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MULTIFUNCTIONAL RURAL LAND MANAGEMENT

Economics and Policies



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How do Farms’ Economic and Technical Dynamics Contribute to Landscape Patterns?

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Introduction

Multifunctionality is a key issue in the sustainable development of the rural countryside. The reason for this is that the notion of multifunctionality implies the ability to manage in the long run tensions and complementarities between multiple functions associated with the three pillars of sustainable development (environmental, economic and social). Understanding the dynamic interactions between those functions is therefore required to develop appropriate decision support systems (Aumand et al, 2006; Walford, 2005).

From an economic point of view, multifunctionality indicates that multiple marketed and non-marketed goods are jointly produced (Bonnieux et al, 2000). The consequence of this is that any modification in the supply of any marketed output (food, fibre, energy) induces modifications in the supply of joint public goods that are usually not marketed. When certain products exhibit public goods characteristics or correspond to positive externalities, it is difficult to evaluate the processes that intervene in their production and that support their development (Bateman et al, 1995). This is especially the case when the public good results from the activity of several producers who concentrate on the supply of market goods. Besides, multifunctionality

questions the ability of governance organizations to develop and implement appropriate policy schemes for supporting local development. After all, policy making regarding multifunctional land use – with a concentration of functions and activities – is quite different from the sectorial policy making process that regulates monofunctional land use, and which provides for a spatial separation of functions.

In elaborating on this assertion, this chapter examines two interrelated statements that arise in designing suitable policies on multifunctionality:

- Current policies do not allow farmers to define long-term strategies based on clearly locally defined environmental objectives; there is also an inadequateness between missions and means of the governance organizations that intervene to support such objectives.
- There is a need to acquire knowledge on processes in order to design long-term survey systems useful for the support of landscape adaptive management (Liu and Taylor, 2002).

In this chapter, the multiple functions related to landscape and landscape management take centre stage. Landscape is here considered as the continuous assemblage of the various landscape elements in space and time. As such, the rural landscape can be viewed both as a frame for, and a product of, human activities (Deffontaines et al, 1995). It carries patrimonial and aesthetic values that provide opportunities for, inter alia, recreational activities in the countryside.

Moreover, the landscape structure controls key ecological processes, such as the movements of species in space and time; this confers ecological functions on the landscape, such as habitat or corridor functions. Landscape ecological functions have often been assessed in their local context and, for instance, for a limited set of species or biophysical processes. One difficulty in assessing these functions is their high number, their interactions and the multiplicity of their drivers (Burel and Baudry, 2003). The relationships between the structure of the landscape mosaic and the persistence of species' populations may vary from one species to another. Besides, it is still largely unknown how trajectories of landscape change lead to shifts in ecological processes (Swift et al, 2004). Nevertheless, most studies agree in emphasizing that losses of biodiversity and a lack of regulation over pest dispersal at local to regional scales are due to (i) the homogenization and fragmentation of perennial landscape elements, such as ponds, ditches and hedgerows; and (ii) the homogenization of the mosaic of land cover and land use types, in time and space (Benton et al, 2003).

Assessing the multiple functions of landscapes presupposes that human activities are associated with these landscapes. One major reason for this presupposition is the importance of human-related landscape functions (goods and services). Humans can modify the landscape according to their vision and to suit their own needs. In this respect, it is instructive to recall what Nassauer wrote (2003, p40): 'the appearance of landscape is separable from its function;

any given commodity can be produced in many different landscape patterns'. Another reason is that human activities are the main driving force of landscape evolution; some of them, such as landscape management activities, are direct drivers, while others are indirect.

In the literature, the notion of landscape management often relates to the activities of policy makers or of natural resource managers who develop and coordinate collective actions (Liu and Taylor, 2002). In this chapter, however, landscape management is envisaged primarily as a farmer's activity (Busck, 2002; Kristensen et al, 2001; Primdahl et al, 2002). For characterizing farmers' landscape management, we applied an agronomic approach of technical management systems in farms. This approach consists in focusing on how farmers choose farming techniques and on how they develop and coordinate production and land management practices according to evolving farm characteristics (Papy, 1994). Such an approach, when applied to farmers' landscape management, attempts to explain the spatiotemporal organization of the farming practices that involve all kinds of landscape elements (e.g. field, field boundaries, ponds, woods) (Le Du et al, 2008; Thenail et al, 2004).

This chapter presents a case study undertaken in Basse-Normandie, France. The aim of the study was to derive elements for understanding how economic and technical dynamics of farming systems contribute to landscape patterns, which, in their turn, affect ecological processes. In the next sections, we will give a description of the case study and its results. This chapter ends with a discussion and some concluding remarks.

Description of the case study in Natural Regional Park of Cotentin-Bessin (Basse-Normandie, France)

Basse-Normandie is a NUTS2 region situated in the northwestern part of France, with the English Channel to the north, Bretagne to the west and Pays de Loire to the south (Figure 12.1).¹ We particularly focused on the Natural Regional Park of Cotentin-Bessin (NRP Cotentin-Bessin).

The next subsection provides a description of the NRP Cotentin-Bessin, together with a brief analysis of the farmers' strategy in the area. Then, elements of hypotheses and the research methods are presented.

The Natural Regional Park of Cotentin-Bessin

The area of NRP Cotentin-Bessin is characterized by hedgerows (*bocage*) and marshlands, and is a major wetland for migrating birds (Ramsar Convention). There are some key environmental issues that pertain to the area, in particular the protection and conservation of birds and vegetation, and water management. When the NRP Cotentin-Bessin was established, in 1991, the ecological quality of the marshlands was identified as very dependent on agriculture; there was, in other words, a strong joining of production. Extensive breeding farms were considered especially important, because of their grassland management. Due to this link between agriculture and ecological quality, the

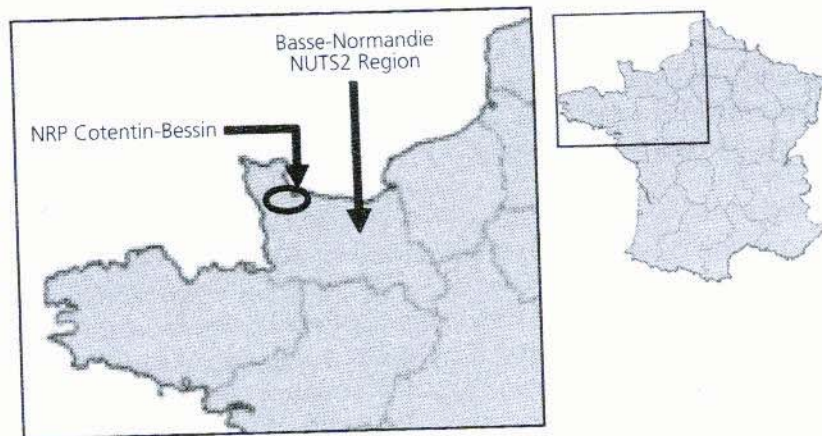


Figure 12.1 Location of Basse-Normandie and NRP Cotentin-Bessin in France

decline in agricultural activities is seen as a major driver of marshland perturbation. But also the intensification of the remaining agricultural production is supposed to have adverse impacts and is viewed as the cause of a significant deterioration of the environmental quality of the marshlands in the area. The loss of biodiversity in the areas was the major reason for the establishment of the NRP Cotentin-Bessin.

When it was created, the NRP Cotentin-Bessin took the opportunity offered by the Common Agricultural Policy (CAP) to design agri-environmental schemes to achieve two objectives: (i) the restoration of hedgerows threatened by a particular tree disease; and (ii) the maintenance of extensive agricultural practices on marshlands. Low productive marshlands were threatened by abandonment, while the environmental benefits of more productive marshlands were threatened by agricultural intensification.

Since 1991, several surveys of farmers have been conducted to understand the determinants of farmers' behaviour and participation in agri-environmental schemes (Deraeve, 2002). Based on the result of these surveys, the main drivers of long-term farm development could be determined. It appeared that they were strongly rooted in the implementation of the CAP. For example, the most important driver was the access to dairy quotas. Like everywhere in France, dairy quotas were primarily allocated by the administration. Exchanges of quotas between farms were possible through the land market, which is itself partially regulated by a regional committee of administration and representatives of farmers' organizations. In order to establish viable farms, young farmers had an official privileged access to milk quotas. Older farmers could enlarge their farm through the land market, although political influence in the professional sphere was often necessary to achieve or even to promote land market operations. The link between land and milk quotas explained why all types of farms had marsh grassland. Despite lower

agricultural productivity, marsh grassland was the key to the restricted access to milk quotas.

Questions and methods

In this study, we put the emphasis on agri-environmental schemes, which were seen as a possible support system for maintaining and developing landscape functions. We analysed the induced effects of agri-environmental schemes on landscape patterning, thereby paying particular attention to the evolution of landscape management activities. We also addressed the issue of the appropriate spatial and temporal scales to be used. Because relationships between farming systems and landscape are dynamic, explicitly involving time in an analytical framework is necessary for characterizing the trajectories of these interactions (Veldkamp and Lambin, 2001; Verburg, 2006).

The issue of agri-environmental schemes is absolutely crucial if we consider the new European and French agri-environmental policy (2007–2013) that advocates a bottom-up approach, with greater consideration of local conditions. Such an 'upward' approach that reflects local conditions is necessary for effectively directing European and local funds into projects that benefit from a strong local initiative. In this respect, it is interesting to assess the efficiency and pertinence of institutions and government organizations that have experience with collective development projects in local areas. We were particularly interested in the question of whether such local institutions and organizations possess (and exercise) the capacity to enhance the efficiency of agri-environmental policies, for example by favouring the continuity of actions in time. This question is fairly relevant because the decoupling of the first pillar of support reduces the ability of the CAP to drive farmers' long-term strategy.

One municipality, Montmartin-en-Graignes, was chosen for this case study. Farmers were interviewed and the landscape was mapped from field observation and aerial photos (Winckler, 2006). The interviews aimed at characterizing (i) farm technical management systems that contribute to farmers' landscape management; and (ii) the way farm socio-economic developments and agri-environmental measures have influenced this management. As mentioned earlier, the case study benefited from several years' surveys in the NRP Cotentin-Bessin on the socio-economic development of farms and the farmer's application to agri-environmental schemes (see Arnaud, 2004; Deraeve, 2002; Ducos and Dupraz, 2007). Farmers' interviews made during these surveys had already given a description of the various types of farm socio-economic developments and the agri-environmental contracting in a broader context (Deraeve, 2002).

Regarding farmers' landscape management, we focused in particular on the spatial organization of land use and hedgerow management on land islets. This means that the spatial unit of management considered here is that of the land islet. Land islets are the spatial units used for the registration of the farmers' CAP-eligible crops (and are called 'land parcels' by Leteinturier et al (2006)). A land islet is defined as a piece of land that is part of a farm, and

which is demarcated by roads, lanes, water, or the fields of other farms. Land islets are the product of collective and individual land development processes. Moreover, with many fragmented farms in the region, land islets can be viewed as the smallest pieces of landscape managed by farmers (Thenail and Baudry, 2004). Therefore, land islets are interesting and relevant units to assess the way landscapes are shaped by farmers' land development and their management.

Results of the case study

Farm types: Socio-economic structure and development

Seventeen farmers were interviewed (Winckler, 2006). Their land covered 40 per cent of the municipality's total area, including 33 per cent of the marshlands. Farms were classified according to selected technical criteria, as well as criteria describing the socio-economic developments as proposed by the earlier classification of Deraeve (2002). Based on these criteria, three types of farms could be distinguished, most of them being dairy farms (how these three types differ in their practical application of specific agri-environmental measures is described in a later subsection):

- Farms of type A ('traditional extensive farms'; four farms). They were the smallest farms (27–41ha), with 90–100 per cent of their area consisting of permanent grassland. Farms of type A were dairy farms with a traditional use of permanent grassland in pasture and hay; they were the most extensive farms of the group, with an average stocking rate of 0.9 animal units per ha of fodder area. Their equipment was limited; some of them had a mobile milking machine. These farms were either tending to diversify their production, mainly by including extensive meat cattle in their production system, or decreasing their production in a perspective of ceasing their agricultural activity.
- Farms of type B ('intermediate farms'; eight farms). These farms were intermediate in size (52–149ha). The proportion of cropland area ranged between 0 and 21 per cent of their farmland. Their stocking rate was 0.9 to 1.3 animal units per ha of fodder area and their production relied on dairy cows with an intermediate productivity and level of equipment. Farms of type B were tending to enlarge and diversify, mainly through adding extensive beef cattle to their production system, and by intensifying the fodder system with more fodder crops.
- Farms of type C ('large intensive farms'; five farms). These farms varied in size but were, on average, larger than type A farms (43–300ha). The proportion of cropland areas was the highest (19–34 per cent) of the studied farms. They were the most intensive farms in the group, for example in terms of the fraction of fodder crops in the fodder system, but also with respect to the stocking rate (1.3 animal units per ha of fodder area). They were basically dairy farms with a high productivity and level of equipment. Farms of type C were enlarging in area and diversifying their production,

mainly with beef cattle, which was often intensively reared. They had two approaches for the development of their fodder management system. The first approach was by increasing the management intensity on the most convenient parts of the farm territory, while the second approach was by decreasing the management intensity on parts located in marshlands.

The unequal access to milk quotas, as explained earlier, determined the differentiated strategies of farm development. Farms of type A, with the lowest quotas per worker, operated at a minimal cost with a grassland-based animal diet. The other farms intensified their production system by converting non-marsh grassland into arable crops, taking advantage of arable crop CAP payments and by investing in dairy equipment and highly productive livestock. However, this intensifying process was more limited by milk quotas for farms of type B than for farms of type C.

Farmers' landscape management

The spatial organization of land use at each farm followed a concentric pattern centred at the farmstead. This pattern arises from the fact that land use is determined by the distance to the farmstead. Intensive land use types, with relatively high labour requirement or the need to have access to farm buildings, are situated closer to the farmstead than extensive land use types. The concentric patterns of land use were constrained and distorted by several scattered land islets. Many of these islets were situated 1–3km (in Euclidean distance) from the farmstead.

In the dairy cattle breeding farms of our study, dairy cows were kept in close proximity to the farmstead (generally located in the uplands). The fields located further away from the farmstead provided grass and maize fodder that was gathered for the feeding and maintenance of indoor-housed livestock. Fields that were furthest away were used as areas for growing crops, or for grazing animals that require hardly any human intervention.

Superimposed on this pattern was that farmers organized their land use types mainly according to the suitability of their major contrasting land types, namely marshlands and hedgerow uplands. Marshlands, when compared to hedgerow uplands, were generally devoted to hay making and to the grazing of heifers and other immature breeding cattle, because they were the most constraining and remote land in farms.

Types of land islets in the hedgerow uplands and the marshlands are summarized in Table 12.1. The islets were classified by their land use and average size. Farmers' interviews, aerial photos and field observations for sampled land islets made it possible to characterize the hedgerow network structure and the management of land islets. In Table 12.1, the term 'intensive management of hedgerows' refers to a high frequency of hedgerow trimming (once every three to five years), brush clearing (once a year) or even herbicide spraying. We found that the hedgerows within or bordering intensive crop islets and crop-grassland islets were narrower in size than those of other land islets.

These narrow-sized hedgerows were showing signs of branch cutting and brush clearing (LI1, LI3 and LI4). Moreover, in the field margins of these intensive crop islets and crop-grassland islets, a herbaceous vegetation was observed that is characteristic of a disturbed and nutrient-enriched environment (e.g. cleaver, *Galium aparine*). Furthermore, our observations of the evenness of the grassland cover and of indicator species (Hill et al, 1999) confirmed the information taken from farmers' interviews concerning the grazing and cutting management of the grassland islets, as well as the management intensity of these islets.

Intensive farms of type C have an above-average proportion of intensive crop and grassland islets and of crop rotation islets. Farms of types A and B, on the other hand, have an above-average proportion of extensive grassland islets on hedged fields. Grassland islets located on marshlands (except those for the production of cattle grass bedding) were equally distributed among all farm types. The islets for the production of cattle grass bedding were mainly found in intermediate B farms. In traditional extensive A farms, the lack of housing facilities for livestock explained the lower need for cattle bedding production.

It was also found that the management intensity of hedgerows increased from farm type A to B to C. Hedgerow management also became more mechanized from farm type A to C, with an increasing use of tractor-mounted equipment such as hedge cutters and flails. Therefore, hedgerows management in land islets varied according to both land use and farm types.

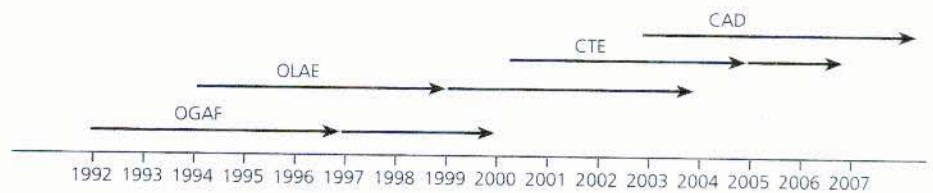
Moreover, we measured the size of the clusters formed by similar adjacent land islets in terms of land use and hedgerow management. This provided information about the way farmers, individually and collectively, contributed to the connectedness of landscape mosaics. For example, Table 12.1 presents, in its last column, the number of clusters of land islets of the same type, and the average size of these clusters. As mentioned earlier, the studied farms covered 40 per cent of the municipality area. It should therefore be kept in mind that the clustering of similar land islets only applies on the studied area of farmland.

In the marshlands, we observed that a diversity of micro-mosaics of grassland islets was produced. We found, for instance, large clusters (6.9ha on average) of three to five land islets that were managed for cattle grass bedding, but also fine mosaics of two to seven islets with a completely different grassland management system. Such a diverse organization is the basis for a multifunctional landscape; it provides habitat for species with different ecological requirements.

In hedgerow uplands, current aerial photos showed at first glance that the connectedness of grassland and hedgerow pattern was still very high and therefore should provide proper corridors for related flora and fauna. The land islet analysis confirmed the persistence of extensive grassland islets with moderately managed hedgerows. Nevertheless, large clusters of intensive crop-grassland islets were also identified in the hedgerow uplands, mainly due to the size of the land islets themselves. As mentioned earlier, such islets fragmented the landscape mosaic of grasslands by their contrasting land use, landscape structure and the way these islets were maintained.

Table 12.1 Description of the land islets (LI) regarding their land use, hedgerow management, size, location and clustering in space

Code	Location	Number of LI (medium size)	Description of the types of land islets	Number of LI clusters (medium size)
LI1	Hedgerow uplands	28LI (13.3ha)	Intensive grassland-crop islet: <ul style="list-style-type: none"> • permanent grassland and fodder maize • dairy cows and heifers' pastures; grassland silage making • intensive management of hedgerows 	20 clusters (16ha)
LI2	Hedgerow uplands	23LI (7.3ha)	Medium intensive grassland islet 1: <ul style="list-style-type: none"> • permanent grassland • dairy cows' pasture; hay making • diverse management of hedgerows 	19 clusters (8.5ha)
LI3	Hedgerow uplands	16LI (5.5ha)	Intensive crop-grassland islets: <ul style="list-style-type: none"> • maize/cereal or maize/cereal/ temporary grassland • dairy cows' pasture or grassland silage making • intensive management of hedgerows 	15 clusters (6ha)
LI4	Hedgerow uplands	30LI (2.6ha)	Intensive crop rotations islets: <ul style="list-style-type: none"> • maize mono-cropping or maize/ cereal rotation • intensive management of hedgerows 	27 clusters (2.9ha)
LI5	Hedgerow uplands	65LI (3.6ha)	Extensive grassland islet 1: <ul style="list-style-type: none"> • permanent grassland • heifers' pasture • diverse moderate management of hedgerows 	46 clusters (4.2ha)
LI6	Hedgerow uplands and marshlands	21LI (2ha)	Extensive grassland islet 2: <ul style="list-style-type: none"> • permanent grassland • hay cutting grassland • diverse moderate management of hedgerows or no hedgerow 	15 clusters (2.2ha)
LI7	Marshlands	20LI (4ha)	Extensive grassland islet 3: <ul style="list-style-type: none"> • permanent grassland • hay cutting grassland (dairy cows or heifers' pasture) • no hedgerow 	16 clusters (4.2ha)
LI8	Marshlands	26LI (6ha)	Medium intensive grassland islet 2: <ul style="list-style-type: none"> • permanent grassland • silage cutting grassland and heifers' pasture • no hedgerow 	15 clusters (10ha)
LI9	Marshlands	34LI (4ha)	Grass bedding land islet: <ul style="list-style-type: none"> • permanent grassland • grass cutting for animal bedding • no hedgerow 	18 clusters (6.9ha)



Notes: For each framework, the first arrow indicates the contracting period for farmers, who applied at the beginning of the scheme implementation, and the second arrow the contracting period for farmers who applied at the end.

Source: Arnaud, 2004.

Figure 12.2 The succession of frameworks for implementing agri-environmental schemes in NRP Cotentin-Bessin

Agri-environmental measures

Figure 12.2 presents the different agri-environmental schemes in NRP Cotentin-Bessin. It shows a succession or even a superposition of frameworks that differ in the farming practices involved and in the process of application and implementation of the schemes. For instance, OLAE (*Opérations Locales Agri-Environnementales*) were rather similar to Environmentally Sensitive Areas, but usually designed for even more limited areas. The CTE (*Contrats Territoriaux d'Exploitation*) were agri-environmental contracts with farmers and included investment support. The CAD (*Contrats d'Agriculture Durable*) did not provide this investment support anymore; the agri-environmental measures were chosen in each local designated area from a set of measures proposed in a regional menu.

The application procedures for the schemes did not always allow continuity between frameworks. It was, for example, not possible to convert an OLAE field into a CTE or CAD field before the expiration of the OLAE contract (Arnaud, 2004). In order to characterize the changes that occurred in farm profiles and farmers' landscape management practices, we took the whole sequence of contracts into account.

Farmers' application to agri-environmental measures

Agri-environmental measures (AEM) were grouped into six types according to the landscape elements concerned (numbers 1, 2 and 3) and, for grassland, to the level of management requirements (numbers 4, 5 and 6):

- 1 AEM Crops: introduction of catch crop; no tilling before March;
- 2 AEM Hedgerows: rules for managing short or tall hedgerows;
- 3 AEM Ditch: rules for ditch clearing;
- 4 AEM Grassland 1 (basic management constraint): grassland premium and basic limitation of fertilization;
- 5 AEM Grassland 2: limited fertilization and pesticide application, and centrifugal mowing (so as to allow nesting birds to escape from the grassland field);

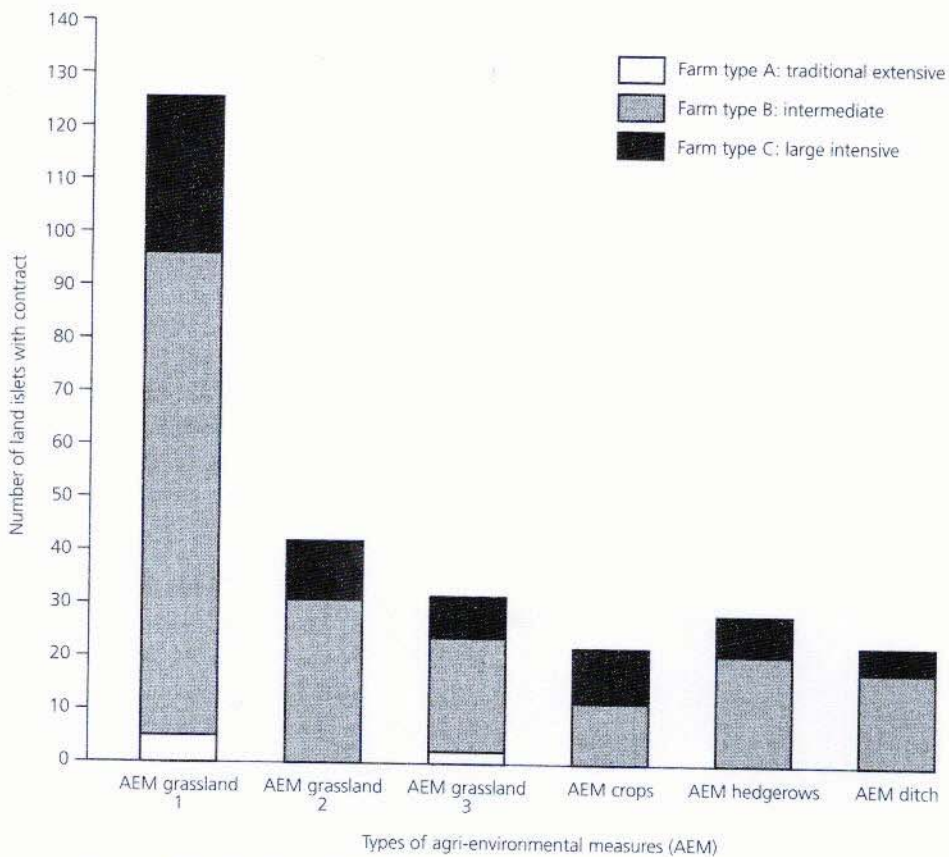


Figure 12.3 Number of land islets with agri-environmental measures (AEM), by farm type and AEM type

- 6 AEM Grassland 3: delayed cutting period (possibly with no fertilizers or pesticides).

We observed that the three farm types applied for different agri-environmental contracts (Figure 12.3). Farmers of traditional extensive farms (type A) applied for a small number of contracts (one grassland premium and one OGAF/OLAE contract). These contracts were typically concerned with grassland management practices. From the three farming types, farmers of type B (intermediate farms) applied the most for agri-environmental contracts. To be more specific, all B-farmers applied for a grassland premium (number 4: AEM Grassland1); half of them applied for CTE or CAD contracts, and two also had OGAF/OLAE contracts. The contracts held by B-farmers dealt with all kinds of management practices. Finally, C-farms (large intensive farms) were mostly not eligible for grassland premiums due to their level of intensification. Nevertheless, all C-farmers applied for CTE or CAD contracts. The contracts in C-farms dealt with all kinds of management practices.

The principle of agri-environmental schemes is that the changes that these schemes instigate will be maintained by farmers after the expiration of the contracts. The AEM Grassland 3 ('delayed grass cutting') and AEM Hedgerows are informative but contrasting illustrations in this respect. For AEM Grassland 3, the continuation of delayed grass cutting depends on the type of farm and the function of marshlands in their fodder management system. Intermediate B-farms had sufficient land for ensuring the fodder stock, and, therefore, they only used marshlands to generate flexibility in their fodder system during dry and drought years. This allowed them to mow the surplus grass from remote marshland islets late in the year, especially when there is no drought. Such, however, is clearly not the case for smaller traditional farms (type A) – because they lack the room for and freedom of manoeuvre – or for large intensive farms (type C) that keep on expanding their acreage and intensifying their upland hedgerow fields. For C-farms, it is doubtful whether it is worthwhile to continue managing marshlands without future agri-environmental measures. This was confirmed by farmers' interviews (Winckler, 2006).

For AEM Hedgerows, the limitation that this scheme imposes appeared to be the same for all farmers and was primarily due to the unsuitability of the contract to the local situation. During interviews, all farmers asserted that the imposed hedgerow management practices were too intensive. For instance, regarding the frequency of use of the hedge cutter, farmers declared that the first cut was efficient but that the second one has to be made when the branches were still too young and frail. In addition, the contractual commitment that dictates the AEM Hedgerows increased the mechanization costs for farmers. They therefore agreed to continue trimming their hedgerows, but less frequently. Such a discrepancy between new contractual practices and the rationale of existing technical management systems on farms was also found in the case of hedgerow plantation schemes in Brittany in the 1990s (Le Du et al, 2008). Here, it was observed that farmers who used to manage their hedgerows did not include new hedgerows – designed as windbreaks – in their existing management systems, which consist of the pruning of lines of trees.

The role of a governance organization in the implementation of agri-environmental measures

As mentioned earlier, the fact that each type of farms possesses marshlands results from the link between land and milk quotas. The abandonment of the agricultural activities of these marshlands is, in various ways, prevented by grassland AEMs. The decoupling of first pillar CAP supports and the phasing-out of dairy quotas may completely change the long-term decisions of farmers. Market prices will play a much bigger role in farmers' strategies. Also AEMs may potentially have a higher influence on farmers' decisions, at least if public authorities are able to settle credible commitments in terms of local environmental objectives in the long run. This will depend on the ability of local organizations, such as Natural Regional Parks or Water Management Agencies, to build and maintain a political compromise around these objectives

and to find the means for their enforcement. During the most recent period of the AEMs, local organizations lacked this ability.

For arranging contracts, park coordinators of the NRP Cotentin-Bessin – in corporation with agricultural institutions – played an important role in drawing up files and correctly filling out forms. Most applicants appreciated the work of these coordinators, who encouraged the farmers' application and supported them in applying to the relevant AEM schemes, thereby taking into account their particular situation (Arnaud, 2004).

The role of the NRP Cotentin-Bessin in the agri-environmental schemes can be divided into two phases (Collective, 2006). In the first phase, lasting from 1991 to 1999, and which consisted of the first generation of agri-environmental measures ('OGAF' and 'OLAE'), an associated zoning of the NRP Cotentin-Bessin was registered in its convention, and used for the definition of environmental objectives and for the implementation of locally adapted solutions. In the programme that represented the first phase, NRP Cotentin-Bessin ensured the continuity of the agri-environmental measures between 1991 and 1999. Moreover, it provided compensation for the difficulties that the standard five-year contracts could give and favoured the achievement of longer-term results.

The second phase saw the implementation of 'CTE' and 'CAD' (after 1999). A brief but insightful analysis of the CTE scheme showed that this scheme differed significantly from earlier schemes. In contrast to what was agreed in the first phase, the AEM contracts for marshland areas in the second phase were not derived from the objectives laid down in the park convention. Two explanations for this difference are possible. First, NRP Cotentin-Bessin, despite its legitimacy, encountered difficulties in supporting environmental projects in surroundings dominated by agricultural professional organizations. For these organizations, a contract must not be too restrictive as it should be accessible by all farmers. Second, CTE schemes were implemented very quickly and in haste, so the park did not have time to develop measures suitable to specific local circumstances and conditions. Therefore, despite a collective project that was locally well defined, the NRP Cotentin-Bessin could not accommodate the peculiarities of the park area for formulating and implementing a suitable local AEM contract.

The impact of agri-environmental measures on farmers' landscape management

For reasons of space, we focus here on two kinds of agri-environmental contracts: those dealing with grassland management (AEM Grassland 1 to AEM Grassland 3) and those concerning hedgerow management (AEM Hedgerows). Tables 12.2 and 12.3 summarize land islet management methods according to whether or not they were related to the respective agri-environmental measures.

Table 12.2 Trajectories of land islet management and their link to agri-environmental measures – the case of grassland management (AEM Grassland 1 to 3)

	Change in the management?	Which change or continuity?	Which types of land islets were mainly concerned?	In which farm type notably?
Without AEM Grassland	No change	Continuity of intensive management	Intensive crop-grassland islets (LI1 and LI3) and grassland islets (LI2)	Large intensive C-farms
		Continuity of extensive management	Extensive grassland islets (LI5 to 7)	Traditional extensive A-farms
	Change	Maintenance of the late date of cutting Less fertilization (AEM Grassland 1 and 2)	Grass bedding land islets (LI9) Grassland islets on marshlands (LI6, LI7, LI8 and LI9)	Intermediate B-farms Large intensive C-farms.
With AEM Grassland	No change	Continuity of extensive management (AEM Grassland 1 and 2)	Extensive grassland islets (LI5, LI6, LI7 and LI9)	Large intensive C-farms; intermediate B-farms
		Maintenance of the late date of cutting (AEM Grassland 3)	Grass bedding land islets (LI9)	Intermediate B-farms
	Change	Less fertilization (AEM Grassland 1 and 2)	Intensive crop-grassland islets (LI1 and LI3) and medium intensive marshes islets (LI8)	Large intensive C-farms; intermediate B-farms

AEM Grassland

Changes in grassland management practices due to agri-environmental measures consisted mainly of reduced fertilization (AEM Grassland 2 in particular). Farmers of large intensive C-farms applied more for AEM Grassland than farmers of intermediate B-farms. Nevertheless, only one-third of the land islets of C-farms with a decrease in fertilization were under contracts. Indeed, C-farmers also chose to reduce their fertilization independently of agri-environmental measures. The reason for this was that they were engaged in enlargement and that they were already decreasing the intensity of their fodder management system on parts of their land. These 'independent' reductions of fertilization intensities mainly concerned grassland islets located on marshlands. Therefore, the AEM Grassland – especially AEM Grassland 2 – mostly ensured the continuance of the already existing extensive management practices on the grassland islets LI5, LI6, LI7 and LI9 (see Table 12.1). The same was true for AEM Grassland 3, which aimed at delaying the cutting date: it was mainly used on grass bedding land islets (LI9) for which the date of

cutting was already the latest. Because the intermediate B-farmers had a relatively high number of grass bedding land islets, they applied more for AEM Grassland 3 than the other two type of farmers.

In terms of landscape mosaic patterning, it can be concluded that, especially on the marshlands, the grassland measures supported the diversity of existing extensive grassland management (and grass bedding production practices) as related to farm and land islet diversity. To a lesser extent, they promoted a decrease in the management intensity of grasslands on crop-grassland islets. However, in hedgerow uplands, the fragmentation process of grasslands by crops was not influenced by the grassland measures.

AEM Hedgerows

More B- than C-farmers applied for the hedgerow agri-environmental measures. Nevertheless, it was found that in all farms the intensity of hedgerow management increased with the uptake of AEM Hedgerows, due to the schedule of conditions in these measures. They stipulated, for instance, that a hedge cutter should be used twice every five years for tall hedgerows, which is a more frequent management practice than farmers were used to. Hedgerow agri-environmental measures were mainly used on the intensive crop-grassland islets (LI1 and LI3) that were already experiencing more intensive hedgerow management. Field observation confirmed the more severe cut of hedgerows under the hedgerow measures.

Table 12.3 Trajectories of land islet management and their link to agri-environmental measures – the case of hedgerow management (AEM Hedgerows)

	<i>Change in the hedgerows management?</i>	<i>Which change or continuity?</i>	<i>Which types of land islets were mainly concerned?</i>	<i>In which farm type notably?</i>
Without AEM Hedge	No change	Continuity of moderate management Continuity of intensive management	Hedgerow grassland islets (LI2, LI5 and LI6) Intensive crop-grassland islets (LI1, LI3 and LI4)	Traditional extensive A-farms; intermediate B-farms Large intensive C-farms
	Change	Less management	Hedgerow grassland islets (LI2, LI5 and LI6)	Traditional extensive A-farms; intermediate B-farms
With AEM Hedge	No change	Continuity of moderate management Continuity of intensive management		
	Change	More intensive management, without herbicides	Intensive crop-grassland islets (LI1 and LI3)	Large intensive C-farms, intermediate B-farms

It is also worth mentioning that these measures stipulated that herbicides may not be used on hedgerows. However, it was found that in farms that participated in AEM Hedgerows, the hedgerows that were subject to the measures were still being sprayed with herbicides, especially in intensive management situations (land islets LI1 and LI3).

Finally, it appeared that C-farmers have most frequently invested in tractor-mounted equipment (hedge cutters and flails) for hedgerow management. These tasks were also increasingly subcontracted to private enterprises and cooperative machinery pools.

In term of landscape mosaic patterning, it can be concluded that the AEM Hedgerows contributed to the enhancement of the intensive management of the hedgerow network in crop-grassland hedgerow islets. It was noted that these islets, by forming large patches, tended to fragment the grassland corridors at the landscape scale. Moreover, by promoting severe cutting, the AEM Hedgerows may also contribute to the effect of fragmentation of the hedgerow network that was initiated on these islets.

Discussion and conclusions

The aim of this chapter was to give some background for understanding how the economic and technical dynamics of farming systems influence and contribute to landscape patterns, which, in their turn, are important for ecological processes. To that end, we analysed driving forces and processes that occurred at different spatial and temporal scales, and at various levels of organization.

The results showed that farmers' application to agri-environmental contracts was dependent on the history of their farm profiles and commitment to earlier schemes. Moreover, it appeared that the largest farms are more involved in AEM than the smallest farms. This result is consistent with earlier findings, by, for example, Dupraz and Rainelli (2004) and Ducos and Dupraz (2007). The results also confirmed that a higher proportion of grassland on the farm has a significant positive effect on the decision of farmers to adopt grassland measures.

Farmers' private statements helped us to understand why they joined agri-environmental schemes. We found that farmers with a higher general education were (much) more willing to participate in biodiversity-oriented AEMs than other farmers. But the farmers' professional environment, such as membership of a farming organization or advisory service, also influenced their participation.

Our results emphasized the role of NRP Cotentin-Bessin, in terms of coordination in and institutional support for the application of agri-environmental schemes. However, this role appeared to be rather limited due to the rapidity of the succession of the different phases of agri-environmental schemes, which left little room for anticipation.

Agri-environmental measures had different consequences for farmers' landscape management practices. Moreover, the impact of these measures on

landscape structuring was to a large extent dependent on between- and within-farm diversity. Landscape changes in the direction of more or less spatial heterogeneity of the landscape mosaic seemed to go hand in hand with altering farm practices. Agri-environmental measures influenced these changes by moderating them, for example, by maintaining homogeneous or heterogeneous marsh grassland mosaics. Although a general feature of European agri-environmental measures is to support extensive farmers to maintain their (traditional) practices, we found something that was quite the opposite. That is, in our case study, agri-environmental measures contributed to the enhancement of observed farm changes. AEM Hedgerows, for examples, led to the intensification of large clusters of crop- and grassland.

A general conclusion that can be drawn from our analysis is that to truly understand the impact of agri-environmental schemes on the evolution of farming systems, it is crucial to account for the diversity of the spatial organization of farming practices. These practices are a main driver for changes in landscape structure. On land islets we found, for example, a direct link between hedgerow management and the choice of crop-grassland patterns. Moreover, it appeared that farming practices are a product of farm socio-economic characteristics and technical development. As such, there is a close interaction between social and natural components that can lead to land use change. In other, more practical words, when analysing landscape patterns, it is crucial to examine how factors influencing farm changes may affect the management of landscape elements.

Finally, it is essential to design policies that frame farmers' long-term strategy. Our analysis showed that failures occurred in the management of multiple functions in the countryside that were related to a lack of long-term commitment and planning by government entities, such as national government and local municipalities. Due to this lack, there were no (or hardly any) objectives or targets formulated in terms of the production of agricultural non-market goods. Once these objectives and targets are set, local government organizations can support farmers in their application of agri-environmental schemes and in fulfilling their commitments. This was illustrated by our analysis in Basse-Normandie. Here, agri-environmental policies, which are ultimately related to agricultural non-market goods, are usually formulated and designed at a higher governance level than the local one. And although the NRP Cotentin-Bessin did not have the means and political influence for integrating agri-environmental schemes into a coherent local development plan, it certainly had the ability to design a long-term strategy on which local farmers could rely. That is, the legal status of the NRP appeared to be appropriate to coordinate well-targeted policies on various agricultural non-market goods.

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Note

- 1 For a definition of European regions, see http://ec.europa.eu/eurostat/ramon/nuts/home_regions_en.html.

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