field experimental study in Družstvo Bramko CZ and further computation in Microsoft Excel

**Table-48: Production factors – wheat**

	Y1	X3	X4	X5
	Yield (tonnes per hectare)	Machinery (hours per hectare)	Fertilizer (kilograms per hectare)	Chemicals (litres per hectare)
Maximum	8,3	11,5	360	16
Minimum	5,4	5	200	7
Average	7,1	5,4	234	8

Source: Own work of an author based on field experimental study in Družstvo Bramko CZ and further computation in Microsoft Excel

**Table-49: Correlation matrix -wheat**

	Y1	X3	X4	X5
Y1	1			
X3	0,277646	1		
X4	0,248783	-0,3842	1	
X5	0,297107	-0,29826	-0,30096	1

*Source: Own work of an author based on field experimental study in Društvo Bramko CZ and further computation in Microsoft Excel*

**Table-50: Production factors carrots**

	Y1	X1	X2	X3	X4
	Yiled (pieces per hectare)	Labour (hours per hectare)	Machinery (hours per hectare)	Fertilizer (kilograms per hectare)	Chemicals (litres per hectare)
Maximum	48	36	47	1300	31
Minimum	38	16	30	1080	12
Average	42,6	19	35	1131	15

*Source: Own work of an author based on field experimental study in Društvo Bramko CZ and further computation in Microsoft Excel*

**Table-51: Correlation matrix - carrots**

	Y1	X1	X2	X3	X4
Y1	1				
X1	0,142071	1			
X2	0,221357	0,313103	1		
X3	0,212808	-0,28569	-0,31672	1	
X4	0,12041	-0,29227	-0,34964	-0,27907	1

*Source: Own work of an author based on field experimental study in Društvo Bramko CZ and further computation in Microsoft Excel*

**Table-52: Coefficients – early potatoes**

R squared	0,675114	
	Coefficient	P value
Intercept	-5,53274	0,251507
X2	0,407039	9,57E-07
X3	0,350869	4,22E-05
X4	0,008371	0,000145
X5	0,407431	1,97E-06

*Source: Own work of an author based on field experimental study in Društvo Bramko CZ and further computation in Microsoft Excel*

**Table-53: Coefficients – late potatoes**

R squared	0,61562215	
	Coefficient	P value
Intercept	-1,8873614	0,873872
X2	0,54295745	4,77E-06
X3	0,40660778	0,000225
X4	0,02728188	0,000327
X5	0,26735807	3,04E-05

*Source: Own work of an author based on field experimental study in Društvo Bramko CZ and further computation in Microsoft Excel*

**Table-54: Coefficients - wheat**

R squared	0,81072977	
	Coefficient	P value
Intercept	-0,2736361	0,738763
X3	0,3246075	1,84E-09
X4	0,01267263	3,42E-09
X5	0,29254623	2,54E-09

*Source: Own work of an author based on field experimental study in Društvo Bramko CZ and further computation in Microsoft Excel*

**Table-55: Coefficients - carrots**

R squared	0,69091141	
	Coefficient	P value
Intercept	-10,347112	0,226968
X2	0,2047023	0,001572
X3	0,21488712	0,000228
X4	0,03264263	1,02E-05
X5	0,30438984	5,28E-05

*Source: Own work of an author based on field experimental study in Društvo Bramko CZ and further computation in Microsoft Excel*

**Table-56: Statistics of unemployment**

	Number of unemployed people in thousands	Unemployment rate (percentage)
2009 1 Q	302,8	5,8
2009 2 Q	333,9	6,3
2009 3 Q	387,0	7,3
2009 4 Q	385,0	7,2
2010 1 Q	422,7	8,0
2010 2 Q	374,7	7,1
2010 3 Q	374,2	7,1
2010 4 Q	363,0	6,9
2011 1 Q	376,2	7,2
2011 2 Q	354,6	6,7
2011 3 Q	345,7	6,6
2011 4 Q	337,9	6,4

*Source: Own work of an author based on data from Czech Statistical Office*

**Table-57: Structure of foreigners in the Czech Republic**

Date	Total	Permanent stay	Other types of stay	Ukraine	Slovakia	Vietnam	Russia	Poland	Other
31.1.2009	441 705	173 807	267 898	133 055	76 406	60 763	27 390	21 766	122 325
28.2.2009	442 694	174 365	268 329	133 700	76 957	60 875	27 534	21 826	121 802
31.3.2009	443 268	174 837	268 431	133 570	77 614	60 892	27 779	21 936	121 477
30.4.2009	443 870	175 020	268 850	133 548	78 024	60 986	27 988	21 942	121 382
31.5.2009	444 410	175 404	269 006	134 707	77 985	61 092	28 874	21 792	119 960
30.6.2009	442 506	175 882	266 624	134 456	77 432	61 063	29 044	21 378	119 133
31.7.2009	439 762	176 508	263 254	133 773	76 956	60 998	29 144	20 700	118 191
31.8.2009	440 012	177 215	262 797	133 600	76 630	61 088	29 480	20 502	118 712
30.9.2009	437 251	177 769	259 482	133 033	75 915	60 996	29 479	20 155	117 673
31.10.2009	436 116	179 436	256 680	132 481	75 210	61 012	29 976	19 790	117 647
30.11.2009	435 755	180 487	255 268	132 437	74 578	61 113	30 210	19 608	117 809
31.12.2009	433 305	181 161	252 144	131 977	73 446	61 126	30 395	19 273	117 088
31.1.2010	432 356	182 038	250 318	131 566	72 865	61 185	30 603	19 003	117 134
28.2.2010	431 587	182 856	248 731	130 924	72 499	61 166	30 796	18 901	117 301
31.3.2010	430 310	183 674	246 636	130 561	71 950	61 067	30 860	18 857	117 015
30.4.2010	428 582	183 995	244 587	129 588	71 444	60 931	31 113	18 746	116 760
31.5.2010	426 749	184 724	242 025	128 636	71 392	60 931	31 037	18 572	116 181
30.6.2010	426 498	185 437	241 061	128 085	71 394	60 962	31 162	18 487	116 408
31.7.2010	425 172	186 174	238 998	127 484	71 411	60 894	31 077	18 429	115 877
31.8.2010	426 511	187 162	239 349	127 267	71 581	60 812	31 466	18 386	116 999
30.9.2010	425 568	187 840	237 728	126 521	71 676	60 605	31 297	18 328	117 141
31.10.2010	426 286	188 796	237 490	125 806	71 884	60 438	31 640	18 302	118 216
30.11.2010	426 500	189 428	237 072	125 256	71 839	60 363	31 858	18 278	118 906
31.12.2010	425 301	189 962	235 339	124 339	71 780	60 301	31 941	18 242	118 698

31. 1. 2011	430 137	190 058	240 079	122 215	77 661	59 456	31 535	18 862	120 408
28. 2. 2011	428 494	190 666	237 828	121 151	77 990	59 155	31 358	18 837	120 003
31. 3. 2011	425 167	191 337	233 830	118 986	78 289	58 660	31 015	18 843	119 374
30. 4. 2011	422 225	192 028	230 197	117 104	78 617	58 015	30 618	18 877	118 994
31. 5. 2011	419 689	192 986	226 703	115 496	78 977	57 779	30 282	18 852	118 303
30. 6. 2011	417 424	193 708	223 716	114 014	79 315	57 552	29 801	18 890	117 852
31. 7. 2011	413 928	194 404	219 524	112 217	79 669	57 041	29 303	18 907	116 791
31. 8. 2011	412 612	195 139	217 473	110 733	79 924	56 716	29 337	18 942	116 960
30. 9. 2011	408 036	195 865	212 171	109 012	80 235	56 055	28 143	18 989	115 602
31. 10. 2011	407 531	197 055	210 476	107 491	80 631	55 827	27 960	19 020	116 602
30. 11. 2011	406 211	197 884	208 327	106 040	80 967	55 585	27 321	19 048	117 250

*Source: Own work of an author based on data from Czech Statistical Office*