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Assessment of the impact of high fragmented land upon the productivity and profitability of the farms

-The case of the Macedonian vegetable growers

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Проценка на влијанието на високата фрагментираност на земјиштето врз продуктивноста и профитабилноста на фармите
-Влијанието врз Македонските производители на градинарски култури

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Abstract

Land is an essential natural resource, both for the survival and prosperity of humanity, and for the maintenance of all global ecosystems. Land fragmentation is the practice of farming a number of spatially separated plots of owned or rented land by the same farmer and can be seen as common phenomenon in the Macedonian agriculture as well as in many developing countries. Land fragmentation can be seen to have negative effect on agricultural productivity, but it may also provide benefits for farm households. This study was conducted to find out the influence of land fragmentation measured by the number of plots on the value of vegetable produced in the Skopje and Southeastern region in Republic of Macedonia. The analysis uses models such as Cobb-Douglas production function as well as General Linear Model. The findings of the regression estimations supported the negative and statistically significant impact of land fragmentation over productivity and profitability of growing vegetables in the research area. A reduction of the Simpson index increases income from vegetable production indicating better use of modern agricultural technologies and decreasing the costs of labour. However, labour showed a positive relationship with output implicating risk diversification and labour smoothing due to crop diversification. Therefore, appropriate policies such as creating functioning markets for land, improvements in credits, modern graphical techniques, etc. which will promote successful land consolidation in the regions where it is an issue, and where an increase in agricultural production capacity is needed.

Key terms: Macedonia, land fragmentation, Simpson index, parcel size, vegetable production, land consolidation, future policy implications.

Апстракт

Земјата е основен природен ресурс за опстанок на човештвото, како и за одржување на сите глобални екосистеми. Фрагментираност на земјиштето која што е честа појава во земјоделството во Република Македонија како и во останатите земји во развој, може да се дефинира во основа како земјоделска активност на повеќе различни сопствени или пак изнајмени парцели. Фрагментираноста може да има негативни, но и позитивни ефекти врз земјоделското производство. Оваа студија беше изведена со цел да се испита влијанието на земјишната фрагментираност претставена преку бројот на парцели врз производството на градинарски култури во Југоисточниот регион и регионот околу Скопје. Самата анализа беше изведена со помош на економските модели како Cobb-Douglas-овиот и Генералниот Линеарен Модел. Резултатите од регресионата анализа го подржаа заклучокот дека фрагментираноста на земјиштето влијае негативно и статистички значајно врз продуктивноста и профитабилноста на фармерите кои одгледуваат градинарски култури во регионот каде што беше извршено истражувањето. Намалување на Симпсоновиот индеџ ќе го зголеми приходот од производство на земјоделски култури и во исто време укажувајќи на зголемена употреба на модерна земјоделска механизација. Како и да е, показателот врзан со земјоделската работна сила покажа позитивна поврзаност со производството. Според тоа може да се каже дека фармерите се уште посакуваат одреден степен на фрагментираност поради можноста од природни непогоди заради плодоред и правилна употреба на расположливата работна сила во однос на плодоредот. Затоа, соодветна политика како подобрувње на пазарот на земјиште, употреба на модерни техники за мапирање на земјиштето, итн. е потреба за успешна консолидација на земјиштето во региони каде е потребна, која ќе влијае позитивно на целокупното земјоделско производство.

Клучни термини: Република Македонија, фрагментирност на земјиштето, Симпсонов индекс, големина на парцела, градинарско производство, консолидација на земјиштето, идни импликации за подобрување на земјишната политика.

Abbreviations

CAP – Common Agricultural Policy
CD – Cobb-Douglas
FADN – Farm Accountancy Data Network
FAO – Food and Agricultural Organization
FMS – Farm Monitoring System
GDP – Gross Domestic Product
GIS – Geographical Information System
GLM – General Linear Model
IPARD – Operational Programme under the EU instrument for Pre-Accession for Rural Development
MAFWE – Ministry of Agriculture, Forestry and Water Economy
MKD – Macedonian denar
NARDS – National Agricultural and Rural Development Programme
NEA – National Extension Agency
RM – Republic of Macedonia
SAGW – State Authority for Geodetic Works
SI – Simpson index
SSO – State Statistical Office
WTO – World Trade Organization

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1 Introduction

Land is an essential natural resource, both for the survival and prosperity of humanity, and for the maintenance of all global ecosystems (Internet, FAO, 2008, 1). In other words land is a finite, non-reproducible consumption resource held as a source of livelihood and a financial security transferred as wealth across generations (Ellis, 1992). Over millennia, people have become progressively more skilled in exploiting land resources for their own ends.

1.1 Problem background

Macedonia which is still in a transition process is a landlocked country, covering an area of 25.713 km^2 (See Appendix 1). Its natural advantages (fertile soil and favorable climate) encourage agricultural development. Agricultural land in the Republic of Macedonia amounts to 1.275.000 ha (1999-2004 average), or approximately 50% of Macedonia's total territory. (MAFWE, Annual Agricultural and Rural Development Report, 2007). Although Macedonia is still trying to recover from destabilizing effects, such as the conflict in 2001 as well as the major challenges and the structural reforms, agriculture is still playing crucial role in the contribution to the national economy (GDP) by 12% comparing the 1,6% to EU-25 (MAFWE, NARDS 2007-2013, 2007). The process of transformation of the state ownership (around 95%) in the agricultural sector goes slowly and is not yet finalized. The most often used method is by privatization or by dividing the so-called 'agrokombinat'[1] into smaller units, which are then privatized (Internet, NCSA, 2008). This process is also followed by the negative trend in the total cultivated arable land. According to the last agricultural census in 2007 the total used arable land by the farmers was around 400.000 ha, compared to the 537.000 ha in 2006 (MAFWE, Annual Agricultural and Rural Development Report, 2007). 80% of the total 400.000 ha are owned or rented by the over then 180.000 individual farmers. Rest of the 20% is state owned land and it is cultivated by 136 agricultural enterprises (MAFWE, NARDS 2007-2013, 2007).

The results of the Project for analysis of land disposition (in private ownership or leased) and productivity in agriculture in the Republic of Macedonia, executed by the University of Wisconsin's Land Ownership Management Center, in cooperation with the Faculty for Agricultural Science and Food, concluded that small private farms are more productive and profitable than expected, despite the unfavorable institutional situation in the transition period (Melmed-Sanjak *et al.*, 1998).

Even though most of the arable land belongs to and is cultivated by individual farmers, the effective use of agricultural land in Macedonia is threatened by the serious problem of parceling and fragmentation stemming from previous limitations on usable areas and ownership[2], inheritance customs, as well as the long tradition of informal relations in the land market (MAFWE, Annual Agricultural and Rural Development Report, 2007). In 1994 there were around 178.000 registered agricultural households cultivating approximately 460.000 ha,

[1] Agrocombinat was state owned vertically integrated agro-business with large areas of available arable land. They were diversified in the primary production, food processing industry, commercial storing, as well as market services. Often they were major supplier of raw materials to the farmers as well as major buyers of their production, but indirectly through the state owned agricultural cooperatives (MAFWE, Annual Agricultural and Rural Development Report, 2007)

[2] Until 1984 the maximum amount of land that the farmer could own was 10 ha or 20 ha in the mountain regions (MAFWE, NARDS 2007-2013, 2007)

with the average size of the individual farm of 2,5-2,8 ha, with internal parceling of 0,3-0,5 ha in fields and diversified production structure (SSO, Census, 1994). Around 40% of the private farms belong to the small-scale farm production group and own less than 2 ha land (also fragmented). Their production is mainly for their own use (MAFWE, NARDS 2007-2013, 2007). The lack of land, followed by the lack of social security, keeps supporting the process of fragmentation and diversify production in small plots. The activity of the land market has so far failed to contribute to consolidation (ibid).

Still the long-term presence of small and highly fragmented farms, even with higher productivity doesn't allow more intensive use of modern agricultural technologies which results with reduced competitiveness.

1.2 Problem formulation

Land fragmentation is the practice of farming a number of spatially separated plots of owned or rented land by the same farmer (McPherson, 1982). According to Melmed-Sanjak *et al.*, (1998, p.60) "it's a phenomenon of agricultural land distributed in undersized holdings as well as holdings that consist of noncontiguous and spatially dispersed plots of land". In Macedonia the both types of fragmentation are present. "In general, farmers are operating on very smallholdings which are composed of numerous, spatially dispersed parcels" (ibid).

The main causes of fragmentation in Macedonia may be cited as partial inheritance and land shortage (ibid). "Traditional inheritance practices of transferring property equally to all children in each generation has, over time, divided land in Macedonia into increasingly smaller holdings" (ibid). The division of parcels continues in practice due to differences in land quality and location. The influence of inheritance on fragmentation has been reduced by the joint operation of separately inherited holdings, the redistribution of land among families by gift, lease, or purchase, and land market transactions with other farmers (ibid).

Even though, at present the landholders in Macedonia are not bound by the legal limit, this ownership restriction has made a serious influence on the farm sizes. Land shortage and ineffective land market activity extends the fragmentation issues as well. But according to Simmons (1987) the pros and cons of land fragmentation may be examined irrespective of the source.

"In the small-scale private agricultural sector in Macedonia, the most common and frequently cited disadvantages of fragmentation include increased labor costs, increased transportation time and cost, land lost to border markings and access roads, and difficulty in accessing the parcels" (Melmed-Sanjak *et al.*, 1998, p.60). Fragmentation may also affect the access to irrigation networks as well as inefficient use of modern agricultural technologies which on long run may cause less efficient production.

Despite the disadvantages there are also some advantages that have to be mentioned. Melmed-Sanjak *et al.*, (1998, p.60) conduct that "the advantages of fragmentation in Macedonia are related to the ability of farmers to disperse risk by cultivating a diverse variety of crops on numerous plots, each with diverse characteristics". High production diversification in Macedonia is possible due to the wide variety of microclimates and just because of these variations the farmers may gain benefits.

1.3 Research purpose

The aim of this study is to investigate *how the highly fragmented land affects productivity and profitability on the farms*. Furthermore, it aims to give insights into the *current degree of fragmentation* in Macedonia and how this affects the productivity of small-scale private farms. By understanding of the fragmentation advantages and disadvantages, the *creation of land policy for good land management* can be enhanced. Simply stated the main objectives of this study, are to address the following issues:

- What is the current level of fragmentation in Macedonia?
- How does highly fragmented land impact the productivity and profitability of the farms?
- How can highly fragmented land serve as basis for creating improved land policies for good land management?

1.4 Method

In order to reach the objectives of this study quantitative approach was used followed by the Cobb-Douglas model as well as the General Linear Model. The required data for the model I collected from the National Extension Agency (NEA), because of the availability on good and descriptive technical structure based on Farm Monitoring System (FMS) data. The Farm Monitoring System encompasses the recording of resources, yields, income, and expenditures, labor in the production process of individual farmers. Based on this information a calculation of the parameters will be conducted which will be essential to carry out the empirical analysis.

1.5 Delimitations

This study emphasizes only the small-scale individual farmers because of the fact that small private farms are more productive and profitable than expected, even though in the introduction it was mentioned that 20% of the state owned land is operated by the 136 agricultural enterprises. Furthermore, I would like to delimit this study due to time constraints and resource, only to two regions such as Skopje and Southeastern region (see Appendix 1). The empirical data is obtained only for the vegetable producers in these two important regions, since these groups of farmers typically grow crops on fragmented plots. Vegetable production by itself forces the farmers to operate on fragmented parcels.

Furthermore, the empirical data was not collected from a random statistical sample. As a main criteria for the selection of the farmers to be included in the study was that their gross margin from vegetable production accounts for at least 50% of the overall gross margin, even though the fact that in Macedonia a farmer can be categorized as vegetable producer when his gross margin from vegetable production takes account for two thirds from the overall sales (see Appendix 2). Hence if I applied to the second requirement there would not be enough observations to do this research, since most of the farms have a rather diversified production system. This is a fact because a majority of the farmers in Macedonia are part-time farmers.

Other factors that have to be mentioned which limits the validity and choice of data was that for some farmers, there were no continuous data in the system.

Nevertheless, since one of the objectives of this study is to examine the current level of fragmentation in Macedonia, I can not make a generalization due to the geographically demarcation. I can only present the land fragmentation level for the vegetable production of the two regions where the study is undertaken. The question of what is the degree of fragmentation in Macedonia will remain open until someone or I, conduct a study on a wider area, i.e. Republic of Macedonia.

1.6 Structure of the research

The outline of the thesis illustrated in Figure 1 is intended to give the reader a picture of the structure of this research. ***Chapter 1*** will give the reader information about the problem background as well as the problem area, which were essential to set the aim. Before explaining and giving a more extensive account of the method in ***Chapter 3,*** in ***Chapter 2*** there is an insight into the literature review where the land fragmentation and land consolidation issues are explained, followed by the characteristic of the Macedonian land fragmentation and consolidation based on secondary sources. The empirical background such as the vegetable production in Macedonia between the period from1995 to 2007 is discussed in ***Chapter 4.*** The empirical findings are presented in ***Chapter 5*** which is the basis for the analyses and discussion part in ***Chapter 6***. From all together analysed and discussed, some general conclusions are given to fulfil the aim in ***Chapter 7***.

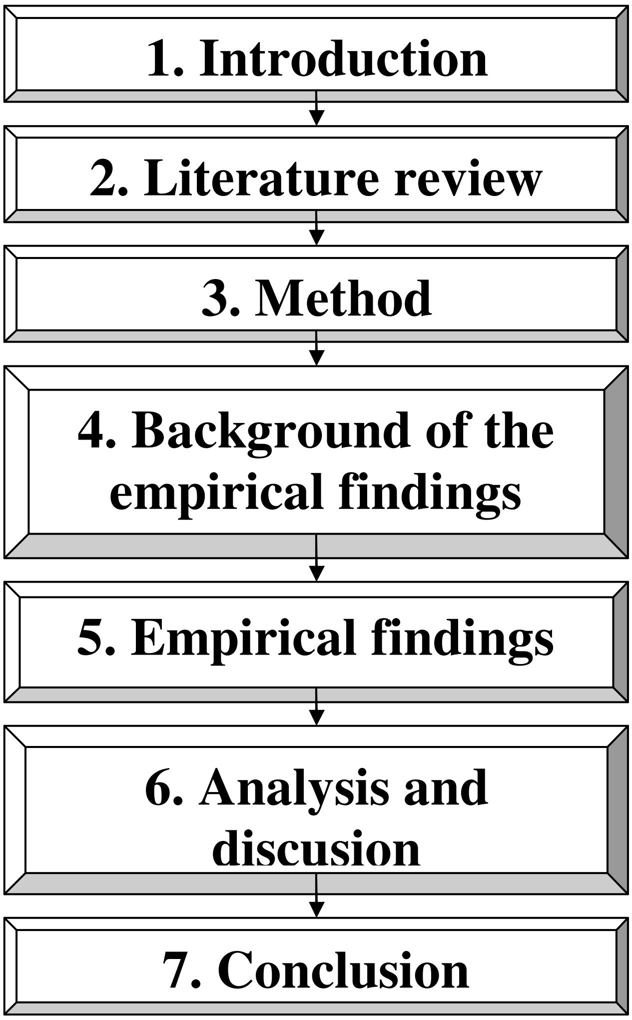

Figure 1 Outline of the study

2 Literature review

“Fragmentation of private farmers’ landholdings causes costs in terms of travel time and difficulty of using efficient cultivation techniques, but it also has some benefits in terms of spreading the risk, crop diversification, and equitable sharing of available land resources (e.g., subdivision of each parcel via inheritance)” (Melmed-Sanjak *et al*., 1998, p.94-95). The literature review listed below illustrates theoretical background of land fragmentation and consolidation, such as definition, causes and how people perceive it. The conceptual framework of this chapter will be the basis for better understanding the problem and achievement of the research aim.

2.1 Land fragmentation policies

2.1.1 Definitions

The relationship between land and the people is reflective. Although the livelihood of people is directly linked to land, the ownership of land is decreasing rapidly (Niroula and Thapa, 2005). Land fragmentation has been a prominent feature in many countries since at least the 17^{th} century (Tan, 2005) and in the literature is defined in different ways. Worldwide concern about it, started much later or in 1911, when a conference on the “consolidation of scattered holdings” was held to deal with the “evils of fragmentation” (Lusho and Papa, 1998, p.11). One of the researchers that first defined fragmentation as a “misallocation of the existing stock of agricultural land” was Schultz (1953), cited in Tan (2005, p.12). He argues that a fragmented farm is “…a farm consisting of two or more parcels of land so located one to another that it is not possible to operate the particular farm and other such farms as efficiently as would be the case if the parcels were reorganized and recombined”. Simply stated land fragmentation is a basis for inefficiency. Dovring (1960) cited in Tan (2005, p.12), regards land fragmentation as “the division of land into a great number of distinct parcel”. Here the distance between the plots can be seen as a main reason for inefficiency. On the contrary to the above stated definitions, Binns (1950), cited in Tan (2005, p.12) points out the fragmentation as “…a stage in the evolution of the agricultural holding in which a single farm consists of numerous discrete parcels, often scattered over a wide area”. It’s a temporary event in agricultural holding’s evolution.

Land fragmentation is a common feature of agriculture in many countries, especially in developing countries (Van Hung *et al.,* 2006) and from the previous statements, can be considered as an obstacle to efficient farm management. Besides letting each land parcel grow smaller and smaller over the time, land fragmentation leads to physical dispersion of parcels. “Fragmentation used to be closely associated with Europe, but it has been documented in all parts of the world” (Sundqvist and Andersson, 2006, p.3).

2.1.2 Causes and its consequences

In the literature, scholars have classified causes of land fragmentation into two broad categories: supply-side and demand-side causes (Bently, 1987; Blarel *et al.,* 1992). The supply-side causes refer to an exogenous imposition on farmers of a pattern of land areas as a result of inheritance laws, population pressure and scarcity of land (McPherson, 1982; Blarel *et al.*, 1992), while the second reflects varying degrees of fragmentation chosen positively by farmers in order to reduce risk from natural disasters (such as floods, droughts, fires and other perils), promote crop diversification, as well as to ease allocation of labour over cropping seasons (Fenoaltea, 1976; Ilbery, 1984; Tan, 2005).

Several forces have been generally cited as causing or contributing to involuntary fragmentation (Blarel *et al.,* 1992). First of them is the partible inheritance. Many authors argue that partible inheritance logically leads to fragmentation when farmers desire to provide each of several heirs with land of similar quality (ibid). Furthermore, the trend toward increasing population which leads to scarcity of land may lead to fragmentation as farmers in search of additional land will likely to accept any available parcel of land within reasonable distance to their house. Failure of land markets and state laws can be also one of the major causes for fragmentation, where the transaction on land is restricted. This can have negative effect on the land consolidation policy. At the end, the nature can be mentioned as reason for fragmentation on the supply-side (ibid). More specifically the boundaries such as waterways and wastelands don't allow the acquisition of separate pieces of land. Demand-side causes of fragmentation assume that the private benefits of fragmentation exceed its private costs (ibid). The fact that fragmentation may benefit farmers stems from the understanding that land is not homogenous. The parcels can be different with respect to soil type, water retention capability, slope, altitude and microclimate conditions. By diversifying the labour intensive cultures on different plots in peak times the risk may be reduced. It is also possible that the transaction costs are adequately high so that farmers are unwilling to accept the set of land transaction that would be needed to reduce the degree of fragmentation (Van Hung *et al.,* 2006). In addition, land fragmentation induced by land reforms has improved food security and equity among farm households by distributing land plots in terms of soil quality and family size in several countries (Blarel *et al.,* 1992). Land fragmentation helps the farmers to avoid risk. According to Block (1966) and McCloskey (1976) the destructive forces of hail, insect pests, plant disease, flood and drought may also strike one area and leave others untouched. Some fields produce well in some years, while others do well in other years (Carlyle, 1983). The above demand-side reasons for fragmentation explain the choice of farmers to retain certain levels of fragmentation that they perceive are beneficial to them.

However, land fragmentation is more often believed to be one major problem existing in rural land management, especially in developing countries (Rusu, 2002). Blarel *et al*., (1992) argue that land fragmentation besides the positive effects causes many negative effects including higher costs (extra labour, more fuel inputs for traveling between plots, more waste due to increased leakage and evaporation of fertilizers, water, pesticides, etc.) increased negative externality (such reduced scope for irrigation and soil conserving investments, access routes), lost of land due borders and greater possibilities for disputes between neighboring farmers. Because of increased cost for inputs, farmers pay more attention to parcels which are closer to their farms (Neupane, 2000) and the more distanced parcels are less intensively cultivated where sometimes in extreme situations farmers even abandon their parcels due to very low yields (van Dijk, 2003). According to Wan and Cheng (2001) land fragmentation causes resource disutilization and underutilization where it's hard to apply some new technologies of agricultural modernization and reap the economies of scale when farms are small and fragmented. It's most harmful for farms with high labour and capital costs. Small fragmented farms might also cause complexity for certain crops, and prevent farmers from changing to high profit crops. More profitable crops (fruit crops), require larger plot areas. Hence, if the farmers only have small and fragmented plots they may be forced to grow only less profitable crops (The World Bank, 2005). Finally, Blarel *et al*. (1992) find out that land fragmentation tend to constrain efficient delivery of support services because of the increased cost of extension and land improvement services that rise with the increased number of land parcels. Thus, if the crops are affected with diseases, extension workers have to depend only on the information provided by the farmers which may be incomplete and may not help in preventing the damage.

Therefore, simply stated the impact of land fragmentation is related to the number of plots and may be viewed to have an economic cost in terms of lower agricultural productivity, prohibit proper land management and sustainable agriculture development. The less land people have the more efficient use they must make of it. As the plots sizes steadily decrease with land fragmentation, it becomes crucial to discuss how a reduced parcel size influences agricultural productivity and profitability.

Table 1 Cost and benefits associated with land fragmentation

Benefits of many plots		**Cost of many plots**	
Private benefits	**Public benefits**	**Private costs**	**Public costs**
Immediate and ongoing benefits/costs			
Risk spreading - flooding - diseases and pests - output variation Crop rotation - flexibility/diversity Seasonal labour - spreading	Equality of treatment Implicit insurance	Cost increases More labour used Access difficult Border land loss	Less labour released Higher transaction cost when used as collateral
Longer term benefits/costs			
Inheritance flexibility Small parcels to transfer/sell/mortgage	Increased biodiversity Reduced spread of diseases	Disputes increased Irrigation difficult Mechanization difficult Application of new technology difficult	Mechanization delayed Application of new technology delayed Planning of commercial production zones difficult Land use planning difficult

Source: Van Hung *et al.,* 2006, p.200

2.1.3 Former studies

Ever since the publication of Schultz's theory (1964) which argues about the inverse relationship between land holding size and productivity there has been a debate about it because of the general positive relationship belief (Niroula and Thapa, 2005). Despite this fact, many researchers such as Berry and Cline (1979), Ellis (1989), Ram et al, (1999) and van Dijk (2003) have assumed that "a landholding is a single parcel and that there is no effect on accessibility to individual farmer's share of land when it is subdivided" (Niroula and Thapa, 2005, p.360). But this hypothesis may not be the true in context of Macedonia or other developing countries, where fragmentation of the land holdings leads to fragmentation of several parcels of different attributes, even though Thapa (2007, p.2) argues that "several economists put the inverse relationship as valid for traditional agriculture". The inverse relationship has been weakened due to the availability of size-neutral biotechnology such as seed and fertilizer, differences in management input and adoption on new capital intensive technologies (Ram *et al.,* 1999).

Results from research on the negative effects imposed by land fragmentation on productivity and efficiency in agriculture are mixed (Rahman and Rahman, 2008). Blakie and Sadeque (2000) argue that land fragmentation is becoming a serious limit in increasing productivity in Nepal, India and other nearby regions. On the contrary, in Malaysia and Philippines high land fragmentation is not considered an impediment in paddy farming (Wong and Geronimo, 1983, cited in Niroula and Thapa, 2005). In the case of China, the results on land fragmentation impact over productivity are contradictory, where Wu *et al,* (2005) and Wan and Cheng (2001) found completely opposite effects. About the efficiency, Sherlund *et al.* (2002) and Tan (2005) conclude that the increased number of plots has a positive relation with rice production in Cote d'Ivoire and China, whereas in Pakistan and Bangladesh land fragmentation reduces efficiency in rice production (Parikh and Shan, 1994 and Wadud and White, 2000).

Even though land fragmentation may limit agricultural production, Hartvigsen (2006, p.3) argues "that a high degree of land fragmentation is not always an important problem for development of the agricultural sector". For example 0,45 hectares is the average parcel size in Slovakia with 12-15 owners (Lazur, 2005). However, "both countries are among the countries in the region with the least fragmented use of agricultural land" since agricultural land in these countries are strongly controlled by large enterprises (Hartvigsen 2006, p.4).

In Macedonia little attention has been paid to understand the impact of land fragmentation on productivity, resource use efficiency and profitability (production efficiency). A high level of productivity does not necessary mean high profitability. Most scholars have studied the impact of holding size rather than parcel size, even though there is often a positive correlation with parcel size (Nquyen *et al,* 1996). Empirical studies on how land parcel fragmentation affects productivity and profitability are few (Clay *et al*, cited in Niroula and Thapa, 2005). To clarify, land holding is an ownership unit, whereas the land parcel is an operational unit. Therefore, Schultz's theory of inverse relationship is irrelevant when the impact of land parcel fragmentation is considered due to labour scarcity and economic use of inputs. In a study by Blarel *et al.* (1992) of Ghana and Rwanda, they questioned the importance of economic costs of land fragmentation and found that "parcel size either had an insignificant effect on yield or was negatively related to yield" (Nguyen *et al.,* 1996, p.170). Moreover, Jabarin and Epplin (1994) in their study for northern Jordan, the main finding was that an increase in average plot size will point to a noteworthy, but small, negative impact on production costs. Other questions have to be taken in consideration when productivity is planned to be taken as an indicator of profitability. If farmers produce crops only for household production then the above relationship is true, otherwise there is no mutual relationship due to competition between small-scale and large farmers on the market. The efficient use of the resources may generate the highest profits. Consequently, net profits should be used for evaluating profitability, but not productivity (Wattanutchariya and Jitsanguan, 1992). Financial result per unit of land is a function of cost and volume of production. The higher the cost of production, the lower the profit and vice versa. In the context of productivity, it is important to study the impact of land fragmentation on crop yield with emphasize on how to increase output per unit of land and per unit of input. In general, as land allocation to a farmer increases, production is expected to expand. This is especially the case where the farmer only produces one crop and reaps the economies of scale, i.e. specialization.

Table 2 Research on the effects caused by land fragmentation on productivity

Studies	Issues	Results
Blakie and Sadeque (2000)	holding size	serious problem in increasing productivity in Nepal, India and the nearby regions
Wong and Geronimo (1983)		not considered as impediment in paddy farming in Malaysia and Philippines
Wan and Cheng (2001)		limit in productivity in China
Wu *et al*. (2005); Tan (2005)		have positive effect on rice production in China
Sherlund *et al*. (2002)		increased number of plots affect positively the rice production in Cote d'Ivoire
Parikh and Shan (1994); Wadud and White (2000)		reduces efficiency in rice production in Pakistan and Bangladesh
Blarel *et al.* (1992)	parcel size	parcel size in Ghana and Rwanda either had an insignificant effect on yield or was negatively related to yield
Jabarin and Epplin (1994)		increase in average plot size have small but noteworthy negative effect in northern Jordan

2.2 Fragmentation in Macedonia in the 90's

In the previous introduction chapter the reasons for land fragmentation followed by the disadvantages as well as the benefits which are recognized by the Macedonian farmers where presented. It's almost impossible to make a generalization concerning the fragmentation problem due to the diversity of agricultural production and variations in the agricultural environments. In Macedonia with a transition to a market economy, the government must address several issues such as the major impediments to increased productivity and profitability of private farming which are caused by the small fragmented farms. There appear to be significant restraints to the efficient use of land and labour resources due to high fragmentation. The market for agricultural land as another constraint is not active and has historically contributed to fragmentation rather than consolidation. In the study conducted by Melmed-Sanjak *et al*. (1998), they assessed and found a high level of land fragmentation in Republic of Macedonia. The results were following (Table 3):

Table 3 Degree of land fragmentation by farm operation size

Mediterranean region							
Farm structure by size (ha)	Number of farms	Mean plot size	Mean number of plots	Mean distance to farthest parcel (km)	Mean distance to nearest parcel (km)	Believe land is too fragmented (% of group)	Mean of fragmentation index
<1	85	0,214	3,76	2,8	0,98	89	0,53
1-2	81	0,274	6,80	3,05	0,92	91	0,45
2-5	112	0,390	11,48	3,14	0,60	90	0,35
>5	28	0,629	13,17	4,03	0,44	93	0,36
Total[3]	306	0,305	17,16	3,05	0,83	90,1	0,45
Pelagonian region							
Farm structure by size (ha)	Number of farms	Mean plot size	Mean number of plots	Mean distance to farthest parcel (km)	Mean distance to nearest parcel (km)	Believe land is too fragmented (% of group)	Mean of fragmentation index
<1	23	0,247	3,00	1,75	0,52	68	0,63
1-2	39	0,321	5,07	2,06	0,40	72	0,48
2-5	60	0,328	11,35	2,52	0,45	83	0,33
>5	26	0,519	16,32	3,06	0,53	85	0,30
Total	148	0,329	7,84	2,24	0,47	78,2	0,46
Western region							
Farm structure by size (ha)	Number of farms	Mean plot size	Mean number of plots	Mean distance to farthest parcel (km)	Mean distance to nearest parcel (km)	Believe land is too fragmented (% of group)	Mean of fragmentation index
<1	31	0,217	3,48	2,21	0,91	76	0,55
1-2	52	0,273	5,60	3,00	0,74	88	0,46
2-5	43	0,456	7,12	3,24	0,85	86	0,43
>5	5	1,03	8,40	2,90	0,27	-	0,42
Total	131	0,328	5,36	2,79	0,80	83,2	0,48
Skopje-Kumanovo region							
Farm structure by size (ha)	Number of farms	Mean plot size	Mean number of plots	Mean distance to farthest parcel (km)	Mean distance to nearest parcel (km)	Believe land is too fragmented (% of group)	Mean of fragmentation index
<1	32	0,238	3,66	1,73	0,65	85	0,59
1-2	50	0,374	4,92	2,78	0,88	86	0,53
2-5	62	0,777	6,66	2,64	0,53	77	0,48
>5	24	1,281	6,58	4,92	0,72	61	0,45
Total	168	0,626	5,55	2,83	0,69	79,2	0,51

Source: Melmed-Sanjak *et al.*, 1998, p.62-63

[3] All totals are weighted averages according to the population distribution across farm sizes.

Farms are categorized by size structure and according to the fragmentation index in the last row in the table, all holdings in all regions and in all ranges of farm sizes are significantly fragmented. The results revealed “that the distance factor also contributes to the high level of fragmentation as the average one-way distance to the farthest parcel is over 2 kilometers for each of the regions sampled” (ibid, p.64). Farmer belief also corresponds in all regions with the results. The mean plot size is increasing as the size of the farm operation increases. This increase is statistically significant between most farm size groups for all of the regions. Any decline in the level of fragmentation from the increase in mean parcel size for the farms which are over then 5 hectares is balanced by the addition of noncontiguous parcels to the farm. Thus, the largest farms with the highest agricultural output also operate subject to under a high level of fragmentation. In the Pelagonian region, the average parcel size is around 0,5 ha with farmers operating on an average of 16 parcels.

In order to address the importance of these issues, the degree, advantages and disadvantages of fragmentation “need to be appraised and considered against the potential benefits and costs of consolidation efforts when formulating agricultural strategies” (ibid, p.59). To do this first the extent of fragmentation must be measured, like in the study done by Melmed-Sanjak *et al.* (1998), which leads to the next section within this chapter.

2.3 Measurement of fragmentation

Despite being a common phenomenon, land fragmentation can be measured in several ways. According to Walker (1990) fragmentation means different things to different people since the degree of land fragmentation is different among the countries. Thus, generally, “a distinction can be made between single dimension indicators and integrated indicators” (Tan, 2005, p.13). Rembold (2004) in his study uses three single dimension land fragmentation indicators: the number of land owners per country (or region), the number of users per country (or region) and the overlap of these two.

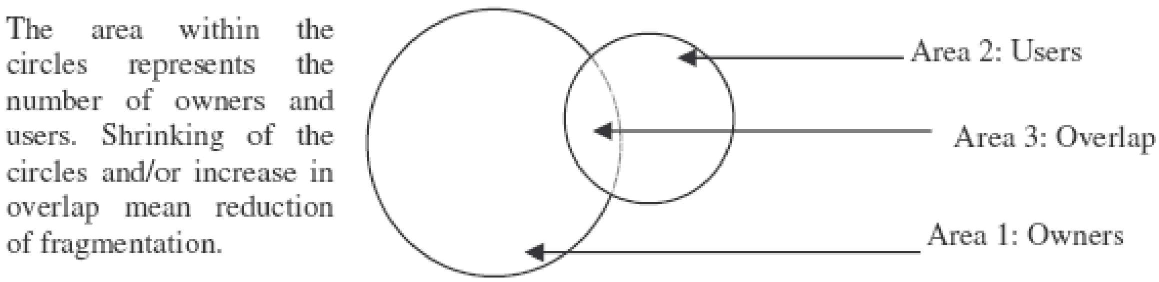

Figure 2 Rembold’s approach to measuring land fragmentation

Source: Tan, 2005, p.13

Area 1 in figure 2 corresponds to the number of owners where a large circle represents a larger number of land owners consequently referring to a smaller area per owner. But to give a full picture of fragmentation Rembold (2004) uses a second indicator (the number of users) as well as third indicator (the overlap which represents the owners that are also users). Area 1 minus area 3 denotes the number of land owners who don’t cultivate the land themselves whereas area 2 minus area 3 represents the number of users who do not own their land. To simplify, any shrinking of the circles and/or increase in overlap means a reduction of fragmentation.

However, this way of measuring land fragmentation has one drawback. It focuses only on the average size of owned or managed landholdings, but not on the number of plots or the spatial dispersion of the plots. This disadvantage, Dovring (1960) cited in Tan (2005), tries to eliminate by using the ratio of the number of plots to the total farm size in hectares to measure "excessive" fragmentation. He argues that "10-hectare farm suffers from excessive fragmentation if it is divided into more than 10 plots" (Tan, 2005, p.14). At the same time, he also quantifies the distance aspect by measuring the total distance that the farmer would travel by visiting each of his plots and returning to his farmhouse after each visit. This measurement has also weakness as the previous one. "It assumes uniform field sizes and farmers' routines" (McPherson, 1983, cited in Tan, 2005, p.14).

Besides these two methods to identify the degree of fragmentation, there are six parameters which are used by some scholars: farm size (total holding), plot number, average plot size, plot shape, spatial distribution of plots and the size distribution of the plots (Simmons, 1988; Bentley, 1987, cited in Melmed-Sanjak *et al.* (1998); King and Burton, 1982, cited in Van Hung *et. al.*, 2006). From these parameters, size and spatial distribution (distance) are most significant. The shape of the plots is an essential parameter when mechanization is introduced since farm mechanization is considered to be most efficient on rectangular plots.

On the contrary from the single dimension indicators, the integrated indicators use the information from several single indicators into one index. Blarel *et al.*, (1992) argue that the two most popular integrated indicators are the Januszewki index (K) and the Simpson index (SI). The index developed by Januszewski in 1964 is defined as:

$$K = \frac{\sqrt{\sum_{a=1}^{n} a_i}}{\sum_{a=1}^{n} \sqrt{a_i}} \qquad (1)$$

This index, where n is the number of plots, and a_i is the area of each plot, "divides the square root of the total farm area by the sum of the square roots of the plot sizes" (Melmed-Sanjak *et al.* 1998, p.62). It ranges between 0 and 1, with a value of 1 indicating a farm operation with one contiguous parcel or the smaller value, the higher degree of land fragmentation. According to Melmed-Sanjak (1998, p.62) "this index has three properties: fragmentation increases (the value of the index decreases) as the number of plots increases, fragmentation increases when the range of plot sizes is small, and fragmentation decreases when the area of large plots increases and that of small plots decreases". The Januszewski index, however, has one disadvantage as the other methods. It fails to account for farm size, plot distance, and shape of plots.

The Simpson index is similar to some point, with Januszewski's index and can be defined in the following way:

$$SI = 1 - \frac{\sum_{i=1}^{n} a_i^2}{A^2} \quad (2)$$

where a_i is the area of the i-th plot. A which can be rewritten as $\sum a_i$ is the farm size. The Simpson index is also located between 0 and 1 as the Januszewski index. However, a value of zero indicates complete land consolidation. The value of the Simpson index is also determined by the number of plots, average plot size and the plot size distribution. As well as the other index *SI* does not take farm size, distance and plot shape into account.

Even though using six parameters to present full picture of the land fragmentation level, often due to data limitations, the choice of appropriate measures and indicators is limited. In this study the Simpson index is chosen. The results of the current fragmentation level of vegetable production in the study are presented in the next chapter.

2.4 Land consolidation and land management

Land management is suitable for bringing current land use and other land ownership issues in accordance with interests and actions for eliminating effects that disrupt rational land use (Seele, 1992 cited in Thomas, 2006). Land consolidation is one of the means to manage land, whereas consolidation is the solution to fragmentation. According Melmed-Sanjak *et al.*, (1998, p.137) "consolidation is a spatial problem-solving technique, whereby landowners are obliged or compelled to surrender their scattered plots in order to receive an equivalent area or value of land in fewer and larger plots". In the transition countries, land consolidation is one of the most important fundamentals for helping to resolve the structural problems in agriculture and agricultural production. It can be seen as a "secret weapon for economic growth and shared wealth" (Thomas, 2006, p.245) which consist of policies and schemes for new infrastructure, irrigation systems, etc.

2.4.1 Types of land consolidation

Land consolidation may be conducted in different ways, ranging from the simple re-organization of parcels to sophisticated rural development projects (ibid). Agricultural holdings may be rearranged in a sense to improve the production and working conditions in agriculture as well as encouraging the general use and development of land and rural areas. Referring back to the previous note land consolidation is a part of land management, containing elements of special policies and schemes. This relationship between them is illustrated in the following figure:

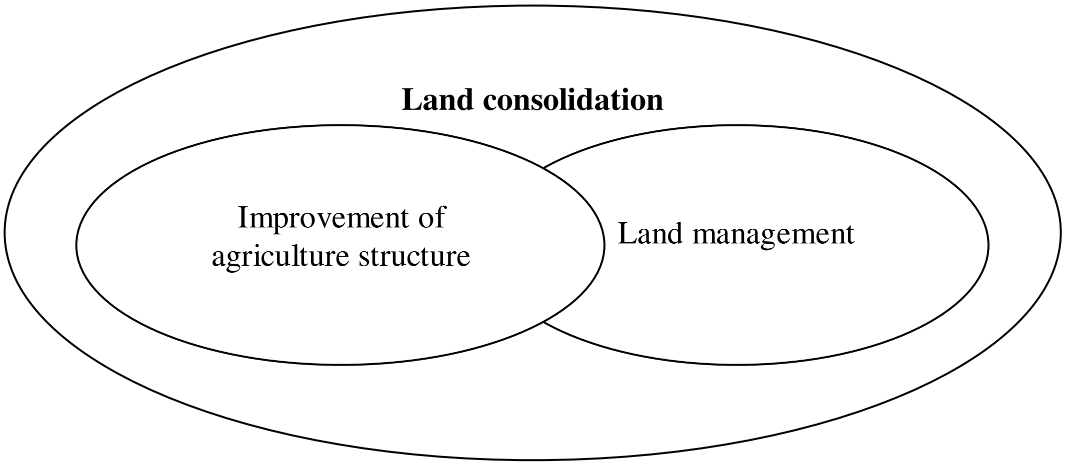

Figure 3 On the character of land consolidation

Source: Thomas, 2006, p.246

There are quite extensive necessities of realizing a consolidation programme. Land consolidation can be successfully carried out only if the decision to take such measures is the outcome of a conscientious analysis and comprehensive diagnosis, with clearly set goals due to specific structural conditions.

In the literature the scholars try to differentiate land consolidation in a narrow sense which is "simple land consolidation" and land consolidation in a broader sense which is "comprehensive land consolidation" or "complex land consolidation" as well as in a context of how is done, "possibly voluntary", executed voluntarily on a legal base through a special law, or as a compulsory administrative procedure or legally-enforced (ibid).

Simple land consolidation is commonly perceived as merge and re-allocation of plots and parcels which is carried out fast by the *voluntary land exchange*. It is called voluntary because the owners have to agree to all measures necessary to realize the switch, including proportional valuation of the corresponding parcels or shares of parcels, merging of parcels, transfer or extension of rights as well as new boundary lines. If there is a need to consolidate many scattered and/or inefficiently shaped parcels in a community the land consolidation procedure should be concentrated on the merging and reshaping of bordering parcels, a form of *accelerated land consolidation* where the outcome is units of economic size and rational shape. "Several Western European countries have a land consolidation practice where the landowners participation can be *compulsory"* (Germany, the Netherlands and Sweden), but only a few percentage of the landowners are mandatory participants (Hartvigsen, 2006, p.16). In some land consolidation pilot projects implemented until 2006 in Central and Eastern European countries, a completely voluntary approach has been used (ibid). The main reason for this is to build up a crucial trust, for the future activities, between the local landholders and the land consolidation agency, such as the Ministry of Agriculture or the State Cadastre Authority, because of the failures of some land consolidation projects.

Throughout **comprehensive (or "complex") land consolidation**, land holdings can be re-arranged with a vision to improve the production and working conditions in agriculture as well as endorse the general use and development of land (ibid). A comprehensive land consolidation corresponds to a longer-term solution for agricultural structures. It aims to preserve and implement the stability of farms, the environment and landscape in harmony with agricultural production. Comprehensive land consolidation projects are usually planned and implemented by a state authority or agency.

2.4.2 Potential results and impacts of land consolidation procedures

The results of land consolidation procedures can differ according to the type of land consolidation chosen. Even though the consolidation programmes are results of good in advanced planning and government policies, "ranging from large-scale mandatory programmes to decentralized small programmes encouraging consolidation on a more voluntary basis" (Sundqvist and Andersson, 2006, p.5). Some programmes have failed to overwhelm the disadvantages of fragmentation. One of the reasons for this is the nonwillingness of the landowners to participate because of the fear that they will be driven out as employees of the agriculture due to farm mechanization facilitated by land consolidation (Niroula and Thapa, 2005). King and Burton (1983) cited in Niroula and Thapa (2005) noted that the voluntary consolidation in India in the 80's had been a failure just because of the previously mentioned reason. Only minor economic advantages can be attained on a local level for the involved farmers. "Farmers tend to prefer a voluntary land exchange that lasts only a few weeks or months" (Thomas, 2006, p.249). One other factor that has to be mentioned as a constraint for land consolidation is heterogeneous land quality (Mearns, 1999). The farmers don't want to participate in the consolidation programme because they are not sure about the parcel quality level which is going to be allocated to them in exchange for their fertile parcel. Other impediments in conducting land consolidation as Singh (1987) cited in Niroula and Thapa (2005, p. 366) are "lack of scientific land records, corrupt bureaucracy, legal loopholes and lack of technical skills on the part of officials".

Nonetheless, "consolidation experiences reveal varying degrees of administrative and farmer-level participation" (Melmed-Sanjak *et al.*, 1998, p.137). According to Melmed-Sanjak *et al.* (1998, p.137), "in Austria, the decision to consolidate requires a minimum vote of 33% of the landowners at least 50% of the land". "Consolidation programmes in Spain were lead by a considerable publicity campaign including meetings, films, news releases, radio broadcasts, demonstration visits, and interviews with farmers" (ibid). In India the land consolidation operation were commenced on a voluntary base only when one-third of the villagers at least one-third of the land demanded support for consolidation (Niroula and Thapa, 2005). According to Burton and King (1983) cited in Melmed-Sanjak *et al.*, (1998) land consolidation programmes sometimes were materialized with help by specially created decision-making agencies or legislation.

An option to consolidation is to use government funds to relax some of the constraints which reduce voluntary consolidation. Simmons (1988), comments that by improving the economic environment of farmers, farmers may be willing to participate in the consolidation process. "Improved access to credit, agricultural markets, and related agricultural infrastructure such as transportation and irrigation all improve the production incentives of farmers" (Melmed-Sanjak *et al.*, 1998, p.138).

Evaluating the success of consolidation is to some extent complicated. "There is an evidential lack of empirical facts on land consolidation due to the complexity of comparing consolidated areas with previous holdings" (ibid). "While the measurement of the advantages of land consolidation are probably doable" (Oldenburg 1990, p.184), it is possible to argue about the possible benefits and costs of consolidation in broad terms.

The potential results of land consolidation include merged, enlarged and better-shaped parcels where the farmer will gain better access to roads, water channels, and other infrastructure. Evidence from field research in Western Europe has shown that through land consolidation or decreased number of parcels per owner which results reduction in the types of agricultural activities, especially traffic, it is possible to reduce operating costs by up to 20 percent (Thomas, 2006). Keymer et al. (1989) cited in Thomas (2006) found out that merged parcels from 3,5 to 1 will reduce the farmer working time by up to 40 percent, the productivity of full-time farmers increases with up to 44 percent and the productivity of part-time farmers by as much as 49 percent. In addition, consolidated and parcels have higher market values which will help to encourage the land market. Irrigation and/or drainage-systems may be renewed and adjusted to the new plots and parcel outline. Furthermore, some actions may be taken into consideration for flood protection and transformation of water bodies and sources, soil conservation and control of the erosion. Moreover, land consolidation is likely to promote an understanding of cooperation and to encourage the willingness of farmers to cooperate. On the contrary to their previous experiences farmers may recognize that cooperation has advantages for all parties involved.

Although the benefits of land consolidation may ensure increased production, the potential costs for consolidation programmes are very high (Sundqvist and Andersson, 2006). The technical and administrative costs of consolidation “include surveying and detailed mapping of location, elevation, size, soil type, value etc. of every parcel” (ibid, p.6). Farmers often bear the indirect costs of consolidation, even if programmes are government sponsored (Bentley, 1987). The consolidation process “can interrupt the crop cycle for several years, and disrupts the ecological benefits of land fragmentation” (Sundqvist and Andersson, 2006, p.6). Land consolidation activities aimed to improve agricultural production and working conditions have negative impacts on the environment. Thomas (2006, p.252) states that “measures for increasing agricultural productivity during the 1960’s and 1970’s in Western Europe destroyed natural structures, biotopes, waterways, vegetation belts and other landscape features” where the ecological stability of landscapes was disturbed and biodiversity reduced. Hence, present land consolidation measures should assure the principles of sustainability. Land consolidation is useful for a rapid reduction of fragmentation, and it is also important for continuously adapting farm outlay to the constantly changing conditions of world market, agricultural policies or regional economic developments (van Dijk, 2002).

While in the case of land fragmentation the costs exceed the benefits, in the case of land consolidation the benefits exceed the costs. That’s why, according to King and Burton (1983), cited in Melmed-Sanjak *et al.*, (1998, p.138) “large farms tend to benefit at the expense of small farms” due to the lower ratio of labour to land where they try to gain by diminishing their travel time through land consolidation. How does the land fragmentation affect the productivity and profitability in the small-scale sector in the study area? Which result may be of importance for future policy implication, especially for land consolidation?

2.5 Land consolidation in Macedonia

“All countries in the Central and Eastern European region have been through a procedure of land reorganization with a focus on de-collectivization, restitution of private ownership to land and privatization of agricultural land” (Hartvigsen, 2006, p.3). The outcome of the land reforms and privatization processes in most countries in the region have been agricultural structures inappropriate for today's Europe and the globalizing economy, where small fragmented farms have emerged. Most of the countries in the region have had practices with land consolidation over the last decade (ibid). Table 4 tries to summarize past and on-going activities in some of the countries.

Table 4 Experiences with land consolidation activities in Central and Eastern European Countries (status July 2006)

	Land consolidation pilot projects under implementation	Land consolidation pilot projects already implemented	National land consolidation strategy under preparation or already prepared	Land consolidation legislation developed	On-going national land consolidation programme
Albania		x			
Armenia	x		x		
Bosnia & Her.					
Bulgaria		x	x		
Croatia	x		x		
Czech Rep.				x	x
Estonia		x			
Hungary		x	x		
Kosovo	x			(x)	
Latvia		x			
Lithuania		x	x	x	x
Moldova	x		x		
Poland			x	x	x
Romania	x		x		
Serbia	x		x	(x)	
Slovakia				x	x
Slovenia				x	x

Source: Hartvigsen, 2006, p.5

"Five of the twenty countries became EU-member countries in May 2004 and have access to EU co-funding of the land consolidation activities over the national rural development programmes" (ibid, p.5). Thus, already they have on-going national land consolidation programmes.

The limited area of fragmented arable agricultural land in Macedonia, extract the need for adjusting the agricultural policy. The historical process of land fragmentation[4], lead to convey a Law for "arondacija"[5] (reallocation of holdings) as special act of the agricultural policy. Arondacija "is type of land consolidation (agricultural land, forests, forestry land) for the purpose of achieving optimal land use, mechanizing the process of production, carrying out reclamation and erosion prevention actions, viable production units, planting of forest trees and afforestation" (Melmed-Sanjak *et al.*, 1998, p.29). Arondacija, where only few parcels are re-arranged, is a special part of "komasacija" which can be seen as comprehensive land consolidation mostly used for complete re-arrangement of villages, municipalities and regions

[4] The average plot size in the small-scale production sector was decreasing from 4,49 ha in 1939, to 3,14 ha in 1960, 2,57 ha in 1969, 2,07 ha in 1981 (Murarcakiev, 1994) and 0,3-0,5 ha in 2007 (MAFWE, Annual Agricultural and Rural Development Report, 2007).
[5] Official Gazette SRM 18/76

(Lazarevski *et. al.,* 1980). Although, komasacija in Macedonia is not regulated by law, it is still has significant position in the agricultural policy (Murarcaliev, 1994). But, this procedure is not very popular due to the high costs and the complexity of common participation by the subjects which are part of the consolidation process.

Since arondacija compared to komasacija is on a more narrow level which can be commenced more easily, it was a typical measure that was used to create larger blocks of arable land (previously in social ownership). The decision for *arondacija*, a combination of expropriation and appropriation, "is issued by a committee selected by one or several municipal meetings where the owner of the land (either full-time or part-time farmer) receives compensation in money or in land of the same cadastral class, crop and probably same location by the user" (Melmed-Sanjak *et al*., 1998, p.29).

Macedonia is undergoing a major development in the area of land administration, denationalization, systematic cadastral surveys and rights adjudication, registration system development, data conversion, as well as introduction of modern survey techniques and privatization of land survey services (Internet, FAO, 2008, 2). With approximately 50% of its land valuation completed, Macedonia is at the very first stage of the land consolidation procedure aiming at improved land profitability, higher yields, reduction of unproductive frontier areas, clarification of all relevant legal aspects and reduction of disputes and conditions for recording new and updating real estate records (Internet, FAO, 2008, 3). Through the process of land consolidation fragmented areas will be expanded by finding out the taken over parts by the illegal owners regulating the ownership issues at the same time.

In Zletovo, a region in the eastern part of Macedonia (See Appendix 1), prior to the start of a water-accumulation project for resolving the severe drinking-water problem and irrigation, land consolidation should take place (Internet, FAO, 2008, 2). Pelagonia, as the largest wheat-growing region and with great geo-strategic importance, is a key region in Macedonia because of the uniformity of the land structure and value. In order to maintain this status, land consolidation will be performed with expected minimal problems in relation to geodetic and legal features (ibid). The Kukurechani community belongs to the Pelagonia region covering an area of 1854,23 hectares spread over 5417 cadastral lots where 1681,09 ha is arable land and 173,14 ha is non-productive land (ibid). Taking into consideration the circumstances in general and the government at the time, Popovski (1984) in his post-graduate work for this region concludes that the best way to manage the land within that community is by grouping of the crops i.e. functional land consolidation (re-parceling). He especially emphasizes that with the functional consolidation the troubles of unplanned production in the individual sector has been overcome and for all grouped parcels the 4-year culture cycles are planned and markets secured. The financial results from this gave positive effects in a situation without irrigation and better results with irrigation. The positive financial results were mainly due to the change in production structure but also due to the improved yields per unit area and reduction of production costs. One of the primary institutions responsible for many of the land consolidation activities is the State Authority for Geodetic Works (SAGW). Having an updated cadastral record in the SAGW department in Bitola land enlargement (arondacija) was performed in the cadastral community Egri in order to provide a more rational use of cultivated agricultural land and to improve the conditions for improved agricultural production (Georgievski, 2006). Table 5 summarizes the cadastral evidence from the Egri community.

Table 5 Egri community cadastral evidence

Surfaces, parcels, ownership document	Cadastral community Egri	Urban area	Arrange land	Land consolidation area
Total surface (ha)	2209	46,1	1672	490,7
Number of parcels (No)	1557	498	161	898
Number of ownership doc.(No)	187	187	22	155
Average surface of parcel(ha)	1,42	0,09	10,39	0,54
Average number of parcels in ownership doc.(No)	8,33	2,7	7,32	5,79

Source: Georgievski, 2006, p.3

Examining the last row in Table 5, reveals that the land consolidation area is comprised of 898 plots totaling 490,7 ha with 155 ownership documents. The average size of a plot is 0,54 ha and the typical ownership document have 5,79 plots.

Before starting the process of land consolidation, it was specified that the re-arrangement of the parcels should be on voluntary base (ibid). After allocating the plots to a new position depended on the position of plots concerning the property owner as well as the familiarity or productive relationship with the neighboring participants the following results were gained.

Table 6 Property structure before and after land consolidation in cadastral community Egri

Number of parcels in the ownership doc.	Before consolidation			After consolidation		
	Number of ownership doc.	Number of parcels	Total surfaces (m^2)	Number of ownership doc.	Number of parcels	Total surfaces (m^2)
1	36	36	172971	125	125	1951328
2	16	32	179557	25	50	1112047
3	20	60	215231	3	9	180586
4-5	25	112	430592	-	-	-
6-10	25	180	2193585	1	6	1504858
11-15	23	306	1196907	-	-	-
16-20	10	172	557511	1	20	157935
Total	155	898	4906754	155	210	4906754

Source: Georgievski, 2006

From Table 6 above before and after the land consolidation it can be concluded that the number of new parcels was reduced to 210 from 898 as well as the number of ownership documents (have one or two plots is 150 and with 3, 6-10 and 16-20 parcels, only 5 ownership document).

Having in mind the fact that in Macedonia 192.378 farmers are cultivating 636.911 parts of agricultural land (SSO, Agricultural Census 2007) with land consolidation projects the number of plots will be considerably reduced at the same time having a great effect on creating more competitive agricultural production.

3 Analytical framework

This chapter consists of the methods used along the study, such as the methods of collecting the data as well as the statistical models use for doing the research. At last, the Cobb-Douglas model and the GLM (General Linear Model) are outlined.

3.1 Methods of data collection

The secondary data collection was conducted for the small-scale producers in two regions: Skopje and the Southeastern regions (See Appendix 1), manly because in these two regions the vegetable production prevails. The collection was concluded during the period of February and March 2009 electronically at several occasions by visiting the National Extension Agency (NEA) regional offices in Gevgelija and Skopje. This method was used since most of the farmers in those regions are registered, so there was statistical data available. The sampling approach was not random but the farms were chosen by the people, i.e. advisors employed in NEA, because they were directly involved in the data collection process and familiar with data quality. All the information collected from the selected 28 farms for the given period from 2004-2007 was relevant and useful, providing the descriptive values that are important in answering the aim of this study. The farm size and crops grown between the samples differs. Table 7 below provides summation of the approach used for this research.

Table 7 Research method used

Study location and period	Number of farms	Sampling approach	Number of visits	Results
Skopje, Gevgelija, Radovis and Strumica, 2004-2007	Vegetable producers (28)	Not random sample	Several visits of the NEA regional offices in Skopje and Gevgelija	Total farm annual report

3.2 General description of the FMS/FADN

The quality of the collected data by the NEA was ensured by the Farm Monitoring System (FMS). This system has been widely accepted and recommended by the EU experts as a solid basis for a future upgrade of the Farm Accountancy Data Network (FADN). This system is used for evaluating the CAP (Common Agricultural Policy) type (MAFWE, Annual Agricultural and Rural Development Report, 2007). The NEA which was established by the Law on NEA[6] with the headquarter in Bitola consists of a database of 450 individual agricultural producers. Data concerning resources, yield, income, expenses, labour and similar are published annually. The Information System was supported by the World Bank in 2001 and in the past years it has been upgraded with assistance from the Swedish Statistics, financed by SIDA - Swedish International Development Agency (ibid). During the latter years, appropriate data processing that satisfy the Farm Accountancy Data Networking

[6] Official Gazette no.3/98

(FADN) regulations, the needs of the State Statistical Office as well as the Ministry of Agriculture, Forestry and Water Economy, and most importantly, the needs of the advisory service were implemented. Table 8 identifies the principal data collected which is used to calculate the gross margin.

Table 8 Principal information collected by FADN

- Production of crops
- Labour inputs
- Number and value of animals and livestock purchases and sales
- Grants and subsidies
- Taxes
- Interest and finance charges
- Cost of paid labour, contract work, fuels, feedstuffs, seeds, insurance, electricity and water
- Land and buildings
- Investment and depreciation
- Machinery and equipment
- Stocks and working capital
- Debts
- Quotas
- Area under different land tenures

Source: FAO Land Tenure Policy, 2006

The gross margin is an "estimate of the income created by the farming enterprises and is the value of the output less the variable costs directly attributed to the enterprise" (FAO Land Tenure Policy, 2006, p.12). Farm income, presented in Figure 4 can be derived by deducting expenses, payments for external resources, depreciation and taxes plus adding the grants and subsidies.

Total output by product
-
Intermediate consumption of the inputs produced on the holding used in the production of other inputs
+
Farm subsidies
-
Balance of taxes and value added tax
=________________________________
Gross farm income
-
Depreciation
=________________________________
Farm net value added
+
Investment grants and subsidies
-
Wages, rents and interest paid
=________________________________
Family farm income

Figure 4 Income model in FADN

Source: FAO Land Tenure Policy, 2006

The data exclude any non-farming activities of the farm, except for forestry and tourism related to the household. Hence, FADN does not provide full information on the standard of living of the agricultural household. However, the Court of Auditors found out that many of the variables which the data is collected are highly skewed (ibid). Macedonian reporting based on FMS which is used for summarizing the data, is displayed in Appendix 5.

3.3 Data analysis approach

The data collected through the study were summarized by using numerical methods (*tabulations*) and graphical methods (*charts*) because both methods can be applied to the sample data sets. *Descriptive statistics* as part of the numerical methodology, such as mean, median, standard deviation, maximum and minimum were used to present the data. In addition, descriptive statistics was used as well to present the land fragmentation degree calculated by the Simpson index formula, mentioned in the previous chapter. Tabulated presentations were also used to present the regression results from the production function.

Pie chart, as appropriate object for the analysis of the graphical methodology was used to describe each variable share from the overall variables used to estimate the production function. In addition, *bar chart* presentation was used, illustrating all the results separately in graphs. Furthermore, *normal probability plot* of residuals was used to present the relationship between the total output and the residuals. The main purpose of this was to estimate if it's the residuals normally distributed. In the figure, the data is plotted in relation to the theoretical normal distribution. If some of the points do not fall on the straight line then there is a deviation from normality. At last, *scatter plots* were used to present the connection between two variables by graphing them against the other.

To measure the strength or degree of linear association between the variables I used correlation coefficient. Al though, the correlation coefficient can be measured in several ways, I used the following model:

$$r_{xy} = \frac{\sum x_i y_i - nM_x M_y}{\sqrt{\left(\sum x_i^2 - nM_x^2\right)\left(\sum y_i^2 - M_y^2\right)}}, \text{ where} \quad (3)$$

r_{xy} the correlation coefficient;
x, y variables, written as x_i and y_i, where i can be 1, 2, … n; and
M_x, M_y means of the variables (Gjosevski, 2005, p.139).

Having in mind the fact that the study area is vegetable production and from the economic point of view by the neo-classical theory, the issue is to address the impact of land fragmentation on the production. A *Cobb-Douglas* (CD) production function was used because it's the most widely used specification for function. The function is an adjusted, to a multiple inputs CD regression because the original CD function uses only two inputs, labour and capital (Debertin, 1986). The adjusted function allows the estimated parameters to the inputs to sum to a number different than 1, allowing for non constant returns to scale. The form was following:

$$y = \beta_0 K^{\beta_1} A^{(\beta_2 + \alpha_2 LF)} OI^{\beta_3} L^{\beta_4} DG^{\beta_5}, \text{ where} \quad (4)$$

Y	value of farm output;
$\beta_0, \ldots \beta_5, \alpha_2$	partial elasticities;
K	capital services cost;
A	land (in ha);
LF	land fragmentation (Simpson index);
OI	other inputs (seeds, fertilizers, chemicals, …);
L	labour cost; and
DG	dummy for greenhouse, 1 = if the farmer owns (pers. comm. Andersson, 2009).

To estimate the parameters, the variables must be transformed into logarithmic form in order to estimate a linear regression model. By transforming to logarithms the function takes a new form, which is:

$$\ln y = \beta_0 + \beta_1 \ln K + \beta_2 \ln A + \alpha_2 LF \ln A + \beta_3 \ln OI + \beta_4 \ln L + \beta_5 \ln DG + \varepsilon \quad (5)$$

In the linear equation ε is "the error term which captures the effects of all omitted variables assuming zero mean and unit variance" (Thapa, 2007, p.11).

The estimated partial elasticities (β_i's) can be defined as "the ratio of the percentage change in output to the percentage change in input" (Thapa, 2007, p.11). The higher the elasticity of the input is, the higher the impact it has on the output.

After the transformation, a regression analysis can be conducted. The regression analysis is concerned with the study of the dependence of one variable, the *dependent variable*, on one or more other variables, the *explanatory variables,* i.e. the outcome variable (vegetable production) to be predicted from the other factors.

In addition to the CD production function, the *General Linear Model* (GLM) was used, since it's also utilizes regression analysis. The simple linear regression function is the following:

$$y_i = a + bx_i + e_i \text{ , where} \quad (6)$$

y_i	the value of the response variable;
a and b	the intercept;
x_i	the value of the predicted variable; and
e_i	the random error term (Gjosevski, 2005, p.139).

The observed data were used to estimate the parameters of the regression function, i.e. the impact of the land fragmentation on the farm productivity and profitability.

The explanatory variables that were used in the analysis and their expected impacts (anticipated sings) on the total production are provided in Table 9. A larger value of the Simpson index is expected to decrease production, since modern agricultural technologies are more complex to use on the fragmented parcels. However, as the literature reveals it may also increase the production by facilitating labour use more efficiently and risk management. Hence, the impact of the Simpson index may be ambiguous. By increasing the acreage of the farm the total production is expected to increase. The capital services comprise by the use of modern agricultural mechanization is expected to have the same impact as the farm size. However, due to the capital services association with the mechanization and the opportunity to properly apply the technology due to land fragmentation this variable may be indistinguishable. Larger amounts of other inputs (seeds, fertilizers, chemicals, irrigation, …) are expected to increase the total production as well as the income. Moreover, owning a greenhouse yields high profits, because the farmer is able to grow early spring crops during controlled conditions, which are highly valued on the market. At the end, since labour use may also depend upon Simpson index it may also have indeterminate sing.

Table 9 Anticipated sings of the variables included in the model based on the literature

Explanatory variables	**Expected sign**
Simpson index	-/+
Farm size	+
Capital services	-/+
Other inputs	+
Labour	-/+
Dummy variable for greenhouse, 1 = if the farmer owns	+

To examine if the model fits with the real conditions of farming, I used the coefficient of determination - R^2. The goodness of fit of the fitted regression line to examine how well the sample regression line fits the data. If all observations were to lie on the regression line, we would obtain a perfect fit. However, generally there will be some positive e_i and some negative e_i. The coefficient of determination R^2 is a summary measure and can be calculated in the following way:

$$R^2 = \frac{\sum \left(\hat{Y}_i - \overline{Y}\right)^2}{\sum \left(Y_i - \overline{Y}\right)^2} \tag{7}$$

One impediment of this measure is that if new variables are added to the model then it increases. The model can be also estimated by the adjusted R^2, because it decreases when new irrelevant variables are added.

4 Background for the empirical study

This chapter gives insights in the overview of the countrywide traditional vegetable crops for the period from 1995 to 2007, especially for the open field and protected vegetable production.

4.1 Significance of vegetable production

The historical development of the vegetable production is closely affiliated with human development. The origin stems from the shift from nomadic to station (agricultural) life where the domestication path of many wild plants was difficult and lengthy. In the human diet, many varieties of vegetables are used as fresh, canned or processed. The forms of vegetative parts (stem, fresh bulb and leaf) and generative parts (fruits, ripe and unripe seeds and flower). The importance of vegetables, especially of fresh vegetables is not due to only the contents of minerals, vitamins and fats, but also by the sustenance that other types of food have sparsely of, or absence, which are essential for human development and health (Martinovski *et. al.*, 2002). Despite the fact that some vegetables have low energy value due to high water content, vegetables still are of great importance and according to the latest researches the protein content in vegetables is almost similar to meat and milk (ibid). Due to the fact that minerals, carbohydrates and proteins are found in soluble form in vegetables, the human body absorbs them easily and without effort. Furthermore, some substances with antibiotic effect i.e. phytocides, are found in some vegetables (onion, garlic, horseradish and other). Thus, the significance of vegetables is even greater. To summarize, from the all-above said there is a great need in vegetables worldwide which suggests the importance of production and quality by improving management.

4.2 Vegetable production

"The production of vegetables, especially early vegetables, are one of the significant characteristics of the country's agricultural sector and is one of the most important sub-sectors that offer a solid ground for further competitive development of the Macedonian agriculture" (MAFWE, IPARD programme, 2008, p.67). Even though vegetable production is in a development phase it is still a traditional production sector due to the accentuated vegetable market orientation.

The production of vegetables, such as tomatoes, peppers, cabbage, melons and watermelons, as well as cucumbers and potatoes is mainly "located in the northern parts of Macedonia (Skopje and Kumanovo) with a mild continental climate and in the southern parts of the country with a Mediterranean climate (Strumica, Gevgelija, and Valandovo)" (MAFWE, IPARD programme, 2008, p.67, See Appendix 1). These crops are traditionally produced in Macedonia, along with other vegetable crops such as: beans, garlic, leek, cauliflower, lettuce, carrot, and etc. In the recent years due to the demand on the EU markets and beyond, the farmers introduce new crops such as: broccoli, asparagus, Chinese cabbage and other vegetables, which enable them to earn a higher income.

Table 10, presents the structure of vegetable sub-sector from which can be noted that mainly family farms are engaged in vegetable production (approximately 97% at average), while the remaining volume is produced by the legal entities.

Table 10 Structure of the vegetable production

	Vegetable area, ha			%	
	Republic of Macedonia	Individual sector	Legal entities	Individual sector	Legal entities
Tomatoes	**2136,99**	1977,66	159,33	92,54	7,46
Peppers	**5109,35**	4984,88	124,47	97,56	2,44
Cucumber	**551,1**	491,54	59,56	89,19	10,81
Bean	**1880,7**	1879,7	1	99,95	0,05
Potato	**5201,19**	5174,99	26,2	99,50	0,50
Onion	**1248,04**	1215,73	32,31	97,41	2,59
Garlic	**168,91**	168,71	0,2	99,88	0,12
Carrot	**144,33**	144,03	0,3	99,79	0,21
Cabbage	**1208,19**	1196,19	12	99,01	0,99
Watermelon	**3472,35**	3342,8	129,55	96,27	3,73
Melon	**570,91**	545,26	25,65	95,51	4,49
Strawberries	**265,97**	264,67	1,3	99,51	0,49
Other	**737,03**	665,43	71,6	90,29	9,71

Source: SSO of RM, Agricultural Census: Book I, 2007

Vegetables are yet largely produced on small parcels of land (see Table 11) and production is not really market oriented, where a substantial share of this production meets the households' needs. "Though the country has a long tradition of vegetable production, it lacks new technologies" (MAFWE, NARDS 2007-2013, 2007, p.36).

Table 11 Area of utilized agricultural land in the vegetable production (ha)

	Arable land, gardens and kitchen gardens
up to 0,50	13675,63
0,51 – 1,00	20009,10
1,01 – 3,00	66507,26
3,01 – 5,00	34859,42
5,01 – 8,00	23674,31
8,01 – 10,00	8205,16
above 10	23794,99

Source: SSO of RM, Agricultural Census: Book III, 2007

Vegetable farms that operate an area of 1 to 3 ha account for the largest share of total utilized vegetable area (34.9%). Large-scale vegetable producers (utilizing above 10 ha agricultural land) account for 12.5% of the total area.

In the period from 1995 to 2007, on average, traditional vegetables were grown on 62.385 ha on open field and 260 ha in glasshouses, i.e. in total of 62.645 ha (see Appendix 3). This area represents around 11,3% of the arable land of the Republic of Macedonia (Sector Analysis Study for the Macedonian Agriculture, 2009). Furthermore, vegetables use around 17% of the area in field crops. After years of research, the area of vegetables varied from 52.162 ha in 2006, to 70.883 ha in 1996 (See Appendix 3).

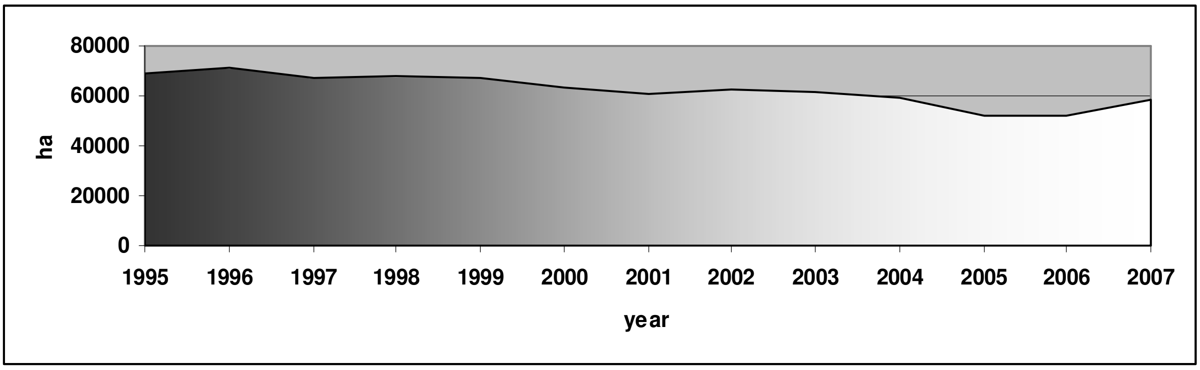

Figure 5 Dynamics of the total open field area of vegetables

Source: SSO of RM, Statistical Yearbooks 1995 - 2007

The analysis of the acreage dynamics of vegetables demonstrate a continuous reduction (with an interval difference of 33.622 ha), which, is partly due to the unstable market relations in the country after achieving independence, and especially with liberalization which occurred after the Republic of Macedonia was accepted in WTO (2003).

In addition to open field production, vegetable production is conducted in glasshouses on a total area of 260 ha as well 4740 ha under plastic tunnels (MAFWE, Annual Agricultural and Rural Development Report, 2007). However, due to the long-standing poor maintenance and the unfinished process of privatization of public capital, glasshouse production of vegetables is carried in around 195 ha or in 70-80% of the available capacity (Sector Analysis Study for the Macedonian Agriculture, 2009). Taking into consideration the fact that vegetable production is operated mainly in two systems, i.e. open field vegetable production and vegetable production in protected areas it is obvious that the degree of intensification differs. Therefore, different yields are achieved.

4.2.1 Open filed vegetable production

Results from research reveal that, contrary to the continuous reduction of the area of vegetables, improved yields are realized in almost all vegetables (ibid). This is mostly due to the increasing application of new technologies, new species with higher genetic potential, i.e., the organizing of vegetable production with a higher degree of intensification compared to a period of ten years ago. As a result of the increased average yields per area, the total production of vegetables, is increasing as well.

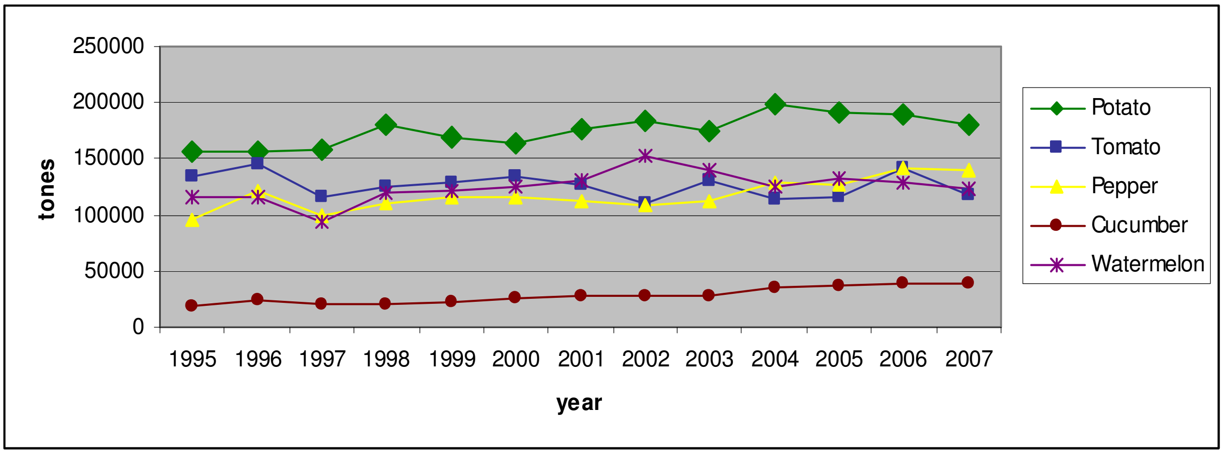

Figure 6 Dynamics of total production of more relevant vegetables

Source: SSO of RM, Statistical Yearbooks 1995-2007

Potatoes are one of the most common crops in Macedonia which involves a large share of the work force especially at the hillside and mountainous production region. The production of potatoes in the Republic of Macedonia in the period of 1995-2007 varies from a minimum of 156.436 tons in 1995 to 189.867 tons in 2006, or 175.335 tons on average (See Appendix 4). The increase in the production of the potatoes in 2007 compared to the starting 1995 amounts to 14,9%.

About 80% of the production of tomatoes occurs in the south-eastern part and in the region Povardarie. In the period from 1995 to 2007 the production varies in the interval of 109.506 tons in 2002 to 146.103 tons in 1996, and the average production of the ten-year period of analysis amounts to 126.556 tons (See Appendix 4). In contrast to the remaining gardening cultures, the production of tomatoes is decreasing. However there was a substantial increase in 2006, whereas in 2007 it decreased again. The increase of production in 2006 in relation to 2005 was 22%.

The production of peppers has long tradition in Macedonia and it varies from 95.570 tons in 1995 to 140.905 tons in 2006, in other words, 117.541 tons on average (See Appendix 3). There was an increase of pepper production of 47,1% in 2007 compared to 1995.

The average production of cucumbers in the Republic of Macedonia in the period from 1995 to 2007 amounted to 27899 tons, and it varied in an interval from 19258 tons in 1995 to 39320 tons in 2006 (See Appendix 3). This crop experienced the largest increase of production in comparison to the remaining vegetables. The produced quantities in 2007 were 103,3% larger than the starting 1995.

The production of watermelons which includes production of melon and watermelons, in the period of analysis varied from 93.242 tons in 1997 to 152443 tons in 2002. The increase in the produced quantities in the final 2007 compared to 1995 amount to 6,5%.

4.2.2 Vegetable production in glasshouses and plastic tunnels

Early vegetable crop production is a controlled production system for which there are good conditions in terms of soil and good climate, with an optimal number of sunny days. The protected production (where some glasshouses are heated with geo-thermal water) is "mainly gravitating around urban area i.e. has significant features of peri-urban agriculture" (MAFWE, IPARD programme, 2008, p.67) and is characteristic for Strumica, Valandovo, Gevgelija, Sveti Nikole, Kumanovo, Veles, Stip, Kocani and Vinica. It begins intensively from 15.03 and lasts until 30.06. In this period, i.e. from 01.06 until 30.08 parallel to the glasshouse production, the production of vegetable crops from plastic tunnels "(simplest construction in high 0,8 m and wide 3 m while the length can differ, made from wood or metal construction and covered with plastic sheeting)" (ibid) is also organized.

Due to the fact that the State Statistical Office does not publish any production results of the glasshouse production the area, production and yields of vegetables grown in glasshouses for the period 2002-2004 are presented based on the study by Dimitrievski and Krstevska (2008).

Of the 185 ha total area used for glasshouse production, the tomatoes accounts to 68.11%, the cucumber 23,19%, and the peppers 4,11%. 4,59% of the total area is used for growing flowers (Dimitrievski and Krstevska, 2008). A feature of the size of the area on which these vegetables are grown is that in terms of tomato and pepper, there has been a reduction in the areas solely in 2004 compared to the starting year 2002. The area has been reduced by 19% for tomatoes and 76% for peppers. The area of cucumbers has increased 2,7 times in 2004, compared to 2002 and 2003 (Table 12).

Table 12 Glasshouse area and production

Index		Vegetable		
		Tomatoes	Cucumbers	Peppers
2002	Area (ha)	126	42,9	7,6
	Production (t)	10262	6082	6
2003	Area (ha)	126	42,9	7,6
	Production (t)	11307	6232	5
2004	Area (ha)	102,2	113,8	1,8
	Production (millions)	8906	7513	1,2

Source: Dimitrievski and Krstevska, 2008

Prodction of glasshouse tomatoes in the period of 2000-2004 was carried out on an average area of 118,1 ha, at which an average production of 10.158 tones per year was realized, as well as an average yield of 86,1 t/ha. In comparison with the realized average yields of tomatoes grown in the open, the glasshouse yields are 4,6 times higher. The cucumber production of the period included for analysis of glasshouse production was carried out on an average area of 66,5 ha, at which an average production of 6609 tones per year was realized, as well as average yields of 117,7 t/ha.

The protected production of peppers was carried out on an average area of 5,7 ha. In the period of 2002-2004 an average production of 4,1 million peppers per year was realized, i.e. 1,4 million peppers per hectare.

As mentioned earlier production of major important vegetable crops under plastic tunnels is carried out on a total surface of about 4740 ha. In 2007 the tomatoes were planted on about 1800 ha with an average annual production of about 100.000 tons, whereas red/green peppers are planted on a surface of about 1400 ha with total production of about 47.000 tons (MAFWE, Annual Agricultural and Rural Development Report, 2007). The potatoes were planted on an area of 210 ha, and averaged accomplished production was about 200 tons, while the surface under cucumbers was about 580 ha with a realized production for about 34.400 tons. Furthermore, the realized production from watermelon in 2007 was 600 tons and in the case of cabbage the surface was about 420 ha with average production amounting to 6500 tons (ibid).

5 The empirical study

In this chapter is a summation from the findings obtained from the NEA annual farm reports. Furthermore, the data and the results are presented which are used for the regression analysis.

5.1 Evidence of fragmentation from the obtained data

Having in mind the fact that the main purpose of this study is to measure the land fragmentation impact on the farm profitability and productivity, it is first essential to calculate the current degree of land fragmentation from the data. In order to do so the Simpson index formula presented in the first chapter was used. The results are the following:

Table 13 Land fragmentation results from the obtained data

Farm structure by size (ha)	Number of observations	Mean plot size	Mean number of plots	Mean of fragmentation index
≤0,5	50	0,18	1,56	0,2
0,51-1,0	24	0,26	3,29	0,6
1,01-1,5	20	0,31	3,9	0,59
1,51-2,0	7	0,41	4	0,5
2,01-2,5	8	0,2	11	0,88
>2,51	3	0,69	5,67	0,68
Total	**112**	**0,29**	**3,28**	**0,43**

Source: NEA, farm annual reports 2004-2007

While examining Table 13 it's noticeable that the farms are categorized by size relevant to the data and methodology used. The farms were summarized in such a manner that the total arable land was taken into consideration, not the total available land. That's why the number of observation is 112 instead of 28 because even though the farmer is growing similar crops every year, he/she is growing on different parcel sizes. Regarding the fragmentation index almost all farms in all ranges of farm size are noticeably fragmented, except for the first group. The main reason for this result is because the households are usually cultivating only one parcel or two (with mean value of 1,56 and mean plot size of 0,18). The fragmentation starts to increase from smallest to highest farm size, followed by similar high fragmentation level and a decline in the last category. The mean plot size is increasing as the farm size increases as well. However there is yet another omission in the 5th group (2,01-2,5) where the mean plot size is 0,2 with 11 plots on average. Consequently, this leads to a result of very high fragmentation index which is the opposite to the expectation that larger farms are characterized by low production costs per unit output due to potential economies of scale. These results are important as they reveal that the larger farms, those with higher output, are cultivating given higher level of land fragmentation.

The overall summation of the land fragmentation Simpson index is displayed in Table 14.

Table 14 Descriptive statistics of Simpson index

Mean	0,434
Median	0,5
Standard Deviation	0,317
Minimum	0
Maximum	0,917

Source: NEA, farm annual reports 2004-2007

From the 112 observations for the data for the years from 2004 till 2007 for each of the 28 studied farms, the fragmentation level varies from total land consolidation (0) to very high land fragmentation 0,91 with a mean value of 0,43. In addition, the results from the relation of the fragmentation index with percentage of the households with varying acreage are presented in Figure 7.

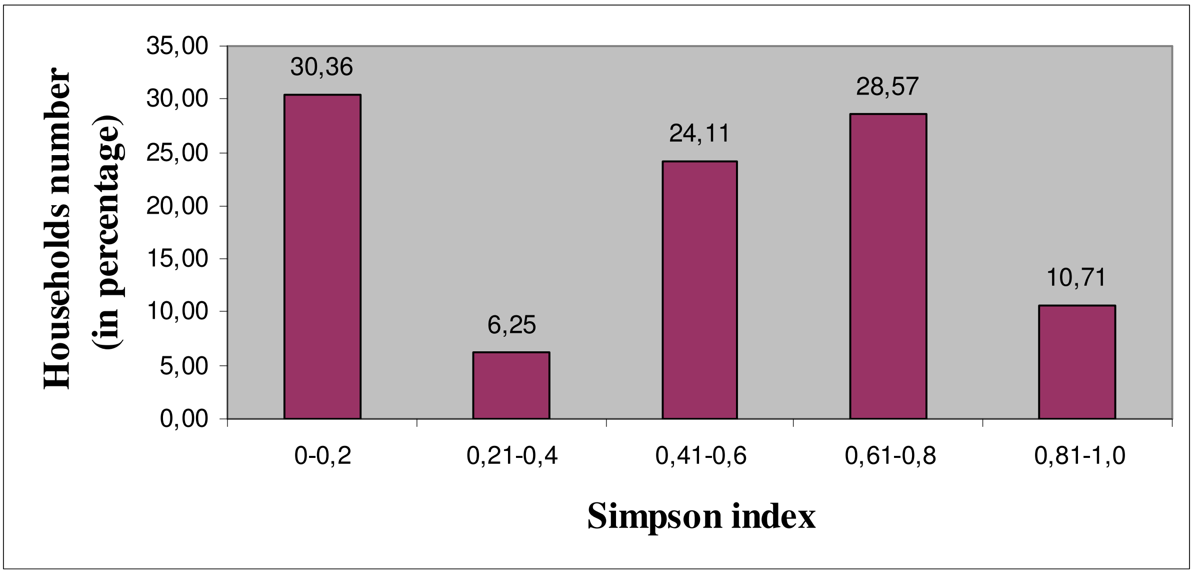

Figure 7 Percentile of households' relation with Simpson index

Source: NEA, farm annual reports 2004-2007

Figure 7 reveals that less then one third (30,36%) of the farms cultivate on consolidated land or on land with a low level of fragmentation. The logic behind this lies in the close relation between the farm size and the plot size. When farm size is small, individual parcel areas on average can't be very big and vise versa. However, Table 12 reveals that there is a growing trend of land fragmentation index as the farm size increase, because the land fragmentation is measured by the number of parcels. Hence, even though the farm size is relatively large they still cultivate many parcels. Consequently, the rest of the observed households operate on significantly fragmented farms.

5.2 Variables used in the model

5.2.1 Land

Since land is an essential natural resource and farm size is one of the variables in the production function where the Simpson index doesn't take into consideration land, there is also a need to provide insights of how to capture the effect of economies of scale. The actual acreage was measured by considering the double cropping as well. Double cropping is the act of growing crops twice on the same piece of land each year (pers. comm. Andersson, 2009). Therefore, some of the farms with a low tillable acreage, were able to enhance the acreage operated by double cropping. Nevertheless, observations where double cropping were present did not cause any substantial increase to overall farm size. Other important site specifics that has to be mentioned and is omitted in the data is the shape of the plots, distance to them, if there are any boundaries present, forest, rivers, trees in the parcels as well as the infrastructure around the plots. These objects may very well influence the overall production, i.e. the use of inputs and consequently the output.

Table 15 Descriptive statistics of farm size

Mean	0,88
Median	0,75
Standard Deviation	0,73
Minimum	0,05
Maximum	3,5

Source: NEA, farm annual reports 2004-2007

By examining Table 15 it may be noticed that the range of the observed data is from 0,05 ha (half decar[7]) to 3,5 ha with 0,88 ha on an average. Since the actual farm size is actually measured by observing the total acreage which explains why the minimum acreage is so small. Referring to the previous section (5.1), farm size is closely related to the plot size. Table 16 present the overall summary statistic of the plot sizes.

Table 16 Descriptive statistics of plot siz***e***

Mean	0,27
Median	0,2
Standard Deviation	0,26
Minimum	0,03
Maximum	2

Source: NEA, farm annual reports 2004-2007

The results from the plot size descriptive statistics are almost similar with the farm size results except for that the range varies from 0,03 ha to 2 ha with a mean value of 0,27 ha. The minimum plot size is actually the back yard plot.

[7] One decar is 0,1 ha

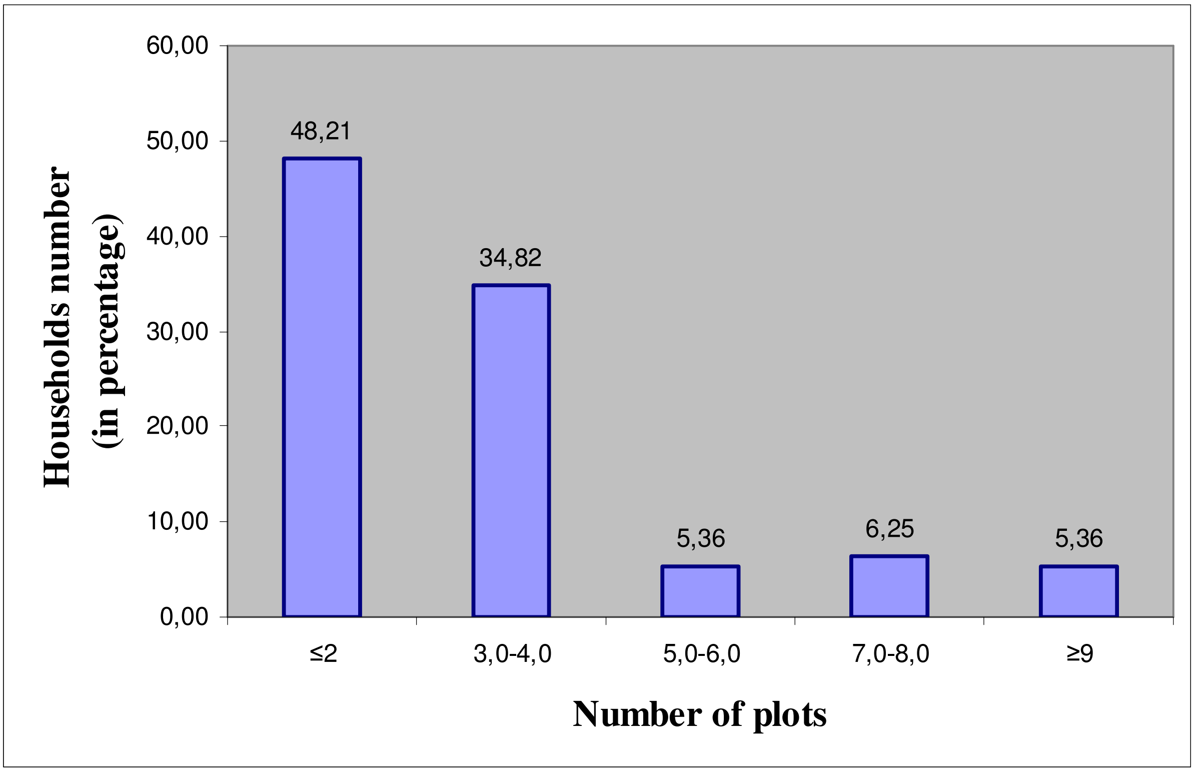

Figure 8 Percentile of households' relation with plot number

Source: NEA, farm annual reports 2004-2007

The observed farms in the 112 observations were mainly cultivating 2 or less then 2 plots (48 %), while around 35% were growing crops on 3-4 parcels. Roughly around 6% of the households had more then 9 parcels, as well as 5-6 and 7-8. Because the degree of fragmentation was measured by the number of plots, farms with more plots were characterized as more fragmented. Hence, the conclusion that larger farms are more fragmented.

5.2.2 Capital services

This variable was obtained by calculating several variables from the total farm annual report. The following formula was used:

Capital services = ∑depreciation rate*present value of building + ∑depreciation rate*present value of equipment + fuel costs + cost for hired mechanization

Machinery maintenance costs were not taken in consideration since the majority of the farm annual reports did not include this information. Of all observed farms the most common reported capital assets were houses, warehouses for the equipment and the harvest, greenhouses, tractors, cultivators, caravans, irrigation pumps, ploughs, disc harrows and other additional equipment. Appendix 6 displays the depreciation rates used for the calculation. The fuel cost in the annual farm reports were the costs for fuel, lubricators for running mechanization, the cost for heating the greenhouses, as well as the costs for the irrigation motor pumps. Besides using linear depreciation to compute the capital services variable, all the other panel data which was expressed in currency was multiplied by the corresponding consumer price index (see Appendix 7). The main reason for this was that the used model was constructed to measure production and inputs at the same price level.

In the same manner as farm size is related to the plot size, capital services are also related to farm size. For small farms the capital services are small with a minimum value of 3080 and vice versa with a maximum value of 360.305 or on an average 43.742,25 MKD[8] (see Table 17). While examining the data it is noticeable the positive relationship between the buildings and equipment to the fuel cost. Whereas the relationship with the hired mechanization is negative[9]. Therefore, if the farmer does not own any farm equipment or farm object the fuel costs is low whereas the costs for rented machinery services may remain high.

Table 17 Descriptive statistics of capital services

Mean	43742,25
Median	28791,57
Standard Deviation	49565,36
Minimum	3080
Maximum	360305

Source: NEA, farm annual reports 2004-2007

The shares respectively of the variable capital services is displayed in Figure 9. Farm object present values obtained the highest share (54%) of the overall cost to measure the capital services.

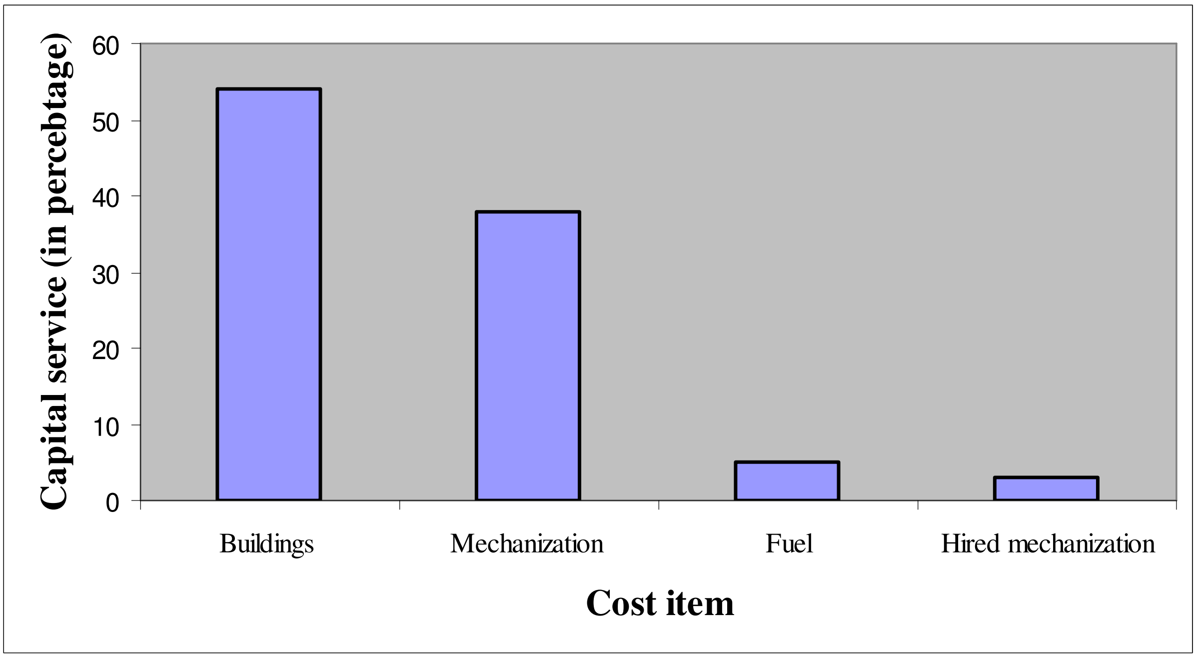

Figure 9 Distribution of the capital services inputs

Source: NEA, farm annual reports 2004-2007

[8] MKD (Macedonian denar) a currency used in Macedonia, with exchange rate of 100SEK = 583,61 MKD (Internet, Tutunska Banka, 2009)

[9] the correlation matrix is displayed in section 5.3

5.2.3 Labour

The labour input is obtained as the sum of the family labour costs and the hired labour force costs. It varies from 7050 MKD to 290.700 MKD with an average value of 70.370,92 MKD (see Table 18).

Table 18 Descriptive statistics of labour services

Mean	70370,92
Median	60175
Standard Deviation	50454,17
Minimum	7050
Maximum	290700

Source: NEA, farm annual reports 2004-2007

From the data it is noticeable that the major share of labour originates from family labour mainly the farm owner and his wife (around 86%), but their children are engaged occasionally (see Figure 10). According to the personal communication with one of the advisors (pers. comm. Markovska, 2009) a substantial share of the farmers are actually part time vegetable producers. Hence, to manage their farm sometimes the farmers are helping each other where the entire family will work at the neighbouring farm (ibid). However, these costs are not reported since data is not available.

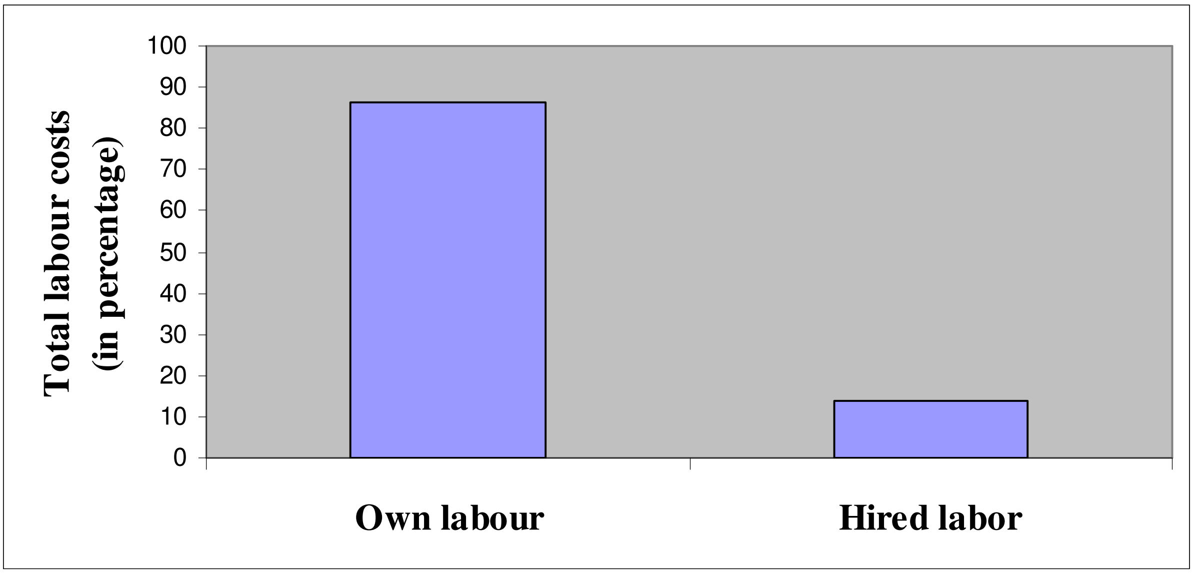

Figure 10 Distribution of labour costs

Source: NEA, farm annual reports 2004-2007

Hired labour force increases with farm size. The net wages of labour engaged in the agricultural production in Macedonia amount to 460 MKD per day (MAFWE, NARDS 2007-2013, 2007). However, even though it's reasonable that larger farms have a higher costs for external work force but examining Figure 11 it's noticeable that as the farm size grows the total costs for external labour force tend to fluctuate.

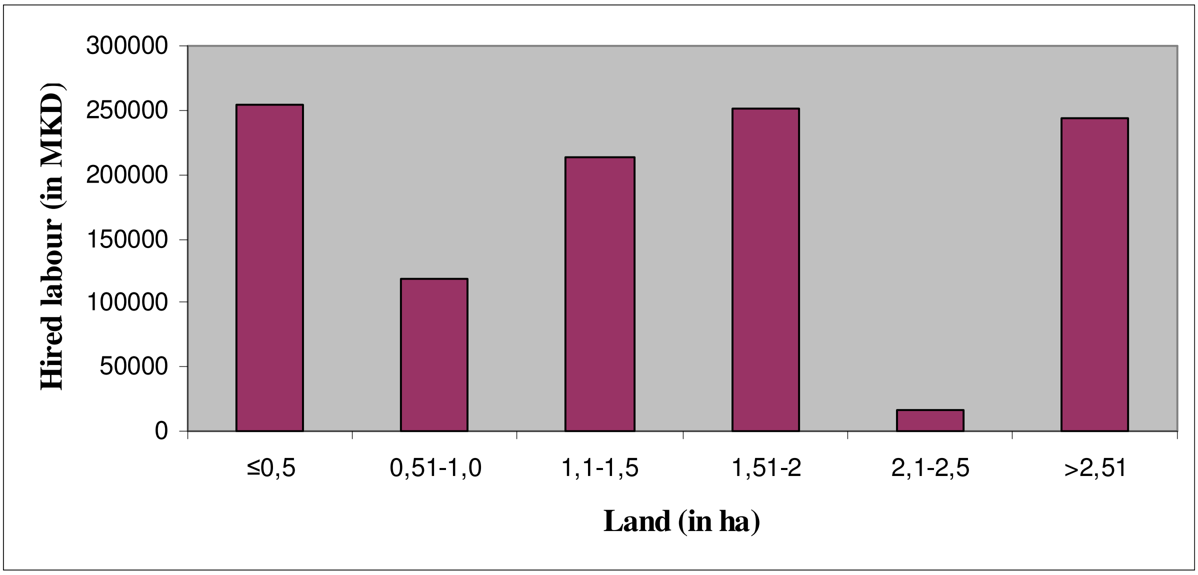

Figure 11 Hired labour costs with relation to farm size

Source: NEA, farm annual reports 2004-2007

5.2.4 Other material inputs

Vegetable production is complex because it depends on many material inputs essential for the final output. To mitigate the problems of multicollinearity (Verbeek, 2004) the most important inputs are summarized into one variable of the production function. The "other inputs variable" is a summation of seeds cost, fertilizers and chemicals costs, as well the cost for plastic cover used for the plastic tunnels, packaging and irrigation costs. Seed inputs are imported mostly from the neighbouring countries, such as Greece, Bulgaria, Montenegro and Serbia. On the other hand, several households produce some quantities of seed in order to satisfy the needs of the planned production. With the intention to achieve sufficient output, appropriate quantity of fertilizers, relating to the seeds and farm size as well, is added. Manure costs are rather minor in contrast to other fertilizers cost, so they are added to the overall fertilizer costs. In the same manner as for the fertilizer, separate cost for chemicals such as fungicides and insecticides are included. The costs for packaging are closely related to the achieved yield. However, depending on the crop different types of packaging are used (crates, plastic bags, etc.). In addition to the all above mentioned inputs, the costs for plastic cover were included. The main use of this input was for construction of plastic tunnels where early season vegetable crops with high prices, are grown. Since there was no information about dripping system in the farm annual reports and most of the farmers did report irrigation pumps as part of the mechanization, a generalization can be made that many of the farms use traditional irrigating system with water pumps. Hence, most of the costs reported were the cost of water (see Appendix 5). The amount differed because the need for irrigation also depends on weather conditions. However, it's still important production input which needs to be taken in account.

In the Table 19, a summary of the "other input variable" is presented.

Table 19 Descriptive statistics of other material input costs

Mean	119272,37
Median	67853
Standard Deviation	178618,19
Minimum	3760
Maximum	1550500

Source: NEA, farm annual reports 2004-2007

The overall cost from the most important vegetable production inputs varied from 3760 MKD up to 1.550.500 MKD with a mean value of 119.272,37 MKD. The highest share of this input belongs to the seed cost (34%), followed by fertilizers (25%) and chemicals (17%). The less significant contribution to the "other input material" variable is the packaging costs (4%). The rest of the variables, plastic cover and irrigation display a similar share (see Figure 12).

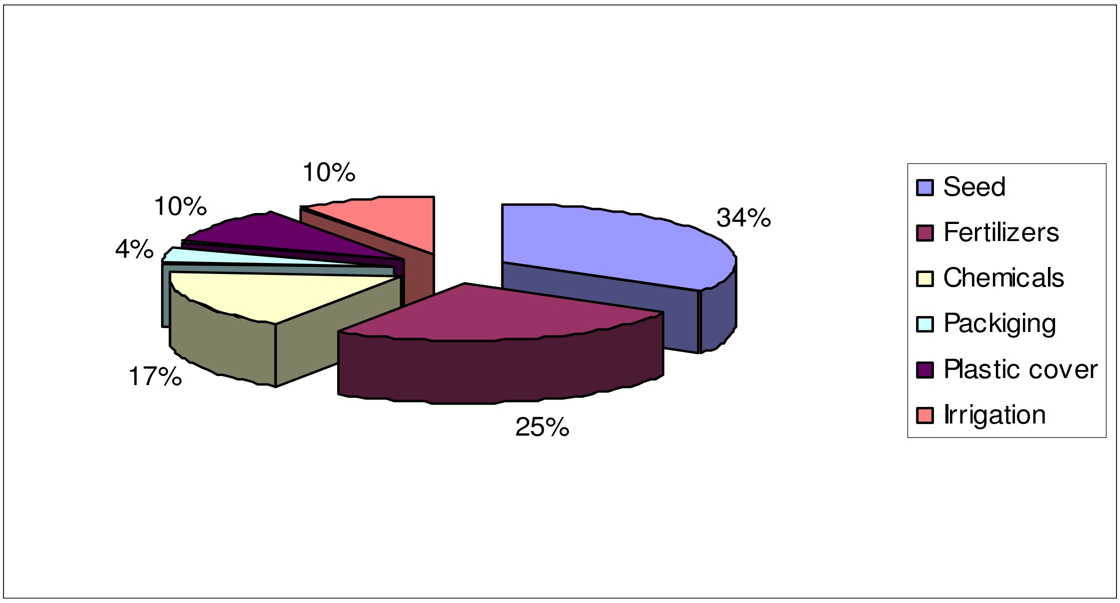

Figure 12 Other material inputs distribution

Source: NEA, farm annual reports 2004-2007

5.2.5 Output

Even though at the beginning of this chapter we observed that the production of vegetables is mainly conducted on small parcels, they are still dominating crops. The main reason why vegetables are the most cultivated culture, especially under plastic tunnel, is the price which is characterized by seasonal variation. The early season ranges from January up to April when the prices are at the highest, followed by a constant decline until September when vegetables grown on open fields are harvested. Most often crops grown in the open field under plastic tunnels or greenhouses were tomatoes, cucumbers, peppers, cabbage, potatoes, watermelons and sometimes carrots. The maximum revenue in the data was obtained from growing early spring vegetables with a value of 2.710.800 MKD whereas the minimum value was 13.000 MKD (see Table 20). The average income from the observed panel data amounts for 406.777,62 MKD. Nevertheless, from figure 13 shown it's noticeable that there exists a relationship between income from vegetable production and the acreage of cultivated land.

Even though it is expected that a larger area of land would yield higher income, this study does not reveal any clear relationship. The reason may be the farmers tend to grow vegetable crops which are highly valued on the market and they are therefore able compensate a smaller farm size by growing more valuable vegetables.

Table 20 Descriptive statistics of the income

Mean	406777,62
Median	310380
Standard Deviation	430257,25
Minimum	13000
Maximum	2710800

Source: NEA, farm annual reports 2004-2007

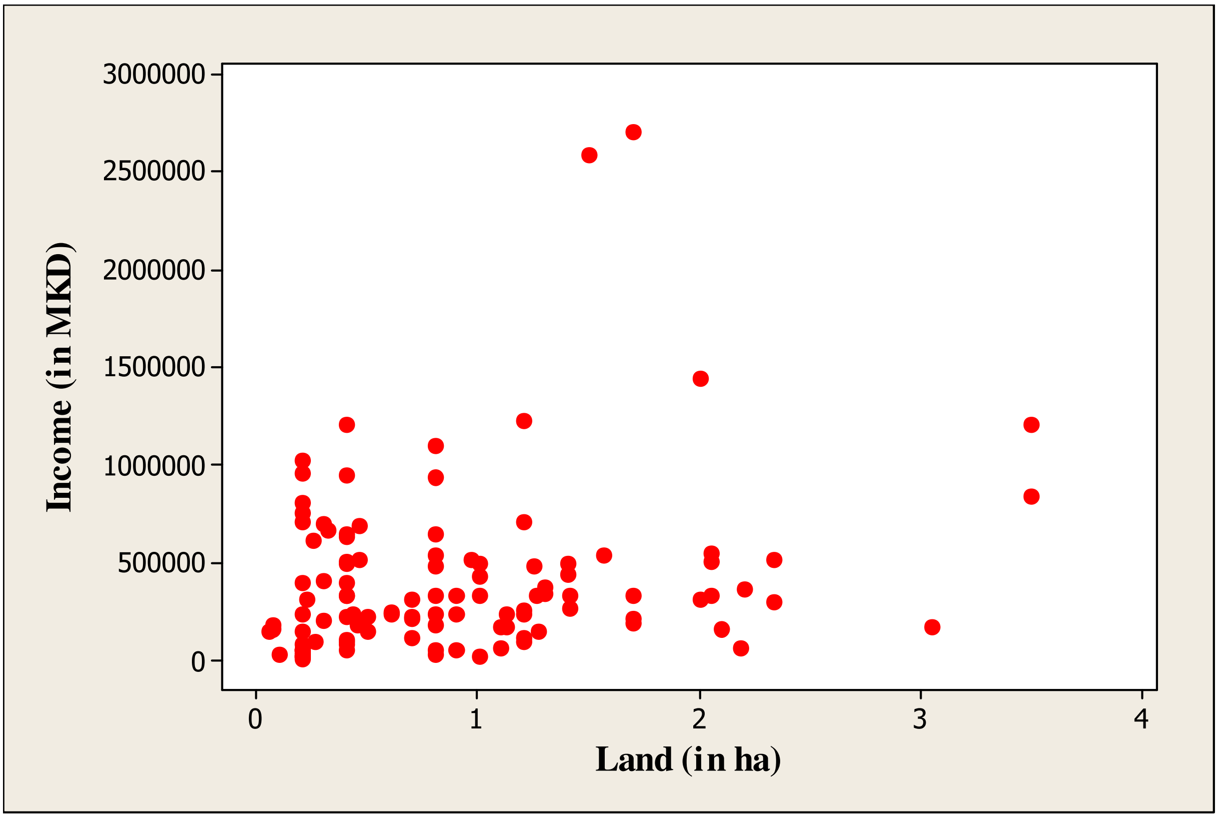

Figure 13 Relationship between the income and the farm size

Source: NEA, farm annual reports 2004-2007

5.3 Factors influencing the vegetable production

As in every production process, the most important item is the final outcome. It's obvious the total vegetable revenue is affected by a set of specific factors. In order to estimate the impact of the land fragmentation on the vegetable total productivity and give a simplified representation of the actual vegetable production in the Skopje and Southeast region in Macedonia a CD production function is used. As a first attempt to evaluate the impact of fragmentation on production, simple correlation coefficients were estimated between the variables used in the production function.

Table 21 Correlation matrix of the variables

	Income	**Capital services**	**Land**	**Land fragmentation (Simpson index)**	**Other inputs**	**Labuor**
Income	1,00					
Capital services	0,78	1,00				
Land	0,24	0,32	1,00			
Land fragmentation (Simpson index)	0,02	0,14	0,60	1,00		
Other inputs	0,81	0,82	0,27	0,12	1,00	
Labuor	0,44	0,37	0,60	0,32	0,36	1,00

Source: NEA, farm annual reports 2004-2007
Note: the correlation matrix is for the nonlog form

Examining Table 21 it can be noticed that none of the correlation coefficients between the explanatory variables display a high level of correlation. Therefore, the problem of multicollinearity may not be serious in this estimation, because this problem may arise when the correlation coefficients are larger then 0,8-0,9 and it may cause is insignificant regression coefficients (Verbeek, 2004). The total income is positively correlated with all variables used in the regression analysis. The positive, but very low correlation between the degree of fragmentation degree and income ($\rho = 0{,}02$) as well as with the capital services ($\rho = 0{,}14$) and other inputs ($\rho = 0{,}12$) does not necessary imply that an increase of the land fragmentation also increases income, the use of capital services or the use of inputs. Hence, the impact of the land fragmentation impact upon the value of production is ambiguous.

To examine whether the estimate of the model is appropriate, i.e. the assumption of normally distributed residuals is examined through normal probability plot (see Figure 14, Gujarati, 2004). Examining the figure 14 it's noticeable that the normal probability plot of residuals reveals an almost linear pattern. Hence, the assumption of the normally distributed residuals can not be rejected and the estimates are well presented by the CD function.

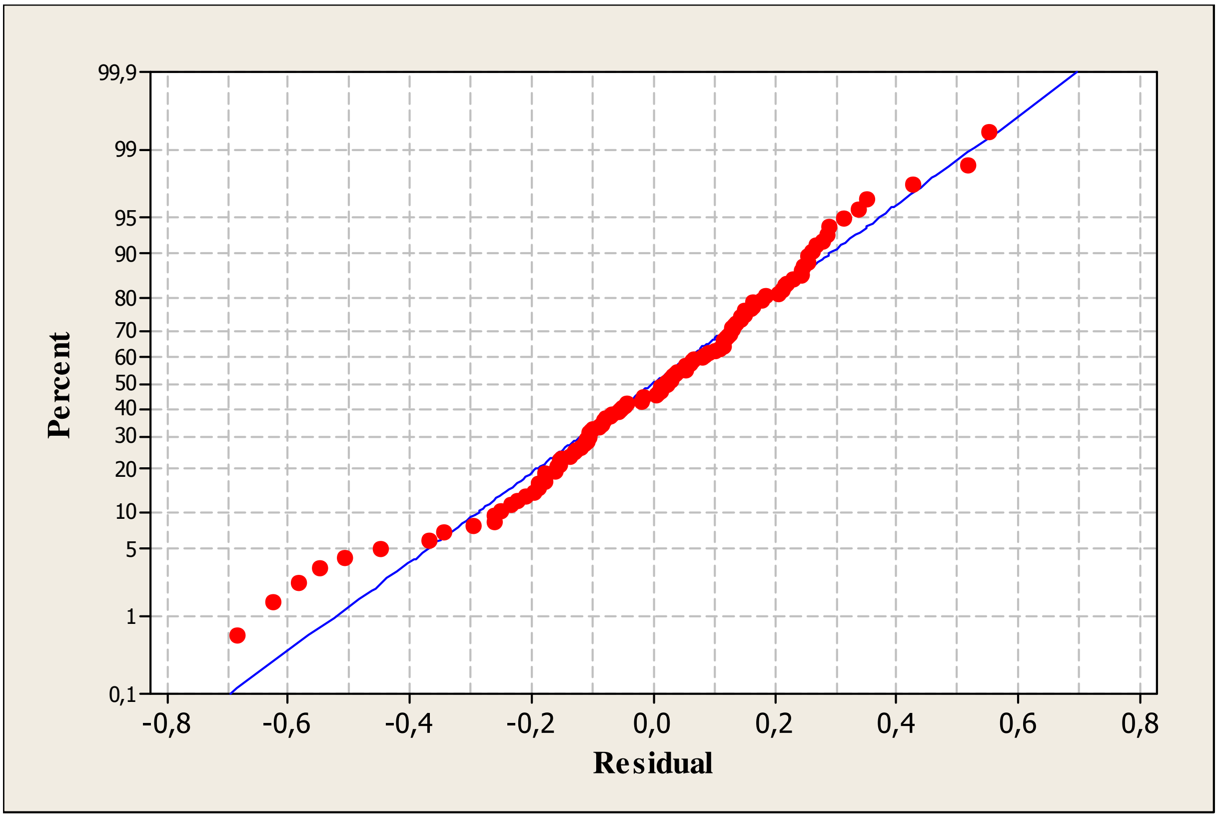

Figure 14 Relation between the total income from vegetable production with the corresponding factors

Source: NEA, farm annual reports 2004-2007

The results from the estimation of the used CD function are displayed in Table 22:

Table 22 Results from regression analysis for the used CD model (equation 5)

Estimates	**Coefficients**	**t-statistics**
Capital services	0,18**	2,29
Land	0,04	0,53
(Ln)Land*Simpson index	-0,13	-0,71
Other inputs	0,61***	8,80
Labuor	0,15*	1,66
Dummy Greenhouse	0,14**	2,39
Constant	0,98**	2,47
R^2	0,77	
Adjusted R^2	0,75	
Number of observations	112	

Notes: Variables are in logarithm
*Significant at 10% level, **Significant at 5% level and ***Significant at 1% level
Source: NEA, farm annual reports 2004-2007

The estimated model which yields an R^2 of 0,77. Land fragmentation is found to have negative but insignificant impact upon the total value of production per vegetable farm. This result implies that farms with higher Simpson index may be able to offset the negative impact of fragmentation by management and technology adoption or improved risk management strategies or improved labour allocation through the year. As expected, land has positive but also insignificant impact on the value of production. The main reason for this result may be explained by the fact that most of the observed farms are cultivating on almost similar acreage. Hence, land probably is not able to come into consideration. The other variables the model, yield a positive and statistically significantly effect on the value of production, i.e. the income. By increasing the factor level of other inputs with 10% the total average income from vegetable production will increase with 6,1%. The similar estimate is 1,8% from the capital services and 1,4% if the farmer grows vegetable crops in greenhouse as well as 1,5% if labour is increased.

Since the Cobb-Douglas model shows that the land fragmentation does not significantly affect the vegetable production, even though it's a rather common model for estimating production functions, an alternative (GLM) is used. Estimation of the GLM model is proposed to provide an alternative model of the data, having in mind that the relationships between the dependent and the explanatory variables are complex in the presence of land fragmentation.

Table 23 Results from regression analysis for the used GLM model

Estimates	**Coefficients**	**t-statistics**
Capital services	2,83***	3,72
Land	-2123,16	-0,05
Simpson index	-163217,39**	-1,92
Other inputs	1,23***	5,31
Labuor	1,52***	2,76
Dummy Greenhouse	129726,70**	2,29
Constant	88935,44**	1,97
R^2	0,75	
Adjusted R^2	0,73	
Number of observations	112	

*Significant at 10% level, **Significant at 5% level and ***Significant at 1% level
Source: NEA, farm annual reports 2004-2007

The regression results for the GLM model yield an almost similar sum of squares value (R^2 = 0,75). The result reveal that land fragmentation represented by the Simpson index influences the income of growing vegetables negatively and it's statistically significant at least the 10% level of significance. Assuming that the input and output prices are independent of the degree of land fragmentation, this results demonstrate that an increase in the Simpson index by 0,01 decrease income with 1632 MKD. Even though the fact that land in this model shows negative impact on the total vegetable production it is still not statistically insignificant. This result seems to indicate that for vegetable farms in the study area, land doesn't play a crucial role for the total income. This observation is also supported by the dummy variable for the greenhouse, with a magnitude of 129.726,70 MKD which positively and significantly affects the total value of production. Since, the application of modern technologies is limited when the parcels are more fragmented, the coefficient for capital service shows positive and statistically significant impact on vegetable production. The rest of the variables used in the regression analysis such as "other inputs" and "labour" are found to be positive and statistically significant. The positive labour coefficient verifies that an increase in the allocation of labour increases the value of production.

Nevertheless, an extended analysis of the impact of land fragmentation is required to take into consideration all the features that might be important for the vegetable producers to make future managerial decisions. This analysis is carried further.

6 Analysis and Discussion

To better understand in what manner the high fragmentation degree impacts the farm profitability and productivity a comparison of the results gained from the panel data calculation and the literature findings was deployed.

6.1 Land fragmentation vs. total vegetable production

Referring back to the previous statement where a farm modelled by production function, typical in neo-classical economics. Output, in this case vegetable production, is affected by many inputs, such as land, labour, capital, seed, fertilizers, etc. A structured model of farm household production was developed to address the impact of land fragmentation on vegetable production. The model specification accounts for the role of land fragmentation described by the parcel size on farm level in a way to present the relationship with the output of vegetable crops. Therefore, two models were used such as the Cobb-Douglas and the General Linear Model. Even though the CD production function, a most widely used function, in this study reveals that the impact of land fragmentation is negative but still insignificant. It may not be argued that the CD function is inappropriate for this study but the main reason for the result may be due to the fact that most of the farms have an almost equal acreage and the CD function is rather restrictive in it's functional form. Hence, the impact of the degree of fragmentation couldn't be taken into account.

Nevertheless, the linear production function with the following form gave a statistically significant result.

$y_i = a + bx_{CS} + cx_A + dx_{SI} + fx_{OI} + gx_L + hx_{DG}$, where

Y	the total income from vegetable production;
a	constant;
$b,c,d,\ldots$	estimated variables for a exacting variable;
x_{CS}	capital services costs;
x_A	total acreage;
x_{SI}	Simpson index;
x_{OI}	other inputs costs;
x_L	labour costs; and
x_{DG}	dummy for greenhouse, 1=if the farmer owns a greenhouse.

The estimation result from the GML regression analysis indicates that land fragmentation has a negative and statistically significant influence of production (see Table 23). Keeping all other factors constant, a higher Simpson index decreases the total output from farming vegetables. The remainder of the variables linked in the linear equation (described qualitatively in the next paragraph) expect for land show a significant positive impact on the production itself. However, there are some other important factors that affect the economic performance of a vegetable farm, such as distance to plots. However, these variables are omitted due to lack on information in the annual farm reports and the difficulty to observe them.

The capital services costs as the empirical chapter revealed, affects production in a positive manner. With an increase of the capital services income increases simultaneously. This result encourages better and more effective utilization of the farm mechanization if the fragmentation degree is reduced. Simply stated, it supports the need for future policy implications where land consolidation can be an option.

Besides the fact that land is the most important input in the agricultural production in both of the models it appears not to be statistically significant. Referring back to the empirical chapter, the explanation for this result might be due to the almost similar farm size in the panel data. The other reason may be the fact that in the cost of capital services the present value of the greenhouses is taken into consideration, as well as the fact that most of the farmers are using plastic tunnels. Therefore, the production of early spring vegetable crops may overcome the impact of land on the production. This result is confirmed also by the positive and statistically significant relationship of the dummy variable for greenhouse with total production.

Labour has a positive and statistically significant effect upon the vegetable production. The data reveal that the majority of the farms are cultivating small parcels. Even if the farm size is larger the acreage ramains a summation from many fragmented plots. Hence, an explanation may be that the farmers maintain a high level of fragmentation so they are able spread their peak labour needs more efficiently.

In a study of land disposition in Republic of Macedonia conducted by the University of Wisconsin's Land Ownership Management Center, in cooperation with the Faculty for Agricultural Science and Food the results are consistent with the Schultz theory (1964) of inverse relationship between the holding size and productivity, i.e. smaller farms are more productive then the larger ones. However, the findings in this study revea that a higher value of production mainly is achieved by efficient use of labour, other inputs and capital services whereby the impact of total land area is less important.

Detailed information from the data allows us to calculate the magnitude of the impact of land fragmentation upon the total income of vegetable farms. So far, most of the researchers done in this field have never tried to calculate how much actually the production will increase if the land fragmentation degree is reduced. In the study area, the average income from vegetables is 406.777,62 MKD, where as the average farm size and Simpson index are 0,88 ha and 0,43. From the regression analysis the fragmentation affected negatively the production with 163.217,39 MKD on average. This indicates that at the price level of the year 2007, vegetable production will be increased by 7,06%[10] if the fragmentation degree is reduced to 0,2 i.e. very low fragmentation. This result reveals that land fragmentation is an important factor in terms of future policy implications. Some policy implications may be proposed so the farmers livelihood, irrespective if they are vegetable producers, can be increased.

Improvement of farmers' livelihood require an improvement in income which can be improved by input-use efficiency. But this is less doable for the households who own fragmented acreage. Hence, land parcel consolidation that is socially acceptable and economically reasonable is required for promoting sustainable agriculture in the study area.

[10] 163.217,39 MKD*0,88 ha*0,2 = 28.726,26 MKD
28.726,26/406.777,62*100 = 7,06%

6.2 Future policy implications

In the theoretical part advantages and disadvantages with land fragmentation were mentioned, although the disadvantages seem to be more pronounced. The advantages were related to diversification in terms of opportunities to grow a wider range of crops and to avoid labour restrictions. The disadvantages were related to difficulties in using modern agricultural mechanization as well as increased transportation costs.

In the case of Macedonia, land fragmentation occurred as a result of the democratic characteristics of land allocation and can therefore be said to have supply-side causes. However, the facts that land is still very fragmented and that the evolution of land consolidation programs is slow suggest that land fragmentation may have demand-side explanations. Also in the empirical section, the results reveal that a higher labour use increases income from growing vegetables. Thus, to some level this is preferred by the farmers. This may well be a disagreement with land consolidation programs, but it should also be pointed out that there are many market drawbacks that might prevent farmers from participating in land consolidation programs, even if they would like to.

Some important findings emerged from this research which can be useful for future policy implications. It was found that vegetable output could rise simply by eliminating land fragmentation. This is possible by letting the farms be intact. But eliminating fragmentation doesn't imply that the farmers should operate only one piece of land. Rather, it implies that individual crops should be planted on the same parcel. According to Wan and Cheng (2001) in many ways it would be an easier policy proposal to implement instead of asking the farmers to cultivate one piece of land.

"While it is preferable for market forces to play a crucial role in determining proper farm sizes and degrees of fragmentation, in the early stages of market operation such forces may not give sufficiently clear signals" (Melmed-Sanjak *et al.*, 1998, p.103). The most preferred way of overcoming the fragmentation issue is land leasing and subcontracting of cultivation rights (Wan and Cheng, 2001). However, this process is not an easy task because sometimes the parcel is situated in the middle of the field which may also be very small or non-contiguous. The extension service is the most relevant government agency to establish any consolidation efforts or farmer initiatives. It should initiate pilot programs, perhaps based on the assessment of an established research projects, and identify areas where fragmentation is a drawback. Given that, farmers distinguish it to be a problem, they may express a willingness to participate in consolidation.

According to Wan and Cheng (2001) land exchange may be a better alternative, but economic analyses are needed to produce the foundation for such an exchange. It would be difficult to find compensation for the exchange of good plots and the cultivating rights of the farmers. To ensure food security and agricultural growth, policy options such as input subsidies and credit assistance can be proposed to speed up the land exchange (ibid). Furthermore, from a practical point land consolidation should not be compulsory. In that manner, land consolidation schemes should be initiated or experimented where the farmers based on the outcome of the schemes could choose either to, or not to participate in the land consolidation process.

Stipulation of law for controlling the land fragmentation is also an option (Niroula and Thapa, 2005). Any parcel of land less then one unit of the standardized area set by the government should be considered as fragmented and can not be transferred to anyone. But a strong legal backup must be present, otherwise the households even if the consolidation program is successful, they might slip back to their pre-consolidation state over time (ibid). Other legal measures according to Niroula and Thapa (2005) might be imposition of high taxes on inherited land. However, an attempt to implement this measure can also be difficult due to the resistance by landholders as well as other effects.

Cooperative farming is considered to be an effective way of overcoming the negative effect of land fragmentation (Rahman and Rahman, 2008). A consolidation of small and fragmented farms into an economically operational unit may transform the agrarian economy and defeat the obstacles of efficiency, improved productivity and efficient utilization of labour or modern agricultural technologies.

The lack of judicial land records and the lack of technical skill on the part of government officials may be major impediment toward successful land consolidation (Melmed-Sanjak *et al.*, 1998). Modern graphical techniques such as Geographical Information Systems (GIS) may support the design of more rational landholding models, especially in zones where land is of nearly equal quality. GIS techniques can be a powerful contributor to a clear and participatory process that reveals understanding of the historical and economic processes responsible for the fragmentation.

If any of the above stated policy implications are achievable consolidation programs should be characterized by appropriate motivation, institutional resilience, a suitable infrastructure and most important the users to be directly involved in the process. From an economic perspective, consolidation involves costs as well. For instance the cost from land consolidation can be associated with losses due to risk insufficient diversification. Furthermore, with intensive labour use in agriculture the land consolidation processes may be hindered even though an enlargement of farm and plot size is expected to have significant impact upon the farm income. Probably one solution to reduce the economic costs will be government intervention where their attention should be given to establishment of land markets and improvements for credits especially in a period whit an ongoing economic crisis.

7 Conclusions

This chapter tries to address the three research question mentioned at the beginning of this paper. The objective of this paper was to answer the question such as *how the high fragmented land impacts over the productivity and profitability on the farms*, *current degree of fragmentation* and by the gained results *creation of land policy for good land management.*

Upon death of the owner, in Macedonia it is common that agricultural land is divided among heirs. By doing this over time the acreage of the household land decreases. Hence, the process of land fragmentation can be seen as a main obstacle to efficient production of field crops. However, the impact of high land fragmentation upon the profitability and productivity of vegetable producers in the Southeastern and Skopje region in Republic of Macedonia has not been determined. From a theoretical point of view, land fragmentation has benefits and costs. These pros and cons will differ for different farms and by that affecting their outcome individually.

The objective of this study was to determine if the land fragmentation influences the production. The aim was to examine if land fragmentation represented by the Simpson index (measured by the number of plots) is beneficial, costly or an insignificant factor. In this study, various methods have been used to investigate the impact of land fragmentation over farm productivity and profitability, including both the Cobb-Douglas production function and the General Linear Model. Using panel data from 112 observations, from 28 vegetable farms for four continues years from 2004 till 2007 in the Southeastern and Skopje region it was found that fragmentation had negative impact on vegetable productivity. The estimates from the Cobb-Douglas model revealed that land fragmentation did not have any significant impact on the production. The General Linear Model confirmed the negative and statistically significant influence. The modeling effort suggests several implications especially that land fragmentation is indeed a problem to efficient cultivation of vegetable crops in the region. Labour showed statistically significant and positive impact upon productivity which implies that one of the advantages of land fragmentation in this region refers to decreasing risk associated by growing diversified crops on many parcels with different ripening time thereby concentrating labour on different plots at different period. The regions microclimate allows a higher level of diversification by cultivating of great variety of vegetables.

The findings also showed that the current level of fragmentation in the region is not so high. At the beginning of this study the aim was to investigate the current degree of fragmentation in Macedonia. However, the study was limited to only vegetable producers. Therefore, the average land fragmentation degree of 0,43 pertains to Skopje and the Southeastern region. However, as the farm size was increasing the average Simpson index was increasing as well indicating that the larger vegetable households are facing the highest degree of land fragmentation.

These findings have some important suggestions for the design of future land consolidation programmes, implying that consolidation into farms with fewer plots with larger parcel sizes can stimulate the use of modern agricultural technologies, but is also likely to reduce the agricultural employment. The question remains as to what type of public policies to be proposed to reduce the level of land fragmentation or to mitigate the cost enforced by land fragmentation. Therefore, it will be essential to create a system of targeted incentives to encourage the farmers to seek ways of consolidation, by entering into agreements with the neighbors to swap parcels, to increase farm size or increase the average size of their parcels.

The incentives could consist of tax credits, other government-supported schemes, improved access to credits or could be attached to other programmes such as access to leasing of state-owned land or technical support from the extension service. When the consolidation programme is structured, it should be preceded by severe attempts to understand the entire set of restraints to consolidation but also by the promotion of public information about the objects and the procedures of the consolidation programme.

Needless to say, the findings and policy implications of this study are conditional on the analytical framework and data used. Although the data are representative and of reasonable quality, carefulness must always be exercised if making generalizations from the numerical results of economic models. Nevertheless, the results may have a wider applicability beyond the study regions and Macedonia since in many developing countries land fragmentation is an important policy problem.

8 Further research

Since there are very few studies on parcel size and productivity as well as profitability relationship carried out in Macedonia, the results from this thesis could be helpful for future studies. Further studies may be conducted to explore the impact of land fragmentation on other agricultural production where fragmentation is an issue or in other area, as well as crop specific productivity in order to identify the best fitting crop for increasing productivity. Furthermore, even though the fact most of the observed farms were growing almost the same crops on same acreage probably some farm characteristics have been changed since 2007. One important characteristic which the Simpson index doesn't take into consideration is the traveling distance from the household to the parcel as well as from one parcel to another. Thus, it would be feasible in the future if this aspect is included in the analysis. It can be useful for future improvement of farm management and for increasing the efficiency of the vegetable production as well as the rest of the agricultural productions in Macedonia. Nevertheless, since labour showed a positive relationship with production and capital services as well, it would be feasible to develope an optimization model and try to find out what is the optimal desired level of fragmentation by the farmers.

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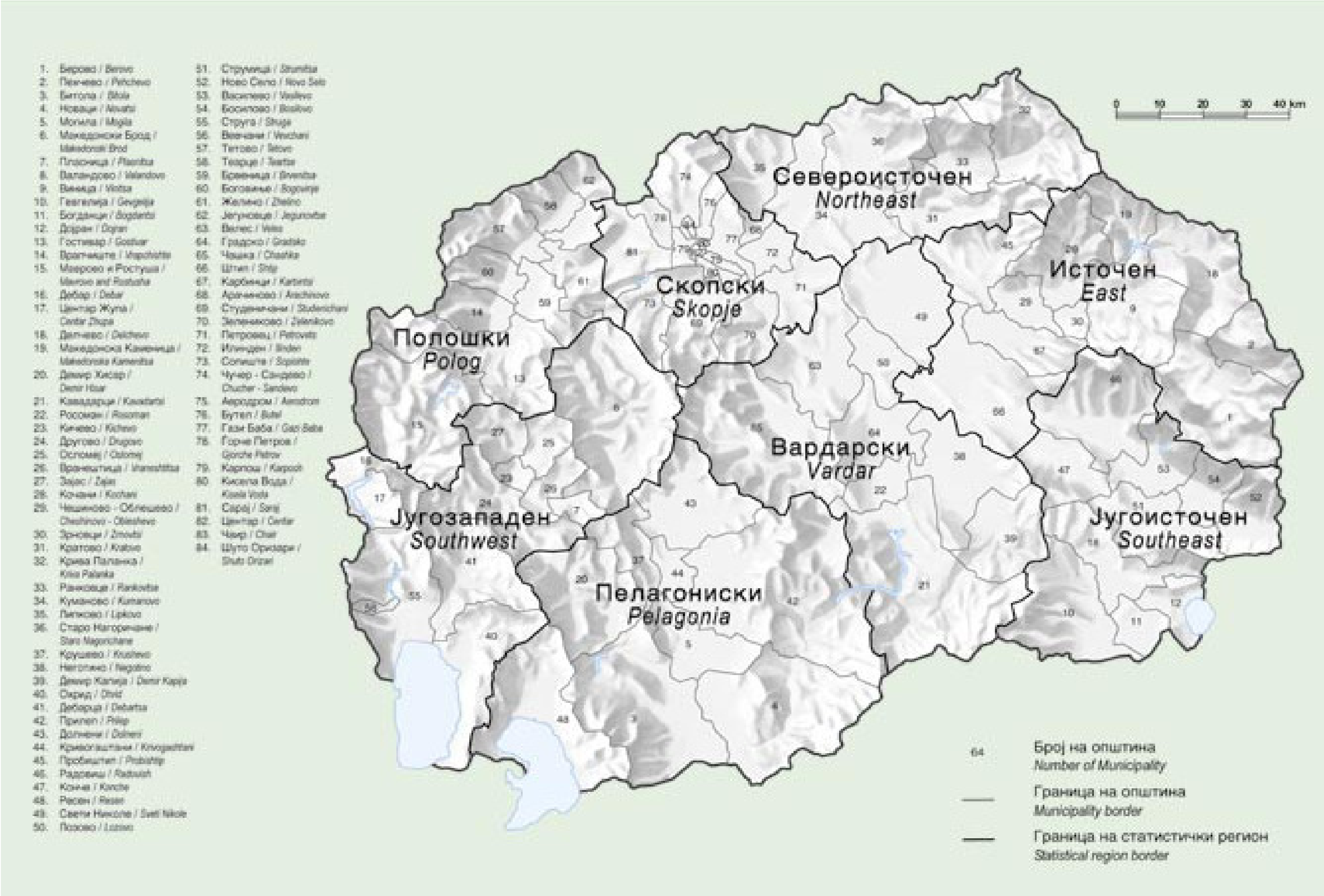
Personal messages

Markudova Savka
Head of the NEA regional office Gevgelija, R. Macedonia
Personal meeting, 2009-03-18

Hans Andersson
Professor, SLU, Uppsala, Sweden
Personal meetings, from 2008-15-11 continually until 2009-06-02

Appendix 1: Map of municipalities and statistical regions



Source: SSO of RM, Agricultural Census: Book III, 2007

Appendix 2: Farm typology in the Republic of Macedonia

Type of farm	**Definition of the type of farm**
A. Vegetable farms	More than 2/3 of the sales come from vegetables
B. Fruit farms	More than 2/3 of the sales come from fruit
C. Vine growing farms	More than 2/3 of the sales come from vine
D. Cereals farms	More than 2/3 of the sales come from cereals
E. Mixed crop farms	More than 2/3 of the sales come from crops
F. Cattle farms	More than 2/3 of the sales come from cattle
G. Sheep farms	More than 2/3 of the sales come from sheep
H. Goat farms	More than 2/3 of the sales come from goats
I. Pig farms	More than 2/3 of the sales come from pigs
J. Mixed animal farms	More than 2/3 of the sales come from animals
K. Mixed farms	No activity is present in more then 2/3

Source: MAFWE, Annual Agricultural and Rural Development Report, 2007

Appendix 3: Total area of more relevant vegetables in Macedonia in the period 1995-2007, in ha

Crop	Year													Average
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	
Potatoes	14468	14420	13892	13731	13884	13690	13549	14235	14110	14010	13486	13598	13799	13913
Tomatoes	7244	8706	6946	6727	6751	6778	6373	6372	6361	5972	5728	5642	5368	6536
Peppers	8028	8611	7947	7681	7533	7702	7264	7450	7573	8124	8141	8313	8331	7900
Cucumbers	1171	1298	1171	1189	1300	1219	1118	1132	1351	1318	1398	1430	1478	1275
Watermelon	8805	9150	7949	8271	7877	8422	7419	7995	7178	6463	6503	6466	6152	7588
Open field (total)	**68433**	**70883**	**67595**	**67872**	**66943**	**63130**	**60706**	**62214**	**61554**	**59110**	**52202**	**52162**	**58204**	62385
Glasshouses (total)	**260**	**260**	**260**	**260**	**260**	**260**	**260**	**260**	**260**	**260**	**260**	**260**	**260**	260
Total	**68693**	**71143**	**67855**	**68132**	**67203**	**63390**	**60966**	**62474**	**61814**	**59370**	**52462**	**52422**	**58464**	62645

Source: SSO of RM, Statistical Yearbooks 1995-2007

Appendix 4: Total production of more relevant vegetables in Macedonia in the period 1995-2007, in tones

Crop	Year													Average
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	
Potato	156436	156612	158411	180135	169258	164486	176336	184487	174661	198510	190432	189867	179729	175335
Tomato	134141	146103	116527	125705	128382	134654	126313	109506	129739	114490	116633	142387	117981	126351
Pepper	95570	120813	99985	110631	116468	116597	111611	108073	111494	127852	127472	140905	140558	117541
Cucum-ber	19258	23597	19729	20543	22500	25900	26700	27271	27606	34921	36187	39320	39156	27899
Water-melon	116233	116421	93242	119620	121277	124968	130073	152443	140393	125381	132872	129564	123840	125102

Source: SSO of RM, Statistical Yearbooks 1995-2007

Appendix 5: Total farm annual report based on the NEA Farm Monitoring in Republic of Macedonia

NEA Information system
Sub-system; Farm databese

Farm annual report

Year: 2001
Region: Strumica
Farm: Reprezentative

Note: This report lists all the available data of a single farm for one year period.

1 Equipment

Type	Month-Year	Starting value
24 Caravan	01-2002	80 000,00
37 Tractor	01-2002	200 000,00
546 Plough	01-2002	40 000,00
		320 000,00

2 Building

Type	Month-Year	Size in km^2	Starting value
139 Warehouse	01-2002	100,00	600 000,00
190 Plastic tunnels	01-2002	1 000,00	70 000,00
250 House	01-2002	110,00	2 000 000,00

3 Labour

Type	Month-Year	Number of workers	Number of working hours
1 Farm owner	03-2001	1,00	4,00
1 Farm owner	04-2001	1,00	19,00
1 Farm owner	05-2001	1,00	26,00
1 Farm owner	06-2001	1,00	26,00
1 Farm owner	09-2001	1,00	60,00
1 Farm owner	10-2001	1,00	30,00
1 Farm owner	11-2001	1,00	41,00
2 Family member	03-2001	1,00	4,00
2 Family member	04-2001	1,00	19,00
2 Family member	05-2001	1,00	26,00
2 Family member	06-2001	1,00	26,00
2 Family member	09-2001	1,00	16,00
2 Family member	10-2001	1,00	8,00
2 Family member	11-2001	1,00	41,00
			346,00

Appendix 5: Continues

4 Land

Land type	Plot		Soil class	ha	Value/ha
1 Arable	1	Под селото	2	0,10	3 200 000,00
1 Arable	2	Под селото	2	0,10	3 200 000,00
1 Arable	3	Црвена горничка	3	0,20	400 000,00
1 Arable	4	Керамидарница	3	0,30	233 333,33
1 Arable	5	Скрт	4	0,40	250 000,00
1 Arable	6	Необработливо	7	1,90	100 000,00
				3,00	**7 383 333,33**

5 Crops

Plot	Crop		ha	Open field	Irrigate	Main crop
1 Под селото	7.2.1	Tomato	0,10	Yes	Yes	Yes
4 Керамидарница	7.2.8	Onion	0,40	No	No	No
5 Скрт	7.2.3	Watermelons	0,40	Yes	No	No
			0,90			

6 Yiled

Field	Crop		Date		Amount
4	7.2.8	Onion	5-20-2001	kg	1 000,00
4	7.2.8	Onion	5-25-2001	kg	2 100,00
1	7.2.1	Tomato	5-26-2001	kg	105,00
1	7.2.1	Tomato	5-28-2001	kg	293,00
4	7.2.8	Onion	5-29-2001	kg	4 960,00
1	7.2.1	Tomato	5-30-2001	kg	440,00
1	7.2.1	Tomato	6-1-2001	kg	615,00
1	7.2.1	Tomato	6-3-2001	kg	720,00
4	7.2.8	Onion	6-5-2001	kg	2 000,00
1	7.2.1	Tomato	6-6-2001	kg	840,00
4	7.2.8	Onion	6-7-2001	kg	2 100,00
1	7.2.1	Tomato	6-9-2001	kg	630,00
1	7.2.1	Tomato	6-10-2001	kg	735,00
4	7.2.8	Onion	6-11-2001	kg	1 950,00
1	7.2.1	Tomato	6-13-2001	kg	620,00
1	7.2.1	Tomato	6-15-2001	kg	638,00
1	7.2.1	Tomato	6-17-2001	kg	710,00
1	7.2.1	Tomato	6-19-2001	kg	815,00
1	7.2.1	Tomato	6-22-2001	kg	690,00
1	7.2.1	Tomato	6-24-2001	kg	621,00
1	7.2.1	Tomato	6-27-2001	kg	432,00
1	7.2.1	Tomato	6-30-2001	kg	205,00

Appendix 5: Continues

7 Incomes

Income type	Crop		Date		Amount	Price	Value
15.2	7.2.8	Onion	5-20-2001	kg	1 000,00	6,00	6 000,00
15.2	7.2.8	Onion	5-25-2001	kg	2 100,00	8,00	16 800,00
15.1	7.2.1	Tomato	5-26-2001		1,00	4 200,00	4 200,00
15.1	7.2.1	Tomato	5-28-2001		1,00	11 720,00	11 720,00
15.2	7.2.8	Onion	5-29-2001	kg	4 960,00	10,00	49 600,00
15.1	7.2.1	Tomato	5-30-2001		1,00	15 400,00	15 400,00
15.1	7.2.1	Tomato	6-1-2001		1,00	17 220,00	17 220,00
15.1	7.2.1	Tomato	6-3-2001		1,00	18 720,00	18 720,00
15.2	7.2.8	Onion	6-5-2001	kg	2 000,00	12,00	24 000,00
15.1	7.2.1	Tomato	6-6-2001		1,00	19 320,00	19 320,00
15.2	7.2.8	Onion	6-7-2001	kg	2 100,00	13,00	27 300,00
15.1	7.2.1	Tomato	6-8-2001		1,00	13 860,00	13 860,00
15.1	7.2.1	Tomato	6-10-2001		1,00	13 230,00	13 230,00
15.2	7.2.8	Onion	6-11-2001	kg	1 950,00	18,00	35 100,00
15.1	7.2.1	Tomato	6-13-2001		1,00	12 400,00	12 400,00
15.1	7.2.1	Tomato	6-15-2001		1,00	12 760,00	12 760,00
15.1	7.2.1	Tomato	6-17-2001		1,00	14 200,00	14 200,00
15.1	7.2.1	Tomato	6-19-2001		1,00	17 930,00	17 930,00
15.1	7.2.1	Tomato	6-22-2001		1,00	12 420,00	12 420,00
15.1	7.2.1	Tomato	6-24-2001		1,00	14 283,00	14 283,00
15.1	7.2.1	Tomato	6-27-2001		1,00	10 800,00	10 800,00
15.1	7.2.1	Tomato	6-30-2001		1,00	5 125,00	5 125,00
							372 388,00

8 Costs

Type			Date		Amount	Price	Value
13.1. Pesticides	7.2.1	Tomato	2-15-2001	kg	3,00	1 600,00	4 800,00
13.1. Fertilizers	7.2.1	Tomato	2-18-2001	kg	300,00	16,00	4 800,00
13.1. Fuel costs	7.2.1	Tomato	2-23-2001	l	30,00	42,00	1 260,00
13.1. Fertilizers	7.2.8	Onion	3-12-2001	kg	100,00	13,00	1 300,00
13.1. Fuel costs	7.2.8	Onion	3-15-2001	l	40,00	50,00	2 000,00
13.1. Fertilizers	7.2.1	Tomato	4-1-2001	kg	100,00	13,00	1 300,00
13.1. Fuel costs	0		4-6-2001	l	50,00	50,00	2 500,00
13.1. Fuel costs	0		5-8-2001	l	75,00	50,67	3 800,00
13.1. Packeging	7.2.1	Tomato	5-19-2001	kg	9 000,00	2,20	19 800,00
13.1. Transportation	7.2.1	Tomato	6-30-2001	kg	9 000,00	1,00	9 000,00
13.1. Transportation	7.2.8	Onion	6-30-2001	kg	14 000,00	1,00	14 000,00
13.1. Fuel costs	0		6-30-2001	l	75,00	50,67	3 800,00
13.1. Irrigation	7.2.1	Tomato	6-30-2001	kg	80,00	60,00	4 800,00
13.1. Fuel costs	0		7-31-2001	l	50,00	50,00	2 500,00
13.1. Irrigation	7.2.8	Onion	7-31-2001	kg	100,00	120,00	12 000,00
13.1. Seed	7.2.8	Onion	8-21-2001	kg	0,50	16 600,00	8 300,00
13.1. Manure	7.2.8	Onion	8-28-2001	kg	8 000,00	8,00	64 000,00
13.1. Pesticides	7.2.8	Onion	8-28-2001	kg	1,50	1 066,67	1 600,00
13.1. Fertilizers	7.2.8	Onion	9-14-2001	kg	400,00	14,00	5 600,00
13.1. Fuel costs	7.2.8	Onion	9-14-2001	l	10,00	38,00	380,00
13.1. Fuel costs	7.2.8	Onion	10-20-2001		52,00	7,31	380,00
13.1. Fuel costs	7.2.8	Onion	11-10-2001	l	10,00	36,00	360,00
13.1. Pesticides	7.2.8	Onion	11-15-2001	l	4,50	466,67	2 100,00

Appendix 6: Depreciation rates of farm assets

Ordinal number	Name	Annual depreciation rate (in %)
1	**Buildings and other structures**	**2**
	production of early seasonal vegetables and fruits	7
2	**Equipment for establishing activities from vegetable, fruit and vine-growing production as well as giving farm services**	**12**
	tractors with one axis with their additional equipment	16
	seeding and crop nursing equipment	16
	cleaning, sorting and packaging equipment	9
	disc harrows, sprinklers, fertilizer and chemical distributing equipment	20

Source: Milanov and Martinovska-Stojceska, 2002

Appendix 7: Consumer price indexes

2004	94.2
2005	94.7
2006	97.8
2007	100.0

Source: SSO of RM, Monthly statistical bulletin, 2009

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