Conventionalisation of organic agriculture: an analysis of organic crop farms in Italy

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Abstract

Conventionalisation in organic agriculture (OA) was defined by Darnhofer et al. (2010), in their extensive review on the topic, as “the introduction of farming practices that undermine the principles of organic farming”. To measure the phenomenon properly, it’s necessary to consider organic farms as a whole entity, based on IFOAM values. With this idea in mind, Darnhofer et al. (2010) outlined a framework to be used as guideline in future research on conventionalisation. This study proposes a way to operationalize that framework, using a set of indicators to verify the conventionalisation trend in Italy, focusing on organic crop farms. Were used data at farm level from RICA (FADN) dataset from 2008 to 2015. Through the construction of a composite indicator, was obtained a score per farm that can be interpreted as a conventionalisation degree of the farm. This indicator was later used to verify the conventionalisation trend in Italy and to identify whether a relation between this exist and the economic farm performance. The analysis shows that crop farms seems to be more conventionalized in recent years. However, the economic performance and conventionalisation indicator are not overall positive correlated, except for a specific crop farm size, from 20 to 30 hectares.

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1. Introduction

1.1 Organic agriculture history and IFOAM principles

In the mid twentieth century in Europe and all over the world the agricultural production was boosted by the green revolution (Khush 1999). This revolution helped many nations worldwide to inflict a blow to malnutrition (Meena et al. 2013) but the same time it had some negative consequences on the environment. In fact, due to the huge amount of pesticides, chemical fertilizer and bad agronomic practices like monoculture, the soil started to degrade; food quality declined (residues from pesticides based on toxic elements such as arsenic, mercury or copper) and even the social and economic situation in the countryside changed dramatically with migration from the land, declining of rural tradition and rural lifestyle (Vogt 2007).

During '20s and '30s some people, the organic farming pioneers, started to search for alternatives to this unsustainable production scheme. At the same time some new scientific studies about mycorrhizal fungi, agricultural bacteriology, dynamics of soil organic matter and the relations between plant roots and soil, came out. By applying new farming practices, based on these studies, farmers improved farming methods in areas such as soil cultivation, composting, organic fertilization, green manuring and crop rotation (Vogt 2007).

During '50s and '60s organic agriculture started to grow especially in Germany, Switzerland, France and UK, each country with its own private certification bodies and different standards.

During the '70s there was a raising desire to have a unified system of rules, in order to remove any barriers of free trade, and this led to the foundation in 1972 of the International Federation of Organic Agriculture Movements (IFOAM) (Luttikholt 2007).

EU also became interested in organic agriculture mainly because it was seen as a public good, delivering environmental and social (especially in rural areas) benefits. For this and other reasons (reduce confusion and fraud for both consumers and producers, and assist the development of a common market for organic food) the EU began to draft legislation defining organic crop production that became law in 1993, while organic animal livestock were regulated in 2000 (Padel et al. 2009).

In 1992 the CAP was reformed and was introduced the agro-environmental support program, implemented from 1994. This was the very first kind of economic support by EU to organic farmers that later in the years increased with the introduction of direct payments.

Organic agriculture is based on values and principles, which were defined by IFOAM in order to inspire action:

- The principle of **health**: "Organic agriculture should sustain and enhance the health of soil, plant, animal and human as one and indivisible";
- the principle of **ecology**: "Organic agriculture should be based on living ecological systems and cycles, work with them, emulate them and help sustain them";
- the principle of **fairness**: "Organic agriculture should build on relationships that ensure fairness with regard to the common environment and life opportunities"; and
- the principle of **care**: "Organic agriculture should be man- aged in a precautionary and responsible manner to protect the health and well-being of current and future generations and the environment".

The main problem with the EU organic standards is that they don't take into account all the original principles and values of organic farming by IFOAM. This is due mainly because the values that are more difficult to operationalize are not translated into rules (Padel et al. 2009) but also because stricter and more specific standards could be difficult to implement in organic agriculture, which is very diverse regionally. The ideal situation, as indicated by IFOAM, would be a good balance between ethical principles and legal regulations (Luttikholt 2007).

1.2 Conventionalisation hypothesis

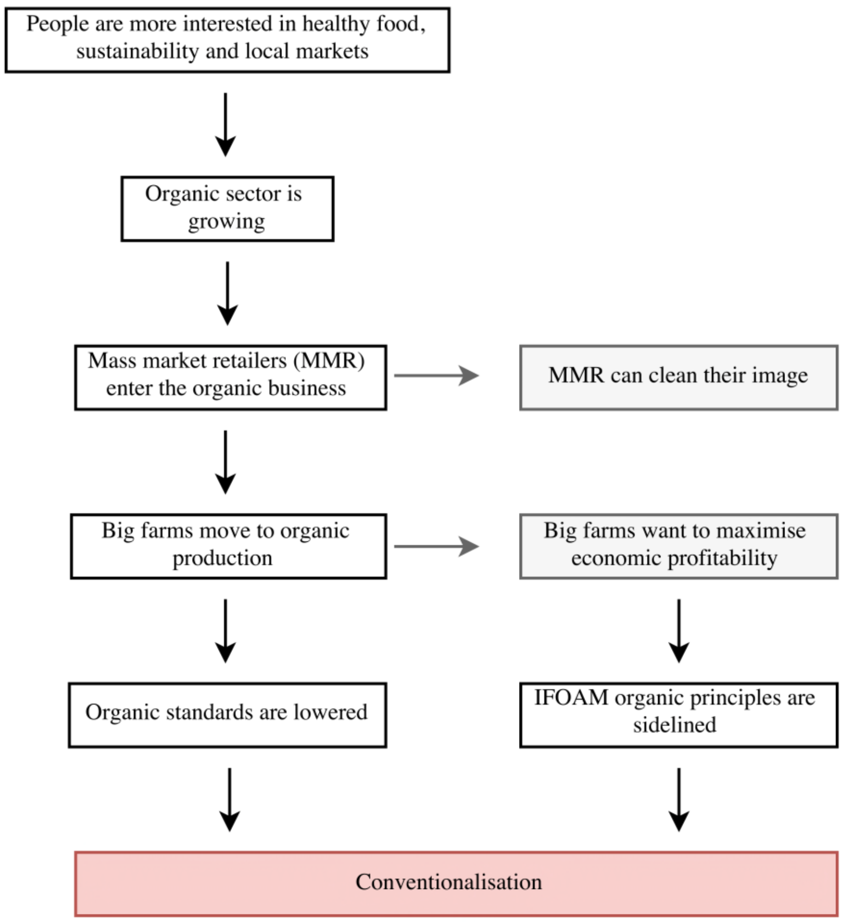


Figure 1: The diagram shows the origins and main causes of conventionalisation

Buck, Getz, & Guthman in 1997 were the first to came out with the conventionalisation theory. They argued that some agribusiness firms in California, due to the growth of organic sector, were appropriating of the most lucrative organic commodity chains and were going to abandon the agronomic and marketing practices typical of organic agriculture.

Later, other research came out studying the phenomenon in Brazil, China, Egypt, Australia and Ontario (Oelofse et al. 2011, Hall & Mogyorody 2001) identifying conventionalisation under different aspect.

Darnhofer et al. (2010), in their extensive review on conventionalisation gave a definition of the trend: “organic farming is becoming a slightly modified version of modern conventional agriculture”. They also propose to define conventionalisation “as the introduction of farming practices that undermine the principles of organic farming”. In fact, many farms are becoming larger by implementing economies of scale; they are increasing reliance on non-farm inputs and implementing resources substitution. They also argue that this trend implies some changes in farming practices and for this reason the process of conventionalisation should be clearly evident at farm level.

Another reason of conventionalisation could be the discrepancy between IFOAM principles and the EU legislation on organic production, as addressed by De Wit & Verhoog (2007).

Organic agriculture was originally subsidized due to its positive externalities on the environment (on soil, water, climate change and people's health) and rural society. Conventionalised organic farms respect only the minimum criteria imposed by the law and do not take into account all the organic principles, but at same time they get identical subsidies of "real" organic farm. For these reasons, the conventionalisation trend may undermine the whole organic sector and jeopardize the economic contribution from European Union through the CAP.

The diagram in Figure 1 tries to schematize, according to different literature sources on the topic, the origins and the main causes of conventionalisation.

1.3 Research question

Darnhofer et al. (2010), identified some weaknesses in methods used in previous studies on conventionalisation phenomenon. The main three are the lack of data at farm level, which implies the impossibility to make distinction between farm type; the lack of statistical time-series data that is needed to assess long term trends and lastly the unreliability of many "symptoms" that have been used to identify conventionalisation at the farm level.
Therefore, in this study was conducted an analysis that try to overcome all those weaknesses in methodology's previous research, by using Italian FADN dataset (RICA) that contains farm level data from 2008 to 2015 combined with the assessment framework suggested by Darnhofer et al. (2010).

The study objective is, thus, to investigate whether there is a recent conventionalisation trend in Italian agriculture and if conventionalised organic farms have a better economic performance than organic farms.

The main research question is formulated as follow:

- Is there a clear trend of conventionalisation in Italian organic farming? And to what extent does conventionalisation influence the economic performance of organic farms?

The research question can be decomposed in the following sub questions:

1. Which are the differences between the original principles of organic agriculture and the EU organic production requirements?
2. How to use conventionalisation indicators to assess whether an organic farm is conventionalised?
3. Is there a recent conventionalisation trend in Italian agriculture?
4. Which are good economic indicators to assess the performance of a farm?
5. Is there a relation between the economic performance of an organic farm and its degree of conventionalisation?

Sub question 1 is answered in paragraph 1 and 2 through a literature research. Sub question 2 is answered in paragraph 3.3 and 5.2. Sub question 3 is tackled in paragraph 4.2 through the analysis results. Sub question 4 is explained in paragraph 3.4 through literature research. The results to sub question 5 are presented in paragraph 4.3.

2. Theoretical framework

In their review paper, Darnhofer et al. (2010), differentiated from previous researches on conventionalisation, proposing a different methodology to measure the phenomenon. They argue that it's necessary to identify the right indicators for conventionalisation directly from IFOAM principles by using a hierarchical framework. In fact, up to that point, conventionalisation was measured finding every change in agricultural practices from the pioneers' organic values. There is no doubt that organic agriculture (OA) is changing, but Darnhofer et al. (2010) assert that not every change is necessary bad and that OA shouldn't be limited to the practices and methods of the pioneers. Rather, as also included in IFOAM principles (IFOAM, 2005), OA should be a dynamic system that continuously adapt and review existing methods.

For these reasons, they developed the hierarchical framework linking all IFOAM principles, criteria, indicators and reference values. In this way, it is possible to understand the farm as a complex organism rather than the sum of different activities.

The indicators used to assess conventionalisation in crop production proposed by Darnhofer et al. (2010), are shown in Table 1. They are oriented to identity a production logic aiming to maximise production.

Some indicators are also linked to economic profitability, because it is what the most guide conventionalised farming. In fact, despite in OA long-term sustainability should be preferred to short-term objective, some farms could for example reduce the share of legumes in rotation in a year because they generally have a low gross margin.

Indicators of conventionalisation	Justification and comments	Principles of organic farming
Low share of legumes in the crop rotation	Legumes are necessary for humus build-up and a key element of the nitrogen supply. As an indicative reference value, there should be at least 20% legumes, but this could be higher, depending on the agro-ecological specificities of a site	Ecology – Production is to be based on ecological pro- cesses. Nourishment is achieved through the ecology of the specific production environment. In the case of crops this is based on soil fertility and diverse crop rotation (to build up resilience of the agro-ecological system)
High share of cereals in the crop rotation	A high share of cereals tends to lead to plant diseases and pests, deficiencies in the nutrient supply and poor humus build-up. As an indicative reference value, cereals should not use more than 70% in the crop rotation	Ecology – Organic agriculture should attain ecological balance and resilience (see above) through the design of cropping/farming systems

Inadequate crop rotation or unbalanced crop sequence.	The incidence of (soil-borne) pests, diseases and weeds increases. Also, crop rotations are needed to balance the soil nutrient demands of various crops and to avoid soil depletion	Ecology – Organic agriculture should be based on living agro-ecological systems and cycles, work with them, emulate them and help sustain them
Reliance of easily soluble (nitrogen) fertilisers (e.g vinasse)	High levels of easily soluble nutrients (esp. nitrogen) threaten plant health, lower product quality and lead to problematic NO3 and N2O emissions.	Ecology – Production is to be based on ecological processes and recycling.
Prolonged and intensive use of plant protection products that are known to be problematic (e.g sulphur, copper, pyrethrum).	These products are known to be toxic and to accumulate in the soil. They threaten beneficial insects and soil fertility	Ecology and Health – Organic agriculture should avoid the use of fertilisers, pesticides, etc. that may have negative ecological and health effects.
Widespread use of practices that require a high level of external inputs (energy, fertilisers, feedstuffs, materials).	A farm (or a region) should aim at a balanced energy and nutrient budget and not be excessively dependent on external inputs. External inputs tend to be linked to high levels of CO2 emissions and energy use.	Ecology – Inputs should be reduced by reuse, recycling and efficient management of materials and energy in order to maintain and improve environmental quality and conserve resources.
High share of varieties or cultivars which are not adapted to organic farming.	As the varieties are not adapted to the local agro-ecosystem and/or organic management they do not lead to sTable yields appropriate to the local conditions. They usually require higher levels of external inputs.	Ecology – Organic management must be adapted to local conditions, ecology, culture and scale, in order to build up agro-ecological resilience
Low level of biodiversity on the cropland	The agro-ecological stability and the biodiversity are reduced. Cropland biodiversity includes the types of crops planted each year, and the number of cultivars used for a crop as well as the varieties used as green manure.	Ecology – Organic cropping is based on resilient agro- ecological systems, where biodiversity plays an important role. Organic agriculture should contribute to the maintenance of genetic and agricultural diversity
Low level of biodiversity around the cropland (e.g., hedges, field margins).	Reduced agro-ecological stability (e.g. of beneficial organisms), poor protection of natural resources, lack of habitats and lack of contribution towards the cultural landscape.	Ecology – Organic farming should protect and benefit biodiversity (e.g. rare species), air and water. Role of biodiversity in resilience.
Few measures to actively protect and care for ecologically sensitive areas on the farm (e.g., ponds, marshes)	Reduced agro-ecological stability; lack of habitats. These areas are often of high ecological value, but of low economic/productive value.	Ecology – Those who produce organic products should protect and benefit the common environment including landscapes [and] habitats.

Table 1: conventionalisation indicators for crop farms as suggested by Darnhofer et al. (2010)

3. Data and Methodology

It is important to underline that the framework (Table 2) has never been operationalised. This would be the first attempt in trying to use it with real data currently available.

In the first step were identified and downloaded the right data from RICA website. In the second step the 7 indicators were built and merged. Third step consisted in preparing indicators for building the composite indicator. The fourth step consisted in a correlation analysis between the conventionalisation indicator and the three farm economic indicators.

3.1 RICA (FADN) database

The Farm Accountancy Data Network (FADN) was launched in 1965 as an instrument for evaluating the income of agricultural holdings and the impacts of the Common Agricultural Policy. It consists of an annual survey carried out by the Member States of the European Union. Each country, through its Liaison Agency, is responsible for collecting accountancy data from a sample of the agricultural holdings in its territory. Derived from national surveys, the FADN is the only source of microeconomic data that is harmonised between all EU countries. The survey does not cover all the agricultural holdings in the Union but only those which due to their size could be commercially considered.

The aim of the network is to gather accountancy data from farms for the determination of incomes and business analysis of agricultural holdings. Currently, the annual sample covers approximately 80.000 holdings. They represent a population of about 5.000.000 farms in the EU, which covers approximately 90% of the total Utilised Agricultural Area (UAA) and account for about 90% of the total agricultural production. The information collected, for each sample farm, concerns approximately 1000 variables. These variables aim to provide data along three dimensions: region, economic size and type of farming (European commission, 2013).

The responsible agency in charge of collecting data in Italy is the "consiglio per la ricerca in agricoltura e l'analisi dell'economia agraria" (CREA) (Council for research in agriculture and analysis of agricultural economy), which operates under the Italian Ministry of Agricultural Policies. All the data are collected in the RICA database, which is also an instrument through it is possible to use and analyse data. The database is constituted by 11.000 Italian holdings which are selected in order to include all the different farm typology and size and cover 95% of UAA and 97% of the total agricultural production (RICA, 2017). This study is focused on organic crop farms whose representation in the RICA database is highlighted in Table 2.

Year \ **RICA category**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Tot.**
2008	73	2	130	61	1	41	5	313
2009	34	1	71	38	1	19	5	169
2010	45	2	169	72	3	22	2	315
2011	60	3	273	72	5	35	3	451
2012	63	6	255	72	8	42	2	448
2013	56	6	261	64	8	52	2	449
2014	58	4	281	64	7	46	4	464
2015	63	3	270	64	6	34	3	443
Tot.	452	27	1710	507	39	291	26	3052

Table 2: Organic farms in RICA/FADN dataset per year and farm category: 1= crop; 2= horticulture and floriculture; 3=permanent crops; 4=herbivorous animals; 5=granivorous animals; 6=polyculture; 7=different animals

CREA every year provide to the farms, a form to fill in and the related instructions. The content and the structure of the form is in accordance with EU regulation. However, only a minimum level of information is regulated by law, while many agency, including CREA, collect much more data that uses for internal analysis. After a first quality check by the agency, data is electronically sent to the commission which operate a second quality check before they can be published.
The variables are divided in 25 main categories; e.g. crop field information and balance sheet.

3.2 From RICA data to actual indicators

Firstly, the required information to create each indicator were selected and downloaded from RICA online database. Despite this is the most complete dataset at farm level currently available in Italy, not all needed values to measure conventionalisation were present. Table 3 shows the indicators as proposed by Darnhofer et al. (2010) and the indicators used in this research and how they were calculated.

	Indicators of conventionalisation as proposed by Darnhofer et al. (2010)	Indicators calculation
1.	Low share of legumes in the crop rotation	Legumes (ha) / UAA
2.	High share of cereals in the crop rotation	Cereals (ha) / UAA
	~~Inadequate crop rotation or unbalanced crop sequence.~~	No information to estimate it
3.	Reliance of easily soluble (nitrogen) fertilisers (e.g vinasse)	Kg of easily soluble fertiliser / UAA
4.	Prolonged and intensive use of plant protection products that are known to be problematic (e.g sulphur, copper, pyrethrum).	Kg of plant protection product / UAA
5.	Widespread use of practices that require a high level of external inputs (energy, fertilisers, feedstuffs, materials).	(Cost of water + electricity + fuel + pesticide + herbicide + feed + litter) / total operating costs / UAA
	~~High share of varieties or cultivars which are not adapted to organic farming.~~	No information to estimate it
6.	Low level of biodiversity on the cropland	N° of crop variety / UAA
7.	Low level of biodiversity around the cropland (e.g., hedges, field margins).	Payment from ecological subsidies / UAA
	~~Few measures to actively protect and care for ecologically sensitive areas on the farm~~	No information to estimate it

Table 3: conventionalisation indicators selected in this study and how they were calculated

3.2.1 Data selection and extraction from RICA dataset

The selection of data needed was made directly on RICA webpage. In fact, the database interface allows to select one by one the data and download it in ".csv" file. Were selected all the regions in Italy and all the year available; from 2008 to 2015.

Different data were selected based in the indicator. Table 4 shows the data used in detail, for each indicator.

	Data	Variable name in STATA
Common data between indicators	Year	year
	Farm unique identification code	farm_id
	Farm category	farm_category
INDICATORS (Name in STATA)		
Share of legumes (share_legumes)	Utilised Agricultural Area	UAA
	Species name	Species
	Species identification number	species_id
	Hectare per specie	species_ha
Share of cereals (share_cereals)	Utilised Agricultural Area	UAA
	Species name	Species
	Species identification number	species_id
	Hectare per specie	species_ha
Easily soluble fertilisers (minfert_ha)	Utilised Agricultural Area	UAA
	Fertiliser category name	fertiliser_category
	Fertiliser category number	fertiliser_id
	Fertiliser distributed per hectare (Kg)	fertiliser_ha
Plant protection products (protection_ha)	Utilised Agricultural Area	UAA
	Plant protection category name	protection_category
	Fertiliser category number	protection_id
	Plant protection distributed per hectare (Kg)	protection_ha
Level of external inputs (share_ext_input)	Cost for water, electricity and fuel	water_elect_fuel
	Costs for pesticides and herbicides	prot_pest
	Cost of fertiliser	fertiliser
	Costs of fodder	fodder
	Costs of feed	feed
	Operating costs	operating_costs
	Utilised Agricultural Area	UAA
Biodiversity on the cropland (variety_ha)	Utilised Agricultural Area	UAA
	Species name	species
	Species identification number	species_id
Biodiversity around the cropland (eco_subsidies_ha)	Codice tipo aiuto	subsidy_id
	Subsidy amount	subsidy_amount
	Utilised Agricultural Area	UAA

Table 4: column 1 shows the conventionalisation indicators and the corresponding name in STATA; in column 2 are shown the data in RICA/FADN dataset used to calculate each indicator; in column 3 are shown the variable name in STATA

3.2.2 Building the indicators

The exported variables were then imported in STATA that was used to build the 7 indicators. Some common operations were made for all the indicators. Variables were renamed in English and in an easier way to understand; were eliminated all the farms that didn't belong to the production category "Crop Farm". These, by EU definition, are farms with at least 2/3 of the "Standard Output[1]" coming from one of the crop shown in Table 5.

RICA Category 1 – Crop farms	
Rice	Tobacco
Wheat	Rapeseed
Durum wheat	Sunflower
Rye	Soy
Barley	Flaax seed
Oats	Hemp
Corn	Medical and aromatic plants
Other cereals (Sorghum, Millet, Spelt…)	Spices
Dried Legumes (Fava bean, bean chickpea, lentil)	Horticulture
Potatoes	Grasslands
Beetroot	Pasture
Hops	Seedling for arable land

Table 5: crops that a farm should produce to be part of RICA category 1

Other operations in STATA differed depending on the indicators to calculate. The following paragraphs explain the methodology applied to calculate each of the 7 indicators used in the research.
Despite Darnhofer et al. (2010) in their framework suggested to set reference values, in this research all the indicators were used to build the composite indicator as they were found from calculations showed in Table 3.

1. In computing the first indicator, were selected among all the species, only the **legumes**, or rather, species that belong to the Family *Fabaceae.* The selected species are shown in Appendix 1, Table 14. Then, all the entries that were not legumes were deleted from the database. Later, the hectares of legumes were added together in order to obtain a single value for each farm in every year. Finally, the actual indicator was generated per farm per year, by diving the number of hectares of legumes per farm's UAA. According to the framework, legumes should occupy at least 20% of crop rotation. In this research was not identified a threshold above and below 20% neither other percentage; the indicator was used according to the principle "the higher is better".

2. For the second indicator, an identical approach as legumes was used. Firstly, were selected only the plant considered a **cereal**. The world "cereal" is not part of taxonomy and for this reason was used the definition and classification given by FAO (1994). In appendix 1, the Table 15 shows which species of cereals were used in this research. The actual indicator was generated per farm per year, by

[1] Standard Output (SO): It's the average monetary value of the agricultural output at farm-gate price, in euro per hectare per head of livestock. The sum of all the SO per hectare of crop and per head of livestock in a farm is a measure of its overall economic size and it is used to classify agricultural holding by type.

diving the number of cereal's hectares per farm's UAA. Even in this case was not identified a threshold (<70% as proposed in the framework), but rather was used according to the principle "the lower is better".

3. The third indicator represents the quantity of **mineral and fast absorption fertilisers**. In appendix 1, the Table 16 shows which fertiliser categories were chosen. Mineral and synthetic fertilizer are much more easily absorbable than manure and if not used properly can lead to percolation and leaching damaging the environment. Furthermore, they need to be bought from outside the farm, violating the Ecology principle (refers to section 1.1). According to this, organic farms should reduce inputs by reuse, recycling and efficient management of materials and energy (Luttikholt, 2007). The indicator was built by adding up the Kg of selected fertilisers used per farm and year and divided it by farm's UAA. It was used according to the principle "the lower is better".

4. The fourth indicator is about the **plant protection product**. The indicator was calculated by selecting the protection products in Appendix 1, Table 17 and adding up the quantity (Kg) used per hectare, per farm per year and divided per farm's UAA. The indicator measure how intensive is the use of these products but not if it was prolonged, as indicated in the framework since temporal information was not present in the dataset. The indicator was used according to the principle "the lower is better".

5. The fifth indicator is about the **level of external input**. In this case were selected the costs related to the inputs, like water, electricity and fuel, shown in Appendix 1, Table 18. The costs of the inputs were summed up per farm and per year and then divided by the total operating farm costs and then per farm's UAA. The indicator was used according to the principle "the lower is better".

6. In computing the low level of **biodiversity on the cropland**, was used the number of crop varieties in the farm. The indicator was calculated dividing the number of variety per farm per year by farm's UAA. The indicator was used according to the principle "the higher is better".

7. In computing the low level of **biodiversity around the cropland,** it was used the amount of subsidy each farm received from ecological payments. In particular, as indicator was used the money from agri-environment payments which are included in Axis 2, which is included in Pillar II (rural development policy) of the Common Agricultural Policy (Council Regulation No 1698/2005 and No 1974/2006). The indicator was built by adding up the amount with the subsidy code "1214" (identifies subsidies from agri-environment payments) per farm per year, and then divided per farm's UAA. The indicator was used according to the principle "the higher is better".

The 7 indicators so constructed, where then merged into a single file used for building the composite indicator.

3.3 Constructing conventionalisation composite indicators (aggregating indicators)

A composite indicator is defined by (Saisana & Tarantola 2002) as "the mathematical combination of individual indicators that represent different dimensions of a concept whose description is the objective of the analysis". In this research, the composite indicator represents the conventionalisation degree of a farm.

Composite indicators are increasingly used in several disciplines as a method to synthesize a multitude of information, in a compact and unique way (Santeramo, 2017). In fact, they allow to illustrate complex and multidimensional concepts which cannot be captured by a single indicator (JRC & OECD, 2008). According to Sharpe (2004) there are many debate around the accuracy and the subjectivity in selecting the indicators, in the treatment of missing values, in weighting process, and Saisana et al. (2005) write "it is hard to imagine that debate on the use of composite indicators will ever be settled". However, many pros and cons of composite indicators have been identified (JRC & OECD, 2008)(Saisana & Tarantola, 2002). Main advantages are: they can summarize complex realities; are easier to interpret then a set of indicators; reduce the size of indicators without dropping the underlying information; can assess progress of entities over time. On the other side, there are few disadvantages which the main are: they can send misleading messages if poorly constructed; may invite simplistic conclusions; may be misused if the construction process is not transparent.

3.3.1 Building composite indicators: the framework

Methodological approach in building composite indicators is broad and many procedures, although interesting, are still experimental. For this reason, the approach in this research is based on a report from (JRC & OECD, 2008) were only the well-established methodologies and procedures are taken into account. The handbook proposes a checklist/framework to follow during the construction of the composite indicator, which is shown in Table 6.

Step	Why it is needed
1. Theoretical framework Provides the basis for the selection and combination of variables into a meaningful composite indicator under a fitness-for-purpose principle (involvement of experts and stakeholders is envisaged at this step).	• To get a clear understanding and definition of the multidimensional phenomenon to be measured. • To structure the various sub-groups of the phenomenon (if needed). • To compile a list of selection criteria for the underlying variables, e.g., input, output, process.
2. Data selection Should be based on the analytical soundness, measurability, country coverage, and relevance of the indicators to the phenomenon being measured and relationship to each other. The use of proxy variables should be considered when data are scarce (involvement of experts and stakeholders is envisaged at this step).	• To check the quality of the available indicators. • To discuss the strengths and weaknesses of each selected indicator. • To create a summary Table on data characteristics, e.g., availability (across country, time), source, type (hard, soft or input, output, process).
3. Imputation of missing data Is needed in order to provide a complete dataset (e.g. by means of single or multiple imputation).	• To estimate missing values. • To provide a measure of the reliability of each imputed value, so as to assess the impact of the imputation on the composite indicator results. • To discuss the presence of outliers in the dataset.

4. Multivariate analysis Should be used to study the overall structure of the dataset, assess its suitability, and guide subsequent methodological choices (e.g., weighting, aggregation).	• To check the underlying structure of the data along the two main dimensions, namely individual indicators and countries (by means of suiTable multivariate methods, e.g., principal components analysis, cluster analysis). • To identify groups of indicators or groups of countries that are statistically "similar" and provide an interpretation of the results. • To compare the statistically- determined structure of the data set to the theoretical framework and discuss possible differences.
5. Normalisation Should be carried out to render the variables comparable.	• To select suiTable normalisation procedure(s) that respect both the theoretical framework and the data properties. • To discuss the presence of outliers in the dataset as they may become unintended benchmarks. • To make scale adjustments, if necessary. • To transform highly skewed indicators, if necessary.
6. Weighting and aggregation Should be done along the lines of the underlying theoretical framework.	• To select appropriate weighting and aggregation procedure(s) that respect both the theoretical framework and the data properties. • To discuss whether correlation issues among indicators should be accounted for. • To discuss whether compensability among indicators should be allowed.
7. Uncertainty and sensitivity analysis Should be undertaken to assess the robustness of the composite indicator in terms of e.g., the mechanism for including or excluding an indicator, the normalisation scheme, the imputation of missing data, the choice of weights and the aggregation method.	• To consider a multi-modelling approach to build the composite indicator, and if available, alternative conceptual scenarios for the selection of the underlying indicators. • To identify all possible sources of uncertainty in the development of the composite indicator and accompany the composite scores and ranks with uncertainty bounds. • To conduct sensitivity analysis of the inference (assumptions) and determine what sources of uncertainty are more influential in the scores and/or ranks.
8. Back to the data Is needed to reveal the main drivers for an overall good or bad performance. Transparency is primordial to good analysis and policymaking.	• To profile country performance at the indicator level so as to reveal what is driving the composite indicator results. • To check for correlation and causality (if possible). • to identify if the composite indicator results are overly dominated by few indicators and to explain the relative importance of the sub-components of the composite indicator.

9. Links to other indicators Should be made to correlate the composite indicator (or its dimensions) with existing (simple or composite) indicators as well as to identify linkages through regressions	• To correlate the composite indicator with other relevant measures, taking into consideration the results of sensitivity analysis. • To develop data-driven narratives based on the results.
10. Visualisation of the results Should receive proper attention, given that the visualisation can influence (or help to enhance) interpretability	• To identify a coherent set of presentational tools for the targeted audience. • To select the visualisation technique which communicates the most information. • To present the composite indicator results in a clear and accurate manner.

Table 6: the guideline on how to build a composite indicator from JRC & OECD (2008)

The first step is not discussed in the methodology, in fact it was decided to use the theoretical framework from the conventionalisation review paper (see section 2) as it is. The second step is explained in section 3.2.1. The third step is also not discussed because the RICA dataset hadn't any missing value.

3.3.2 Multivariate analysis

The handbook stresses the importance of a multivariate analysis, as one of the firsts procedures, in order to check the quality of the indicators. In particular to assess the interrelationship between them and to assess the suitability of the data set.

The Cronbach coefficient Alpha is used for this dataset and it was computed in STATA. Along with the Alpha calculation, it was computed also the option that allow to standardize the values with mean 0 and standard deviation 1 and the option that displays the Alpha effects of removing one indicator.

3.3.3 Normalisation of data

Normalization is a required step when data has different measurement units. Table 7 shown shows the different measurement units of the indicators used.

Indicators	Unit	Type of quantitative variable
share_cereals	None (ha/ha)	Ratio
share_legumes	None (ha/ha)	Ratio
minfert_ha	Kg / ha	Ratio
protection_ha	Kg / ha	Ratio
share_ext_input	€ / ha	Ratio
variety_ha	N° / ha	Ratio
eco_subsidies_ha	€ / ha	Ratio

Table 7: for every variable are shown the unit and the typology

Before computing the normalisation, the variables "share_legumes", "eco_subsidies" and "variety_ha" were reversed in scale. This allows to have all the seven variables with the same logic; the lowest the number, the better it is. Reversing the scale doesn't affect neither the correlation nor the Alpha coefficient.

Top three normalisation methodologies are: ranking; standardisation (z-scores) and Min-Max (Re-scaling). In this research, the latter was used.

Min–Max (Re-scaling): converts all the indicators to a common scale between 0 and 1, using the following formula:

$$Normalized\ indicator \rightarrow I_f = \frac{x_f - min_f(x)}{max_f(x) - (min_f(x)}$$

where x_f = the indicator value for a generic farm f; max_f and min_f are respectively the maximum and minimum value of x across all farms. The formula was applied per year.
Here, the scaling factor is the range of the indicator values. For this reason, indicators with a small range are widened after re-scaling and they increase the effect on the composite indicator.

3.3.4 Weighting and aggregation

These two steps have the higher impact among the others on the result of the composite indicator. For this reason, the most common methodologies were taken into consideration, in order to assess how they affect the composite indicator.

Weighting is a very subjective step and there is no correct way to proceed. Instead, weights have the property to make explicit the idea of the constructor.
Weights can be used to compensate the correlation between indicators assigning a low weight to the correlated ones. Further, they can also be used to increase the importance of statistically reliable indicators.
Weighting techniques are divided in two main groups: those based on technical manipulation and those based on expert opinion. In this research, due to time constraint, I focus on the former group.
Most common weighting methodologies based on technical manipulation are: equal weighting, principal components analysis (PCA) or factor analysis (FA) and data envelop analysis (DEA).
In this research was used the equal weighting technique, which consists in giving an equal weight to the indicators. Equal doesn't mean zero. It's not a good technique when indicators are correlated. In fact, a significant correlation could indicate that two or more indicators represents the same aspect of a phenomenon. In this research, even if correlation exists between some indicators, it was decided to proceed anyway because correlation it is not significant and was made the assumption that they measure different aspects of phenomenon.
The correlation matrix in Table 8 shows that indicators are low correlated between each other.

INDICATORS	share_ cereals	share_ legumes	minfert_ ha	protection _ha	share_ext _input	variety_ ha	eco_subsi dies_ha
share_cereals	\						
share_legumes	-0,3663	\					
minfert_ha	0,1964	-0,1688	\				
protection_ha	-0,0414	-0,0190	0,1298	\			
share_ext_input	-0,1768	-0,0494	-0,0784	0,1370	\		
variety_ha	-0,1995	-0,0513	-0,1465	0,1745	0,8688	\	
eco_subsidies_ha	-0,1531	0,1176	-0,0232	0,0660	0,0338	0,0486	\

Table 8: correlation matrix of the indicators. Computed in STATA using the Pearson's correlation coefficient

Aggregation techniques

Aggregation is a crucial step when building a composite indicator, and the different methodologies must be carefully assessed before proceeding. The most used are: linear aggregation, geometric aggregation and the multi-criteria-approach (MCA). The best to use depends on the kind of data available and if the constructor allows the compensability between indicators. When full compensability is allowed, a poor performance in some indicators can be compensated with high values in other indicators.

In this research, the methodologies that best fit the data is geometric aggregation. This technique is used for partial compensability; when indicators are in different ratio scale and strictly positive.

Aggregating the individual indicators into the composite indicator, is what provided the conventionalisation score for every farm. Geometric aggregation (or geometric mean) consists in applying the following formula for every farm per year:

$$\left(\prod_{q=1}^{7} x_q\right)^{1/7} \qquad x_q \in [0,1]$$

Where x represents the indicators and q the value of the indicators, which is, after the min-max normalisation, between 0 and 1.

3.4 Selecting economic indicators and correlation analysis between these and conventionalisation composite indicator

Motivations behind the conventionalisation trend are various and there is not an overall agreed interpretation (Lockie & Halpin, 2005) (Guthman, 2004). However, a big trend responsible for conventionalisation in OA, is agricultural intensification, which is caused, according to Guthman (2004), by the agribusiness involvement. In fact, agribusiness make the smaller operations less profitable, as they compete directly with larger producers on the same markets. In addition, Hendrickson & James (2005) state that the combination between the economic pressure farmers face and the growing constraints in decision-making, could cause an erosion of the ethical attitudes and behaviours of farmers.

According to literature conventionalisation should be visible not only at farm operational level (Darnhofer et al., 2010) but also at economic performance level. This section, thus, assesses the correlation between the economic farm performance and the conventionalisation indicator; investigate those differences between farm type and farm size. Farm type detailed information can be seen in Table 19 in Appendix I.

In order to have a complete overview of business performance, it's necessary to select indicators that reflect three different areas: profitability, efficiency and financial performance (Kay et al., 2011). I decided to pick one indicator for each of these areas. Literature suggests that the optimal indicator changes according to the purpose and data used. For this reason, I used the indicators the EU uses for his annual report on farm economics overview (European Commision 2015).

Economic data in RICA dataset are divided between "Conto Economico" (correspond to the Income Statement) and "Stato Patrimoniale" (correspond to the Balance Sheet).

Farm **profitability** was assessed using the Return on Assets (ROA); for **efficiency,** it was used the "output–input ratio" and **financial performance** was assessed with solvency using the "liabilities–assets ratio".

ROA was calculated using the following formula:

$$\frac{Net\ operating\ income + interest\ expenses - family\ labor\ cost}{Average\ assets\ value} * 100$$

Output–Input ratio was calculated with the following formula using the revenues from agricultural products and dividing them by the cost of inputs used for producing those products.

Liabilities–Assets ratio was calculated dividing total liabilities by total assets.

Correlation analysis was run on STATA correlating the composite indicator, calculated in previous step, with a single economic indicator, per year.

4. Results

4.1 Summary statistic of the indicators

Table 9 shows the summary statistic for each indicator. Scatter plot of value distribution for each indicator are shown in Appendix II.

Stat. / Indicators	Observation	Mean	Median	Standard deviation	Min	Max
share_cereals	452	0,3514	0,3498	0,3136	0	1,3636
share_legumes	452	0,2617	0,1202	0,3185	0	1
minfert_ha	452	62,48	8,51	124,81	0	1000
protection_ha	452	16,91	0,725	40,936	0	367,73
share_ext_input	452	0,1204	0,0044	0,0300	0	0,3219
variety_ha	452	0,2024	0,0913	0,3723	0	3,4188
eco_subsidies_ha	452	106,40	86,66	117,90	0	703,29

Table 9: summary statistic of the indicators

Table 10 presents summary statistic of the seven indicators after the Min-Max normalization

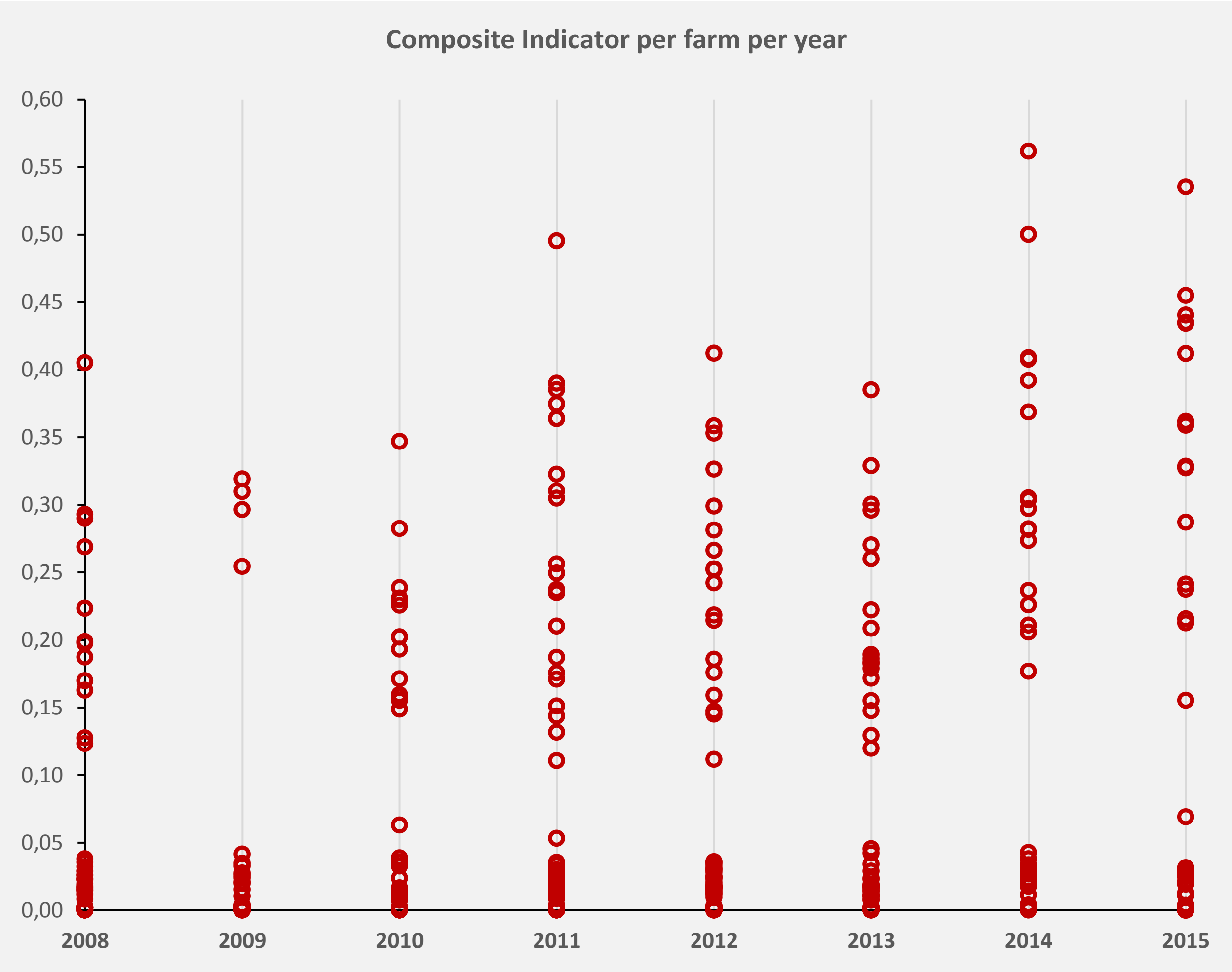
Stat. / Indicators	Observation	Mean	Median	Standard deviation	Min	Max
share_cereals	452	0,3417	0,3349	0,3079	0	1
share_legumes	452	0,7379	0,8794	0,3190	0	1
minfert_ha	452	0,0998	0,0114	0,1899	0	1
protection_ha	452	0,0875	0,0026	0,1971	0	1
share_ext_input	452	0,0855	0,0285	0,1687	0	1
variety_ha	452	0,8755	0,9408	0,1963	0	1
eco_subsidies_ha	452	0,7652	0,8381	0,2601	0	1

Table 10: summary statistic of indicators after Min-Max normalization

4.2 Conventionalisation trend over 2008-2015

With geometric aggregation, the last step in building the composite indicator, a conventionalisation score per farm was obtained.

The Graph 1 shows the scatter plot of composite indicator values per farm over years, calculated with Min-Max normalisation and geometric aggregation. The higher the value of composite indicator, the more conventionalised is the farm. In order to better present the composite indicator graphically, all the 0 values for each indicator, before computing geometric aggregation, were substituted with $1x10^{-8}$ value. The most conventionalised farm was registered in 2014 with a composite indicator value of $0{,}56$.
The overall trend over years is better visualized in Graph 2.

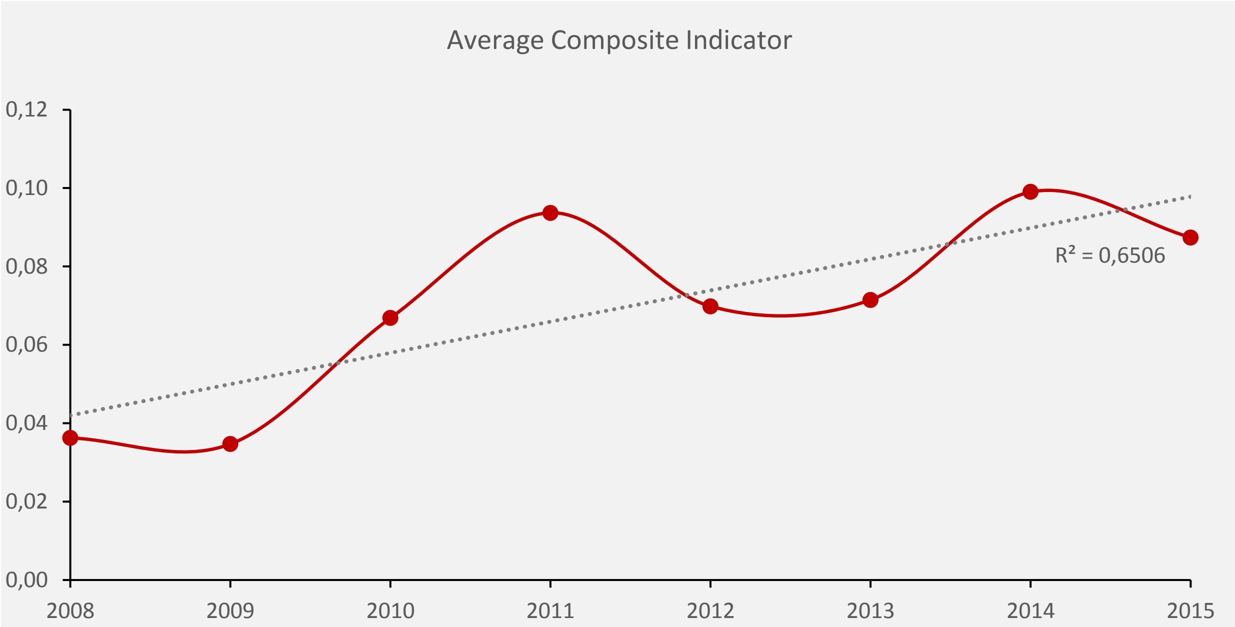


Graph 1: scatter plot of farm's composite indicator per year. The higher the value of composite indicator, the more conventionalised is the farm

It's important to highlight that most of the composite indicator values are below 0,05, as shown in Table 11. This effect the composite indicator's mean in Graph 2.

Year	Values <0,05	Values <0,05 / Tot. Values
2008	61	84%
2009	30	88%
2010	30	67%
2011	38	63%
2012	45	71%
2013	38	68%
2014	40	69%
2015	46	73%

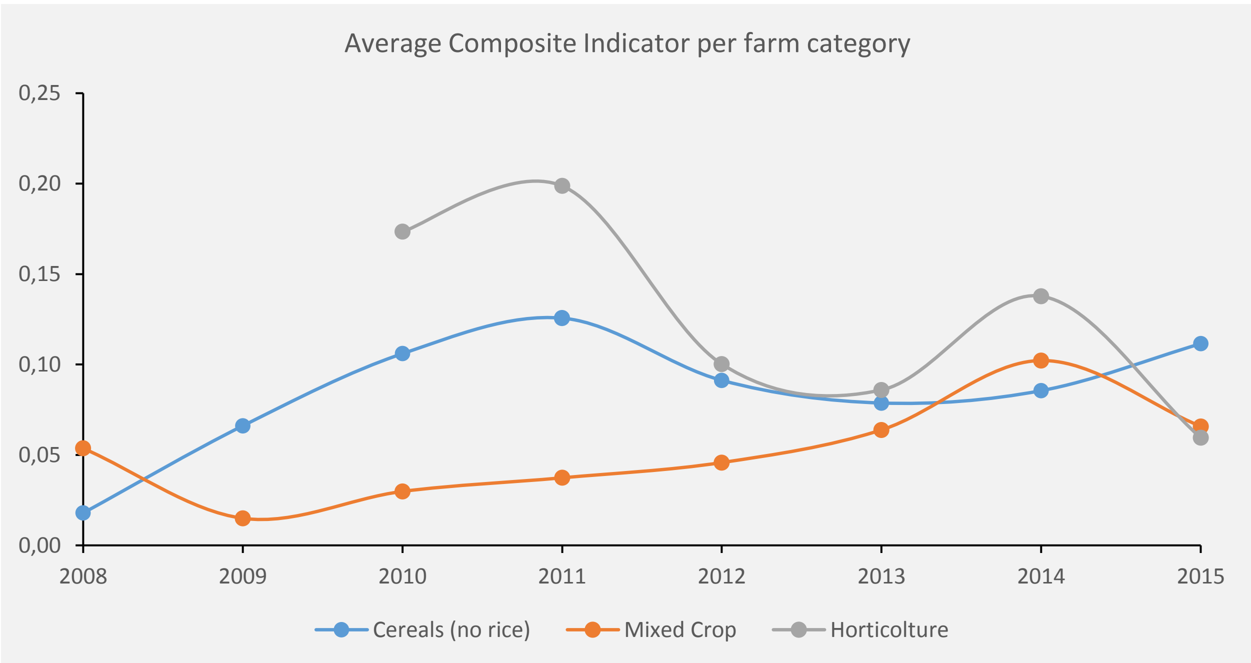
Table 11: Composite indicator values share per year



Graph 2: Representation of composite indicator's mean (dots) per year and a linear equation between the mean and the years

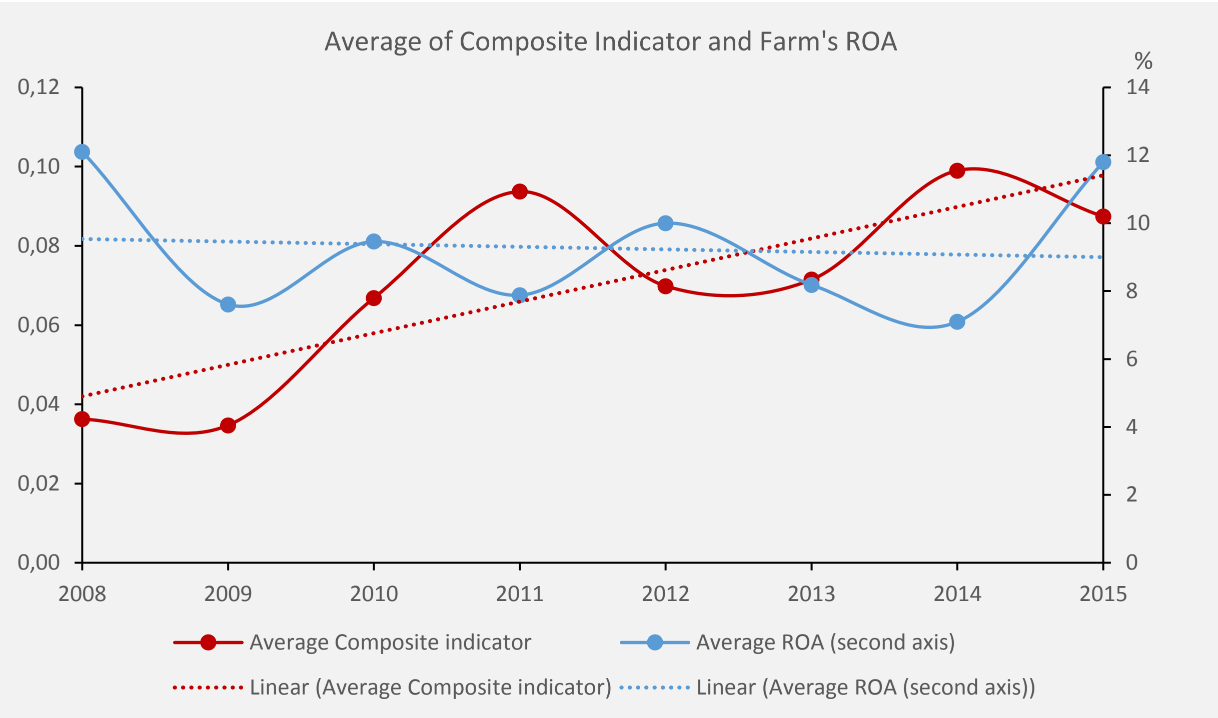
Despite was not defined a threshold for conventionalisation, Graph 1 shows that most of the farm performed well in term of conventionalisation while Graph 2 shows that in Italy the trend increased over 2008- 2015.

Graph 3 shows conventionalisation's trend over years, per farm category. The main group "crop farm", which is the object of this study, was further broken down in 3 sub-categories. Farm focused on cereals shows a slightly increasing conventionalisation trend. A similar trend is registered for farm focused on combined crops. On the other side, farm specialized in Horticulture registered a decreasing conventionalisation trend over 2008-2015.



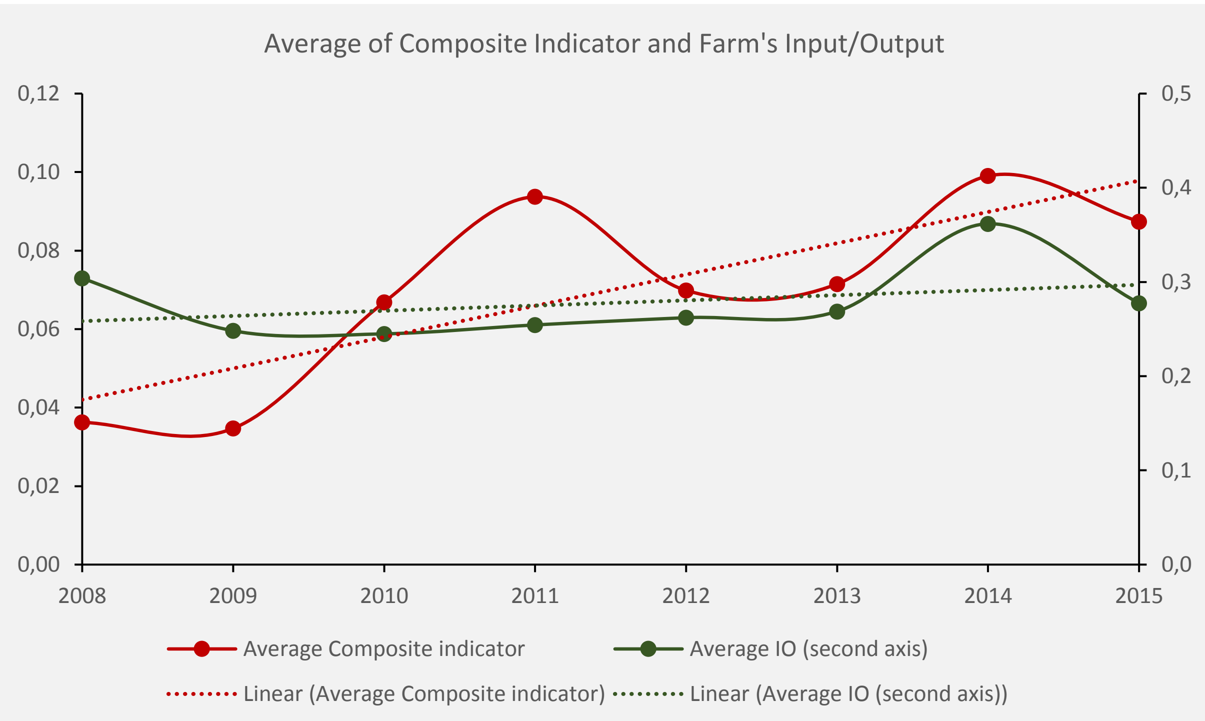
Graph 3: Average composite indicator over years per sub-groups of crop farms

The following graphs, 4, 5 and 6 shows the conventionalisation trend over years with the yearly average economic performance indicator.
Over 2008-2015 ROA registered a fluctuating trend from the lowest point in 2014 with a value of 7, to the highest point in 2008 with a value of 12,1. The overall trend is not correlated with the conventionalisation one, as it is also shown in Table 12.



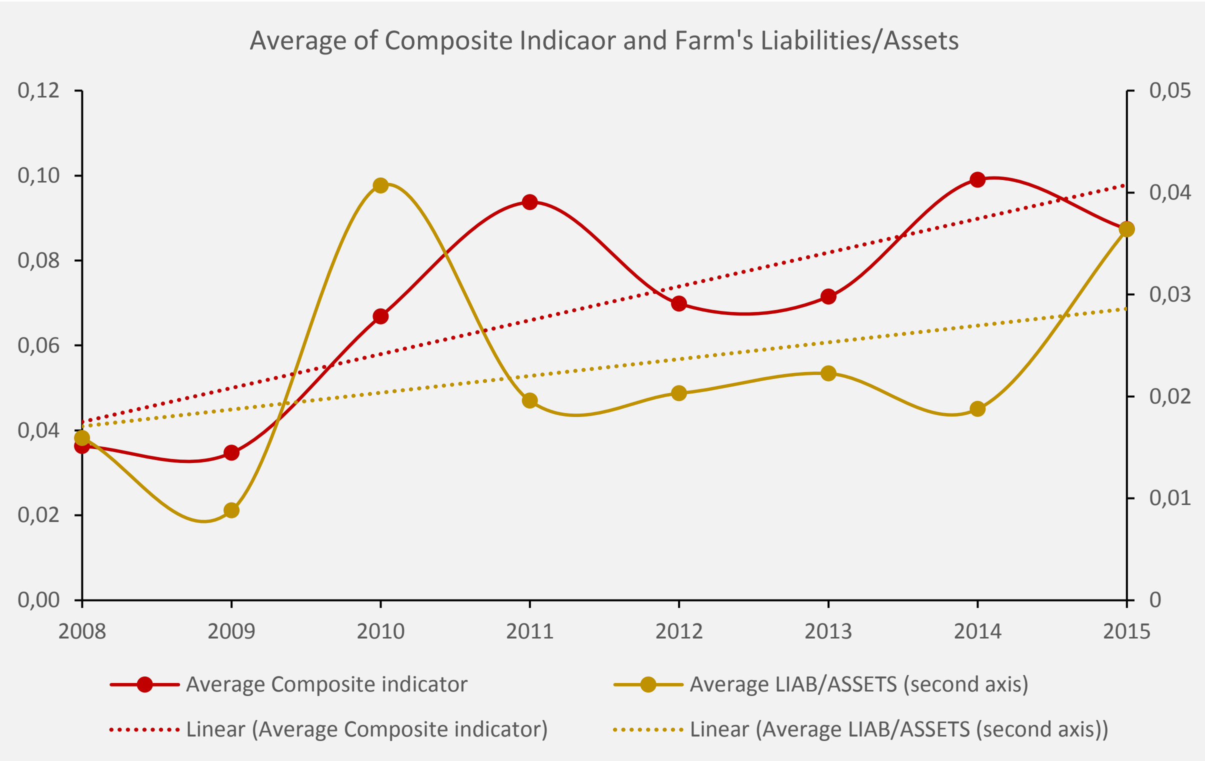
Graph 4: Average composite indicator and farm's ROA over years

In Graph 5 it is visible the trend of Input-Output ratio that is slightly increasing over years, although it is mainly flat with a peak of 0,36 in 2014. The correlation with the composite indicator is not significant, as shown in Table 1



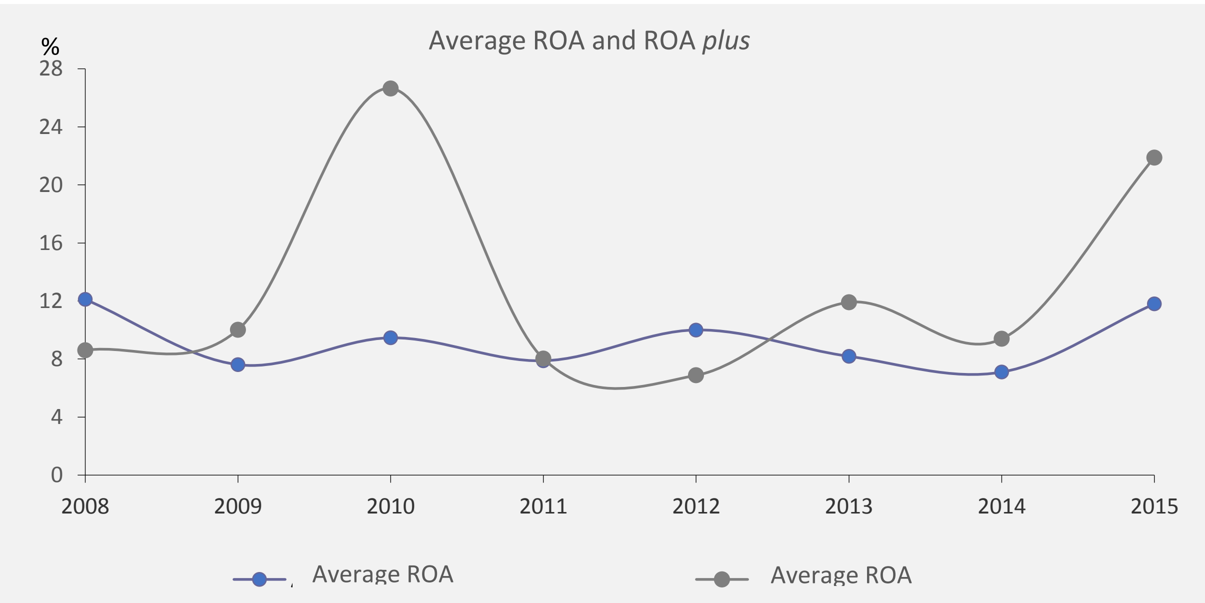
Graph 5: Average composite indicator and farm's Input/Output over years

Graph 6 shows the trend of the average Liabilities-Assets ratio and composite indicator. The former fluctuated with a peak of 0,04 in 2010, and overall slightly increasing with the latter over ’08-’15.

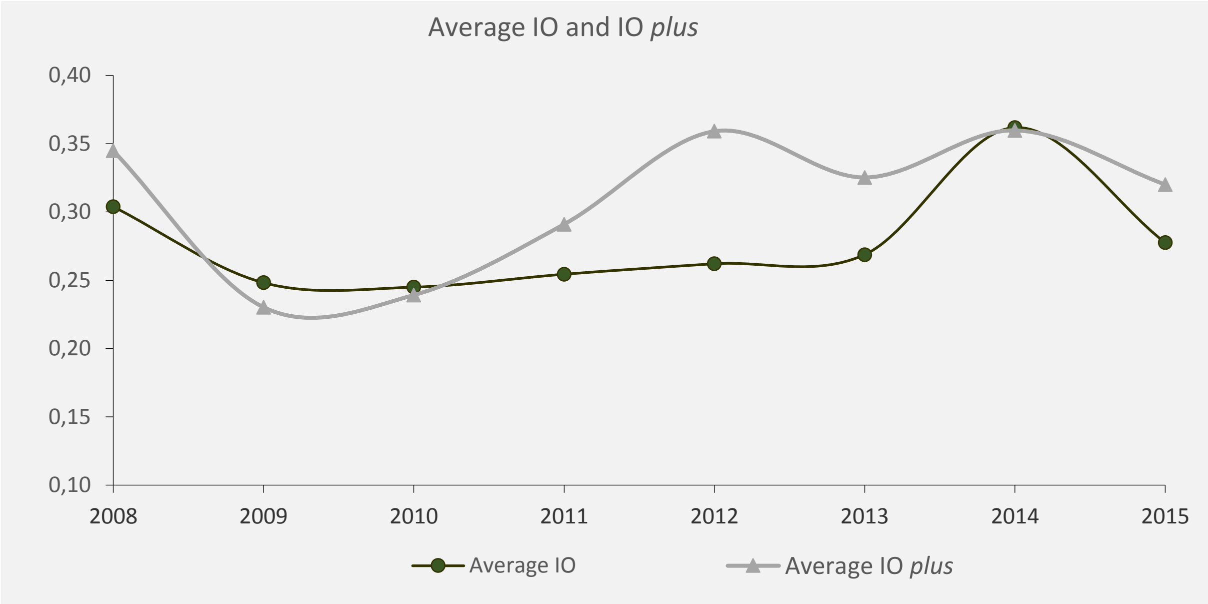


Graph 6: Average composite indicator and farm's liabilities/assets overs years

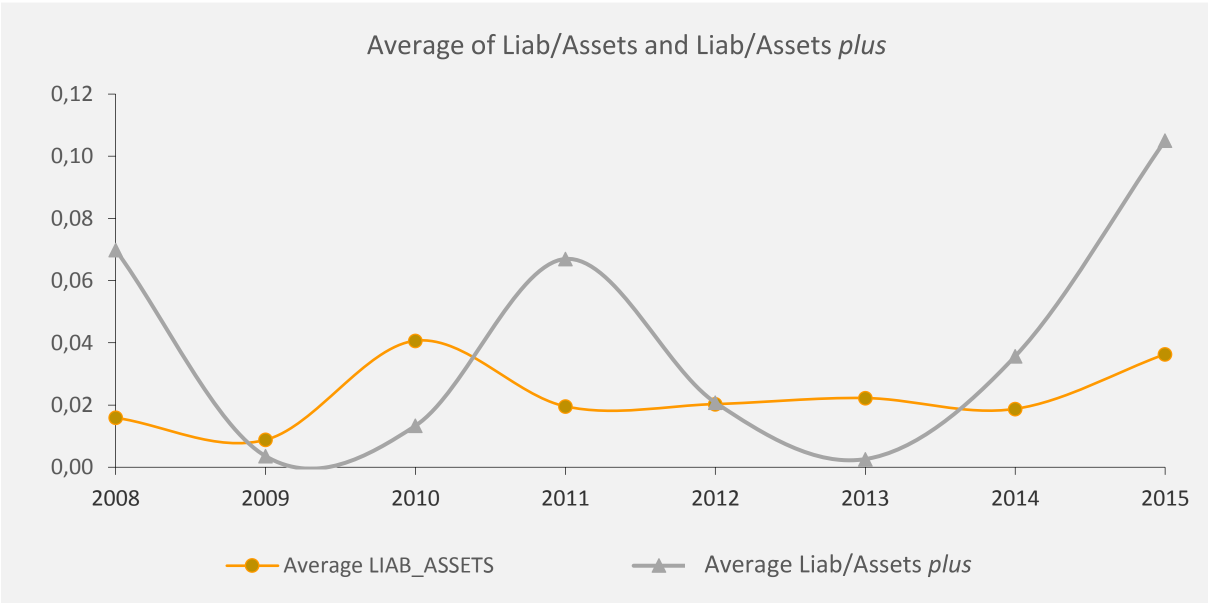
Graph 7, 8 and 9 shows a focus only on more conventionalised farms. Were analysed only farms (called “plus”) with a composite indicator higher then 0,3, which are above 90% percentiles.
It is noticeable that ROA and IO are on average higher in those farms. Liabilities-Assets ratio instead is fluctuating significantly but higher in last two years than other farms.



Graph 7: Average ROA including all farms and average ROA plus only of more conventionalised farms (ROA plus)



Graph 8:Average Input-Assets ratio including all farms and average Input-Assets plus only of more conventionalised farms (IO plus)



Graph 9: Average Liabilities-Assets ratio including all farms and average Liabilities-Assets ratio only of more conventionalised farms (Liab/Assets plus)

4.3 Correlation results between economic indicators and composite indicator

The following Table shows the correlation between each economic indicator and the composite indicator. The overall correlation in all three cases, is not significant. However, the situation is different when looking data more in detail in Table 13.

	ROA	Liabilities-Assets ratio	Input-Output ratio
Composite indicator	0,06	0,12	0,12

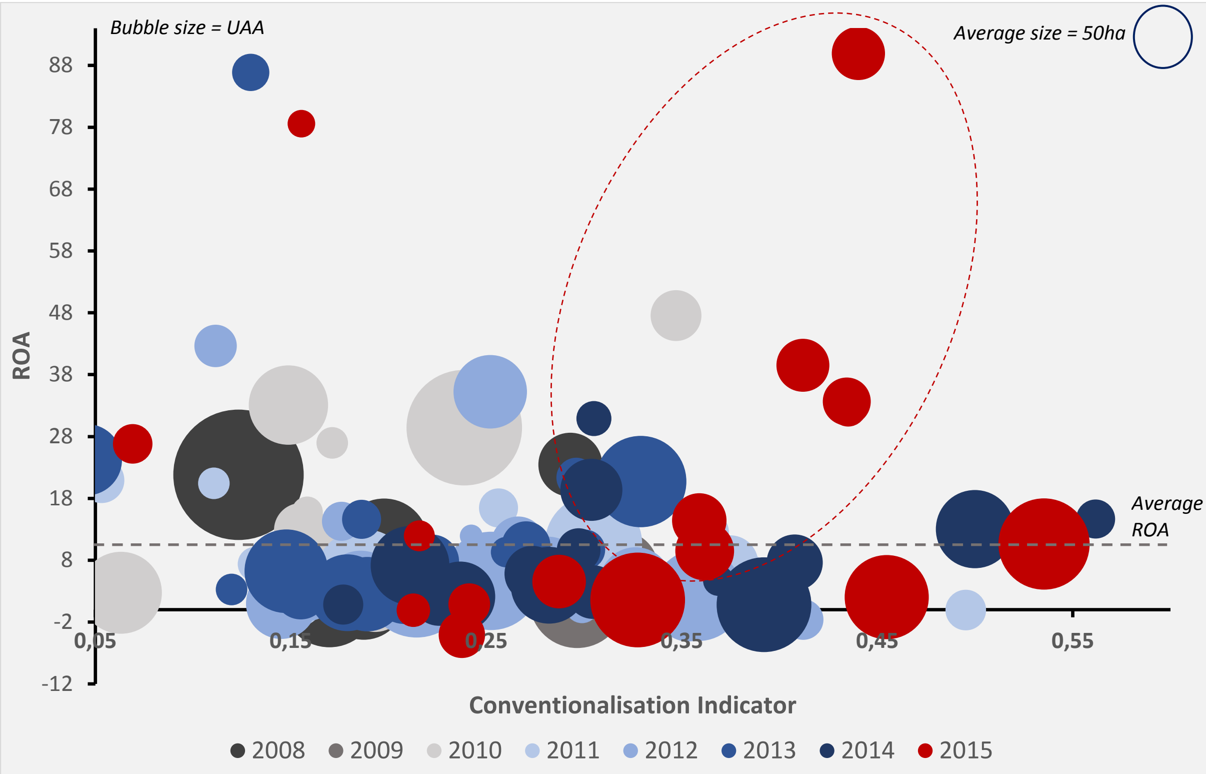
Table 12: Correlation Table between composite indicator and the three economic indicators

Table 13 shows correlation between the composite indicator and the three economic indicators, per farm size. From the Table, it's clear that a positive correlation (highlighted in green) exist with ROA and Liabilities-Assets ratio in the range between 30 to 50 hectares. These farms have also the highest composite indicator value.

UAA (hectares)	ROA	Liabilities-Assets ratio	Input-Output ratio
≤10	-0,06	-0,06	0,06
10–20	0,17	-0,05	0,02
20–30	-0,04	0,21	0,19
30–40	0,39	0,64	-0,02
40–50	0,72	0,61	-0,10
<50–60	0,05	0,33	0,14
60–70	-0,25	-0,01	0,11
70–80	-0,12	-0,16	0,01
80–90	0,19	-0,05	0,39
90–100	-0,10	-0,12	-0,38
>100	-0,05	0,20	0,39

Table 13: Correlation between composite indicator and the three economic indicators, per farm size

In Graph 10 a scatter plot shows the relation between ROA and conventionalisation for every farm. For a better graphical representation, farm with a composite indicator lower than 0,05 are excluded. It's visible that farm with a higher conventionalisation degree and above the average ROA, are medium size and recent data. The graph also clearly shows that highest score both in ROA and Conventionalisation are reached in recent years, between '13 – '15.



Graph 10: ROA and Conventionalisation value for all the farm in the analysis. Farm with conventionalisation value below 0,05 are excluded for better graphical representation

On the other side, in Table 14 no interesting correlation is happening between farm types.

RICA farm type code	ROA	Liabilities-Assets ratio	Input-Output ratio
1310 & 1510	0,13	0,17	0,18
1443 & 1660	0,03	0,17	0,08
1630	-0,02	-0,09	0,22

Table 14: Correlation between composite indicator and the three economic indicators, per farm type. 1310 (2008 -2009) and 1510 (2010-2015): farm specialized in cereals (excluding rice), oily crops and protein crops. 1443 (2008-2009) and 1660 (2010-2015): farm with prevalence of crops combined. 1630 (2010-2015): farm specialized in horticulture.

In the group of farm size from 30 to 50 hectares the correlation is significantly positive. Since the average organic farm size in Italy is 30 hectares (AssoBio, 2016), it's possible to assume that the farms that stay in the average face more competition and need to buy more assets (E.g. more efficient production machinery) to try to perform better. In fact, it's a size range where it's difficult to position yourself in the market; small farms can sell in niche market like on-farm sales and local market, while big farms have already a developed distribution channel.

The analysis on farm type shows no correlation. The results could be expected since the farm types are very similar between each other and are all a sub-group of the bigger crop farms category which has already shown no correlation in Table 12. A more in-depth farm type analysis requires a bigger sample or a deeper farm subdivision (E.g. per crop), which is not present in RICA/FADN database.

5. Discussion

5.1 Does the conventionalisation framework fit the FADN data?

RICA/FADN has clearly a different scope from try to asses a conventionalisation indicator. In some circumstances, it lacks more detailed data, needed to perfectly fit the framework. However, it was decided to use the database because it is the only tool that contains data on a representative sample for many years. Since the main objective of this study was to assess the conventionalisation trend over the year, no other methodology was possible in this time frame. A solution to perfectly use the framework, would be to interview farmers, which is, on the other side, too much time consuming with a similar sample size. Furthermore, it's important to keep in mind that RICA contains data from a sample that varies from year to year. For this reason, any differences over a time period could be attributed not only to the evolution of the sector but also to the evolution of the sample. Nevertheless, since the sample is big, data provide a useful information on the sector evolution.

5.2 Methodology on building composite indicators

Considering the overall methodology to assess conventionalisation, in this research was chosen to use a composite indicator mainly because it provides an impartial result (see paragraph 3.3) that could be replicated, even in different locations, and compared with future data. However, the process of aggregating heterogeneous information is itself very challenging and exposed to numerous threats; according to Santeramo (2017) different normalization and weighting approaches do not alter the composite indicator, while varying the data imputation and aggregation methods lead to a consistent change in results.

Another possible approach could be to create a panel of expert that for every variable fix a threshold to identify conventionalisation.

Multivariate analysis

Cronbach coefficient Alpha results are show in Table 13. Alpha coefficient is 0,513. The Alpha column shows the change in Alpha when the corresponding variable is removed from the analysis.

In general, acceptable depends on the discipline, but Nunnally (1978) suggest that should be at least 0,7.

Despite the Alpha coefficient is not significant, it's reasonable to believe that the framework proposed by Darnhofer et al. (2010) it's good in measuring conventionalisation. However, this result could indicate that variables used may not be calculated perfectly. In fact, as also discussed in paragraph 3.2 and 5.1, there were some compromises in order to uses RICA data with this framework.

Indicators	Alpha
share_cereals	0,4197
share_legumes	0,5096
minfert_ha	0,5161
protection_ha	0,5427
share_ext_input	0,4004
variety_ha	0,3745
eco_subsidies_ha	0,5214
	0,5131

Table 15: In bold the Cronbach coefficient Alpha of the variables used. The "Alpha" column shows how the coefficient would change if that variable was removed.

Normalizing data

Ranking: consists in ranking each indicator across farms. It has two main advantages; the simplicity and the independence to outliers. However, this method involves a loss of information because the absolute value is replaced with the ranking.

Standardisation (z-scores): converts all the indicators to a common scale with an average of zero and standard deviation (SD) of one, with the following formula:

$$Normalized\ indicator \rightarrow I_f = \frac{x_f - \bar{x}}{\sigma}$$

where x_f = the value of a generic farm f; $\bar{x}$ = the average across farm; σ = the SD across farms. With this method, the scaling factor is the SD across farms, and for this reason indicators with extreme values will have a greater effect on the composite indicator. This methodology was not used in this study due to the aggregation technique used. In fact, geometric aggregation requires that values are strictly positive.

Weighting

PCA and FA: where not used because if the original data are uncorrelated then the analysis is of no value (correlation matrix Table 8). In fact, according to the handbook (JRC & OECD, 2008), using PCA and FA "weighting intervenes only to correct for overlapping information between two or more correlated indicators and is not a measure of the theoretical importance of the associated indicator".
DEA: the very first constraint is the positivity of the individual indicators; that is, the higher the value the batter for the farm. My individual indicators are mixed, 4 out of 7 are not positive.

Aggregation

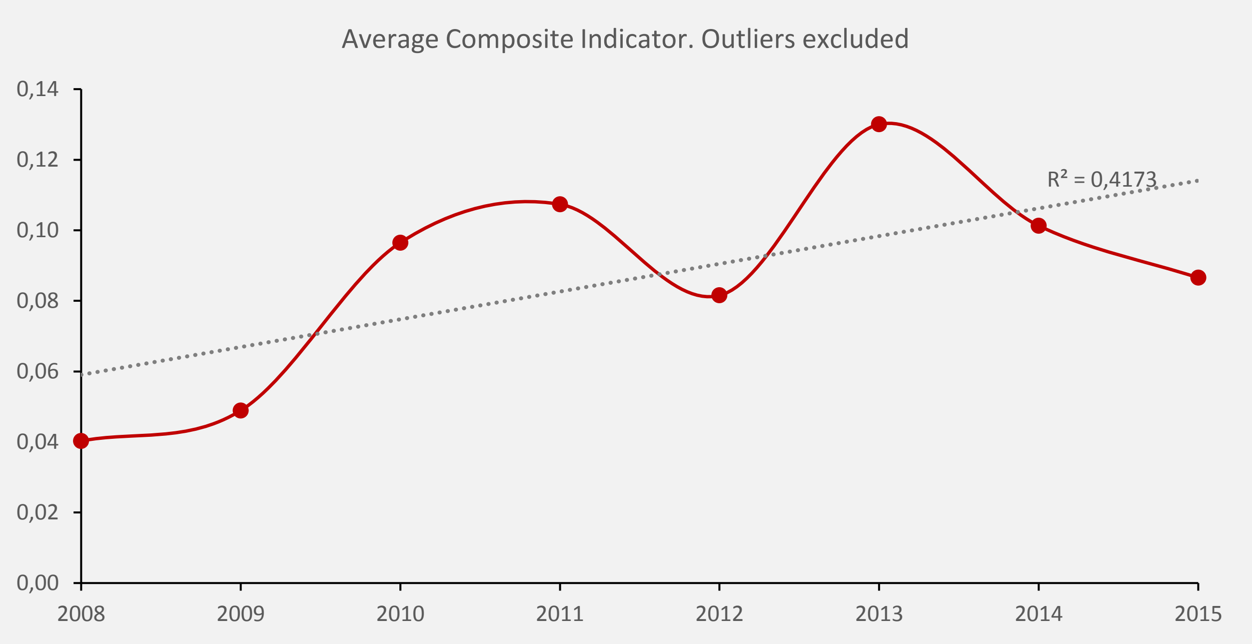
Linear aggregation: it used for full compensability, that is poor performance in some indicators can be compensated with high values in other indicators. Can be used only when the indicators are mutually preferentially independent (they don't have interaction between each other); Funtowicz et al. (1990) suggest that when dealing with environmental dimensions, assuming no synergies between indicators in unrealistic. Can be used when indicators have the same measurement of unit. Composite indicator is meaningful only if data are in expressed in comparable interval scale.
Multi-Criteria-Approach (MCA): non-compensability (used when different goals are equally legitimate and important). According to the literature, it is usually used in environmental indexes where different dimensions like social, environmental and economics are involved. The main disadvantage is the computational time needed when the number of observation is high.

Uncertainty, sensitivity to assess robustness

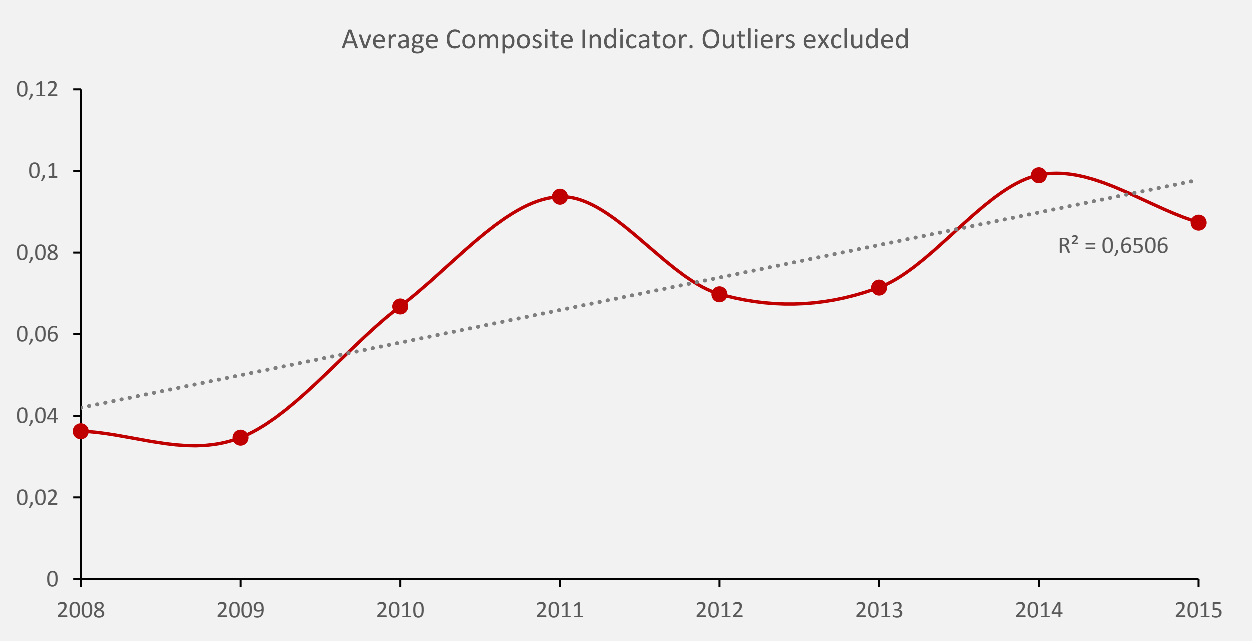
As previously said, the composite indicators may send misleading messages if they are poorly constructed. In fact, in every step of the building phase choices on methodology have to be made (different normalisation, different weighting and different aggregation methods). Each technique requires different assumptions and this introduces uncertainty due to subjective judgment. For this reason, a combination of uncertainty and sensitivity analysis help to help to measure the robustness of composite indicator and improve transparency. (Saisana et al. 2005; Saisana & Tarantola 2002). However, in this research only one methodology for each step was chosen and a sensitivity analysis is not required. Furthermore, (JRC & OECD 2008) highlights the concept that "the assessment of robustness is not enough for guaranteeing a sensible composite", but is the theoretical framework which has the primary importance (see the framework in paragraph 2).

5.3 Do the outliers influence the result? To what extent?

Data in RICA/FADN database are double checked and already corrected for evident errors. I had no reasons to remove some big outliers with the assumptions they were errors. However, two parallel analysis were run without outliers, based on percentile, to see if they could affect the composite indicator. The first analysis (Graph 3) was run removing, before reverting scale and normalisation, values minor of 1 percentile and greater than 99 percentiles. The second analysis (Graph4) had the same procedures but the lower and higher percentiles were set respectively at 5 and 95. In following Graphs, the mean values of composite indicator over years are shown.



Graph 11: Outliers removed according to percentile, <1 and >99. Mean values (red dots) of composite indicator per year with a regression line of Y on X



Graph 12: Outliers removed according to percentile, <5 and >95. Mean values (red dots) of composite indicator per year with a regression line of Y on X

Indeed, some changes occur, but the overall conventionalisation trend is still increasing over year.

5.4 What does the correlation between economic indicators and composite indicator tell?

ROA, which is a profitability indicator, measures the effectiveness of a company's assets in generating revenue. It is possible to argue that conventionalised farms, which according to Lockie et al. (2006) are oriented to input substitution (E.g. synthetic fertilizer instead of manure), could generate more revenue with same assets. A similar approach is valid for the Input–Output ratio where conventionalised farm could be expected to be more efficient in production.

Liabilities–Assets ratio shows the percentage of farm's assets that are financed through liabilities. A high ratio could represent that a farm recourse heavily on outside financing. According to Guthman (2004), agribusiness involvement unleash the logic of intensification, so it is possible to argue that conventionalised farms make more loans to buy assets.

6. Conclusion

This research provides some insights and new methodology approach on conventionalisation trend. It also confirms that measuring the phenomenon is tricky due to a lack of an overall agreement on the best methodology.
From data found it seems that conventionalisation is happening in Italy. Although it is not possible to define a clear and solid conventionalisation trend in all sectors, it is however possible to argue that the most conventionalised farms are gaining economic advantages showing, on average, a higher ROA and Input-output ratio. The results are significant because support with a quantitative analysis a trend that has been discussed but was never proved in Italy. What is overall agreed in literature, is that OA is changing, also in Italy. In fact, the number of organic farms is decreasing but the average size is increasing, implementing economies of scale. These phenomena together, make think that agribusiness is more and more involved in OA. This could lead to intensifications (Guthman, 2004) and so to conventionalisation. Moreover, the situation is expected to get worse since the organic products values sales, in mass market retailers, rose by 40% from 2008 to 2016 (AssoBio, 2016).

With the actual OA situation in mind, these results, along with similar studies conducted in other countries, should stimulate stakeholders involved in the organic chain, to reflect on the future implications of the sector’s transformation. In particular, policy makers should realize that an urgent action is needed in OA in order to prevent the loss of its real values and consumers trust. It may be important to intervene to protect OA and the environment through policy. In fact, IFOAM underlines that mentioning the principles somewhere in the regulation will be a great stimulus for the organic movement, particularly for new converters; to make them aware that the organic values are of importance.
Furthermore, conventionalisation could have economic implications on “real” organic producers. These types of farmers could face an increasingly stronger competition from conventionalised producers that are able to sell their products at a cheaper price, at the expense of the environment. This introduce a big question addressed to all stakeholders but especially to policy makers: Does the subsidies provided with the CAP to organic farms are still worthy? Probably they should be re-thought in order to reward better farms.

Finally, still a big question remain partially not answered; does the RICA/FADN dataset fit the Darnhofer et al. (2010) framework? Even though the dataset is the most complete in agriculture at farm level, probably still miss some details to make the analysis more precise.
An ideal solution for future research, although time consuming, would be to interview farmers with a precise set of questions focused on conventionalisation. Furthermore, it would be interesting if future research will apply the conventionalisation framework with a different methodology; assessing variables with expert opinions instead of building a composite indicator.

During the thesis, I certainly learned a lot of analytical skills, especially in processing and analysing data. I also understood deeply the scientific world reading articles, publications, ecc., that made me reflect on the importance, for the whole world, in producing solid and reliable research.

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APPENDIX 1

Following Tables represent data from RICA dataset used in the analysis in STATA

RICA species ID	RICA Species name (Ita)	Species name (Eng)
18	Cece	Chickpea
19	Cicerchia	Chickling
20	Fagiolo	Bean
21	Fava	Fava bean
22	Lenticchia	Lentil
23	Lupino	Lupin
25	Pisello	Pea
26	Soia	Soy
27	Mix legume	Legumes mix
28	Mix legume-cereali	Cereals-legumes mix
37	Arachide	Peanut
135	Fagiolini	Green bean
136	Fagiolo da sgusciare	Beans
137	Fava verde	Green fava bean
154	Taccola	Snap pea
155	Pisello da sgusciare	Mixed peas
175	Erba medica	Alfalfa
176	Favetta	Small green fava bean
178	Lupienlla	Saìnfoin
181	Sulla	Sulla
182	Trifoglio ladino	Ladino clover
183	Trifoglio pratense	Pratense clover
185	Veccia	Vetch
188	Erbaio fava	Fava bean herbage
189	Erbaio favino	Broad been Herbage
199	Erbaio di trifoglio alessandrino	Egyptian clover Herbage
200	Erbaio trifoglio incarnato	Crimson clover Herbage
201	Erbaio altri trifoglio	Other clovers Herbage
202	Erbaio trigonella	Trigonella Herbage
204	Erbaio di veccia	Vetch Herbage
209	Erbaio legumimose	Leguminous Herbage
216	Acacia	Acacia
243	Ginestra	Genistae
269	Carrubo	Carob tree
452	Trifoglio alessandrino	Egyotian clover

Table 16: legumes (Fabaceae) crops used in this study

RICA species ID	RICA Species name (Ita)	Species name (Eng)
1	Avena	Oats
2	Farro	Spelt
3	Frumento duro	Durum wheat
4	Frumento tenero	Wheat
5	Grano saraceno	buckwheat
6	Mais ibrido	Maize Hybrid
7	Mais	Maize
8	Miglio	Millet
9	Orzo	Barley
10	Panico	Foxtail millet
11	Riso	Rice
13	Segale	Rye
14	Sorgo	Sorghum
15	Triticale	Triticale
16	Miscuglio di cereali	Mix of cereals
17	Altri cereali da granella	Cereals for grain
51	Sorgo zuccherino	Sorghum sugary
145	Mais dolce	Maize sweet
179	Mais ceroso	Maize for silage
180	Mais in erba	Maize in grass
186	Erbaio di avena	Oats herbage
189	Erbaio di frumento	Wheat herbage
191	Erbaio di miglio	Millet herbage
192	Erbaio di orzo	Barley herbage
193	Erbaio di panico	Foxtail millet herbage
196	Erbaio di segale	Rye herbage
197	Erbaio di sorgo	Sorghum herbage
203	Erbaio di triticale	Triticale herbage

Table 17: cereal crops used in this study

RICA Fertiliser ID	RICA Fertiliser category (Ita)	Fertiliser category (Eng)
44	Concimi minerali solidi	Solid mineral fertiliser
45	Concimi organo-minerali solidi	Solid organic-mineral fertiliser
46	Altri concimi e fertilizzanti	Other fertilisers
47	Concimi a base di microelementi	Fertilisers with microelements
141	Concimi fluidi	Liquid fertilisers

Table 18: type of fertiliser used in this study

RICA Protection product ID	RICA Protection product name (Ita)	Protection product name (Eng)
49	Acaricida	Acaricide
50	Anticrittogamico	Fungicide
51	Bagnante	Wetting
52	Coadiuvante	Adjuvant
53	Diserbante	Herbicide
54	Fitoregolatore	Phytoregulator
55	Geodisinfestante	Disinfesting products
56	Insetticida	Pesticide
57	Molluschicida, nematocida, rodenticida	Mollusc, nematode and rodent killer
59	Repellente	Repellent

Table 19: type of plant protection product used in this study

RICA External input (Ita)	External input (Eng)
Fertilizzanti	Fertilisers
Antiparassitari e Diserbanti	Pesticides and herbicides
Mangimi	Feed
Foraggi e lettimi	Fodder
Acqua, elettricità e combustibili	Water, electricity and fuels

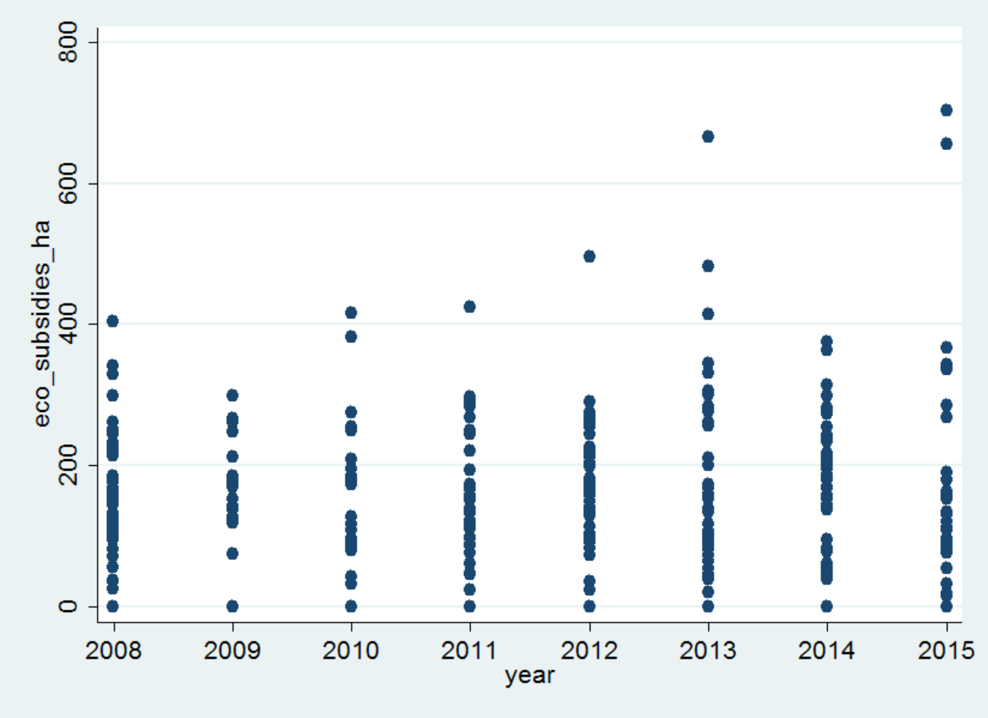
Table 20: external input used in this study

RICA farm type code	RICA farm type description (ITA)	Farm type description (ENG)
1310 (from 2008 to 2010) 1510 (from 2011 to 2015)	Specializzate in cereali (no rice), piante oleose e proteiche	Specialized in cereals (excluding rice), oily crops and protein crops
1443 (from 2008 to 2010) 1660 (from 2011 to 2015)	Prevalenza di colture di seminativi combinate	Prevalence of crops combined
1630 (from 2011 to 2015)	Specializzate in orticoltura	Specialized in horticulture

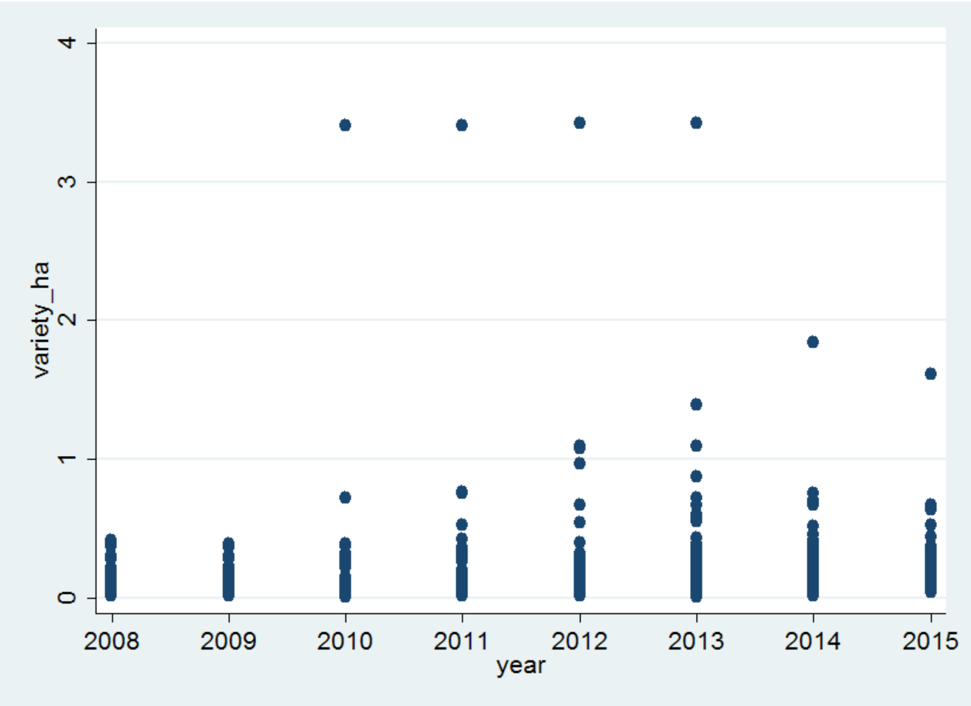
Table 21: detailed farm type used in this study

APPENDIX 2

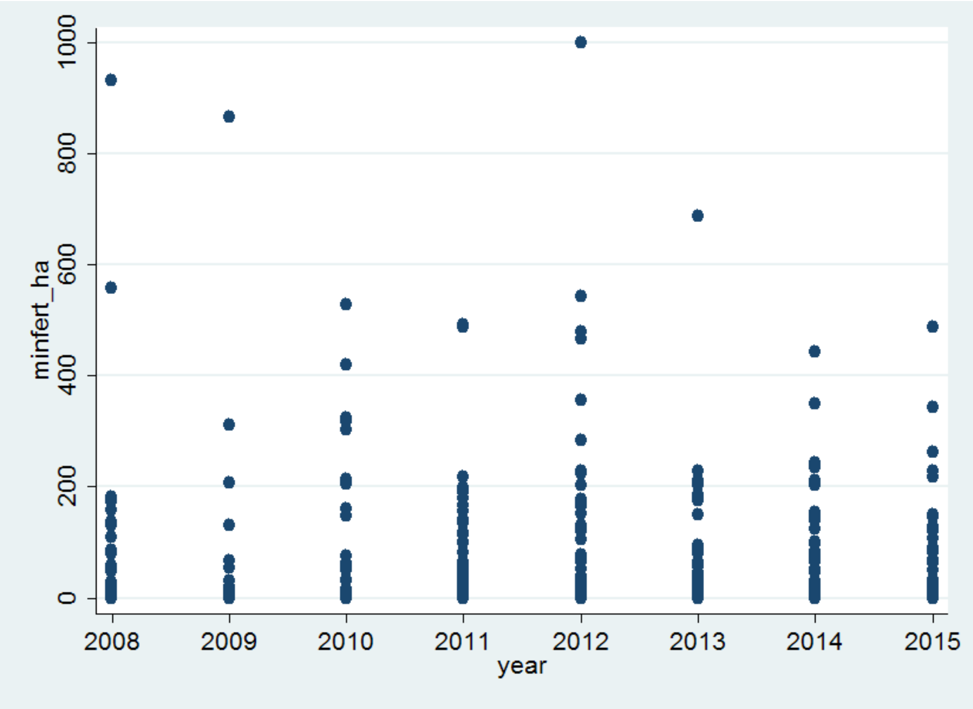
Following picture shows the values distribution of the 7 individual indicators.



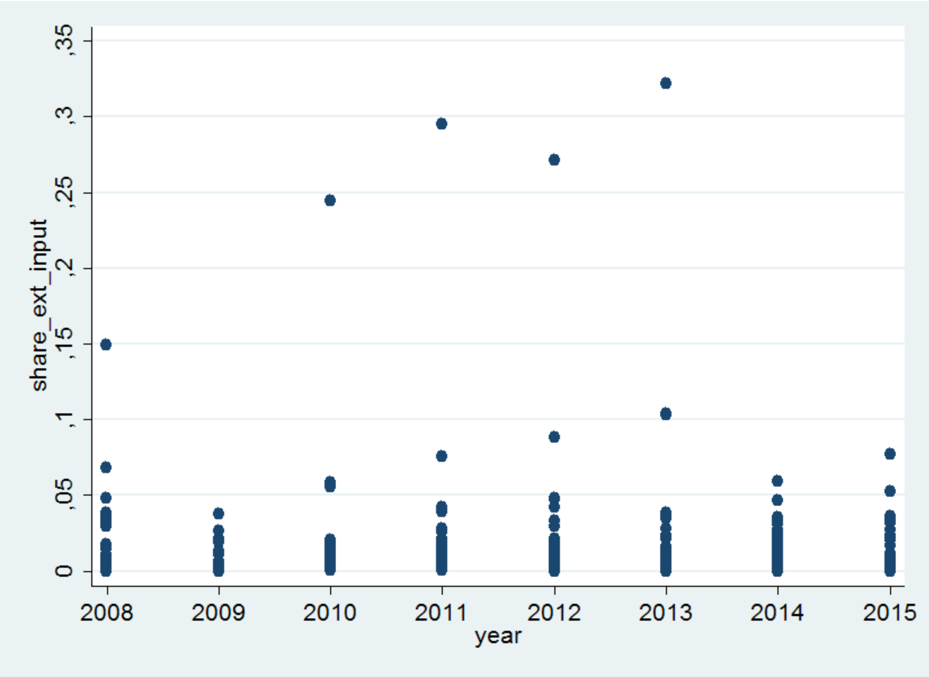
Graph 13: scatter plot of "eco_subsidies_variable" values



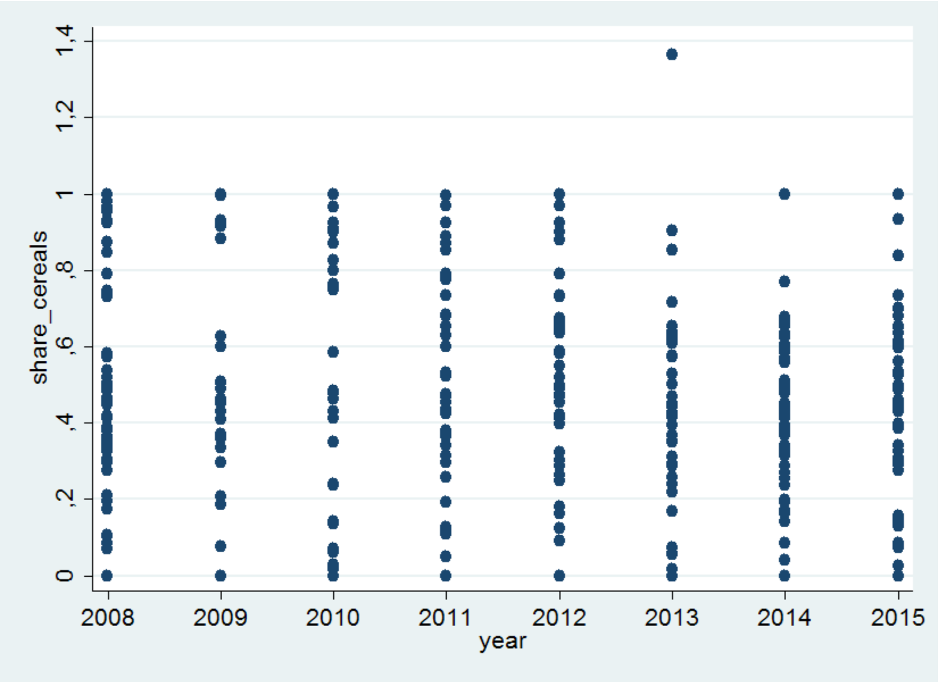
Graph 14: scatter plot of "variety_ha" values



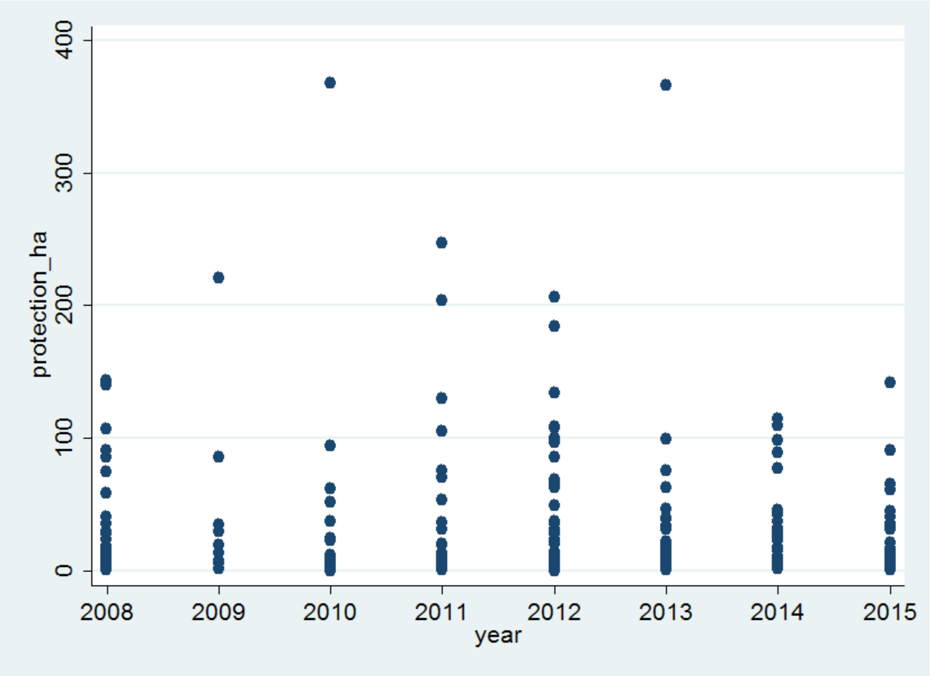
Graph 15: scatter plot of "minfert_ha" values



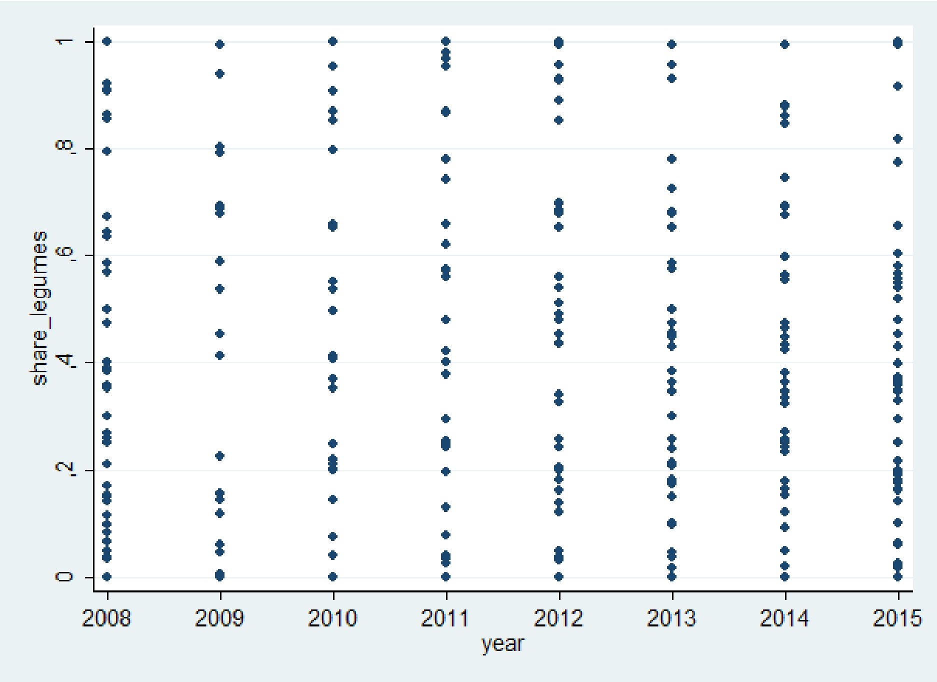
Graph 16: scatter plot of "share_ext_inpout" values



Graph 17: scatter plot of "share_cereals" values



Graph 18: scatter plot of "protection_ha" values



Graph 19: scatter plot of "share_legumes" values