# EQUESTRIAN ACTIVITIES AND RISK ANALYSIS AT THE FARM LEVEL

Subtheme: Systems and Alternative Enterprises

Jaka Zgajnar

Univerza v Ljubljani Biotechnical faculty, Domzale, Slovenia

**Abstract:**

*This paper deals with equestrian-farm planning problem under stochastic conditions caused by price and cost risk. Exposition to risk and eventual efficiency on risk reduction in horse industry is studied on a hypothetical farm oriented in horseback riding, livery and breeding. We analyse how different set of those activities on a holding could influence risk management and especially where the main challenges are in production planning in the sense of optimal allocation of resources as well as which activities to select to (i) reduce risk or (ii) at given level of risk achieve better economic result. For this purpose module-tool has been developed based on linear and quadratic risk programming approaches. Linear program serves to prepare optimal production plan maximizing expected gross margin, assuming that farmer is risk averse, while the second approach is based on E-V efficient rule, minimizing total variance as a measure of risk. Results point on important set of activities in horseback riding schools that besides significant improvement of gross margins reduce total risk at farm level.*

***Key words:*** *riding school, livery, risk modelling, horse breeding*

## Introduction

In recent years, horse industry is growing, evolving, and therefore gaining on importance in many countries in the EU (Liljenstolpe, 2009). On many farms, horse-related activities are becoming main or an important side-line activity that brings new challenges also from managing perspective. As for example, which activities to focus on and consequentially also to include them in production plan to be most efficient in allocating available resources. Additionally, like for other sectors, also for horse industry holds that

it could be characterised by a strong exposure to risk. Significant part of it is due to production risk typical for all agriculture, however important part also due to price risk and changes on demand side for horse-related services. Due to different risk sources it is important to consider risk when preparing a farm production plan (Martins and Marques, 2007). On the other hand for farmers it is typical that they are risk averse, which causes the farmers are following the less risky activities and remove some profitable opportunities. This opens up a number of challenges, how to effectively organize those holdings, which activities to select to (i) reduce risk or (ii) at given level of risk achieve better economic result.

In respect of leisure activities with horses, horseback riding is the far most popular activity in northern Europe (Hess et al., 2014). Since more people are engaged in riding sport than own a horse, riding schools fill the gap by providing access to horses also for non-horse owners (Hess et al., 2014), either by renting a horse for riding or through various activities of riding schools. Besides many horse owners have a lack of time, knowledge and adequate infrastructure to take care for their horse. Livery is also an important opportunity for a number of such holdings. In practice, we can meet different types and standards of horse livery. More precisely they are presented by Estwood et al. (2008) and range from full livery up to “do it yourself” (DIY) livery. On holdings with horse livery structures different types are usually offered at different prices and the challenge is which type to focus on. It is not just the issue of different gross margins and break-even point, but also riskiness of each.

Between farms that deal with horse-related activities large diversity exist. Zasada et al. (2013), based on the cluster analysis of farms in Germany (peri-urban area around Berlin), defined four generic types of farms dealing with horses. With the largest share (34 %) are traditional farms, where horse-related activities are part of diversification measures. In that case farmholders see horsekeeping as an additional source of income. In many cases, this could be important strategy also to manage risk at the farm level. The second farm type is labelled as extensive horse-oriented farm. These are in majority run on part-time or hobby basis and are not traditional, but were established with a horsekeeping purposes. The third type are hobby farms (15 %), that have in common that they usually do not aim at income and additional employment but are rather leisure and self-fulfilment oriented. The forth type with 22 % share are intensive equine service farm type, particularly focused on horsekeeping activities. According to study from Zasada et

al. (2013), those farms are highly intensive in terms of employment and utilisation of resources and are among all other farms located within 10 km of city border. This goes in line with Hess et al. (2014), who stress that the classical riding school is usually located in peri-urban area to attract enough demand, mainly from urban people. It provides regular riding lessons, mainly to customers that enjoy riding, but do not have a horse. Therefore, riding schools usually owns different number of school horses. In that respect is the main challenge to sell enough riding lessons and other activities to cover costs of keeping and maintaining the required number of horses. Important challenge is also, what is the optimal balance between those activities, considering benefits, costs and riskiness.

To address this kind of problems from perspective of preparing efficient production plan, different approaches can be taken. One of them is mathematical programming framework. It captures both agriculture-production theory and modelling (Buysse et al., 2007). Mathematical programming based on modern portfolio theory is one of the most conventional means of analysing decisions making under risk in agricultural (Romero, 2000). Risk management can be addressed in different ways. Either at farm level or by sharing risk with others. In this paper we are concerned with a possible reduction at the holding level, particularly concerning those possibilities that decision maker has available in the field of planning a business. It is an issue of diversification of production plan.

To model this problem, the expected value and variance (E,V) model, based on the risk-balancing hypothesis proposed by Markowitz is going to be utilised. It uses the mathematical concept of variance to quantify risk. It is presumed that decision maker relies solely on mean and variance. In the literature different approaches that yield the same form of efficient set, based on E,V efficiency rule could be found (Romero, 2000; Hardaker et al., 2007 etc.). One of them is quadratic risk programming, minimizing the sum of total variance while certainty equivalent (e.g. gross margin) is parameterized over the feasible region.

The purpose of the given paper is to show on main challenges and possibilities that a riding schools offering also horse livery face by planning activities. With suggested approach, one could formulate the set of farm plans laying on the E-V efficient frontier and enables analysis of which activities to include to either, (i) reduce risk at certain

level of gross margin or, (ii) increase gross margin at certain level of risk. Contribution proceeds with the description of applied approach and developed model-tool for analysing the possibility of improving the economic situation of equestrian centres primarily engaged in equestrian activities. In the first part a mathematical model concept, with key activities and restrictions are presented. Further hypothetical holding is described and analysed. The contribution concludes with a summary of key findings.

## Material and methods

*Developed model tool*

Main objective of this study is to analyse risk reduction efficiency on a farm type specialised in equine services. It is a classical problem of optimal allocation of production resources considering also risk. For this purpose a spreadsheet model-tool has been developed. Microsoft Excel has been used as a basic platform, which enables relatively simple integration, complementarity and adjustment of the model-tool to any analysed horse oriented farm. Such models can be solved by mathematical programming concept with Excel Solver for solving linear and non-linear models (Powell in Baker, 2009). Optimisation is carried out on the basis of minimizing or maximizing the objective function. Developed model-tool consists of three sub-models.

The first sub-model is simple simulation model that calculates economic and technical parameters for different horseback riding, livery and breeding activities. It generates technological cards for each of activities and calculates revenues, variable costs and gross margins for different states of nature considering simple production functions. This is especially beneficial when we would like to analyse different farms with different technologies, since the model itself generates technical coefficients. Or in our study where the technologies were fixed and we have changed prices and costs, expected in different situations. These data are mainly obtained by Agricultural Institute of Slovenia (AIS, 2016) and national statistical data for the period 2007 till 2016 (SORS, 2016).

Second sub-model is based on optimization concept utilising linear programming (LP). The objective function with total gross margin at farm level is subject to maximization. It has to be noted that solution is obtained on the basis of expected gross margins, which means the most possible value (subjective probabilities) that farmer could expect considering last ten years price-costs shares. In our modelling concept, LP model is necessary to find the optimal solution yielding the highest expected gross margin within

the set of given (farming) constraints. The solution presents the starting point (value) for the parametric constraint in the third sub-model. Namely, third sub-model is based on quadratic risk programming (QRP) that considers also riskiness of activities. It enables calculating optimal solution at a given level of risk that in set of optimal solutions forms efficient production frontier. The basic idea to formulate the efficient E-V frontier is, therefore, to minimize the variance as the argument of objective function, reaching certain expected gross margin expressed as constraint in the model.

*Set of activities and constraints*

Model considers different equestrian related activities that could be practices on such a farm. They can be allocated into three basic groups: (i) livery activities, (ii) horseback riding activities and (iii) horse breeding activities. From viewpoint of livery supply, we considered part livery with full care excluding exercise of a horse and free-range breeding also with full care. Within activities of riding school, we considered only activities of lessons for adults and possibility of trekking riding. Significant part of activities presents also the third group of horse breeding activities. This group considers all categories of horses form broodmare and filly, up to breakdown four years old horse or home bred working five-year old horse. It is assumed that younger horses at any stage in between foal and four-year horse could be sold and broken horse could be also used as school horse.

We included also the set of constraints defining production resources of the farm. They best describe the characteristic of analysed farm type. In the first place there are infrastructure constraints (e.g. stable capacity - number of boxes for particular horse categories and livery type), labour constraints at the annual level, considering different profile (taking care for horses and trainers) categories and possibility to hire additional labour of both profile at peak times if needed. Further, we included also set of constraints ensuring adequate working burden per particular category of animal as well as needed hours for training and breaking at annual level. To ensure balance within different categories of horse breeding and horse keeping activities the model-toll includes additional set of constraints. Important part of constraints is also expected demand and market restrictions that define the level of demand for specific services and leisure activities at such a centre.

*Analysed case farm*

In this study we focus on an average intensive horse-keeping farm located in peri-urban area in central Slovenia. Latter influences prices of horse-related activities as well as demand for them. We suppose that it attracts enough demand, mainly from urban people. Therefore we will focus on analysing possibility of increasing economic efficiency considering mainly risk reduction possibilities through shifts in production plan at given level of demand.

We consider that this hypothetical farm provides different on-farm equine services such as riding school, livery and horse breeding. They have capacity for stabling of 35 horses, out of 5 are appropriate for free range breeding and the rest as part livery including full care, excluding exercise. We assumed that average price for part livery is 285 € per month and on average 180 € for free-range breeding. For both types of livery, it is assumed that there is sufficient demand.

For leisure horseback riding activities, we assumed (a) private lesson at average price of 45 € and expected annual demand of 600 lessons. Further we assumed that they offer also (b) group riding lesson with an average of three riders. Average price charged is presumed to be 25 € per an adult rider on a horse. Hypothetical assumption was that farm has demand up to 2,500 such lessons annually. As a third possible activity, we included (c) trek riding in the countryside that is also group activity and is price per rider on a horse 20 €. We supposed that they have demand for 650 such services annually. On average, this means that they have all together demand from average 10 customers per day.

To measure breeding potential on such a centre it is of course necessary to include also information regarding prices for purchasing or selling different categories of horses. We assumed average price for school horse that can be put to work and for home reared and trained horse for sell on average 6,000 €. Purchase price for broodmare or filly is on average 5,500 €. Average sell prices for foul, yearling, two/three-year horses are 25%, 37 %, 48 %, and 60 % of trained horse respectively. Even though in practice sell prices vary significantly we did not consider this aspect in our study.

We assumed that holding has available in total 3,600 labour hours to take care for horses, which includes needs for preparing voluminous forage as well as feeding, cleaning, bedding and putting horse in walking machine and on pasture. In the case of providing riding school enterprises there is available also 1,800 riding instructor working hours.

This profile of labour is needed for teaching of riders as well for horse training and breaking. In the case additional labour is needed holding could hire additional one, at average cost of 6.5 € for livery work and on average 8.45 € for qualified instructor.

Even though fixed costs could play important role in decision-making, we simplified this study and did not pay special attention to facilities. We presumed that farm has all needed facilities to perform all supposed activities. Even though on many holdings especially indoor and in some cases also outdoor riding arena could be bottleneck for offering both school enterprises and livery.

*Prices and trends*

Since we analyse hypothetical farm, we did not have accurate data for last ten years for that farm. Therefore, we used information from secondary data sources. For variable cost of hired labour, home produced fodder, purchased concentrated feed, bedding, different services (e.g. veterinary – medicine, farrier) and other costs (e.g. insurance, water) we considered data prepared by Agricultural institute of Slovenia for their analytical calculations (AIS, 2016). For other, like different type of livery, riding activities that are not included in AIS database, we consider that prices changed in last ten years with the trend observed by statistical office of the Republic of Slovenia (SORS, 2016) considering sport activities – fitness. We decided to take this trend according to Cordell (2003), who is stressing how indirect competitors could influencing setting prices for horse related leisure activities.

**Results with discussion**

In this section, we present main results for analysed hypothetical farm. We analysed two basic scenarios, regarding which activities could be selected and included in production plan. In the first scenario (A02) we assumed that farm is oriented only in livery and horse-breeding, while in the second scenario (B02) also riding school enterprises for adult riders could be selected.

In Table 1 we present main results and economic indicators for both scenarios, generated with the second (LP) sub-model. Further, we present results from the third sub-model (QRP), for both scenarios (A02 and B02). On Figure 1, we present efficient frontier in expected value variance space for both scenarios and on Figure 2, relative changes regarding risk reduction and consequential reduction of expected gross margin.

Table 1: Optimal solutions and economic indicators for maximized expected gross margin

| | Scenario | |
|---|---|---|
| | **A02** | **B02** |
| **Economic indicators at farm level (€)** | | |
| **Total revenue (R)** | 114,600 | 199,927 |
| **Total variable costs (VC)** | 62,881 | 85,335 |
| **SD of EGM (€)*** | 6,096 | 9,538 |
| **Total gross margin (GM)** | 51,719 | 114,592 |
| **Activities** | | |
| **Breeding (No.)**** | | |
| **Horse livery (No.)** | | |
| Partial livery | 30.0 | 24.7 |
| Free-range livery | 5.0 | 5.0 |
| **Working horse** | | |
| School horses (purchased) | 0.0 | 5.3 |
| School horses (breeding) | 0.0 | 0.0 |
| **School riding enterprises (h)** | | |
| Private lesson | 0.0 | 600.0 |
| Group lesson | 0.0 | 833.3 |
| Trekking riding - group lesson | 0.0 | 216.7 |
| **Annual effective labour input (h)** | | |
| Home - stable work | 3,800.0 | 3.800.0 |
| Home - riding instructor | 0.0 | 1,800.0 |
| Hired - stable work | 1,530.8 | 1,459.7 |
| Hired - riding instructor | 0.0 | 118.3 |
| **Post-optimal analyses** | | |
| **Reduce cost (€)** | | |
| Working horse - home breeding | -6,000 | -2,010 |
| Broodmare / Filly | -68 | -2,730 |
| **Shadow price (€)** | | |
| Demand for private lesson | 0.0 | 22.8 |
| Demand for group lesson | 0.0 | 12.4 |
| Demand for trekking riding | 0.0 | 4.6 |

*Legend: *Standard deviation of gross margin calculated with third sub-model (QRP), **Since no activity enters the optimal solution, we do not present them in the table, A02 – model can include breeding and livery activities, B02 – model can include school riding activities for adults;*

On such a holding with capacity for stabling of 35 horses, farm could reach 114,600 € of annual revenue considering conditions of scenario A02 (Table 1). Regarding available home labour capacity and possibilities of hiring additional labour (1,530.8 h) at average price 6.5 €, they could breed 30 horses in boxes with partial livery and 5 horses in free-range conditions. All those horses would be privately owned and at expected total

variable costs of 62,881 €, farm reaches 51,719 € of total expected gross margin annually.

If the riding centre has possibility, also to include riding school enterprises (B02) expected revenue increases for 74 %. As it is apparent form Table 1, there is a shift in number of private horse and school horses. Due to changed structure of horses and mainly in respect to additional labour costs for riding lessons, total expected variable costs increase for 36 %. These costs include also additional costs of farrier, veterinary – medicine and need for regular horse training of school horses. In respect to expected demand for riding lessons for adult riders, model includes 5.3 school horses in exchange for the same decrease in number of privately stabled horses. Possibility of horseback riding activities increase expected gross margin for 122 %. In latter case they need in total 1.918,3 hours of riding instructor, which means that they have to hire also additional 118,3 hours at average cost of 8,45 €. In other words, revenues made with 5.3 school horses would be enough to cover costs of annual permanent employment of riding instructor. In this estimation, we considered also basic risk that horse could be unavailable part of the time due to health problems. Namely, we considered that average school horse could work 900 h annually and broodmare 56 % less.

As apparent from Table 1, at given hypothetical holding horse-breeding activities are not interesting to include in optimal solution. Namely, opportunity cost is too high in both scenarios. In the first case (A02) reduce cost is relatively low, 68 €, however much higher (-2,730 €) is when there is also possibility of riding school activities (B02). This is besides price-cost ratio also due to considered demand of horseback riding and livery activities. From viewpoint of post-optimal analysis it also interesting which (purchased or own bred and broken) working horses have been selected in optimal solution. As apparent from Table 1 only purchased school horses (5.3) enter the optimal solution. Reduced cost shows that this solution is 2,010 € cheaper as homebred horse. This shows on high costs of horse-breeding in boxes on one site and limited infrastructure capacities and in given demand for other horse related activities on the other. However, if working cost for instructor would be considered as fixed cost, than we could expect shift especially in the first scenario.

Further, we analysed also the risk associated with given production plan. For this analysis, third sub-model has been applied based on QRP. As apparent from Table 1,

standard deviation (SD) in both cases is relatively low in comparison with the level of expected gross margin (EGM). Namely, economic conditions were relatively stable in observed period. In that manner is coefficient of variation (CV) in the first scenario 0.12, however with horseback riding activities it decreases for 3.46 %. Figure 1 presents efficient solutions form expected value and variance perspective and creating efficient frontier. Both right-up points present optimal LP solution maximizing EGM that is precisely presented in Table 1. These solutions present situations where farmer would be indifferent to risk, with the only objective to maximize EGM. Further in both cases EGM was further parameterized (-5 % in each step), searching for optimal solution by minimising SD. As apparent (Figure 1) riding school activities can significantly increase EGM at the same level of risk (expressed as SD). Which could be interpreted also as increased risk management efficiency. However, which solution is optimal from the set of solutions depends from decision maker's risk aversion coefficient that is beyond the scope of this paper.

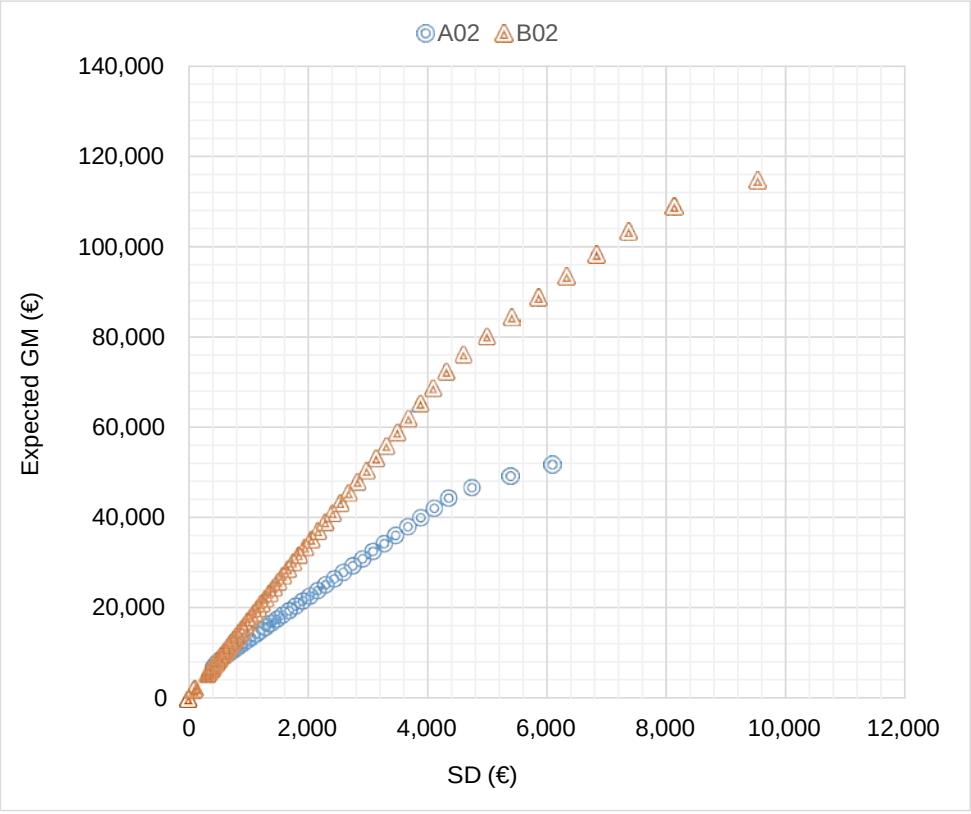


Figure 1: E-V efficient frontier for scenario A02 and scenario B02

How efficient a farm is in reducing risk or achieving at the same level of risk, higher expected gross margin, is presented on Figure 2. Here production plans are compared on

the basis of relative change of EGM and SD along within 0 and theoretical 95 % decrease of either of them. Steeper the curve is less efficient is farm in risk reduction and it is more costly. In other words, more gross margin one have to give up to reduce deviation for one unit. As apparent from Figure 2, by minor decrease of variability (less than 30 %), both scenarios (A02 and B02) are more or less comparable. In reduction of risk as SD between 30 % and 77 % is efficiency in favour of riding school activities (B02) and for larger decrease as 77 % livery activities are more efficient (A02).

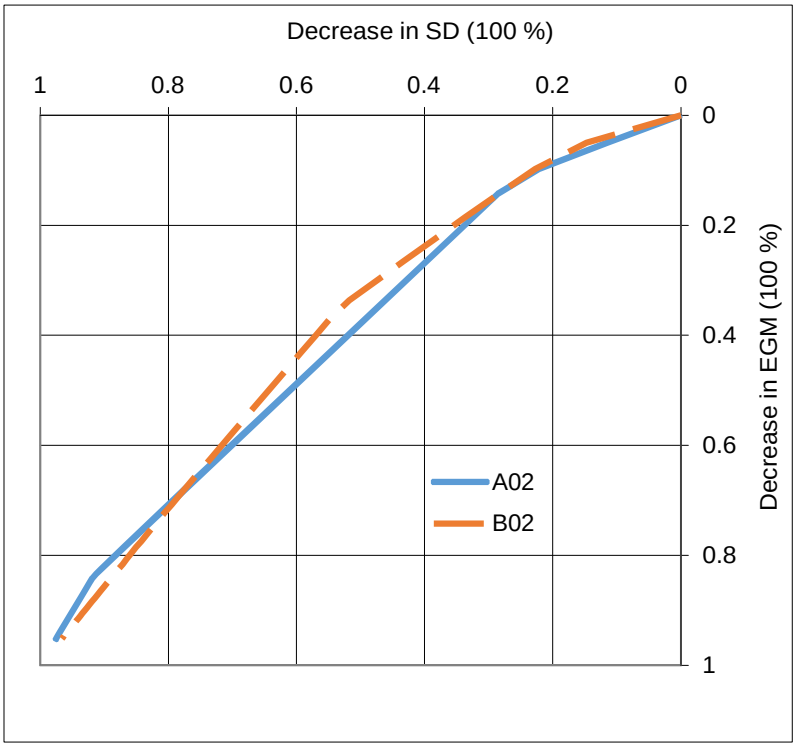


Figure 2: Diversification efficiency for scenario A02 and B02

## Conclusions

In the paper modul-tool to analyse risk performance of equestrian farm is presented. The efficiency of diversification strategies is measured as movement of risk reduction by whole farm planning, assuming that diversification is commonly accepted as a method of reducing risk (Backus et al., 1997). Based on the results of this research we can conclude that equine service farm type, particular focused on horse keeping and riding activities could be interesting alterative. Main conditions is of course sufficient demand for their activities in the nearby market. Model results show that in supposed conditions breeding horses is not interesting alternative, mainly due to relatively high opportunity costs. Of

course this would change at different conditions, regarding demand or considering employment of home labour.

If appropriate infrastructure is available results show that riding school activities could be good alternative to diversify production plan in the detriment of livery. On analysed hypothetical farm expected gross margin improves up to 122 % and at the same time risk efficiency increases. The results obtained show that better position in E-V space does not necessary mean better farm efficiency in the sense of diversification as the first move in risk reduction. However, by minor reduction of risk, bot group of activities are similarly costly.

**References**

AIS. 2016. Model calculations. Agricultural Institute of Slovenia http://www.kis.si/Modelne_kalkulacije_OEK

Backus, G.B.C., Eidman V.R. and A.A. Dijkhuizen, 1997. Farm decision making under risk and uncertainty. Netherlands Journal of Agricultural Science 45: 307-328

Buysse J., Huylenbroeck G.V., Lauwers L. 2007. Normative, positive and econometric mathematical programming as tools for incorporation of multifunctionality in agricultural policy modelling. Agriculture, Ecosystems & Environment, 120: 70-81.

Cordell L. 2003. Equinomics: The secret of making money with your hourse business. Esprit de Equestre Publishing: 124 p.

Estwood S., Jensen A-L. R., Jordon A. 2008. Business management for the Equine industry. 2nd edition. Estwood. Blackwell Publishing: 158 p.

Hardaker, J.B., Huirne, R.B.M., Anderson, J.R. and G. Lien. 2007. Coping with Risk in Agriculture. 2nd ed. Oxfordshire: CABI Publishing. 332 pp.

Hess S., Surry Y., Kron R., Liljenstolpe C., Lindberg G., Andersson H. 2014. A hedonic analysis of the price for horse riding lesson in Sweden. Journal of Outdoor Recreation and Tourism, 7–8: 65–74

Liljenstolpe C. 2009. Horses in Europe. Report. Swedish University of Agricultural Sciences: 26 p. http://www.wbfsh.org/files/EU%20Equus%202009.pdf

Martins, M.B. and C. Marques, 2007. Methodological aspects of a mathematical programming model to evaluate soil tillage technologies in a risky environment. European Journal of Operational Research. 177: 556-571

Powell S. G., Baker K. R. 2009. Management science: The art of modeling with spreadsheets. 3rd edition. Hoboken. John Wiley & Sons: 511 p.

Romero, C. 2000. Risk programming for agricultural resource allocation. Annals of Operations Research. 94: 57-68

SORS. 2016. SI-Stat Data Portal. Ljubljana, Statistical office RS http://pxweb.stat.si/pxweb/dialog/statfile1.asp

Zasada I., Berges R., Hilgendorf J., Piorr A. 2013. Horsekeeping and the peri-urban developement in the Berlin Metropolitan Region. Journal of Land Use Science, 8, 2: 199–214