Using a view of livestock farms as social-ecological systems to study the local variety in their trajectories of change

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Abstract: *In the Pyrenees National Park (France), as in other European mountain areas, the decline of agriculture and the reforestation of agricultural landscapes depress many assets of local importance for rural development. In comparison with other mountain areas, the relatively high capacity of Pyrenean family farms to survive is being increasingly challenged by growing uncertainties in the local and global social-economic environment. Rural development stakeholders thus place increasing value on the maintenance of livestock farms and on their multifunctional role in landscape management. In this paper we present the results of a tentative analysis to improve assessment of variety in the long-term patterns of change in individual family farms of the current farm population by means of a case study. We combined a conceptual model of a family farms as a social-ecological system and multivariate analysis to build a typology of the histories of 24 family farms in the study area, and to explain their individual development paths since 1950. Our approach allowed us to distinguish four groups of farm trajectories. These are compared with the different types of temporal patterns of change in the family farms in our sample. Our results confirm the importance of considering family dynamics to explain farm trajectories.*

Keywords: *long-term trajectories, family-farm systems, social-ecological systems, sustainability*

Introduction

The aim of the present study was to develop a comprehensive assessment of the diversity of individual trajectories of change in a family farm population of a valley in the Pyrenees National Park (PNP) (France) since 1950. Research on family-farm trajectories has increased in recent decades. Studies aimed first at improving our understanding of the processes of change in farming and agricultural systems regarding the modernization of agriculture (e.g. Gasson and Errington, 1993; Cochet and Devienne, 2006) and second at providing technical and economic advice to farmers (Capillon, 1993). The study and modeling of farm trajectories is currently increasing worldwide due to the challenges family farms have to face to adapt and survive a widening range of site-specific and global pressures of unprecedented speed, magnitude and uncertainty (Ickowicz et al., 2010). Most of the works rely on survey data at relatively large farm samples to assess the local diversity in farm trajectories according to their technical-economic change (e.g. Cots-Folch et al., 2009; Brossier et al., 2006), or with reference to drivers of change (e.g. García-Martínez et al., 2009) to better adjust public policies or advice to farmers. A few studies privilege in-depth farmer interviews at small farm samples to assess the relationships between the process of farm change and the farmer strategies (e.g. Cialdella et al., 2008). Indeed, studies of family-farm trajectories within a particular population are missing in the literature. The work presented in the paper represents the first application of the methodological framework we are in the process of developing to meet this gap.

Research rationale

In the PNP, as in most European mountain areas (Soliva et al., 2008), the continuous decline of the agricultural population and the natural reforestation of landscapes are increasingly depressing agricultural and ecosystem services which are of major importance for the sustainability of rural development (biodiversity, landscape aesthetics, local historical experience and cultural identity, natural resources for future agricultural economies). In the trans-disciplinary research project on

change in the local land-use/landscape system of which this work is part (cf. Gibon et al., 2010), local stakeholders place special emphasis on the persistency of local family farms and sustainability of agricultural land-use. To tackle these issues, a better understanding of long term changes in farms is required. For instance, working on long-term and spatially-explicit farm trajectories, Mottet (2005) proved that land abandonment is not a final state. Contemporary farms were also found in previous work to mostly result from the continuation of an ancient family-household farming tradition according to a 'house-based' social system, including farm holding transfer to a single heir, who was bound to care it for next generation (Gibon et al., 2010 op.cit.). In this system, the household is typically a "stem" family composed of three generations: grandparents, parents, unmarried uncles or brothers, and children. The domestic group is characterized by the sharing of accommodation and domestic functions on the farm (e.g. Sourdril, 2006). Traditionally, these families also have off-farm activities.

Methodology

Case study area

The case study area comprises five contiguous villages in the Argelès-Gazost valley located about 180 km southwest of Toulouse, and 20 km south of Lourdes, France. The local agro-pastoral system comprises small family farms which mainly raise cattle and/or sheep for meat production. These farms use both private agricultural land located between 500 m and 1,500 m asl. and common pastures located at higher altitudes. Private agricultural land is mainly used for grazing and haymaking (see Mottet et al., 2006 for details on the agricultural system and geographical characteristics of the study area). In 2003 (the most recent date considered in this study) about 50 farms were working land in these villages.

Conceptual framework approach to long-term change in family-farms

Our study relies on a view of a family-farm as a complex that closely links an ecological and biotechnological system (the farm and farming system) and a social system (the family group). This approach refers to the conceptual view of social-ecological systems (Holling, 2001) and is used to support the integrated assessment of livestock farms' adaptive capacity and sustainability (Gibon and Hermansen, 2006).

Studies of long-term changes in family farms rely on a view of the "farm trajectory" as a succession of chronological steps characterized by structural and/or organizational changes in the farm and farming system (Capillon, 1993; Moulin et al., 2008). A wealth of studies have contributed to the widespread view of the farm development process as a succession of steps related to major periods and stages in the farmer's professional life and in the family life cycle, i.e. transition, growth, stability, and decline (e.g. Gasson and Errington, 1993). These steps are also -and increasingly- regarded as the result of a farmer's strategic decisions and actions to face (or benefit from) changes in the farm environment or in the family objectives and/or conditions (e.g. Moulin et al., 2008). Regarding the adaptive character of the farmer's decision-making process, this concept now includes the role of uncertainty in the social-economic environment. Some social-economic studies have also focused on topical issues linked with farm transfer, which are viewed as an important process in the design of long-term changes in the structure and orientations of family farms (e.g. Brossier et al., 2003; Gasson & Errington, 1993). However, the systematic study of trajectories of change in family farms in the course of successive generations of farmers has been little documented up to now. Mottet (2005) developed a systemic model of a family-farm trajectory of change to support its assessment by using indicators of the farm's structural and functional change and the successive lifecycles of the farmer household (Gibon et al., 2010). Cialdella et al. (2008) built on advances in the view of a family farm as a social-ecological system and on Mottet's results to analyze in a sample of 14 farms (in Savoie, France) the temporal types of livestock farm change in relation to farmer strategies since 1950 from in-depth farmer interviews. In this paper we go further by simultaneously analyzing long-term farm

and family trajectories of change using a method that allows us to assess both the amplitude of changes and links between farm and family temporal patterns.

To do so, we combined the views previously developed for the assessment of trajectories of change in livestock family farms with recent advances in management sciences concerning the long-term persistence of farms or other family businesses over family life cycles. Mignon (2001) and Macombe (2006) pointed to a certain specificity in the strategic management of long-lasting firms and farms in relation to the family's "job ethics" and its durability. This led us to assume that the persistence of family farms relies to a large extent on the farm-management strategy of the family with regard to the relationships between the farm and the household according to three main dimensions (Manoli, 2008): (i) the farm holding as a material heritage and its intergenerational transfer within the household; (ii) the farming activity as a way of life and as a support for ethical and cultural values, and technical-ecological knowledge and skills; (iii) the farm as a business that contributes part of -or the entire- family livelihood. These dimensions are closely interwoven. The approach we designed for the analysis of farm trajectories is based on analysis of the structural and organizational configuration of the farm at regular time-steps using non-inferential statistics, followed by their analysis in relation to the family's temporal patterns. We believe that this method facilitates the assessment of the impacts on adaptive decisions concerning external changes, i.e. changes in the social-economic environment, and internal changes, on individual trajectories within a local family farm population. This paper describes a preliminary application of the first of a two-stage method we are now developing. We intend to complete the first stage with an analysis of the impacts of major temporal changes in the local environment (e.g. off-farm job opportunities, public policies). The second stage will consist in a social-economic survey of a sub-sample of the farms in the population, in order to confirm and refine the assessment of the types of farm development pathways observed in relation to family strategic decisions with respect to family-workforce allocation to on- and off-farm jobs, occurrence of unexpected events within the family/farm, and changes in the environment.

Data collection and elaboration

The data used in this study were collected in two consecutive interviews with farmers at every family farm (43) in the five villages of the study area in 2003 and 2009. Information was collected about the social-economic characteristics of the farm and the family and their respective history up to 1950 using a semi-open questionnaire and GIS maps (see Mottet et al., 2006 for additional detail on the method).

Description of temporal patterns of changes in the farms and families

We used a limited set of qualitative and quantitative indicators (Table 1) to describe the successive conditions of each farms in the period from 1950 to 2003 at 5-year time step. Eight indicators were selected according to the conceptual model presented above and after checking the availability and quality of appropriate information in the survey data. To describe the changes in the farm-family composition and its livelihood, according to the same time-step, we used the four qualitative indicators described in table 2. The reference to generations allows accounting for the inter-generational farm transfers occurring during the study period.

Table 1. Description of farm indicators used to analyze farm trajectories.

Indicator of...	Criteria used	Heading	Units
Area used for agricultural activities	Total Agricultural Area (except woods)	AAt	Ha
Size of family farm holdings	Proportion of Agricultural Area in property	AAp	= ha of AA in property of the family (except woods) / AAt
Size of family holdings	Number (Nb) of barns in intermediary zones	barn	Code : 0= no barn, 1= 1 or 2 barns, 2= more than 2 barns
Size of herd	Nb of total Livestock Units of the herd	LUt	= Nb of cows + Nb of ewes*0,16 + Nb of goats*0,16 + Nb of mares
Production orientation	Proportion of cattle in the herd (bovine Livestock Unit)	LUb	= cattle LU / LUt
Farm functioning and other potential sources of income for the farm	Other agricultural production (housed rearing unit with pigs, calves or rabbits, cereals)	OProd	Code : 0= no activity, 1= one or more activities
Farm functioning and other potential sources of income for the farm	Other occupations (rural cottage, sale of wood)	OOc	Code : 0= no activity, 1= one or more activities
Technical production system and cultural heritage, link with pastoralism	Use of mountain summer pastures	MSP	Code: 1= traditional use (the whole herd), 2= use only for a part of the herd or no use

Table 2. Description of family indicators used to analyze the temporal patterns of change in the families.

Indicator of...	Criteria used	Heading	Units
Succession of generations	A number indicating the generation which has managed the farm since 2003	Generation	0= the current generation, 1= the precedent generation, 2= former generations
Family social type	Composition of the family living on the farm	TypSocF	1= multi-generational family / 2= nuclear family
The composition of the farmer's family	Composition of the family managing the farm	TypStruF	1=couple, widowed people or young single (<35 years old), 2 single people (between35 and 60 years old), 3=retired people
Additional income on the farm and/or off-farm jobs	Off-farm activities	Pluriact	"yes"= when one or more members of the family have an off-farm job / "no"

Data analysis

To assess the variety in local farm trajectories, we used the method developed by Dolédec and Chessel (1987) to assess differences in profiles of temporal change among individuals in a population from a matrix where statistical individuals represent the state of each individuals in the population, described with a series of variables, at a given time in the time series considered. In the first stage, we applied an Hill and Smith's (1976) Component Analysis on the 288 statistical individuals representing the successive configurations of the farms in the course of the study period (24 farms*12 dates).This method is appropriate for the analysis of the main significant factors of differences among statistical individuals described with a mix of quantitative and qualitative variables. In a second stage, we performed within- and between-class inertia analyses on the scores of the statistical individuals of the main factors of the Hill and Smith's analysis, using dates and farms as grouping factors to assess the respective role of the time-period and the individual farms. Monte-Carlo tests (based on 1000 permutations) were applied on the between-groups inertia percentage to check for significance of the differences between groups. In the last stage, to build a typology of individual farm trajectories assessing the individual patterns of change of the farms in the sample, we used the within-date analysis' results, which represent the individual farm condition at each date once the average effect of date in the farm population is removed. A HAC (Hierarchical Ascendant Classification) was used to elaborate the typology of trajectories (using Euclidean distances and Ward's aggregation method). We applied a PCA (Principal Component Analysis) on the statistical individuals' coordinates on the four first factors of the within-date analysis, prior to the HAC. Cluster

tests, which calculate p-values for hierarchical clustering via multi-scale bootstrap resampling (Suzuki and Shimodaira, 2004), were applied to the HAC to check the homogeneity of the groups.

To characterize the families' temporal patterns of change, ACM (Multiple Correspondence Analysis) was performed on the 24 statistical individuals corresponding to the farm-family states at the successive 12 dates, described with the 4 indicators presented in table 2 (i.e. a series of 48 variables) prior to a HAC. Here again, cluster tests were applied on the HAC. Additional information was used to interpret the types of temporal patterns of the family farms: date and modalities of farm transfers, and notes about particular events that could have a major impact on the functioning and/or structure of the family farm (e.g. notes about deaths, diseases affecting the herd).

We analyzed a sample of 24 farms among the study population after discarding farms created after 1950 (10 farms) and those with too much missing data (9 farms). All statistical analyses were made with R® 2.8.1. software.

Comparison of the two typologies

We built a table crossing farm trajectories and family temporal patterns to see possible links between them.

Results

General trends in the farm sample

The four first factors of the Hill and Smith's analysis, which explained 73.5% of the total variance in the individual configuration of the farm sample at the series of dates considered, provide an overview of major trends in overall variations. These variations are mainly due (in order of importance) to variations in the size of the farm holding (AAt), in the size of the herd (LUt), and in the share of farmland owned by the farm household (AAp) on the first axis, which explained 31.8% of the total variance. The three other axes explained respectively 15.9%, 13.5% and 12.2% of the total variance.

The results of the factorial analyses of the scores of the farm-date individuals on Hill and Smith's four first factors revealed that, even though the differences between dates were highly significant ($P< 0.001$; Monte-Carlo test), they explained only 7.57% of the overall variance. Plots of the results showed that the effect of date, which was very low from 1950 to 1970, subsequently increased considerably. Between- and within-farm variations explained respectively 58.84% and 41.16% of the overall variance ($P< 0.001$; Monte-Carlo test). The overall variety among farms thus appears to result mainly from structural and functional differences between individual farms rather than from within-farm change. To sum up, there was considerable initial diversity in farm structural and functional traits that increased over time. This diversity was mainly due to farm size.

Typology of farm trajectories

We obtained four broad groups of farm trajectory types (Figure 1). The cluster test confirmed that the groups were homogeneous (approximately unbiased (au) p-values> 79). Table 3 helps characterize each group more precisely.

All groups underwent a varying increase in farm and herd size (AAt and LUt) between 1950 and 2003, with the biggest change occurring between 1975 and 2003. These results suggest that the increase in size was first due to land purchase from 1950 to 1970 and second due to acquisition of rented land (general decrease in AAp) from 1975 to 2003. Yet, except for group 2, the proportion of farm-owned land property nevertheless remained high (LUp > 70%). The general trend of change (described in the preceding paragraph) was based on different modalities depending on the group.

Group 1 (6 farms) includes relatively small farms, specialized in cattle raising in 1950 (LUb= 90%) and which subsequently diversified production to include other species (LUb= -31% from 1950 to 2003) while increasing their size and that of their herd. The increase in size (+13 ha between 1950 and 2003) paralleled a decrease in LUp, especially after 1975 (-21%).Some farms started other activities after 1975 and 83% of them made less use of MSP. Group 2 (4 farms) includes the smallest farms in 1950 (AAt=7.98 ha; LUt=9.4), which underwent a huge increase in size and specialized in cattle raising (except from one farm which remains small). They were the biggest farms in 2003 (AAt=45.25 ha; LUt=54.6). This huge increase in AAt was mainly due to the acquisition of rented land with a decrease in AAp (-44%). In parallel to the huge increase in the size of their herd (LUt = +278% after 1975), they became specialized in cattle raising (LUb= +48% after 1950) and did not start any other activities. Group 3 (8 farms) includes the biggest farms in 1950 (AAt=20.63 ha), which underwent the least change (AAt= +3.6 ha; LUt= +2.78 from 1950 to 2003) and continued with a mixed production system (LUb is about 50%). They did not start any other activity and other types of production decreased (from 63 to 25% between 1950 and 2003). Group 4 (6 farms) includes farms with the traditional system (mixed herd and traditional use of mountain summer pastures) but which started other activities (0 to 83% from 1950 to 2003). They were already large in 1950 (AAt=16.05 ha) which explains why they owned several barns (5).

Figure 1. Farm trajectories in the Hill and Smith's analysis plan. Different colors represent the different farms. Black "**o**" represent date of farm transfers. Main variables explaining variations are reported: AAt, LUt and AAp for the horizontal axis and barn=2, barn=1 and LUb for the vertical axis.

Table 3. Characteristics of farms in each trajectory group (4 groups, 24 farms).

	Group N°1	Group N°2	Group N°3	Group N°4
Number of farms	6	4	8	6
AAt 1950 (ha)	10.93 ±4.58	7.98 ±4.32	20.63 ±9.47	16.05 ±6.88
AAt 2003 (ha)	23.92 ±15.42	45.25 ±33.86	23.79 ±16.98	28.75 ±22.34
Change: period 1/ period 2	34 / 41	16 / 282	-16 / 34	3 / 66
AAp 1950 (%)	0.98 ±0.04	0.70 ±0.34	0.89 ±0.15	0.86 ±0.21
AAp 2003 (%)	0.71 ±0.32	0.44 ±0.39	0.77 ±0.28	0.75 ±0.26
Change: period 1 / period 2	-8 / -21	-9 / -33	2 / -14	-5 / -4
LUt 1950	12.40 ±5.85	9.40 ±5.94	20.78 ±9.86	17.85 ±7.71
LUt 2003	22.55 ±14.15	54.60 ±54.82	23.56 ±17.97	36.11 ±37.06
Change: period 1 / period 2	7 / 60	0 / 278	7 / 12	-10 / 134
LUb 1950 (%)	0.90 ±0.17	0.37 ±0.25	0.56 ±0.29	0.66 ±0.21
LUb 2003 (%)	0.64 ±0.37	0.72 ±0.48	0.54 ±0.40	0.55 ±0.45
Change: period 1 / period 2	0 / -31	0 / 48	-14 / 8	-19 / 25
barn 1950 / 2003 (nb)	1 ±1 / 1 ±1	0 ±0 / 4 ±8	2 ±1 / 3 ±2	5 ±3 / 5 ±3
Change: period 1 / period 2	0 / 0	0 / 0	0 / 33	0 / -3
OProd 1950 / 2003 (%)	0 / 0	100 / 75	63 / 25	0 / 0
OOc 1950 / 2003 (%)	0 / 50	0 / 0	0 / 0	0 / 83
MSP 1950 / 2003 (%)	50 / 83	0 / 100	0 / 100	0 / 0

Legend: AAt, AAp, LUt, LUb, barn, OProd, OOc and MSP (see Table 1 for definitions): "mean for the given date ±standard deviation", % of presence of OProd and OOc and % of less or no use of MSP. Change= % of average differences in period 1=[1950-1970] and period 2=[1975-2003] for a given variable.

Temporal patterns of family change

The HAC was performed on the first 5 axes of the ACM, explaining 69% of the total variance. It resulted in a classification of family trajectories in seven groups, suggesting general traits among the diversity of family temporal patterns. These groups are homogenous (au> 80 except group 7: au=68).

Families in group 1 (5 farms) and 2 (3 farms) experienced two farm transfers during the period. They differed in the date of farm transfers (the first transfer began in 1970 and the second in 1985 in group 1, the first in 1960 and the second in 1980 in group 2). These 2 groups include traditional families. Nevertheless, two out of five families abandoned all activities except farming (after the farm transfer or the association of the spouse on the farm) in group 1. The family became nuclear after the farm transfer in this group. Group 3 (8 farms) includes traditional families but only experienced one farm transfer (beginning in 1970), except for one farm. The four remaining groups were not so close to the traditional type of family farm. Group 4 (2 farms) includes families where two or three generations succeeded one another. They differed from traditional type because they only started other activities after the transfer of the farm (i.e. after 1965). Group 5 (3 farms) only experienced one farm transfer (from 1975 to 1985). The farms in this group were managed by couples at the beginning and by single people after the farm transfer, which explains the takeover of off-farm activities. In group 6 (2 farms), two generations succeeded one another, but the farm transfer took place later (after 1985). Farms were subsequently managed by retired people: one couple and one single man. Group 7 (1 farm) is different because it is the only one in which the farm was first managed by a single man and then by a couple after the farm transfer in 1975.

We observed that the great majority of farm transfers were traditional (> 80% in all groups): the child or the son/daughter-in-law settled on the parents' or parents-in-law's farm. In a few cases of wider family transfers, in groups 1, 2, 3 and 7, the farm was transferred to a nephew or to grandchildren. In groups 1 and 7, the majority of installations were direct. In groups 2, 3 and 5, most new farmers had an off-farm job. No trends were apparent in groups 4 and 6.

Relationships between the individual farm patterns of change and family or other events revealed that periods of farm transfer were often followed by major changes in the farm trajectory (see "**o**" in Figure 1). Other changes appear to have occurred parallel to a variety of special events or accidents that affected the family and/or the farm, e.g. disease of the herd followed by slaughter, the death of a relative followed by abandonment of one type of herd, the opening of a new road enabling an increase in AAt.

Linking farm and family trajectories

Our analysis only allowed a preliminary comparison of farm and family typologies. Despite our limited sample, some links between farm and family groups were apparent. Traditional types of families (groups 1, 2 and 3) include all types of farm trajectories, suggesting a wide array of possible change for these families. Despite this fact, we noted that the majority (13 out of 16 farms) of farm trajectory types were traditional (i.e. a strategy of diversification of farm trajectory typology in groups 1, 3 and 4). We also observed that groups 5, 6 and 7, which include farms managed by single or retired people after farm transfer, do not include any farm of type 1 (production diversification and other activities) or 2 (huge size increase and specialization).

Discussion

Novel insights into changes in Pyrenean livestock farming systems

Our study provides evidence of a significant acceleration in change between 1950 and 2003, and of the increasing diversity in individual family-farm pathways. Both the overall trend in the farm sample and the strong synchronicity observed in individual temporal patterns of change suggest that this acceleration began at the end of the 1970s. This confirms the knowledge of broad types and processes of change in individual family farms in the Pyrenees gained in previous research (Mottet 2005; Gibon et al. 2010). In addition, our work enabled us to appreciate the amplitude of changes in farm trajectories. It confirmed the existence of an important variety in farm size in the 1950s, as previously shown by Mottet (2005) in our study area and by Cialdella et al. (2008) in French Alps. It also stressed out that off-farm activities, which are regarded as a major feature of past traditional farm households in the area was not as much systematic as usually considered. It eventually pointed to unexpected trends in farm-size change: the smallest farms in 1950 became the biggest ones in 2003.

Searching for a method of assessment of the variety of individual pathways of development within a local family-farm population

The contextual conditions of our study led us to develop a different method to assess the variety in the individual pathways of historical development of all the livestock farms working land in a given geographical area since 1950, while considering them as adaptive social-ecological systems. This objective involved a series of methodological challenges, from data collection to the interpretation of results.

First, like all empirical studies of trajectories of change in family-farm systems based on interviews with farmers, our study had intrinsic limitations. Collection of data inevitably relies on farmers' (and other family members') memories of past family-farm conditions and events. The resulting data present an inherent vagueness that increases with the time and which clearly hampers precision in temporal analysis (Mottet 2005; Cialdella et al., 2008). These authors also stressed the partial vanity of efforts to address *a posteriori* behaviours and strategies applied in distant periods in the farmer's life or by previous generations. In our case study, additional limitations resulted from the wide range of issues tackled in the two consecutive interviews. This inevitability led to heterogeneity -and some gaps- in the information collected. Due to the cost of supplementary interviews, we preferred to

build our method using available data, in order to check if we were on the right methodological track as rapidly as possible and to verify its potential before organising additional interviews with farmers.

Second, there is an increasing agreement about the need to study changes in livestock family-farms as social-ecological systems (e.g. Thompson and Nardone, 1999; Gibon and Hermansen 2006). There is no proven general method available for assessing and comparing trajectories of family-farm change with reference to the major issues involved in this view, i.e. the properties that support their adaptive capacities and persistence (Berkes et al., 2003). Most authors analyse changes in farming systems regardless of the type of family which runs the farm. In these studies where change is analyzed and assessed using large farm samples and statistical methods, trajectories are most often described by comparing an initial and a final state, without any description of intermediary stages (e.g. Perrot et al., 1995). Studies that address intermediary changes usually consider only one particular dimension of farm change, such as change in farm structure and management from the point of view of technical-economic efficiency (e.g. Benoît and Laignel, 2004; Perrot et al., 1995; Brossier et al., 2006) or productive farming systems and land management (Cots-Folch et al., 2009). The few studies that do consider family-farm interactions often limit their scope to a specific topical issue, e.g. multiple job holding or farmers' strategies in farm development (Fiorelli et al., 2005; Cialdella et al., 2008) and are mainly based on retrospective studies of small farm samples (e.g. a 14-farm sample in Cialdella et al.'s 2008). To our knowledge, the only exception is the study of change in livestock family-farms in the Spanish Pyrenees by García-Martínez et al. (2009). Two social-economic surveys based on a 70-farm sample, enabled these authors to analyse the family-farm trajectories by comparing farms and family conditions and farm management at an interval of ten years (1991-2001).

To develop a suitable method for our objective, we chose to (i) select a limited set of indicators that could apply to every farm in the study area in order to describe the farm condition and technical management and the family condition at a regular time-step and (ii) explore and typify the variety in the development paths of the family farms from this set of indicators using multivariate statistics. As others (e.g. Cots-Folch et al., 2009) we considered that building a clear conceptual view of family-farm trajectory characteristics facilitates the choice of using statistical methods for assessing patterns of change in individual farm characteristics with key indicators. As García-Martínez et al. (2009) before us, we could also appreciate the interest of using the statistical methods developed by Dolédec and Chessel (1987) for the analysis of trajectories of change in ecosystems, enabling the building of both a static classification of types of farm functioning and a dynamic point of view based on trends of change (Cerf et al., 1987). Despite the limited set of indicators and farms we used, we were able to identify several meaningful trends in changes in farm and family characteristics. The method can easily be improved by refining the set of indicators.

Conclusion

Despite the fact our study is a first and incomplete effort to develop a novel method for the characterisation of individual family-farm trajectories within a farm population and the assessment of their variety, we believe our results are promising from both a methodological and practical point of view. They suggest the relevance of our approach to capture long-term changes in family-farm trajectories and their amplitude. They confirm the importance of taking into account an intergenerational time lag as we clearly observed links between major changes and farm transfers, too. Nevertheless, our conclusions may differ a little when a larger sample is used.

As our first results being encouraging, we intend to redo the statistical analysis after acquiring missing data in the indicator set by contacting the farmers concerned and complete our study with analysis of the potential impact of change in the local environment (off-farm job opportunities, public policies) on family-farm trajectories. We would also like to include criteria concerning micro-economic aspects of family-farm- systems, which could explain certain changes, including farm income, investment, income from off-farm jobs. It would be interesting to compare family and farm trajectories in a more systematic way (using co-inertia analysis, for instance) for a shorter period

(from 1985 to the present, for instance) for which it is possible to work with more precise and reliable data.

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