Influence of Crop Diversity on Value Added in High-Yield Areas of Sweden

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Abstract

An increasing world population has led to a higher demand of food. The agricultural intensification and farm-specialization during the last decades has provided sufficient food but the accomplishment to do so has led to significant social and ecological externalities. One way of generating more resilient and high-yield harvests and at the same time mitigating externalities is through crop diversity. This thesis estimates a production function using a fixed-effects model to investigate if crop diversity is positively related to economic performance in areas of Sweden. The results show that there is a positive significant relationship between crop diversity and economic performance measured as growthrates between years of value added per hectare of land between the years 2009-2018. The results are relevant to policymakers and farmers who wants to implement crop diversity within different regions of Sweden.

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1. Introduction

While industrialized and innovative agricultural systems produce sufficient food to feed the current world population, the accomplishment to do so has led to significant social and ecological externalities (Hazell & Wood 2008). Agricultural intensification during the last century has led to simplifications in landscapes (Landis, 2017). Increased agricultural intensification is associated with higher environmental damage, such as increased input of fertilizers and pesticides, larger field sizes, removal of non-crop habitants and general monoculture. This has led to a simplified crop production resulting in a biodiversity-loss (Frison et al., 2011; Matson, 1997). One way of battle bio-diversity loss is by enhancing crop diversity (Sjulgård et al. 2022). To achieve higher crop diversity on a regional scale, it needs to be economically viable so that farmers and regions have an incentive to become more diverse.

Previous work related to crop diversity within the agricultural sector of Sweden mentions how crop diversity can contribute to an increased economic performance and ecological benefits (see e.g Nilsson et al. (2022), Sjulgård et al. (2022) and Schaak et al. (2022)). Reidsma et al. (2008) contributed with insights on farm economic-performance in regions in Europe. These studies have contributed to the relationship between crop diversity and economic performance. In my thesis, I expand these ideas by focusing on high-yielding areas and compare them to lower yielding areas in Sweden. The aim of this thesis is to assess how the crop diversity influences value added in all agricultural areas of Sweden. Specifically, I do this by (i) investigating whether crop diversity influences crop diversity in general and (ii) if there are differences between high and low yield areas.

This is interesting because most of the high-yielding areas are located down south and the low-yield areas mainly located up north. In a long country like Sweden with different growing conditions this is important for policy-makers when discussing potential policy-implementations regarding agriculture and the importance to keep in mind the geographic differences and growing conditions. The analysis is based on Swedish municipality-level sample data, spanning the years 2009- 2018, aggregating population-based farm-level observations, which permits an analysis of high-yield areas in Sweden.

As the world population increases the agricultural systems are expected to produce more food and the food needs are projected to increase substantially. To meet the higher demand for food in an ecologically and socially sustainable manner has become essential and is a global imperative (Kremen & Miles 2012). According to the IPCC (2013) The magnitude and frequency of extreme weather events such as heatwaves and droughts are expected to increase. Higher diversity in crops may mitigate the effects of drought and heat stress on the crop yield (Marini et al. 2020). However, we need to understand if more crop diversity regionally is related to better economic performance to stimulate more crop diversity. Nilsson et al. (2022) links the advantages with crop diversity and the resilience to a higher economic performance on farm level by reducing risks and reducing inputs in combination to a higher harvest. The contribution of this thesis is on a regional level and one reason why it is important is to see where crop diversity contributes to a higher economic performance. This would create incentives for these areas to implement crop diversity.

The reminder of this thesis is structured as follows: section 2 presents relevant background information for the study. Section 3 presents the methodology which includes data description, model specification and methods used. Section 4 shows the results of the study. Section 5 includes a discussion regarding the results. Finally section 6 includes some concluding remarks.

2. Background

2.1 Measuring crop diversity

Diversity in crop species on farmland strongly influences non-crop species diversity (Sjulgård et al. 2022). High crop diversity in areas may provide nesting sites for insects and increase resource continuity. It has been associated with natural antagonists of pests, greater diversity of pollinators and may increase the diversity of soil microbial communities due to diversity in plant litter and root exudates (Sjulgård et al. 2022). It has been suggested that diversity in crop species will be essential to adapt agricultural and arable systems to climate change by providing yield stability and improving crop productivity (Lin, 2011).

One way of measuring crop diversity is to use the Shannon index. The Shannon index is the most applied measure when it comes to crop diversity. This thesis defines crop diversity as functional crop diversity, following Schaak et al. (2022), where groups of crop species grown on farms are considered to complement each other in an ecological way. In this thesis the Shannon index will be referred to as crop diversity:

$$\mathrm{H}^{s} = -\sum_{c=1}^{n} \mathrm{Pc} * \ln(Pc)$$

where H is the Shannon index, n is different land use (n=1,..., c) c is crop and p is the proportion of land that a crop is cultivated.

When a farm produces only one crop n = 1 and the diversity index returns a value of 0. The index takes a value of ln(n) when all crops are distributed on the same share of land on the representative farm. I aggregate farm-level data to municipality data because the data refers to municipality aggregate. A higher value of H implies higher crop diversity.

Sweden has experienced different weather events in recent years such as drought in 2018 and more rain than usual in 2023 which affected the yield and therefore the profit of farmers. According to Sjulgård et al. (2022) by creating more resilient agricultural systems the yield is not as much affected by unusual or extreme weather events which can lead to a more stable income and supply. A more stable and increased supply contributes to a higher self-sufficiency degree which is currently at 50% in Sweden (LRF, 2023). This would make Sweden less dependent on import during difficult times.

2.2 Literature review

Reidsma et al. (2008) examines the impacts of climate variability on European farmers and their adaptive strategies. Through a multi-level analysis, they assess how both yield and income of farmers are affected by the changing climate conditions. The study finds that European farmers are vulnerable to climate variability, with significant impacts on both crop yields and farm incomes. The authors find that adaptation strategies play a crucial role in mitigating impacts and the effectiveness of adaptation strategies varies across regions and farm types, influenced by factors such as access to resources, institutional support, and socio-economic conditions.

Sjulgård et al. (2022) investigate spatiotemporal dynamics of crop diversity in Swedish agriculture. By examining crop rotation patterns and changes in land use over time, Sjulgård et al. (2022) identify opportunities for promoting agricultural diversification and ecosystem resilience. The study shows spatial variation in crop diversity across different regions due to factors such as climate, soil type and

historical agricultural practices. The study also shows that enhancing crop diversity can contribute to improving the resilience of agricultural systems to different factors such as climate change, diseases and pests. Diversified crop systems can also provide ecological benefits, such as enhanced soil health, biodiversity conservation, and reduced reliance on external inputs.
Schaak et al. (2022) found that farms adapt to specialization and monoculture due to technical advancements, market demands etc. These types of homogenetic agricultural systems may pose risk to the resilience and ecosystem stability and in the longer run become more vulnerable towards environmental stressors which can affect the economic performance.

Nilsson et al. (2022) tests farm diversity to the farm performance with the aim to understand how crop diversity can contribute to farm outcome and sustainability and demonstrate that farm performance and crop diversity are positively related to profitability and gross margin, implying that a higher level of crop diversity may improve better economic outcomes. The study also finds that farms with a higher level of crop diversity rely less on inputs such as pesticides and fertilizers which contributes to lower costs and less ecological externalities.

These papers include data and information in line with the needs of this thesis.

2.3 Climatic factors and high-yield areas

There are many factors determining whether or not a harvest will be high or low in agriculture. The human factor, inputs and weather to mention a few (365farmnet, 2022). Some areas in Sweden have proven to continuously generate a higher-yield on the same area compared to other parts of Sweden. Sunhours, temperature and precipitation are included in climate which is a big factor for the yield, as well as soil quality, fertilizers, pests etc. Also selected crops in the right area are affected as the case of wheat were relatively cool summers and mild winters often contributes to a higher yield than cold winters and hot summers (Cornes et al. 2018).

For soil to perform at its best and provide the land with a high-yield it requires a balance of organic matter, minerals, air and water. When the soil is unbalanced the crop is not getting enough of one or more elements resulting in a lesser ability to take up fertilizers or other nutrients which leads to a smaller harvest (Kinsey, 2013). Nilsson et al. (2022) discuss the crop diversity resulting in a wider range of ecosystem functions and the potential growth factors available in the farm which is not the same with specialized systems. The more specialized systems could in the case of Sweden be interpreted as the areas with a lower yield due to unfavorable weather and growing conditions, such as the northern parts, where they have less possibility to try and select higher yield crops to obtain a more resilient plant. Nilsson et al. (2022) further discusses that the economic performance of the farm increases when selecting crops that has contrasting ecological functions compared to similar genetic functions. Reidsma et al. (2008) points out the climatic conditions in different regions throughout Europe and links it to adaptation approaches to obtain a higher economic performance. The more high-yield areas are believed to obtain a higher yield due to different factors such as soil, weather and also management, which is crop diversity. This is why I believe that the crop diversity will contribute to a higher profit, in the high yielding areas of Sweden due to more favorable weather and growing conditions, such as soil, for different types of crops compared to the low yielding areas.

3. Methodology

3.1 Data

Sweden is located in Scandinavia, northern Europe, more precisely between latitude 55 and 69. Due to the differences in latitude the climate varies across Sweden, especially north and south. The northern and more central part of Sweden belongs to subarctic climate and the southern parts belong to the hemiboreal climate (Peel et al. 2007).

Sweden is divided into 290 municipalities and 21 counties (SKR, 2022). The municipalities were used in this paper as regional entities since it is available in the data and a rather precise way to differentiate from high-yielding areas and normal/lower yielding areas in combination with a Swedish standard harvest map (figure 1). The High-yield areas were selected in color code where the darker colors show areas with a higher harvest in Sweden. The harvests are relative to the Swedish yield and not other countries.

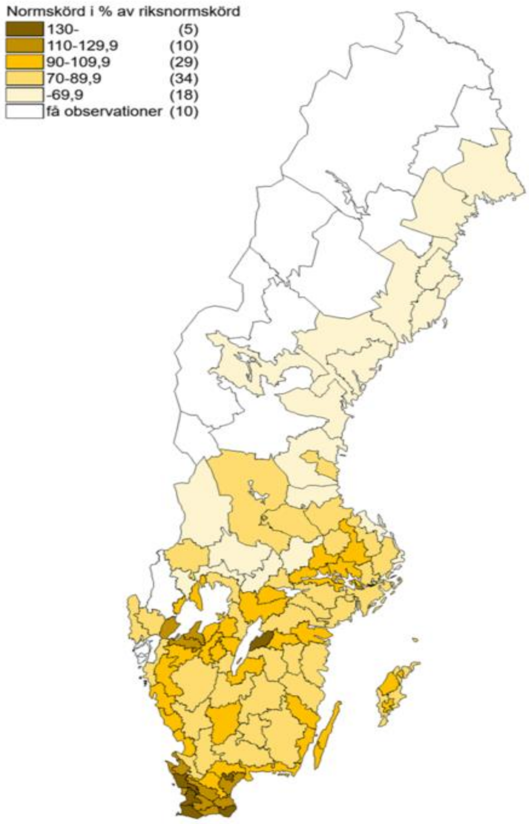

Figure 1. Swedish standard harvest map for the year 2021 (SCB, 2021).

The data set spans across 2009-2018 and consists of 2,339 observations and is compiled from several registers, including Statistics Sweden (farm financial accounts), the Swedish Board of Agriculture (land use) and the E-OBS Copernicus datasets (historical meteorological data). All variable definitions and summary statistics can be found in table 1. Natural logarithm has been generated to the output and input variables to obtain a more normally distributed data and be able to interpret my regression output as percental changes. I estimate a production function that considers output, inputs and other variables. The output VA is defined as VA/AL (value added divided by land area) to be able to compare regions. This is to make a better fit for the interpretation since bigger units are more likely to obtain a higher VA because of a bigger land area. Growth rates, which in this thesis reflects the percentage change of the VA between two years, were computed. The reason to add growth rates is to see whether or not crop diversity is associated with a potential growth in economic performance per year.

Table 1. Data-set including variable, definition, mean and standard deviation and data source.

Variable	Definition	Mean	Standard deviation	Data source
Value added (VA) divided by Agricultural Land (AL)	Farm net value added (calculated as the value of total production (GVP) minus the value of intermediate inputs (M) and the consumption of fixed capital (depreciation) in k SEK as a proxy of farm income (c.f. Reidsma et al., 2007). Divided by the total number of hectares of agricultural land (arable and pasture)	0.085	0.257	Statistics Sweden
Capital (K)	Value of the total stock of capital (machinery, buildings) of farms in k SEK	277	384	Statistics Sweden
Labour (L)	The number of employees in Full Time Equivalents (FTEs) including the farm owners/managers.	2.043	1.859	Statistics Sweden
Intermediates (M)	Total cost of variable inputs (fertilizer, fuel, feed etc.), farm net turnover minus VA in k SEK (Levinsohn and Petrin, 2003).	116	223	Statistics Sweden

Agricultural Land (AL)	The total number of hectares of agricultural land (arable and pasture).	282	581	The Swedish Board of Agriculture (AICS/LPIS)
On-Farm Diversity (DIV)	Shannon diversity index calculated as previously mentioned.	0.762	0.378	The Swedish Board of Agriculture (AICS/LPIS)
Consecutive dry days (CDD)	Average annual maximum number of consecutive dry days in local area.	23.3	6.27	E-OBS Copernicus
Precipitation (Pp)	Average annual growing season precipitation in mm in local area.	342	65.0	E-OBS Copernicus
Clay Content (SQ)	Average clay content (local) higher content proxy better soil quality (Pikki and Söderström, 2019).	19.1	9.74	National geodatabase of soil texture in Sweden
High-Yield areas (HYA) Dummy variable	Selected municipalities providing a higher yield crop harvest than average (100 or more in figure 1) in Sweden. 5 municipalities were excluded due to lower yield and not really inside of the marked areas in the map.	0.161	0.367	Statistics Sweden

Micro-level registry data have restricted public access in Sweden (due to confidentiality reasons). Therefore, I have only access to aggregated data at municipality level. This means the analysis is for a production function for a representative farm i in time t using municipality-level panel data.

This thesis estimates a production function where the chosen variables, the response(dependent) variables, is Value added/Land (VA/AL) and the growthrate between two years for Value added/Land (Growthrate_VA_LAND). To estimate Value added the following explanatory variables are included. Inputs (i) Capital (K), Labour (L), Land (AL) and Intermediates (M). These inputs are often considered in production functions and explain how much value added is generated in regions (Nilsson et al. 2022). Diversity indices (ii) On-farm diversity (DIV). Commonly used measurement of crops within a limitation such as farm or region. Climate variables: (iii) Clay Content (SQ), Precipitation (Pp) and Consecutive Dry Days (CDD). These climate variables capture differences in climatic circumstances and are often linked to yield and value added because of their impact on the crops (Schaak et al. 2022; Sjulgård et al. 2022). These are included accordingly to Nilsson et al. (2022) and previous studies mentioned in the literature review such as Sjulgård et al. (2022) and Schaak et al. (2022) including the On-farm diversity index. The selected variables are linked to economic performance either direct in economic terms or indirect through possibilities to a higher yield due to favorable weather and growing conditions. Definitions for the variables can be seen in table 1.

3.2 Method and econometric specification

In this thesis a production function is being estimated using a fixed effects model. The aim of using a regression model is to estimate the relationship between crop diversity and economic performance.

The statistical software STATA 18 is used for data analysis. To identify high-yield areas, a map from Statistics Sweden (Figure 1) has been used. This map shows standard harvests. The map then contributed to the selection of municipalities that were able to represent these areas in the data set. The three more darker colored areas which spann from 90 and up got chosen and municipalities that barely had any land inside of the colored areas got rejected as high-yield areas. This resulted in 39 municipalities that were identified as high-yielding regions (see Appendix 1).

I estimate the following model specification:

$$y_{it} = \beta_0 + \beta_1 \ln K_{it} + \beta_2 \ln L_{it} + \beta_3 \ln M_{it} + \beta_4 \ln AL_{it} + \beta_5 DIV_{it} + \beta_6 SQ_{it} + \beta_7 CDD_{it} + \beta_8 Pp_{it} + \beta_9 HYA_{it} + \tau_t + \mu_i + \varepsilon_{it}$$

Where y_{it} is the value added per land unit, K_{it} is capital, $L_{it}$is Labour, M_{it} is intermediates, AL_{it} is the land area, DIV_{it} is the Shannon-index measured as crop diversity, SQ_{it} is the soil quality, CDD_{it} are the number of consecutive dry-days in the area, Pp_{it} is the annual precipitation in the area, HYA_{it} are the high-yield areas selected (see appendix 1). τ_t captures time fixed effects, μi are individual fixed effects and ε_{it} is a normally distributed error term.

I estimate 5 different model specifications: (i) main model, (ii) model with years as levels for the high-yield areas that captures the change of the value added for that specific year. Models with growth rates as dependent variable where (iii) is a separate model for high-yield areas and (iv) is a separate model for low-yield areas which enables for a comparison between the different regions. The fifth model (v) has growth rates as dependent variable and measures growth rate between the years. All models contain the same explanatory variables except (iii) and (iv) which does not include HYA_{it} as these model specifications only consider low or high yielding areas.

The advantage of a fixed effects model is the usage of panel data to control for time-invariant omitted variables. There may, however, still be potential sources of endogeneity that are not addressed using the within transformation. These time variant sources of variation may introduce endogeneity. These sources of endogeneity could for instance be introduced by including crop diversity as an explanatory variable, which is dependent on decisions made by the farmer and could potentially introduce correlations between the error term and the independent variables. However, the results could still give insight into the relationship between the variables. Hence, I interpret these results of this thesis as correlations and not causal estimates.

4. Results

Table 2 presents the results from the 5 estimated regressions mentioned in section 3.2.

Table 2. Results provided by the five conducted regressions.

	(1)	(2)	(3)	(4)	(5)
Capital	0.097***	0.093***	0.113	0.084**	0.079**
	(0.019)	(0.019)	(0.071)	(0.035)	(0.032)
Labour	0.197***	0.193***	0.005	-0.015	-0.016
	(0.046)	(0.046)	(0.111)	(0.087)	(0.073)
Intermediates	0.578***	0.579***	0.077	0.381***	0.345***
	(0.024)	(0.024)	(0.073)	(0.046)	(0.041)
Land	-0.897***	-0.913***	-0.406***	-0.782***	-0.751***
	(0.046)	(0.047)	(0.146)	(0.084)	(0.075)
Crop Diversity	-0.028	-0.015	0.182	0.203*	0.210**
	(0.062)	(0.062)	(0.185)	(0.111)	(0.0994)
Clay Content	-0.025***	-0.025***	0.064	-0.019	-0.015
	(0.006)	(0.006)	(0.028)	(0.012)	(0.011)
Consecutive dry-days	0.001	0.002	-0.001**	-0.003	-0.003
	(0.002)	(0.002)	(0.004)	(0.003)	(0.003)
Precipitation	-0.004	-0.005	-0.007	-0.002	-0.004
	(0.003)	(0.003)	(0.009)	(0.005)	(0.005)

High-Yield area 2010		0.049			-0.031
		(0.116)			(0.176)
High-Yield area 2011		0.099			0.010
		(0.117)			(0.174)
High-Yield area 2012		0.241**			0.238
		(0.117)			(0.176)
High-Yield area 2013		0.249**			0.161
		(0.118)			(0.174)
High-Yield area 2014		0.189			0.058
		(0.118)			(0.177)
High-Yield area 2015		0.286**			0.268)
		(0.117)			(0.175)
High-Yield area 2016		0.237**			0.069
		(0.118)			(0.176)
High-Yield area 2017		0.254**			0.0628
		(0.119)			(0.179)
High-Yield area 2018		0.378***			
		(0.119)			
Constant	**2.564****	**2.759*****	**5.016**	**4.986*****	**5.837*****
Observations	**2.339**	**2.339**	**336**	**1.722**	**1.753**
Municipalities	**249**	**249**	**39**	**208**	**246**
R-Squared	**0.440**	**0.444**	**0.098**	**0.133**	**0.129**

Heteroskedasticity and autocorrelation robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 2 shows the results from the five conducted regressions. The results of the estimated equations are presented in elasticities to allow direct comparison. As the results show, there is no significance between crop diversity and value added in the case of Sweden in general (1), which means I am not able to say anything about the results or interpretations. The Variable HY is omitted because of within transformation. In the second regression (2) which is Sweden in general + the years as levels there is no significant value for crop diversity. The years 2012, 2013, 2015, 2016, 2017 and 2018 shows significant values which could be interpreted as the VA for these years increase by the coefficient by each year. For the year 2018 it increases VA by 0.378 for every 1% increase to give an example. The third regression (3) is the growthrate for only the HY areas and the fourth regression (4) is growthrate for the LY areas. Regression (3) results in no significant values but regression (4) shows significance on crop diversity to a 90% degree. This means that a 1% increase in crop diversity will increase the VA by 0,203. The fifth regression (5) which is the growthrate for HY areas between years shows a higher significance than the previous regression, showing a 95% significance degree. This means that there is an increase by 0.210 in VA for each 1% increase in crop diversity for the growthrate between the years. This could also be interpreted as how much the crop diversity will affect value added. 2009 and 2018 are omitted due to no comparison year for growthrate calculation.

The results are in line with previous findings such as Nilsson et al. (2022). For farms specialized in crop production, diversification strategies have a positive affect on the growth in economic performance.

I find that all inputs (land, labour, capital and intermediates) are positively related to the dependent variables in model 1 and 2. This means that higher levels of land, labour, intermediates, and capital, in general reveal higher VA/land, and that regions with higher inputs have higher VA/land. This is to some extent in line with Nilsson et al. (2022) who found some positive relationships between inputs and profitability. This could be linked to economies of scale as regions with more inputs in general have higher VA/Land, which could suggest that larger production is better. Model 3, 4 and 5 does not have significant values to the dependent variable from all of the input variables. Labour does not show correlation to the dependent variable in these models which means that labour doesn not have a significant relation to the growthrate. Crop diversity have a 90% significance for model 4 and a 95% significance level on model 5. This means that there is significance between crop diversity and growthrate between the years in model 5 and to low-yield areas in model 4. The climate variables (Clay content, consecutive dry days and precipitation) show little to none significance to the dependent variable throughout the models. Clay content is significant and negative to 99% in model 1 and 2. This means that a 1% increase in clay content affects the dependent variable negative, meaning that regions with a higher level of clay content in these models reveal a smaller value added/land. Consecutive dry days is significant to 95% in model 3. The variable shows a negative value meaning that an increase in consecutive dry days will affect value added/land for high-yield areas.

5. Discussion

The aim of this thesis was to assess how crop diversity influences value added in all agricultural areas of Sweden and investigate if there are differences between high and low yield areas. I find non significant relationships in some regression models, meaning that increased levels of crop diversity are not related to higher regional economic performance in some regions. These findings differ across the model specifications. For instance, in model 5 there are some notable findings, especially for the model with the growthrate measured for each year individually (Regression 5). For the year 2010 the crop diversity influences value added negatively but in the other years there is a positive interaction between crop diversity and value added where a 1% increase in crop diversity will result in a 0.210 increase on the growthrate of value added divided by land. In model (4), I find a significant relationship between crop diversity and regional economic performance at a 10% significance levels. This means that a 1% increase in crop diveristy will result in a 0.203 increase on the growth rate of value added divided by land.

As previously mentioned no significant values were obtained until the growthrate between each individual year was measured. This means there is no significant relationship between crop diversity and value added divided by land for the initial models. This depends on the dependent variable that is being considered and wheater there are high or low yield areas. However, when the growthrate is used, which is also an indicator for economic performance, significant results were obtained. One unit of va/ha as levels, which is the regression without growthrate did not give any results to fullfill the aim whilst crop diversity did affect growth rates.

There are 2 limitatitations of this thesis. First, simultaneity bias may occur when two variables influence each other simultaneously and so creates a bidirectional relationship. The simultaneity bias is mentioned in Nilsson et al. (2022). To be able to deal with the problem, data for cost of separate inputs by type and the farm´s internal resource cycling, in other words, self-sufficiency could be used to be able to control for the simultaneity bias. A higher usage degree, and availability of inputs cycled internally could influence the economic performance on the farm. This means that my findings should be interpreted as correlations and not as causal relationships. Nilsson et al. (2022) dealt with the simultaneity bias by using an identification strategy to rely on both internal and external instruments and applied a two-system equation SYS-GMM estimator accordingly to (Di Falco and Chavas, 2008). What could have been conducted in this thesis is a Levinsohn-Petrin regression model where endogenous and exogenous variables are controlled for and so eliminating the simultaneity bias.

Second, it is important to keep in mind that the data is aggregated at municipality level and not on farm-level. This means that I work with average municipality data, which could mask some of the heterogeneity at farm level. Hence, my results cannot be interpreted as farm-level effects. Not all farms were included and the selection were farms of mid-size and up, leaving smaller farms unobserved. This may have implications for the representativeness of my sample and it should be interpreted as effects on regional level.

The findings of this thesis have implications for agricultural policy makers and farmers who are interested in crop diversity. Since growth rates increases with crop diversity in high-yield areas over time the results could be useful for policymakers when discussing policy-changes or implementations, especially because of the positive externalities crop diversification has proven to have (Schaak et al. 2022; Sjulgård et al. 2022). Because of Sweden's length, growing conditions differ from south to north with most high-yield areas located south, meaning that policies could be better on a regional level. For farmers this means that high-yield agricultural systems could benefit from implementation of crop diversity to obtain a higher economic performance and also contribute to mitigation of negative externalities.

A considerable amount of further research should be done in order to properly verify this. Further research could study the influence of crop diversity on value added on farm-level and with a larger timespan to obtain a result that could be compared to an actual existing unit which would allow for a more nuanced analysis. The model is not a perfect fit either which could say that there are some variables missing to fully explain the estimated equation.

6. Conclusions

The aim of the thesis is to investigate the relationship between crop diversity and economic performance at regional level. The estimation of the results were conducted using a fixed effects model with compiled data that span from 2009-2018. The results depend on how the 5 estimated models have been specified and the relationship differs across the models. One of the models shows that there is a significance between crop diversity and the growth rate for value added per hectare in high-yield areas between all the years except for 2010, which to some extent confirmed the hypothesis of a higher economic performance with crop diversity in high yield areas. These results are of interest for policymakers and farmers when deciding on implementation of crop diversity. For policymakers it is important not to force crop diversity on all locations, especially if there are no economic compensation. A potential policy could mitigate some ecological harm and gain economic performance for high-yield areas. It is relevant for farmers who are thinking of implementing crop diversity to decide if it is justifiable or not, considering the economic outcome for the specific land. For farmers based in high-yield areas it is positive to implement crop diversity. Even though the thesis contributed to some valuable insights there are factors that needs to be considered to say more. Further research is necessary to fully evaluate the actual effects of the crop diversity over a longer period of time and also on farm-level which could be done by having a longer time period and bigger data set. A study could also be conducted in practical terms with two or more farms in different regions where the data and results are obtained in field-studies.

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Appendix 1

0509 Ödeshög
0580 Linköping
0583 Motala
0584 Vadstena
0586 Mjölby
0125 Ekerö
0139 Upplands-Bro
0486 Strängnäs
1880 Örebro
0483 Katrineholm
1446 Karlsborg
1471 Götene
1470 Vara
1494 Lidköping
1444 Grästorp
1487 Vänersborg
1445 Essunga
1315 Hylte
1380 Halmstad
1381 Laholm
1382 Falkenberg
1383 Varberg
1384 Kungsbacka
1281 Lund
1282 Landskrona
1283 Helsingborg
1284 Höganäs
1285 Eslöv
1286 Ystad
1287 Trelleborg
1290 Kristianstad
1291 Simrishamn
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