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ASSESSMENT OF THE EFFICIENCY OF THE INVESTMENT OBJECTIVE OF CHANGING THE SOIL TILLAGE SYSTEM UNDER THE CONDITIONS OF A SPECIFIC COMPANY

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The topic of the research is based on the possibility of improving the economic results in crop production by changing the tillage technology. The aim of the paper is to compare the effectiveness of the investment objective of buying a new seeder that allows the use of strip till technology and the existing minimization method of tillage in the conditions of a specific company. The company owns the other necessary mechanization. Investment objectives are developed in a Microsoft Excel spreadsheet using its @Risk add-on. Variant solutions are developed using a different ratio of utilization of land cultivation methods and subvariant in a different combination of financing the investment plan. Using the net present value (NPV) criterion, the deterministic efficiencies of individual variants of investment plans are compared in the conditions of a small, medium and large enterprise.
Based on the obtained results, we can conclude that the original variant minimization method of tillage achieves better NPV values in the conditions of a small business compared to the other variants in which the purchase of a new seed drill is assumed. However, what is significantly more efficient compared to the original method of soil cultivation are the subvariants that use strip-till technology, but count on sowing as a form of services.
In the conditions of a medium-sized and large company, if the share of strip-till technology is calculated to be higher than 30%, it is already more advantageous to acquire a seed drill compared to the original variant. However, the best variant in the case of a medium-sized enterprise is still the variant with the realization of sowing in the form of services, but in the conditions of a large enterprise it is already the variant counting on the procurement of its own seed drill.
The results obtained by the simulation analysis fully confirmed the conclusions from the deterministic efficiency evaluation. In the comparative comparison, the stochastic dominance rule of the first degree was applied in most cases, with a preference for variants of new technology, but with the provision of sowing in the form of services in the conditions of a small and medium-sized enterprise and in the conditions of a large enterprise by purchasing one's own seeder.

Keywords: *strip-till, minimization method of tillage, net present value; simulation analysis, Monte Carlo simulation*

INTRODUCTION

The long-term interest of any agricultural business entity is to ensure good economic results, save time, costs, labour, improve the water regime, prevent soil degradation, improve soil structure, protect against erosion, maintain organic matter in the upper parts of the profile. The introduction of strip-till land treatment technology, consisting of strip tillage, can significantly contribute to the fulfillment of these goals. The economic impact of the introduction of this system in the conditions of a specific company can be different.

From an economic point of view, based on the empirical experience of companies that farm in comparable conditions of the analysed company, it is possible to save up to 54% of costs and up to 73% of time per hectare with strip-till technology compared to conventional farming and up to 32% of costs and up to 39% of time per hectare versus minimization tillage. Strip-till in winter oilseed rape, according to Saldukaite et al., (2022) can significantly reduce fuel consumption, CO_2 emissions, the time required for field preparation, and the overall production cost compared with conventional systems. With strip till technology, there may also be an increase in yield, e.g. Gorski et al. (2022) compared strip-till to conventional tillage using four commercial sugar beet varieties. A significant increase was found in root yield (6.6%) and, accordingly, in technological sugar yield (8.2%) in strip-till treatment relative to conventional tillage. Analogically Morrison (2002) concluded that both deep and shallow types of strip tillage increased corn growth and yield, in some cases over conventional chisel ploughing and tandem disking tillage, but there was no advantage to the use of deeper knife-chisel zone treatment over shallow sweep zone tillage in the soils tested. Likewise, Jaskulska et al. (2020)

compared the grain yield of winter wheat under different tillage systems. In case strip-till was similar as in conventional technology and significantly, up to 10.4%, higher than in reduced technology.

An important criterion for evaluating the investment intention of changing the tillage system in the conditions of a specific enterprise is that the investment intention is economically acceptable. The new investment objective should meet the main objective of the firm investment policy formation and realization of investment projects that could lead to the increase of the firm market value represented by its net present value. In reality, investments are evaluated by accounting related techniques: the present value payback and the accounting rate of return. Both approaches don't belong to reliable techniques of project evaluation. They serve as complementary tools, mainly in the evaluation projects of short-term character and risky ones. In terms of accuracy, two approaches are considered as among the best in evaluating the investment objectives: The Net Present Value (NPV) and The Internal Rate of Return (IRR). The advantages and potential problems faced while using such approaches are treated for example in the articles of Northcott (1992), Lumby (1996), McLaney (1994), Žižlavský (2014). The suitability of the NPV method was confirmed by Brandes et al. (2018) when evaluating the efficiency of the production of ordinary bioenergy crops. They looked at which landscape area could be more profitable to switch to energy grass production than growing corn and soybeans. Technical-economic analysis of biofuel production using the NPV criterion was applied by Ingle et al. (2020) and provided organizations with the basis for deciding which projects to continue and how to optimize them. Similarly, Chandel et. al. (2019) used NPV, which in this case acquired negative values, to evaluate the investment intention of fermenting waste mass into biofuels. However, going forward, they anticipate that R&D efforts focused on innovation can lead to cost reductions and a positive NPV. Ehrhart et al. (2015) analysed production returns using NPV methodology, including sensitivity analysis to determine the effects of changes in financial parameters, inputs, chemicals and market prices. The study Dong et al. (2023) highlights the profitability of geothermal projects by developing a techno-economic coupling model for economic evaluation of Closed-loop geothermal systems based on net present value.

Risk management is currently an integral part of the evaluation of investment projects. According to Junkes et al. (2015), the Monte Carlo simulation method can be used in probability analysis. The task of the mentioned method is to model the influence of individual risk factors on the effectiveness of the investment plan. The problems in using this method mainly include determining the appropriate probability distribution of risk factors, due to the fact that each investment project is specific and potential factors affect individual investment projects differently. Stochastic-technical-economic analysis was performed for example by Frank et al. (2018) in the production of willow biomass. The model was based on input price parameters for production and willow yield. With Oracle Crystal Ball program, they earned 24-year net present value under price and revenue uncertainty. They found the interval at which it moves and NPV at 95% confidence level. The main contribution of their paper is determining the probability of acquiring NPV values. The financial viability of four bioenergy production scenarios from pine was investigated by Campbell et al. (2018) in the US. He used the Monte Carlo method to display the NPV distribution function of the project and to analyse the sensitivity of key economic and production variables, thanks to which he also took into account possible uncertainty. The Monte Carlo method was used by Li et al. (2019) in their study focused on a coal-fired power plant project. In conjunction with the Monte Carlo method, he also applied NPV. He compared the effectiveness of three variants. He used a representative 600 MW technology to investigate the impacts of increasing coal input, reducing electricity generation and changing flue gas capture. Thanks to the results from the method used, he arranged the individual variants based on the expected profitability. Similarly, Colantoni et al (2021) in their study evaluates the overall uncertainty in the Net Present Value of investment in cogeneration plants composed of a gasifier fed with biomass and a bottoming Internal Combustion Engine fed by the gasification product gas. Monte Carlo simulation assesses the probability of a positive Net Present Value for three sizes of cogeneration plants. Regarding sizes, the chance of generating a positive Net Present Value ranges from 66% to 90%, while the larger plants have a higher chance. The sensitivity analysis findings show that above all, biomass cost and then the sale price of electricity and the quantity of gasification product gas are the most dominant parameters. The technical-economic efficiency of gasification of biomass from Spartina argentinensis in Argentina for combined energy purposes was evaluated by Emiliano (2017). The investment plan was subjected to a sensitive analysis, based on which the lower and upper limits of NPV were expressed. He pointed out on the importance of the impact of natural gas prices on economic results. According to research, energy efficiency and selling price of electricity have been identified as the most important factors affecting NPV. Franco-Sepulveda et al. (2017) analysing an open pit gold mine project based on NPV criteria used genetic algorithm metaheuristic simulations, which combine basically Monte Carlo simulations provided by the Palisade Risk software with the O'Hara cost model. In the paper Repiský (2019), aimed at evaluating the risk in the investment intention of planting vineyards, risk factors are identified with the help of sensitivity analysis and are subsequently formulated in a stochastic model as random variables with a certain probability distribution. Investment intentions and their effectiveness are evaluated based on critical values of NPV target indicators and using distribution functions. Similarly, in the article by Repiský (2006) aimed at identifying the optimal investment strategy in the area of permanent cultures, the risk is evaluated not only with the help of a simulation model, but also with the application of decision trees using the Certainty Equivalent criterion.

The topic of the research is based on the search for alternative ways of improving the economic results in the plant production in the conditions of a specific enterprise. In the past, the company switched from the conventional form to a minimalist tillage, which had positive effects on economic results. Currently, the owner is considering a potential change to strip-till technology, which requires investment costs. The aim of the paper is to compare the effectiveness of the investment objective of buying a new seeder that allows the use of strip till technology and the existing minimization method of tillage in the conditions of a specific company. Although the company currently manages only 139.85 ha of land, it is also considering the possibility of expanding the area of cultivated land in the form of rent. For this reason, the deterministic efficiencies of individual variants of investment plans are compared in the conditions of a small, medium and large enterprise, and then the risk of selected investment plans is evaluated using simulation analysis.

RESEARCH METHODS

Achieving the goal requires the creation of multi-period investment models of two tillage systems with subsequent deterministic assessment of the effectiveness of individual investment plans. The Microsoft Excel spreadsheet using its @Risk add-on is used to develop investment plans. The model itself consists of the following parts: cost estimation: capital, variable, fixed, working capital, estimation of production, depreciation, financing of the investment, loan, repayment scheduling, projected annual income statement, projected cash flow and projected balance sheet. The deterministic evaluation of the efficiency is on the basis of the net present value criterion (Northcott, 1992; Lumby, 1996, Repiský, 2000, Eerhart et al. 2015, Brandes et al. 2018, Dallimer et al. 2018, Chandel et. al. 2019, Ingle at al. 2020).

$$NPV = \sum_{t=0}^{n} \frac{CF_t}{(1+i)^t} - I_0 , \qquad (1)$$

where: *NPV* – Net Present Value;
i – discount rate;
$1/(1+i)^t$ – discounted factor at time t;
I_0 – initial investment costs;
n – number of years of investment;
CF_t – Cash Flow from the investment in different years.

The model solution is created based on the specific conditions of the agricultural enterprise Jozef Múčka s.r.o. The main focus of the company is plant production, for which it uses 139.85 ha of leased arable land. Currently, he grows rapeseed cabbage (45% of the total area), winter wheat (40%) and winter barley (15%) and uses a minimization method of cultivation with his own mechanization and plans to switch to strip-till technology in the future. The company currently has five wheeled tractors, a New Holland TX 66 combine, Tagris 4 m discs, a Horsch seed drill, Cambridge rollers, a Hardi sprayer, an industrial fertilizer spreader and other additional equipment.

On the basis of hectare yields, sales prices, costs achieved by the company using minimization technology (Jozef Múčka) and by companies using both minimization and strip-till technology (Donau farm Kálná s.r.o., but also other companies operating in comparable conditions) it is possible to quantify the expected Contribution margin € ha^{-1} (Revenue - Variable costs) for both methods of tillage. We calculate that hectare yields increased for each cultivated crop (wheat by 0.08 t/ha, rapeseed by 0.5 t/ha and barley by 0.33 t/ha) compared to the minimization method. The way the land is cultivated will not affect the selling prices, but it will greatly affect the costs.

All work operations and their associated costs are rigorously quantified in the model. For reasons of space, we only present the work operations in the cultivation of rapeseed cabbage (Table 1) in a minimal way. In addition to the above mentioned 1006.5 €.ha^{-1}, additional wage and social costs of 61.15 €.ha^{-1} plus other 95.52 €.ha^{-1} must be added to the total variable costs.

Table 1. Work operations in the cultivation of rapeseed cabbage - minimization method

Operation	Units	Amount (ha^{-1})	Price per unit (€ ha^{-1})	Costs (€ ha^{-1})
Disking up to 15 cm			25,00	25,00
Fertilizer -NPK (nitrogen, phosphorus, potassium)	t	0,18	340,00	61,20
Spreading - application			18,00	18,00
Disking up to 15 cm			25,00	25,00
Sowing			22,00	22,00
Seeds	kg	2,3	42,00	96,60
Rolling			15,00	15,00
Gallant - herbicide	l	0,4	28,00	11,20
Rafan max - insecticide	l	0,05	76,00	3,80
Spraying - application			18,00	18,00
Orius 25 EW - fungicide	l	1	16,31	16,31
Retacel extra - growth regulator	l	1	2,80	2,80
Rafan max - insecticide	l	0,05	76,00	3,80
Spraying - application			18,00	18,00
Fertilizer – Uniko (nitrogen)	t	0,182	600,00	109,20
Spraying - application			18,00	18,00
Fertilizer – Uniko (nitrogen)	t	0,182	600,00	109,20

Table 1. Continuation

Spreading - application			18,00	18,00
Gallant - herbicide	l	0,4	28,00	11,20
Urea 46%	kg	10	0,9	9,00
Spraying - application			18,00	18,00
Corinth - fungicide	l	0,8	28,02	22,42
Apis 200 SE - insecticide	l	0,2	109,22	21,84
Lebosol Bór - liquid fertilizer	l	1,5	2,90	4,35
Urea 46%	kg	10	0,9	9,00
Spraying - application			18,00	18,00
Fertilizer – Dam 390 (nitrogen)	t	0,15	450,00	67,50
Spraying - application			18,00	18,00
Pictor - fungicide	l	0,4	88,23	35,29
Aceptir - insecticide	l	0,15	102,90	15,44
Lebosol Bór - liquid fertilizer	l	1,5	2,90	4,35
Urea 46%	kg	10	0,9	9,00
Spraying - application			18,00	18,00
Combine harvest + diesel			110,00	110,00
Grain transport			24,00	24,00

In the case of strip-till technology, the costs of disking and rolling are eliminated. Other work operations and the dosage of individual chemical preparations and fertilizers do not change significantly. The following figure shows the variable costs per hectare (Figure 1) that the company must spend when growing individual crops with different methods of cultivating arable land. Growing crops with strip-till technology is cheaper for each crop grown compared to the minimal tillage method. The highest difference was recorded for winter barley, whose variable costs per hectare decreased by roughly 10%.

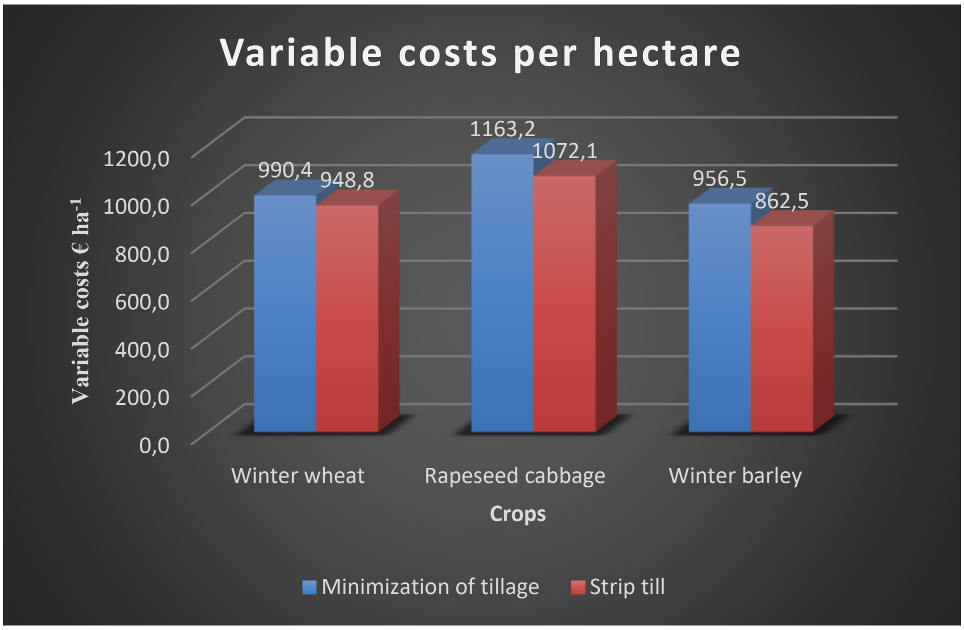

Figure 1. Variable costs € ha^{-1} different soil treatment technologies

Similarly, with Contribution margin (Figure 2), better results were achieved with strip-till technology, e.g. for rapeseed cabbage up to €423.6 ha^{-1}. However, the new tillage technology requires a new investment in the form of the purchase of a new seeder, or the carrying out of sowing in the form of services. The company is considering the purchase of a Bourgault seeder at a purchase price of €289,000.

Variant solutions are created using a different ratio of areas cultivated by both technologies, subvariant by different ways of financial coverage of the investment, i.e. the ratio of own and foreign capital, or provision of work operations in the form of services. Using the net present value (NPV) criterion, the deterministic efficiency of individual variants of investment plans in the conditions of a small, medium and large enterprise is compared.

The risk assessment of individual investment plans is carried out using simulation analysis. The risk factors in the deterministic models are identified with the help of the sensitive analysis. They are represented by random variables, where a change in their level, causes a significant change in the estimated criteria figure. The following parameters are identified as risk factors: yields, prices of all considered plants and material costs.

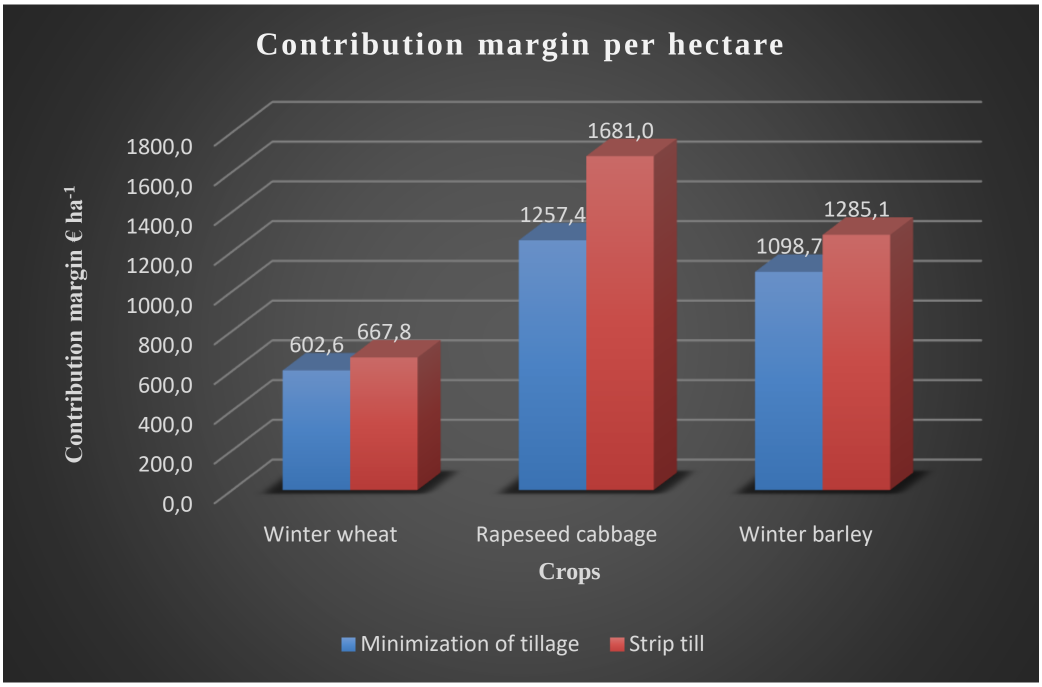

Figure 2 Contribution margin € ha^{-1} different soil treatment technologies

The simulation analysis, after the risk specification, is executed in the following stages:

- the estimation of the shape of risk factors distribution and the estimation of distribution parameters,
- the construction of the probability distribution of the analysed criterion indicator and determination of its basic characteristics.

We formulate the identified risk factors in the stochastic model as random variables with certain probability distribution (Goodwin, 1991, Junkes et al. 2015, Emiliano 2017, Frank et al. 2018, Campbell et al. 2018, Repiský 2019). The types of probability distribution as well as parameter estimation are defined upon subjective expert estimations. For the estimation of yields, we assume normal distribution with adequate parameters - mean m and standard deviation. Prices of all considered plants and material costs are defined based on symmetric triangle probability distribution, reciprocally differentiated by different parameters. Distribution parameter represent pessimistic, optimistic and the most probable estimation. The effectiveness of the selected variants is assessed on the basis of statistical indicators, critical values of target indicators and distribution functions. The comparison of the distribution function of different projects enables the identification of optimal strategy while the critical values of the objective criteria offer information about the expected value of risk taking. The simulation analysis is executed by the program @Risk for Excel programme based on the Monte Carlo method.

RESEARCH RESULTS AND DISCUSSION

Deterministic evaluation of the effectiveness of individual variants

Based on the model solution, it is possible to simulate different scenarios and quantify their net present value of NPV. Variant solutions differ in the way the arable land will be cultivated and subvariant from the point of view of financial coverage of the investment, i.e. the ratio of own and foreign capital, or provision of work operations in the form of services. The interest rate does not change for individual variants and subvariants, its amount is 3.5%. Since the company is also considering expanding the cultivation area, the efficiency of individual variants and subvariants is calculated in the conditions of a small, medium and large enterprise (Table 2). The total estimated area that the company would have at its disposal is 131.79 ha for a small company, 263.58 ha for a medium-sized company and 527.16 ha for a large company.

- Variant 1: the original variant, the entire area will be processed 100% in a minimization way.
- Variant 2: the arable land will be cultivated 70% with minimization method and 30% with strip-till technology. This and other variants include 5 sub-variants A, B, C, D, which will differ in how the own and foreign sources of financing for the purchase of the seeder will be used (A ratio 100:0, B 70:30, C 30:70, D 0:100) and subvariant E sowing with strip-till technologies in the form of services
- Variant 3: the arable land will be cultivated 30% with minimization method and 70% with strip-till technology.
- Variant 4: in this variant, the arable land will be cultivated 100% with strip-till technology.

Table 2. Resulting NPV values of individual variants

Variant	Min. techn.	Strip till	Sources		Small size company		Medium size company		Large size company	
			Own	Cre dit	NPV (€)	Differ. (€)	NPV (€)	Differ. (€)	NPV (€)	Differ. (€)
Var 1	100%	0%			715 972	0	1 640 685	0	3 490 110	0
Var 2A	70%	30%	100%	0%	451 688	-264 284	1 449 003	-191 682	3 443 632	-46 478
Var 2B	70%	30%	70%	30%	457 923	-258 049	1 455 237	-185 448	3 449 864	-40 246
Var 2C	70%	30%	30%	70%	466 146	-249 826	1 463 548	-177 137	3 458 178	-31 932
Var 2D	70%	30%	0%	100%	471 959	-244 013	1 469 782	-170 903	3 464 411	-25 699
Var 2E	70%	30%			763 301	47 329	1 733 120	92 435	3 672 755	182 645
Var 3A	30%	70%	100%	0%	551 457	-164 515	1 645 574	4 889	3 833 805	343 695
Var 3B	30%	70%	70%	30%	557 690	-158 282	1 651 807	11 122	3 840 039	349 929
Var 3C	30%	70%	30%	70%	566 002	-149 970	1 660 119	19 434	3 848 351	358 241
Var 3D	30%	70%	0%	100%	572 236	-143 736	1 666 353	25 668	3 854 584	364 474
Var 3E	30%	70%			826 406	110 434	1 856 366	215 681	3 916 283	426 173
Var 4A	0%	100%	100%	0%	626 281	-89 691	1 792 997	152 312	4 126 435	636 325
Var 4B	0%	100%	70%	30%	632 514	-83 458	1 799 233	158 548	4 132 670	642 560
Var 4C	0%	100%	30%	70%	640 827	-75 145	1 807 544	166 859	4 140 981	650 871
Var 4D	0%	100%	0%	100%	647 060	-68 912	1 813 779	173 094	4 147 214	657 104
Var 4E	0%	100%			873 736	157 764	1 948 800	308 115	4 098 930	608 820

In Table 2, we see the NPV values of variant solutions for individual types of businesses. The original variant 1 for a small business with a minimal tillage method achieves better NPV values compared to the other variants, where the purchase of a new seeder is assumed. Compared to the original method of soil cultivation, only the subvariants that count on sowing using strip-till technology in the form of 2E, 3E and 4E services are more effective. The best variant is variant 4E, which reaches an NPV value of €873,736. When comparing the same ratio of the use of strip-till technology, but provided with its own new seed drill, financed 100% from foreign sources, which is the 4D variant, the variant providing sowing in the form of services achieves a higher NPV value of €226,676. A small acreage business should prioritize service over investing in a new Bourgault planter. In the event that it is necessary to use both methods of tillage, e.g. due to the different structure of arable land, the more efficient variants with a higher proportion of strip-till technology with the possibility of using services for sowing cultivated crops are more effective.

Similarly, even for a medium-sized enterprise, the most effective variants are those that count on sowing when using strip till technology in the form of services. With a higher proportion of strip till technology, compared to the original method of tillage, the acquisition of a new seeder is advantageous.

With a large area of the enterprise, the original variant 1 achieves better results only if the share of strip till technology is 30%, with a higher share, similar to the case of a medium-sized enterprise, it is already more advantageous to procure a seed drill. The most advantageous variant in the case of a large enterprise is variant 4D with an NPV value of €4,147,214. This variant uses only strip-till technology with its own seeder for tillage, and the financing of the investment plan is fully from foreign sources. The loan in the amount of €311,000 is repaid over 8 years with the same annuity amount at an interest rate of 3.50%. Cumulative cash flow is positive throughout the entire period of 16 years and is characterized by a growing character. Variant 4E, which achieved the best result for both small and medium-sized enterprises, in this case achieves an NPV value of €48,284 lower compared to the best variant 4D. Even in this case, if it is necessary to use both methods of soil cultivation, the most suitable options are the use of strip-till technology sowing services.

Risk analysis through simulation models

The results of the simulation analysis are primary statistic indicators NPV, critical values of the target indicator (Table 3.) and distribution function. For reasons of space, we present the investment efficiency based on critical values of the target indicators only in the conditions of a small business (Table 3).

Table 3. Critical NPV values of selected variants - small business

Risk	Var 1 (€)	Var 2B (€)	Var 2E (€)	Var 3B (€)	Var 3E (€)	Var 4B (€)	Var 4E (€)
3%	545 360	325 650	633 173	427 215	696 471	461 074	707 730
10%	583 713	355 243	660 792	455 415	727 548	500 577	742 670
20%	631 567	392 530	697 277	490 036	761 294	546 967	787 692
25%	646 662	406 041	710 212	503 935	774 368	564 145	804 223
30%	661 906	416 280	722 120	517 200	785 410	580 736	820 046
35%	675 703	428 231	733 445	527 919	795 485	595 583	833 645
40%	690 447	438 025	743 570	538 429	805 649	607 159	847 023

The investor is willing to accept only a certain degree of risk. Under assumption than the investor is risk averse than we suppose that the investor is willing to accept a 10 up to 35% of risk. The perceptual values give the probability where the NPV falls under the value assigned to the given probability. In the case of a small business for example with probability 10% we might expect that the NPV for Variant 2E will be less €660,792 and the original Variant 1 will be less €583,713, which means that when accepting a risk of 10%, variant 2E is more effective than the original variant.

It is possible to evaluate the project efficiency also by analysing the distribution function and density function. The distribution functions make the basis for a complex comparative analysis of efficiency for each strategy respecting the risk according to the rule of stochastic dominance. The distribution functions of the 7 selected variants, in the case of a small business (Figure 3), indicate that the stochastic dominance of the first degree applies between the variants. Variants using strip-till technology with the option of services for sowing cultivated crops, 4E, 3E and 2E, are dominant compared to the original variant 1. The other analysed variants 4B, 3B and 2B are dominated, which confirms the conclusions from the deterministic evaluation.

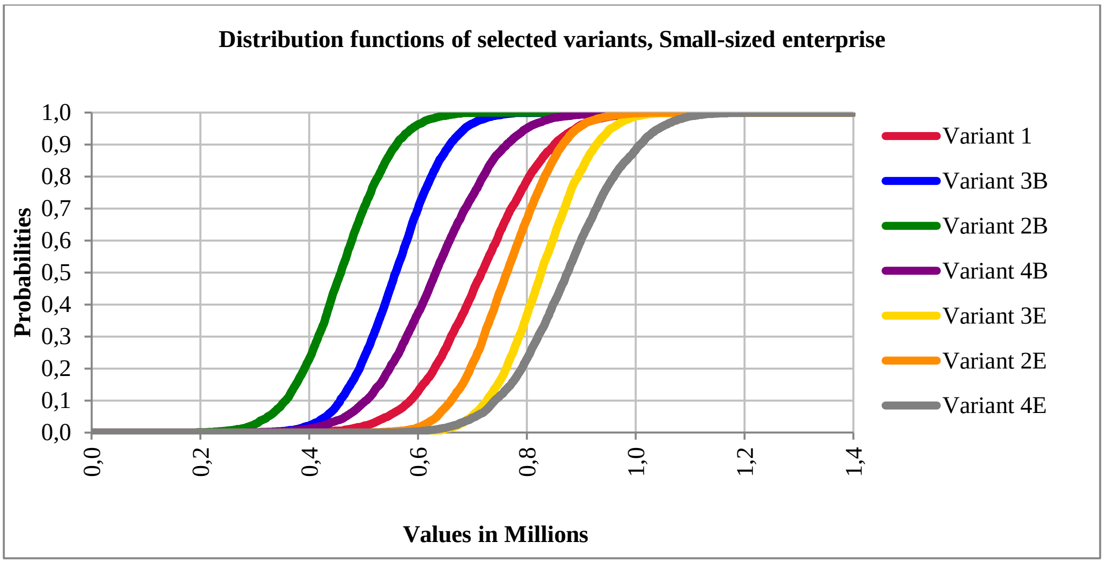

Figure 3. Distribution functions of selected variants, Small-sized enterprise

In the case of a medium-sized enterprise (Figure 4), stochastic dominance of the second degree is already applied. As in the case of a small business, variants 4E, 3E and 2E are dominant compared to the original, but the dominant variant compared to the original is only variant 2B with the purchase of its own seeder, in which the use of strip-till technology is calculated for only 30%.

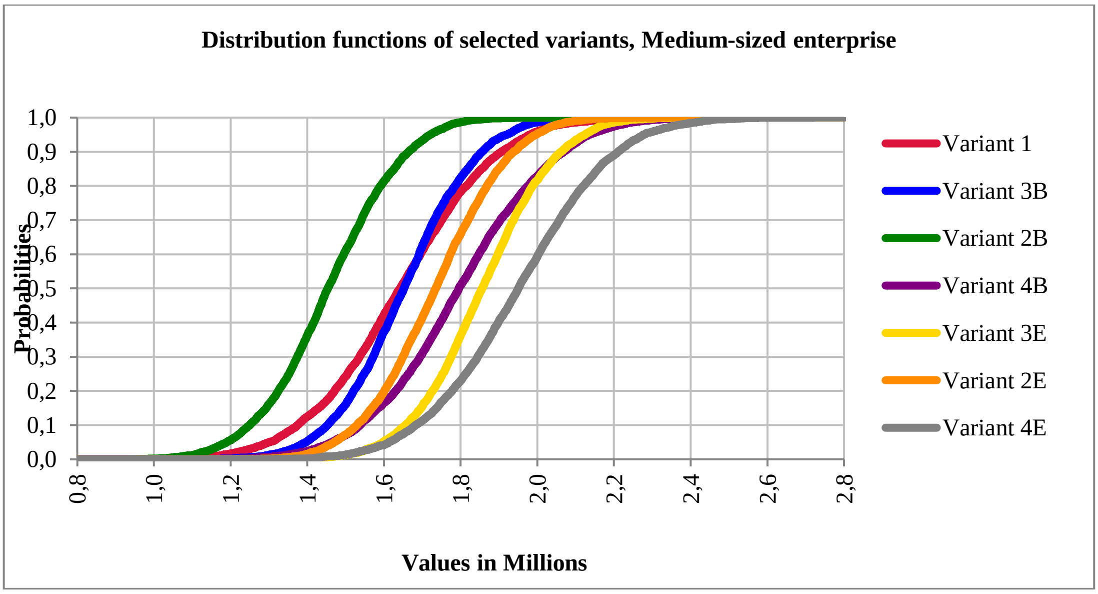

Figure 4. Distribution functions of selected variants, Medium-sized enterprise

Similarly, for a company with a larger area (Figure 5), stochastic dominance of the second degree is also applied. The dominant variant is variant 4B with the purchase of one's own seeder, the financing of which is in the ratio of 70:30 and 100% strip till technology. All the variants in which tillage with the strip till technology with a share higher than 30% are calculated are more favourable from the point of view of the risk level compared to the variant where the minimization method is used. It follows that even decision-making subjects with a risk-averse attitude will prefer the introduction of strip till technology.

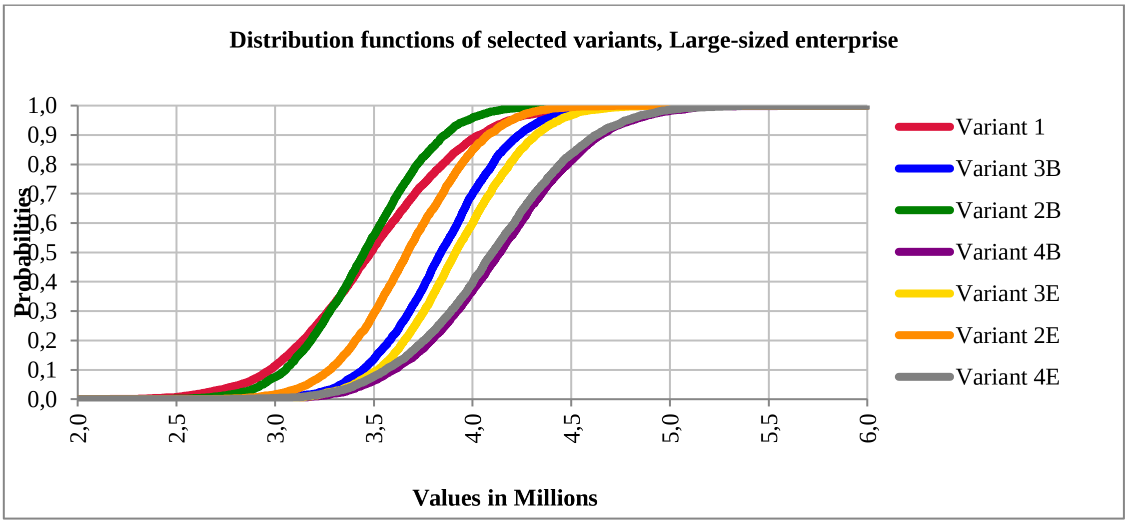

Figure 5. Distribution functions of selected variants, Large-sized enterprise

In recent years, Slovakia, as well as other countries, experienced drought and the associated risk of a lack of drinking water or crops in the fields. In addition to water retention measures, the use of strip-till soil treatment technology can help retain moisture and thus protect the crop from drought. This method of planting in strips reduces driving over the field, reduces erosion, allows moisture to be retained and, in addition, significantly, based on the results obtained from companies farming in comparable conditions, it contributes to reducing costs and, with strict adherence to technological procedures, leads to comparable and even higher harvests as with the conventional or minimal tillage method. Similarly, from the point of view of evaluating the effectiveness of investment plans to change the tillage system from minimization tillage to strip-till technology, investment plans with the largest possible share of strip-till technology are more effective. In the conditions of a small enterprise with the provision of sowing in the form of services and in the conditions of a medium one either in the form of services or by procuring its own seeder and a large enterprise with the acquisition of its own seeder (table 2). It is obvious that if we were to compare the change from the conventional form of tillage to strip-till technology on the basis of deterministic efficiency and taking risk into account using simulation analysis, the results would be even more in favour of strip-till technology.

CONCLUSIONS

Based on the results obtained when comparing the effectiveness of the investment intention of buying a new seed drill and the current minimization method of soil cultivation, we can conclude that the original variant 1 (100% minimization tillage) way achieves better NPV values in the conditions of a small business compared to the other variants in which the purchase of a new seed drill is assumed (Table 3). Compared to the original method of soil cultivation, only the subvariants that count on sowing using strip till technology in the form of services 2E, 3E and 4E are more effective (different ratio minimization tillage and strip-till tillage 2E: 70:30, 3E: 30:70, 4E: 0:100, E sowing with strip-till technologies in the form of services). The best variant was variant 4E, which reached an NPV value of €873,736, which is €157,764 more than the original tillage method. This variant uses 100% strip till technology for tillage.

In the conditions of a medium and large enterprise, the original variant achieved better results only if the share of strip till technology is 30%, with a higher share it is more advantageous to procure a seeder (Table 3). In the case of a medium-sized enterprise, the best variant is variant 4E with a value of €1,948,800, which is €308,115 more than the original variant, but in the conditions of a large enterprise already variant 4D with the purchase of a new seeder and, of course, the cultivation of the entire area with strip till technology and with financial coverage of the investment from foreign sources. The NPV value is €4,147,214, which is €48,284 more compared to the same variant, the difference of which lies in the use of services during sowing, and €657,104 more than the original variant.

When looking at the variants in which both methods of tillage are used, subvariant E achieved the best result for all types of enterprises, regardless of the ratio of the use of both technologies. In this variant, the company uses the option of services for sowing cultivated crops before investing in a new bourgault seeder. Of course, the best values were achieved by variant 3E with a 70% share of the use of the strip till tillage method, whose NPV value reaches €826,406 under the conditions of a small business, or €1,856,366 for medium and €3,916,283 for large enterprises.

The results obtained by the simulation analysis fully confirmed the conclusions from the deterministic efficiency evaluation. In the comparative comparison, the stochastic dominance rule of the first degree was applied in most cases, with a preference for variants of new technology, but with the provision of sowing in the form of services in the conditions of a small and medium-sized enterprise and in the conditions of a large enterprise by purchasing one's own seeder.

Based on the obtained results of the effectiveness of individual variants of investment plans, we recommend that the investigated company with a small acreage switch to the new strip till technology to the greatest extent possible, with the fact that sowing will be provided in the form of services. In addition, the use of this technology can also contribute to maintaining the natural fertility of the soil. The question of the possible purchase of a new bourgault seeder remains to be considered by the management of the company and other aspects, such as the risk of non-compliance with agrotechnical deadlines when using the service option, or in the case of the purchase of a machine, the possibility of providing a service to other agricultural entities. Based on the mentioned outputs, from the point of view of economic results, a solution with the purchase of one's own seeder is also permissible.

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