COST-BENEFIT ANALYSIS OF REDUCED INTENSITY TILLAGE SYSTEMS, STRAW AND GREEN MANURE COMBINATIONS

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Introduction

Reduced intensity farming systems face the challenges to increase productivity of the soil, reduce the costs of production, provide high-quality products, and, finally, ensure soil conservation. But there are controversial views on reduced tillage effects on net economic results. The aim of our study is to assess economic effects of the long-term application of reduced intensity tillage systems, straw and green manure combinations. 6 different farming systems on Spring oilseed rape (Brassica napus L.), a winter wheat (Triticum aestivum L.), and a spring barley (Hordeum vulgare L.) – the most popular crops grown in Lithuania – were analysed in the study.

Methodology

Research was carried out during the period of 2000-2020 in a long-term field experiment, at the Experimental Station of Vytautas Magnus University. The soil in the experimental site was Epieutric Endocalcaric Endogleyic Planosol (*Endoclayic, Aric, Drainic, Humic, Episiltic*) according to the WRB 2014 classification. The long-term experiment was laid out in a split-plot design with 4 replications and a total of 48 plots. The initial plot size was 102 m^2 (6 m x 17 m) and the harvested plot size was 30 m^2 (15 m x 2.0 m). Two factors were tested: straw retention (S) or removing (W) (factor A) and 6 farming systems (factor B) on Spring oilseed rape (*Brassica napus L.*), a winter wheat (*Triticum aestivum L.*), and a spring barley (*Hordeum vulgare L.).* Crops yields and crops price was analysed to evaluation the income. For total cost analysis cost of seeds, fertilizers and crop prodection products, labour cost, cost of fuels and oils, depreciation of the mechinery, cost of repairing and technical servicins of machinery and other cost were analysed. Cost effect of production and production profitability were evaluated.

Table 1. Description of analysed farming systems

No	Soil tillage treatments	Direct drilling of cover crops	Shallow discing after harvest	Primary tillage	Seedbed preparation
1.	Conventional deep ploughing **(control, CP)**	no	yes	ploughing at 23-25 cm depth	cultivation
2.	Shallow ploughing **(SP)**	no	yes	ploughing at 12-15 cm depth	cultivation
3.	Ploughless tillage **(PLT)**	no	yes	discing at 8-10 cm depth	cultivation
4.	Seedbed discing **(SD)**	no	no	no	discing at 4-5 cm depth
5.	Cover crops **(CCD)**	yes	no	no	discing at 4-5 cm depth
6.	No-tillage **(NT)**	no	no	no	no

Results

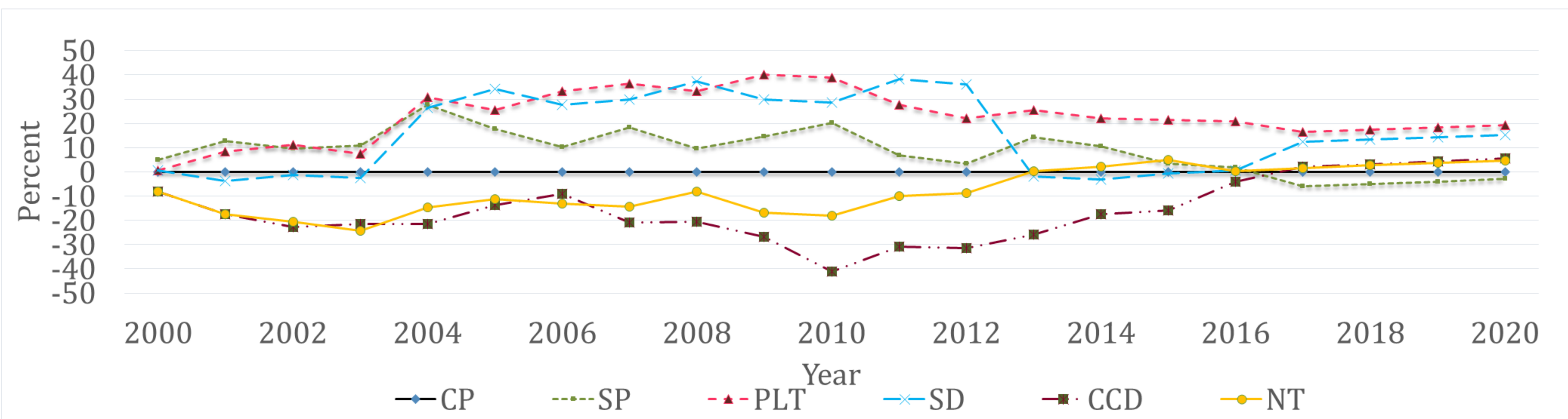
Analysing the effect of straw retention on crop yields in more 70 percent of cases there were positive effect varying: from 1,95 percent of yield increase in 2015 and more than 10 percent in 2009. Cumulative crop productivity differences allow to evaluate that long-term reduced intensity tillage and no-tillage technology, combined with the use of crop residues and green manure, allow to maintain the stability of agroecosystem productivity in 2000-2020. Use of redused intensity farming systems (SD, CCD and NT) allows to decrease cost effect of production. This decrease is mainly driven by decrease of costs in fuel and tech. service cost (about 50 percent) and labour and other costs (about 40 percent) with no or minimal penalty in yields (or even increse of yield in winter wheat case). The tendency of higher production profitability are seen winter wheat, spring rape and spring barley using SD, CCD and NT tillage systems comparing with CP.

Table 2. Effect of yields applying different straw combinations

Year	Crop	Yield of the crops, t/ha	
		W	S
2000	spring barley	2.30	2.3
2001	spring barley	4.00	4.2
2002	spring barley	5.00	5.1
2003	spring barley	4.10	4.4
2004	spring rape	2.37	2.25
2005	winter wheat	9.81	10.36
2006	spring barley	3.33	3.59
2007	spring rape	2.05	2.1
2008	winter wheat	7.07	7.56
2009	spring barley	4.63	5.1
2010	spring rape	1.50	1.5
2011	winter wheat	5.80	6.1
2012	spring barley	4.59	4.53
2013	spring rape	0.57	0.6
2014	winter wheat	7.79	8.40
2015	spring barley	7.17	7.31
2016	spring rape	1.23	1.18
2017	winter wheat	9.30	9.82
2018	spring barley	4.72	4.84
2019	spring rape	1.45	1.52
2020	winter wheat	9.93	9.4

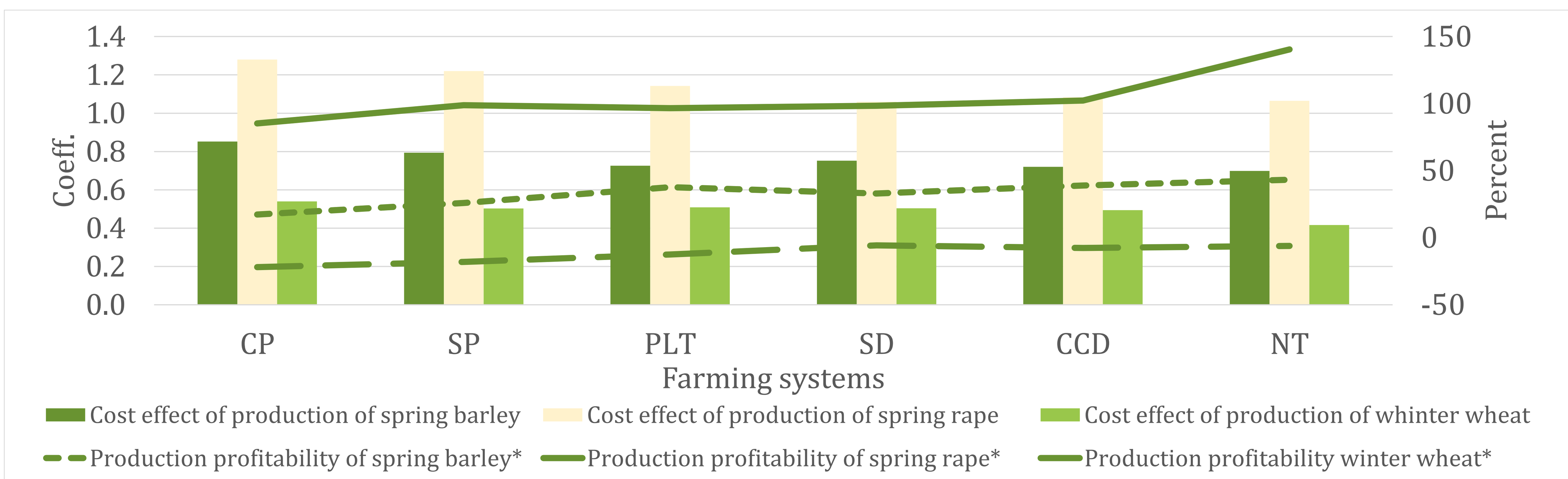
Source: own calculation

Figure 1. Crop productivity differences % as influenced by long-term complex measures of different intensities cumulative differences compared with CP (control), 2000-2020



Source: own calculation

Figure 2. Cost effect of production and production profitability of spring barley, spring rape and winter wheat using different tillage systems



Source: own calculation

Conclusions

Long-term application of less intensive soil tillage in combination with the use of plant residues and green manure allows maintaining stability of productivity of agroecosystems. In most of the cases the straw retention has possitive effect on crop yields. Economic benefits are achieved by reducing production costs while using less intensive tillage systems. Most of the savings are driven ty lower fuel costs and repairs and tech. service costs and labour and other costs. The highes economic effect of using less intensive tillage technologies (SPS, TP, NT) is seen in winter wheat cultivation and is determined by both the increase in income and the decrease in costs due to the need for smaller tillage operations.

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