Collective (family) human capital and transition towards multifunctional agriculture in localized agrifood systems

Luigi Simeone, Luca Bartoli, Marcello De Rosa

University of Cassino and Southern Lazio – Department of Economics and Law

Abstract: *Localized agrifood systems are coping with a continuously evolving scenario marked by higher levels of competitiveness bringing about a functional repositioning of agricultural activity. Patterns of transition are differentiated with respect to either territorial or structural and social variables. Framed within a family farm business perspective, this functional repositioning is the exit of strategic decisions, taken at collective entrepreneurial level. This paper sets against this background, with the purpose of exploring decision-making processes at family farm level concerning the transition towards quality-oriented agriculture. The specific aim of the paper is to test eventual connections between the level of human capital at the family level and transition towards quality agriculture and sustainable agrifood systems. Recent studies have emphasized the relevance of human capital in performing a farm's transition towards sustainable systems. However, few studies have pointed out the same question on a collective base with a family farm perspective. This paper tries to fill a gap in literature by emphasizing the family farm's collective decision-making process. Therefore, the unit of analysis is the family farm business, articulated according to the stage of life cycle and the number of components.*

From the empirical analysis, a clear differentiation in the transition paths among various typologies of family farms and their endowment of human capital should emerge. Policy implications are evident, in terms of strengthening rural policy for upgrading entrepreneurial skills of farmers. As a matter of fact, the first priority of recent rural development policies regards this aspect. Consequently, a strong correlation between the virtuous transition of localized agrifood systems and endowment of human capital empowers and stimulates the enforcement of this priority.

Keywords: *Human capital, family farm business, localized agrifood systems, differentiated and diversified farms*

1. Introduction

This paper deals with processes of transition towards multifunctional agriculture carried out by family farm businesses, through investigating how formal education affects paradigm shift towards multifunctional agricultural activity.

The analysis of family farm businesses implies high levels of variability in order to take into account the huge diversity among these businesses (Offutt, 2002). On the other side, a common trait of the family business is linked to the high levels of persistency, due to the collective entrepreneurial traits and to the F-connection (family, friend, firm) boosting higher resilience (Ben Porath, 1980; Pollack, 1985; Darnhofer, 2013). Due to the importance of the family context in European agriculture, Common Agricultural Policy (CAP) has devoted much attention to family farm businesses, by providing family farms with a large set of measures to support farm strategies (Davidova, Thomson, 2014; Davidova et al., 2013). One of the dimensions taken into account in the policy provisions is related to the upgrading of the level of family education, under the hypothesis that this may accelerate the transition towards the multifunctional paradigm in European agriculture (Van Huylenbroeck, Durand, 2004).

The multifunctional paradigm represents the new frontier of rural development policies, with the aim of supporting multiple roles of farming activities. As a matter of fact, the new European agricultural model is centred around the following four dimensions (van der Ploeg, 2010):

1. "high-added-value farming with high-quality primary and processed products";

2. "farming open to regional markets";
3. "farming geared to local markets";
4. "agronomically sound and sustainable agricultural systems as vital to guaranteeing competitiveness on local, regional and international markets".

Consequently, the new rural paradigm aims at strengthening localized agrifood systems based on quality products and sustainable agriculture (Carbone, 2018). These agrifood systems are strictly embedded in their territories of origin, so consolidating the various dimensions (social, cultural, territorial) of agricultural embeddedness (Methorst, 2017; Chiffoleau, 2009).

Furthermore, policy discourses stress the rising level of competitive pressure and the consequent need for farmers to adapt, to which a call for a more entrepreneurial, competitive and sustainable model in farming activity is associated (Phillipson et al., 2004).

This paradigm shift is marked as a sociotechnical transition (Geels, Schot, 2007; Lamine, 2011), bringing about rural innovation. The concept of rural innovation is relatively recent and has been introduced in the SCAR (2012) report which draws on Knickel et al.'s (2009) definition: *"innovation involves much more than technology; more and more it relates to strategy, marketing, organization, management and design. Farmers looking for alternatives to industrial agriculture don't necessarily apply "new" technology. Their novelties emerge as the outcome of different ways of thinking and different ways of doing things".*

Rural innovation has been defined as a 'must' for rural regions: set in this background, human capital may be identified as a key driver of innovation (OECD, 2007). Empowering human capital is a target to be fulfilled through a double channel: by upgrading rural education and by attracting external talents.

Against this background, the aim of the paper is to underline the relevance of human (family) capital in boosting this transition. The role of education in farming activity has been deeply recognized in recent literature concerning both developing and developed countries. An abundant share of literature points out the importance of human capital for increasing agricultural productivity; similarly, education has a positive impact on the adoption of new technology, as underlined in studies concerning both developing and developed countries (Lin, 1991; Winger, Wall, 2006). In recent years, the role of education has been recalled in order to act as an engine for the transition towards sustainable models of agriculture (Suvedi et al., 2010; Groupe de Bruges, 2010; Contò et al., 2011; Djokoto et al., 2016).

Nonetheless, the literature has usually taken into account the level of education of the farm manager, without any consideration of the family decision-making process. This paper tries to fill this gap in the literature by considering the family farm framed in a collective process of decision-making affected by the level of formal education of all family members. Decision-making process is here considered as related to small businesses, sharing the family farms important characteristics with small businesses (Methorst, 2016). Following Liberman-Yaconi et al. (2010), the strategic decision-making process is not linear, but it happens through three overlapping circles of activities, underlined by Methorst (2016, 26): 1) informing; 2) option generating; and 3) deliberating. Set in the framework of the farm family business, these steps may be marked by high complexity, above all in cases of transition towards multifunctional agriculture. As a matter of fact, recent literature has demonstrated that specified entrepreneurial trajectories at farm level usually bring about the involvement of the family members, as in diversification of agricultural activities (Hansson, 2013; McElwee, Bosworth, 2010). Furthermore, dynamics of farms' strategies are strictly linked to the life cycle of the family farm (Gafsi, 2017). Consequently, the emergent strategy (Mintzberg, 1994) is the exit of a diversified set of factors which may originate a diversified set of results.

Against this background, the hypothesis we are going to explore is that these activities are carried out within a collective process, involving all family members. On account of previous considerations, the family farm is our unit of analysis and the research questions are the following:

- To what extent may family composition and family level of education boost transition towards multifunctional agriculture?
- Starting from both family composition and level of education, what kinds of non-conventional agriculture are privileged in this transition?

The paper is structured as follows: the following paragraph describes the methodological approach, with the purpose of providing a classification framework of quality-oriented agricultural activities, family composition and level of formal education. Paragraph 3 is devoted to the results of the empirical analysis applied to Italian agriculture. Finally, some preliminary conclusions will end the paper.

2. Materials and method

Data refer to Italy and have been collected for the year 2015 from the Farm Accountancy Data Network (*FADN*). The sample under study includes 10,453 family farms, stratified according to either their territorial localisation or their economic dimension and main activity. An adequate indicator for the report to the universe has been applied. Consequently, data processed refer to the entire universe.

In order to take into account level of education, we have considered the maximum level of formal education at family farm level: this refers to the level of formal education achieved by the most highly formally educated person in the family, who lives in the family farm. The underlying hypothesis is that the decision-making process is a collective one. Consequently, the variables taken into account are the following:

1. Family life cycle and composition, through which a typology of family farms has been specified, with 18 modalities.
    a. On the basis of the family, it is possible to classify:
        i. single household;
        ii. couples with or without children;
        iii. one-parent families;
        iv. other families.
    b. On the basis of the localization of life cycle, it is possible to classify:
        i. Young families (<40 years, age referred to the household head)
        ii. Mature families (40-65 years)
        iii. Old families (>65 years)
2. Maximum level of education in the family, with 7 modalities:
    a. No qualification/Primary school;
    b. Middle school diploma;
    c. Professional diploma;
    d. High school diploma;
    e. Bachelor;
    f. University degree;
    g. Postgraduate degree.
3. Strategies of product qualification
    a. Conventional agriculture;
    b. Organic farming;
    c. Geographical indication (GI);
    d. Sustainable agriculture (either good agricultural practices or good agro-environmental conditions and low environmental impact, as ruled by the Common Agricultural Policy);
    e. Process certification systems (ex. Hazard analytical control point, Genetically modified organisms free, gluten free, etc.)

After a descriptive analysis aiming at testing the relevance of each typology at family farm level, an index of specialization has been calculated, with the aim of identifying levels of farm specialization, according to the following formula:

$$\frac{n_{ij}/n_{i.}}{n_{.j}/n}$$

Where:

n_{ij}: number of farms with the i typology (or level of education) and the j family type (or the farm typology).

The index compares alternatively:

- the incidence of typology *i* adopted by family farm *j* with the relevance of the same family farm typology;
- the incidence of farms with the level of education *i* positioned in the farm typology *j* with the total relevance of the farms with the same level of education.

Finally, a logistic regression has been estimated, with the purpose of testing the probability of transition towards not conventional agricultural practices as typical examples of multifunctional agriculture. According to our hypothesis, this probability is linked to the level of education, the family farm profile and to the capability of gaining access to rural policies. The equation describing estimation function is as following:

$$Y = \log it(x) = \ln[odds(x)] = \beta_0 + \beta_1 X_1 + ... + \beta_k X_k$$

where:

- Y represents the dichotomous dependent variable that holds 1 (“yes mfa”) or 0 (“no mfa”);
- β_i are estimated coefficients (through maximum likelihood method)
- X_i are the explicative categorical variables, related to: level of education, family farm composition, access to rural policies.

The model is based on the concept that the odd logarithm (logit) is a linear function of each regressor’s parameters (Berry and Feldman, 1985). Odd is a way to express a probability through a ratio; more precisely, it expresses the ratio between the probability an event occurs and the probability it does not; more precisely:

$$odd(Y=1) = \frac{\Pr(Y=1|\underline{X})}{\Pr(Y=0|\underline{X})}$$

As a consequence, odds (Y=1) becomes:

$$odd(Y=1) = \frac{\dfrac{e^{(a+\beta X)}}{1+e^{(a+\beta X)}}}{\dfrac{1}{1+e^{(a+\beta X)}}} = e^{(a+\beta X)}$$

Finally, $\ln(e^x) = x$; therefore, by calculating odd’s logarithm, it is possible to observe that odd’s natural logarithm of Y=1 is a linear function of X:

$\ln(odds_{Y=1}) = \alpha + \beta X$.

A stepwise procedure has been implemented, through a forward methodology. None of the three variables introduced in the model (education, family farm composition, access to policies) have been removed in the statistical procedure.

3. Results

3.1 Family type and strategic approach

Table 1 presents the distribution of the Italian family farms, according to the farm profile relating to the quality strategy:

Table 1 – Distribution of family farms according to the farm's profile

Farm profile	N.	%
Farm's quality systems	695	0.12%
GIs	1,578	0.27%
Other	2,060	0.35%
Sustainable agriculture	25,313	4.26%
Organic farming	64,483	10.84%
Conventional agriculture	500,629	84.17%
TOT.	594,758	100.00%

Source: data processed by the FADN database

The majority of farms adopt conventional farming while only 16% of the total sample privileges high-added-value agriculture. Moreover, a clear bias in the adoption of strategies of value creation privileging organic farming and practices of sustainable agriculture is evident. This goes to the detriment of collective strategies of value creation, like marks of geographical indication.

The second variable under study concerns the classification of family farms according to the life cycle and family composition (table 2)

Table 2 – Distribution of family farms according to life cycle and family composition

Family type	**n.**	**%**
Single	339,229	57,037%
Couples without children	106,823	17,961%
Couples with children	29,339	4,933%
Single-parent families	41,738	7,018%
Single parent with a son/daughter as manager	28,561	4,802%

Other families	49,067	8,250%
TOT	594,757	100%
Life cycle	**n.**	**%**
Young families (Y)	89,021	14,97%
Mature families (M)	334,810	56,29%
Old families (O)	170,926	28,74%
Total	594,757	100,00%
Family type	**n.**	**%**
1a. Single Y	57,107	9,60%
1b. Single M	191,400	32,18%
1c. Single O	90,722	15,25%
2a. Couples without children Y	6,152	1,03%
2b. Couples without children M	70,886	11,92%
2c. Couples without children O	29,785	5,01%
3a. Couples with children Y	216	0,04%
3b. Couples with children M	16,854	2,83%
3c. Couples with children O	12,269	2,06%
4a. Single-parents Y	54	0,01%
4b. Single-parents M	14,755	2,48%
4c. Single-parents O	26,929	4,53%
5a. Single-parents with son as manager Y	16,444	2,76%
5b. Single-parents with son as manager M	11,834	1,99%
5c. Single-parents with son as manager O	283	0,05%
6a. Other families Y	9,048	1,52%
6b. Other families M	29,081	4,89%
6c. Other families O	10,938	1,84%
TOT.	594,758	100,00%

Source: data processed from the FADN database

On the whole, there is a high incidence of single-person households: more precisely, single mature families are the most relevant family farms, absorbing about 1/3 of the total. Moreover, there is also a high incidence of elderly single-person households, with almost 10% of the total number of farms. With regard of a life cycle, it must be underlined how the problem of generational renewal is still urgent in Italian agriculture, with the relevance of family farms located either in the mature or in the elderly phases of the life cycle.

Relationships between family type and farm profile are explored in table 3, which presents the values of the specialization indexes.

Table 3 – Specialization indexes between household types and farm production strategies.

	organic farming	*sustainable agriculture*	*Other*	*conventional agriculture*	*geographical indications*	*process certification*
Single Y	2.12	0.54	1.84	0.88	0.54	0.61
Single M	1.08	0.80	1.09	1.00	0.64	1.89
Single O	0.60	0.79	0.41	1.06	2.00	-
Couples without children Y	1.37	1.60	-	0.93	1.53	0.28
Couples without children M	0.83	1.25	0.65	1.01	0.45	-
Couples without children O	0.34	1.33	3.81	1.06	0.66	2.52
Couples with children Y	6.79	-	-	0.31	-	-
Couples with children M	0.95	1.72	1.37	0.97	2.15	0.35
Couples with children O	0.33	2.79	-	1.00	1.69	-
Single-parents Y	1.25	0.69	1.43	0.98	0.69	1.29
Single-parents M	0.86	1.23	0.00	1.01	2.00	0.80
Single-parents O	0.52	1.67	0.38	1.04	0.00	0.00
Other families Y	2.01	1.03	0.64	0.87	1.33	0.19
Other families M	1.10	0.92	0.70	0.99	1.96	2.44
Other families O	0.55	1.14	0.00	1.06	0.76	0.00

Source: Data processed from the FADN database

A first element to be considered is that conventional agriculture is particularly developed within mature and elderly phases of the life cycle. Generally, non-conventional agriculture is particularly developed in young family farms (above all in cases of organic farming) and in mature farms with special reference to geographical indications. Collective action linked to the development of GIs is carried out within mature families, even though good results have been found in young couples with children (1.53). Furthermore, the presence of children represents a stimulus to develop value-creation strategies of agrifood products, maybe in order to boost higher levels of revenues. This is particularly true in elderly families: as a matter of fact, elderly couples with children present higher levels of incidence of non-conventional agriculture. Furthermore, their entrepreneurial attention is oriented towards non-conventional agriculture, different from organic farming, which differentiates this type of family from the other elderly families.

Regardless of the phase in the life cycle, only couples with children and other families are below the mean of conventional agriculture, so privileging alternative and multifunctional agricultural models based on sustainable agriculture (9,15%) and use of GIs (0,51%). In both cases, the presence of children is a discriminating factor for strategic planning: single-parent families show a double percentage of non-conventional farming (6.79% vs 3.20%); in single-parent(?) families, the presence of children grants a double percentage of farms with GIs with respect to single-parent with no children (0.51% vs 0.26%). This percentage is systematically higher also with respect to couples without children (0.15%) and to single-person households (0.11%).

A chi-squared statistic has been carried out, with the purpose of testing the statistical significance of the relationships between the two variables (family composition and family farm typology). As evident from table 4, the link is statistically significant, so confirming the goodness of our theoretical perspective that the demographic variable may affect strategic decision-making at the family farm level.

Table 4 – Chi-squared statistics

Statistics	**DF**	**Value**	**Prob**
Chi-squared	85	24.206	<.0001

3.2 The relevance of education in farm household strategic decision-making

Table 5 shows levels of education in the farms under study. As already said, in our paper, we are considering the maximum level of education at family farm level, under the hypothesis of a collective decision-making process.

Table 5 – Distribution of farm according to level of formal education

Maximum level of formal education	**N.**	**%**
No qualification/Primary school	96.929	16,30%
Middle school diploma	192.031	32,29%
Professional diploma	79.734	13,41%
High school diploma	173.903	29,24%
Bachelor	5.479	0,92%
University degree	46.106	7,75%
Postgraduate degree	576	0,10%
Total	594.758	100%

Source: data processed from the FADN database

In most farms, there is a low level of education in terms of either no qualification/elementary school (16.3%) or middle school diploma (32.3%). The academic level is registered in less than 9% of the farms (8.8%) represented by the Bachelor (0.92%), University degree (7.75%) and post-graduate studies (0.10%). Finally, a professional diploma is held by 13.41% of the farms. On average, a farmer spends 10.5 years on training, a lower period with respect to the total population of Italy, spending 17 years. Consequently, a well-known conclusion can be derived: the level of education is lower in the rural contexts.

Links between the level of education and farm profile are presented in table 6, presenting specialization indexes between the two variables.

Table 6 – Specialization indexes of farms with reference to formal education

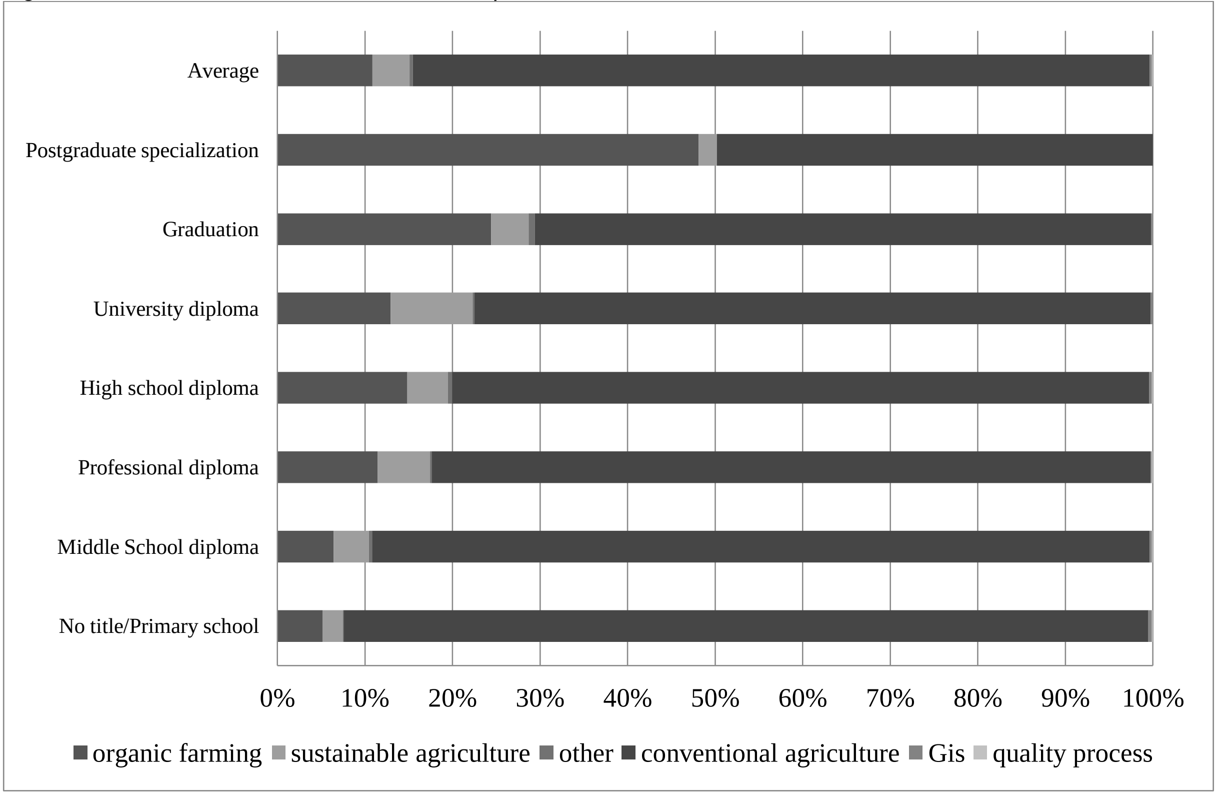
Maximum level of formal education	Farm profile					
	Organic farming	*Sustainable agriculture*	*Other*	*Conventional agriculture*	*Geographical indications*	*Process certification*
No title/Primary school	0,5	0,5	0,2	1,1	1,6	0,9
Middle School diploma	0,6	0,9	1,0	1,1	0,9	1,1
Professional diploma	1,1	1,4	0,6	1,0	0,4	1,5
High school diploma	1,4	1,1	1,4	0,9	1,1	0,9

Bachelor	1,2	2,2	0,6	0,9	1,0	0,0
University degree	2,3	1,0	1,9	0,8	0,7	0,1
Postgraduate degree	4,4	0,5	0,0	0,6	0,0	0,0

Source: data processed from the FADN database

Overall, the higher the level of education, the higher is the probability of transition towards multifunctional agriculture (figure 1). Organic farming and sustainable agriculture are usually associated with higher levels of education. Thus, multifunctional agriculture in the profile of organic and sustainable farming is particularly developed in farms in which a household member holds a college diploma or university degree. On the contrary, the choice of GIs is not commonly linked with the level of formal education, with a partial exception related to a situation of “indifference”, with high school diploma and the bachelor.

Figure 1 – Level of formal education and farm profile



Source: Data processed from the FADN database

Finally, a statistical test of association between the previously explored variable has been carried out, which is reported in table 7. The chi-squared statistic reveals the relationships between education and type of farming activity, which is statistically significant with a high level of probability.

Table 7 - Chi-squared statistics

Statistics	*DF*	*Value*	*Prob.*
Chi-squared	30	22.962	<.0001

3.3: A synthesis of results through specialization indexes and regression logistics

In order to synthesize previous analysis, specialization indexes are used with the purpose of stressing the links between the variables under study. Table 8 illustrates relationships between family composition and life cycle, level of education and the agricultural practices (conventional vs non-conventional).

Table 8 – Specialization indexes between the analyzed variables

Modalities	**Farm profile**	
	Non-conventional	**Conventional**
Young	1.5	0.9
Mature	1.0	1.0
Old	0.7	1.1
Couples with children	1.1	1.0
Single parents	0.9	1.0
Single	1.0	1.0
Couples without children	0.9	1.0
Basic school	0.6	1.1
Diplomas	1.2	0.9
University graduate and postgraduate studies	1.8	0.8

Source: Data processed from the FADN database

Both demographic variables and levels of education matter in boosting transition towards multifunctional agriculture. The young families display higher levels of specialization (1.5) to non-conventional agricultural practices, compared with mature (0.9) and elderly families (0.7). Old families seem more linked to path-dependency strategic schemes, may be motivated by the short remaining life horizon.

The presence of children steers strategic behaviour by repositioning the farms along processes of boundary shift (Banks et al, 2002), but only in cases of couples (1.13 with respect to 0.9 in couples without children and to 0.9 in single-parent families with children). Nonetheless, our analysis has demonstrated the relevance of education in performing transition towards sustainable and multifunctional agriculture. As a matter of fact, educated farmers have a higher proclivity towards non-conventional farming, whereas in less educated families the index is lower than 1 (0.6).

In table 9, we complete our analysis by linking not conventional types of farming with the explored variables. The youngest family types are usually oriented towards organic farming and towards the adoption of organic farming (1.9) and other quality indicators (1.5)

Table 9 – Specialization index: family type, level of education and type of farming

	Non-conventional agricultural practices				
	organic farming	*sustainable agriculture*	*Other*	*GIs*	*Quality process*
Young	1.904	0.689	1.511	0.716	0.673
Mature	1.004	0.987	0.894	0.898	1.373

Old	0.521	1.188	0.787	1.940	0.204
Couples with children	0.731	2.154	0.941	1.347	0.441
Single-parents	0.821	1.272	0.481	0.917	0.609
Single	1.126	0.752	1.037	0.989	1.168
Couples without children	0.725	1.296	1.495	0.568	0.721
Basic school	0.553	0.812	0.748	1.138	1.068
Diplomas	1.270	1.189	1.126	0.893	1.115
Graduation and post-graduate studies	2.166	1.122	1.782	0.758	0.066

The same young families are relatively less inclined towards geographical indications (0.7). The collective nature of the GI mark makes it necessary to cope with multiple actors, producers and other stakeholders, then making the process more bureaucratic and difficult to implement. Similarly, families with the highest level of education privilege individual actions based on organic farming (graduate farmers: 2.2: farmers with diploma: 1.3), while, in cases of basic levels of education, the index lowers to 0.5. Farmers with a basic level of education are more inclined towards geographical indications (1.14). On the other side, the higher level of education may disconnect farmers from collective farming initiatives based on the origin of products. The chi-squared statistics let us confirm the statistical significance of the association between education and family composition on the one side, and the type of farming activity on the other side.

Finally, a logistic regression has been carried out, with the purpose of estimating the probability of transition towards not conventional agricultural practices as specifically linked to multifunctional agriculture. Tables 10 and 11 illustrate the general statistics of the model, by showing its soundness.

Table 10 - Link between foreseen probabilities and observed answers

Concordant percentage	71.0	Di Somers	0.436
Discordant percentage	27.3	Gamma	0.444
Linked percentage	1.7	Tau-a	0.089
Couples	9890016	C	0.718

Table 11 – Recap of the stepwise procedure

Step	Effect		DF	Score Chi^2	Pr > Chi^2
		Removed			
1	Education	-	6	16424.2242	<.0001
2	family farm type	-	17	10973.3554	<.0001
3	access to policy	-	2	4265.9034	<.0001

Table 12 evidences maximum likelihood estimations, all significant with a couple of exceptions. Estimations from the logistic regression confirm previous results.

Table 12 - Maximum likelihood estimations

Parameter		Estimation	Standard error	Wald Chi^2	Pr > Chi^2
Intercept		-1.7828	0.1030	299.4151	<.0001
Level of education	*No title/Primary school*	-2.3609	0.0947	621.3064	<.0001
	Middle School diploma	-2.2410	0.0940	568.6019	<.0001
	Professional diploma	-1.7507	0.0942	345.3487	<.0001
	High school diploma	-1.4711	0.0937	246.5413	<.0001
	Bachelor	-1.7216	0.1025	282.0254	<.0001
	University degree	-0.8145	0.0941	74.8684	<.0001

	Postgraduate degree	0	.	.	.
Access to Rdp	*Access for measures of investments*	1.3877	0.0404	1177.8767	<.0001
	Access for other measures	1.0508	0.0169	3847.6710	<.0001
	No access	0	.	.	.
Family composition	*Single Y*	1.4242	0.0418	1162.2014	<.0001
	Single M	0.7621	0.0411	343.9330	<.0001
	Single O	0.3793	0.0430	77.8613	<.0001
	Couples without children Y	0.5720	0.0553	106.8382	<.0001
	Couples without children M	0.4266	0.0427	99.8708	<.0001
	Couples without children O	-0.1545	0.0512	9.1134	0.0025
	Couples with children Y	3.0922	0.1649	351.6730	<.0001
	Couples with children M	0.4159	0.0481	74.6618	<.0001
	Couples with children O	-0.7888	0.0620	161.8140	<.0001
	Single-parents Y	2.6152	0.3091	71.5883	<.0001
	Single-parents M	0.3153	0.0493	40.9638	<.0001
	Single-parents O	-0.2741	0.0486	31.8309	<.0001
	Other families Y	0.5575	0.0469	141.0898	<.0001
	Other families M	0.3545	0.0524	45.7852	<.0001
	Other families O	-9.4781	29.2653	0.1049	0.7460
	Single Y	1.1436	0.0488	548.6812	<.0001
	Single M	0.5702	0.0447	162.8008	<.0001
	Single O	0	.	.	.

As far as the level of education is concerned, it is evident from the table that, with respect of the maximum level of instruction (postgraduate degree), all the other levels present a growing negative estimation, as the level of education decreases. This means the higher the education is, the higher the probability that the farmer will adopt multifunctional agricultural practices. Similarly, the access to rural policies may be identified as the key tool for introducing multifunctionality, by supporting the cost of adjustment through public funds provided by European Union. Finally, the articulation based on the life cycle evidences the lesser probability for elderly phases of the life cycle to transit towards multifunctionality, while youngest families, above all the ones with children, demonstrated higher probability to this important transition. In the next table 13, the estimations on share ratios are provided, where it is possible to underline the probability of converting to multifunctional activities in relation to a specified variable: in the education variable, the comparison is related to the maximum level of education (postgraduation degree). In the uptake of rural policies, access (for both investment and other measures) is contrasted with no access, while each family type is compared to elderly other families. The share-ratio estimation confirms our hypothesis, by enlightening higher levels of probabilities linked to either higher level of education or youngest life-cycle steps and access to rural policies for investment measures.

Table 13 - Share-ratio estimation

Effect	Estimation	95% Wald confidence intervals	
No title/Primary school vs Postgraduate degree	0.094	0.078	0.114
Middle School diploma vs Postgraduate degree	0.106	0.088	0.128
Professional diploma vs Postgraduate degree	0.174	0.144	0.209
High School diploma vs Postgraduate degree	0.230	0.191	0.276
Bachelor vs Postgraduate degree	0.179	0.146	0.219
University degree vs Postgraduate degree	0.443	0.368	0.533
Access to Rdp for investments vs no access	4.006	3.700	4.336
Access to Rdp not for investments vs no access	2.860	2.766	2.956
Single Y vs Other families O	4.154	3.828	4.509
Single M vs Other families O	2.143	1.977	2.323
Single O vs Other families O	1.461	1.343	1.590
Couples without children Y vs Other families O	1.772	1.590	1.975
Couples without children M vs Other families O	1.532	1.409	1.666
Couples without children O vs Other families O	0.857	0.775	0.947
Couples with children Y vs Other families O	22.025	15.943	30.429

Couples with children M vs Other families O	1.516	1.379	1.666
Couples with children O vs Other families O	0.454	0.402	0.513
Single-parents Y vs Other families O	13.669	7.459	25.052
Single-parents M vs Other families O	1.371	1.244	1.510
Single-parents O vs Other families O	0.760	0.691	0.836
Other families Y vs Other families O	3.138	2.852	3.453
Other families M vs Other families O	1.769	1.620	1.930

5. Discussion and conclusions

This paper aimed at exploring links between transition towards multifunctional localized agrifood systems and the influence of both demographic variables and level of education in boosting this transition. To this end, an empirical analysis of the relationships between variables under study has been carried out, the results of which reveal a systematic interdependence between the level of formal education, collective (family) decision-making and the affirmation of multifunctional agricultural practices.

Statistical analyses have systematically confirmed the initial hypothesis linking the access to not conventional agricultural practices to the youngest steps of life-cycle, to higher levels of education and to the capability of getting funded from rural policies of the European Union. As a matter of fact, the econometric model implemented provided a sound and rigorous validation of these connections. As far as family composition is concerned, it is confirmed that the presence of young couples, above all with children, dramatically raises the probability of transition towards not conventional and high value-added activities (22.025 share-ratio), with respect to other families managed by elderly entrepreneurs. Similarly, the presence of educated farmers significantly increases the functional repositioning of farmers; finally, the propensity to invest by accessing rural development policies becomes a seed for the transition towards multifunctional agriculture, by developing it with a four-times higher probability with respect to farmers non-available to invest through rural policies.

Consequently, our empirical analysis presents relevant implications in terms of rural policy design and implementation: on the one hand, it involves the strengthening of the first priority of the II pillar of the CAP, in terms of upgrading farm educational level. Moreover, our demographic perspective calls for life-long learning too, as addressed in the focus area 1C of the priority 1 of rural development policy 2014-2020, in order to build up a solid process of strong multifunctionality (Wilson, 2007) in localized agrifood systems. On the other hand, the composition of the family farm suggests referring to a collective decision-making process in analyzing family farming, in order to implement policies. Consequently, collective human capital should be categorized as a unit of analysis in analyzing family's entrepreneurial processes. This is not an easy task, as pointed out by Hennessy (2014, 13), "*the challenges differ depending on farm size, location and family structure, thus making policy design to support family farming difficult*".

From this point of view, much work has to be done to fully intercept the complexity of the family farm system, through a much better understanding of intra-household decision-making process and the influence of sex, age and level of education of the different family members in this process.

References

Banks, J., A. Long, and J.D. van der Ploeg (2002) *Living Countrysides: rural development processes in Europe, the state of the art,* Elsevier, Doetinchem

Ben-Porath, Y. (1980) The F-connection: family, friend and firm, and the organization of exchange, *Population and development review* 6(1): 1-30.

Berry, W.D., and S.Feldman (1985) *Multiple Regression in Practice*. London: Sage.

Carbone, A. (2018) Foods and Places: Comparing Different Supply Chains, *Agriculture* 8(1): 6-18.

Chiffoleau, Y. (2009) From Politics to Co-operation: The Dynamics of Embeddedness in Alternative Food Supply Chains, *Sociologia Ruralis* 49(3): 218-235.

Contò, F., M. Fiore, P. La Sala, and P. Papapietro (2011) The role of education, knowledge and human resources for the agricultural development in the perspective of new CAP: a hypothesis of change in Basilicata, Educational research 2: 1773 – 1783.

Darnhofer, I. (2013) Resilience and family farming. Contributing to innovation. Paper presented at international conference: Family farming: A dialogue towards more sustainable and resilient farming in Europe and the world, Brussels, 29 November

Davidova, S., and K. Thomson (2014) Family farming in Europe: challenges and prospects, document prepared for the European Parliament's Committee on Agriculture and Rural Development, Brussels, European Union.

Davidova, S., A. Bailey, J. Dwyer, E. Erjavec, M. Gorton, and K. Thompson (2013) Semisubsinstence farming – value and directions of development. Study prepared for the European Parliament Committee on Agriculture and Rural Development, Brussels.

Djokoto, J., V. Owusu, V., Awunyo-Vitor, D., and F. Yildiz (2016) Adoption of organic farming: evidence from cocoa farming in Ghana, Cogent Food & Agriculture, 2(1).

Gafsi M. (2017) Les stratégies de diversification des exploitations agricoles. Enseignements théoriques et empiriques. Economie Rurale, 360: 43-63.

Geels, F.W., and J. Schot, (2007) "Typology of sociotechnical transition pathways". In: *Research Policy*, vol. 36.

Groupe de Bruges (2010) Towards sustainable agricultural models in 21st century, Committee on 21st century systems agriculture.

Hansson H., R. Ferguson, C. Olofsson, and L. Rantamaki-Lahtinen (2013) Farmers'motives for diversifying their farm business - The influence of family, *Journal of Rural Studies*, 32: 240-250

Hennessy, T. (2014) CAP 2014-2020 tools to enhance family farming: opportunities and limits, Document prepared for the European Parliament's Committee on Agriculture and Rural Development.

Knickel, K., G. Brunori, S. Rand, and J. Proost (2009) Towards a better conceptual framework for innovation processes in agriculture and rural development: from linear models to systemic approaches, *Journal of agricultural education and extension* 15(2): 131-146.

Lamine, C. (2011) Transition pathways towards a robust ecologization of agriculture and the need for system redesign. Cases from organic farming and IPM, *Journal of Rural Studies* 27: 209–219.

Liberman-Yaconi, L., T. Hooper, and K. Hutchings (2009) Toward a Model of Understanding Strategic Decision-Making in Micro-Firms: Exploring the Australian Information Technology Sector, *Journal of Small Business Management*, 48(1): 70-95.

Lin, J.Y. (1991) Education and Innovation Adoption in Agriculture: Evidence from Hybrid Rice in China. *Am J Agr Econ* 73(3): 713-723. doi: 10.2307/1242823

McElwee G., Bosworth G. 2010. Exploring the strategic skills of farmers across a typology of farm diversification approaches, *Journal of farm management*, 13(12): 819-838

Methorst, R., D. Roep, J. Verstegen, and J.S.C. Wiskerke (2017) Three-Fold Embedding: Farm Development in Relation to Its Socio-Material Context, *Sustainability* 9(10): 1677-1689.

Methorst, R. (2016) Farmer's perception of opportunities for farm development, Ph.D. thesis, Wageningen University.

Mintzberg, H. (1994) The fall and rise of strategic planning. Harvard business review, 72(1): 107-114

Offutt, S. (2002) The future of farm policy analysis: a household perspective, *American journal of agricultural economics* 84(5): 1189-1200.

Pollack, R.A. (1985) A Transaction Cost Approach to Families and Households, *Journal of Economic Literature* 23(2): 581-608.

Phillipson, J., M. Gorton, M. Raley, and A. Moxey (2004) Treating Farms as Firms? The Evolution of Farm Business Support from Productionist to Entrepreneurial Models, *Environment and Planning C: Politics and Space* 22(1): 31-54.

SCAR (2012) Agricultural knowledge and innovation systems in transition. A reflection paper, Brussels.

Suvedi, M., E. Jeong, and J. Coombs (2010) Education Needs of Michigan Farmers. *Journal of extension*, 48(3) 1-11.

Van Huylenbroeck, and G. Durand G. (eds) (2004) *Multifunctional Agriculture: a New Paradigm for European Agriculture and Rural Development*, Ashgate, Aldershot.

Wilson, G.A. (2008) From 'weak' to 'strong' multifunctionality: conceptualising farm-level multifunctional transitional pathways, *Journal of Rural Studies* 24 (3): 367-383.

Winger, R., and G. Wall (2006) Food product innovation. A background paper, FAO, Rome

World Bank (2006) Enhancing Agricultural Innovation: How to Go Beyond the Strengthening of Research Systems, Washington, DC.