Economics of Peppers and Salad Cucumbers Production on an Open Land and in a Protected Space

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Summary

The research is based on the economic analysis of growing peppers (*Capsicum annum* L.) and salad cucumbers (*Cucumis sativus* L.) in an open land and in a protected space. For this purpose the simulation models were developed for the growing of the peppers and salad cucumbers that were based on the technological-economic input data for two growing systems, in the open and in the protected space. The results of the economic analysis show that the growing of peppers and salad cucumbers in the protected space is more profitable than growing them in the open land. The growing of salad cucumbers in the protected space has proven to be more reasonable than growing peppers, as the coefficient of economics (C_e) of growing salad cucumbers reached the value $C_e = 1.4$, while the value in growing peppers was $C_e = 1.1$. This was also confirmed with two scenarios that were analysed using the sensitivity analysis.

Key words

economics, sweet pepper, cucumber, technological-economical simulation model

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The technological data was gathered on the basis of long year experiences of Robert Wernig, the manager of growing vegetables on his own agricultural estate and the president of the specialized vegetables agricultural cooperative Vrtovi panonski z.o.o in Prekmurje.

Introduction

Growing vegetables has become a market opportunity for numerous growers in Slovenia. Growing vegetables is a very prospective agricultural branch, for it enables making of a high yield even on smaller field surfaces that characteristic for our land are.

The main characteristic of vegetable growing is mainly the granularity and the unorganized ways of the growers, which puts them in the subordinate position compared to the sellers and growers of vegetables in other member states of the EU. A high percentage of individual sales of quantities uninteresting for the market in Slovenia have got a great influence on the competition among growers and thus they reduce the prices of their own products. In some periods we thus face a too big offer of certain vegetables, while there is a big lack of them in other periods of the year (Bavec, 2003). The consequence is a great rising and falling of selling prices throughout the year and a great import (151,000 tons of vegetables in the year 2008), since the domestic market has its needs for a certain amount of vegetables in different periods. Many vegetables are also being imported while the domestic growing is possible, which leads to competition between the imported goods and home-grown vegetables (SURS, 2009). The greatest factor for not deciding to grow vegetables at home is a lack, an inaccessibility of information about the economic parameters for growing of vegetables. The research provided by Jurišić et al. (2006) was based on economic results of growing cucumbers in the open in Croatia. A classic economic analysis was used in the research. Engindeniz and Guel (2009) researched the economic analysis of growing cucumbers that was based on growing cucumbers in a mixture of perlit and zeolit, and the growing of cucumbers in the ordinary soil. The purpose of the research was to determine the cost and the income and to set up an example of a budget for the growers. Lee et al. (2008) completed the economic analysis of the characteristics of peppers in the high temperatures period outside in regards to the altitude of growing. On the other side, there are some obstacles in the context of necessary information and its availability to provide the economic analysis for farm products. Many authors use simulation modelling as a tool in the process of decision making during the farm production to solve the above mentioned problem. In this way, Rozman et al. (2002) developed a computer based simulation model for calculating the cost for growing pumpkins at a conventional farm and a simulation model for producing pumpkin oil. Pažek et al. (2007) developed an integrated deterministic simulation model for judging the economic justification of growing and producing agricultural products in the area with limited factors for agricultural production. The developed tool thus represents a good basis for further development of more complex integral models that are mainly used in the process of planning and decision making (Pažek et al., 2008). Andrieu et al. (2007) developed a simulation model for evaluation of the consequences for yield in dairy farming systems when taking the land diversity at farm level into account in the decision-making process. Some authors combined economic simulation models with other developed models, i.e. bio-models. The aim of such integrated models is to find an optimal tool for decision support in real life situation (Mosnier et al., 2009).

To enable the producers of vegetables to make the easiest decision whether to grow peppers and cucumbers outside or in the closed space which ever is economically feasible, the integrated technological-economical simulation model was developed. The model, based on calculation of total costs, will help the decision makers (i. e. producers) to make the decision of economical feasible production, while at the same time it will enable the "what – if" analysis, too.

Methodology

For the economic analysis of growing peppers and cucumbers in the protected space and outside, the methods of simulation modelling and calculation of total cost were used. The technological-economical model of growing peppers and cucumbers in the protected space and outside was developed. Microsoft Office Excel 2007 was used for the analysis and the processing of data.

To make the calculations easier and to simplify the work and speed up the seeking of alternative resolutions, the use of a personal computer in developing and calculating the technological-economic simulation model was inevitable. The use of appropriate computer programs enables fast and easy calculating. Thus we can quickly and successfully determine different alternatives and choose the best among them. However, simulation modelling, which is a well-known and used method in business, is commonly used method for estimating cost of agricultural production (Rozman et al., 2002). Such a method is very suitable in determining of the economy of growing, since the use of technological mathematic formulas helps us to show the relationships between individual inputs and outputs and thus enables to adapt to the circumstances in real time (Pažek et al., 2007).

The development of presented simulation model based on input data that was gathered by enlisting the individual phases of the technological process of integrated growing of peppers and cucumbers in two different ways of production (in the protected space and outside) on the basis of long year experiences and expert studies and literature. The most important economic parameters for each growing site with different ways of production could be determined by the help of the developed simulation models.

First of all, all the necessary data, inputs and their cost and expenses that arise in the first year of growing were used. The size of the surface where the vegetables would be grown was determined, too (1 ha). Furthermore, the input data about spent quantities (variable costs) and their prices and expenses (i.e. number of plants, covering foil, irrigation system, hanging lines, packing, labels, human and machinery labour, soil analysis, etc.) were collected. The agro-technical needs, done by contractual work in the model (plugging, harrowing, liming, etc.), were considered. Irrigation costs are very important in the pepper and cucumber production (i.e. 1.37% – 1.61% by the vegetable production in protected space and 3.43% – 4.39% in the open land production system). Moreover, the fertilizing and the protection plan were developed and included in to the cost structure. Fertilizing and protection plan followed the directives of the Regulation (Ur. l. RS, No. 63/02 – integrated vegetable production). The natural enemies of the pests (predators), biological and environment friendly means are also included in the model (regarding Ur. l. RS, No. 63/02).

Secondly, the selling prices of pepper and cucumber are determined on the basis of momentary valid market prices in the specialized vegetables agricultural cooperative Vrtovi panonski z.o.o in Prekmurje. The data about other variable costs that would arise in the first year of growing (electricity, water for the irrigation, heating with biomass) were defined. Further costs of building (in the model expressed as amortization costs) followed (i.e. the construction of a greenhouse, the double foil for the greenhouse, the basic equipment in the greenhouse, the irrigation system, the cold store, the administration costs, the land). The non-refundable means (75% of the investment is co-financed by non-refundable means in a 40% part) were considered, too.

The amortization cost is different in different production systems of growing in the observed problem. The annual amortization with vegetable production of the construction of the greenhouse is 20 years, the double foil seven years, the basic equipment in the greenhouse 20 years, the irrigation system 15 years and the cold store (512 m^3) 20 years. The only considered amortization in the production system outside is that for the irrigation system (which is 15 years) and for the cold store 250 m^3 (which is 20 years).

In the end, it is necessary to enlist the labour costs (the laying of the foil, bonding of the robes, plantation, spring pruning, picking, loading and unloading, sorting, packing) that arise from the different ways of growing each vegetable. The income – subsidies – for each product the same amount (517 €), which is set by the catalogue of calculations for planning the business on farms in Slovenia (2010, http://www.kis.si/pls/kis/!kis.web?m=177&j=SI), was included.

For growing in the protected space the pepper 'Bianca F1' was chosen. It was grown in two tops with the estimated yield of 150 t/ha, whereas it would be fertilized from March to December.

The second analyzed vegetable hybrid was the cucumbers 'Darina F1'. The cucumbers would be grown in a single top with the estimated yield of 450 t/ha, that would be achieved in two periods. The first would be from February to June (estimated yield of 300 t/ha), and the second one from July to December (the estimated yield of 150 t/ha).

The same pepper (Bianca F1) was chosen for growing outside (there would be a yield of 40 t/ha). The growing would take place from May to September.

The same hybrid of cucumbers (Darina F1) will grow outside too, whereas the estimated amount of growing outside was 60 t/ha. The growing would take place from May to September.

The variable costs (the costs of material), labour costs (hired manual work), the costs of hired machine work, some other variable costs and the costs of building (expressed as amortization costs) are shown as the costs of production in the calculation system.

The complete calculation system is shown in Figure 1 that is the same for growing peppers and cucumbers in the protected space and outside. The difference can be seen at the beginning

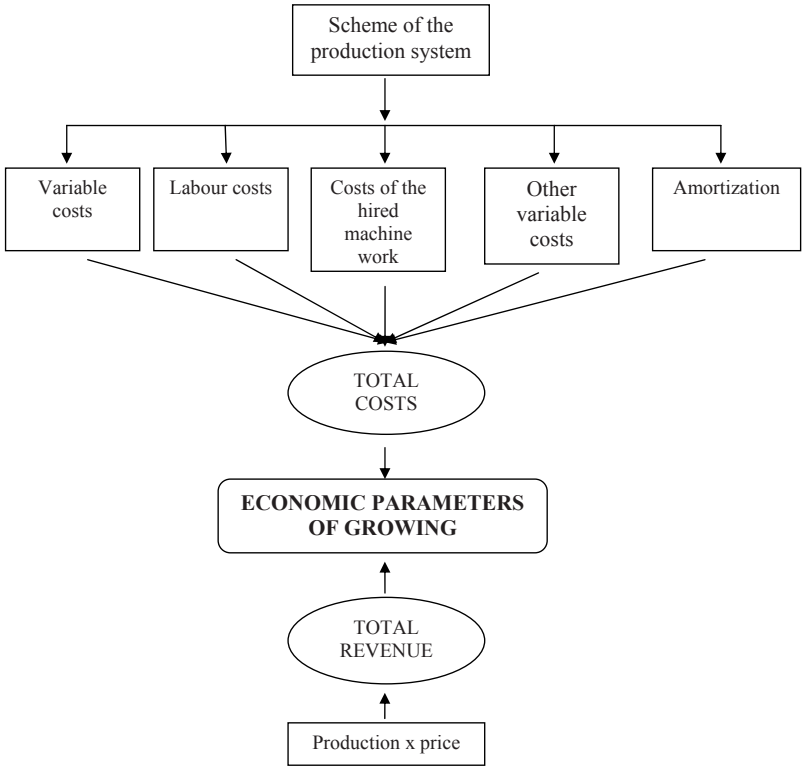

Figure 1. The structure of the developed simulation model

stage of growing in the protected space, where the set costs represent the cost of constructing the greenhouse, the cost of the double foil for the greenhouse and the cost of the basic equipment for the greenhouse, which is not present when growing outside. The system is connected with mathematical-functional relationships between the technological and economic variables (Figure 1).

There are some most important economical parameters calculated in the enterprise budget, i.e. break even point of production and coefficient of economics (Ce). Break even point is defined as production quantity and it is calculated as a ratio between total production costs and yield price and measured in monetary unit kilo. The coefficient of economics is defined as a ratio between total production revenue and total production costs. For the economical efficiency of production its calculated value should be >1.00.

The technologic-economic simulation model enables analysis of different production scenarios. Furthermore, two simulated additional scenarios are presented (S1 and S2).

1. There is some loss of the yield because of pests and diseases that can ruin the yield of the two chosen vegetables in the protected place. The suppression of the enlisted factors in time could cause the loss up to 20% of the totally produced yield (scenario 1 – S1). However, in the system where cucumbers and peppers grow outside 20% loss of yield could even be higher. If the pests and diseases are present, it could be up to 30–40%.

2. In the second scenario (S2), the loss of yield in the beginning phase of both production systems can occur. This loss can be up to 10–20% of the yield.

Results and discussion

Based on the developed specific models the computer program for calculation calculates the technological and economical parameters of the production. Moreover, four developed models for growing peppers and cucumbers in the protected space and outside thus gather the data and based on mathematic equations calculate specific economic parameters (income, financial result, break even price and break even point of production, the break even price with and without the subsidy, and the coefficient of economic) under different starting parameters (different inputs, prices, fertilizers, different yield, surface, % loss, etc.).

Under model assumption the selling price of the peppers grown in the protected space is 0.80 €/kg, while it is 0.70 €/kg for peppers grown outside. The selling price of cucumbers is different in the two periods. The selling price is 0.55 €/kg in the first period from February to June, while the selling price reaches 0.70 €/kg from July to December. The price in the second period is higher because the quantity on the market is much lower and thus the prices are higher. The selling price of cucumbers grown outside is 0.60 €/kg. All calculated economic parameters are presented in the Tables 1–5.

The total cost together with the non-refundable means for the growing peppers in the protected space was 109,109.30 €, whereas the total cost without the non-refundable means was higher, i.e. 115,023.56 €. The financial result together with the non-refundable means was 2.20 times lower amount then the amount with the non-refundable means. The coefficient of economic for the growing peppers in the protected space with and without non-refundable means shows the economic efficiency of peppers production. Other calculated parameters are presented in the Table 1.

The total cost of growing peppers outside in contrast to growing peppers in the protected space does not change much depending on using the non-refundable means, as seen in the Table 2. Other calculated parameters showed that the peppers production in the open land is also suitable from economical point of view and interesting for a farmer.

The analysis of production system of growing cucumbers in the protected space showed that the total costs in the second period were almost half of the amount, since the hanging ropes were still intact from the first period and thus the variable costs of purchasing the ropes and the costs of manual labour were not added here. Similarly, some fertilizers were not used in the second period and thus the variable costs were almost 50% lower than in the first period (from 45,097.00 € to 24,220.00 €). The income in the first period of growing cucumbers was 165,000.00 €, while it was 105,000.00 € in the second. The difference could be explained by the fact that in the first period the yield was bigger, namely 300 t, while there were only 150 t in the second period. The yield data was the data achieved in the practice. The financial result in the first period was 51,061.40 € together with the non-refundable means (which was the highest financial result from all the developed models), without the non-refundable means the financial result was 48,104.62 €. Other calculated parameters are presented in the Tables 3 and 4.

Table 1. Calculated parameters for growing peppers in the protected space (selling price 0.80 €/kg and the total yield 150 t/ha)

	With the non-refundable means	Without the non-refundable means
Total costs (€)	109,109.30	115,023.59
Total revenue (€)	120,000.00	120,000.00
Financial result (€)	10,890.70	4,976.00
Break even price of production (€/kg)	0.73	0.77
Break even point of production (kg)	136,387	143,779
Break even price with the subsidy (€/kg)	0.72	0.76
Break even price without the subsidy (€/kg)	0.73	0.77
Coefficient of economics (Ce)	1.10	1.04

Table 2. Calculated parameters for growing peppers outside (selling price 0.70 €/kg and the total yield 40 t/ha)

	With the non-refundable means	Without the non-refundable means
Total costs (€)	27,320.10	27,755.10
Total revenue (€)	28,517.00	28,517.00
Financial result (€)	1,196.90	761.90
Break even price of production (€/kg)	0.68	0.69
Break even point of production (kg)	39,029	39,650
Break even price with the subsidy (€/kg)	0.67	0.68
Break even price without the subsidy (€/kg)	0.70	0.71
Coefficient of economic (Ce)	1.04	1.03

Table 3. Calculated parameters for growing cucumbers in the protected space for the first period (selling price 0.55 €/kg and the total yield 300 t/h)a

	With the non-refundable means	Without the non-refundable means
Total costs (€)	113,938.60	116,895.74
Total revenue (€)	165,000.00	165,000.00
Financial result (€)	51,061.40	48,104.26
Break even price of production (€/kg)	0.38	0.39
Break even point of production (kg)	207,161	212,538
Break even price with the subsidy (€/kg)	0.38	0.52
Break even price without the subsidy (€/kg)	0.38	0.52
Coefficient of economic (Ce)	1.45	1.41

The total costs with non-refundable means were a bit higher in the production system when growing cucumbers outside than when growing peppers outside (Table 5). There is a request to use more fertilizers in this production system that costs consequently higher variable production costs. The specifics in this production system is the expensive fertilizer Calciogreen that is needed for fertilizing of cucumbers outside (i.e. for the production of pepper outside Calciogreen is not necessary).

The financial result was very similar to the one of growing peppers outside, namely 1,568.90 € with the non-refundable means and 1,133.90 € without the non-refundable means. All the cal-

Table 4. Calculated parameters for growing cucumbers in the protected space for the second period (selling price 0.70 €/kg and the total yield 150 t/ha)

	With the non-refundable means	Without the non-refundable means
Total costs (€)	74,787.08	77,744.22
Total revenue (€)	105,000.00	105,000.00
Financial result (€)	30,212.92	27,255.78
Break even price of production (€/kg)	0.50	0.52
Break even point of production (kg)	106,839	111,063
Break even price with the subsidy (€/kg)	0.50	0.52
Break even price without the subsidy (€/kg)	0.50	0.52
Coefficient of economic (Ce)	1.40	1.35

Table 5. Calculated parameters for growing cucumbers outside (selling price 0.60 €/kg and the total yield 60 t/ha)

	With the non-refundable means	Without the non-refundable means
Total costs (€)	34,948.10	35,383.10
Total revenue (€)	36,517.00	36,517.00
Financial result (€)	1,568.90	1,133.90
Break even price of production (€/kg)	0.58	0.59
Break even pointof production (kg)	58,247	58,972
Break even price with the subsidy (€/kg)	0.57	0.58
Break even price without the subsidy (€/kg)	0.59	0.60
Coefficient of economic (Ce)	1.04	1.03

culated parameters show that the cucumbers production in the open land is suitable from the economic point of view (Table 5).

The simulation results of the sensitiveness analyses for the first and the second scenario are further presented in the paper only for the coefficient of economics. The economic analysis is provided on the basis of simulation results, presented in the Tables 6 and 7.

Under presumption of the same selling price of peppers grown in the protected space and outside (0.80 €/kg) with and without the non-refundable means production will be economic unfeasible (Ce<0). The coefficient of economics would be feasible in the first period of growing cucumbers with the same selling price (0.55 €/kg). The analysis shows, that the same could be quoted for the second period of growing cucumbers. On the other hand, in the production system where growing peppers outside (under assumption that selling price is 0.60 €/kg), the value of coefficient of economics would be under 1.00. It should be stressed here, that the yield loss in the production system outside could be very high, depending on environmental condition. The yield loss of 35% was expected in the presented case. It is obvious that the yield quantity and its prices (under assumption of effective product marketing) determined the economic feasibility of production.

The similar economic situation could be seen in S2 as well. 15% of yield loss is expected in all production systems in the scenario 2. In the starting phase of vegetable production, the farmer comes across different unfavourable production circumstances (i.e. knowledge deficiency and experiences, technical problems,

Table 6. The sensitiveness analysis results for the first scenario (S1)

	Total yield before the scenario (t/ha)	Total yield after the scenario(t/ha)	Ce (with the non-refundable means)	Ce (without the non-refundable means)
Peppers in the protected space	150	120	0.88	0.83
Peppers outside	40	26	0.69	0.67
Cucumbers in the protected space (I. period)	300	240	1.16	1.13
Cucumbers in the protected space (II. period)	150	120	1.12	1.08
Cucumbers outside	60	39	0.68	0.68

Table 7. The sensitiveness analysis results for the second scenario (S2)

	Total yield before the scenario (t/ha)	Total yield after the scenario (t/ha)	Ce (with the non-refundable means)	Ce (without the non-refundable means)
Peppers in the protected space	150	127.5	0.93	0.89
Peppers outside	40	34	0.89	0.88
Cucumbers in the protected space (I. period)	300	225	1.23	1.20
Cucumbers in the protected space (II. period)	150	127.5	1.19	1.15
Cucumbers outside	60	51	0.89	0.88

etc.). Consecutively, the economic situation depends on extension of unfavourable production circumstances or yield loss. However, as seen in the both scenarios, the only economically feasible would be the growing of cucumbers in the first and the second period, because the coefficient of economics of all the others would be under value 1.0 as mentioned previously.

Conclusions

With the development of technological-economic simulation models for growing peppers and cucumbers outside and in the protected space the important economic parameters were calculated. Analysis shows that growing peppers and cucumbers in the protected space gives more income than growing outside. Based on the comparison of growing peppers and cucumbers in the protected space we can see that growing cucumbers is more profitable. At this point the role of the subsidies that are in production system should stress its necessity and improve the economic efficiency. The presented simulation models enable a precise estimation of economic parameters. The presented approach has fulfilled most of our expectations. The approach also provides some useful features, such as "what-if" analysis, which contributes to the comprehensibility and justification of the assessment and decision process, and may also give specific advice to farmers how to improve the economic position of their farms.

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