THE DIFFERENTIATED EFFECTS OF PLOT SIZES AND FARM-FIELD DISTANCES IN ORGANIC AND CONVENTIONAL FARMING SYSTEMS: AN ECONOMIC ANALYSIS AT FARM LEVEL

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Abstract

We quantify the effect of plot sizes and farm-field distances on the economic performance in conventional and organic farming systems and discuss their impact on the decision of conversion. This is an aspect so far not considered in the large body of literature which compares the economic performance of organic and conventional farming. Our paper analyzes three German case study farms which recently converted from conventional to organic farming. We link information on the farm from interviews to big data on field operation for a large-scale sensitivity analysis. Our results show for both systems, as expected, that larger plot sizes reduce labor requirements and costs associated with crop production while growing farm-field distances increase them. At same plot sizes and farm-field distances organic farms face always lower costs in crop production and, at given market prices, higher profits. Cost and labor savings from larger plot sizes are however higher in conventional farming systems as are cost and labor increases from growing farm-plot distances. This implies economic benefits of conversion are higher for farms managing smaller plots farther away from the farm. This might motivate regionally differentiated subsidy rates which not only consider yield potentials.

Keywords

economic performance, organic and conventional farming, plot size, farm-field distance.

1 Introduction

A large body of literature analyzes factors driving decisions to switch from conventional to organic farming. Thereby, economic considerations gain importance, as conversion to organic farming increasingly developed to an economic decision (KOESLING et al. 2008). Despite the great diversity of studies on economic considerations of conversion, literature leaves effects of plot sizes and farm-field distances, hence the distance of the plot from the farm building, unconsidered. Literature suggests that plot sizes and farm-field distances affect resource requirements of field operations and thus, have a considerably impact on the economic performance. Increasing plot sizes provide economies of scale by reducing unproductive turning and driving times of field operations while farm-field distances affect resource requirements and costs related to transport distances (HERRMANN and PAPESCH 1996; JAHNS et al. 1983; KUHLMANN 2015; LATRUFFE and PIET 2014; LOOGA et al. 2018; LU et al. 2018). Thereby, the size of the effects on the economic farm performance depend on the type and the number of performed field operations (JAHNS et al. 1983). As conventional and organic farming systems exhibit major differences in crop production programs, the performed field operations differ considerably (KUHLMANN 2015). As a result, the economic effects of plot size and farm-field distance may turn out differently between conventional and organic, influencing the decision of conversion. This study addresses a gap in the literature by analyzing the effects of plot sizes and farm-field distances on the economic performance in organic and conventional farming systems and the impact on the decision to convert.

2 Method

The effects on plot sizes and farm-field distances on the economic performance of conventional and organic farming systems are assessed by determining the profit, costs and labor requirements of case study farms subject to plot sizes and farm-field distances. We analyze as case studies an arable, a pig fattening and a dairy farm located in Western Germany. The farms have been recently converted organic such that we receive detailed information about the farm program as well as relevant technical and economic information under the conventional and organic system (Table 1). The case study data is linked to a large-scale data base from the *Kuratorium für Technik und Bauwesen in der Landwirtschaft* (KTBL). The database provides details on revenues, costs and labor requirements of livestock and arable production, reflecting details such as the type of housing used and feeding choices and the applied tillage system for conventional and organic production systems (KTBL 2019a, 2019c). Further, details on necessary field operations for more than 100 crops are provided, reporting resource requirements and related costs (e.g., cost for maintenance and fuel). The resource requirements of field operations are provided for different plot sizes and farm-field distances, separated by farming system, amounting to more than 3.6million data records (KTBL 2019b). This data is used to derive the regression model for the large-scale sensitivity analysis, determining resource requirements of field operations as function of plot size and farm-field distance. By linking the results of the regression model to the aforementioned economic data, economic performance indicators are determined as a function of plot size and farm-field distance. Using the function, we assess the economic performance and determine the effects of plot sizes and farm-field distances.

3 Results and conclusion

The results show for both farming systems that larger plot sizes reduce labor requirements and costs associated with crop production (Table 2)[1]. In contrast, growing farm-field distances increase them. Our results suggest that the effects are higher in conventional farming systems, implying that overall costs increase stronger with farm-field distance and decrease stronger with plot size. This mostly relates to a higher number of field operations for most crops in conventional systems. Thus, conventional farms benefit to a greater extant from large plot sizes and small distances while adverse effects of small plots and large farm-field distances is lower for organic farming systems. Despite the higher effects for conventional farms, independent of the plot size and the farm-field distance, the profits are higher under organic production. In this context it must be noted that we analyze as case studies three farms which recently converted to organic farming which renders it more likely to find a positive effect on profits compared to farms staying in the conventional system. Further, organic farmers face higher production risks which are not covert in our study (GARDEBROEK 2006). Nevertheless, the economic benefits of conversion are higher for farms operating in more fragmented land markets. This might motivate regionally differentiated subsidy rates which not only consider yield potentials.

The study is conducted based on case study analysis, giving first insights into the differentiated effects of plot sizes and farm-field distances in conventional and organic farms. The strength of the analysis lies in the nature of the large-scale sensitivity analysis using big data. By running a large set of regression functions for over hundredth crops and many different field operations we derive various cost positions and labor use per ha as function of plot size and farm field distance. These functions are of interest beyond the study, for instance, as a data base in farm scale modeling. This could further contribute to a better understanding to which extent plot sizes and farm-field distances effect the decision of farmers and, for example, interact with various policy instruments. Clearly, a larger sample of farms from different regions is needed to generalize our findings. This is hampered by two important data limitations. First, as underlined by our case studies, switching from conventional or organics affects a farm in many aspects such that observations are required before and after conversion, with quite some detail in farm management. Such observations are quite scarce in existing single farm records.

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[1] Interactive graphs, depicting the profits, costs and labor requirements of the three case studies as function of plot size and farm-field distances are provided online. https://chrispahm.github.io/Economic-Effects-Distance-Plot-Size/

Second, data on actual plot size and farm-field distances of farm are needed. These are currently not part of official statistics (e.g., FADN and FSS).

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Table 1: Key attributes of the case study farms

		Arable Farm		Pig Fattening Farm		Dairy Farm	
		Conv	Org	Conv	Org	Conv	Org
Farm size	ha	100		56	42	100	
Number of animal places			2500	800	240	100	105
Crop rotation	%	Sugar beet (35%) Wheat (25%) Barley (25%) Potatoes (15%)	Grass-clover (17%) Grain peas (17%) Triticale (17%) Potatoes (13%) Barley (12%) Wheat (8%), Spelt (8%) Pumpkin (4%) Grain maize (4%) Catch crop (30%)	Wheat (46%) Barley (27%) Silage maize (27%) Catch crop (27%)	Grain maize (25%) Field bean (20%) Triticale (20%) Barley (20%) Wheat (10%) Oat (5%) Catch Crop (15%)	Grass-clover (32%) Permanent Grassland (15%) Grain maize (15%) Silage maize (12%) Rye (11%) Barley (7%) Wheat (5%) Oat (2%) Catch crop (10%)	Grass-clover (75%) Permanent grassland (15%) Whole crop silage (10%) Catch crop (10%)
Average farm-field distance	km	0.5		1.1		2	
Average plot size	ha	5.1		6		4	

Table 2: Effects of plot size and farm-field distance on profits [€ ha^{-1}], costs [€ ha^{-1}] and labor requirements [h ha^{-1}].

		Arable		Pig fattening		Dairy	
		Conv	Org	Conv	Org	Conv	Org
Intercept	Profit including org. subsidy [€ ha^{-1}]		768		1.280		-61
	Profit without org. subsidy [€ ha^{-1}]	582	508	-331	1.020	-301	-285
	Costs of arable production [€ ha^{-1}]	990	958	836	737	961	733
Effect of	Farm-field distance (1) [€ ha^{-1}]	-9.84	-8.68	-13.84	-8.68	-15.77	-14.23
	Plot size (1) [€ ha^{-1}]	5.28	5.04	9.61	6.96	6.25	2.66
Intercept	Total labor requirements [h ha^{-1}]	12	62 (2)	27	36 (3)	44	58 (3)
	Arable labor requirements [h ha^{-1}]	12	17	11	9	10	8
Effect of	Farm-field distance [h ha^{-1}]	0.22	0.17	0.30	0.16	0.28	0.24
	Plot size [h ha^{-1}]	-0.19	-0.14	-0.23	-0.20	-0.12	-0.06

Notes: Results of the regression analysis. (1) the coefficient is the same for profits and costs, however, the direction of the effect is inverse (2) impact of integrating livestock in production system, (3) reflects higher labor needs of specific requirement in organic livestock production

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