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Pierre Chiaverina[a1], Sophie Drogué[a], Florence Jacquet[a], Larry Lev[b] and Robert King[c]

[a]UMR MoISA, Univ Montpellier, CIRAD, CIHEAM-IAMM, INRAE, Institut Agro, IRD, Montpellier, France

[b]Oregon State University, Corvallis, OR, US

[c]University of Minnesota, St. Paul, MN, US

[1]Correspondence: Pierre Chiaverina, INRAE, UMR 1110 MoISA, 2 place Pierre-Viala - Bât. 26, 34060 Montpellier Cedex 2, France. Email: pierre.chiaverina@inrae.fr

Abstract:

Many researchers, policy makers and food activists view Short Food Supply Chains (SFSC) as attractive levers for improving farm income and the sustainability of farming systems. However, the empirical evidence documenting the association between SFSC participation and farm economic performance has been mixed. In this study, through a meta-analysis using a logistic regression, we identify key factors to explain differences between studies that find better economic performance in SFSC and those that do not. Our meta-analysis consists of 48 studies published in English and French from 2000 to 2022 that examine the economic performance of farms engaged in SFSC. Based on far more empirical evidence than previous reviews, we find that the relationship between SFSC participation and farmer income remains ambiguous. More specifically the findings indicate that the reported effect of SFSC on a farm economic performance varies depending on location and the indicator used to capture the economic performance of farms. Studies conducted in Europe are more likely to report higher farmer income as are studies that use profit satisfaction metrics rather than measures of gross or net income. We also emphasize the need to interpret the reported results cautiously because few are based on causal inference methods. Furthermore, the very few studies that account for selection bias often do so with inadequate corrections.

Keywords: Meta-analysis, Farmers, Short Food Supply Chains, Income, Economic performance

JEL CLASSIFICATION: Q13, Q14

1 Introduction

Local food supply systems (LFS) and short food supply chains (SFSC) have garnered increasing interest from academia and policy-makers in recent decades. Their development has been encouraged in the European Union (EU) by the European Agricultural Fund for Rural Development (EAFRD) devoting up to 10% of its expenditures to the promotion of food chain organization (Dwyer et al., 2016). Similarly, the U.S. Department of Agriculture through the 2014 Farm Bill invested $501.5 million over five years in diverse programs promoting local food production (Martinez, 2016). A growing number of farmers have chosen to market through SFSC and LFS even though this growth appears to be plateauing in the US (Low et al., 2015). By 2015, 15% of EU farms sold more than half of their production directly to consumers (European Parliament, 2016). In 2015, fewer than 9% of U.S. farms marketed food locally with 34% of them using only direct marketing channels (Martinez & Park, 2021).

There is no "official" definition of LFS, which has a strong subjective aspect related to local context. It refers most of the time to a distance of about 10 to 30 miles up to 100 miles between the point of production and the point of sale (Feldmann & Hamm, 2015) but can also be understood in relation to a recognized geographical area such as a county or a national park. By contrast, the EU rural development policy 2014-2020 has adopted a common definition of SFSC, defined as a supply chain including a minimal number of intermediaries (European Parliament, 2013). This is the case in France, where SFSC have been officially defined by the French Ministry of Agriculture as a marketing mode involving no more than one intermediary between the producer to the consumer and therefore including both direct sales as well as sales through an intermediary such as a cooperative or supermarket (LOI N° 2010-788, 2010; LOI N° 2010-874, 2010)[2].

The dividing line and relationship between LFS and SFSC is blurred because SFSC embrace diverse forms overlapping most of the time the local concept, regrouped in the "sales in proximity" category (Aubry & Chiffoleau, 2009). Therefore, the European literature refers mainly to SFSC owing to the difficulties of defining the "local" concept. However, the North American literature refers to LFS covering both direct-

[2] The term "circuit court" – short circuit - appears in the legal provisions, in Articles L. 1 and L. 111-2-2 of the Rural Code, in the 2010 law on the National Commitment for the Environment, and in the 2010 law on modernization of agriculture and fishing.

to-consumer (DTC) and intermediated sales (e.g., sales to institutions or regional distributors). In addition, most studies included in this analysis do not look at SFSC or LFS in their entirety but rather at something more restrictive such as direct marketing (DM) or at some component of DM such as community supported agriculture (CSA) or farmer markets (FM).

Public opinion often considers agricultural incomes as structurally lagging behind incomes in other sectors (Katchova, 2008; Rocchi, Marino, & Severini, 2021). The modernization of agriculture has put pressure on farmers to invest continuously in new technologies and produce for mass food markets, thereby squeezing economic margins (Ploeg et al., 2000). This increasing pressure on the value captured by farmers in conventional supply chains has favored the emergence of local distribution channels (Marsden, Banks, & Bristow, 2000; Renting, Marsden, & Banks, 2003). They represent an opportunity for farmers to capture more of the overall margin by eliminating intermediaries and offer direct access to consumers who are more willing to pay for locally produced foods. They can, therefore, contribute to improving the viability of farm households and, indirectly, increasing the resilience of agricultural and food systems (Darnhofer, 2014; Finger & El Benni, 2021). However, the positive impact of SFSC on farm viability has been questioned because of numerous obstacles hindering their performance (Plakias, Demko, & Katchova, 2020; Rucabado-Palomar & Cuéllar-Padilla, 2020). SFSC have limited sales volume, and sellers receive prices that may not cover their higher production and marketing costs (e.g. significant labor, packaging and transportation expenses) as well as transaction costs (e.g. information, negotiation and control costs) (Cesaro et al., 2020; Kneafsey et al., 2013; Uematsu & Mishra, 2016).

To the best of our knowledge, one report and two articles have conducted systematic reviews of the effect of SFSC participation on farm economic performance in addition to other aspects of their sustainability, and they find conflicting evidence (Chiffoleau & Dourian, 2020; Enthoven & Van den Broeck, 2021; Kneafsey et al., 2013). The results of the economic performance assessments of farms engaged in SFSC are difficult to compare because they are based on different methodologies and data. In addition, SFSC is an umbrella term covering a wide variety of marketing forms and levels of involvement such that the SFSC marketing strategies adopted by farmers influence their economic performance (Enthoven & Van den Broeck, 2021). Other variables such as farmer characteristics, time scale and geographic context might also affect the economic performance achieved within SFSC (Enthoven & Van den Broeck, 2021).

We conduct this meta-analysis to identify the structural characteristics that might explain differences between studies that find better economic performance in SFSC and those that do not. In addition, the literature search conducted for this meta-analysis is the first exclusively concentrated on the effect of SFSC participation on farm economic performance, allowing a more thorough analysis than previous reviews.

The paper is structured as follows. Section 2 provides a description of the methods employed in the meta-analysis and the systematic review protocol used. Section 3 presents the results of the meta-analysis. In the last two sections, we discuss our findings and present implications for future research and policy.

2 Methods

"Meta-analysis provides an objective approach to review empirical literature through applied statistical methods that allow testing for the effect of different factors on the empirical results reported in the literature" (Stanley & Jarrell, 2005). This meta-analysis seeks to identify the structural variables associated with conflicting results regarding the economic performance of farms involved in SFSC. First, we conduct a literature search to identify studies that examine the relationship between SFSC participation and farm economic performance (see part 2.1). Second, we identify structural variables that might distinguish studies finding positive economic effects for SFSC from those that do not (see part 2.2). Third, we use a logistic regression analysis that controls for differences in study design characteristics to determine which factors can explain variations in the economic performance of farmers using SFSC (see section 3).

2.1 Literature search and selection criteria

The literature review identifies all the articles investigating the effect of SFSC participation on farm economic performance. It is performed by following the checklist of the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) (Liberati et al., 2009) (Figure 1). The review protocol containing information on the search terms, databases, eligibility criteria and selection process is presented below.

2.1.1 Information sources and literature search

The literature review was conducted using Scopus and Web of Science databases that are among the most valued databases for this field of interest. We applied a combination of three lists of comprehensive search terms detailed in Table A1 in appendix, which explored the article title, abstract and keywords of every

published document identified. The list including “Farmer”,”Grower”, ”Rancher” or “Producer” keywords was mainly used in order to avoid an excess of unsuitable articles. Additional filters were used in order to limit the search within the social science discipline. The last search was run on October 16th 2022.

2.1.2 Eligibility criteria

The Population, Intervention, Comparison, Outcomes, and Study (PICOS) design criteria was used to identify both qualitative and quantitative papers (Table A2 in appendix). All English or French articles published in peer-reviewed journals from January 2000 to October 2022 analyzing the effect of SFSC participation on farm economic performance are included. Studies not conducted in Europe, Northern America or Australia where the specific context could induce different outcomes were also excluded. Finally, literature reviews, theses and dissertations, letters, book chapters, reports, author comments, and other grey literature were not included. Contrary to research articles which are mainly written in English, grey literature is usually published in the language of the country where the studies take place. Consequently, grey literature we might consider would have not been representative of other non-English and French-speaking countries. In addition, studies from the grey literature have not necessarily been subject to a peer-reviewed process and it is thus more difficult to assess their quality.

2.1.3 Study selection process

Figure 1 describes the process by which articles were selected for this analysis. After removing duplicates between the Scopus and Web of Science databases, 1321 candidate records were identified. Then two independent reviewers screened article titles and abstracts using an Excel spreadsheet, and disagreements between them were resolved through discussion. During this phase, 1226 records not meeting the eligibility criteria were excluded. The eligibility assessment continued with the lead author reviewing in detail the full-text of the 95 remaining articles. Among those, 50 records fell outside the scope of the review (not farmer specific or not conducted in Europe, Northern America or Australia) and were removed. Finally, we added three relevant studies to the 45 articles identified previously, leading to a total of 48 articles included in the literature review[3] (Figure 1).

[3] One relevant study was not identified through the PRISMA selection process because it was slightly outside the period range of this meta-analysis (Govindasamy, Hossain, & Adelaja, 1999), another was published in a journal not included in Web of Science or Scopus (Richard, Chevallier, Dellier, & Lagarde, 2014) while the third one was not identified for unknown reasons (Park, 2015).

2.1.4 Data Collection Process

Content analysis was conducted by lead author while a second author checked the extracted content. Every selected article was carefully read and the following information was tabulated by the lead author: authors, year, setting, supply chain characteristics, methodology, sampling, outcome unit, outcome focus and the effect found (Table B1 in appendix).

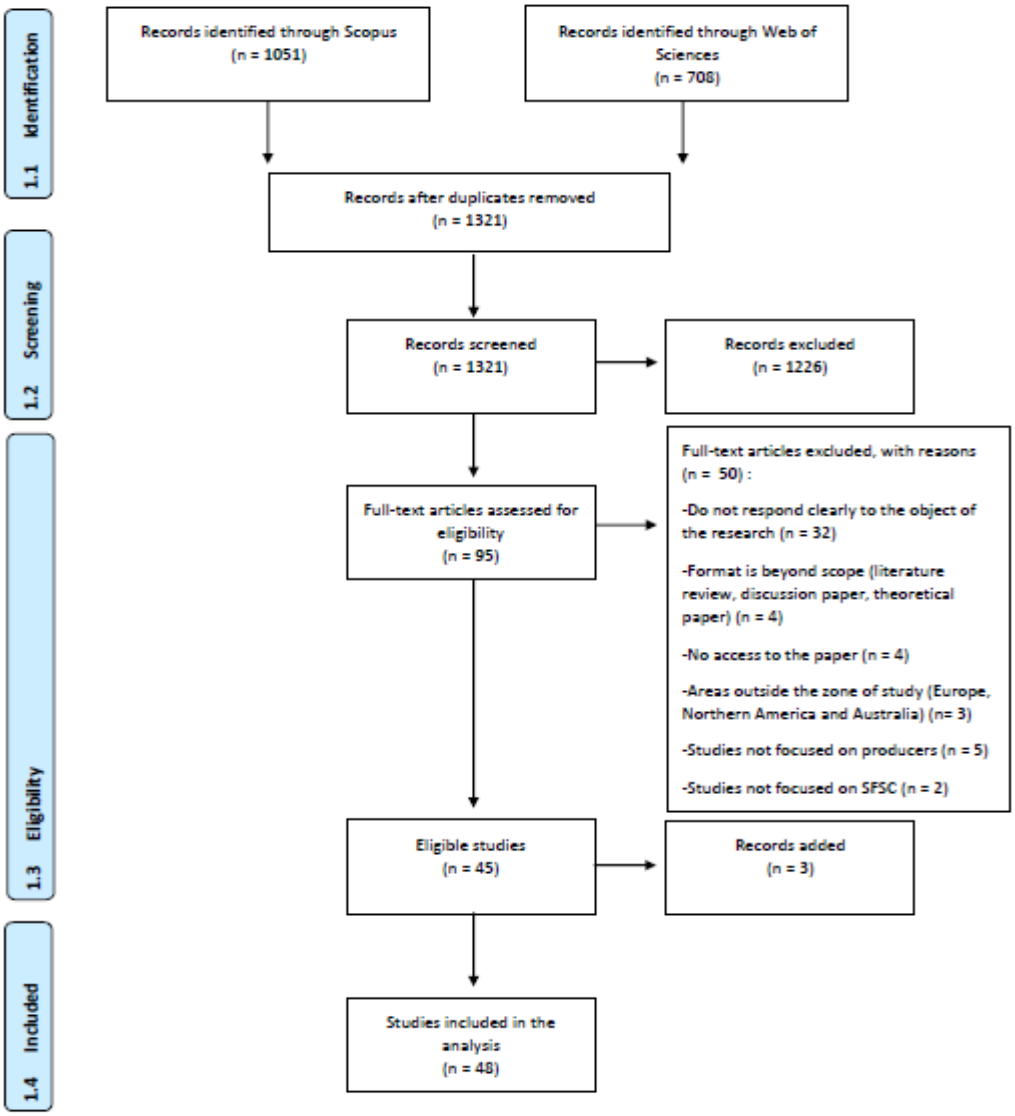

Figure 1. The PRISMA flow diagram

2.2 Meta-analysis

2.2.1 Structural variables

There is no guidance on which explanatory variables we should use; however, there are some study design characteristics that the literature indicates may have an impact on the economic performance of farmers in SFSC. In addition, some structural variables that have been frequently investigated in other meta-analyses might also affect the economic performance of farmers in SFSC. In this study, we classify the structural

variables investigated into four categories: data sources (secondary or survey data), study characteristics (study period, location, duration and number of SFSC forms examined), data analyses (endogeneity correction and analysis method) and dependent variables (outcome unit). Table 1 presents these variables, which are identified and coded.

First, we include variables that account for the nature of the data used in different studies. Because study accuracy depends upon the quality of the data analyzed, data should be accurate and contain few and only minor errors. Consequently, the data source is critical for the analysis. Data from secondary sources usually have larger farm samples, increasing the generalizability of the study results. In addition, their larger sample sizes provide results with lower standard errors, making it easier to distinguish the effects of SFSC from random noise (Lee, Choe, & Park, 2015). However, they lack detail and flexibility due to the use of predetermined categories (Lee et al., 2015). Kneafsey et al., (2013) argue that the positive results found by localized case studies, which often use small sample questionnaires, contrast with findings from large surveys, which more often report lower economic performance. The number of respondents from studies identified varies greatly, ranging from 3 to 78,559 (Table B1 in appendix). Twelve percent of the studies rely on samples that reflect the entire farm population (e.g. studies with samples based on census or representative sample data). We control for two types of data sources used in studies identified: field surveys and secondary databases.

Most of the studies use data for one year which may not be sufficient to provide a clear view of the economic performance of farmers engaged in SFSC. Farmers entering in SFSC may need several years before becoming viable, as SFSC participation may require investments and developing a customer base (Clark, 2020; Dono, Buttinelli, & Cortignani, 2022). Studies based on short-term data collection might, therefore, produce results more favorable to SFSC because they do not account for this establishment period. In addition, once a firm is established, time-varying factors (economic, climatic, etc.) can cause economic performance to vary over time. Therefore, panel data can help us to understand whether the positive performance is just a one-time occurrence or something the firm achieves consistently. To test the effect of using multiple year datasets, we include a duration variable composed of two categories: one year and multi-year.

The motivation for distinguishing between different study periods is that we want to examine whether the returns to SFSC participation have been stable, increasing or declining over time. In addition, compared to earlier studies, later studies generally display improvements in the models, methods and data employed. For example, all of the limited number of research studies that evaluate the causal impact of SFSC on farm economic performance with endogeneity correction were conducted since 2010. Similarly, in Europe, questions on supply chain participation are more detailed in the recent farm accountancy data network (FADN) surveys and agricultural census than the previous ones, allowing for studies with more representative and larger samples.

We also test whether results differ by location. Farming systems vary across countries and continents, which might affect the economic performance found in SFSC. In addition, farmers involved in SFSC might have different motivations and face different challenges depending on their location. To test for the role of location, we have classified the samples into two regions: Northern America and Europe.

Many studies fail to distinguish among SFSC types, even though there are a wide diversity of SFSC forms (Aubry & Kebir, 2013). For example, studies estimating causal impact often use a binary variable to designate farms using SFSC and provide limited or no descriptive statistics on the forms of SFSC used by farms in their samples. Considering all SFSC to be the same might blur the effect of SFSC on economic performance because it combines what could be opposing results of different SFSC types. In this meta-analysis, it is difficult to consider the different SFSC forms given the limited information available. However, we can distinguish between studies investigating the economic performance of a specific type of SFSC and those involving multiple SFSC forms. We test whether the results from studies focused on a single form of SFSC (FM and CSA in our case) differ from those that look at SFSC all inclusively.

Although a few studies evaluate the effect of SFSC on farm incomes based on causal inference methods, only a subset of these studies make use of regression analysis methods accounting for selection bias. This is partly due to the difficulties of measuring quantitatively the economic benefits of SFSC that could be invisible and confidential (Kneafsey et al., 2013) while finding valid instrumental variables (IV) (which are often used to address endogeneity issues) is one of the most challenging tasks in applied agricultural economic analysis (Kubitza & Krishna, 2020). We test the effect of employing causal inference accounting for selection bias by including a dummy variable equal to 1 if studies use such methods. Those studies

might provide different results because they control for unobserved factors affecting the adoption of SFSC that are correlated with farm income. When selectivity corrections are neglected, results might be biased indicating that earnings are over or underestimated.

Some studies examine the economic implications of SFSC involvement for farm viability while others compare the economic performance of farmers in SFSC to those in LFSC (long food supply chains). Consequently, they might provide different conclusions: farmers in SFSC might (not) be economically viable but achieve lower (higher) economic performance than ones in conventional markets. To test whether the nature of the analysis (relative/absolute) influences the results, we define a binary variable that distinguishes studies looking at viability of farms in SFSC from those comparing economic performance between SFSC and LFSC.

To investigate whether the economic effects of SFSC involvement might be affected by the types of economic measures used, we group the numerous economic indicators into three main categories: gross income, net income and farmer self-assessment of their business situation. First, studies considering gross income might provide more positive results than ones using net income because they do not consider production costs that could be higher in SFSC due to their high labor requirements. Second, we must recognize that the use of subjective performance measures may lead to findings that differ from those based on objective performance measures. In many studies, subjective and objective measures of farm performance have been often treated as equivalent although they are often not correlated (Jackson-Smith, Trechter, & Splett, 2004; Mäkinen, Rantamäki-Lahtinen, Ylätalo, & Vehkamäki, 2009). One explanation is that farmers are not very familiar with economic indicators typically used in business analysis. They rate their own financial success based on the liquidity available in their bank account for private consumption and to pay the bills (Mäkinen et al., 2009). Subjective ratings therefore reflect a broader view of farm performance than objective measures focused on more specific financial indicators capturing the production side of agriculture at the enterprise level. Subjective measures most often focus on overall performance at the household level reflecting the consumption possibilities of the farm family depending on both farm and nonfarm incomes. SFSC farmers are more likely to rely on non-agricultural diversification activities (e.g. equestrian activities) (Park, Paudel, & Sene, 2018; Rocchi, Randelli, Corsini, & Giampaolo, 2019) and off-farm work (Bruce & Som Castellano, 2016) helping them to stabilize their total household income (Mishra,

El-Osta, Morehart, Johnson, & Hopkins, 2002). In addition, these studies are more likely to rely on different types of methods (e.g. logistic regressions) and data (field survey) than other ones.

2.2.2 Regression model

This meta-analysis examines the impact of the previously described structural variables on the reported economic performance of farms engaged in SFSC. A logit regression is used to model the likelihood of a study finding a positive effect of SFSC on farmer economic performance as a function of the structural variables (Maddala, 1986). The model assumes an underlying latent success variable y_i^* defined by the relationship:

$$y_i^* = \beta' x_{ik} + \mu_i \quad (1)$$

Where we assume that μ_i are IN$(0, \sigma^2)$

However, in practice we observe y defined by

$$y_i = 1, \qquad \text{if } y_i^* > 0, \qquad y = 0 \text{ otherwise} \quad (2)$$

According to the logit model, the probability of a study finding a positive effect of SFSC on farmer economic performance ($Y_i = 1$), given its characteristics (x_i) is $Prob[Y_i = 1 \mid x_i]$ and can be specified as :

$$Prob[Y_i = 1 \mid x_i] = \frac{\exp(x_i'\beta + \varepsilon_i)}{\{1 + \exp(x_i'\beta + \varepsilon_i)\}} \quad (3)$$

The probability of finding a negative/neutral effect, $Prob[Y_i = 0 \mid x_i]$, is therefore

$$Prob[Y_i = 0 \mid x_i] = 1 - Prob[Y_i = 1 \mid x_i] = 1 - \left[\frac{\exp(x_i'\beta + \varepsilon_i)}{\{1 + \exp(x_i'\beta + \varepsilon_i)\}}\right] = \frac{1}{1 + \exp(x_i'\beta + \varepsilon_i)} \quad (4)$$

The relative odds of finding a positive versus negative effect are given by

$$\frac{Prob[Y_i = 1 \mid x_i]}{Prob[Y_i = 0 \mid x_i]} = \frac{[\exp(x_i'\beta + \varepsilon_i)][1 + \exp(x_i'\beta + \varepsilon_i)]}{[1 + \exp(x_i'\beta + \varepsilon_i)]} = \exp(x_i'\beta + \varepsilon_i) \quad (5)$$

By taking the logarithms of both sides,

$$ln\left[\frac{Prob[Y_i = 1 \mid x_i]}{Prob[Y_i = 0 \mid x_i]}\right] = x_i'\beta + \varepsilon_i \quad (6)$$

The maximum likelihood approach can be used to estimate the above equation.

The reduced form of the model is

$$EEFFECT = \alpha_0 + \beta_1 DSOURCE + \beta_2 DURATION + \beta_3 PERIOD + \beta_4 LOCATION + \beta_5 NSFSC + \beta_6 DANALYSIS + \beta_7 NANALYSIS + \beta_8 MEASURE \quad (7)$$

where our binary dependent variable (EEFFECT) equals one for studies reporting a positive effect of SFSC on farm economic performance and 0 for studies reporting a neutral or negative effect. The selected explanatory variables for this study include the data source (DSOURCE), the duration of data (DURATION), the period when the studies were set up (PERIOD); the location where the studies are conducted (LOCATION); the number of SFSC forms considered (NSFSC); whether the analysis employs causal inference accounting for selection bias (DANALYSIS); whether comparisons with performance in LFSC are made (NANALYSIS) and the types of economic measures used (MEASURE). A complete description of the variables that have been employed is given in (Table 1).

3 Results

3.1 Descriptive Statistics

Table 1 presents the frequency distribution for each of the structural variables examined. Approximately 54% of the 48 studies included in this analysis report a positive impact of SFSC participation on farm economic performance while 46% exhibit no effect or a negative impact. The number of publications evaluating the economic performance of farmers in SFSC has dramatically increased since 2016, reflecting increased research interest in this topic. More than 54% of the publications in this analysis were completed between 2016 and 2022. Most of the studies were conducted in North America (70%), particularly in the US[4]. The larger number of US articles may be explained by the availability of data, publication bias (number of academics in the US, etc.) and because the review is looking only at English and French language literature.

Among the 48 studies considered, 32 examine whether farmers using SFSC are more viable or have better economic performance than they would in conventional supply chains while the remaining 16 studies

[4] The single Australian study identified was included with the European studies.

consider whether farmers participating in SFSC are viable. The studies focus on one of three alternative performance measures; net income (60%), gross income (17%), or a self-assessment of the business situation (23%). Most studies rely on field surveys (60%) with data for a single year (85%). Only a few studies make use of regression analysis methods accounting for selection bias (13%). A limited number of studies focus on one SFSC form (25%), while most do not distinguish among multiple SFSC forms.

Table 1. Frequency distribution of structural variables and dependent variable

Structural variables	Abbreviation	Coding	Dimension	Number of observations
Data source	DSOURCE	0	Field survey	29 (60%)
		1	Secondary data	19 (40%)
Duration	DURATION	0	One year	41 (85%)
		1	Multi-year	7 (15%)
Study period	PERIOD	0	[2000-2010]	9 (19%)
		1	[2011-2015]	13 (27%)
		2	[2016-2022]	26 (54%)
Location	LOCATION	0	Europe	14 (30%)
		1	US	34 (70%)
Number of SFSC forms	NSFSC	0	One form of SFSC	12 (25%)
		1	Multiple forms of SFSC	36 (75%)
Data analysis	DANALYSIS	0	No Endogeneity correction	42 (87%) 6 (13%)
		1	Endogeneity correction	
Nature of the analysis	NANALYSIS	0	Farm viability	16 (33%)
		1	Comparison with conventional markets	32 (67%)
Types of economic measures	MEASURE	0	Gross income	8 (17%)
		1	Net income	29 (60%)
		2	Profit satisfaction	11 (23%)
Economic effect	EEFFECT	0	Negative or neutral	22 (46%)
		1	Positive	26 (54%)

3.2 Empirical model

Using logistic regression, we examine how different structural characteristics are associated with conflicting findings on the effect of SFSC engagement on farm economic performance.

Table 2 presents the results, which identify the structural variables that have a statistically significant association with findings of positive economic performance for SFSC participation. The empirical model also reports marginal effects, computed as the difference between the probabilities estimated at the sample

means when the outcome variable takes the values 1 and 0, respectively (Table 2, column 2). The confusion matrix evaluates the predictive performance of the logistic regression model by comparing the classification of the predicted responses with the effective values of the exogeneous variable in the sample. One of the most common indicators derived from the confusion matrix is accuracy, which is the percentage of correct predictions. Our model made 75% correct/appropriate predictions which is quite good considering the sample size and the number of predictors (Table 3).

The structural variables for outcome measure type and location are statistically significant. The profit satisfaction category exhibits a positive and statistically significant value, indicating that studies capturing economic performance with a profit satisfaction measure are more likely to report a positive economic effect of SFSC participation than studies using net or gross income measures. In terms of marginal effects, studies using a profit satisfaction measure are 75.7 percentage points more likely to report that SFSC adoption increases farm performance than studies using the gross income measures. The logistic regression results also reveal that the economic performance of SFSC depends on location. Studies conducted in US are significantly less likely to report positive economic benefits from participating in SFSC than those conducted in Europe. Marginal effects indicate that studies conducted in North America are 48.4 percentage points less likely to report a positive effect of SFSC adoption on farm performance than studies conducted in Europe (or Oceania). Other structural variables in the analysis are not statistically significant.

Table 2. Results of the logistic regression analysis of the economic performance benefits of Short Food Supply Chains

	(1) Coefficient estimate	(2) Marginal effect
DSOURCE		
Field surveys	-1.125	-.267
	(1.127)	(.250)
DURATION		
Multi-year	-1.624	-.374
	(1.308)	(.248)
PERIOD		
[2011-2015]	-1.698	-.399
	(1.301)	(.269)
[2016-2022]	-.597	-.132
	(1.161)	(.243)
LOCATION		
US	-2.352**	-.484***
	(1.047)	(.156)
NSFSC		
Multiple forms of SFSC	-1.386	-.311
	(1.143)	(.219)
DANALYSIS		
Endogeneity correction	-.662	-.163
	(1.736)	(.420)
NANALYSIS		
Comparison with conventional markets	.205	.050
	(.928)	(.230)
Types of economic measures		
Net income	1.879	.372
	(1.755)	(.247)
Profit satisfaction	3.982**	.757***
	(1.984)	(.219)
Constant	2.512	
	(2.379)	
Observations	48	
Pseudo R^2	.26	
ll	-24.482	
Chi^2	17.24	

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3. Confusion matrix

Actual Values / Predicted Values	Negative	Positive
Negative	14	4
Positive	8	22

4 Discussion

Based on far more empirical evidence than previous reviews, this meta-analysis does not establish an unambiguous relationship between SFSC participation and farmer income. However, our meta-analysis does show that the effect of SFSC on farm economic performance varies depending on location and the economic performance indicator used.

Better economic performance of SFSC is more likely in studies conducted in Europe rather than the US. This result does not indicate that all European farmers participating in SFSC are successful. Cesaro et al. (2020) show that SFSC adoption does not significantly affect farm performance in the majority of European member states. Notable exceptions exist, such as in Greece, Slovenia and Croatia where studies find a positive impact of SFSC participation on farm performance (Cesaro et al., 2020). Differences in economic performance between Europe and US might be explained by the specific differences in agricultural and marketing systems between these areas (Kneafsey et al., 2013). For example, lower economic performance found in US may be partly explained by the greater prevalence of CSA farmers than in Europe (7398 farms in US against 2783 in Europe in 2015, despite there being more farms in Europe (Martinez & Park, 2021; URGENCI, 2016)) who prioritize non-economic motivations more than participants in other forms of local marketing channels (Schoolman, Morton, Arbuckle, & Han, 2021).

It is unclear whether the differences in economic performance between Europe and US might be attributed to differences in the policy support for producers who sell through local markets. At the European level, policy support relies mainly on financial incentives from the EAFRD which has been implemented between 2014 and 2020 to promote investments in facilities for selling and processing agricultural products (Dwyer et al., 2016). Similarly, the Value-Added Producer Grant Program provides grant funding for agricultural producers in the US to add value to their products through processing and marketing. It is funded by the

2014 Farm Bill devoting investments of $501.5 million over 5 years in many programs promoting local food production. However, some differences exist in terms of policies promoting local food production. The USDA National Farm to School Program implemented in 2010 directly supports local food purchases in school procurement while the green public procurement (GPP) scheme introduced by the European Commission - to drive food procurement towards more sustainable supply and demand patterns - does not acknowledge territorial criteria. In addition, the EU has recognized the importance of labelling schemes for local products in order to support local farming, an approach that is less prominent in the US (Kneafsey et al., 2013).

We also demonstrate that better economic performance of SFSC is more likely to be found in studies using profit satisfaction rather than gross or net income. This is consistent with Kneafsey et al. (2013), who suggest that farmers' perceptions of their economic performance may differ from measured performance through farm accountancy networks. This might be explained by the fact that subjective rating reflects a broader view of farm performance than objective measures focused on more specific financial indicators. Subjective rating can reflect performance at the household level including income sources beyond the production and marketing of agricultural goods such as from non-farm activities and off-farm work. It could suggest that farmers involved in SFSC might earn an adequate income by supplementing their income from agricultural activities with non-agricultural income. Another possible explanation is that selling locally for many producers is a great source of enjoyment and there are benefits for the community that might compensate their relatively low monetary return (Sage, 2003; Silva, Dong, Mitchell, & Hendrickson, 2015).

Our meta-analysis reveals that results from studies focused on a single type of SFSC do not differ significantly from studies considering multiple ones. This is consistent with the literature that does not identify a specific SFSC form that works best for farmers. Some studies demonstrate that farmers using DM have lower economic performance than those using intermediated marketing channels (Bauman, Thilmany, & Jablonski, 2018, 2019). Azima and Mundler (2022) report the opposite effect while Park et al. (2018) find no significant differences between them. When considering more precise SFSC strategies, some studies report a negative impact for farmers participating in FM and CSA due to high competition, market saturation, consumers' low willingness to pay and inefficiencies in production (Galt et al., 2016; Silva et al., 2015; Uematsu & Mishra, 2016). In contrast, others find that CSA (Jablonski, Sullins, &

Thilmany, 2019; LeRoux, Schmit, Roth, & Streeter, 2010) and FM (Hunter, Norrman, & Berg, 2022; Schmit, Jablonski, & Laughton, 2019) achieve highest income or find no significant differences. Govindasamy et al. (1999) and Uematsu et al. (2016) report lowest financial performance for temporal marketing (e.g. roadside stores) and pick-your-own operations since they are available only for certain periods of the year and for certain seasonal products. Uematsu et al. (2016) and Silva et al. (2015) find higher economic performance for farmers selling to local retailers (e.g. regional distributors, local grocery stores, restaurants, and other local retailers).

The absence of significant effect for the few studies that account for selection bias might be explained by the fact that the correction they provide is often inadequate. Two studies account for selection bias only with the nonlinearity of the residuals from the first step model although using an instrument is highly recommended for a more robust identification (Park & Lohr, 2010; Park, Mishra, & Wozniak, 2014). In addition, some studies rely on instruments that might be considered as "bad instruments" which can lead to a bias in the resulting estimates that is much greater than the bias in OLS. Chen et al. (2019) use their endogenous explanatory variables aggregated at the county level (the number of farms adopting direct marketing) as an IV because having a large number of participants in DM provides farmers incentives to use this SFSC form. However, this IV clearly violates the exogeneity assumption as it might be confounded with other characteristics of the district encouraging farmers to participate in DM and simultaneously affect farm income. The vitality of the local retail environment is also used as IV and could also be suspected of violating the endogeneity condition (Park, 2015; Park et al., 2018).

5 Research and policy implications

Our findings have several implications for future studies addressing the economic consequences of SFSC participation. First, it is crucial to better understand the effect of SFSC participation on farm household income because it appears to differ from the effect determined through standard farm income measurements. It may also be necessary to investigate whether changes in farm business income are sufficient for reaching conclusions on the well-being of farm households (De Mey et al., 2016; Finger & El Benni, 2021).

Future assessments of farm economic performance in SFSC need to be expanded by taking into consideration additional sustainability indicators. Conducting and coordinating parallel meta-analyses of the social and environmental consequences of these supply chains could also be another avenue for research.

Because of the lack of information in the studies identified, this meta-analysis focuses almost entirely on the influence of structural variables related to study methodology without considering more fundamental contextual variables. Previous research demonstrates that the effect of participation in SFSC on farm performance varies as a function of the SFSC forms and the characteristics of the farmers, farms and the area where the farms are located (Enthoven & Van den Broeck, 2021). There is especially a lack of knowledge on the benefits of scaling up and using organic practices for farmers in SFSC (González-Azcárate, Cruz-Maceín, & Bardají, 2022; Mount, 2012). Although we cannot answer the question whether there is a SFSC scheme that works best, a very few studies have examined more closely the results for specific SFSC forms such that more research is needed.

Despite these variables not achieving statistical significance in our analysis, we recommend that future studies more cautiously employ regression analysis methods accounting for selection bias than previous ones. Identifying the potential IV before conducting any survey or considering data from non-standard surveys such as on location could improve the IV used. For example, the distance from the farm operators' home to the nearest large town has been used as an IV because it can influence the likelihood to adopt SFSC without affecting farm performance. In addition, we recommend the use of panel data which could increase the credibility of methods accounting for selection bias by controlling for time-invariant unobservable variables.

Based on our results, policymakers and outreach agencies should be aware that SFSC will not necessarily improve the purely economic performance of farms. However, we suggest that they should continue to recognize and build upon the multifunctional benefits (economic, social and environmental) of these supply chains. If the full set of benefits is considered to be attractive enough, society should consider providing additional resources and support to the producers who participate in these supply chains. Also, because the effect of SFSC participation on farm economic performance is ambiguous, the efficiency of federal support for SFSC must be given careful attention. Policy-makers need to define clear income targets for farmers

443 engaged in SFSC, especially during their start-up phase, and develop appropriate evaluation frameworks in
444 order to assess whether policy measures have achieved their expected outcomes and how they can be
445 improved. In addition, agricultural statistical surveys monitoring farm income and business activities need
446 to collect additional information on farm households' disposable income. They should allow comparable
447 analysis across countries and SFSC schemes by adding similar questions on supply chain participation in
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7 Appendix

7.1 Appendix A

Table A1. Keywords

Supply chain keywords	Population keywords	Topic keywords	Social science discipline filters
Local food	Farmer	**Farmer characteristics:**	**Web of Sciences**
Local market	Producer	Feature	Business Finance
Local supply chain	Rancher	Factor	Business
Alternative food	Grower	Characteristic	Agriculture Multidisciplinary
Short food supply chain		Determinant	Agricultural Economics & Policy
Direct marketing		Driver	Management
Direct-to-consumer		Typology	Political Science
Direct agricultural market		Type	Sociology
Direct sales		Attribute	Economics
Direct selling			Urban Studies
Shortened supply chain			Social Sciences Interdisciplinary
Direct Farm Marketing		**Farmer motivations:**	Regional & Urban Planning
Community supported agriculture Farmers market		Attitude	Geography
		Motivation	Social Issues
Farm-to-school		Expectation	Multidisciplinary sciences
Farm-to-institution		Willingness	**Scopus**
Innovative marketing		Incentive	Business, Management and Accounting
Locally grown		Reason	Social Sciences
		Goal	Economics, Econometrics and Finance
		Barriers:	Agricultural and Biological Sciences
		Barrier	
		Challenge	
		Obstacle	
		Constraint	
		Difficulties	
		Struggle	
		Income Impact	
		Profit	
		Income	
		Expenditure	
		Earning	
		Revenue	
		Return	
		Financial	
		Performance	
		Viability	
		Wage	

720 **Table A2.** The Population, Intervention, Comparison, Outcomes, and Study (PICOS) criteria.

Parameter	Inclusion criteria	Exclusion criteria
Population	Farmers	Articles outside the study zone (Europe, Northern America and Australia)
Intervention	Participation in local food system/short food supply chain	
Comparison	Not applicable	Not applicable
Outcomes	Characteristics, motivations, barriers and economic outcomes of farmers involved in SFSC	Articles not responding clearly to the object of research and to its purpose Articles not targeting SFSC
Study design	Both quantitative and qualitative studies	Literature reviews, theses and dissertations, letters, book chapters, reports, author's comments and other grey literature

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722 **Table A3**. Supply chain abbreviations

Supply chain name	Abbreviation
Alternative food system	AFN
Community supported agriculture	CSA
Direct marketing	DM
Farmers market	FM
Farm-to-institution	FTI
Farm-to-Restaurant	FTR
Long food supply chain	LFSC
Local food system	LFS
Short food supply chain	SFSC
Solidarity purchase group	SPG
Value-based supply chain	VBSC

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7.2 Appendix B

Table B1. Research articles examining the effect of SFSC participation on farm economic performance

	Author	Year	Setting	Supply chain	Farmer sample	Data analysis	Outcome unit	Nature of the analysis	Economic effect of SFSC
1	Govindasamy et al.	(1999)	US	DM	Farmer survey (n= 455 with 79% of farms engaged in retailing). Not representative of general farm population (NR)	Logit model	Profit satisfaction	LFSC comparison	Positive
2	Verhaegen and Van Huylenbroeck.	(2001)	Belgium	Innovative marketing channels	Interviews with actors involved in 6 innovative marketing channels (direct selling (2), co-operatives (2) and labelled traditional marketing channels (2)). NR	Cost–benefit analysis	Net income	LFSC comparison	Positive
3	Govindasamy et al.	(2003)	US	FM	Farmer survey (n= 36) of farms retailing at FM. NR	Logit model	Profit satisfaction	LFSC comparison	Positive
4	Hunt	(2007)	US	FM	Farmer (n=65) and other vendors (n=16) survey of farms marketing through FM. NR	Cluster analysis and probit model	Net income	LFSC comparison	Positive
5	Hardesty and Leff.	(2010)	US	FM, CSA and wholesale	Farmer interviews (n = 3 with 1 farms engaged in FM, 1 in CSA and 1 in wholesale). NR	Cost and return analysis	Net income	LFSC comparison	Negative/Neutral
6	LeRoux et al.	(2010)	US	FM, CSA, Farm stand and U-pick	Farmer interviews (n= 4, with farms marketing trough FM (1), CSA (1), Farm stand (1) and U-pick (1). Farmer survey (n= 14) of farms selling local food. NR	Cost and return analysis	Net income	LFSC comparison	Negative/Neutral
7	Park and Lohr.	(2010)	US	Local selling	Farmer survey (n=817) of farms selling local food. NR	Ordered probit model, Heckman's method	Gross income	LFSC comparison	Negative/Neutral
8	Lohr and Park.	(2010)	US	Local selling	Farmer survey (n= 787) of farms engaged in local selling. NR	Stochastic production frontier models	Gross income	LFSC comparison	Negative/Neutral
9	Detre et al.	(2011)	US	DM	ARMS (2002, n =11,303 farms with 3% of the farmers in the sample using DM). R	Probit model	Gross income	LFSC comparison	Positive
10	Schmit and Gómez.	(2011)	US	FM	Vendor survey in 27 FM (n=103) and market manager survey (n= 21). NR	Multinomial logit specification and ordinary least squares (OLS)	Profit satisfaction	Viability	Positive

11	Broderick et al.	(2011)	Australia	Farm-to-restaurant, supermarket and food service distributors, FM, home delivery	Farmer interviews (n=6) of farms engaged in SFSC. NR	Interviews	Net income	Viability	Positive
12	Galt et al.	(2012)	US	CSA	Farmer interviews (n=54) of farms engaged in CSA. NR	Descriptive statistics	Profit satisfaction	Viability	Negative/Neutral
13	Galt.	(2013)	US	CSA	Farmer interviews (n= 54) of farms engaged in CSA. NR	OLS model and interviews	Profit satisfaction	Viability	Negative/Neutral
14	Richard et al.	(2014)	France	SFSC	Farmer survey (n = 507) of farms engaged in SFSC. NR	Descriptive statistics and interviews	Net income	LFSC comparison	Positive
15	Kim et al.	(2014)	US	FM	Price data were collected, yields were provided by the USDA, cost of production are from various studies, Marketing costs are reported by Utah‘s growers using a survey	Simulation model	Net income	LFSC comparison	Positive
16	Park et al.	(2014)	US	DM	ARMS (2008, n = 340 with 10% of the farms in the sample use direct selling). NR	Multinomial logit (MNL) model with selectivity approach	Gross income	LFSC comparison	Negative/Neutral
17	Tudisca et al.	(2014)	Italy	SFSC (Direct sales, FM, e-commerce, farm shop, SPG and vending machines)	Farmer interviews (n=20) of farms marketing through AFN. NR	Descriptive statistics	Profit satisfaction	Viability	Positive
18	Silva et al.	(2015)	US	CSA, FTI, FTR, wholesale and FM	Farmer survey (n=135 with 60% of the respondents participate in wholesale markets, and less than half market to restaurants or institutions, with 47% using FM and more than 40% using CSA. NR	Multivariate probit model and ordered probit model	Profit satisfaction	LFSC comparison	Negative/Neutral
19	Hu and Shieh.	(2015)	US	Direct sales (« deliviery » to consumers, self-establishment of organic store, sales in private farms, market or on streets,	Farmer interviews (n= 274) of farms participating in direct and indirect sales. NR	Analysis of variance	Net income	LFSC comparison	Negative/Neutral

				production and marketing groups or cooperating with other farmers) Indirect sales (sales to middleman, production and marketing group, delivery companies, supermarket, organic specialty stores, restaurants and others)					
20	Park.	(2015)	US	DM	ARMS (2008-2010, n = 5183 with 646 farms using DM and 4537 not DM). R	Recentered Influence Functions apply on the Unconditional quantile regression model	Gross income	LFSC comparison	Negative/Neutral
21	Tudisca et al.	(2015)	Italy	DM	Farmer survey (n=30) of farms adopting a SFSC strategy. NR	Descriptive statistics	Net income	LFSC comparison	Positive
22	Galt et al.	(2016)	US	CSA	Farmer survey (n= 111) of farms engaged in CSA. NR	Descriptive statistics and correlation analysis	Net income	LFSC comparison	Negative/Neutral
23	Uematsu and Mishra.	(2016)	US	DM	ARMS (2008, n = 4,629 farms). DM strategy includes Roadside stores (n =161), direct sales to local grocery stores, restaurants, or other retailers (n =153), FM (n = 118), Regional distributors (57) and CSA (12). R	Quantile regression	Gross income	LFSC comparison	Negative/Neutral
24	Mundler and Laughrea.	(2016)	Canada	SFSC	Farmer survey (n=32) of farms engaged in SFSC. NR	Descriptive statistics compared to national averages	Net income	LFSC comparison	Negative/Neutral
25	Morel et al.	(2017)	France	DM	Farmer interviews (n= 20) of farms engaged in DM. NR	Stochastic Modeling	Viability	LFSC comparison	Positive
26	Bauman et al.	(2018)	US	DM	ARMS (2013, n= 17 474 farms with 1,013 selling local food). R	Descriptive statistics	Net income	LFSC comparison	Positive

27	Park et al.	(2018)	US	DM	ARMS (2008-2010, n = 5,959 farmers with 234 farms using only direct to consumers, 157 using only direct to retailers and 180 using both direct to retailers and consumers). R	Multinomial treatment effect model	Gross income	LFSC comparison	Negative/Neutral
28	Khanal et al.	(2018)	US	DM	ARMS survey (2012, n = 18,728 farmers) with 5.4% using direct selling. R	Unconditional quantile regression	Net income	LFSC comparison	Negative/Neutral
29	Morckel.	(2018)	US	FM	Farmer survey (n= 45) of farms engaged in FM. NR	Descriptive statistics	Profit satisfaction	Viability	Positive
30	Schmit et al.	(2019)	US	DM	Farmer sample (n= 67 with 47 farms using DM). NR	Means difference tests	Net income	LFSC comparison	Positive
31	Bauman et al.	(2019)	US	Direct-to-consumer and local sales from on-farm store, u-pick, roadside stands, CSAs and FM; local retail outlet such as a restaurant or grocery store; Regional distributor such as food hub; Local institutions such as school or hospital	ARMS (2013-2014, n= 44 536 with 2624 farms selling local food). R	Stochastic profit frontier model	Net income	LFSC comparison	Negative/Neutral
32	Brekken et al.	(2019)	US	Values-Based Supply Chain (VBSC) and DM	Farmer survey (n= 182) of farms engaged in VBSC. NR	TOA-MD Simulation	Net income	LFSC comparison	Positive
33	Chen et al.	(2019)	US	DM	ARMS (2012, n= 14960 with 7.17% of farms adopting DM). R	Bivariate binary choice model	Gross income	LFSC comparison	Negative
34	Malak-Rawlikowska et al.	(2019)	Europe	SFSC (pick your own, sales to individual consumers, Internet deliveries, delivery to consumer, FM, Sales to small	Farmer survey (n=186 with 65% of farms engaged in SFSC) NR	Descriptive statistics	Net income	LFSC comparison	Positive

				retail outlets (one intermediary))					
35	Sroka et al.	(2019)	Germany	DM	Farmer survey (n=199 with 56 using DM). NR	Classification and regression trees	Profit satisfaction	LFSC comparison	Positive
36	Paul.	(2019)	US	CSA	Farmer interviews (n=16) of farms engaged in CSA. NR	Interviews	Net income	LFSC comparison	Positive
37	Clark.	(2020)	US	On-farm selling	Case study on one farm. NR	Cost and return analysis	Viability	Net income	Negative
38	Jablonski et al.	(2020)	US	SFSC (FM, roadside stands, and u-pick), Intermediated channels (direct to restaurants, institutions, or to regional aggregators)	USDA ARMS (2013–16 , n = 78,559 farms) of farms selling local or non-local food. R Samples include 73,191 (positive labor expenditure) and 26,694 (positive wage) producers without local sales and 3,899 (positive labor expenditure) and 1,569 (positive wage) producers with local food sales	Descriptive statistics	Net income	LFSC comparison	Positive
39	Mundler and Jean-Gagnon.	(2020)	Canada	SFSC	Farmer survey (n=32) of farms involved in SFSC. NR	Descriptive statistics compared to national averages	Net income	LFSC comparison	Negative/Neutral
40	Alonso Uga glia et al.	(2020)	France	SFSC	Farmer interviews (n=48) of farms engaged in SFSC. NR	Interviews	Net income	Viability	Positive
41	Hochuli et al.	(2021)	Switzerland	DM	Agroscope annually surveys (n = 3500 dairy farms with 1019 using DM). R	Descriptive statistics and non-parametric test	Net income	LFSC comparison	Negative/Neutral
42	Medici et al.	(2021)	Italy	CSA	Interviews (n = 19 CSA). NR	Descriptive statistics	Profit satisfaction	Viability	Positive
43	Floris	(2021)	Slovakia	SFSC	Farmer survey (n= 43 with 17 in SFSC)	Descriptive statistics	Net income	LFSC comparison	Positive
44	Jablonski et al.	(2022)	US	LFS	USDA ARMS (2013–2016, n = 3,908 beginner farmers using LFS).NR	Descriptive statistics	Net income	viability	Positive
45	Azima et al.	(2022)	Canada	DM	Farmer survey (n=613 farms using DM). NR	OLS controlling for endogeneity	Profit satisfaction	Viability	Positive
46	Hunter et al.	(2022)	Swedish	SFSC	Farmer survey (n=286 farms involved in SFSC) NR	Bi-variate correlations	Net income	viability	Negative/Neutral
47	Dono et al.	(2022)	Italy	DM	Farm accountancy data network (FADN, 2014-2016, n = 4612 with 17.6% of farms using DM) NR	Descriptive statistics, parametric and non-parametric test	Net income	LFSC comparison	Negative/Neutral

48	Floriš et al.	(2022)	Slovakia	DM	Farmer survey (n = 43 farms with 17 involved in SFSC) NR	Descriptive statistics	Profit satisfaction	LFSC comparison	Positive