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Efficiency and Competitiveness of Kosovo Raspberry Producers

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Efficiency and Competitiveness of Kosovo Raspberry Producers

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Abstract

Raspberry production is a growing industry in Kosovo. In addition to private investments, this growth has been supported by grants, subsidies, and direct investment from international donor organizations and governmental institutions. At present, most of the commercially produced raspberries in Kosovo are produced on small farms, harvested by farmers and packed manually by collection centers, and then sold in frozen form for the export market. The long-term viability and continued growth of raspberry production in Kosovo depends on the industry being able to compete in export markets and hold its own against production regions in Poland, Serbia, and Russia. Our study measures the efficiency of Kosovo raspberry producers with an aim towards enhancing industry competitiveness. We collected primary data on raspberry farmers in Kosovo during the summer of 2016. Using these data, we examine producer efficiency using different efficiency frontier methods. Our findings suggest that efficiency improves with production experience and that outreach efforts could emphasize labor management and better allocation of plants per hectare.

Keywords: Raspberries, Kosovo, data envelopment analysis, efficiency measurement

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Chapter I. Introduction

Agriculture is an important sector for Kosovo, and contributes to the economic growth of the country. According to a report by the Central Bank of the Republic of Kosovo, in 2014 agriculture's contribution to the country's GDP amounted to 12%, ranking after the industry classification that comprises mining, manufacturing and construction, and services. Agriculture is the main source of exports in Kosovo, however Kosovo remains Europe's biggest importer of goods per capita. Kosovo's main imports are mineral products, machinery, processed food and beverages (Kosovo Imports, 2017). According to the *Green Report* published by the Ministry of Agriculture, Forestry and Rural Development in Kosovo (2014), Kosovo exported €35 million but imported €584 million leading to a large trade imbalance in agriculture. However, agriculture accounts for 16% of total export value and is a creator of national wealth. Kosovo has high expectations from the agriculture sector. Nevertheless, despite the growth in the agricultural sector since independence, the trade balance in agriculture is still negative (Simnica, 2016). One of the factors preventing a positive balance of agricultural trade is an inconsistent climate, which contributes to variability in quality and quantity (EFSE, 2014). Other factors include high input costs due to diseconomies of scale, low production levels, difficulties in access to international markets and a small budget dedicated to agriculture from Kosovo's government relative to neighboring countries. Nonetheless, raspberry production has been increasing and performing better than other fruits and vegetables in the international market for the past few years. This is as a result of pristine soil, suitable climate and an adequate amount of light that gives raspberries an intense flavor, taste, color and quality. At present, 98% of the raspberries are sold in frozen form on the international frozen market and only 2% are sold in the domestic fresh market.

Table 1 presents the main raspberry producers in the world, expressed in total production of raspberries (tons) and the last column shows the average production for years 2009-2014. The biggest raspberry producer is the Russian Federation with an average production of 137,500 tons, followed by Poland with 111,098 tons, United States of America with 87,415 tons, Serbia with 76,821 tons followed by Ukraine, Mexico, United Kingdom, Canada, Spain, Bosnia and Herzegovina, Bulgaria, Germany and France. However, Kosovo's main competitors remain Poland and Serbia.

Table 1. Raspberry production in the leading countries of the world (2009-2014)

	2009	**2010**	**2011**	**2012**	**2013**	**2014**	**Average**
Russian Federation	140,000	125,000	140,000	133,000	143,000	144,000	137,500
Poland	81,778	92,864	117,995	127,055	121,040	125,859	111,098
United States of America	55,883	88,020	109,502	84,300	83,280	103,510	87,415
Serbia	86,961	83,870	89,602	70,320	68,458	61,715	76,821
Ukraine	27,700	25,700	28,100	30,300	29,510	30,800	28,685
Mexico	13,559	14,343	21,468	17,009	30,411	35,627	22,069
United Kingdom	15,300	17,000	15,546	15,578	14,569	17,765	15,959
Canada	12,672	11,864	12,273	11,989	9,691	12,078	11,761
Spain	12,000	9,226	9,552	12,931	11,703	14,307	11,619
Bosnia and Herzegovina	8,487	7,937	9,459	7,016	9,075	10,613	8,764
Bulgaria	3,510	6,109	7,650	4,850	5,491	4,569	5,363
Germany	5,068	5,212	4,778	4,666	5,086	5,563	5,062
France	4,342	3,590	3,722	3,317	3,976	4,380	3,887

Source: FAO Stats 2017

Farmers have been motivated to start cultivating due to the ability to export and earn profits. The potential for export and profit also motivated international organizations and governmental institutions to encourage and subsidize raspberry production. Farmers have been getting help from different organizations in the form of training, advice, and assistance with different inputs such as plants, irrigation systems, and direct payments. There is still no official record regarding the total number of raspberry farmers in Kosovo. However, unofficial records from USAID show that in 2015 there were 300 raspberry farmers and in 2016 this number increased to approximately 1,000 raspberry farmers in Kosovo. That said, Kosovo raspberry producers face competition from large exporters of raspberries, such as Poland and Serbia, which are geographically close to Kosovo and may hold a competitive advantage in the market.

Harvesting accounts for approximately 30% of the total variable costs of producing raspberries (Rodriguez, et al., 2010). In Kosovo, raspberries are harvested by hand. The most direct way to address high harvest costs and become competitive in the export market is to introduce raspberry harvesting equipment. USAID together with the Kosovo Ministry of Agriculture is looking to support larger raspberry growers through cost sharing mechanisms to support investments in raspberry harvesting equipment. Another issue that has an effect on raspberry production is the cost of is sourcing high-quality planting material. Due to the incredible demand for planting materials, there is an increased risk that poorer quality materials will be imported. USAID is working with the Ministry of Agriculture to ensure that healthy high yielding raspberry planting materials are imported. Despite these efforts, some poor quality materials have been imported to the detriment of the industry. The objective of the paper is to analyze and measure the efficiency of raspberry farms in Kosovo. To achieve this goal, an-input oriented data envelopment analysis (DEA), a non-parametric method, and a stochastic frontier analysis (SFA), parametric method is used.

The remainder of the thesis is organized as follows. The next chapter introduces DEA and SFA and their use in the agriculture sector and other fields. The third chapter of the thesis describes data collection efforts and explains the methods for measuring the efficiency scores of raspberry farms. The fourth chapter presents the results of the efficiency scores from both DEA and SFA approaches and an analysis of factors that explain these scores. The final chapter of the thesis presents the conclusions and discusses limitations of the study.

Chapter II. Literature Review

Efficiency measurement can be done using parametric or nonparametric approaches. The parametric approach assumes a certain production function, parameterizing the input(s)-output(s) relationship (A. Hadi-Vencheha, 2010). In contrast, in the nonparametric approach, there are no assumptions of a parametric production function. Farrell (1957) did the pioneering work of introducing the nonparametric approach to the literature. He showed that it is possible to distinguish efficiency into price efficiency (allocative efficiency), technical efficiency and scale efficiency. Scale efficiency has been developed by Farrell (1957) and by Charnes, Cooper and Rhodes (1978) using a linear programming framework.

Charnes, Cooper and Rhodes (1978) built on the nonparametric approach and introduced Data Envelopment Analysis (DEA), which serves as a method to measure relative technical efficiencies of the same units operating in similar conditions. The goal of DEA is to describe the efficiency frontier (Joro & Korhonen, 2015). For example, if a decision-making unit (DMU) is positioned on the efficiency frontier, it means that it is an efficient unit, and it assigned an efficiency measure of 1. If it is below the efficiency frontier, then it is an inefficient unit and it is assigned an efficiency measure less than 1, with a smaller number indicating a greater distance from the frontier. For example, an efficiency measure of 0.8 means that the firm is 80 percent efficient.

DEA has been used to measure efficiencies in different fields. It has been used to measure the efficiency and risk of banks (Nguyen, et al., 2016; Benites Cava, Salgado Junior & De Freita, 2016; Chen, 2015); health care systems (Gouveia, et al., 2016; Kaya Samut & Cafrı, 2016; Shwartz, Jr.Burgess, & Zhu, 2016) and forms of tranportation (Wu, et al., 2016; Guo, Gong, & Hu, 2015; Omrani & Keshavarz, 2016), etc. There is a considerable amount of literature applying DEA to agriculture. For example, earlier work has measured the efficiency in dairy farms (Balcombe, Fraser, & Kim, 2007; Aldeseit, 2013; Mugera, 2013), wheat production (Chebil, Frija, & Thabet, 2015; A. Hadi-Vencheha, 2010), rice production (García Suárez, 2016), etc. However, when searching for literature on the measurement of the efficiency of raspberry farms, I have found no results in the existing literature.

Many researchers have developed DEA further, in order to allow for errors and enable DEA to analyze imprecise and/or incomplete data. Dealing with imprecise data is important for agriculture. Agriculture takes place in an uncertain environment and therefore the data on inputs and outputs can be imprecise. Furthermore, when respondents are asked to answer questions about their farms, there may be over reporting or under reporting because the questions relate to past activities or experiences. To deal with this problem, one of the methods used is imprecise DEA (IDEA). IDEA was first used by Cooper, Park and Yu (1999, 2001), who transformed a nonlinear programing problem to a linear programming problem through many scales of transformations and variable alternations. They set the upper and lower bounds, and showed that if they increased the upper bounds, the inefficiency of a DMU will improve or will be efficient; however, it will not affect efficiencies of other DMUs. Matin and Hadi-Vencheh (2011) used IDEA to look at the efficiency of Iranian wheat farmers, by alternating variables in the original dataset. The alternations of variables enabled them to define the upper and lower bounds for each DMU. They concluded that some farms are always efficient, regardless of the adjustments, some farms were efficient or inefficient depending on the input/output adjustments and finally, there are farms that are never efficient.

Some of the drawbacks of the DEA approach are that relative efficiencies computed are very sensitive to noise in the data, and any outlier or missing value can cause drastic change in the efficiency measurement of DMUs (Kao & Liu, 2000). Therefore, fuzzy set theory was introduced to the DEA models to deal with inexact numbers. Bellman and Zadeh (1970) were the first to introduce or suggest modeling constraints as fuzzy sets to account for uncertainty. Mugera (2013) measured the efficiency of 29 dairy farms in Pennsylvania. He concluded that the fuzzy DEA model was able to eliminate farms that were sensitive to variation in inputs and/or outputs

Among the parametric approaches, the most commonly used is the Stochastic Frontier Analysis (SFA). This model was pioneered by Schmidt, Lovell and Aigner (1977) and Meeusen and van den Broeck (1977). This approach explicitly assumes inefficiency in the firm/farm. The advantage of this model, compared to DEA, is that it allows for stochastic component of production. There is an array of parametric techniques available to create efficiency frontiers, including Classical Stochastic Frontiers Analysis (CSFA) and Bayesian Stochastic Frontier Analysis (BSFA). Schmid. Lovell and Aigner. (1977) and Meeusen and van den Broeck (1977) introduced CSFA, which assumes that the stochastic frontier includes an error term that is composed of a statistical noise and a one-sided non-negative error (Balcombe, Fraser, & Kim, 2007). BSFA is similar to CSFA but the estimation and inference in this case is undertaken by formulating a prior probability density function (Balcombe, Fraser, & Kim, 2007). A study done comparing CSFA, BSFA and DEA, shows that CSFA and BSFA produced sharper results in showing technical inefficiencies, rather than efficiencies, because their upper bounds are close to one (Balcombe, Fraser, & Kim, 2007). In addition, they showed that comparing the two stochastic frontiers with DEA, showed a minimalistic difference, which could be explained by the deterministic nature of DEA.

Even though stochastic frontiers allow the assumption for the random noise variables and inefficiency error components, many authors believe that it leads to biased efficiency scores (Serra and Goodwin, 2009; Kumbhakar et al., 2007). Thus, Kumbhakar et al. (2007) introduced a new local modeling method that overcomes the limitations of parametric and nonparametric approaches, without foregoing their advantages, using a local maximum likelihood (LML) method. This method does not require deterministic and stochastic components of the frontier and it allows for stochastic variables and measurement error when estimating technical efficiencies (Guesmi, Serra & Featherstone, 2015).

DEA can be output or input oriented. Mujasi, Asbu and Puig-Junoy (2016) in their paper use an output orientation with variable returns to scale (VRS) assumption to measure the efficiency of hospitals in Uganda. Using the VRS model, the researchers were able to see whether the hospital's production had increasing returns to scale, constant returns to scale, or decreasing returns to scale. This was an appropriate model for their problem, since hospitals had a fixed amount of inputs to use and managers are responsible in producing the maximum output. Furthermore, this paper used a Tobit regression to explain the observed hospital inefficiencies (Mujasi, Asbu & Puig-Junoy, 2016). They found that some of the hospitals are more efficient than the others and they recommend that inefficient hospitals should reduce the number of medical staff and the number of beds to achieve higher outputs.

Lauro, Figueiredo and Wanke (2016), used the input oriented model with constant returns to scale (CRS) and VRS models. The CRS models assume that variations in input levels will generate variations in output levels, possibly, increasing the output and being more efficient

(Lauro, Figueiredo, & Wanke, 2016). According to the authors, CRS efficiency is called technical efficiency, whereas VRS efficiency is called pure technical efficiency. Furthermore, they used bootstrap truncated regression in the first stage. In the second stage, they regressed VRS efficiency scores on their explanatory variables. They found that 83% of the schools need improvement to reach 90% efficiency and that the schools with fewer students were the efficient DMUs.

In summary, both approaches, DEA and SFA have their advantages and disadvantages. DEA in many cases is preferred over SFA when the parametric methods cannot be used due to invalid assumptions about the parametric model (Scippacercola & Sepe, 2016). The development of software is making it easier to use the DEA approach as a managerial tool to measure the performance of private and public organizations and businesses. However, DEA has its disadvantages. It is very sensitive to outliers, is very sensitive to the selection of variables, and to data errors. Since DEA includes noise as a part of the efficiency scores, results can be contaminated by omitted variables and measurement errors. SFA on the other hand, is not as sensitive to outliers, can separate random noise from efficiency scores, it is very flexible in terms of specifying aspects of production and it has the ability to obtain specific estimates (Scippacercola & Sepe, 2016). SFA allows for statistical errors, meaning that the deviations from the frontier of the decision-making units are not only a result of inefficiencies but also result from noise in the data. Nevertheless, SFA uses complicated functional forms and requires distributional assumption on technical efficiency measures, which makes this method harder to use in general.

Based on the earlier work reviewed, this thesis will use both a non-parametric and a parametric approach, DEA and SFA, to measure the efficiency of raspberry farms in Kosovo.

These two approaches are chosen because they complement each other to some extent. This paper will analyze DEA under three different assumptions, variable returns to scale (VRS), constant returns to scale (CRS) and decreasing returns to scale (DRS). The input oriented model is chosen because in Kosovo, the raspberry collection centers are facing problems of limited storage capacity. Thus, Kosovo will need a few more years to increase the storage capacities, in order to increase the production without decreasing the price. Furthermore, this paper will use a follow up regression to analyze the efficiency scores of each farm in terms of explanatory variables measuring the existence if a trellis system, irrigation system, water and soil analysis of the farm, etc. Through this analysis, I will be able to analyze how much of the difference in the efficiency scores is explained by independent variables available in the dataset. In addition, I will examine the competitiveness power of Kosovo raspberry farmers in the international market.

Chapter III. Data and Methods

Kosovo is still in the process of gathering, digitalizing and providing data to the public. Thus, this study is a cross sectional study using primary data. The survey with raspberry farmers took place in Kosovo on July 12, 2016 and lasted through August 17, 2016. The survey represents the major regions where most of raspberry production is taking place in Kosovo, such as Podujeva, Prishtina, Prizren, Ferizaj and Lipjan. From these regions, we have successfully surveyed 86 raspberry farmers out of a population of roughly 300 raspberry producers in Kosovo in 2015. The surveys were conducted with farmers who had started their raspberry production in 2015 or before, but who had yields during the summer of 2015. The two maps presented in figure 1 show the map of Kosovo. Panel A (on the left) presents the municipalities visited and the number of surveys conducted in each municipality. Panel B (on the right) is a digitalized map showing all the raspberry farmers in Kosovo.

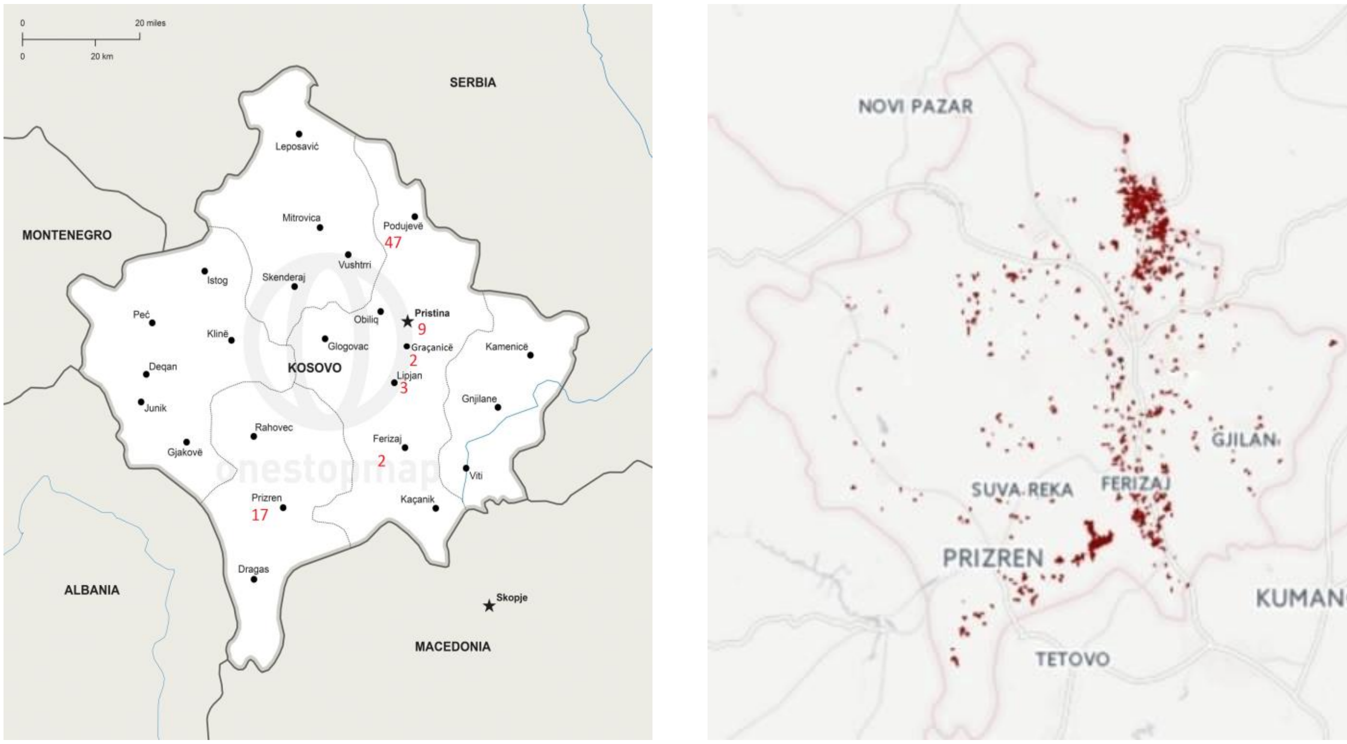

Figure 1 Raspberry production in Kosovo. Panel A (on the left) shows number of farms surveyed by municipality. Panel B (on the right) shows spatial distribution of raspberry producers. As shown in panel A, a high density of raspberry production in municipality of Podujeva, Prishtina, Gracanica, Lipjan, Ferizaj and Prizren are reflected in the survey.
Source of panel A: https://www.onestopmap.com/product/printable-vector-map-kosovo-political-486/.
Source of panel B: https:// facebook.mjedratnekosove.com.

These two maps show that the survey covered the major regions of raspberry production in Kosovo. The surveys took place at different centers, which were used as meeting points between the farmers and the surveyor. The raspberry collection centers represent the locations of the main buyers of raspberries, where the berries are frozen, packed and prepared for sale to the international market. The optimal time to meet the farmers and fill out the surveys was from 6 until 10pm every night, which was the time that farmers delivered their daily harvest. Most of the farmers were delivering their daily harvest every other day, so they would not have to drive every day to the collection centers. The surveys were conducted on an individual basis and most of the farmers were at least second year cultivators of raspberries or farmers who planted their raspberries in the spring of 2015. The farms established in 2016 were not part of this particular survey. The surveys were printed, so the farmers answered the questions and the surveyor wrote down the answers. The survey used is presented in the Appendix.

The aim of the first two questions in the survey was to identify and develop a greater understanding of the challenges and the needs of the raspberry farmers in Kosovo. One of the main challenges of the raspberry farmers relates to infrastructure. Farmers do not have good roads and experience shortages of water and electricity; therefore, they need to use a generator to activate their pumps for irrigation. These issues need to be solved by the government and/or the respective municipality. Another big problem was weed management. Farmers do not know exactly what to use for weed control, do not have adequate products to treat the plants, nor do they have appropriate guidelines to follow. Currently, none of the farmers said that they used any type of herbicides; however, they were using different types of fertilizers, pesticides and insecticides.

Kosovo is divided into small parcels of land, which in many cases, is a problem for farmers because it increases their costs. This was clear in this dataset too. The average raspberry farm was only 0.78 hectares.

The main varieties cultivated in Kosovo are Polka, Willamette, Meeker, Tulameen, Mapema and Bliss. Figure 2 shows the number of farmers cultivating different varieties of raspberries.

The number of farmers cultivating different varieties exceeds the number of actual farmers interviewed because there are some farmers that cultivate multiple raspberry varieties on their farms. Polka, Willamette and Meeker have been shown to provide high yields, have high pest resistance and are mainly used for processed food (Finn, Strik and Moore, 2014). Tulameen is mainly sold on the fresh market. These varieties have been chosen also to increase yield and extend the raspberry production season, thereby allowing producers to get higher prices for their yield.

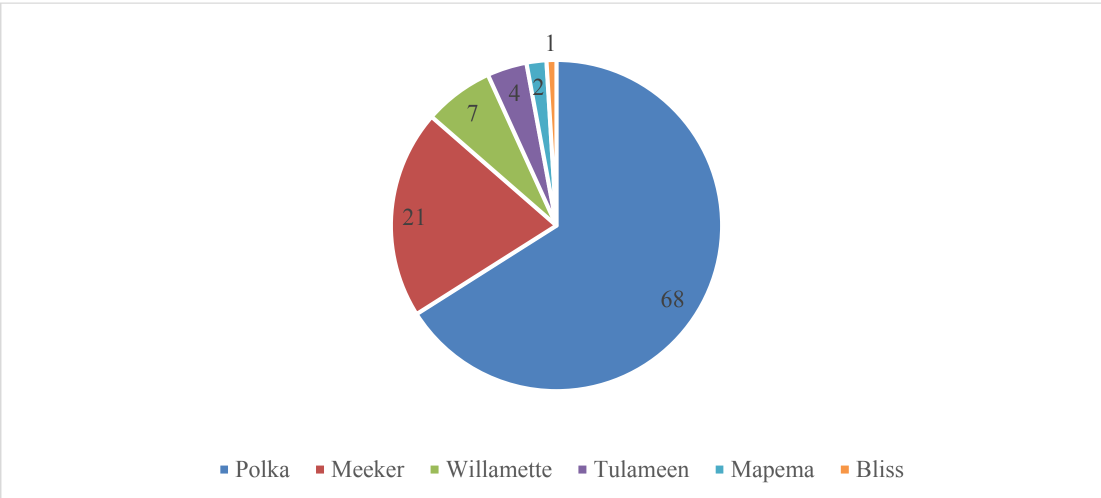

Figure 2 Number of farmers cultivating different raspberry varieties

From the literature and from current practices, the main difference between raspberry farmers in Kosovo and Serbia is the presence of irrigation systems in the farms. Most of the farmers in Kosovo use irrigation systems. Based on the data used in this study, 98% of the farmers surveyed had irrigation systems. The two main sources of the water were rivers and wells. In total, 23 farmers sourced irrigation water from a river and 62 farmers used a well. All of the surveyed farmers used a drip irrigation system.

Proper trellising is critical to increasing fruit and yield. Use of a trellis system was a frequent practice among farmers. The majority, 59 out of 86 surveyed farmers, had trellis systems on their farms. The most common trellising materials are wood, concrete and metal. Materials used for trellis wires were metal and rope. In most cases, farmers built their own trellises. Shade nets are not a common practice yet on raspberry farms in Kosovo. However, in the future they will become more necessary to protect the plants from birds, insects and extensive solar radiation. Table 2 summarizes the technology variables in raspberry farms in Kosovo.

Table 2. Summary of farm technology variables

Variables	Yes	No
Trellis system	59	27
Irrigation system	85	1
Soil Analysis	66	20
Water Analysis	47	39

It is worth noticing that most of the raspberry farmers are specialized only in raspberry farming, meaning that they do not cultivate other crops on their farm. Farmers reporting that they cultivated other crops used only for their own consumption and not for commercial sale, were coded as not having other crops. In sum, 27 of the farmers interviewed said that they cultivate and sell other crops to the markets. One of the crops that is becoming popular among farmers in Kosovo is aronia, which is a relatively new crop to the domestic market and seems to be the next emerging crop in Kosovo. One of the reasons that aronia may be the next emerging crops is because of its cultivation conditions. Aronia berry requires very similar conditions to apples and apples are one of the most cultivated fruit in Kosovo. Farmers have also started to become more interested in cultivating walnuts, as they are informed that these crops have high profit potential. However, the most planted crops were peppers, apples, maize, tomatoes, and cucumbers, to name a few. Given potential returns to specialization, one hypothesis is that farmers who are more specialized, cultivating only raspberries, will have higher efficiency scores.

Raspberry farmers do not have storage places or freezers for the raspberries; therefore, they send their daily harvest to raspberry collectors. The distance from the farms to the collection centers varied, however from talking to farmers, the distance of the two locations could go up to 60 km. The raspberry collectors also package, freeze and sell raspberries to local and/or international markets. There are some cases wherein the raspberry farmers sell their raspberries to the local fresh markets, but the demand for fresh raspberries is not very high for farmers to sell all their yields domestically. Since raspberry farms in Kosovo are small, they cannot be price setters but only price takers. Collectors set the prices in the domestic market, but they are also the ones taking the risk of selling berries on the international market.

There are some questions on the survey that were not incorporated into the dataset because of their incomplete answers. One reason some answers may have been incomplete is that the survey was conducted at the collection centers where farmers did not have access to complete records. One of the questions left out of the dataset pertains to fertilizers, pesticides and herbicides. These are an important part of the cost of cultivating raspberries. Another variable related to the cost is getting GAP certification, which is also excluded from the data because none of the raspberry farmers reported having this certification. Even though responses to this question could not be included in the dataset, they provide important information about where Kosovo farmers and collectors stand in the process of getting GAP certified.

Labor days were divided into labor days for planting, pruning and harvesting. Planting days are excluded from calculating the labor cost because planting is an activity that is done once and is not repeated every year. For each activity, we have family labor days and non-family labor days. For non-family days, we also have number of workers and their salary paid per day, per hour or per kilogram. One of the problems encountered was that the family and non-family days were the same and we did not have the number of family workers engaged in these activities. Raspberry farmers rely heavily on family labor to grow raspberries in Kosovo. In the rural areas, there are approximately eight family members per household. This has not changed since 1948 (Warrander and Knaus, 2010).

By analyzing further labor days, we have noticed that:

- 66 of the surveyed farmers used both family and non-family labor
- 5 of the surveyed farmers used only non-family labor
- 48 of the surveyed farmers used only family labor.

The five farms that are using only non-family labor are the big farms in the dataset and their farm size range from 0.5 hectares to 8 hectares. Whereas the farms that are using only family labor are the small farms in the data set, with a farm size of 0.5 hectares or less.

In order to decide whether to use the total labor days as one of the inputs or only total paid labor days, there was a need to check their correlation. Figure 3 suggests that these two measures are highly correlated with each other. Since the data had a complete number of labor days and an incomplete number of paid labor days, labor is measured as the total labor days.

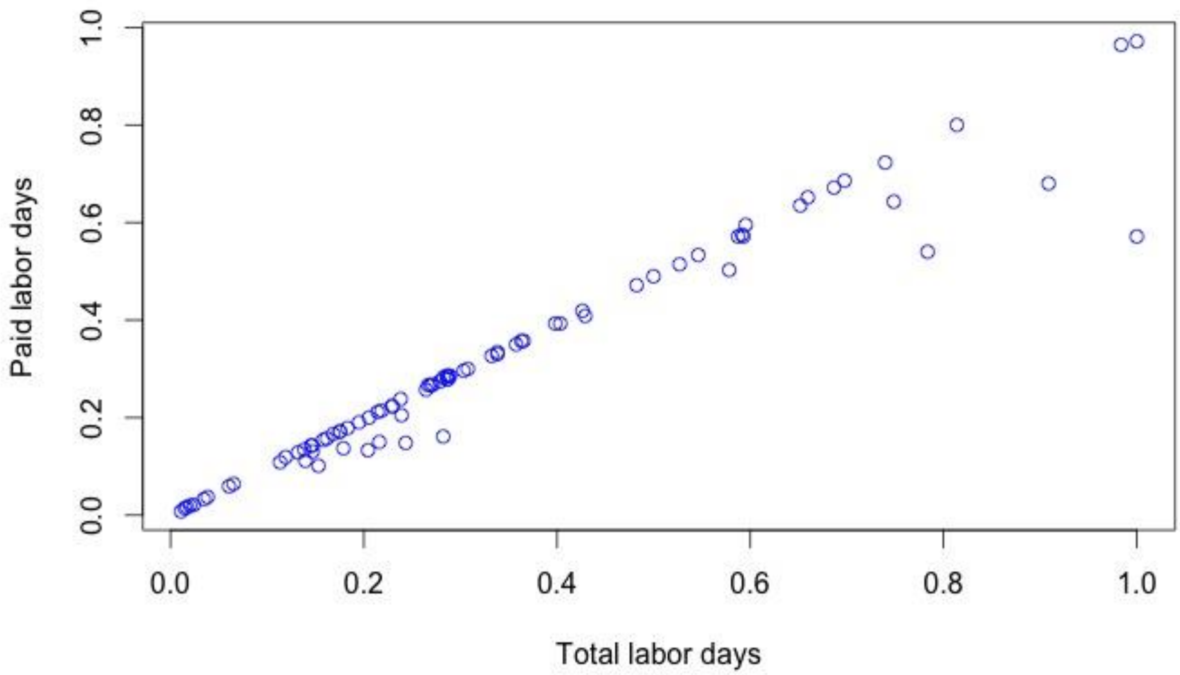

Figure 3 Correlation between paid labor days and total labor days

To calculate the number of plants per farm, we first calculated the plants per one hectare by dividing one hectare by the production the space between each plant and the space between the rows. The next step was to divide the plants per hectare with the size of the farm, which gave us the total plant per farm.

All the data were entered into a spreadsheet, converted to csv format and then read and analyzed with R through RStudio. Additional variables were generated within RStudio. A summary of continuous variables are presented in the table below:

Table 3. Summary of continuous variables

Variables	Mean	St. deviation
Hectares	0.78	1.20
Total yield (kg)	5576.51	8274.42
Price received in euro/kg	1.93	0.24
Days of non-family workers for pruning	0.84	2.64
Days of family workers for pruning	3.45	3.60
Days of non-family workers for harvesting	36.47	46.56
Days of family workers for harvesting	67.67	35.14
Days of non-family workers for planting	1.48	4.24
Days of family workers for planting	3.38	3.55

To look at the relative efficiency performance of each farmer, an input oriented DEA and an SFA were used. The DEA method is flexible in terms of having single input and output and/or multiple inputs and outputs. SFA requires a specification for the production function and it allows for stochastic error in the model. The input oriented DEA approach reduces equiproportionately the use of all inputs (Fare, Grosskopf, & Lovell, 1994). The inputs for DEA and SFA were plants per hectare and total labor days per hectare (including both family and non-family labor). The output was the yield per hectare. The number of observations used was 86 farms. In addition to the SFA efficiency scores, this thesis is going to analyze DEA efficiencies under three returns-to-scale assumptions: CRS, VRS and DRS.

Scale efficiencies were calculated by dividing the CRS technical efficiency scores by the VRS technical efficiency scores. If the farm was efficient or (had an efficiency score of 1) under each return to scale assumption, it is notated as “Efficient”, if the CRS technical efficiency score and DRS technical efficiency scores equal each other but are not equal to1, then it means that the farm is operating under decreasing returns to scale, which means that the farm is using labor and plants per hectare more intensively than they should. Otherwise, the farms at an inefficient scale were operating under increasing returns to scale could increase efficiency by using labor and plants more intensively.

Descriptive statistics used in the DEA are presented in table 4.

Table 4. Descriptive statistics for DEA inputs and output

Inputs	Minimum	Mean	Maximum	St. deviation
Plants per hectare	666	8,577	70,833	11,321
Total labor days	15	269	1,830	288
Output				
Yield per hectare (kg)	286	7,510	23,000	5,269

Chapter IV. Results

The efficiency scores for each farm were measures through DEA and SFA. Distributions of the efficiency scores from these two methods are shown in figures 4 and 5. These figures show that the DEA and SFA distributions are skewed to the left. The SFA efficiency scores are higher than the DEA efficiency scores, but their distributions are very similar.

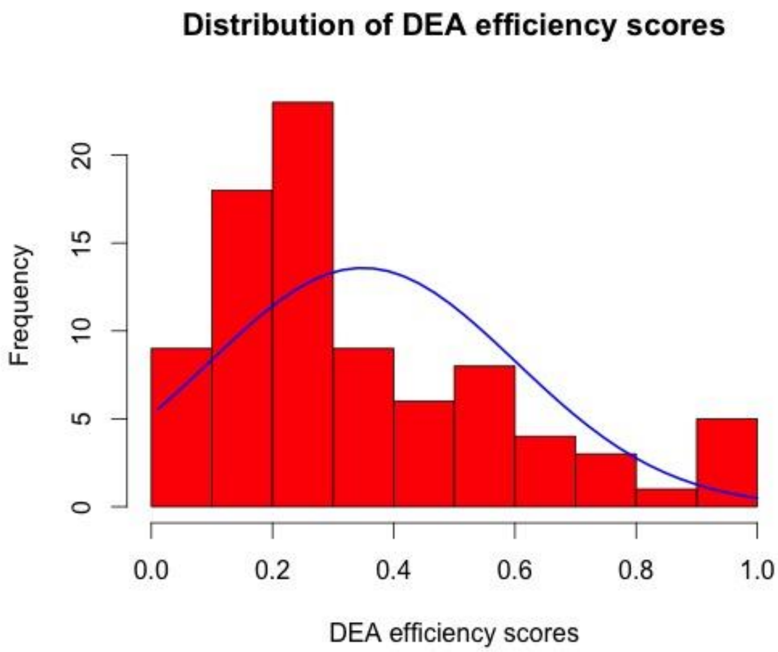

Figure 4 Distribution of DEA efficiency scores

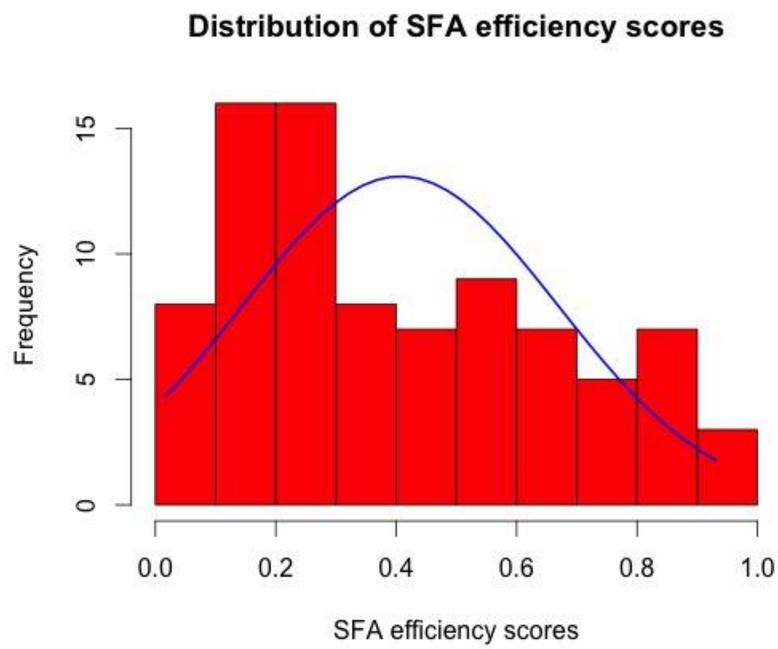

Figure 5 Distribution of SFA efficiency scores

DEA and SFA efficiency scores have a high correlation and their correlation coefficient is 0.91. Figure 6 illustrates their correlation.

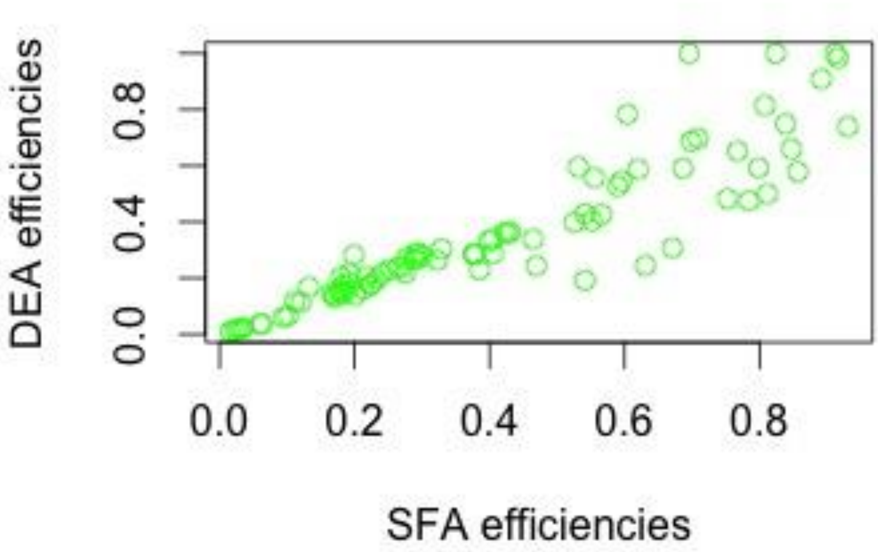

Figure 6 DEA-SFA correlation

Table 5 presents the DEA efficiency measurements under the CRS, VRS and DRS assumptions, SFA efficiencies, scale efficiencies and the source of scale inefficiencies. From table 5, it can be seen that there are only three farms that are efficient under CRS, VRS and DRS assumptions. Of the scale inefficient farms, seven of them are operating under decreasing returns to scale and 76 are in a region of increasing returns to scale. There are nine efficient farms under the VRS assumption and six efficient farms under DRS assumption. There are only three efficient farms over the three returns to scale assumptions. For a farm to be CRS efficient, it must be both technical and scale efficient, but for a farm to be VRS efficient it needs only to be technical efficient. SFA didn't show that any of the farms are efficient, however most of the efficiency scores from SFA are higher than those under CRS assumption, but generally not higher than the efficiency scores under VRS assumption.

Table 5 below shows that most of the raspberry farms in Kosovo are relatively small farms and are operating under increasing returns to scale. For those farms to be more efficient they need to use more labor and possibly more plants per hectare. This also means that if those farms were bigger in size, they would be more efficient. If those farms have the opportunity to increase the size of the farm, they should do so, either in cooperation with other raspberry farmers or on their own. For the remaining seven farms that are operating under decreasing returns to scale, they should consider using less labor and plants per hectare. They should better utilize the intensity of inputs in order to be more efficient because currently they are using inputs in high intensity.

The last farm in the table, number 87, is a hypothetical raspberry farm from Serbia. The inputs and output were retrieved as state averages found while conducting online research (Sredojevic, Kljajic, & Popovic, 2013; Zaric, Vasiljevic, Vlahovic, & Andric, 2013). The DEA and SFA scores were run with the total number of Kosovo raspberry farms and the hypothetical Serbian farm to get the efficiency scores. It can be seen that the DEA efficiency score under the CRS assumption is 0.2. This means that the hypothetical Serbian farm shows similar efficiency score to the majority of raspberry farmers in Kosovo, compared to the distribution of DEA efficiency scores in figure 4. However, comparing the score of the hypothetical farm from Serbia with farms established before 2015 in Kosovo, it can be seen that the old farms from Kosovo show significantly higher efficiency score. The average DEA efficiency score under the CRS assumption of only old farms of the dataset is 0.45 or 45%, which is more than double of the efficiency estimate that the hypothetical farm from Serbia showed.

Table 5. Results of efficiency measurements of 86 farms in Kosovo and one hypothetical Serbian raspberry farm*

Nr	CRS	VRS	DRS	SE	SFA	SE source	Nr	CRS	VRS	DRS	SE	SFA	SE source	Nr	CRS	VRS	DRS	SE	SFA	SE source
1	0.578	0.681	0.681	0.849	0.857	DRS	**30**	0.475	0.475	0.475	0.999	0.784	DRS	**59**	0.162	0.666	0.162	0.243	0.213	IRS
2	0.338	0.514	0.338	0.658	0.464	IRS	**31**	0.119	0.714	0.119	0.167	0.112	IRS	**60**	0.264	0.720	0.264	0.367	0.322	IRS
3	0.020	0.481	0.020	0.042	0.032	IRS	**32**	0.740	1	1	0.740	0.931	DRS	**61**	0.239	0.753	0.239	0.317	0.264	IRS
4	0.061	0.470	0.061	0.129	0.094	IRS	**33**	0.287	0.584	0.287	0.492	0.405	IRS	**62**	0.267	0.628	0.267	0.425	0.292	IRS
5	0.038	0.493	0.038	0.078	0.061	IRS	**34**	0.282	1	0.282	0.282	0.199	IRS	**63**	0.286	0.464	0.286	0.615	0.378	IRS
6	0.035	0.428	0.035	0.081	0.062	IRS	**35**	0.365	0.694	0.365	0.526	0.431	IRS	**64**	0.205	0.849	0.205	0.242	0.217	IRS
7	0.482	0.513	0.482	0.941	0.753	IRS	**36**	0.652	0.774	0.652	0.842	0.767	IRS	**65**	0.687	0.894	0.687	0.768	0.699	IRS
8	0.011	0.453	0.011	0.024	0.016	IRS	**37**	0.363	0.659	0.363	0.551	0.422	IRS	**66**	0.214	0.637	0.214	0.337	0.240	IRS
9	0.403	0.615	0.403	0.656	0.552	IRS	**38**	0.238	0.595	0.238	0.400	0.271	IRS	**67**	0.065	0.417	0.065	0.157	0.101	IRS
10	0.659	0.669	0.669	0.985	0.847	DRS	**39**	0.527	0.785	0.527	0.671	0.590	IRS	**68**	0.338	0.696	0.338	0.486	0.405	IRS
11	0.398	0.557	0.398	0.715	0.525	IRS	**40**	0.814	0.885	0.814	0.920	0.808	IRS	**69**	0.183	0.839	0.183	0.218	0.193	IRS
12	0.429	0.704	0.429	0.610	0.541	IRS	**41**	0.243	0.249	0.243	0.978	0.469	IRS	**70**	0.272	0.738	0.272	0.368	0.277	IRS
13	0.015	0.543	0.015	0.027	0.022	IRS	**42**	0.698	0.857	0.698	0.814	0.709	IRS	**71**	0.595	0.794	0.595	0.750	0.532	IRS
14	0.024	0.522	0.024	0.046	0.036	IRS	**43**	0.749	0.750	0.749	0.998	0.839	IRS	**72**	0.195	0.690	0.195	0.283	0.233	IRS
15	0.017	0.501	0.017	0.034	0.027	IRS	**44**	0.784	1	0.784	0.784	0.604	IRS	**73**	0.139	0.482	0.139	0.289	0.201	IRS
16	0.179	0.560	0.179	0.319	0.225	IRS	**45**	0.984	1	1	0.984	0.917	DRS	**74**	0.175	0.596	0.175	0.294	0.223	IRS
17	0.216	0.832	0.216	0.260	0.192	IRS	**46**	0.132	0.630	0.132	0.209	0.171	IRS	**75**	0.593	0.669	0.593	0.886	0.799	IRS
18	0.591	0.811	0.591	0.729	0.687	IRS	**47**	0.426	0.576	0.426	0.740	0.566	IRS	**76**	0.204	0.806	0.204	0.254	0.179	IRS
19	0.245	0.249	0.245	0.983	0.631	IRS	**48**	0.113	0.902	0.113	0.126	0.120	IRS	**77**	0.288	0.714	0.288	0.403	0.291	IRS
20	0.500	0.504	0.504	0.992	0.812	DRS	**49**	0.303	0.782	0.303	0.388	0.329	IRS	**78**	0.332	0.630	0.332	0.528	0.399	IRS
21	0.557	0.880	0.557	0.633	0.555	IRS	**50**	0.546	0.811	0.546	0.673	0.595	IRS	**79**	0.168	1	0.168	0.168	0.132	IRS
22	0.587	0.903	0.587	0.650	0.620	IRS	**51**	0.282	0.491	0.282	0.575	0.377	IRS	**80**	0.269	0.676	0.269	0.398	0.287	IRS
23	0.193	0.239	0.193	0.807	0.541	IRS	**52**	0.147	0.766	0.147	0.192	0.165	IRS	**81**	0.358	0.673	0.358	0.531	0.427	IRS
24	1	1	1	1	0.824	Eff	**53**	0.146	0.573	0.146	0.254	0.184	IRS	**82**	0.289	0.737	0.289	0.392	0.295	IRS
25	0.308	0.331	0.308	0.929	0.671	IRS	**54**	0.175	0.802	0.175	0.219	0.183	IRS	**83**	0.158	0.733	0.158	0.215	0.178	IRS
26	1	1	1	1	0.912	Eff	**55**	0.138	0.719	0.138	0.193	0.170	IRS	**84**	0.229	0.755	0.229	0.303	0.251	IRS
27	1	1	1	1	0.696	Eff	**56**	0.287	0.665	0.287	0.431	0.376	IRS	**85**	0.909	1	1	0.909	0.892	DRS
28	0.229	0.457	0.229	0.502	0.385	IRS	**57**	0.218	0.580	0.218	0.377	0.275	IRS	**86**	0.147	0.718	0.147	0.204	0.178	IRS
29	0.153	0.522	0.153	0.293	0.184	IRS	**58**	0.279	0.712	0.279	0.392	0.300	IRS	**87**	**0.224**	**0.490**	**0.224**	**0.457**	**0.302**	**IRS**

* CRS- Constant Returns to Scale; VRS- Variable Returns to Scale; DRS- Decreasing returns to Scale; SE- Scale Efficiency; SFA- Stochastic Frontier Analysis; SE source- Scale Efficiency Source.

Table 6 presents the aggregate results by source of scale efficiency. In this table are presented the means of the two inputs and the output of the farms that are operating under decreasing returns to scale and farms operating under increasing returns to scale. The source of scale efficiencies are DRS and IRS.

Table 6. Aggregate results by source of scale efficiency

Source of Scale Efficiency	Number of observations	Year of establishment	Yield per Hectare	Plants per Hectare	Total Labor Days per Hectare
DRS	7	Total Farms	18,144	14,134	284
IRS	76	Total Farms	6,287	11,884	272
DRS	12	Before 2015	18,144	14,134	284
IRS	28	Before 2015	9,337	13,393	284

From table 6 it can be concluded that the farms experiencing DRS have higher yields per hectare than the ones experiencing IRS. This can be attributed to the intensity of plants and labor that those farms are using. The table suggests that farms experiencing IRS need to increase their yields through increased planting density because there is a considerable gap between farms experiencing IRS and DRS in terms of plants per hectare when considering total farms. Total labor days is consistent between farms under the two sources of scale inefficiency. One of the reasons that the total number of farms experiencing IRS have low yields is because half of the farms in the data set are newly established farms in 2015. The last two rows reflect only farms established before 2015. The older farms operating under DRS and IRS assumptions also showed a gap in their yield per hectare. Farms operating under the IRS assumption should consider increasing the intensity of plants per hectare, using the same labor days as farms operating under DRS assumption.

Looking more closely at the results, we regressed the technical efficiency scores under CRS assumption on several explanatory variables. Explanatory variables include the year when the farm was established; the size of the farm in hectares; the source of the water used for irrigation, whether well or river; the existence of a trellis system; indicators for the different municipalities; whether the farmer conducted water and soil analysis; raspberry variety; and whether the farmer is commercially cultivating other crops in addition to raspberries.

The first column of the regressions in table 7 shows the results from the full sample of 86 farms in the data set. The second column shows the regression results of 43 farms that were established before 2015. The third column shows regression results of 43 farms that were established in 2015.

Table 7. Regression results (dependent variable is the technical efficiency CRS)*

Variables	Estimates for all farms (Standard errors)	Estimates for old farms (Standard errors)	Estimates for new farms (Standard errors)
(Intercept)	173.16***	44.21	0.06
	(-36.38)	(-76.32)	(-0.19)
Year	-0.09***	-0.02	
	(-0.02)	(-0.04)	
Hectares	-0.01	0.06	-0.01
	(-0.02)	(-0.07)	(-0.02)
Irrigation using water from the river	-0.15	-0.21	
	(-0.25)	(-0.33)	
Irrigation using water from well	-0.03	-0.02	0.02
	(-0.25)	(-0.33)	(-0.09)
Trellis system	-0.01	-0.06	0.03
	(-0.06)	(-0.12)	(-0.05)
Municipality of Gracanica	-0.05	-0.09	
	(-0.24)	(-0.4)	
Municipality of Lipjan	0.05		0.18
	(-0.21)		(-0.14)
Municipality of Podujeva	-0.001	-0.06	0.04
	(-0.17)	(-0.35)	(-0.12)
Municipality of Prishtina	0.05	0.03	-0.02
	(-0.18)	(-0.34)	(-0.14)
Municipality of Prizren	-0.32	-0.03	-0.09
	(-0.24)	(-0.45)	(-0.19)
Municipality of Shterpce	-0.28	-0.14	
	(-0.22)	(-0.38)	
Soil analysis	-0.03	-0.02	0.05
	(-0.08)	(-0.17)	(-0.05)
Water analysis	0.12**	0.12	-0.02
	(-0.06)	(-0.13)	(-0.04)
Polka variety	-0.25**	-0.13	0.09
	(-0.11)	(-0.19)	(-0.13)
Other crops in the farm	0.08	0.08	-0.05
	(-0.05)	(-0.1)	(-0.05)
R^2	0.4	0.26	0.51
Adjusted R^2	0.27	-0.1	0.34
Number of observations	86	43	43
RMSE	0.22	0.27	0.11

* Significance codes: ‘***’<0.01, ‘**’<0.05, ‘*’<0.1

The first column in table 7 shows that the year coefficient is statistically significant at 1% level and is negative. The negative sign is expected because all raspberry farms are quite new and have access to comparable technology. The new farms, those established in 2015, are expected to be less efficient because the plants are not yet fully mature. Moreover, older farms, those will smaller values for the year variable will be more experienced and have lower costs as a result of learning economies. The range of the years of farms established in the dataset is presented below:

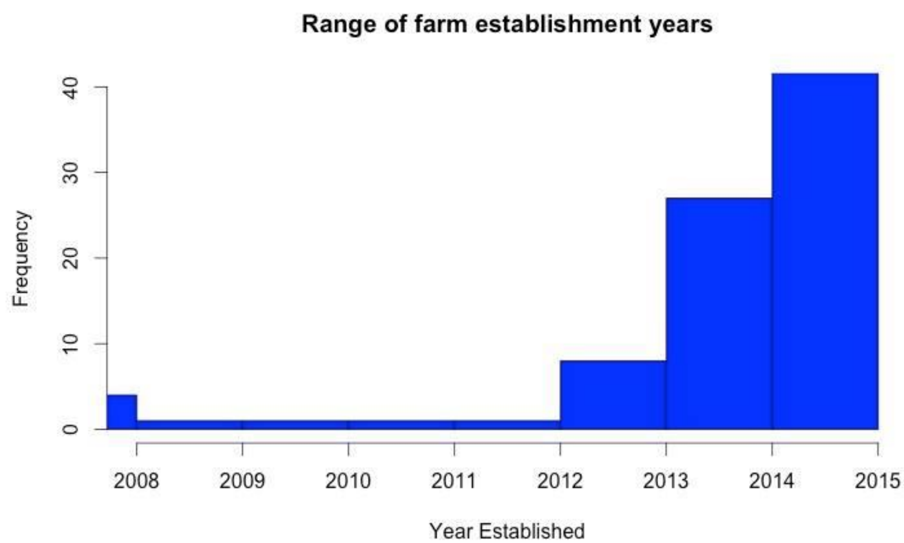

Figure 7 Range of farm establishment years

Water management is an important practice when it comes to raspberry cultivation. It is recommended to do the water analysis before starting the irrigation of the plants. Water with high concentration of dissolved solids may adversely affect the raspberry plants. Also, the pH of the water should be in the range of 6.0 - 6.5 for raspberries. Water analysis showed to be significant at the 5% level of confidence and the sign of the estimate is positive. This means that it benefits the farmers to conduct these analysis before irrigating the raspberries. This could also be reflective of good managerial practices on part of the growers. It is interesting to notice that the water analysis is statistically significant, whereas the soil analysis is not significant. In order to test whether water analysis is also counting for soil analysis, water analysis was excluded from the regression. The result still showed the variable of soil analysis to be insignificant. Whereas, when excluding soil analysis from the regression, water analysis continued to be significant, having similar point estimate as that reported in the full regression.

The Polka variable is significant at the 5% level of confidence and the sign is negative. This could suggest that farmers with this variety will have lower yields per hectare than those cultivating other raspberry cultivars. However, this is not a definitive result because of the significant number of newly established farms in the dataset. New farms are mainly cultivating the polka variety and this is probably the best explanation for the negative estimate. Polka is also a new cultivar presented to the market and is a fall bearing, which has attracted new raspberry farmers to cultivate this variety.

In table 7, the second column of results presents regression results from the subsamples of older farms, those established before 2015. In this regression we can see that the year coefficient is no longer statistically significant. The missing coefficient estimates show that there was no raspberry farmers surveyed that started cultivating before 2015 in the Municipality of Lipjan. In the third column, the year coefficient is missing because there is no variance in year variable. Moreover, there were no newly established farms using water from the river for their irrigation systems. There were no farms in the dataset established in 2012 in the municipality of Gracanica and Shterpce.

It is worth noting that the coefficient of the trellis variable is not significant. Trellising should be associated with higher yields. However, as noted above, many if the farms are new and there is evidence that many farms established in 2014 and 2015 had not yet installed trellises. This may explain why trellising does not show as being significant.

Chapter V. Summary and Discussion

As explained in the introduction, Kosovo is a small and new raspberry producer entering the international market. Kosovo’s main competitors are Serbia and Poland, in terms of exporting frozen raspberries. Poland invests heavily in research and development of new raspberry cultivars, which gives the country a strong groundwork to produce and become one of the largest volume exporters of raspberries in the world. Serbia has been able to sell frozen raspberries at a higher price during the last few years in comparison to Poland, resulting in Serbia having higher value of exports than Poland. Looking at the farms in Serbia and Poland, there is a considerable similarity in the way that these countries and Kosovo produce raspberries. Following these countries as samples for producing raspberries, Kosovo is an emerging competitor on the international market, or at least the European market.

As discussed earlier, Kosovo cultivates mostly the Polka variety, Meeker and Willamette. This is a good combination of cultivars because they provide for an extended harvest period. In Poland the most popular cultivars are Polka and Polana. In Serbia the leading cultivars are Willamette and Meeker. Furthermore, 90% of the farmers in Serbia grow the Willamette cultivar, which is a floricane (summer) bearing and less than 1% of farmer grow Polka in Serbia, which is a primocane (fall) bearing (Nikolic, 2016). Since Kosovo cannot compete with Serbia in terms of quantity, Kosovo should try to compete mainly with Serbia by taking advantage of the extended growing season, which can extend into October with the Polka cultivar, to achieve better prices on the international market. However, Kosovo is disadvantaged in comparison to these two countries because of the lack of experience. Farmers in Poland and Serbia are much more experienced and are better prepared for disease or climate change threats.

The positive note for Kosovo is that its production capacity consists mainly of newly established raspberry farms, and these farms are starting off with better technology than farms that were established years ago in Serbia and Poland. Moreover, these old farms may have a hard time upgrading their technology relative to the newly established farms because once planted raspberries remain in production for many years. A small number of Serbian growers are improving their production by adopting appropriate agro-technical measures and introducing irrigation systems. However, the majority of raspberry producers in Serbia have not made these investments, which results in low yields, as low as 5 tons per hectare, compared to farmers that are investing and getting up to 20 tons per hectare (Keserovic & Magazin, 2014). Poland is in a similar situation as Serbia. Only recently have raspberry producers been starting to install irrigation systems in their farms. This was mostly due to of the dry summer Poland experienced in 2015, which resulted in the lowest yields per hectare in many years, which was 2.86 tons/hectares, compared to the country's average yield, which is 4 tons/hectare (Pawlonka, Nosecka, & Krawiec, 2016). Comparing average yields per hectare of Serbia and Poland with the dataset of raspberry farms in Kosovo, it seems that Kosovo is also doing well because the total average yield per hectare is 7.5 tons per hectare, with a maximum yield per hectare of 23 tons per hectare.

Kosovo and Serbia have small farms, which might be the secret of high quality raspberry production. In the dataset the average raspberry farm size in Kosovo is 0.78, compared to Serbia where the state average for raspberry farms is 0.34 hectares, whereas Poland has larger size farms. However, raspberry production is a good opportunity for sustainable development in rural areas. This activity has been is an income generator in for many families in rural areas and it is a good fit for small farms because the profit is high and the establishment costs are relatively low.

Surveys of raspberry farmers showed that none of the producers have GAP certification. This certification provides assurance that raspberry producers are producing, packing and storing the product in a manner that meets food safety requirements. This way raspberry producers in Kosovo can better market their products and be a stronger competitor in the international market. Serbia has just recently started the process of GAP certification and it is advisable that Kosovo follow Serbia in this regard. In Serbia, there are approximately 20 farmer groups, that have GAP certification, and each group consists of 10-15 raspberry producers (Zaric, et al., 2013). Leaders of these groups are usually the processors, collectors or the traders of the raspberries, but not farmers. Being engages in the GAP certification process would make raspberry producers in Kosovo pay more attention to the marketing side of the production, which would lead towards better meeting consumer preferences and lead to positive financial results for the producers.

Providing higher quality products is the aim of all producers. Kosovo should start adding more value to the raspberries and get better prices in the international market. There are many ways of adding value. These include the aforementioned GAP certification and developing better marketing strategies. Moreover, Kosovo could consider processing raspberries into marmalades, yoghurts, compote, etc. By processing raspberries the revenues from exports could increase significantly.

Overall the study found that there are 76 farms experiencing increasing returns to scale, 7 experiencing decreasing returns to scale and there were three efficient farms under CRS, VRS and DRS assumptions. All the three of these farms were established in 2013 or earlier. Other characteristic of these farms include the fact that they all cultivate the Polka variety, their farm size is 0.5 hectares or bigger and they are operating around the municipality of Podujeva. Two out of the three efficient farms showed that they have irrigation system, trellis system and they do the soil and water analysis on regular basis. However, one of the farms did not show to have any of these characteristics. This means that the majority of the raspberry farms in Kosovo need to expand their production activities. Those 76 farms need to plant more plants per hectare, which would lead to having higher yields and probably there will be the need to be more labor in production activities. By expanding the farm's activities, those farms will have higher efficiency scores. The 7 farms operating under decreasing returns to scale need to plant less plants per hectare to improve efficiency. Thus, they will need a smaller amount of family or hired workers engaged in the raspberry production activities. These farms, by farming less intensively, can achieve higher efficiency scores than they are currently doing. Since Kosovo is divided into small parcels, there may be the possibility of efficiency gains from improved cooperation among small raspberry farms. This could benefit the farms in terms of specialization and utilization of labor and could mean a shift from family businesses to partnerships of some kind.

Harvesting labor has been is a large cost of raspberry production. As such, many farms engage their family member during the raspberry harvest season. One of the ways to decrease their costs, as mentioned in the introduction, is to introduce harvesting equipment for raspberries. By investing in harvesting equipment, the cost of labor will decrease considerably. However, it is important to mention that the quality of the raspberry yield might not be as high as handpicked raspberries, because during the process of harvesting with machinery, raspberries may be crushed. Farmers can still use them, depending on the market that they are interested to sell their harvest. Harvesting equipment may also be complicated because of different raspberry cultivars and their different timing of maturation. Harvest equipment should be applied when raspberries are fully mature, otherwise it would be harder to detach them. Therefore, when investing in harvesting equipment, training farmers would be crucial, prior to the machinery usage.

The lack of farmer cooperation is evident and it is needed now more than ever (Zivkov, 2013). This is one reason that prevents farmers from expanding their operations and activities. There is a general lack of trust and many do not believe the state would fairly regulate disputes within a partnership (Zivkov, 2013). There is a need for greater awareness of the benefits of forming cooperatives that could share skills, decrease the risks, and motivate member farms to succeed (Zivkov, 2013). Forming cooperatives of raspberry farmers will increase production and Kosovo can be a stronger competitor in the international market.

The raspberry industry in Kosovo, as an emerging industry, can be a start to create clusters. The European Commission (2006,2008) considers clusters as factors that highly improve economic growth and investments especially for small and medium enterprises (SMEs). Clusters, according to Porter are defined as "geographic concentration of interconnected companies, specialized suppliers, service providers, firms in related industries, and associated institutions in particular field that compete but also cooperate" (2008, p.15). This means that there should be a vertical and horizontal integration of all the contributors involved in the raspberry production and marketing chain. The creation of clusters benefits SMEs by increasing their competitiveness in the market, as a result of cooperation among farms, governmental institutions and educational institutions. Clusters would also strengthen or even create raspberry producer and seller cooperatives. By having an organized industry, the introduction and application of new and innovative technology in raspberry production would be more efficient and effective. It would also make it easier the introduction of food safety and quality assurance standards. Kosovo has been trying to do this, as explained earlier, through the close relationship of domestic and international institutions with farmers, and the cooperation of farmers with collectors and wholesalers. However, this cooperation needs to be regulated by creating cluster policies in Kosovo, so everyone can follow and also benefit from such organization.

As a conclusion, there is a need for improving the efficiency of raspberry farmers. The main finding of this paper is that raspberry farmers should allocate plants per hectare more efficiently. There are some limitations of this study. The main problem we encountered during this study was in gathering the data. Small farmers may not have accurate records or be in a position to provide exact answers on the questions. This was especially true of questions regarding the use of fertilizers and pesticides. Also, this study could be improved if done a few years later by 1) covering all of the regions in Kosovo, and 2) allowing farmers more time to prepare for the survey and thus provide more exact answers on the questions, especially regarding the fertilizers and pesticides. Further, if replicated in a few years, today's new raspberry producers will have gained experience in production and a better estimate of overall efficiency may be calculated. These limitations aside, this paper provides a baseline of raspberry production efficiency, which could be expanded and elaborated more thoroughly in upcoming studies.

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Appendix 1. Survey with Raspberry Producers in Kosovo

Date: __________

General questions

What are the greatest challenges you face as a raspberry producer in Kosovo?

What is needed to overcome those challenges?

Survey for farmers to complete individually on paper or online

1. In what year did you begin raspberry production? __________
2. For how many seasons have you grown raspberries? __________
3. How many hectares of raspberries did you produce last season (2015)?___________
4. What was the total yield (kg per hectare) in 2015?_________
5. How many varieties of raspberries did you have on your farm in 2015? Please specify these varieties:

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6. Do you have any other crops planted in your farm? Yes No

   If yes, please specify these crops:

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7. Do you have a cooler/storage unit? Yes No
   If yes, what is the capacity?

Table 1. Information on the irrigation

Did you have irrigation system in 2015?	
If yes, please specify the type of you irrigation system (drip, flood, sprinkler, etc)	
How many hectare centimeters did you apply in 2015?	
What is the power source of your irrigation pump (e.g., diesel, electricity)	
What is the depth to ground water at the well site in meters?	

8. What are the main labor operations used to produce raspberries?

___

Table 2. Information on labor force

Main activities	Working days per year		Wage rate per hour or monthly in €
	FM*	NFM*	
Planting			
Pruning			
Harvesting			
Post Harvesting			
Applying pesticide and fertilizer			

*FM-Family Members
*NFM- Non-Family Members
*Questions should be answered regarding year 2015

Table 3. List the machineries that you own and use for raspberry production

No.	Type of the machinery	Year of manufacture	Hours used for raspberry work
1.			
2.			
3.			
4.			
5.			
6.			
7.			

Table 4. Information on the farm

Did you use trellis system in 2015?	
What type of trellis system did you use?	
How many lines wired do you have per row? What gauge of wire do you use?	
How long are the rows (in meters)?	
What is the width between rows?	
How much is the space between each plant in a row?	

Table 5. Other Production materials

What do you use to package your raspberries at harvest	
Total number of packaging units used in 2015	
Did you conduct a water analysis in 2015? If so, what was the cost?	
How often do you conduct a water analysis?	
Did you conduct a soil analysis in 2015? If so, what was the cost?	
How often do you conduct a soil analysis?	
Do you follow global GAP?	
What additional costs do you have or your operation to comply with GAP (handwashing materials, etc)?	

Table 6. Production and prices

Production and Prices					
Year	Production (kg)	Prices received for fresh raspberries €/kg	Average annual price for fresh raspberries €/kg	Prices received for frozen raspberries €/kg	Average annual price for frozen raspberries €/kg
2015					

Table 7. Information on fertilizers, pesticides and herbicides

Fertilizer, Pesticides and Herbicides usage			
Type of raspberry	Type of fertilizer and the amount used per hectare	Type of pesticide and the amount used per hectare	Type of herbicide used and the amount used per hectare
1.			
2.			
3.			

Demographic Questions:

Your gender: Female Male

Your age:

18-25 26-35 36-45 46-65 65 and above

Your village: ________________

Your municipality: _______________

Appendix 2. IRB approval

UNIVERSITY OF ARKANSAS

Office of Research Compliance
Institutional Review Board

July 1, 2016

MEMORANDUM

TO:	Rina Vuciterna Jennie Popp Michael Thomsen
FROM:	Ro Windwalker IRB Coordinator
RE:	New Protocol Approval
IRB Protocol #:	16-06-811
Protocol Title:	*Cost Efficiencies in Raspberry Production in Kosovo*
Review Type:	☒ EXEMPT ☐ EXPEDITED ☐ FULL IRB
Approved Project Period:	Start Date: 07/01/2016 Expiration Date: 06/30/2017

Your protocol has been approved by the IRB. Protocols are approved for a maximum period of one year. If you wish to continue the project past the approved project period (see above), you must submit a request, using the form *Continuing Review for IRB Approved Projects*, prior to the expiration date. This form is available from the IRB Coordinator or on the Research Compliance website (https://vpred.uark.edu/units/rscp/index.php). As a courtesy, you will be sent a reminder two months in advance of that date. However, failure to receive a reminder does not negate your obligation to make the request in sufficient time for review and approval. Federal regulations prohibit retroactive approval of continuation. Failure to receive approval to continue the project prior to the expiration date will result in Termination of the protocol approval. The IRB Coordinator can give you guidance on submission times.

This protocol has been approved for 200 participants. If you wish to make *any* modifications in the approved protocol, including enrolling more than this number, you must seek approval *prior to* implementing those changes. All modifications should be requested in writing (email is acceptable) and must provide sufficient detail to assess the impact of the change.

If you have questions or need any assistance from the IRB, please contact me at 109 MLKG Building, 5-2208, or irb@uark.edu.

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