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SCIENTIFIC PAPER

ECOLOGICAL ASPECTS OF INCREASING INTENSITY IN PEPPER FORCING WITH PRIME ATTENTION TO THE TYPE OF THE GROWING EQUIPMENT

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Abstract: *Significant amount of profit can be generated in forcing technologies by the efficient use of different elements in growing technologies, however, improving production intensity is on the agenda in the sector. Pepper forcing, as the most significant class of vegetable forcing, practically takes place under all the growing equipment widespread in our country, but there is a considerable difference in context of profitability and efficiency. This paper wonders whether the most intensive technology in pepper forcing is efficient regarding the use of forcing equipment, namely modern greenhouses, or growing under greenhouses with significantly lower investment cost is more efficient.*
The analysis represents cost-income factors and efficiency assessed on a long-term basis of different technologies via a deterministic model based on producers' data collections.
As a result of the research, economic indicators are calculated based on exact results which will help to conduct a comparative assessment of economic features in technological varieties.

Keywords: *pepper, forcing, forcing equipment, economic analysis (JEL code: Q12)*

INTRODUCTION

Horticulture is the third most important sector in the Hungarian agriculture, in addition, it ranks the first place by its export performance over a period of years [CZERVÁN, 2014]. Hungarian Central Statistical Office data confirm that vegetable growing (130-140 billion HUF/year) is considered as the most significant subsector in horticulture on the basis of its production value. During production in the vegetable sector, Hungary has comparative advantages due to its favourable agro-ecological conditions and economic-geographical location [LAKNER et al., 1997]. Timing and predictibality of growing and uniformity of products have become basic requirements under today's trade conditions. However, producers who apply traditional, free range growing technology are unable to meet these challenges and they lose competitiveness. Thus, the importance of intensive technological items in vegetable growing is taking wider dimension under current economic, trade and climatic conditions and this tendency is predicted to rise [SKENDER et al., 2011]. In an attempt to boost intensity in vegetable forcing, growing under soilless culture has greater presence. The main feature of soilless forcing is that organic or inorganic, artificial materials are used for nutrition supply and fixing instead of soil [OMBODI, 2008]. According to HOWARD [2013] possible shortcomings of the soil may be eliminated and infectious diseases from soil may be avoided by applying growing mediums. Due to this effect, good nutrition management and plant variations, inter alia, 4-10 times higher yield may be gained by growing mediums compared to soil cultures. However, the author highlights the greatest disadvantage: applying growing mediums requires higher initial capital compared to soil cultures. LIETH et al. [2008] demonstrates in his analysis that, in case of soilless and soil culture as well, irrigation systems contain units suitable for spreading water soluble fertilizer, so irrigation and the spread of nutrition can be done simultaneously. Irrigation water is one of the most vital sources for plants that can be spread precisely under growing medium.

Besides free range vegetable growing, Hungary boasts traditional vegetable forcing culture, but forcing has been characterised by continuous and drastic decrease in its territory since the change of the Hungarian regime. 'Magyar Zöldség-Gyümölcs Szakmaközi Szervezet és Terméktanács' (*Hungarian Fruit and Vegetable Interbranch Organisation*) considers that the area under forcing has decreased from 6 300 hectares to 3 700 hectares (2 600 hectares under shelter), by half in terms of scale, in the last 25 years. Decrease in yield was only 15-20 % from 450 000 tones, a yield of 380 000 tones has been gained in the last few years [FRUITVEB, 2013]. Yield decreased on a smaller scale than the area of arable lands due to the continuous improvement in the production technology. According to BALÁZS [2000] forcing is economical in Hungary as well as abroad despite of the high establishment and operation costs of vegetable forcing equipment. Furthermore, vegetable and ornamental plant forcing is the most profitable activity these days among horticultural sectors.

Growing equipment can be divided into 3 groups. The following list represents development stages at the same time: hotbed, greenhouse and equipment covered by plastic film. The latter two can be applied for soilless growing, as appropriate [GYÚRÓS, 2008]. Greenhouses in Hungary have been built since 1955. They have dual purposes: seedling and forcing. The best known type is the co-called „gyulai blokk", which is a greenhouse with large airspace (the width of span is 3.2 m or its multiple). The main types are listed as follows: Venlo, Prins, Bolgár, Forsche, EG-2. It is responsible for forcing and seedling production in the foil sites where large airspace could provide perfect growing conditions, but due to the high establishment cost, they were scaled back after the presence of plastic tunnel. [TAKÁCSNÉ, 2013a]

From the second half of the 1950's, there was a chance to build equipment totally or partly made from plastic in vegetable forcing due to the rapid development of the plastic industry. Structures equally suitable for growing and forcing seedling can be characterised by lower establishment and operation cost, simpler and faster feasibility in comparison with hot beds and greenhouses. [GLITS et al., 2005]. Plastic tunnels and blocks with large airspace were built from the middle of the 1990's. Technological developments (hydroponics) resulted in the dynamic increase in yield especially for plants with warm tempereature requirements [LEDÓ, 2005].

Forcing technologies applied in Hungary (under greenhouse, plastic tunnel and plastic greenhouse) are in continuous development. Due to the technological developments, cutting-edge plastic covered equipment has almost, but not quite the same features as greenhouses regarding the most parameters (airspace, light transmittance). Pepper is the most significant product in vegetable forcing. 2 250 hectares are utilized by pepper forcing in Hungary, in addition, the annual export of the class is paramount [TAKÁCSNÉ, 2013b]. The size of area in Hungary under pepper forcing is remarkable at European level, as well. According to VAN SICKLE et al. [2005] only 1 200 hectares are utilized in the Netherlands, which is a superpower in vegetable forcing, while 10 000 hectares are under pepper forcing in another vegetable forcing leader, in Spain. Among the protectively grown vegetables, it is the pepper, which requires the careful selection of growing equipment because glasshouse and foil covered equipment are equally suitable for growing in horticultural aspects, unlike tomato.

THE AIMS OF THE RESEARCH

The main goal of this research is to determine whether greenhouses with quite high investment cost or plastic tunnels with relatively lower cost price is more economical in pepper forcing. According to APÁTI [2012] the term 'economical' is a very relative expression and should not be identical with 'profit' and 'profitability'. An activity is economical if it provides profit in line with the producer's expectations. The expected profit should be enough for developments, investments, sufficient reserve and ensuring the livelihoods of families in case of family businesses. The yield of current bank deposits, as a risk-free alternative investment, is considered as a minimum besides relative assessment.

The following questions should be answered as specific goals in line with the main goal:

1. What differences are there in natural expenses, annual growing and investment costs due to growing technologies in forcing equipment?
2. What is the difference between input parameters (yield, product quality, sales price, production value) as a consequence of growing equipment and growing technology?
3. How do the results of technologies, production efficiency, short and long-term profitability develop on the basis of production cost and revenue?

MATERIAL AND METHOD

This research is an economic analysis via a deterministic simulation model primarily based on primer farm data collection. It compares 'good quality' pepper forcing under greenhouse and plastic tunnel. It isn't easy to define 'good quality' because it can't be described by exact data. The growing models don't represent the average national ones, they are in the upper third part based upon yield, good product quality, and high level of expenses, great knowledge and technological discipline.

Natural expenses of total growing technologies are the base of the analysis. Each workflow involves its own labour stages and each expense of raw materials, manual and non-manual labour is taken into account. In order to analyse revenue, yields are divided and processed by months concerning size and quality. Producers' data collection for all technologies required to determine expenses and yields was completed by producers' data acquisition boards. Site visit and professional consultancy in Szentes area were the base of the data collection. It is the place in Hungary where pepper forcing is the most significant. Input data used in calculation model refer to growing farms in line with the represented technological standards, therefore, results are not amenable to draw national conclusions. Data collection was performed in large scale plants of the national average. The size of growing systems under plastic tunnel exceeds 5 000 m^2, while it is 1 hectare under greenhouse. Data collection covered 10 growing farms (8 farms under plastic tunnel, 2 under greenhouse technology) selected by high technological standards.

The prices of input materials were calculated on the basis of a price list of a retail farmers' store with significant role in the area. The total cost of manual labour of 700 HUF/hour – representing the manual cost of farms under the research - is included in the calculation models. Substantial part of the work is done by permanent labour, but temporary workers are needed at peak seasons. A wage cost of 700 HUF/hour is an average wage for permanent and temporary workers.

Monthly price data of one of the most prominent integrator organisation were the base of sales prices. In an attempt to avoid incorrect conclusions arising from annual fluctuation in producer prices, average producer prices of four years are used in the analysis. It was conducted at farm level; models don't cover overhead costs. In addition, margin requirement among income categories is the base of conclusions.

Input prices (materials, manual and non-manual labour) and the cost of production in the cost-benefit analysis reflects price levels for 2015. The price of materials is net of VAT while manual labour costs are calculated with contribution. Calculations refer to the complete scale of the business, but in order to compare technologies and bibliographic data, values at 1 m^2 were also calculated.

In addition to classic cost-benefit analyses, investment-efficiency analyses were carried out to determine long-term efficiency, in which results are assessed by dynamic indicators primarily on the basis of researches of other authors [GRAHAM-HARVEY, 2001; WARREN, 1982; ILLÉS, 2002]. The following indicators were used in the research:

- IRR (Internal Rate of Return) shows is the "annualized effective compounded return rate" or rate of return that makes the net present value of all cash flows from a particular investment equal to zero. It can also be defined as the discount rate at which the present value of all future cash flow is equal to the initial investment or, in other words, the rate at which an investment breaks even. Equivalently, the IRR of an investment is the discount rate at which the net present value of costs of the investment equals the net present value of the benefits of the investment.
- NPV is the acronym for Net Present Value. It is a calculation that compares the amount invested today to the present value of the future cash receipts from the investment. In other words, the amount invested is compared to the future cash amounts after they are discounted by a specified rate of return.
- DPP (Discounted Payback Period) is used to evaluate the time period needed for a project to bring in enough profits to recoup the initial investment. It reveals the time when revenue generated by forcing covers the potential rate of committed capital and the expenses related to investment and operation.
- PI (Profitability Index) is calculated as the ratio of the present value of the future cash flows and the initial investment in the project.

The yield of alternative investments (discount rate) and the income of nearly risk-free government securities in the analysis are investments with long-term maturity of 10-15 years, similar to the useful economic life of the production equipment. The rate of alternative investments and risk-free government securities was around 5.5 % in the last 7 years on the basis of data from Magyar Nemzeti Bank (Hungarian National Bank). Accordingly, a discount rate of 5.5 % was used in the model to measure dynamic investment-efficiency figures. The models don't recognise the residual value of growing equipment because obsolete systems are non-marketable. Therefore, it is inappropriate to use realisable residual value. In this context, useful life means that both technologies become obsolete in 15 years to the extent that it requires modernization as an investment, so it is considered as its useful life. Inflation is recognised in calculations neither at the input nor at the output market. The default assumption is that the income position of the production doesn't change substantially besides the change in output and input price level. Depreciation cost shall not be included, expenses and the impact of tax shield are not considered.

Cost-benefit and investment-efficiency analyses are accompanied by sensitivity analyses (SZŰCS [2004]). Its aim is to measure the impacts of various (as an ordinary in the average model, differ from a normal year) economic and natural environmental conditions on the results of farming so that efficiency of growing can be assessed under non-normal conditions, as well. Elasticity and critival-value approach were applied in the research. By elasticity test, factors affecting profitability are quantifiable while critical value approach shows what value means the turn point in profitability for the most significant factors affecting. As a result of the elasticity test, it is definable and comparable what changes the technologies studied can manage pertaining to factors affecting and it is identifiable which technology is more stable economically.

The tests were carried out by deterministic simulation model likewise the works of SZŐLLŐSI [2008] and APÁTI [2009]. Their input data are economic parameters appropriate to technological data. The model is capable for carrying out complex cost-benefit analysis, investment-efficiency and sensitivity analysis of growing equipment in which the impacts of changes in input, output prices, yields, investment and operation costs on results and efficiency can be measured.

RESULTS

This analysis is an economic comparison of pepper forcing equipment under plastic tunnel with intensive techology and greenhouse (both technologies are featured by relatively high level of expenses and high specific yield). The common feature of each growing equipment showed includes the use of growing mediums, automated irrigation and climate regulation. Both technologies are heated with thermal energy. Primer thermal water is used to keep the greenhouse warm while plastic tunnels are heated with thermal water deriving from greenhouse cooled down at 40 ^{0}C. The plastic tunnel studied has relatively huge airspace, plantation starts in January and production period takes place by December. The greenhouse technology studied covers production by Venlo and modern Dutch techologies where plantation starts in October and production is finished by July.

Table 1. Costs in labour stages in pepper forcing
Unit of measure: HUF/m2

Labour stages	Plastic tunnel	Greenhouse
The preparation of growing equipment	349	332
Planting	787	379
Irrigation	61	-
Nutrition management	490	351
Plant protection	252	328
Green works	401	338
Harvesting	455	681
Other works and costs	521	693
Site costs	723	913
Depreciation of growing equipment	867	1 533
Total indirect cost	4 906	5 548

Source: own edition (2016)

Based upon the data in *Table 1.* there are signicant differences regarding costs at the labour stages of both technologies. The cost driver is planting under plastic tunnel forcing. The second major cost refers to site costs including thermal water for heating and other works (waste removal, property protection) which are used as services of other companies. Site cost is a paramount item among the costs of labour stages under greenhouse production, which also includes thermal water for heating and irrigation and maintenance performed by other companies. Overall, the driver cost for both technologies is the annual depreciation of the growing equipment and its technological items, however, depreciation is not considered as a labour stage. As can be seen in *Table 1.* depreciation cost of greenhouse per m^2 exceeds 1 500 HUF (due to 200 % higher investment cost) which is 80 % higher than the depreciation cost of the plastic tunnel. The investment cost of the greenhouse is 23 000 HUF/m^2 while it is 13 000 HUF/m^2 for the plastic tunnel with huge airspace.

Table 2. The expenses of growing by nature

Expenses by nature	Plastic tunnel		Greenhouse	
	Cost (HUF/ m2)	Proportion (%)	Cost (HUF/ m2)	Proportion (%)
Cost of raw materials	2 126	43.3	1 541	27.8
Payments to the staff	1 308	26.7	1 885	34.0
Machinery and building cost	308	6.3	496	8.9
Othe indirect cost	298	6.2	93	1.7
Depreciation of growing equipment	867	17.7	1 533	27.6
Total	4 906	100.0	5 547	100,0

Source: own edition (2016)
Comment: Differences may occur in the table due to rounding

On the basis of data in *Table 2.* it can be concluded that pertaining to the technologies studied there are significant gaps between the expenses by nature. More than 40 % of the total cost (4 900 HUF/m^2) under plastic tunnel is cost of raw materials while under greenhouse payments to the staff (resulting from technological features) are predominant because this type of expense accounts for more than one-third of the total production cost (nearly 5 550 HUF/m^2). It should be also noted that cost of raw materials and payments to the staff represent high share of the total cost. Irrespectively of technology, these 2 types of expenses account for 60-70 % of the total production cost.

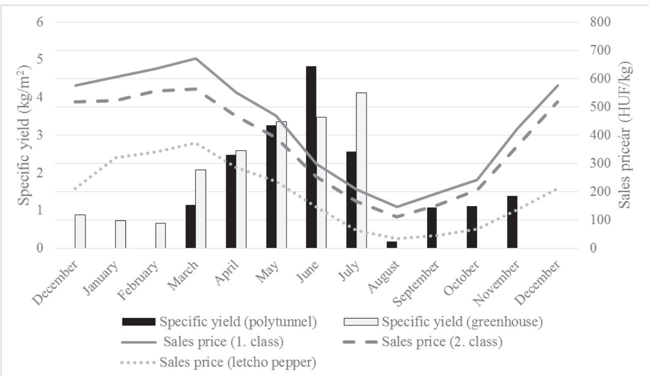
Table 3. Results and efficiency in pepper forcing

Name		Unit	Value/m2	
			Plastic tunnel	Greenhouse
Yield	- 5/8-7/12	kg	10.1	10.9
	- 4/7	kg	6.5	5.7
	- letcho pepper	kg	1.5	1.3
TOTAL YIELD		kg	18.1	17.9
Revenue	- 5/8-7/12	HUF	4 170.1	5 198.2
	- 4/7	HUF	1 740.2	1 684.4
	- letcho pepper	HUF	217.3	210.5
TOTAL REVENUE		HUF	6 127.6	7 093.1
PRODUCTION VALUE		HUF	6 127.6	7 093.1
Total indirect cost		HUF	4 906.2	5 547.0
Total operation cost		HUF	4 039.5	4 013.8
MARGIN REQUIREMENT		HUF	1 221.4	1 546.0
CASH FLOW		HUF	2 088.0	3 079.4
Direct prime cost		HUF/kg	271.4	310.0
Direct cost-profitability ratio		%	24.9	27.9
Fixed asset-profitability ratio		%	9.4	6.7

Source: own edition (2016)
Comment: Differences may occur in the table due to rounding

By studying the results of growing technologies (*Table 3.)*, it should be concluded that there is minimum difference between technologies regarding yield as the most important indicator in growing efficiency (specific yields in the analysis are in line with the results published by TOMPOS [2006]). In addition, it is also noted that higher investment and growing costs in forcing under greenhouse are in relation to 0.2 kg lower yield per $m^{2.}$ Despite, yield under greenhouse generates higher revenue (and production value) than in plastic tunnel. The common features of forced vegetables are that their sales prices are the highest when price pressure of rival products under freerange production is not prevailed. It is clear from the table that there is great difference, in yield over time, between technologies. Most of the yield under greenhouse growing is generated (during winter period when products from freerange production are not available on the market) when sales price (irrespectively of quality category) is relatively high. On the contrary, there is no yield at all under plastic tunnel technology from December to February. Moreover, a substantial part of growing quantity is generated during summer (June, July) when sales price is the lowest in years. Unlike yield, revenue takes a more positive direction (difference is more that 1 000 HUF/m^2 under greenhouse production).

Figure 1: Trends in specific yield and sales prices



Source: own edition based on DélKerTész data

Regarding greenhouse growing, 1 000 HUF higher production value is gained per m^2 by higher indirect cost under the same yields *(Table 3.)*. Therefore, margin requirement of greenhouse forcing is 300 HUF higher per m^2 than in forcing under plastic tunnel. Under forcing in plastic tunnel, nearly the same amount of specific yield can be gained by lower investment and growing cost in comparison with forcing under greenhouse, but due to produce over time, revenue, margin requirements and production value are more favourable under greenhouse technology. Forcing in plastic tunnel performs better in indirect cost price (lower by 39 HUF) and invested return on assets (more than 2.5 % higher). Sectoral revenue of 1 546 HUF is realized under greenhouse forcing.

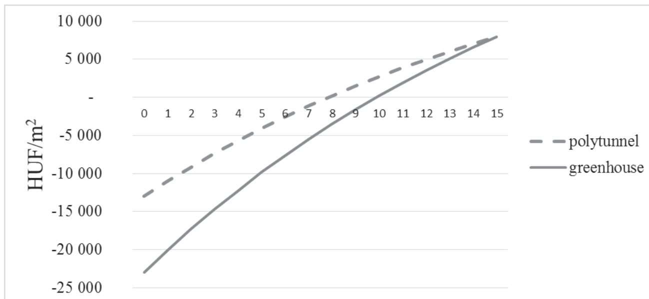
Table 4: An Investment-efficiency results of pepper forcing technologies at the end of its useful life of 15 years

Indicator	Unit	Plastic tunnel	Greenhouse
Net Present Value	HUF/ m2	7 959	7 909
Discounted Payback Period	year	8.	10.
Profitability Index	-	1.61	1.34
Internal Rate of Return	%	13.7	10.3

Source: own edition

The investment cost of the growing equipment and their technological items in the analysis differ significantly. The cost price of plastic tunnel heated is 13 000 HUF/m^2 while the investment cost of greenhouse is 23 000 HUF/ m^2. Net value shows (*Table 4.)* that how much extra profit are generated by each investment within the useful life of 15 years in addition to the calculative rate of 5.5 %. It is evident that both technologies are capable of generating the same amount of revenue on a long-basis, Net Present Value is higher merely by 50 HUF per m^2 under plastic tunnel. Positive Net Present Value indicates that both investments recover within the useful life of 15 years. Discounted Payback Period shows that investment cost of plastic tunnel forcing recovers in the 8th while it recovers in the 10th year under greenhouse (*Table 4, Figure 2.*)

Figure 2: NPV in both production equipment



Source: own edition

Internal rate of return shows the return on equity of investments (*Table 4.)*. Data demonstrate that IRR is higher than 10 % for both investments indicating that they are capable of generating much more profit under current economic environment than risk-free bank investments.

On the basis of results of investment-efficiency analysis, there isn't significant difference between pepper forcing under greenhouse and heated plastic tunnel in context of NPV, but forcing under plastic tunnel is better as regards indicators with the exception of NPV due to its lower investment cost.

Table 5. Results of elasticity test

Growing equipment	Greenhouse		Plastic tunnel	
NPV (HUF/m2)	7 909		7 959	
Factors affecting	NPV (HUF/ m2)	Elasticity (%)	NPV (HUF/m2)	Elasticity (%)
Yield	8 621	9.0%	8 574	7.7%
Average sales price	8 621	9.0%	8 574	7.7%
Quality	7 932	0.3%	7 982	0.3%
Investment cost	8 139	2.9%	8 089	1.6%
Unit cost of nutritients	7 942	0.4%	8 001	0.5%
Unit cost of plant protection substances	7 933	0.3%	7 977	0.2%
Wage	7 968	0.7%	8 083	1.6%

Source: own edition

Table 5. represents the elasticity results of production equipment. Calculated values show how a 1 % improvement in indicators affects NPV (as a value and percentage). Based upon the results, yield and sales price are the most affecting factor on efficiency in both technologies (the values of these indicators are equal because yield and sales price have the same effect on production value). Modelling change in average sales price was carried out by varying monthly sales prices

in each quality group. Quality is worth mentioning besides yield and sales price among output parameters. To stimulate improvement in quality, I cut the quantity of letcho pepper by 1 % and I distributed this 'available' yield in the first and second class in line with the relation between the quality classes. By the technique above, change in quality along with growth in yield may be eliminated which would imply wrong conclusions. A 1 % improvement in quality leads to a 0.3 % change in NPV, regardless of technology, so quality of produce cannot be classified in the most affecting indicators in terms of improvement in efficiency. It should be noted that it is relevant to those pepper forcing businesses where technological standard is outstanding because the rate of lecsópaprika exceeds 10 % only in the hottest months, when produce size is hard to be improved due to weather conditions. This rate is 2-7 % in another production period.

Investment cost is the most paramount among factors affecting input. Data in *Table 5.* show that a 1 % decrease in investment cost implies a change of more than 1.5 % in efficiency of forcing under plastic tunnel while the same amount of change generates an improvement of 3 % in NPV of greenhouse forcing.

Under current economic conditions, the purchase cost of production equipment is not likely to decrease, but based upon the results of the elasticity test, investment grants increase, or would increase, efficiency of the entire sector in a great extent as they cut the purchase cost from the producers' point of view. Among the most significant operation costs, the effect of labour cost is outstanding. Under the technologies studied, a 1 % decrease in wages generates 0.7-1.6 % improvement in NPV. Decrease isn't plausible in wages, however, decrease in public dues could contribute to more profitable production for gardeners. It might be important that wage is likely to increase worsening the economy, so the efficiency of labour might be a crucial point.

Table 6: Results of critical value approach

Factors affecting	Greenhouse			Plastic tunnel		
	Initial value	Value	Rate	Initial value	Value	Rate
Specific yield (kg/m2)	17.9	15.9	11.1%	18.1	15.7	13.3%
Average sales price (HUF/kg)	396.0	352.0	11.1%	339.0	294.0	13.3%
Initial investment cost (HUF/m2)	23 000.0	30 910.0	34.4%	13 000.0	20 960.0	61.0%
Wage (HUF/hour)	700.0	1 638.0	134.0%	700.0	1 147.0	64.1%

Source: own edition

Table 6. shows the results of critical value approach of the most prominent factors affecting based on the results of the elasticity test, ceteris paribus. The numbers in the table are those values at which NPV under technologies at a calculative rate of 5.5 % is zero at the end of the 15th year. In chart 'Value', the critical value of the particular factor was included while 'Rate' indicates that what sort of percentage decrease is acceptable in relation to the 'Initial value' to reach the turn point in efficiency. Data in *Table 6.* suggest that acceptable decrease (11.1-13.3 %) is relatively low for both technologies regarding average sales price. Models in the research include average yield and price, so critical values should be interpreted as an average over years. It should be noted that a decrease of 2-2.5 kg in protected pepper forcing is conceivable under extreme weather conditions in Hungary on average over years.

There is significant gap between the growing equipment in context of investment cost and wages. A 61 % growth in investment cost entails (ceteris paribus) a turn point in efficiency under plastic tunnel forcing while this rate doesn't exceed 35 % under greenhouse forcing. The critical value for the total wage cost per hour is relatively high, but it is clear that growing under greenhouse can bear growth twice more than under plastic tunnel. This is due to the fact that personal cost per 1 kilo of pepper under greenhouse is more favourable than under plastic tunnel forcing. By the results of critical value approach, there are reserves at input and output sides in both technologies studied.

CONCLUSIONS

The main goal of the research was to determine whether greenhouses with higher investment cost or plastic tunnels with relatively lower cost price are more efficient investments in pepper forcing.

The analysis shows that there isn't significant difference between technologies studied in context of the total operation cost per $m^{2,}$ but due to the high investment cost of greenhouses, the total production cost under plastic tunnels are significantly lower, by 650 HUF (43 %), than under greenhouse. Higher cost of forcing under greenhouse isn't expressed in the specific yield because it is 0.2 kg lower than forcing under plastic tunnel. However, a 950 HUF lower production cost is realised per m^2 in forcing under plastic tunnel due to sale prices because most of the yield under greenhouse is generated when sales prices are near their peak values. In conclusion, the total production cost per m^2 is 650 HUF higher while the production value per m^2 is 950 HUF higher under greenhouse growing, therefore margin requirement under greenhouse growing per m^2 is 300 HUF (risen by 21 %) higher than under plastic tunnel. Based upon a cost-benefit analysis of an average year, growing under greenhouse has more favourable income-generating capacity and its profitability is 11 % higher, however, long-term efficiency of investments studied is more favourable under plastic tunnel as the payback period of plastic tunnels and their technological items is 2 years shorter than the payback period of greenhouses. In addition, all of the dynamic investment-efficiency indicators (NPV, PI, and IRR) demonstrate that plastic tunnel forcing is more economical on a long-basis calculated with liquid asset interest. The basic reason for this is listed as follows: greenhouse in its first years of operation gains 26 % higher margin requirement, 47 % higher cash-flow, 10 % more favourable profitability and 77 % higher investment cost.

Scale is also a crucial point. Calculations were carried out with optimal scale and the figures differ significantly in technologies. Plastic tunnel sites are made up of several forcing equipment (besides modern, one-span growing equipment), calculated figures are related to each m^2 of the site. As a conclusion, scale may be minimised – in realistic limits which means at least one plastic tunnel with an average width of 7.5 m and length of 50 m -, so the initial cost of investment and the annual production cost can be kept relatively low. On the contrary, the minimum threshold of the scale operated economically is 5 000 m^2 – it cannot be reduced proportionally - due to high cost technological equipment. According to TÉGLA [2010] growing equipment heated with thermal water is the most economical, but this isn't complied with the required return on sales (24 % or higher) under a scale of 0.5 hectare. As provided above, capital enough for 0.5 hectare is needed to start economical greenhouse growing. As a conclusion -agreeing with LEDÓ [2012] plastic tunnel growing has lower establishment and operation cost compared to hot beds and greenhouses – greenhouse growing may be efficient on a short and on a long basis, however, growing equipment under plastic tunnel is more economical regarding pepper forcing due to much more favourable specific costs (investment and production). It is also backed by the results of sensitivity analysis; it is concluded that pepper forcing under plastic tunnel is less sensitive to the change in factors affecting efficiency than growing under greenhouse.

REFERENCES

APÁTI F. [2012]: A gyümölcstermelés üzemgazdasági jellemzői In.: Gyümölcsültetvények fagy- ésjégvédelménektechnológiai lehtőségei és gazdasági megfontolásai. Debreceni Egyetem, AGTC MÉK, Kertészettudományi Intézet. 2012. 14p. ISBN: 987-615-5183-28-7

APÁTI F. [2009]: The comparative economic analysis of Hungarian and German apple production of good standard. In.: „International Journal of Horticultural Science" Vol. 15., Number 4, 2009., 79-85. pp. HU ISSN 1585 0404

BALÁZS S. [2000]: A hajtatás fogalma In.: A zöldséghajtatás kézikönyve. Mezőgazda Kiadó, Budapest, 13 p.

CZERVÁN GY. [2014]: Zöldség-gyümölcs ágazati stratégia, 2014-2020. Agrofórum. 1. sz. pp. 20-21.

FRUITVEB [2013]: A magyar zöldség-gyümölcs ágazat fejlesztési javaslatai a 2014-2020. évekre. Budapest. 4 p.

GLITS M., GÓLYA E., GYÚRÓS J., GYŐRFI J., HODOSSI S., HOLB I., HRASKÓ I. KOVÁCS A., KOVÁCSNÉ GYENES M., NAGY GY., NAGY J., NÉMETHY Z., OMBÓDI A., PÉNZES B., SLEZÁK K., SZŐRINÉ Z. A., TERBE I., ZATYKÓ F., [2005]: Általános tudnivalók a zöldségfélék hajtatásáról In.: Zöldségtermesztés termesztőberendezésekben. Mezőgazda kiadó. Budapest, 2005. 11 p.

GRAHAM – HARVEY [2001]: "The Theory and Practice of Finance: Evidence from the Field". Journal of Financial Economics 61, 187-243. p.

GYÚRÓS J. [2008]: A talaj nélküli termesztés műszaki alapjai In.:Talaj nélküli zöldséghajtatás. Mezőgazda Kiadó, Budapest, 124p.

HOWARD M. R. [2013]: Soil versus soilless culture. In: Hydroponic Food Production. CRC Press. Taylor & Francis Group. Broken Sound Parkway NW. 2013. 6. p.

ISBN: 978-1-4398-7869-9.

ILLÉS M. (2002): A beruházások gazdaságossága. In: Vezetői gazdaságtan. Szerk.: Illés M. Kossuth Kiadó 2002. 115-162. p.

LAKNER Z. – SASS P. [1997]: A zöldség és gyümölcs versenyképessége. Mezőgazdasági Szaktudás Kiadó Ház, Budapest. 1-199. p.

LEDÓ F. [2005]: A hajtatott zöldségtermesztés szervezése és ökonómiája. In: A zöldségtermesztés, -tárolás, -értékesítés szervezése és ökonómiája. (szerk.: Z. Kiss I. – Rédai I.) Mezőgazda Kiadó, Budapest. 217-228. p.

LEDÓ F. [2012]: A Zöldség - Gyümölcs Piac és Technológia különszáma. A Magyar Paprika Napja 2012. Budapest. 13 p.

LIETH J. H., OKI R.L. [2008]: Irrigation in soilless production. In: Soilless culture theory and practice. Elsevier. Theobald's Road, London. 2008. 117-153 p.

ISBN: 978-0-444-52975-6

OMBÓDI A. [2008]: Intenzív zöldségtermesztési technológiák. SZIE Gödöllő, Egyetemi jegyzet. 11. p.

SKENDER K., OMBÓDI A. [2011]: Az intenzív szabadföldi helyzete és lehetőségei Kelet-Európában, Koszovó és Magyayraország példáján keresztül. Kertgazdaság. 43. évf. 1. sz. pp. 74-83. 11.

SZŐLLŐSI L. (2008): „A vágócsirke termékpálya 2007. évi költség és jövedelem viszonyai" In.: Baromfi Ágazat 8: (4) 2008/4. december, Budapest, pp. 4-12.

SZŰCS I. [2004]: Beruházások gazdasági elemzése. In.: Gyakorlati alkalmazások – Az üzleti tervezés gyakorlata. Campus Kiadó. Debrecen, 2004. 129-139 p.

TAKÁCSNÉ HÁJÓS M.[2013b]: Zöldségnövény fajok hajtatása In.: Zöldséghajtatás. Debrecen. Debreceni Egyetemi Kiadó, 48 p.

TAKÁCSNÉ HÁJÓS M.[2013a]: Termesztőberendezések típusai In.: Zöldséghajtatás. Debrecen. Debreceni Egyetemi Kiadó, 6-7 p.

TÉGLA ZS. [2010]: Üzemi méret és energiaköltség a zöldséghajtatásban. Gazdálkodás. 54 (2): 169-175 p.

TOMPOS D. [2006]: Doktori értekezés. A kőzetgyapotos paprikahajtatás egyes technológiai elemei és ökonómiai összefüggései. Budapest. 103 p.

VAN SICKLE, J., JOVOVICH, E., CANTLIFFE, D., STOFFELLA, P. [2005]: Production & Marketing Reports. HortTechnology.15 (2) 356 p.

WARREN, M. F. (1982): Financial Management for Farmers, the Basic Techniques of 'Money Farming'. Third Edition, Stanly Thornes Ltd, 240-246., 259-260. p.